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GLYNDON EAST TRIBUTARY RESTORATION PROJECT

ENGINEER'S REPORT- REVISED 4.25.2022

BUFFALO – RED RIVER WATERSHED DISTRICT

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I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

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4-25-2022
Date

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1 GENERAL

1.1 PROJECT LOCATION

The Glyndon East Tributary is a tributary to the Buffalo River located in Clay County, MN. The stream is one of many natural waterways within the Buffalo-Red River Watershed District (BRRWD) political boundary. Much of the East Tributary is a DNR-designated Public Water. The Glyndon East Tributary subwatershed is approximately 9.5 square miles in area. The watershed extends southeast of Glyndon, MN, into Section 21 of Riverton Township, and empties into the Buffalo River north of Glyndon, MN in Section 35 of Moland Township. The Glyndon East Tributary is in the Red River Prairie eco-region. Drainage within the subwatershed generally runs from east to west and south to north. A map displaying the Glyndon East Tributary drainage area within the BRRWD is included as **Exhibit 1**. The Glyndon East Tributary has a total stream length of 9.2 river miles, starting at MN State Highway 9 and extending downstream to the Buffalo River. **Exhibit 2** shows the proposed project location within the Glyndon East Tributary subwatershed along with public water courses adjacent to the project area.

1.2 STUDY BACKGROUND

Discussions between the BRRWD and landowners, regarding the existing drainage issues, began several years ago. These conversations led the BRRWD to begin a preliminary investigation to determine the cause of the drainage problems. Data collection for the Glyndon East Tributary was completed in two phases; phase 1 was completed in the summer of 2018 and phase 2 was completed in the Fall of 2020. The phase 1 area survey was initiated after concerns were raised by the City of Glyndon and complaints were heard from landowners over the lack, or perceived worsening, of drainage in the channel from the City of Glyndon's wastewater lagoons and north along the waterway. The poor drainage conditions were especially noticeable to landowners along the stream during times when the City was trying to release water from their lagoons. Phase 2 survey work was authorized after hearing numerous complaints on the drainage southeast of the City of Glyndon. Channel geometry collected included cross-sections, channel centerline profile, sediment test pits, and culverts and bridges along the tributary. The collected channel survey information was used to supplement Light Detection and Ranging (LiDAR) topography data. LiDAR does not penetrate through water to pick up the bottom of the channel, so ground survey was required to fill in the gap in the LiDAR data that existed in those areas that had water on them at the time of the LiDAR survey. The combination of the LiDAR and ground survey information was used in the planning and development of the restoration design.

2 STUDY PURPOSE

2.1 EXISTING CONDITIONS – PROBLEM DESCRIPTION

The collected sediment test pit information shows that mild to significant sediment buildup has occurred within the Glyndon East Tributary. In some areas along the creek, fields have been farmed near the channel in the past, leaving little or no room for a buffer. In several areas, adjacent low ground that is flood prone is also tilled and farmed each year. In addition, breakout flows from the Buffalo River during major floods in the last 25 years resulted in severe field erosion to the east of the tributary in the area north of US Highway 10 and west of MN Highway 9. Sedimented waterbodies have a reduced channel hydraulic capacity, leading to breakout flows occurring more frequently. Breakout flows tend to scour the landscape, causing erosion as they cut new channels through tilled fields and ultimately deposit the

eroded material back in the channel, perpetuating the problem. All these factors have exacerbated the sediment deposition and aggradation problem within the Glyndon East Tributary.

The Glyndon East Tributary is not listed by the Minnesota Pollution Control Agency as an impaired water; however, the Buffalo River, the receiving waterbody for this tributary, is listed as impaired for E. coli and turbidity. Therefore, the Glyndon East Tributary Restoration will have a direct improvement on the impairments for the Buffalo River.

Several other water management problems have been identified as a part of this study. They include:

- **Beaver Dams:** During the initial survey 8 beaver dams were discovered and identified along the Glyndon East Tributary. Additional beaver dam locations were identified in the summer of 2020 when some of the existing beaver dams were removed.
- **Undersized Culverts:** There are three locations along the Glyndon East Tributary, north of the BNSF Railway, where undersized culverts have been installed to facilitate a low water crossing. There is also an undersized culvert located south of the BNSF Railway and east of the City of Glyndon Lagoons, in Section 12 of Glyndon Township.
- **Upstream Drainage Issues:** Landowners along the entire system, but specifically upstream of MN State Highway 9, have expressed their concern over the lack of drainage throughout the watershed. This has been caused by excess sediment filling the channel, severely limiting the capacity and conveyance.
- **Dead Trees in Channel:** Portions of the downstream most reach of the Glyndon East Tributary, between Highway 10 and the Buffalo River, are heavily treed riparian zones. Survey of this stretch along with a review of aerial imagery shows an excess of standing and fallen within the channel, restricting outflow and channel capacity.

2.2 PROJECT GOALS & OBJECTIVES

The BRRWD has established policies aimed at increasing water quality, managing erosion, reducing sedimentation, and enhancing natural resources within natural waterways within its jurisdiction. These policies are documented in Section 3 of the Buffalo-Red River Watershed Comprehensive Watershed Management Plan.

The Project Goals & Objectives for the Glyndon East Tributary Restoration Project are as follows:

- Improve channel conveyance, for agricultural drainage and lagoon discharge from the City of Glyndon, by the removal of excess sediment and improving undersized culverts within the Glyndon East Tributary
- Improve water quality by reducing sediment and nutrient loadings to the creek
- Restore conveyance through the historical meanders
- Improve wildlife habitat along the stream corridor
- Create a funding mechanism, such as a Water Management District, to be used for project implementation and maintenance

The overall goal of the Glyndon East Tributary Restoration Project is to improve the channel conveyance by removing excess sediment, restoring conveyance through the historical meanders, and improving the overall drainage of the current system. In addition, the goal will be to provide and foster stable stream conditions. A stable stream is defined by the MN DNR as a stream that can convey both its water and

sediment load while maintaining its general geometric characteristics, including pattern, profile, and dimension. A stable stream neither aggrades nor degrades over time, but instead balances between the processes of erosion and deposition in a way that does not widen or narrow the channel.

3 PROJECT DEVELOPMENT

Several project features have been identified that would each address one or more of the problems the Glyndon East Tributary is currently experiencing. As with most water resource related projects, there is rarely one single solution that will meet all the objectives of the project. Instead, an array of solutions has been developed that each address a separate aspect of the problems within the region. It is recommended that a combination of features be considered for a project to provide stable stream conditions both now and into the future.

3.1 CHANNEL RESTORATION

3.1.1 RESTORATION EXTENT AND PROPOSED CHANNEL GEOMETRY

The sediment test pits collected during the channel survey show that the Glyndon East Tributary is highly sediment laden throughout several of the surveyed reaches. The project reach from the Buffalo River to the BNSF Railway in Section 12 of Glyndon Township (approximately 3.2 stream miles) is heavy wooded in addition to sediment laden. Due to the tree density, it was determined this reach was best addressed by completing a channel cleanout. A 10.5-foot bankfull width will be established, to match the proposed two-stage channel upstream, while removing the sediment.

From the BNSF Railway in Section 12, Glyndon Township, to the western edge of Section 17, Riverton Township, a two-stage channel will be constructed using natural channel design principles. This area is also highly sediment laden, with sediment depths averaging approximately 3' through the 5-mile reach. The proposed restoration geometry of the channel through this reach is a two-stage design to mimic natural stream conditions. Geometry for the two-stage channel was derived by using the MN DNR River Ecology Unit E-Channel calculator. E-Channels are a typical designation for prairie streams with low grade relief and are defined by the channels natural geomorphology[1]. Specifically, an E-Channel is defined as a channel that is only slightly entrenched with a very low width to depth ratio and highly sinuous. Type E channels are very typical in the lake bottom portion of the Red River valley given the extremely flat topography and wide floodplain widths of the region. Given the low longitudinal slope of the channel and a regional soil type of clay loam/silty clay loam, the Rosgen classification for Glyndon East Tributary is most likely E6. **Table 1** summarizes the proposed conditions for the Valley Width, Channel Depth and Bankfull Width along the proposed Glyndon East Tributary restoration alignment.

Table 1: DNR E-Channel Geometry

Channel	Valley Width (feet)	Channel Depth (feet)	Bankfull Width (feet)
Glyndon East Tributary	45	3	10.5

The final stretch of the project, starting at the western edge of Section 17, Riverton Township, and proceeding upstream to MN highway 9, will be restored using a trapezoidal ditch geometry. The proposed geometry through this reach is a 6-foot channel bottom with 3H:1V sideslopes. This reach is also sediment laden, with sediment depths averaging approximately 2' through the 1-mile reach.

3.1.2 PROPOSED CHANNEL PROFILE

As part of the channel survey, roadway crossings for the Glyndon East Tributary were surveyed to evaluate sizes and inverts of the crossings. The data for all culvert and bridge crossings, as well as the estimated overtopping event, is presented in **Exhibit 3**. The collected data shows the inverts of culverts through major road crossings over the Glyndon East Tributary generally matches well with where the sediment test pits indicate the bottom of the natural channel is located. Therefore, it is recommended that the proposed channel restoration gradeline (riffle gradeline) match each of the major road crossing culvert inverts. The surveyed existing and proposed channel profile, as well as a typical cross section of the proposed channel geometry, is shown on the preliminary construction plans provided in **Appendix A**.

3.1.3 WORK WITHIN BNSF RAILROAD RIGHT-OF-WAY

A portion of the proposed channel restoration work, located in Section 12 of Glyndon Township, is located on the existing BNSF Railroad Right-Of-Way (ROW) and will require further attention to complete the work. Discussions have taken place between the BRRWD and BNSF staff to develop a plan that is acceptable to all involved parties. The BRRWD will continue to work with BNSF to come up with an amicable solution that allows the sediment to be removed from the channel within the BNSF ROW.

3.2 SIDE INLETS AND SEDIMENT BMP'S

Side Inlets and sediment basins or other Best Management Practices (BMP's) are another proposed project feature. The construction of side inlets is a preventative measure to ensure that the same erosion and sedimentation problems that helped create the existing conditions do not re-occur in the future. The side inlet locations are strategically placed where they would be most effective in reducing sediment and nutrient loadings. These strategic locations were identified using a combination of the stream power index terrain analysis and review of aerial photography. The stream power index is a measure of the landscapes likelihood of erosion based on the drainage area and land slope. In total, 20 locations were identified using the stream power index as areas where the installation of side inlets and sediment control basins would be most effective. The side inlet pipes were preliminarily sized based on their contributing drainage area and their proposed locations and sizes are shown in **Exhibit 4**. **Table 2** below summarizes the number and sizes of side inlet pipes recommended for the project. A field review and inventory of existing side inlets should be completed before final locations and sizes are selected for pipe installation.

Table 2: Number of Identified Potential Side Inlet Locations

		Number of Side Inlet Pipe Locations	
	Pipe Sizes:	18" CMP	24" CMP
Waterway	*Contributing Drainage Area (acres):*	< 80	80 - 160
Glyndon East Tributary		14	6

3.3 BUFFER AREAS

A second project feature is the maintenance of a vegetated stream buffer corridor (i.e. buffer strips). As required by the Minnesota Buffer Law, a continuous buffer of perennially rooted vegetation with a 30-foot minimum width and 50-foot average width is required along all streams designated as a Public Water. Vegetated buffer strips have shown to decrease the amount of both nutrients and sediment entering the stream channel from adjacent agricultural field runoff. In several locations along the Glyndon East Tributary, areas are annually tilled and farmed that should be protected by a buffer. Not only do these areas have less of a likelihood of producing a profitable crop given their flooding probability, but they also

contribute sediment loadings to the channel due to a lack of permanent vegetative cover protecting the vulnerable bare soil. Since there are locations where an expanded buffer is recommended, but not currently present, the BRRWD plans to work with landowners to encourage establishing expanded buffers through a permanent conservation easement. As a project minimum, a 50-foot offset from the top of the bank, on each side of the channel, has been proposed as a permanent project easement to satisfy Minnesota Buffer Law requirements. These areas as shown in **Exhibit 5**. If landowners are interested in enrolling additional land in an expanded permanent conservation easement, other conservation programs could be considered for land acquisition. This process is discussed further in Section 5.

3.4 12TH AVE S FLOW RELOCATION

A small DNR public water tributary to the Glyndon East Tributary begins in Section 9 of Glyndon Township, on the south side of the BNSF Railway, and flows southwest through Sections 8 and 9 before intersecting 12th Ave S. Currently, two existing 36" CMP culverts pass the water through 12th Ave S south into Section 17 of Glyndon Township. The water then flows south/southwest across the tilled agricultural land in Section 17 until it intersects the Glyndon East Tributary on the east side of Section 18. Allowing the water to cross 12th Ave S and flow freely across Section 17 has scoured the landscape, causing increased sediment buildup within the Glyndon East Tributary. The proposed plan would construct a drainage ditch on the north and south side of 12th Ave S, allowing the flow to be conveyed parallel to 12th Ave S and converge with the Glyndon East Tributary near the north line of Section 18 of Glyndon Township.

3.5 BEAVER MANAGEMENT PLAN

During the survey collection portion of the study, 8 beaver dams were encountered along the Glyndon East Tributary. A public informational meeting was held on August 22, 2019 to present the data collection portion of the study and solicit input from local landowners concerning drainage issues they have historically experienced along the waterways. Among the most common responses included the persistent beaver problem along the creek.

In the summer of 2020, the BRRWD worked with area landowners and the City of Glyndon on removing a number of beaver dams along the tributary. The removal of beaver dams allowed for the drainage of several feet of water from portions of the waterway north of the BNSF Railway. The lowered water levels revealed several additional older beaver dams along the waterway. Beaver management will be an ongoing issue that will need to be addressed through long term management.

Long-term maintenance will require funding; therefore, it is recommended that the BRRWD establish a Water Management District (WMD) for the project extents to establish a mechanism by which ongoing maintenance of the project, including the removal of beaver dams, can be funded.

4 PROJECT BENEFITS

4.1 NATURAL RESOURCE ENHANCEMENT

4.1.1 WATER QUALITY

The proposed Glyndon East Tributary restoration project would have significant water quality related natural resource enhancement benefits. The stream restoration itself would remove excess

sedimentation from the streambed and re-establish the channel's natural meanders and gradeline. In addition, the strategic placement of sediment best management practices (BMPs) such as side inlet pipes will reduce both the nutrient and sediment loadings to the stream in the future. These actions will promote stable stream conditions, resulting in a better balance of both the water and sediment loads so that the natural stream generally maintains its pattern, profile, and dimension. Removal of excess sediments, re-establishing the natural stream geomorphology (E-Channel geometry), and placement of side inlet BMPs will achieve the project goals of stream stability and enhanced water quality.

4.1.2 HABITAT ENHANCEMENT

Additional natural resource enhancement benefits of the restoration project include the establishment of natural aquatic and wildlife habitat. The increased water quality resulting from stream restoration provides a secondary benefit of increasing aquatic habitat for native fish and macroinvertebrate species. Additionally, the expansion of riparian buffer areas also establishes natural habitat areas for a variety of plant and animal species.

4.2 FLOOD DAMAGE REDUCTION

A hydraulic model of the Glyndon East Tributary was developed starting at the Buffalo River/Glyndon East Tributary confluence and proceeding upstream to the Section 16/17 Line in Riverton Township (at the MN State Highway 9 crossing). In total, approximately 9.2 miles of river channel was analyzed using the Hydraulic Engineering Centers River Analysis Software (HEC-RAS) modeling program. HEC-RAS is hydraulic modeling software developed by the US Army Corps of Engineers. 129 cross sections of the Glyndon East Tributary were developed for the analysis by combining the in-stream collected survey information with LiDAR data in surrounding areas.

Hydrology used in the hydraulic modeling was determined by using the 2009 USGS Regression Equations (Region A). The flows obtained from the regression equations were then calibrated based on historic flow information obtained from local landowners. These equations were then applied to determine discharge rates at flow change locations. Flow change locations correspond to locations where subbasins in the Glyndon East Tributary drainage area converge to form larger and larger contributing drainage areas. **Table 3** tabulates the flow events and flow change locations utilized in the model.

Table 3: Study Hydrology

Waterway	Location	Contributing Drainage Area (Sq. Mi.)	Discharge Flows (cfs)						
			1.5-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
Glyndon East Tributary	BNSF Railroad	6.8	36	51	98	133	181	218	258
	Buffalo River	9.5	46	66	126	172	234	283	336

5 LAND ACQUISITION

The BRRWD will establish an easement corridor for the project using project funds. Several state and federal programs exist to help acquire land easements associated with conservation and restoration projects. However, since each program varies by intent and requirements, it is important to examine whether the goals of the project are consistent with each individual land acquisition program's goals. Such conservation programs are available through the Board of Water and Soil Resources (BWSR), the

Natural Resource Conservation Service (NRCS), as well as other public and private entities. The BRRWD will define the preliminary easement boundary and total acreage that needs to be acquired from each landowner to complete the Glyndon East Tributary Restoration Project. Landowners may elect to expand the buffer beyond these limits. The BRRWD can facilitate expansion of the buffers by connecting landowners with applicable programs and by working closely with their Clay SWCD partner. **Exhibit 5** shows the preliminary permanent and temporary easement boundaries and **Exhibit 6** provides a summary of landowner information, including name, parcel number, and total acres of permanent and temporary easement required for each parcel.

6 REQUIRED PERMITS AND ENVIRONMENTAL REVIEWS

Table 4 lists known permits that may be required for the Glyndon East Tributary Restoration project.

Table 4: Project Permitting

Unit of Government	Type of Application	Status
Federal: USACE	Section 404	Permit acquired
State: MN DNR	Public Waters Work	Permit acquired
State: MnDOT	Drainage Permit	Application to be developed
State: MPCA	Stormwater Permit for Construction	Application to be developed
Local: BNSF	Right-Of-Way Access Permit	Application submitted
Local: Clay County	WCA Permit (for wetland impacts)	Permit acquired
	Highway Construction (Culvert and Road Upgrades/Road closure)	Application to be developed
	County Shoreland Zoning	Application submitted

7 COMPATIBILITY WITH EXISTING PLANS

7.1 OVERALL PLAN

The proposed Glyndon East Tributary Project is compatible with and is listed specifically as a capital improvement project in the recently approved Buffalo-Red River Watershed Comprehensive Watershed Management Plan. The new plan developed through the One Watershed, One Plan (1W1P) process was prescribed by BWSR in October 2020 and adopted by the BRRWD in November 2020. The restoration of Glyndon East Tributary and establishment of sediment controls along the channel puts the Mainstem Planning Region closer to meeting its sediment reduction goals.

8 PROJECT FUNDING AND FINANCING

8.1 PROJECT FUNDING APPROACH

The BRRWD has been looking at a variety of funding sources to help pay for the Glyndon East Tributary Restoration project. Through the recent completion of the BRRW 1W1P Comprehensive Watershed Management Plan, watershed-based funding is available through the Board of Water and Soil Resources. Approximately $400,000 of the available watershed-based funding has been earmarked for use on stream restoration projects within the BRRWD, which could be used towards the implementation of this project. The remaining funds could be raised through the proposed Water Management District or obtained from the BRRWD through funds raised District-wide through the MN Statues 103D.905 Subd. 3 levy. The Opinion of probable cost for the project is 1,150,000. A more detailed Opinion of Probable Cost can be found in **Exhibit 7**.

At the present time, a potential funding scenario would include the following funding arrangement:

- $400,000 BWSR Watershed Based Implementation Funding
- $230,000 Buffalo-Red River Watershed District (20%)
- $520,000 Water Management District

The BRRWD should continue to explore other grant funding opportunities for the project implementation.

8.2 WATER MANAGEMENT DISTRICT

The BRRWD, through their Comprehensive Watershed Management Plan (CWMP), has the authority to establish one or more Water Management Districts (WMD) for the purpose of collecting revenues and paying the costs of projects initiated under sections 103D.601, 103D.605, 103D.611, or 103D.730. To use this funding method, Minnesota law (MS 103D.729) requires that the area to be included in the WMD be described, the amount to be charged identified, the methods used to determine the charges described, and the length of time the WMD is expected to remain in force specified. The Glyndon East Tributary is within the Mainstem Planning Region, as described in the Buffalo-Red River Watershed Comprehensive Watershed Management Plan. The WMD may be dissolved by the procedures prescribed for the establishment of the Water Management District. Based on the Buffalo-Red River Watershed Comprehensive Watershed Management Plan, the maximum WMD revenue limit within each WMD is based on 0.10% of the taxable market value within each planning region. For the project area, located in the Mainstem Planning Region, this equates to a value of approximately $150,000. To help keep the local cost down on a year-by-year basis, an assessment value of $40,000 per year has been chosen. **Figure 5** shows a breakdown of the proposed annual charge per acre within the Glyndon East Tributary watershed of the Mainstem Planning Region. Based on the proposed per acre charge, $40,000 could be raised annually from the Glyndon East Tributary portion of the Mainstem Planning Region. This value has been used for the purposes of computing the estimated WMD charges.

8.2.1 DETERMINING THE WMD BOUNDARY

The drainage area of the project is located in the Mainstem planning Region of the BRRWD. The total calculated area within the project boundary is approximately 6,045 acres. Only that portion of the Mainstem planning region that drains to the Glyndon East Tributary will be included in the WMD. When the drainage area hydrologic boundary crossed a parcel, that portion of the parcel within the hydrologic boundary was included in the WMD. The portion of the City of Glyndon, based on its municipal boundary,

that drains into the East Tributary was included in the WMD boundary. Since the City of Glyndon wastewater lagoons are located east of town, and discharge into the Glyndon East Tributary multiple times per year, the entire municipal boundary was included based on the annual wastewater contribution. The lands shown in **Figure 1** are those within the Mainstem Planning Region and the proposed Glyndon East Tributary WMD.

8.2.2 SUMMARY OF CHARGE DETERMINATION

The CWMP laid out four general methods to determine charges for the Water Management District. The methods proposed to establish the charges will be based upon the proportion of the runoff volume contributed by a parcel or may be based on the drainage area of the parcel, within the Water Management District. The total annual discharge from the City of Glyndon lagoons has also been included in the analysis to determine an assessment percentage to assign to the City of Glyndon. What is described below is a refinement to the methodology listed in the CWMP due to limitations of the available geospatial data in addition to the wastewater discharge contribution from the City of Glyndon.

8.2.3 MODIFIED RUNOFF METHOD

This method establishes rates based equally on a modified runoff method. The runoff method uses SSURGO Soils and Land use data (2019 National Agricultural Statistics and Service) to calculate a curve number related to the percentage of runoff estimated from a rainfall event (10-year, 24-hour). Preliminary review of the 2019 National Agricultural Statistics and Service (NASS) showed several discrepancies with actual landuse data, based on more recent aerial photography and the use of other available tools. Existing riparian corridors were identified and replaced within the NASS data. Lands enrolled in conservation related programs were identified and assigned the landuse of grassland/herbaceous. The National Wetland Inventory (NWI) and the National Hydrography Dataset (NHD) also proved to be more accurate than the NASS data, so this information was used to determine wetlands and waters within the project boundary. Parcels that are inside of corporate limits were considered city lots and assigned the landuse of open space development. Farmstead parcels that were not already split into separate areas were adjusted from agricultural landuse to open space development. Existing road right-of-way data for Clay County was used. Most of the existing right-of-way was present within the parcels; however, parcels that did not include road right-of-way were assumed to be 33 feet on either side of the road centerline. Road right-of-way areas are exempt from this analysis. The existing landuse was identified as seven categories: 1. Open Water, 2. Developed, Open Space, 3. Developed, High Intensity, 4. Grassland/Herbaceous (No Till), 5. Cultivated Crops, 6. Woody Wetlands, and 7. Emergent Herbaceous Wetlands. **Figure 1** shows the landuse types and areas identified within the project boundary, as described above. **Table 5** shows the curve number based on soil type and landuse. The SSURGO Hydrologic Soil Group data within the project area was used to determine the SCS Curve Number (CN) for runoff. For soils that had a dual classification rating (A/D, B/D, and C/D), a weighted average between the drained and undrained condition was used. Wetlands and waters were exempt from this average and the same value was used under all conditions. **Figure 2** summarizes the SSURGO soils map and **Figure 3** summarizes the CN values throughout the project area.

Table 5: Pervious CN by Hydrologic Soil Group

Land Cover Code	Pervious CN by Hydrologic Soil Group						
	A	B	C	D	A/D	B/D	C/D
Open Water	100	100	100	100	100	100	100
Developed, Open Space	45	65	76	82	63	73	79
Developed, High Intensity	92	94	96	96	94	95	96
Grassland/Herbaceous	30	58	71	78	54	68	75
Cultivated Crops	61	71	78	81	71	76	80
Woody Wetlands	78	78	78	78	78	78	78
Emergent Herbaceous Wetland	85	85	85	85	85	85	85

8.2.4 RUNOFF CHANGES

The runoff values for the project area were calculated by comparing the runoff results from a 10-year, 24-hour rainfall event (3.78 inches) for pre-settlement and existing conditions. Pre-settlement conditions used a landuse of grassland/herbaceous across the entire area, while existing conditions used the landuse as exists today. An average CN was calculated to normalize the data and reduce large fluctuations in assessment values between individual parcels within a given area. The difference in runoff values were summed and each parcel was assigned its relative percent of the total project area, by landuse. **Figure 4** shows the runoff difference, in inches, throughout the project area.

8.2.5 CONTRIBUTION AREA

The total contribution area for the project is approximately 9.5 square miles. This includes 0.5 square miles located within the City of Glyndon municipal boundary and 9 square miles in the rural Glyndon area. Using the estimated yearly runoff of 2 inches/year, provided by the USGS[2], surface runoff was calculated across the City of Glyndon and the rural Glyndon area. Results from the approximate yearly runoff are shown in **Table 6**.

8.2.6 CITY OF GLYNDON SANITARY SEWER DISCHARGE

The total annual discharge from the City of Glyndon lagoons was used to determine the assessment percentage assigned to the City of Glyndon. Based on the City of Glyndon, MN 2010 Comprehensive Plan[3], the existing lagoons have a maximum capacity of 159,500 gallons per day. **Table 6** summarizes the total annual discharge from the City of Glyndon lagoons, in addition to the approximate yearly runoff, to determine an appropriate funding distribution for the WMD based on the percent of contribution.

Table 6: Contribution Summary

Project Area	Contribution Area (AC)	Average Runoff (in/yr)	Average Runoff (CF/yr)	Lagoon Discharge (GPD)	Lagoon Discharge (CF/yr)	Total Contribution (CF/yr)	Percent Contribution
City of Glyndon Municipal Boundary	0.5	2.0	5,600	159,500	21,390	**26,990**	**19%**
Rural Glyndon Area	9.0	2.0	114,060	-	-	**114,060**	**81%**
					Totals	**141,050**	**100%**

8.2.7 WMD ANNUAL CHARGE PER ACRE

To calculate the annual charge per acre, the annual project WMD charge estimate of $40,000 was multiplied by the percent contribution shown in **Table 7**. **Figure 5** summarizes the charges per acre/per year.

Table 7: Financial Contribution

Project Area	Percent Contribution	Annual Financial Contribution
City of Glyndon Municipal Boundary	19%	$7,600
Rural Glyndon Area	81%	$32,400
Totals	**100%**	$40,000

8.2.8 THE WATER MANAGEMENT DISTRICT DURATION

The BRRWD anticipates the Water Management District will provide funding to assist with the implementation and maintenance of the Glyndon East Tributary Restoration Project. The Water Management District will remain in existence in perpetuity (or a shorter duration, should the Board decide to limit the duration). Annual assessment of charges could vary from no charges up to the maximum WMD revenue limit of the planning region.

The primary use of the funds collected from charges within the Water Management District will support stormwater runoff and water quality projects that help achieve the goals of the planning regions which benefit residents within the Mainstem Planning Region Water Management District. This Water Management District will be specific to the establishment and maintenance of the Glyndon East Tributary Restoration Project.

8.2.9 THE WATER MANAGEMENT DISTRICT PROCESS

Draft guidance as to the process of creating a WMD has been provided by BWSR. The process involves eight steps. The first two steps are addressed through the revision of the Watershed Management Plan. The remaining steps 3 through 8 must be completed prior to any collection of charges in any WMD. This report provides the guidance for Steps 3 and 4. The remaining steps 5 through 8 still need to be completed.

Step 1. Amend Watershed District Plan to create a water management district.
Amendment must include:

- Description of area to be in the water management district
- The amount to be raised by charges (total amount is necessary if fixed time for water management district to be in force, otherwise annual maximum (cap) amount)
- The method that will be used to determine the charges
- The length of time the water management district will be in force (perpetuity is acceptable)

Step 2. Approval of Plan amendment under M.S. § 103D.411 or as part of a revised Plan under M.S. § 103D.405.

- Revised Plan, or petition and amendment, sent to BWSR
- BWSR gives legal notice, and holds hearing if requested
- BWSR orders approval or prescribes plan or amendment
- BWSR notifies WD managers, counties, cities, SWCDs

Step 3. Watershed District refines methodology for computing charges.

Step 4. Watershed District determines and sets charges for all properties within the water management district after identifying scope of project and deciding method(s) of funding project.

Step 5. Watershed District develops collection mechanism.

- Request County or Counties to collect, or Billing and collection by Watershed District

Step 6. Watershed District holds hearing, orders the establishment (implementation) of a project in the water management district, and initiates stormwater utility charges.

- Projects implemented must be ordered by the managers
- Order for project must specify funding method(s)
- Watershed District must notify counties, cities, and towns within the affected area at least 10 days prior to a hearing or decision on projects implemented under this section of statute

Step 7. Watershed District establishes a separate fund for proceeds collected from the stormwater utility charges.

Step 8. Resolution of Disputes. Local governments may request BWSR to resolve disputes pursuant to M.S. § 103B.101, Subd. 10.

8.2.10 WMD NEXT STEPS AND RECOMMENDATIONS

The recommended charges for the Mainstem Planning Region would be the modified runoff method as described above based on the simplicity of the methodology and the limitations of the coarse nature of the existing land use raster data.

We recommend the Board adopt the proposed charge as described in this report.

The project needs to be established as a Watershed District project in accordance with MN Statutes 103D and the water management district needs to be established as outlined above and as established by BWSR.

9 CONCLUSION AND RECOMMENDATIONS

The Glyndon East Tributary drainage area is a 9.5 square mile subwatershed to the Red River of the North located in Clay County. The creek conveys runoff from a primarily agricultural watershed to an adequate outlet, the Buffalo River, located approximately 2 miles north of the City of Glyndon. Common farming practices and land-use changes within the watershed have caused an altered hydrology which, in combination with other factors, has contributed to the sedimentation of the Glyndon East Tributary. A sediment and nutrient laden stream has both flood damage and natural resource consequences. The Buffalo-Red River Watershed District continues to work toward finding a long-term solution to the water resource problems within the subwatershed.

Several restoration features have been developed that will each partially achieve either the drainage improvement, flood damage reduction efforts, and/or natural resource enhancement goals of the project. These project components include channel restoration to re-establish the waterways natural geometry and gradient, installation of strategic side inlet locations, establishment of a Watershed Management District to fund the project as well as ongoing beaver dam maintenance. Each of these solutions will reduce future sediment and nutrient loadings to the channel. A hydraulic model has been developed based on the collected survey information to evaluate the proposed alternatives effects on the flood profiles for a range of hydrologic events. A preliminary opinion of probable cost for a project that incorporates several of the project measures has been assembled and totals approximately $1,150,000.

The next steps in project development would include establishing the project under MN Watershed Law (103D), developing a local funding source, and obtaining easements and permits for the restoration. Once these items are completed the construction plans can be finalized and the project put out for bid and constructed.

The establishment of the Glyndon East Tributary Restoration Project will provide significant flood damage reduction and natural resources benefits. The Engineer finds that the project is feasible and recommends the BRRWD to take the necessary steps to establish the project.

10 REFERENCES

[1] Rosgen, D. L. (1994). "A Classification of Natural Rivers." *Catena 22, 169-199.*

[2] Lorenz, D.L., Sanocki, C.A., and Kocian, M.J. (2010). "Techniques for estimating the magnitude and frequency of peak flows on small streams in Minnesota based on data through water year 2005: U.S. Geological Survey Scientific Investigations Report 2009–5250, 54 p."

[3] Fargo-Moorhead Metro Council of Governments (2010). "City of Glyndon Minnesota Comprehensive Plan."

EXHIBITS

Georgetown
Felton
Ulen
Ogema
Clay County
Hitterdal
Callaway
Becker County
Moorhead
Dilworth
Glyndon
Hawley
Lake Park
Audubon
Detroit Lakes
Wolf Lake
Sabin
Frazee
Comstock
Barnesville
Vergas
Perham
Wolverton
Pelican Rapids
Dent
New York Mills
Richville
Bluffton
Rothsay
Erhard
Kent
Ottertail
Otter Tail County
Elizabeth
Fergus Falls
Underwood
Battle Lake
Clitherall
Breckenridge
Foxhome
Doran
Wilkin County
Dalton
Urbank

MINNESOTA 32
MINNESOTA 9
MINNESOTA 225
MINNESOTA 34
MINNESOTA 336
MINNESOTA 87
MINNESOTA 228
59
MINNESOTA 108
MINNESOTA 106
MINNESOTA 78
94
75
10

N

Legend
- Project Drainage Area
- BRRWD Boundary

MN Eco-Regions
- Hardwood Hills
- Red River Prairie
- Pine Moraines & Outwash Plains
- Minnesota River Prairie

0 10 20 Miles

Moland Township
Spring Prairie Township
Glyndon
Glyndon Township
Riverton Township

Exhibit 1: Subwatershed Location
Glyndon East Tributary Restoration Project

Drawn by:	Checked by:	Project No :	Date:	Sheet:
NRI	BAU	1915-0256	1/5/2021	1 of 1

HOUSTON engineering, inc.

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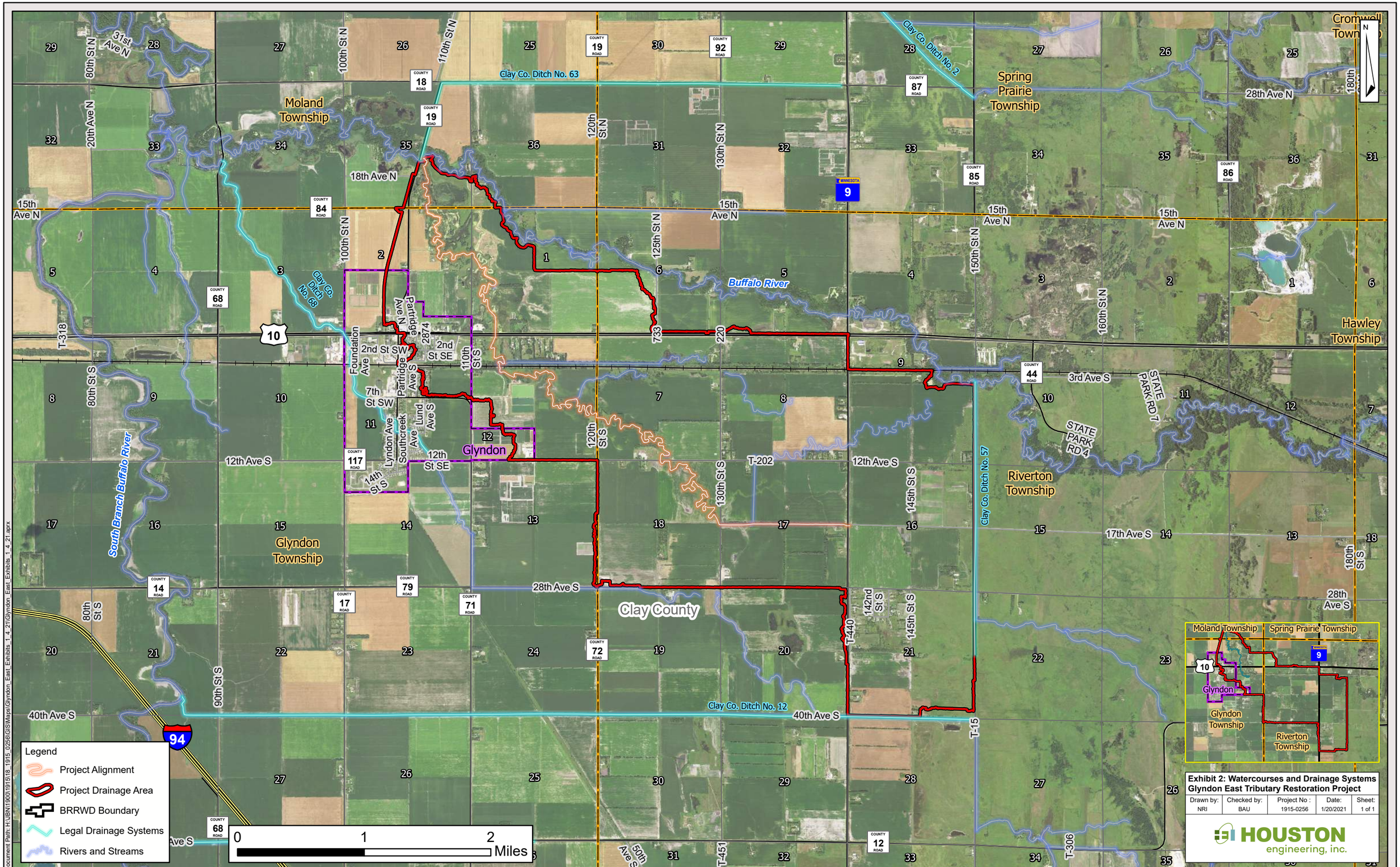
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Cromwell Township
Hawley Township
Glyndon
Glyndon Township
Riverton Township
Clay County
Buffalo River
South Branch Buffalo River
Clay Co. Ditch No. 63
Clay Co. Ditch No. 2
Clay Co. Ditch No. 68
Clay Co. Ditch No. 12
Clay Co. Ditch No. 57
18th Ave N
15th Ave N
28th Ave N
12th Ave S
28th Ave S
40th Ave S
17th Ave S
3rd Ave S
2nd St SW
2nd St SE
7th St SW
12th St SE
14th St S
31st Ave N
20th Ave N
80th St N
100th St N
110th St N
120th St N
125th St N
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90th St S
110th St S
120th St S
130th St S
142nd St S
145th St S
150th St S
180th St S
Foundation Ave
Partridge Ave S
Lyndon Ave
Southcreek Ave
Lund Ave S
STATE PARK RD 4
STATE PARK RD 7
T-318
T-202
T-440
T-451
T-15
T-306
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COUNTY 18 ROAD
COUNTY 19 ROAD
COUNTY 92 ROAD
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COUNTY 17 ROAD
COUNTY 79 ROAD
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COUNTY 72 ROAD
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Legend
Project Alignment
Project Drainage Area
BRRWD Boundary
Legal Drainage Systems
Rivers and Streams
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Exhibit 2: Watercourses and Drainage Systems
Glyndon East Tributary Restoration Project
Drawn by: NRI
Checked by: BAU
Project No : 1915-0256
Date: 1/20/2021
Sheet: 1 of 1
HOUSTON engineering, inc.
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Exhibit 3: Glyndon East Triburary Existing Structure Inventory

HEI Project Number: 1915-0256

Station	Description	Alt Desc.	Structure	Waterway Area (sq. ft.)	Upstream Invert	Downstream Invert	Overtopping Event	Overtopping Elevation	US Field Elev	Comments
Glyndon East Tributary										
	Buffalo River / Glyndon East Tributary Confluence									
127+00	County Road 84	15th Ave N	W. 12' x 8' x 40' RCB	94	907.81	907.49	> 100-YR	918.55	915 +/-	
			C. 12' x 8 x 40' RCB	94	908.17	908.05				
			E. 12' x 8 x 40' RCB	94	908.15	908.04				
				282						
173+00	Field Crossing		24" x 14' CMP	**3.1**	908.82	909.92	2-YR	911.70	914 +/-	Crossing to be replaced with 2-lines of 57" x 38" CMPA
242+00	US Highway 10		W. 10' x 6' x 180' RCB	58	912.07	912.04	> 100-YR	921.24	916 +/-	
			E. 10' x 6' x 180' RCB	58	911.27	911.18				
				116						
245+00	Field Crossing		15" x 14' PVC	**1.2**	913.64	913.68	2-YR	915.45	916 +/-	Crossing to be replaced with 2-lines of 57" x 38" CMPA
242+00	Field Crossing		W. 15" x 12' RCP	1.2	914.66	914.28	2-YR	916.62	919 +/-	Crossing to be replaced with 2-lines of 57" x 38" CMPA
			E. 24" x 14' RCP	3.1	914.63	914.37				
				4.3						
265+50	BNSF Railway		Bridge	**1,767**	-	-	> 100-YR	939.00	919 +/-	
309+00	Field Crossing		36" x 26' CMP	**7.1**	917.02	917.12	5-YR	919.35	920 +/-	Crossing to be replaced with 2-lines of 57" x 38" CMPA
395+00	N-S Township Road	120th St S	84" x 40' CMP	**38.5**	918.42	918.50	> 100-YR	925.5	926 +/-	
444+60	County Road 72	12th Ave S	72" x 34' CMP	**28.3**	921.13	920.39	50-YR	928.00	927 +/-	Crossing to be replaced with 1-line of 83" x 57" CMPA
582+45	MN State Highway 9		71" x 47" x 90' CMPA	**18.1**	935.86	935.92	> 100-YR	942.25	938 +/-	

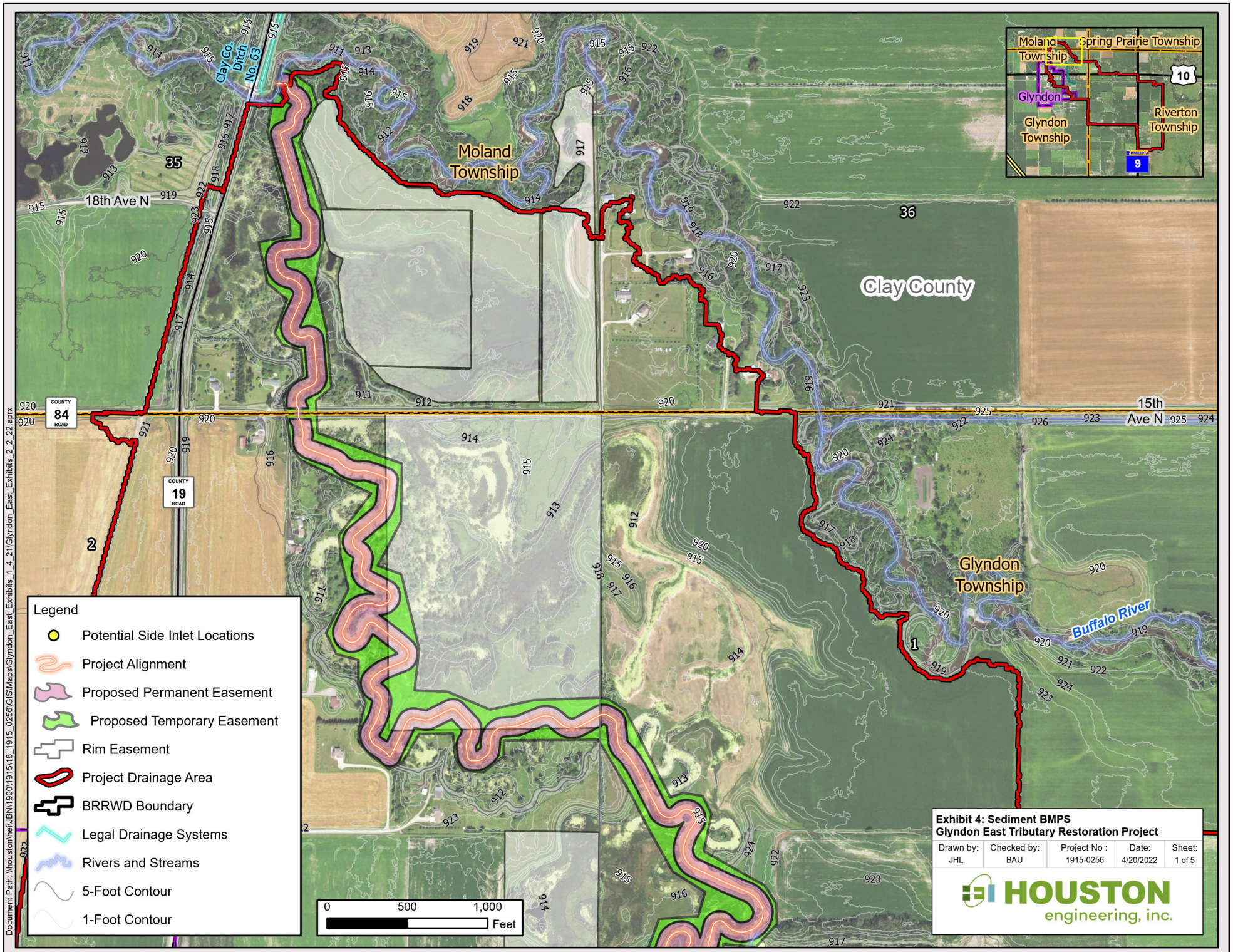
Moland Township
Clay County
Glyndon Township
Buffalo River
Clay Co. Ditch No. 63
18th Ave N
15th Ave N
COUNTY 84 ROAD
COUNTY 19 ROAD
Spring Prairie Township
Riverton Township
Legend
Potential Side Inlet Locations
Project Alignment
Proposed Permanent Easement
Proposed Temporary Easement
Rim Easement
Project Drainage Area
BRRWD Boundary
Legal Drainage Systems
Rivers and Streams
5-Foot Contour
1-Foot Contour
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Exhibit 4: Sediment BMPS
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Checked by: BAU
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Date: 4/20/2022
Sheet: 1 of 5
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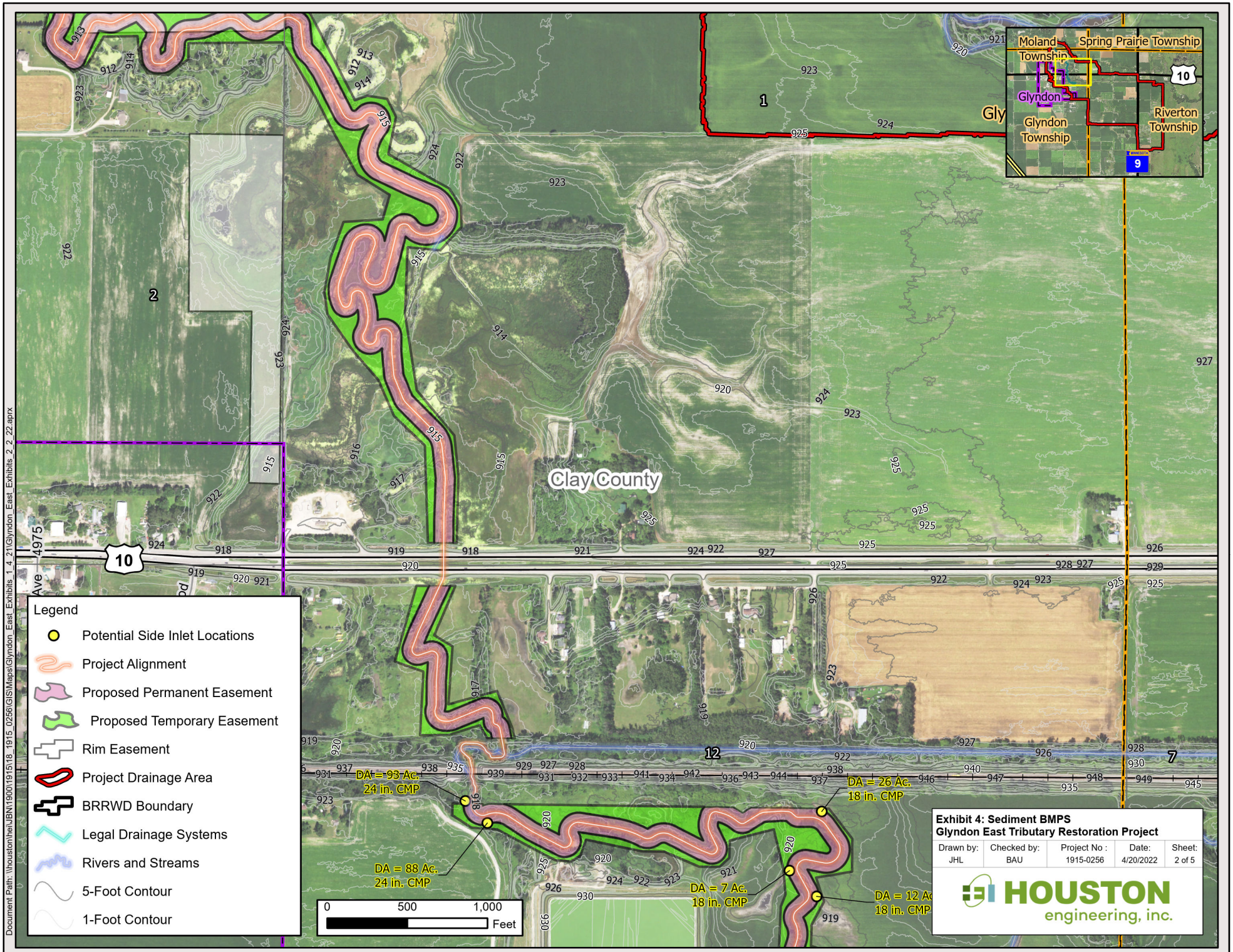
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Spring Prairie Township
Glyndon
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Legend
Potential Side Inlet Locations
Project Alignment
Proposed Permanent Easement
Proposed Temporary Easement
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Project Drainage Area
BRRWD Boundary
Legal Drainage Systems
Rivers and Streams
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Exhibit 4: Sediment BMPS
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Checked by: BAU
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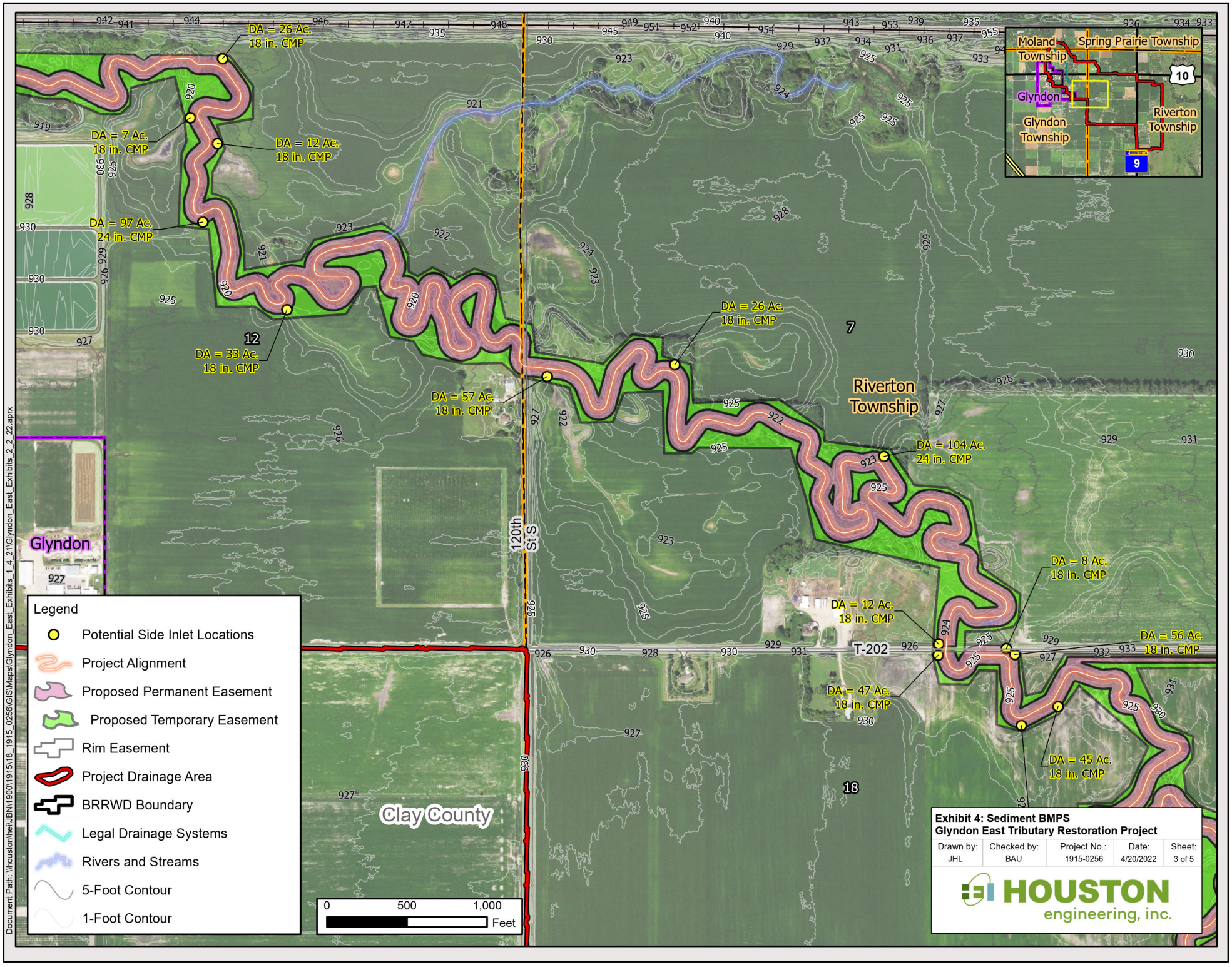
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Potential Side Inlet Locations
Project Alignment
Proposed Permanent Easement
Proposed Temporary Easement
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Project Drainage Area
BRRWD Boundary
Legal Drainage Systems
Rivers and Streams
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Exhibit 4: Sediment BMPS
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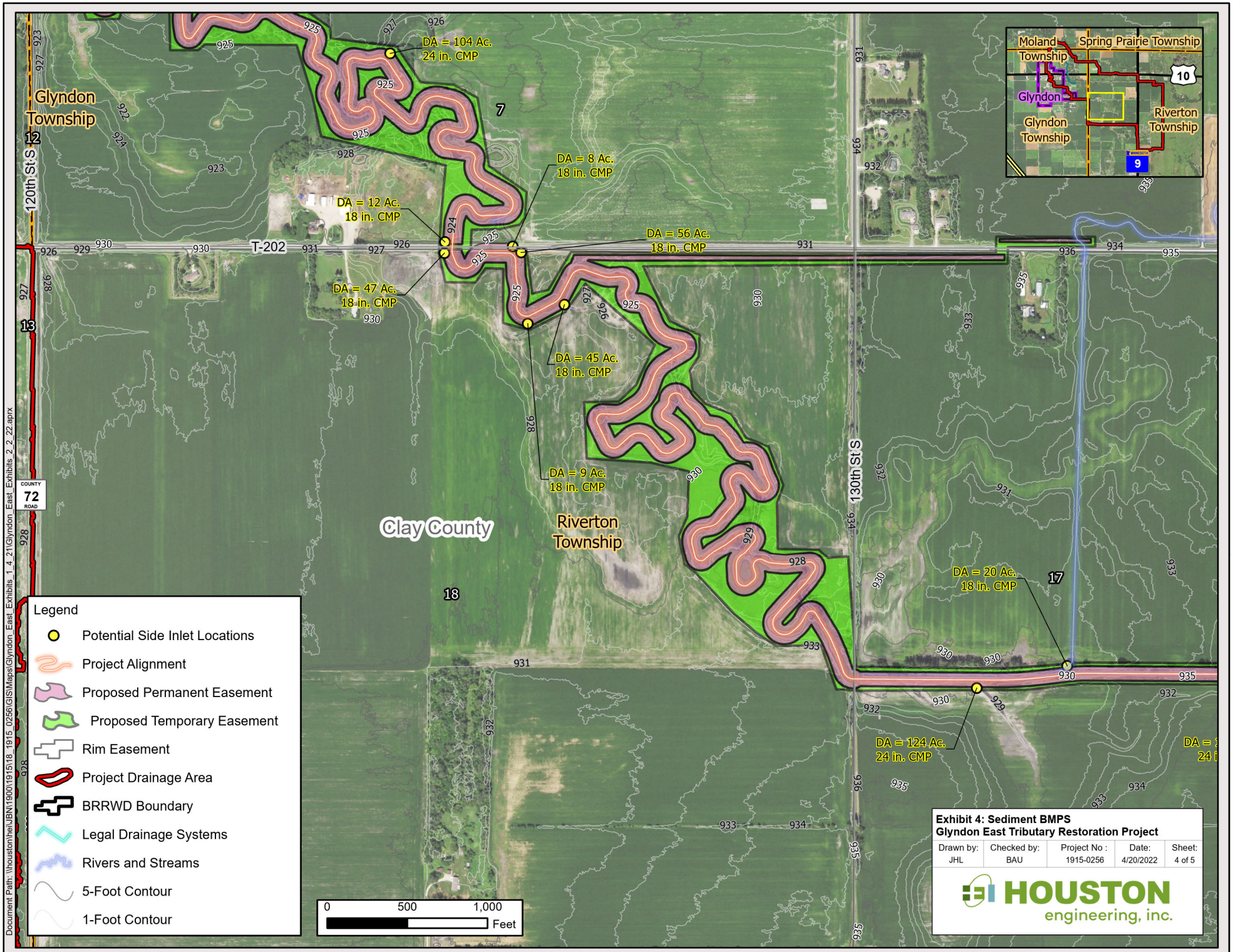
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Potential Side Inlet Locations
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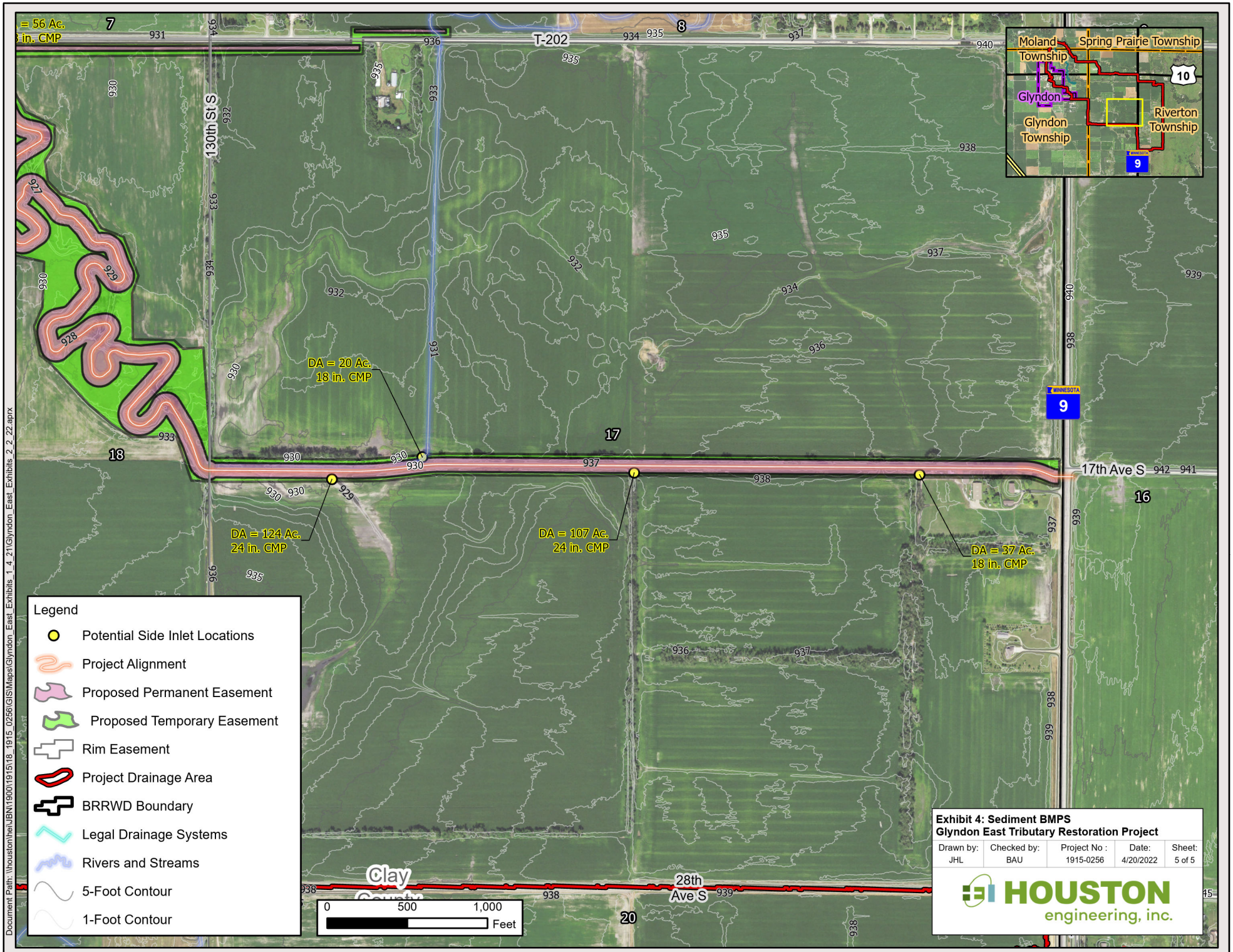
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Potential Side Inlet Locations
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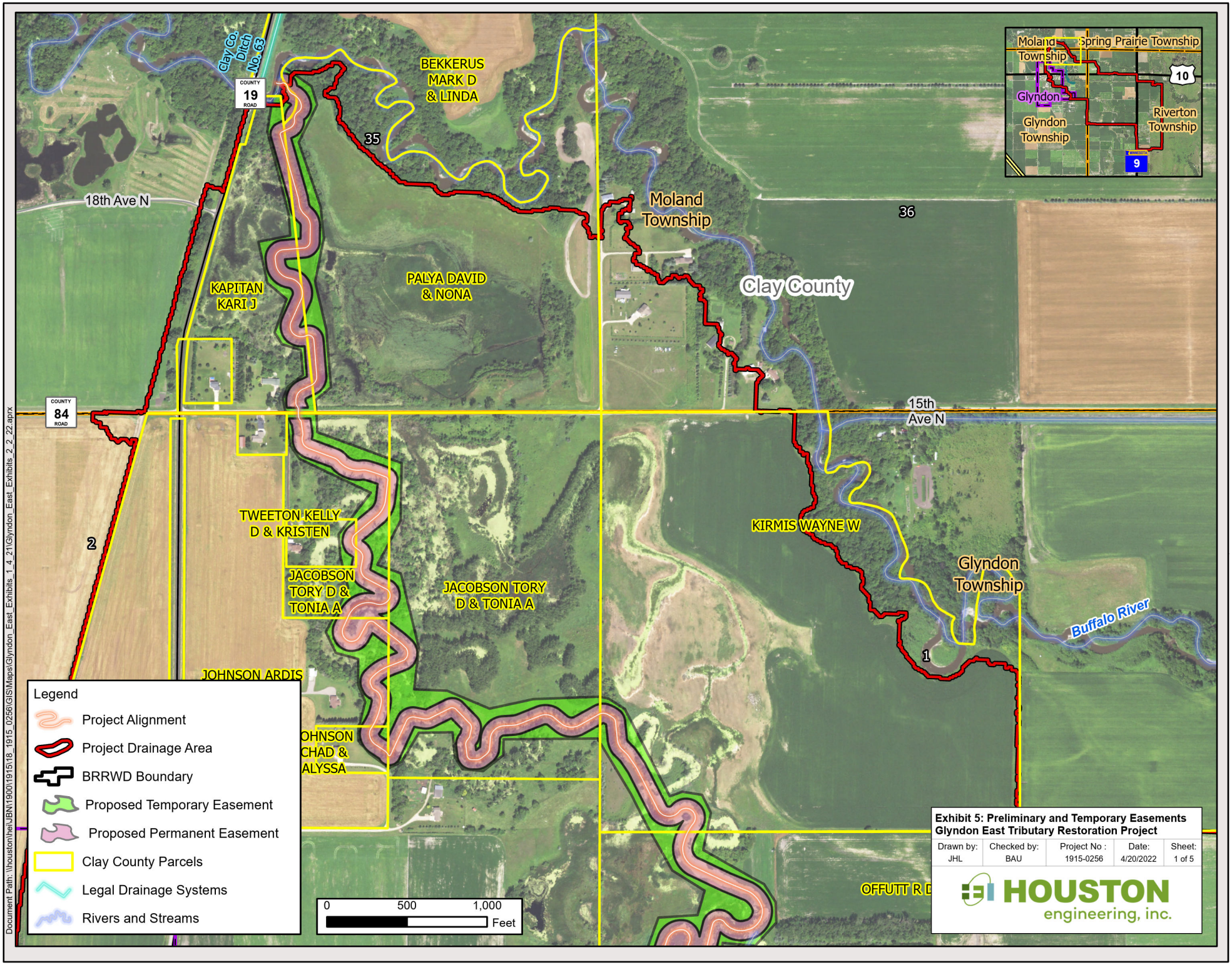
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PALYA DAVID & NONA
Clay County
COUNTY 84 ROAD
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Glyndon Township
Buffalo River
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OHNSON CHAD & ALYSSA
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Spring Prairie Township
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Project Alignment
Project Drainage Area
BRRWD Boundary
Proposed Temporary Easement
Proposed Permanent Easement
Clay County Parcels
Legal Drainage Systems
Rivers and Streams
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Exhibit 5: Preliminary and Temporary Easements
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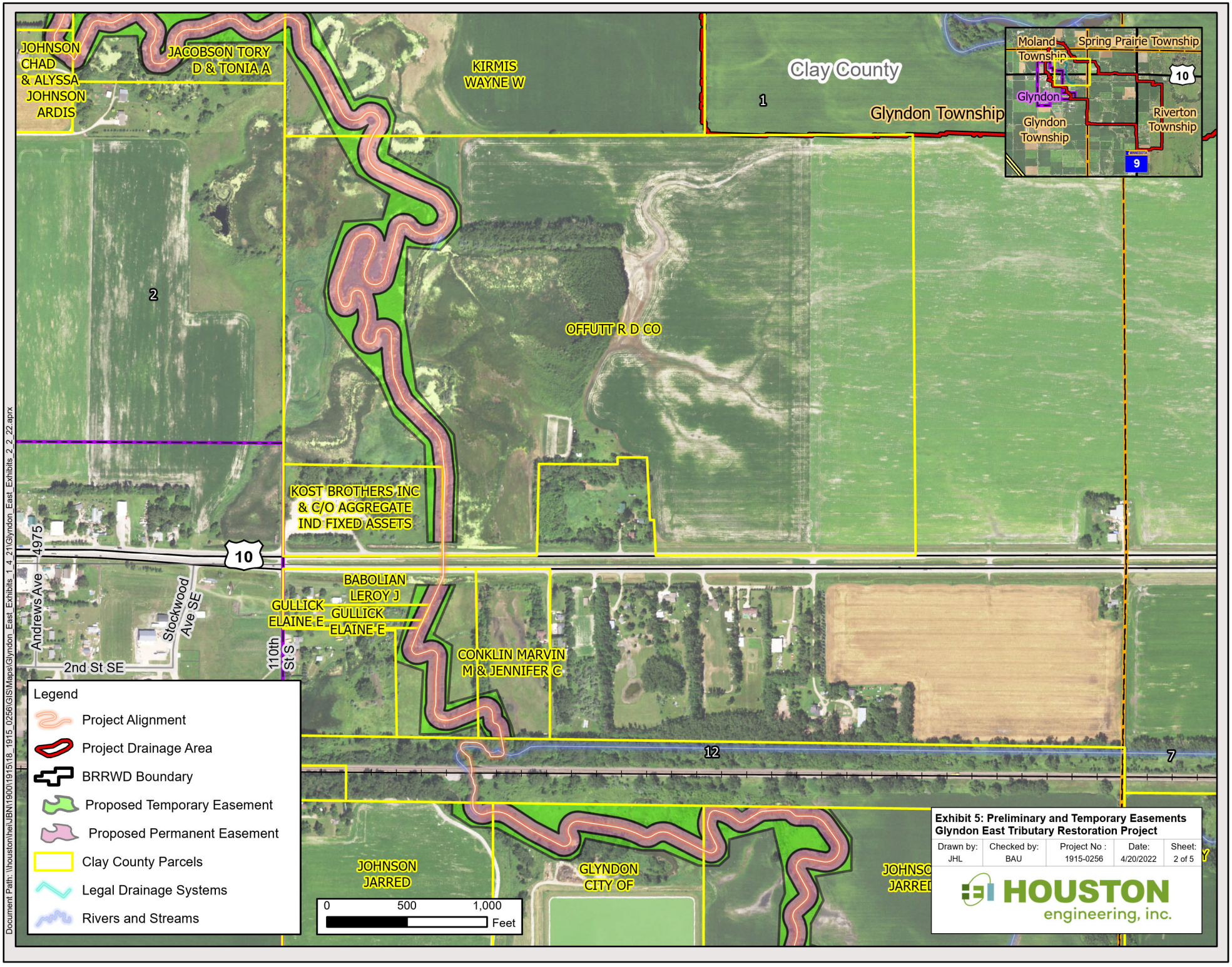
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Exhibit 5: Preliminary and Temporary Easements
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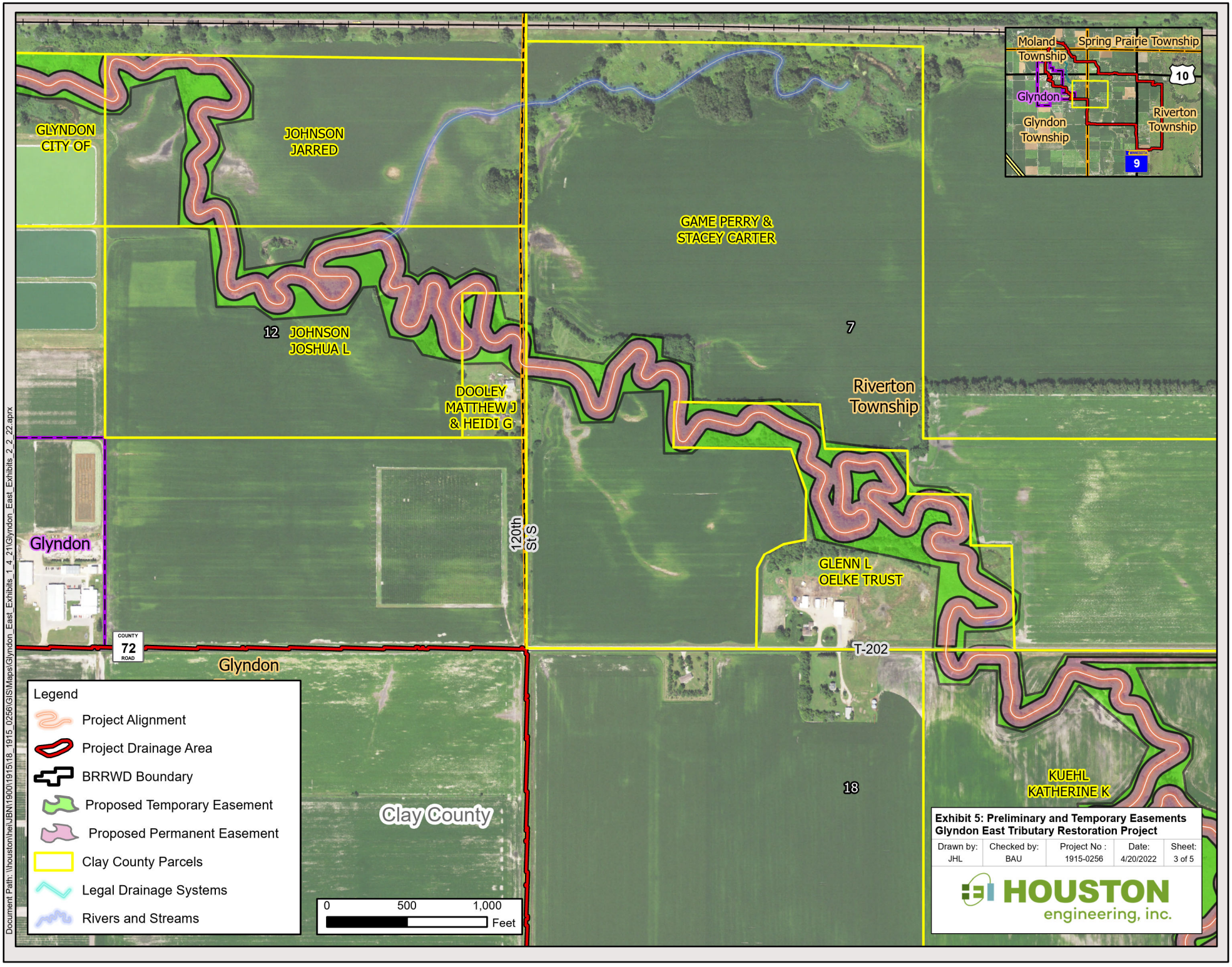
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COUNTY 72 ROAD
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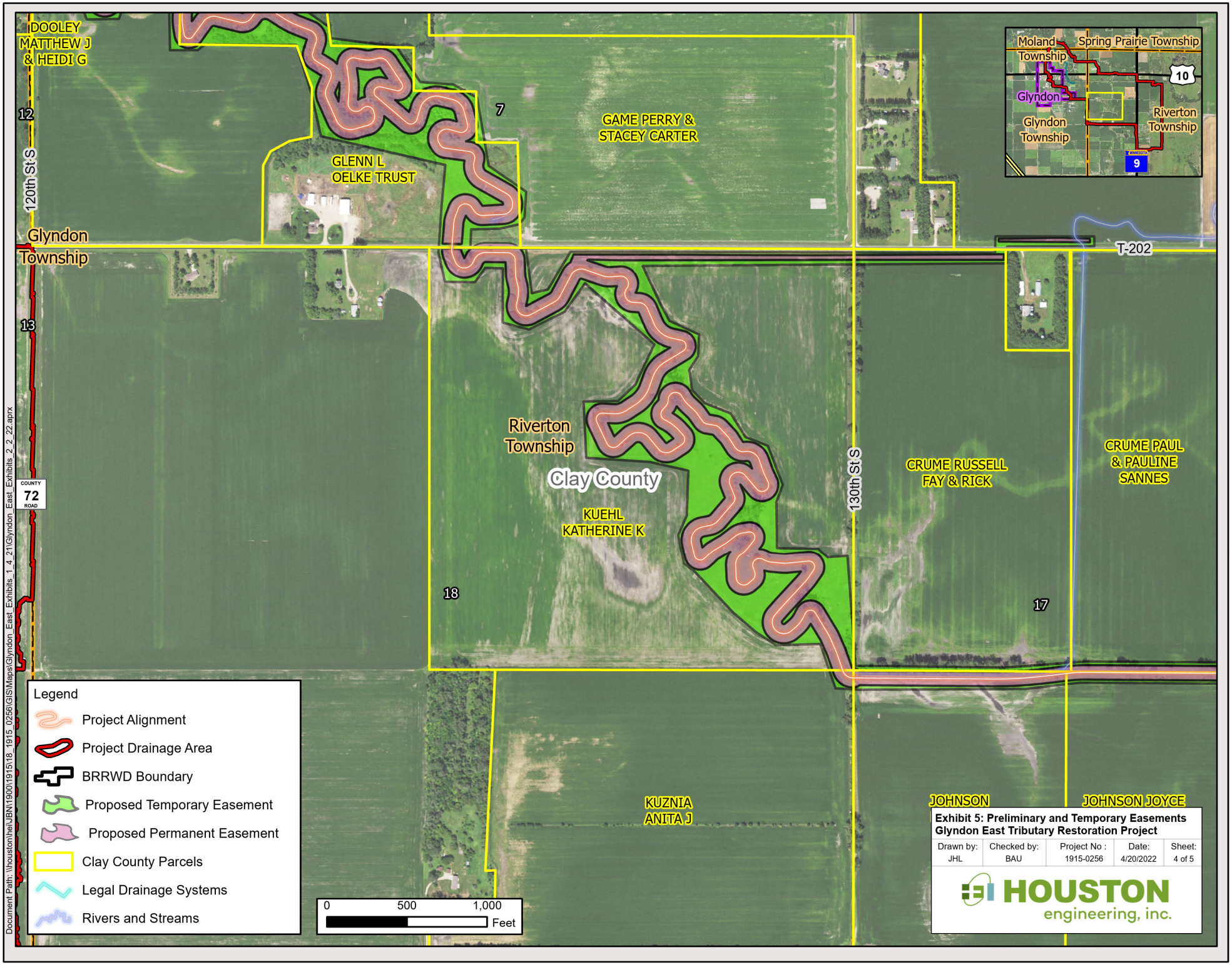
DOOLEY
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& HEIDI G
GLENN L
OELKE TRUST
GAME PERRY &
STACEY CARTER
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Township
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Riverton
Township
Clay County
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CRUME RUSSELL
FAY & RICK
CRUME PAUL
& PAULINE
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Spring Prairie Township
Glyndon
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Township
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Project Alignment
Project Drainage Area
BRRWD Boundary
Proposed Temporary Easement
Proposed Permanent Easement
Clay County Parcels
Legal Drainage Systems
Rivers and Streams
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Exhibit 5: Preliminary and Temporary Easements
Glyndon East Tributary Restoration Project
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HOUSTON
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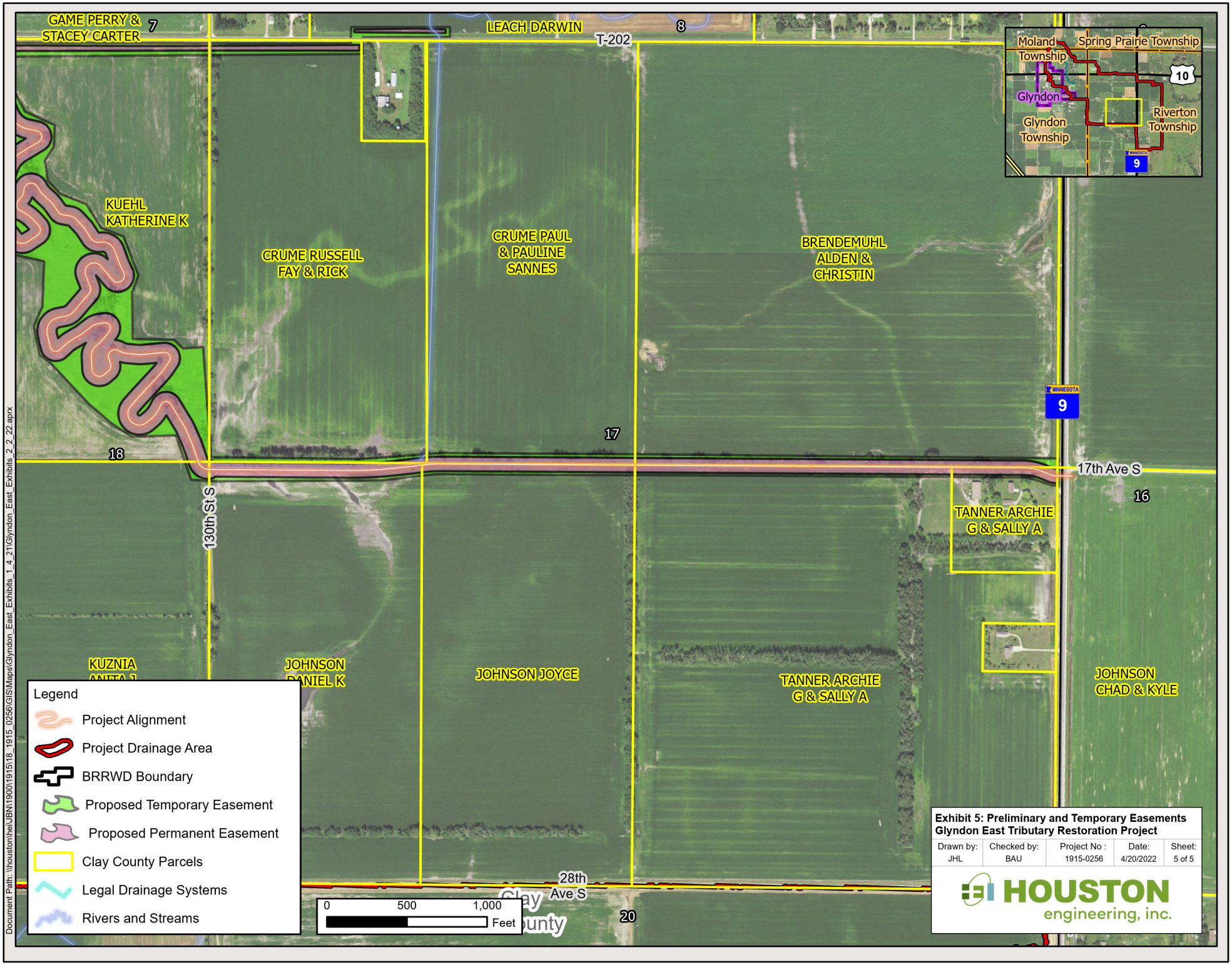
GAME PERRY & STACEY CARTER
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Moland Township
Spring Prairie Township
Glyndon
Glyndon Township
Riverton Township
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KUEHL KATHERINE K
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CRUME PAUL & PAULINE SANNES
BRENDEMUHL ALDEN & CHRISTIN
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17th Ave S
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TANNER ARCHIE G & SALLY A
KUZNIA
JOHNSON DANIEL K
JOHNSON JOYCE
TANNER ARCHIE G & SALLY A
JOHNSON CHAD & KYLE
28th Ave S
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Legend
Project Alignment
Project Drainage Area
BRRWD Boundary
Proposed Temporary Easement
Proposed Permanent Easement
Clay County Parcels
Legal Drainage Systems
Rivers and Streams
0
500
1,000
Feet
Exhibit 5: Preliminary and Temporary Easements
Glyndon East Tributary Restoration Project
Drawn by: JHL
Checked by: BAU
Project No : 1915-0256
Date: 4/20/2022
Sheet: 5 of 5
HOUSTON engineering, inc.
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Exhibit 6: Preliminary Easement Information

Parcel ID	Temporary Easement Acres	Permanent Easement Acres	Taxpayer Name	Address	City	State	Zipcode
10.012.2203	5.143	3.370	BABOLIAN LEROY J	66 110 ST S	GLYNDON	MN	56547
25.017.1000	3.821	2.553	BRENDEMUHL ALDEN & CHRISTIN	14664 15TH AVE N	GLYNDON	MN	56547
10.012.2104	1.035	0.743	CONKLIN MARVIN M & JENNIFER C	11323 HWY 10	GLYNDON	MN	56547
25.017.2000	2.094	1.393	CRUME PAUL & PAULINE SANNES	1661 33RD AVE S # 109	FARGO	ND	58104
25.017.2600	2.676	0.923	CRUME RUSSELL FAY & RICK	131 130TH ST S	GLYNDON	MN	56547
10.012.4502	3.648	2.455	DOOLEY MATTHEW J & HEIDI G	737 120TH ST S	GLYNDON	MN	56547
25.007.4700	9.224	5.192	GAME PERRY & STACEY CARTER	1509 3RD ST NE	STAPLES	MN	56479
25.007.4701	23.112	15.162	GLENN L OELKE TRUST	12374 12TH AVE S	GLYNDON	MN	56547
10.012.2470	8.433	4.368	GLYNDON CITY OF	PO BOX 223	GLYNDON	MN	56547
10.012.2202	0.115	0.073	GULLICK ELAINE E	72 110 ST S	GLYNDON	MN	56547-9691
10.012.2201	0.260	0.154	GULLICK ELAINE E	72 110 ST S	GLYNDON	MN	56547-9691
10.002.1201	7.733	6.717	JACOBSON TORY D & TONIA A	500 110TH ST N	GLYNDON	MN	56547
10.002.1400	12.466	4.832	JACOBSON TORY D & TONIA A	500 110TH ST N	GLYNDON	MN	56547
10.002.1300	2.224	1.390	JOHNSON ARDIS	674 110TH ST N	GLYNDON	MN	56547
10.002.1302	1.526	1.175	JOHNSON CAROL M	674 110TH ST N	GLYNDON	MN	56547
10.002.1301	0.831	0.679	JOHNSON CHAD & ALYSSA	508 110 ST N	GLYNDON	MN	56547-9401
25.017.3600	3.171	2.506	JOHNSON CHAD & KYLE	508 110 ST N	GLYNDON	MN	56547
10.012.2300	0.787	6.706	JOHNSON JARRED	12744 50TH AVE S	GLYNDON	MN	56547-9543
10.012.1000	10.286	0.480	JOHNSON JARRED	12744 50TH AVE S	GLYNDON	MN	56547-9543
10.012.4501	16.928	11.414	JOHNSON JOSHUA L	12399 12 AVE S	GLYNDON	MN	56547-9549
25.017.3000	1.921	1.336	JOHNSON JOYCE	8276 31ST AVE N	GLYNDON	MN	56547
20.035.4302	5.939	3.905	KAPITAN KARI J	10614 15TH AVE N	GLYNDON	MN	56547
10.001.3301	1.029	0.483	KOST BROTHERS INC & C/O AGGREGATE IND FIXED ASSETS	6211 ANN ARBOR RD	DUNDEE	MI	48131
25.018.4000	0.344	0.238	KUZNIA ANITA J	7460 285TH AVE NW	ZIMMERMAN	MN	55398
25.008.0300	0.917	0.301	LEACH DARWIN	8207 S CORALBELL CIR	MESA	AZ	85208
10.012.2302	0.001	0.000	LEACH GARY JR & JAMIE	106 110TH ST S	GLYNDON	MN	56547
10.001.3000	19.646	12.237	OFFUTT R D CO	PO BOX 7160	FARGO	ND	58109
20.035.4303	5.689	3.367	PALYA DAVID & NONA	13868 12TH AVE S	GLYNDON	MN	56547
25.017.4100	1.088	2.103	TANNER ARCHIE G & SALLY A	1727 HWY 9 S	GLYNDON	MN	56547
25.017.4000	2.838	0.834	TANNER ARCHIE G & SALLY A	1727 HWY 9 S	GLYNDON	MN	56547
10.002.1801	0.641	0.370	TWEETON KELLY D & KRISTEN	10637 15TH AVE N	GLYNDON	MN	56547
10.001.2000	5.187	3.099	WATT KIRK & KATHERINE	3149 80TH ST N	GLYNDON	MN	56547
25.018.1000	42.909	25.193	WAYNE & KATHERINE KUEHL LLLP	11586 COUNTY HIGHWAY 11	AUDUBON	MN	56511

EXHIBIT 7

OPINION OF PROBABLE COST
GLYNDON EAST TRIBUTARY RESTORATION PROJECT
BUFFALO-RED RIVER WATERSHED DISTRICT
GLYNDON, MN
1/25/2021

No.	Item	Unit	Quantity	Unit Price	Total Costs
1	Mobilization	LS	1	$ 25,000.00	$ 25,000.00
2	Clearing and Grubbing	LS	1	$ 30,000.00	$ 30,000.00
3	Remove Culverts (All Sizes)	LF	114	$ 30.00	$ 3,420.00
4	Earthwork - Downstream of Railroad Tracks	MI	3.2	$ 15,000.00	$ 48,000.00
5	Earthwork - Upstream of Railroad Tracks	CY	90,000	$ 5.00	$ 450,000.00
6	Aggregate Class 5	TON	100	$ 25.00	$ 2,500.00
7	57" x 38" Corrugated Metal Pipe Arch	LF	192	$ 150.00	$ 28,800.00
8	83" x 57" Corrugated Metal Pipe Arch	LF	50	$ 200.00	$ 10,000.00
9	18" Corrugated Metal Pipe	LF	560	$ 50.00	$ 28,000.00
10	24" Corrugated Metal Pipe	LF	240	$ 60.00	$ 14,400.00
11	Random Riprap, Class III	CY	210	$ 100.00	$ 21,000.00
12	Seeding and Mulching	AC	50	$ 2,000.00	$ 100,000.00
				Total Cost	**$ 761,120.00**

Alternate 1 - 12th Ave S

No.	Item	Unit	Quantity	Unit Price	Total Costs
13	Remove Culverts (All Sizes)	LF	148	$ 30.00	$ 4,440.00
14	Earthwork	CY	5,500	$ 5.00	$ 27,500.00
15	64" x 43" Corrugated Metal Pipe Arch	LF	130	$ 150.00	$ 19,500.00
16	Random Riprap, Class III	CY	70	$ 100.00	$ 7,000.00
17	Seeding and Mulching	AC	1	$ 2,000.00	$ 2,000.00
				Total Alternate 1 Cost	**$ 60,440.00**

TOTAL CONSTRUCTION COSTS				$ 821,560.00
Contingencies (10%)				$ 82,156.00
Engineering				$ 150,000.00
Administrative and Permitting				$ 50,000.00
Permanent Right-of-Way (Existing Stream)	AC	106.0	$ 100.00	$ 10,600.00
Permanent Right-of-Way (Existing Farmland)*	AC	5.5	$ 5,000.00	$ 27,500.00
Temporary Construction Easement (Tilled Land)	AC	15.0	$ 250.00	$ 3,750.00
Temporary Construction Easement (Non-Tilled Land)	AC	35.0	$ 100.00	$ 3,500.00
TOTAL PROJECT COSTS				$ 1,149,066.00

FIGURES

Glyndon East Tributary Restoration Landuse Map

Created By: jlarson Date Created: 1/5/2021 Date Exported: 3/30/2022 Image: 2019 NAIP Elevation Data: NA
Horizontal Datum: NAD 1983 UTM Zone 14N Vertical Datum: North American 1983
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Legend

- Ditches
- Rivers / Streams
- Watershed Boundary
- Municipal Boundaries

Land Use

- 11 - Water
- 21 - Res/Open
- 23 - Med Dev (92l)
- 24 - Com (98)
- 71 - Natrual Veg
- 82 - AG
- 90 - Woody Wetlands
- 95 - Wetlands Emergent
- ROW / City Property

N W E S

0 3,000 6,000
Feet

1 inch = 3,000 feet

HOUSTON engineering, inc.

BUFFALO – RED RIVER WATERSHED DISTRICT

Glyndon East Tributary Restoration
Soils Hydrologic Map

Created By: jlarson Date Created: 1/5/2021 Date Exported: 3/30/2022 Image: 2019 NAIP Elevation Data: NA
Horizontal Datum: NAD 1983 UTM Zone 14N Vertical Datum: North American 1983
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Legend

- Ditches
- Rivers / Streams
- Watershed Boundary
- Municipal Boundaries

Soils

Hydrologic Group

- A
- A/D
- B
- B/D
- C
- C/D
- D

N W E S

0 3,000 6,000
Feet

1 inch = 3,000 feet

HOUSTON engineering, inc.

BUFFALO – RED RIVER WATERSHED DISTRICT

Glyndon East Tributary Restoration
Curve Number Map

Created By: jlarson Date Created: 1/5/2021 Date Exported: 3/30/2022 Image: 2019 NAIP Elevation Data: NA
Horizontal Datum: NAD 1983 UTM Zone 14N Vertical Datum: North American 1983
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Legend

- Ditches
- Rivers / Streams
- Watershed Boundary
- Municipal Boundaries

Curve Number

30 - 35	46 - 50	66 - 70	86 - 90
36 - 40	51 - 55	71 - 75	91 - 95
41 - 45	56 - 60	76 - 80	96 - 100
	61 - 65	81 - 85	ROW / City Property

N W E S

0 3,000 6,000
Feet

1 inch = 3,000 feet

HOUSTON engineering, inc.

BUFFALO – RED RIVER WATERSHED DISTRICT

Glyndon East Tributary Restoration
Change in Landuse Runoff Map

Created By: jlarson Date Created: 1/5/2021 Date Exported: 3/30/2022 Image: 2019 NAIP Elevation Data: NA
Horizontal Datum: NAD 1983 UTM Zone 14N Vertical Datum: North American 1983
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Legend

- Ditches
- Rivers / Streams
- Watershed Boundary
- Municipal Boundaries

Change - Runoff

- No Change
- Low
- Medium
- High
- ROW / City Property

N W E S

0 3,000 6,000
Feet

1 inch = 3,000 feet

HOUSTON engineering, inc.

BUFFALO – RED RIVER WATERSHED DISTRICT

Glyndon East Tributary Restoration
Cost Per Acre Map

Created By: jlarson Date Created: 1/5/2021 Date Exported: 3/30/2022 Image: 2019 NAIP Elevation Data: NA
Horizontal Datum: NAD 1983 UTM Zone 14N Vertical Datum: North American 1983
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Legend

- Ditches
- Rivers / Streams
- Watershed Boundary
- Municipal Boundaries

WMD Assessment Cost Per Acre

- $0
- $0 - $1
- $1 - $2
- $2 - $4
- $4 - $5
- $5 - $6
- $6 - $7
- $7 - $8
- $10 - $16.48
- ROW / City Property

N W E S

0 3,000 6,000
Feet

1 inch = 3,000 feet

HOUSTON engineering, inc.

BUFFALO – RED RIVER WATERSHED DISTRICT

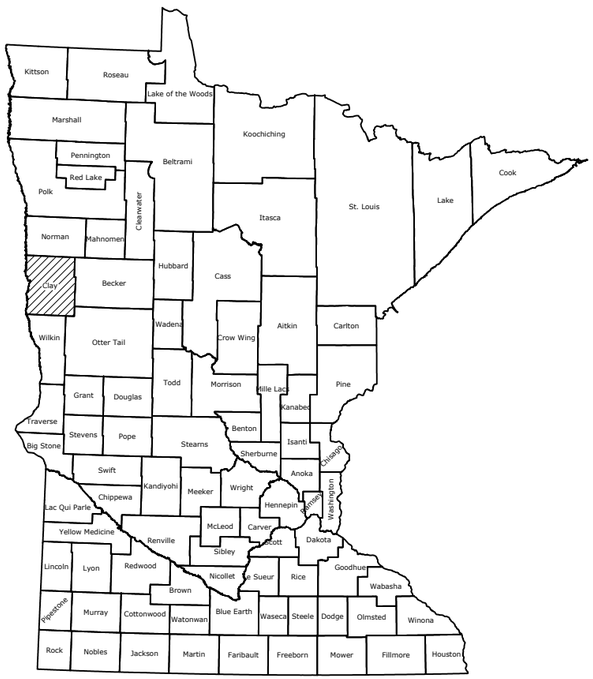
APPENDICIES

PRELIMINARY CONSTRUCTION PLANS FOR

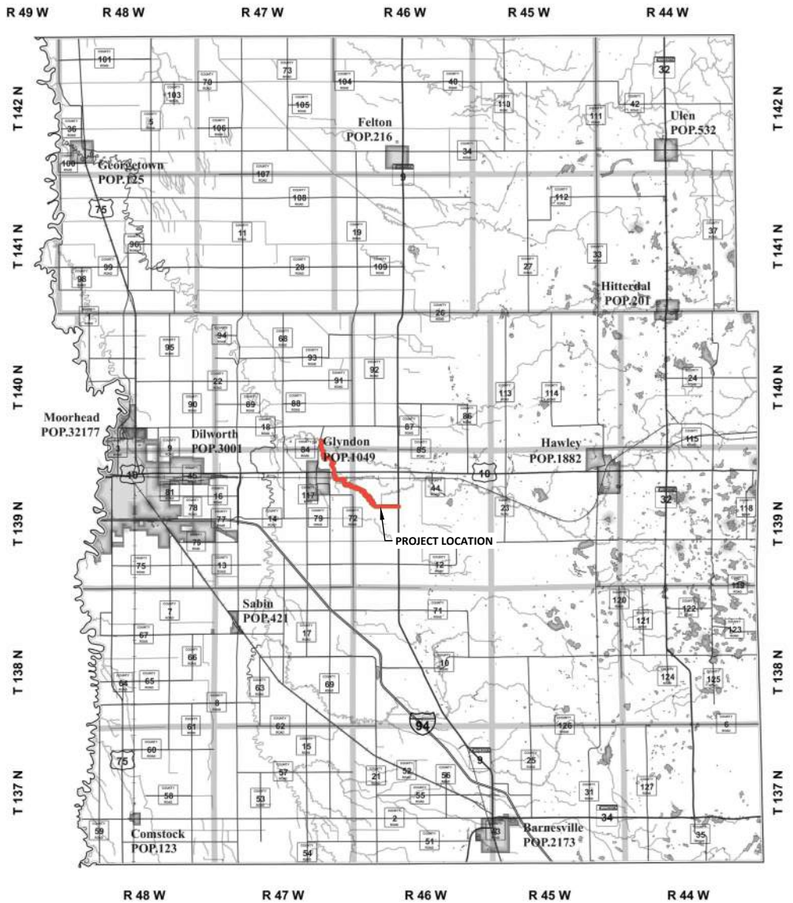
GLYNDON EAST TRIBUTARY RESTORATION PROJECT
BUFFALO-RED RIVER WATERSHED DISTRICT

BARNESVILLE, MINNESOTA

JANUARY, 2021



STATE COUNTY MAP



LOCATION MAP

HOUSTON engineering, inc.

1401 21st AVENUE N
FARGO, ND 58102
P: 701.237.5065
T: 1.866.379.6465
www.houstoneng.com

GOVERNING SPECIFICATIONS:

STANDARD SPECIFICATIONS FOR CONSTRUCTION ADOPTED BY THE MINNESOTA DEPARTMENT OF TRANSPORTATION, 2018 EDITION, STANDARD DRAWINGS CURRENTLY IN EFFECT, AND OTHER CONTRACT PROVISIONS SUBMITTED HEREIN.

UTILITY NOTE:

THE UNDERGROUND UTILITIES SHOWN HAVE BEEN LOCATED FROM FIELD SURVEY INFORMATION, AS-BUILT MAPS AS PROVIDED BY MUNICIPALITIES OR UTILITY COMPANIES, AND/OR EXISTING DRAWINGS. THERE IS NO GUARANTEE THAT THE UNDERGROUND UTILITIES SHOWN INDICATE ALL SUCH UTILITIES IN THE AREA, EITHER IN SERVICE OR ABANDONED. NOR IS THERE A GUARANTEE THAT THE UNDERGROUND UTILITIES SHOWN ARE IN THE EXACT LOCATION INDICATED. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES. THE CONTRACTOR AGREES TO BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MAY RESULT FROM THEIR FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UTILITIES.

SHEET INDEX

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HORIZONTAL DATUM: NAD 1983

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Project No. 1915-0256

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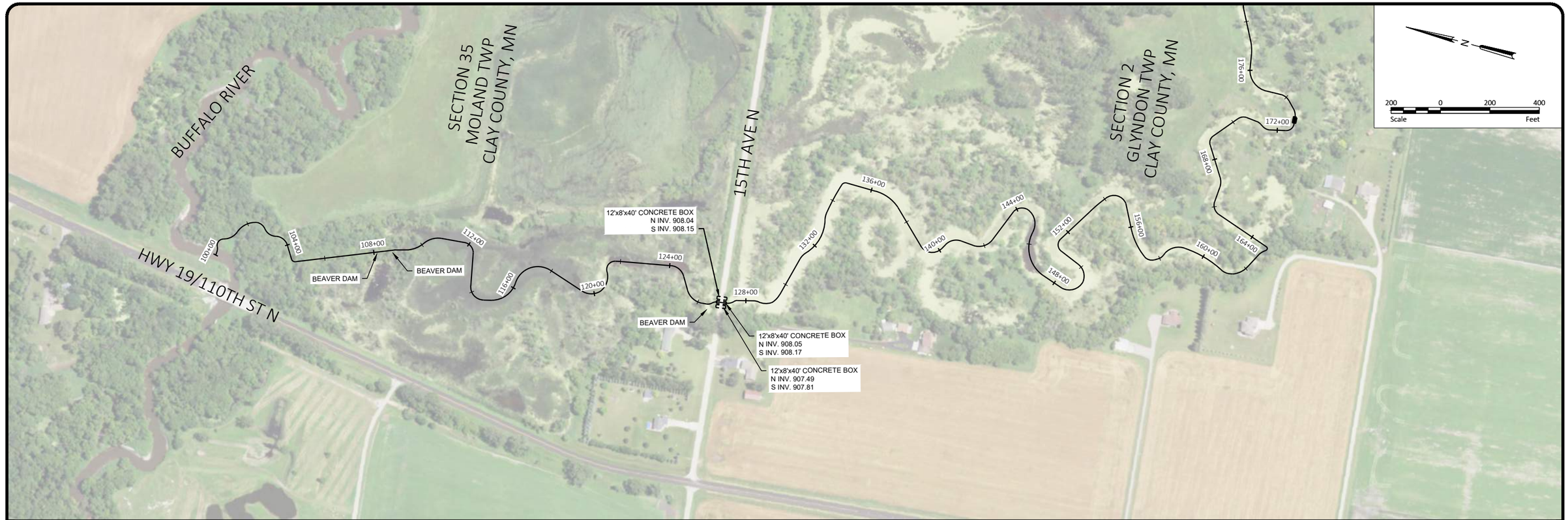

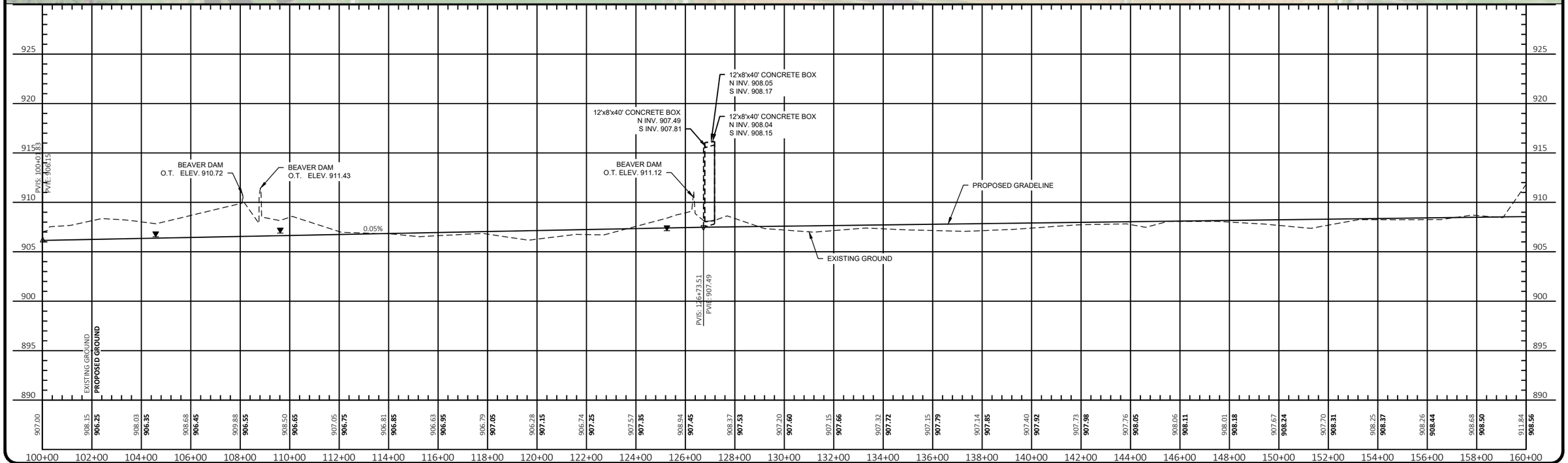

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GLYNDON EAST TRIBUTARY RESTORATION PROJECT
BUFFALO-RED RIVER WATERSHED DISTRICT
BARNESVILLE, MINNESOTA

PLAN AND PROFILE

PROJECT NO. 1915-0256

SHEET 2

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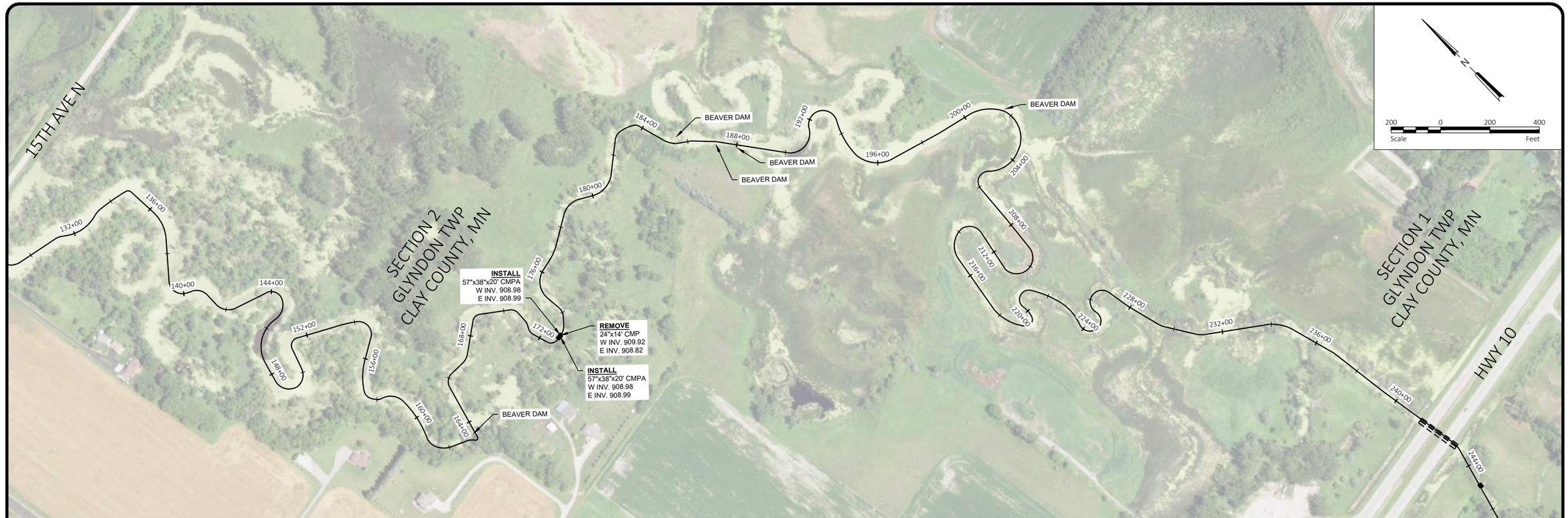

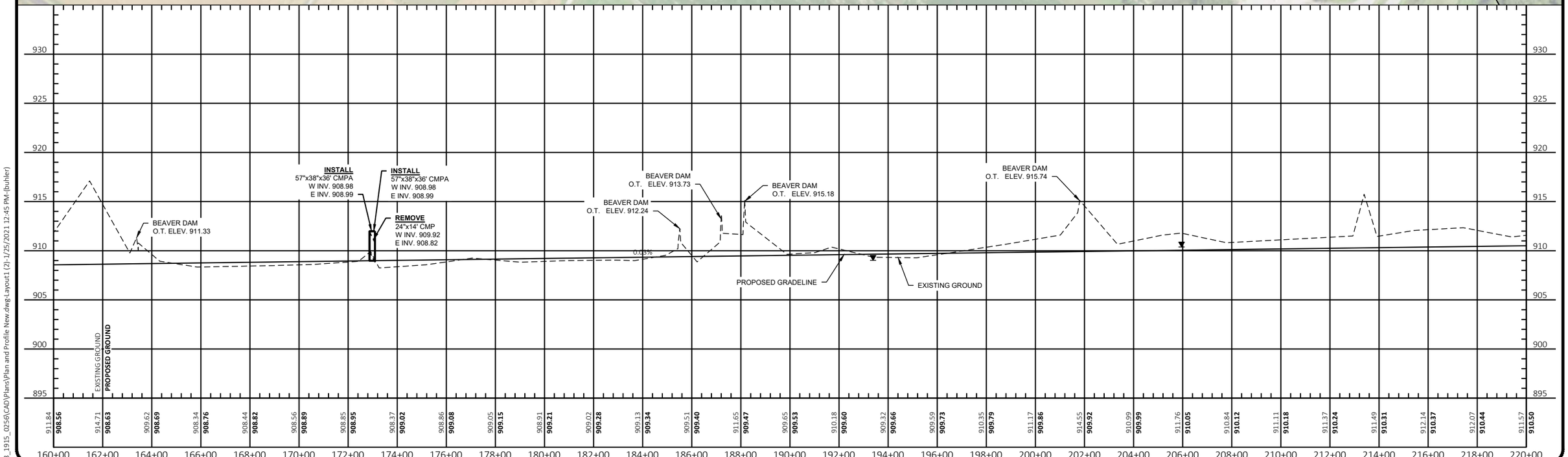

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GLYNDON EAST TRIBUTARY RESTORATION PROJECT
BUFFALO-RED RIVER WATERSHED DISTRICT
BARNESVILLE, MINNESOTA

PLAN AND PROFILE

PROJECT NO. 1915-0256

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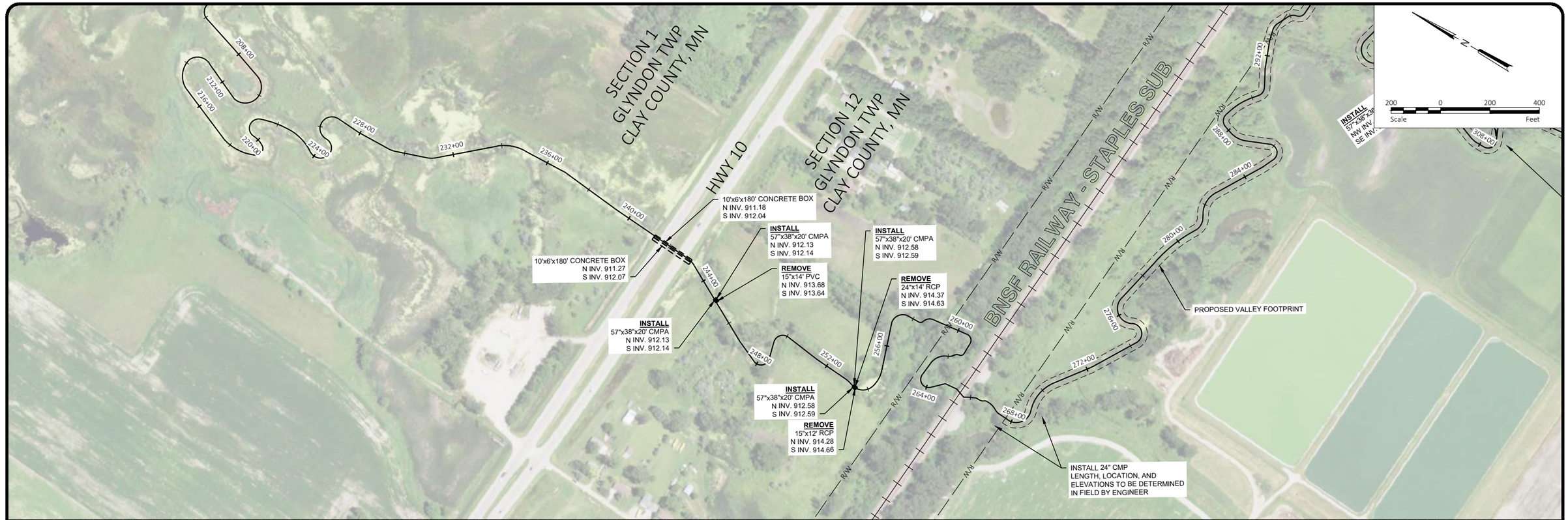

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GLYNDON EAST TRIBUTARY RESTORATION PROJECT
BUFFALO-RED RIVER WATERSHED DISTRICT
BARNESVILLE, MINNESOTA

PLAN AND PROFILE

PROJECT NO. 1915-0256

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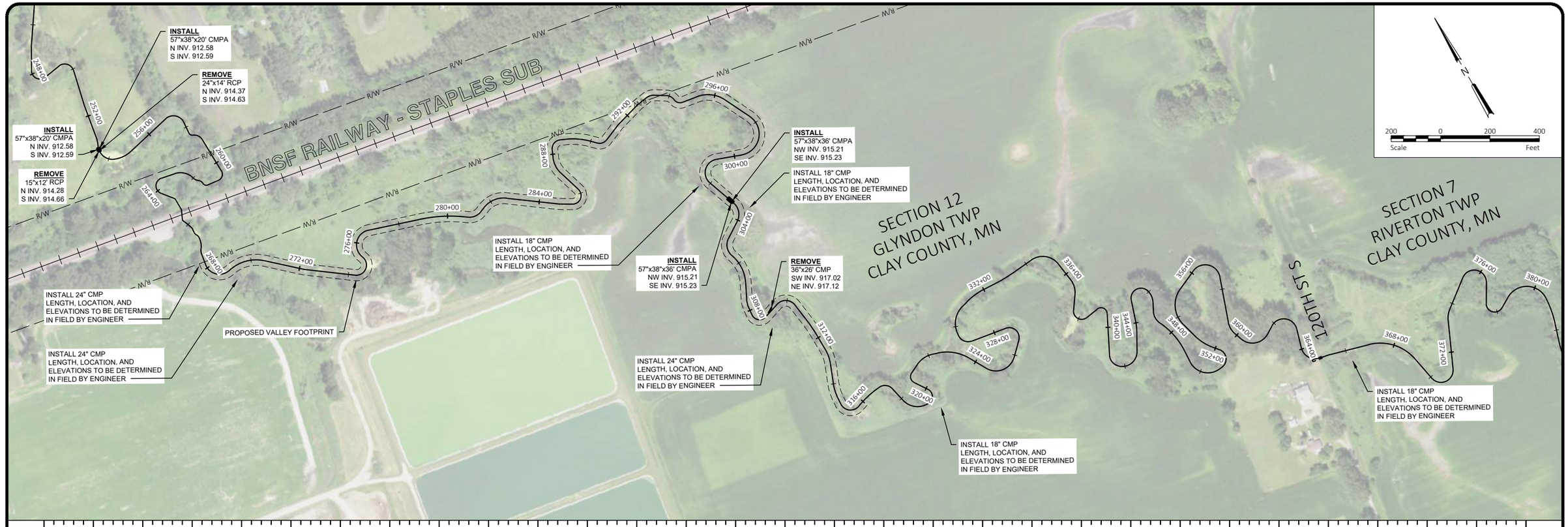

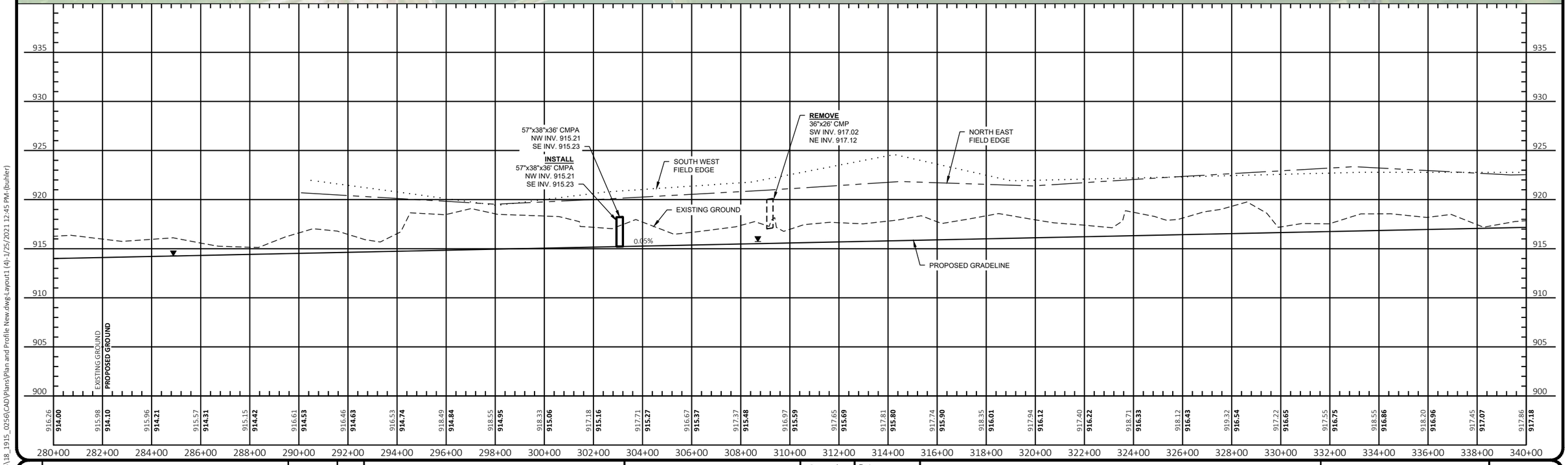

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GLYNDON EAST TRIBUTARY RESTORATION PROJECT
BUFFALO-RED RIVER WATERSHED DISTRICT
BARNESVILLE, MINNESOTA

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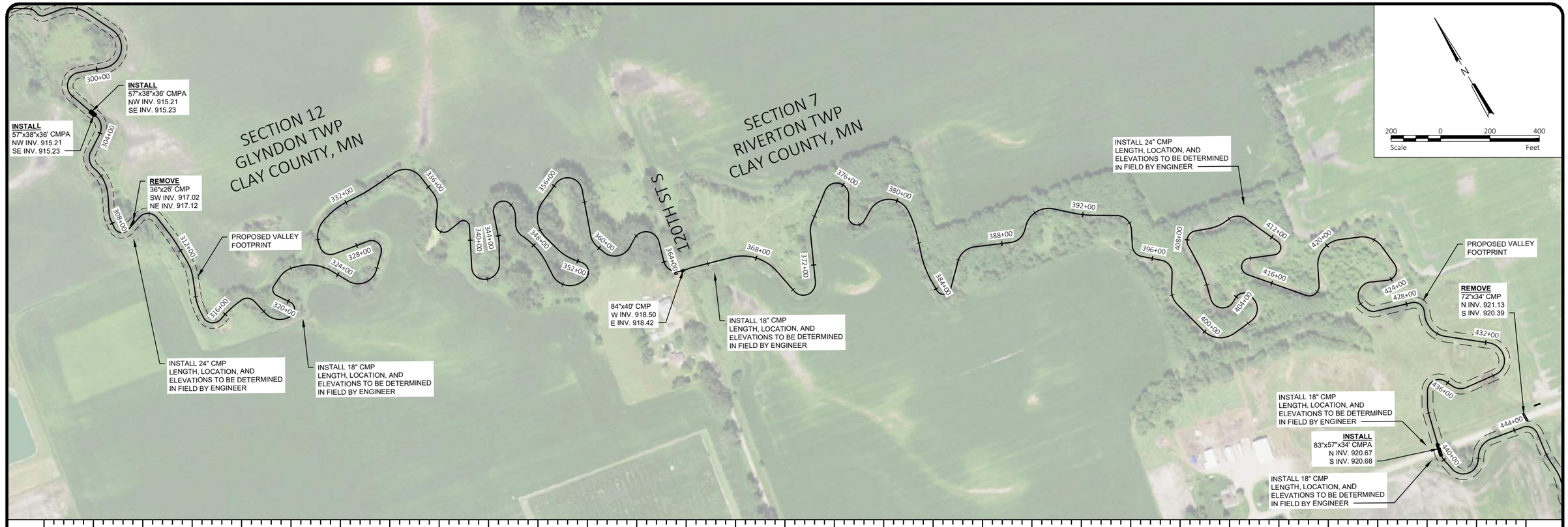

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GLYNDON EAST TRIBUTARY RESTORATION PROJECT
BUFFALO-RED RIVER WATERSHED DISTRICT
BARNESVILLE, MINNESOTA

PLAN AND PROFILE

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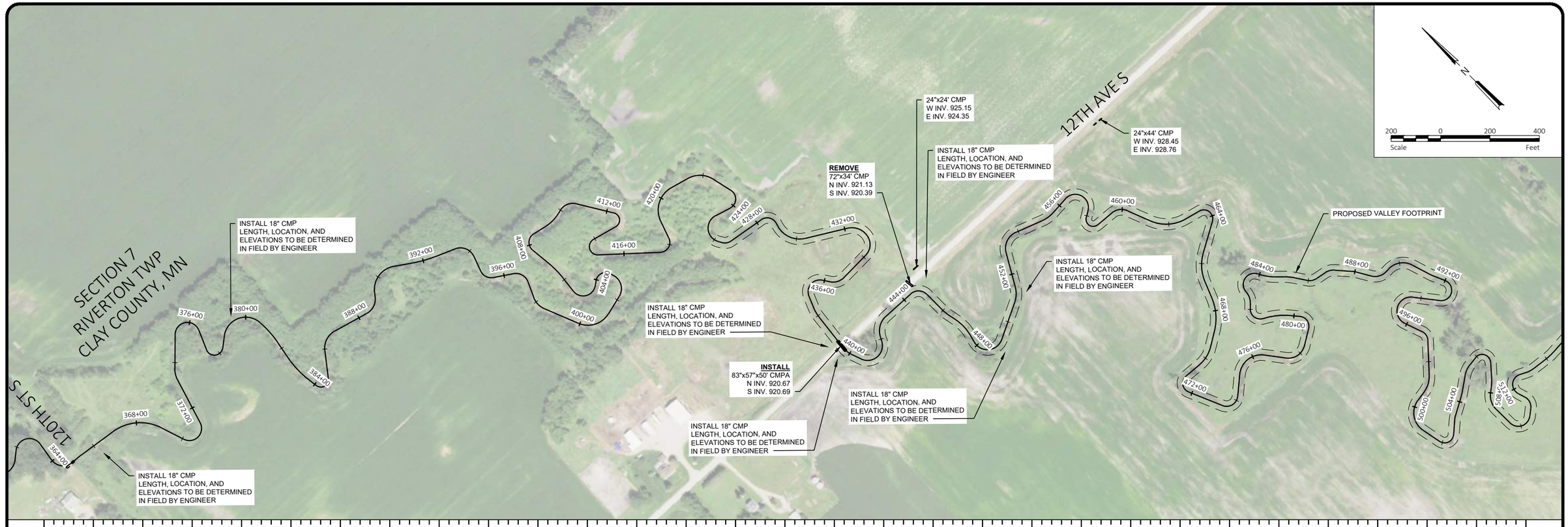

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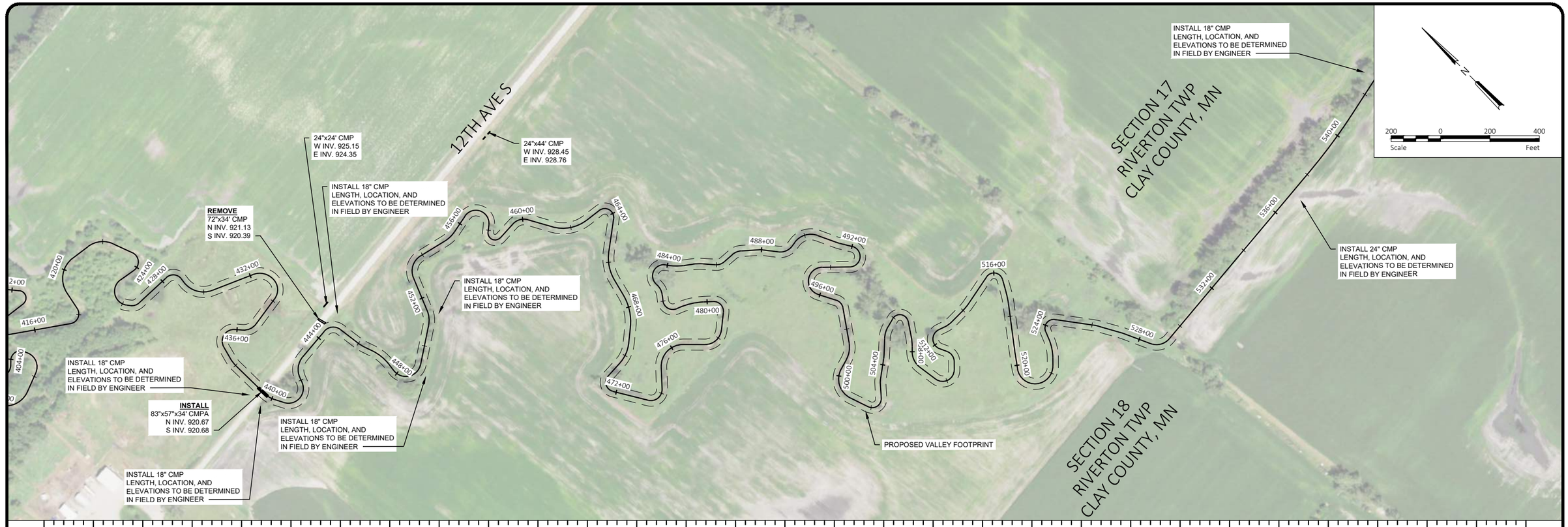
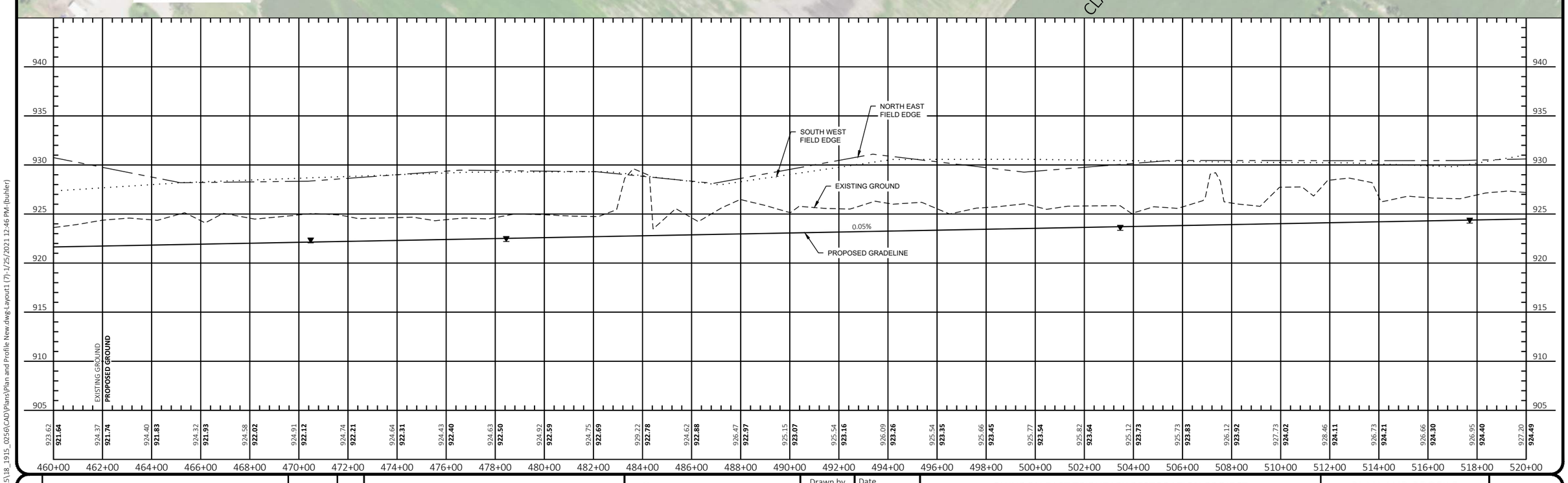
GLYNDON EAST TRIBUTARY RESTORATION PROJECT
BUFFALO-RED RIVER WATERSHED DISTRICT
BARNESVILLE, MINNESOTA

PLAN AND PROFILE

PROJECT NO. 1915-0256

SHEET 7





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GLYNDON EAST TRIBUTARY RESTORATION PROJECT
BUFFALO-RED RIVER WATERSHED DISTRICT
BARNESVILLE, MINNESOTA

PLAN AND PROFILE

PROJECT NO. 1915-0256

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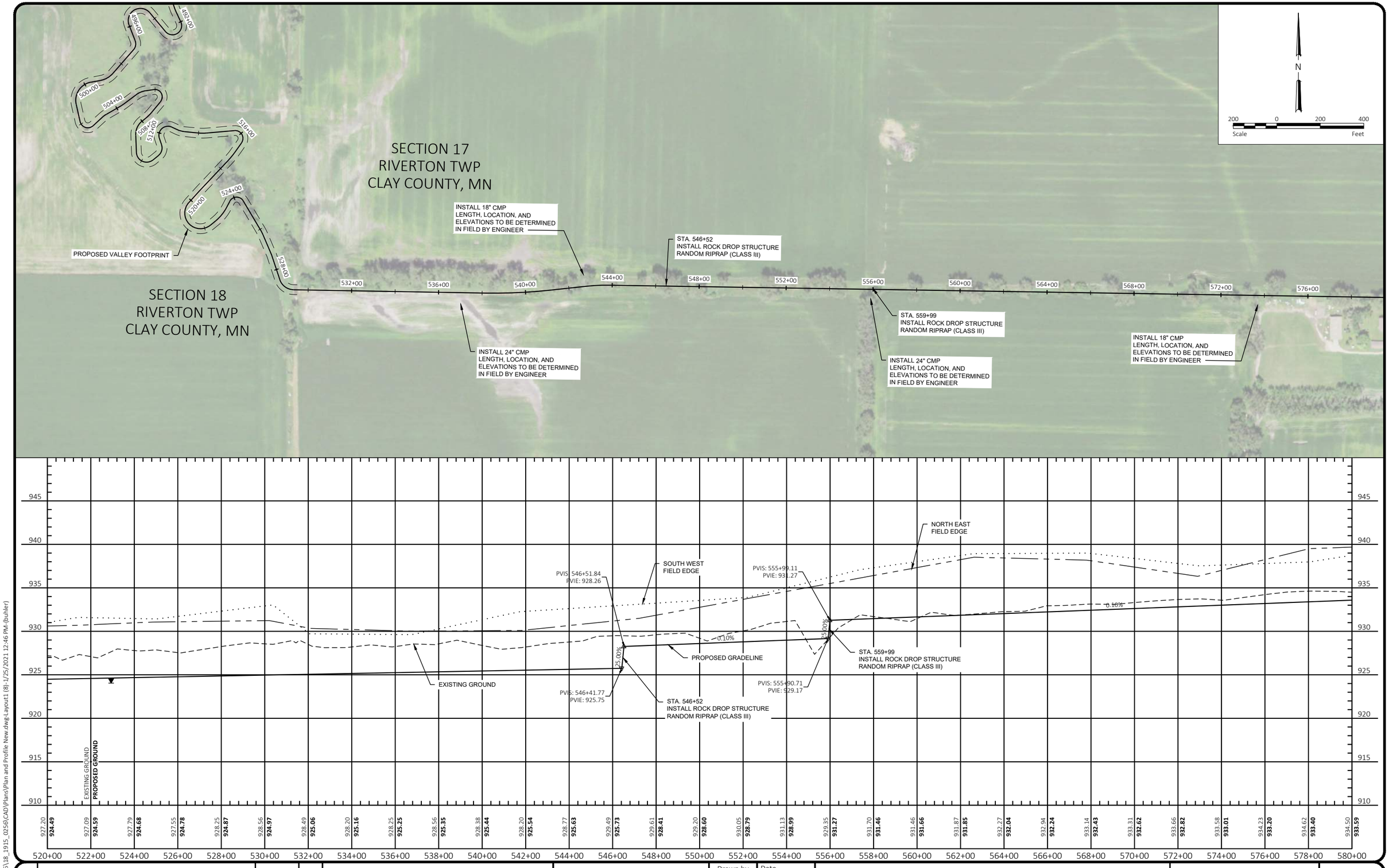

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GLYNDON EAST TRIBUTARY RESTORATION PROJECT
BUFFALO-RED RIVER WATERSHED DISTRICT
BARNESVILLE, MINNESOTA

PLAN AND PROFILE

PROJECT NO. 1915-0256

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GLYNDON EAST TRIBUTARY RESTORATION PROJECT
BUFFALO-RED RIVER WATERSHED DISTRICT
BARNESVILLE, MINNESOTA

PLAN AND PROFILE

PROJECT NO. 1915-0256

SHEET
10

SECTION 7
RIVERTON TWP
CLAY COUNTY, MN

SECTION 8
RIVERTON TWP
CLAY COUNTY, MN

SECTION 18
RIVERTON TWP
CLAY COUNTY, MN

SECTION 17
RIVERTON TWP
CLAY COUNTY, MN

130TH ST S

12TH AVE S

N

200 0 200 400
Scale Feet

400+00 404+00 416+00 420+00 424+00 428+00 432+00 436+00 440+00 444+00 448+00 452+00 456+00 460+00 464+00 468+00 484+00

12+00 16+00 20+00 24+00 28+00 32+00 36+00 40+00 44+00 45+14

24"x24' CMP
W INV. 924.35
E INV. 925.19

STA. 10+46
INSTALL ROCK DROP STRUCTURE
RANDOM RIPRAP (CLASS III)

REMOVE
72"x34' CMP
N INV. 921.13
S INV. 920.39

REMOVE
24"x44' CMP
W INV. 928.45
E INV. 928.76

STA. 14+08
INSTALL ROCK DROP STRUCTURE
RANDOM RIPRAP (CLASS III)

PROPOSED DITCH GRADING

24"x48' CMP
W INV. 929.03
E INV. 928.85

24"x30' CMP
W INV. 930.34
E INV. 930.83

24"x32' CMP
W INV. 930.93
E INV. 930.88

CONSTRUCT DITCH BLOCK
TOP ELEV. = 933.75

REMOVE
24"x24' CMP
W INV. 928.87
E INV. 929.01

INSTALL
64"x43"x60' CMPA
E INV. 928.00
W INV. 928.06

INSTALL
64"x43"x70' CMPA
N INV. 929.80
S INV. 929.00

PROPOSED DITCH GRADING

24"x56' CMP
W INV. 931.82
E INV. 931.92

REMOVE
36"x40' CMP
N INV. 930.42
S INV. 931.33

REMOVE
36"x40' CMP
N INV. 930.35
S INV. 930.90

945 940 935 930 925 920 915 910

927.92 927.92 929.68 929.68 930.38 930.38 930.09 930.09 929.33 929.33 929.65 929.65 929.54 929.54 929.77 929.77 930.46 930.46 930.68 930.68 931.06 931.06 931.86 931.86 932.64 932.64 935.64 935.64 932.72 932.72 934.32 934.32 932.99 932.99

10+00 12+00 14+00 16+00 18+00 20+00 22+00 24+00 26+00 28+00 30+00 32+00 34+00 36+00 38+00 40+00 42+00 44+00 46+00

REMOVE
24"x44' CMP
W INV. 928.45
E INV. 928.76

EXISTING GROUND
(LIDAR + SURVEY)

12TH AVE S ℄

PVIS: 10+45.98
PVIE: 923.77

PVIS: 14+08.35
PVIE: 926.63

PVIS: 13+95.75
PVIE: 924.11

PVIS: 10+21.41
PVIE: 921.31

0.10%
20.00%
20.00%

STA. 10+46
INSTALL ROCK DROP STRUCTURE
RANDOM RIPRAP (CLASS III)

STA. 14+08
INSTALL ROCK DROP STRUCTURE
RANDOM RIPRAP (CLASS III)

PROPOSED DITCH GRADING

REMOVE
24"x24' CMP
W INV. 928.87
E INV. 929.01

INSTALL
64"x43"x60' CMPA
E INV. 928.00
W INV. 928.06

PVIS: 37+56.56
PVIE: 928.98

PVIS: 38+28.41
PVIE: 929.81

INSTALL
64"x43"x70' CMPA
N INV. 929.80
S INV. 929.00

PVIS: 43+64.38
PVIE: 930.34

REMOVE
36"x40' CMP
N INV. 930.42
S INV. 931.33

REMOVE
36"x40' CMP
N INV. 930.35
S INV. 930.90

No.	Revision	Date	By

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HOUSTON engineering, inc.

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AJK	1-25-2021
Checked by	Scale
BAU	AS SHOWN

GLYNDON EAST TRIBUTARY RESTORATION PROJECT
BUFFALO-RED RIVER WATERSHED DISTRICT
BARNESVILLE, MINNESOTA

PLAN AND PROFILE
12TH AVE S
PROJECT NO. 1915-0256

SHEET
11

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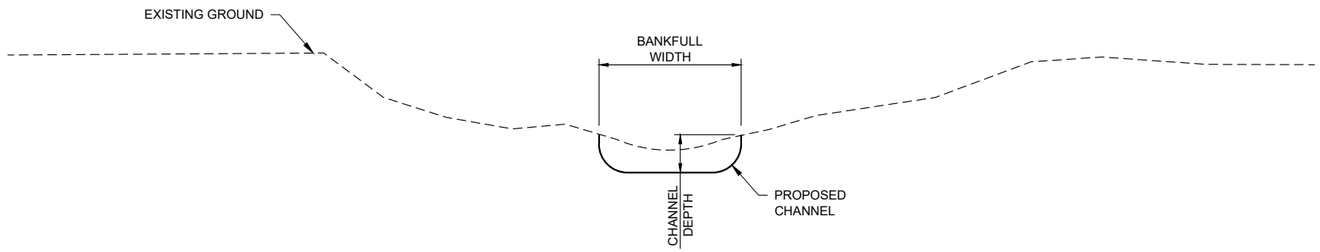
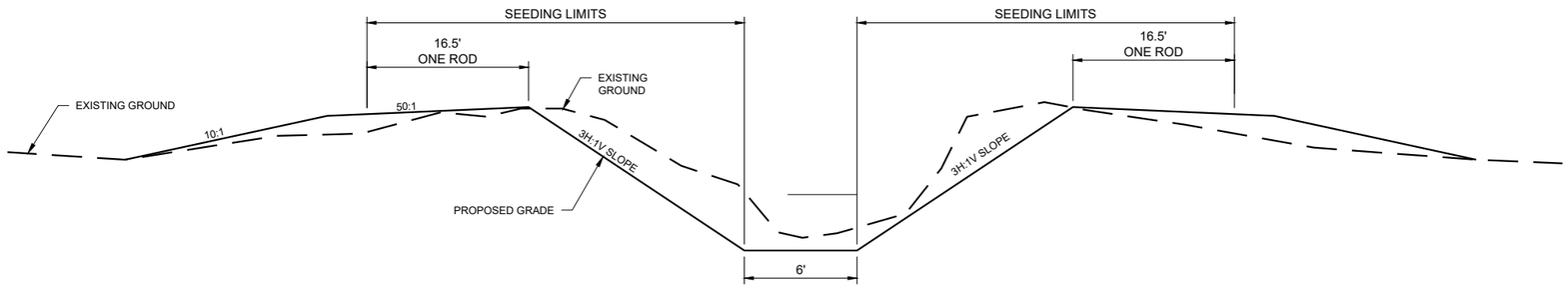


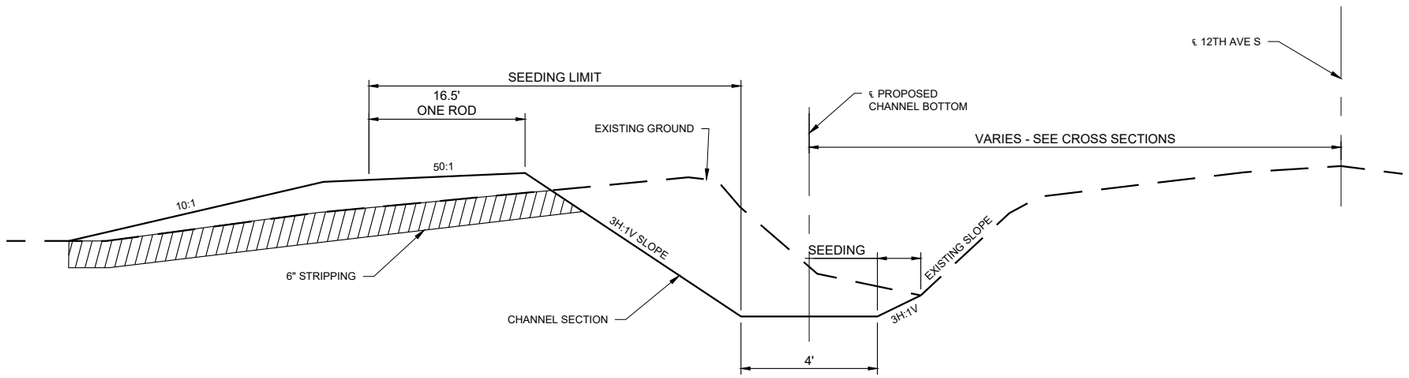
TYPICAL CHANNEL SECTION: STA. 100+00 TO STA. 267+00 AND STA 316+00 TO STA. 426+00

NOT TO SCALE



TYPICAL CHANNEL SECTION: STA. 529+00 TO STA. 582+45

NOT TO SCALE



TYPICAL DITCH SECTION - 12TH AVE S

NOT TO SCALE

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HOUSTON ENGINEERING INC.

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GLYNDON EAST TRIBUTARY RESTORATION PROJECT
BUFFALO-RED RIVER WATERSHED DISTRICT
BARNESVILLE, MINNESOTA

TYPICAL SECTIONS

PROJECT NO. 1915-0256

SHEET
12

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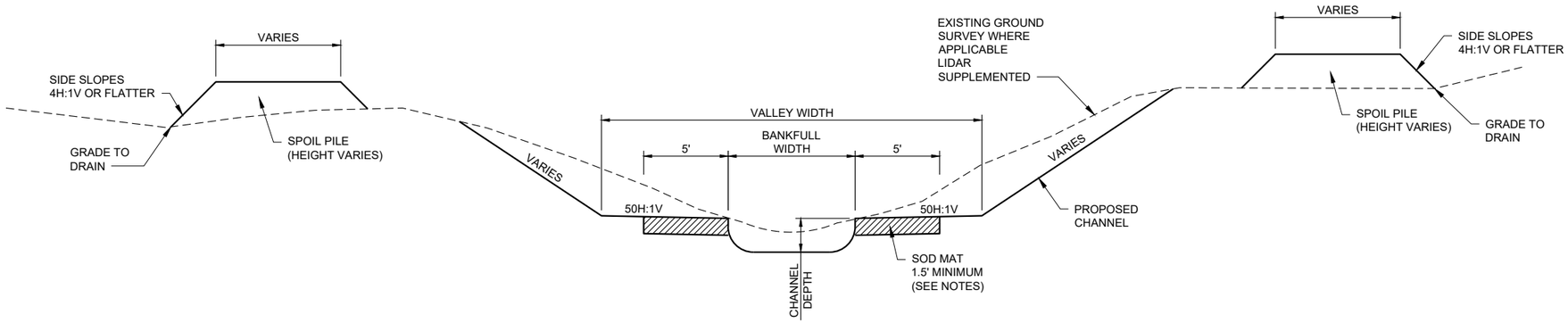
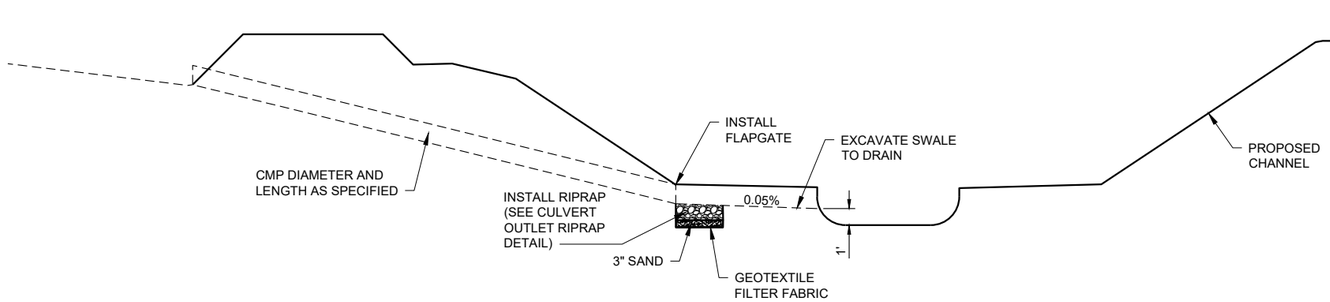


NOTES:

1. SOD MATERIAL SHALL CONSIST OF SUFFICIENT PLANT GROWTH TO BIND THE SOD MAT TOGETHER. SOD MATS CONTAINING WILLOWS AND/OR DENSE STANDS OF GRASSES ARE CONSIDERED IDEAL. ACCEPTABLE SOD MATERIAL SHALL BE DETERMINED BY THE ENGINEER OR FIELD REPRESENTATIVE. IN WETLAND LOCATIONS WHERE SOD MATERIAL IS NOT AVAILABLE, THE CONTRACTOR SHALL INSTALL BIODEGRADABLE EROSION BLANKETS THAT ARE 5' IN WIDTH AND ARE PLACED AT THE VALLEY ELEVATION.
2. SPOIL PILE LOCATIONS TO BE DETERMINED BY THE CONTRACTOR AND APPROVED BY THE ENGINEER. THE CONTRACTOR MAY NOT PLACE SPOIL IN LOCATIONS DENOTED ON THE PLANS OR OUTSIDE OF THE RIGHT-OF-WAY.
3. THE CONTRACTOR SHALL FILL ABANDONED CHANNEL TO THE VALLEY ELEVATION OR MATCH THE ADJACENT GROUND ELEVATION, WHICHEVER IS LOWER.

TYPICAL CHANNEL SECTION: STA. 267+00 TO STA. 316+00 AND STA. 426+00 TO STA. 529+50

NOT TO SCALE



TYPICAL FIELD INLET SECTION

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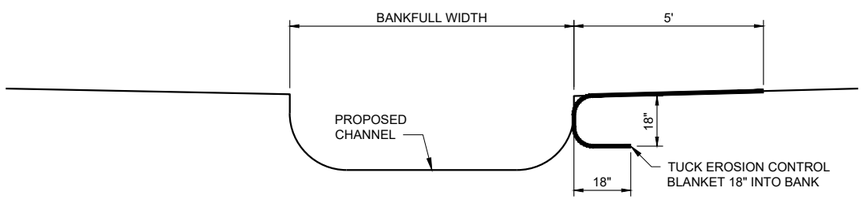
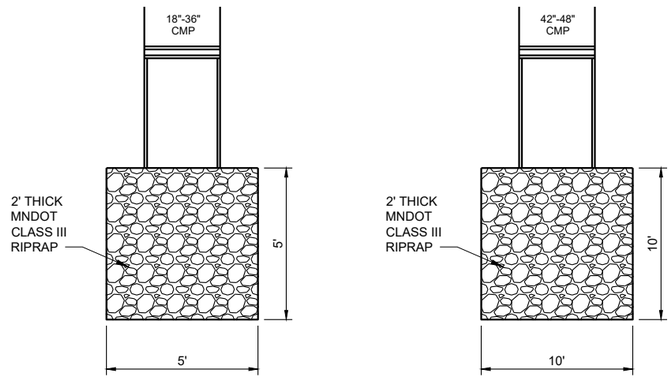


EROSION CONTROL BLANKET



CULVERT OULET RIPRAP DETAIL

No.	Revision	Date	By

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HOUSTON ENGINEERING INC.

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GLYNDON EAST TRIBUTARY RESTORATION PROJECT
BUFFALO-RED RIVER WATERSHED DISTRICT
BARNESVILLE, MINNESOTA

DETAILS

PROJECT NO. 1915-0256

SHEET 13

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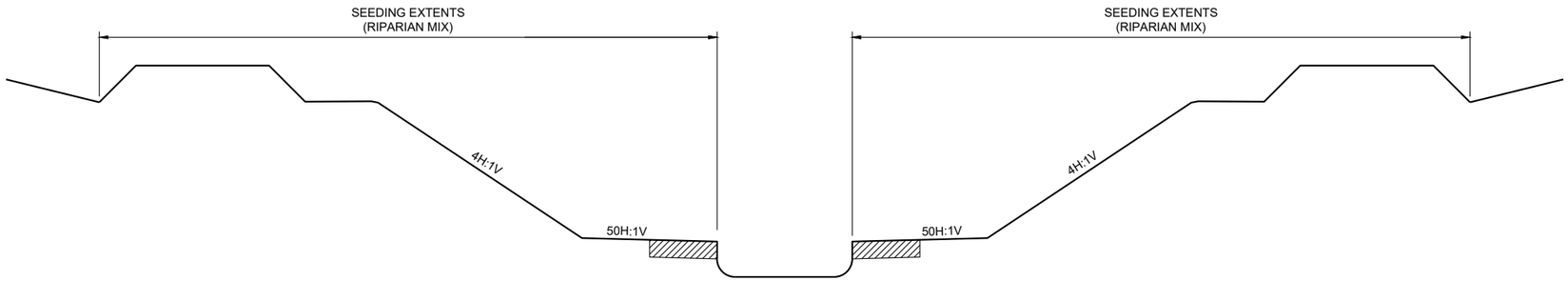

SEEDING LIMITS

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GLYNDON EAST TRIBUTARY RESTORATION PROJECT
BUFFALO-RED RIVER WATERSHED DISTRICT
BARNESVILLE, MINNESOTA

DETAILS

PROJECT NO. 1915-0256

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HEI NO. 1915-0256

PROPOSED CHANNEL PROFILE							
STATION	STRUCTURE(S)	DOWNSTREAM INVERT (FT)	UPSTREAM INVERT (FT)	PROPOSED CHANNEL INVERT (FT)	PROPOSED VALLEY INVERT (FT)	PROPOSED DOWNSTREAM CHANNEL SLOPE (%)	PROPOSED DOWNSTREAM VALLEY SLOPE (%)
127+00	3 - Lines of 12' x 8' RCB	907.49	907.81	907.49	N/A	0.05%	N/A
173+00	2 - Lines of 58" x 36" RCPA	908.98	908.99	908.98	N/A	0.03%	N/A
242+00	2 - Lines of 10' x 6' RCB	911.18	912.04	911.18	N/A	0.03%	N/A
245+00	2 - Lines of 58" x 36" RCPA	912.13	912.14	912.13	N/A	0.05%	N/A
253+50	2 - Lines of 58" x 36" RCPA	912.58	912.59	912.58	N/A	0.05%	N/A
265+50	BNSF Railroad Bridge	N/A	N/A	913.23	N/A	0.05%	N/A
303+00	2 - Lines of 58" x 36" RCPA	915.21	915.23	915.21	918.21	0.05%	0.05%
365+00	1 - Line of 84" CMP	918.42	918.50	918.42	921.42	0.05%	0.05%
439+50	1 - Line of 83" x 57" CMPA	920.66	920.67	920.66	923.66	0.05%	0.05%
303+00	1 - Line of 71" x 47" CMPA	935.86	935.92	935.86	N/A	0.10%	N/A

PROPOSED CHANNEL GEOMETRY					
REACH	DOWNSTREAM STATION	UPSTREAM STATION	DOWNSTREAM BANKFULL WIDTH (FT)	DOWNSTREAM CHANNEL DEPTH (FT)	DOWNSTREAM VALLEY WIDTH (FT)
GLYNDON EAST TRIBUTARY	100+00	268+00	10.5	3	N/A
GLYNDON EAST TRIBUTARY	268+00	529+00	10.5	3	45

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GLYNDON EAST TRIBUTARY RESTORATION PROJECT
BUFFALO-RED RIVER WATERSHED DISTRICT
BARNESVILLE, MINNESOTA

DETAILS

PROJECT NO. 1915-0256

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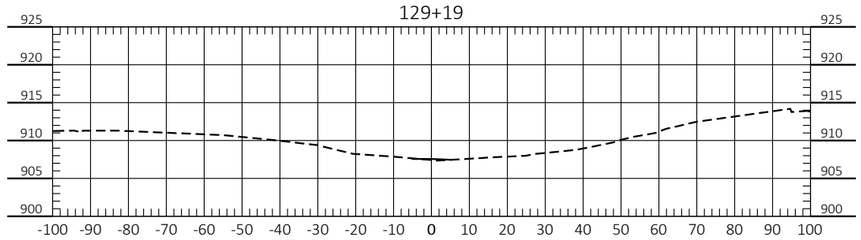
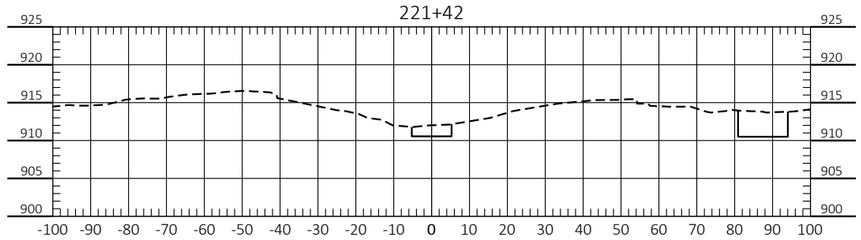
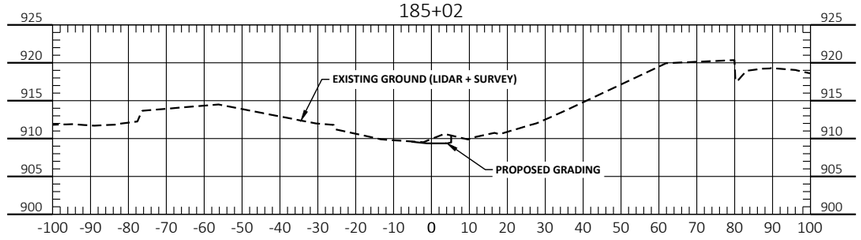
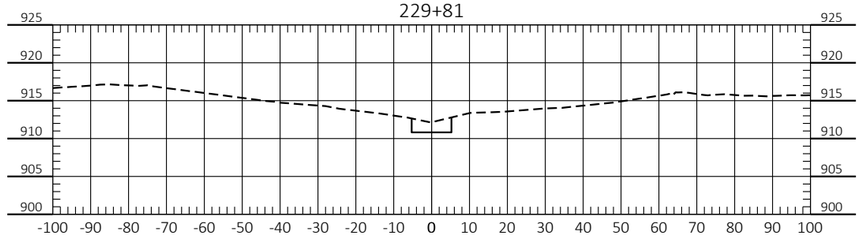
15

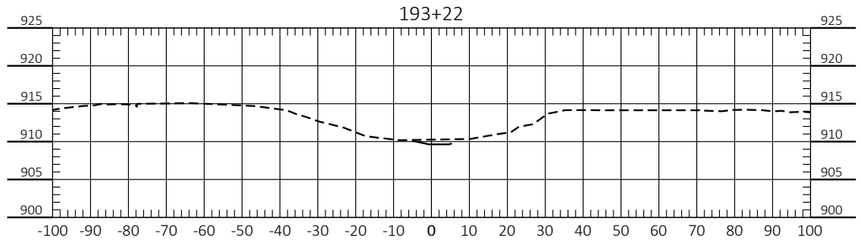
HEI NO. 1915-0256

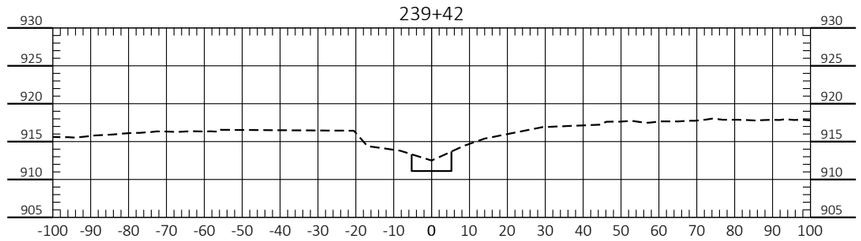


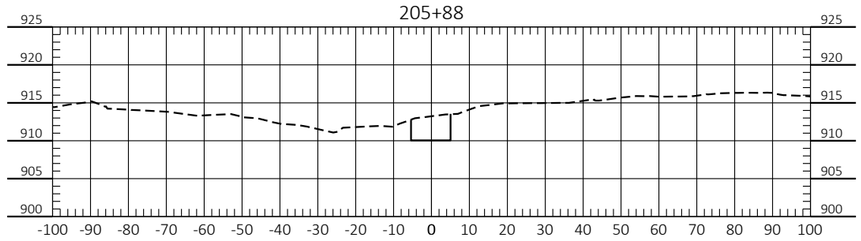


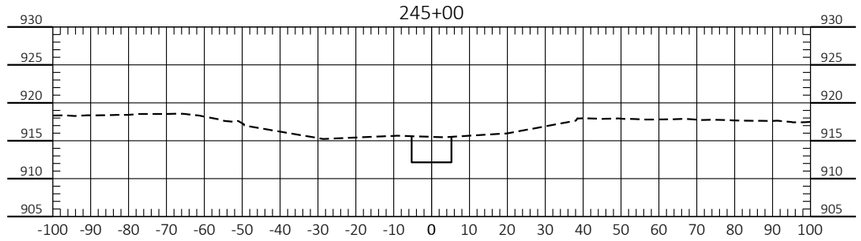












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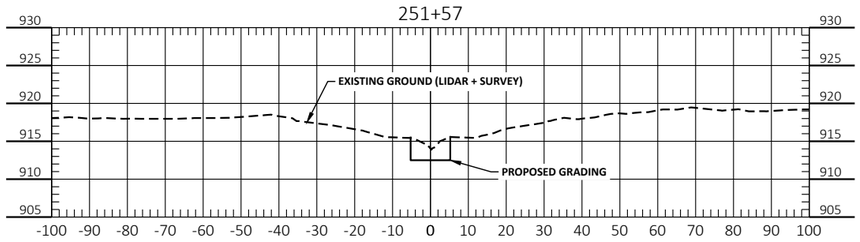
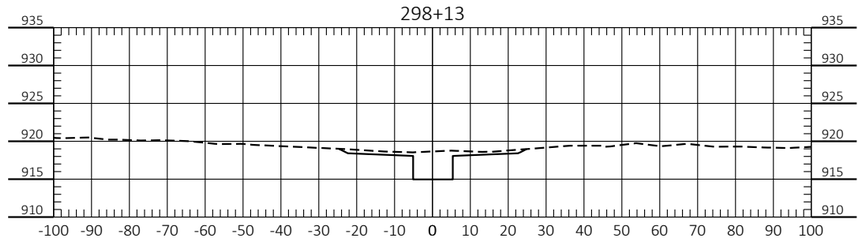
GLYNDON EAST TRIBUTARY RESTORATION PROJECT
BUFFALO-RED RIVER WATERSHED DISTRICT
BARNESVILLE, MINNESOTA

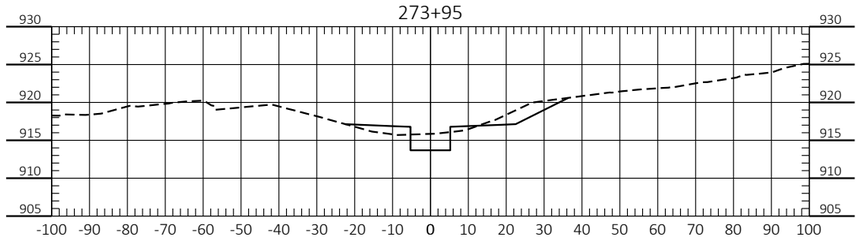
CROSS SECTIONS

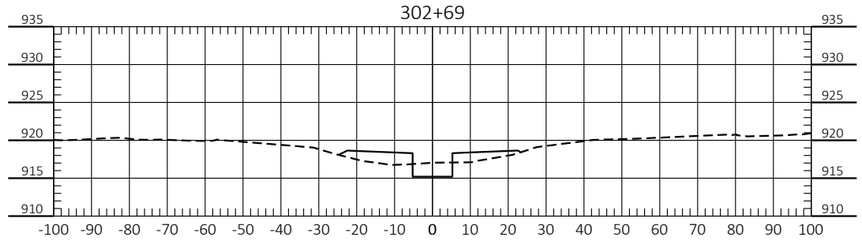
PROJECT NO. 1915-0256

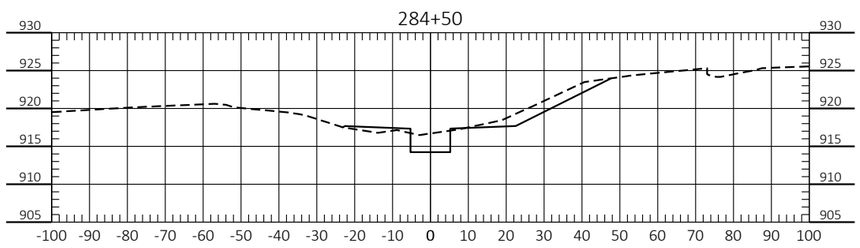
SHEET
16

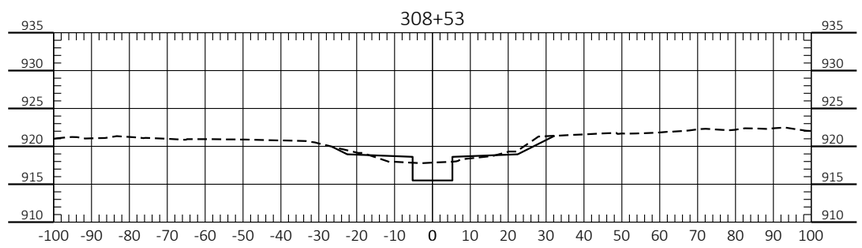


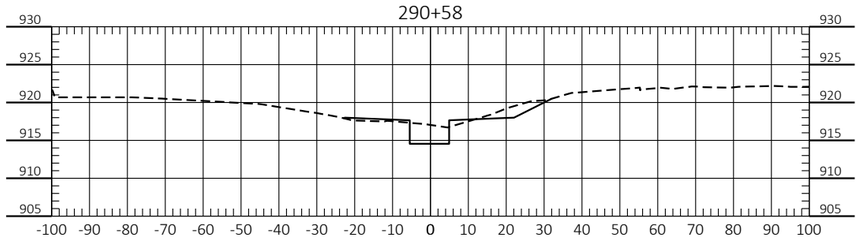


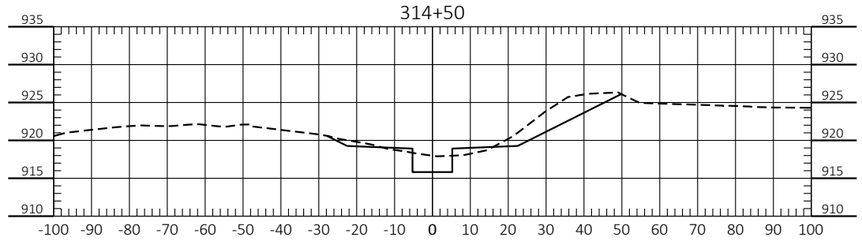












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GLYNDON EAST TRIBUTARY RESTORATION PROJECT
BUFFALO-RED RIVER WATERSHED DISTRICT
BARNESVILLE, MINNESOTA

CROSS SECTIONS

PROJECT NO. 1915-0256

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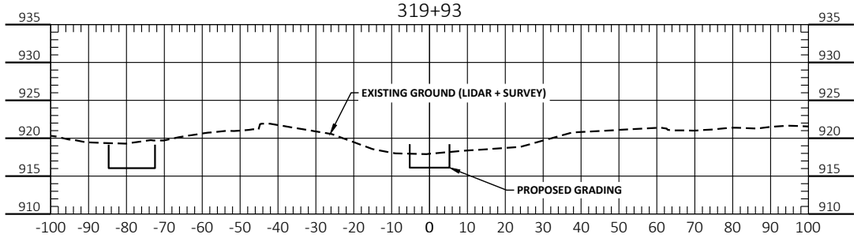
17

319+93



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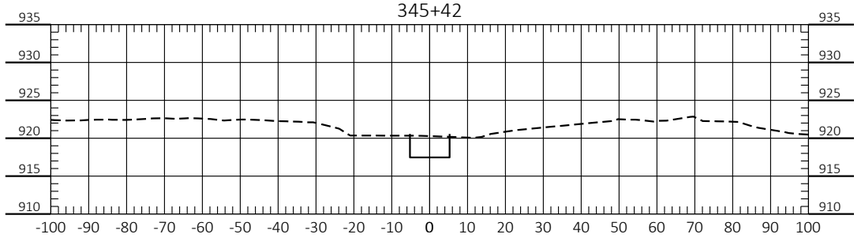

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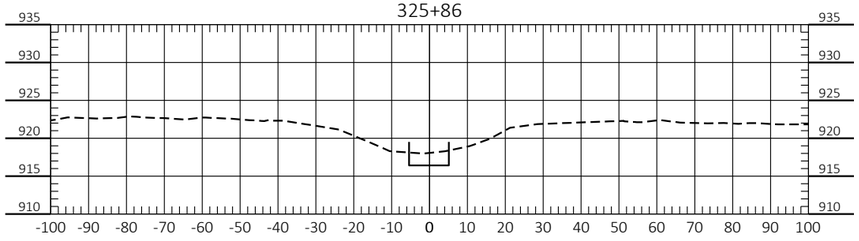

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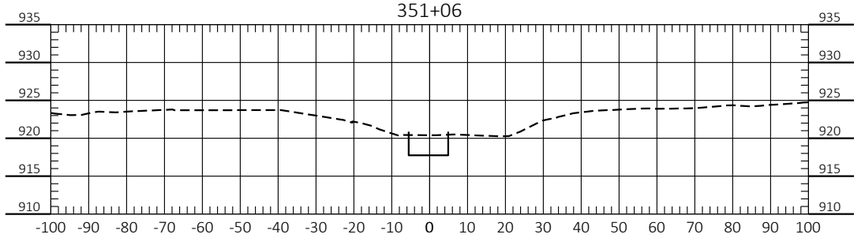

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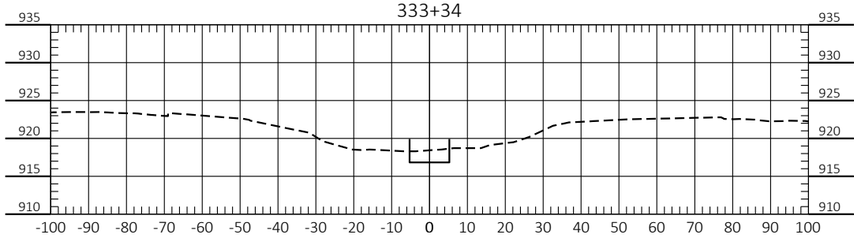

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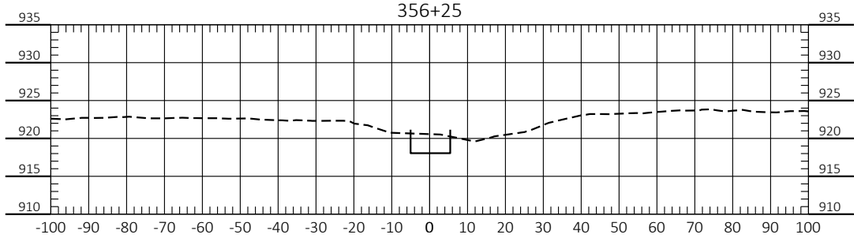

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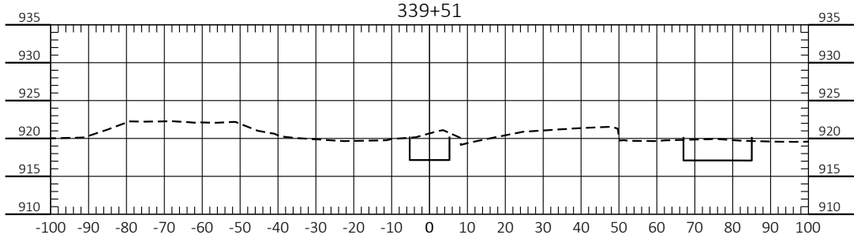

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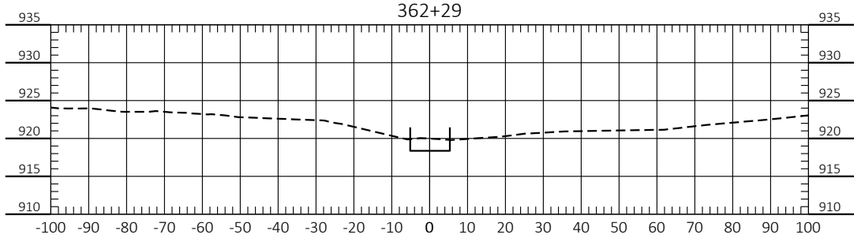

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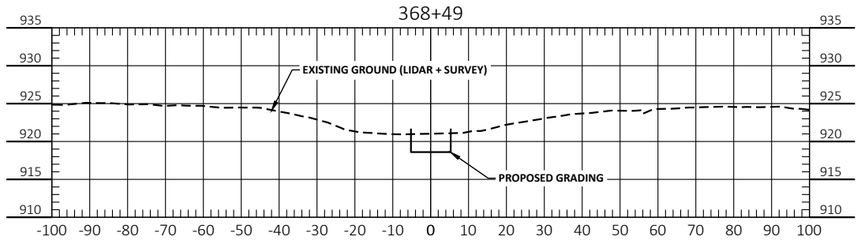
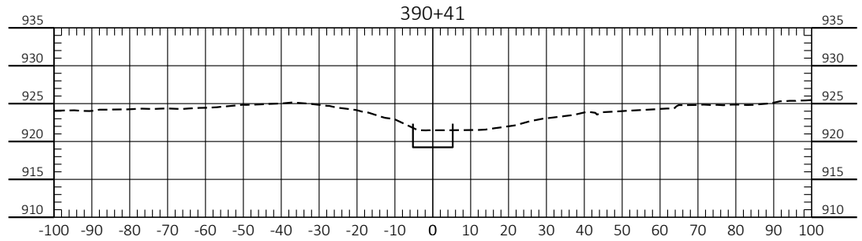
BUFFALO-RED RIVER WATERSHED DISTRICT
BARNESVILLE, MINNESOTA

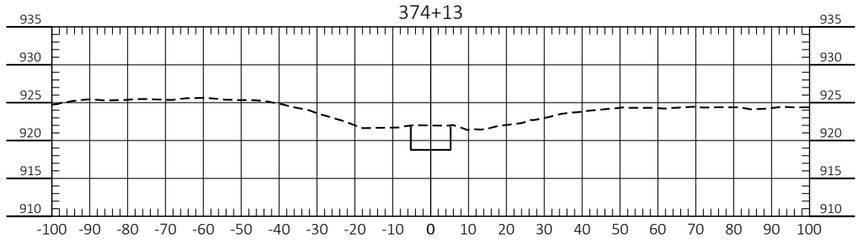
CROSS SECTIONS

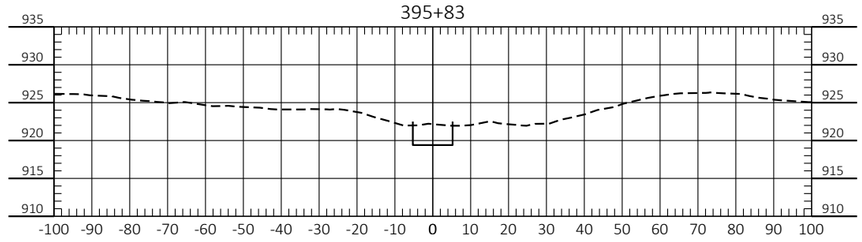
PROJECT NO. 1915-0256

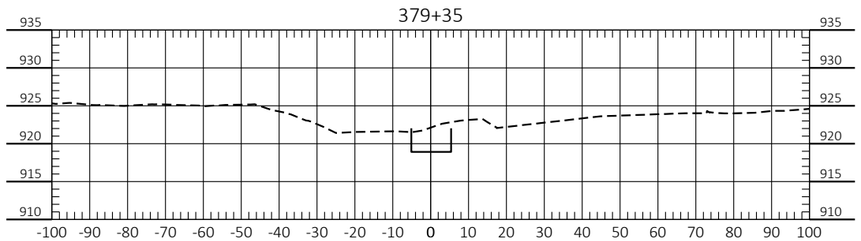
SHEET
18

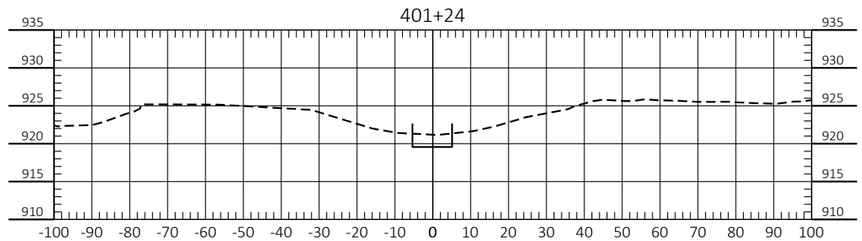


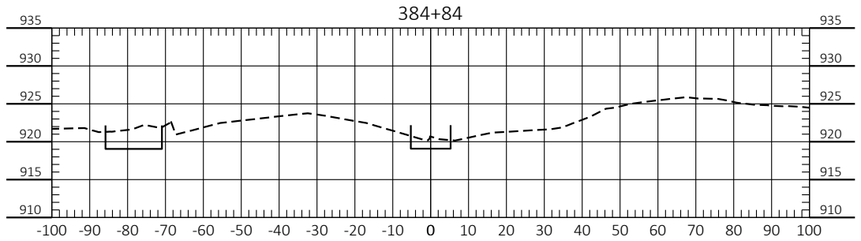


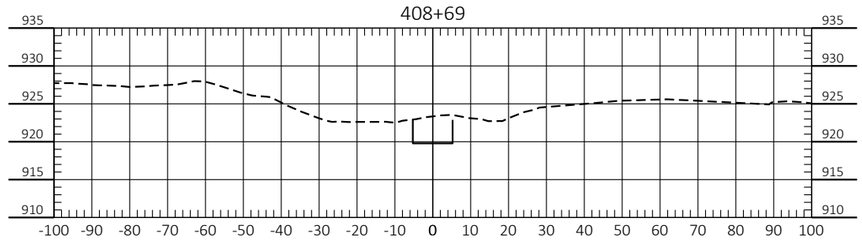












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AJK	1-25-2021
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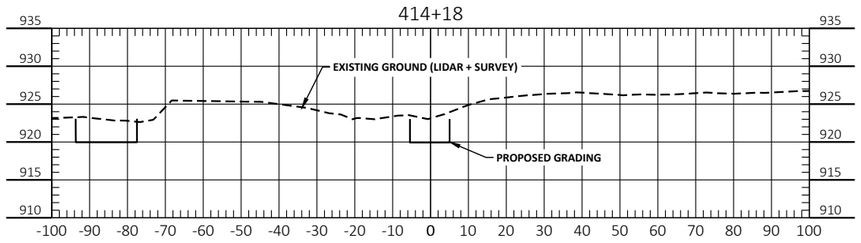
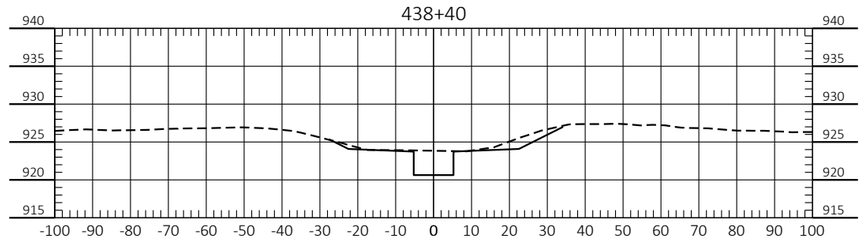
GLYNDON EAST TRIBUTARY RESTORATION PROJECT
BUFFALO-RED RIVER WATERSHED DISTRICT
BARNESVILLE, MINNESOTA

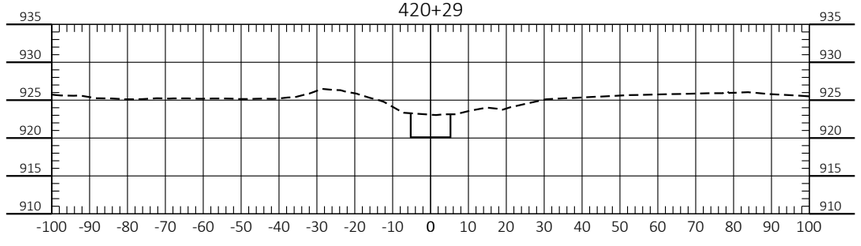
CROSS SECTIONS

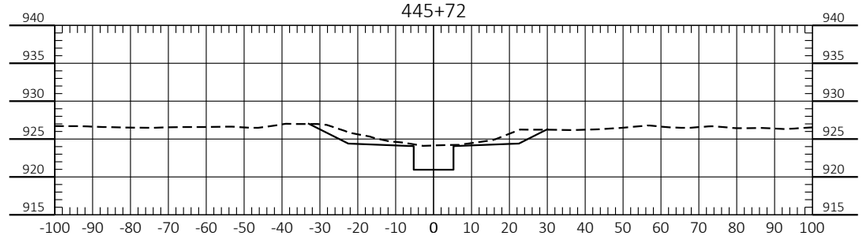
PROJECT NO. 1915-0256

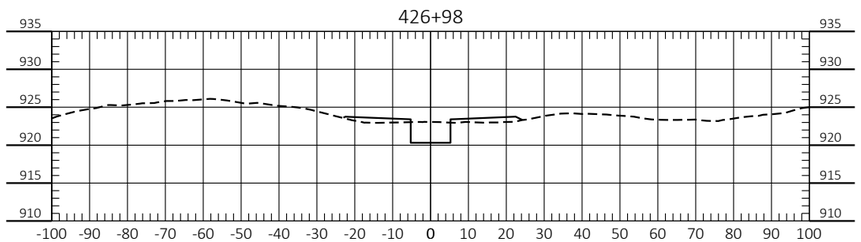
SHEET
19

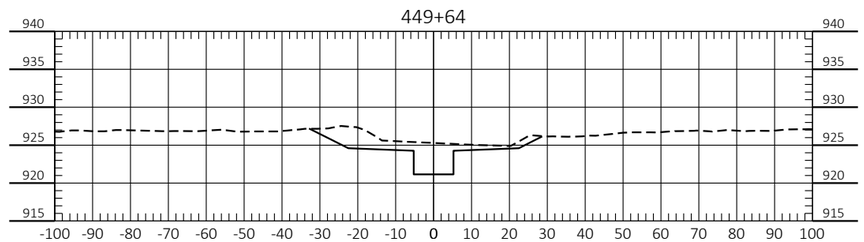


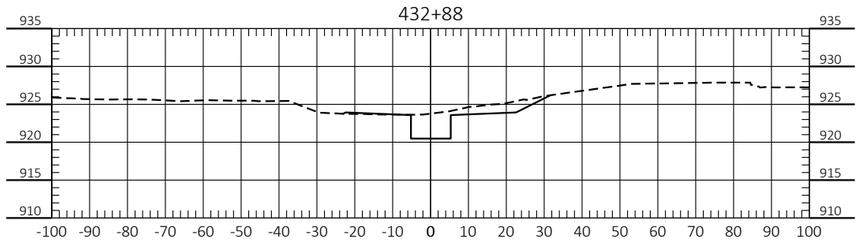


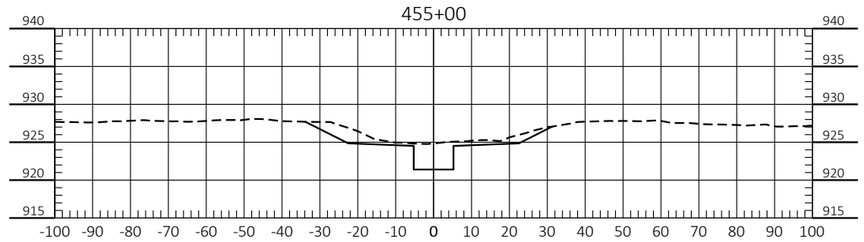












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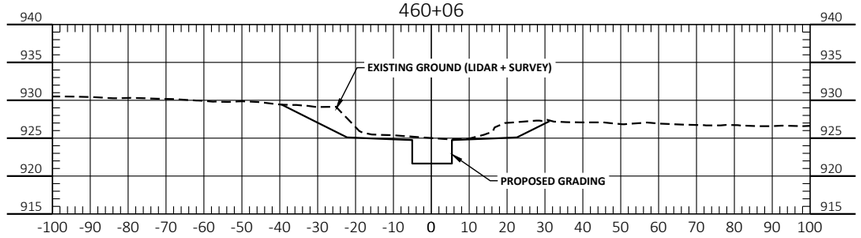
BUFFALO-RED RIVER WATERSHED DISTRICT
BARNESVILLE, MINNESOTA

CROSS SECTIONS

PROJECT NO. 1915-0256

SHEET
20

460+06



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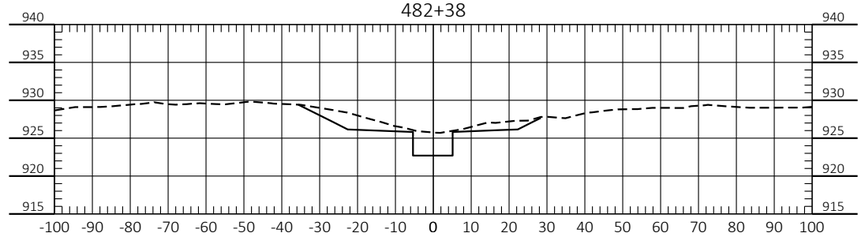

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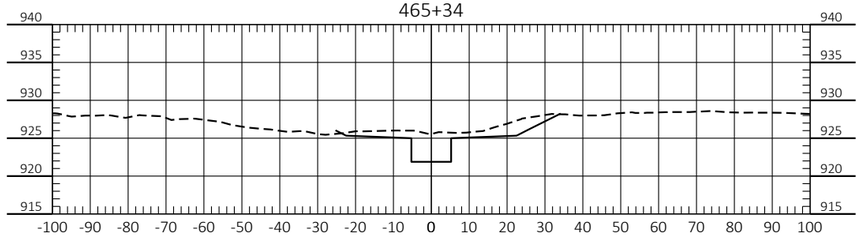

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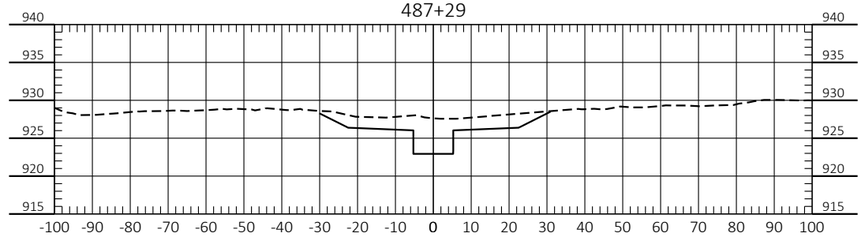

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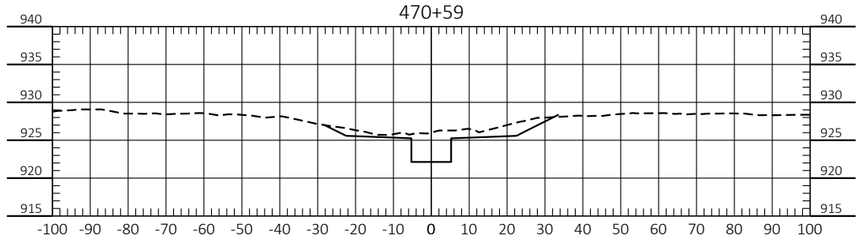

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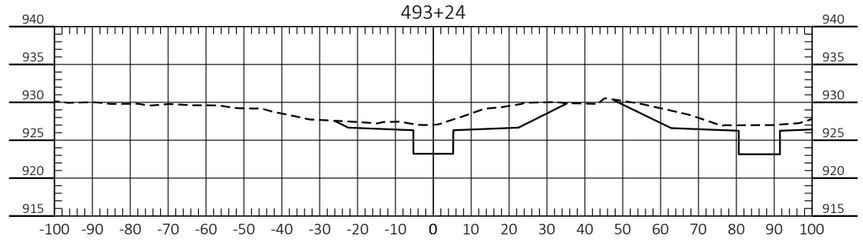

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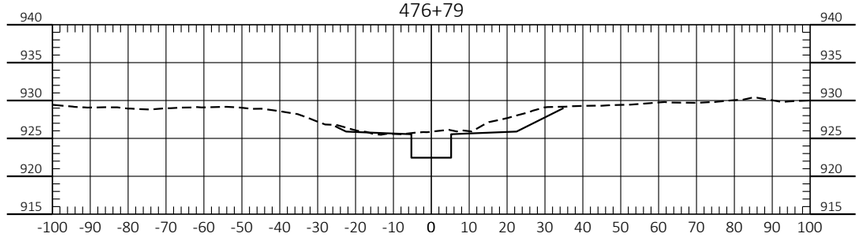

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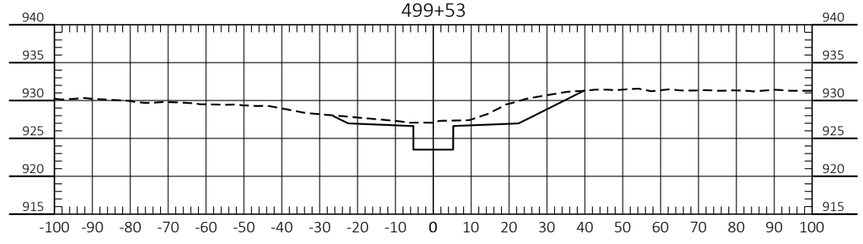

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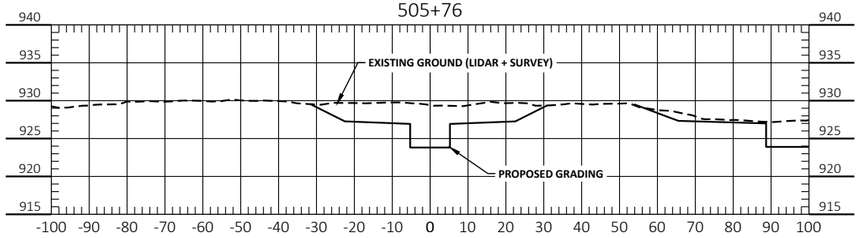
GLYNDON EAST TRIBUTARY RESTORATION PROJECT
BUFFALO-RED RIVER WATERSHED DISTRICT
BARNESVILLE, MINNESOTA

CROSS SECTIONS

PROJECT NO. 1915-0256

SHEET 21

505+76



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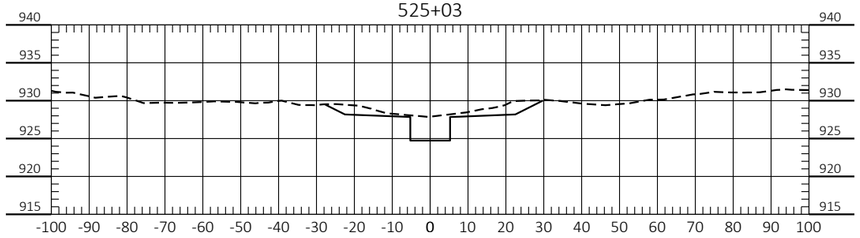

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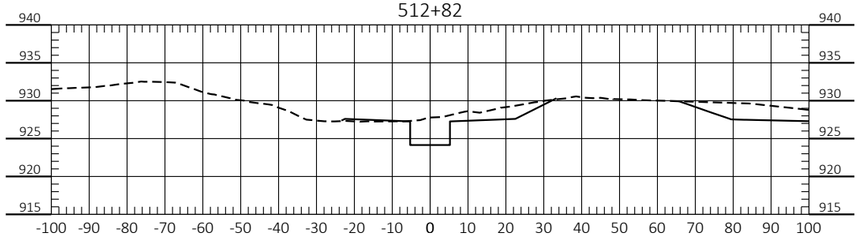

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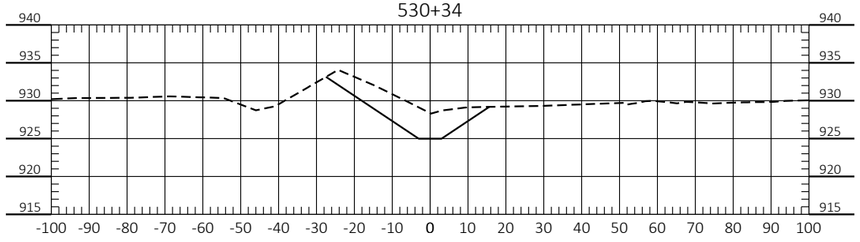

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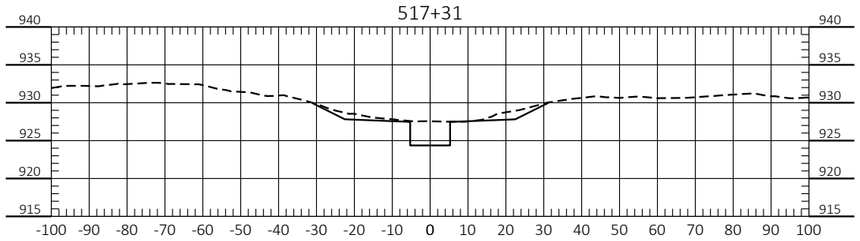

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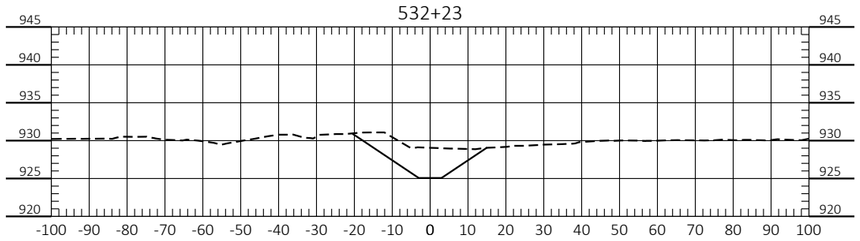

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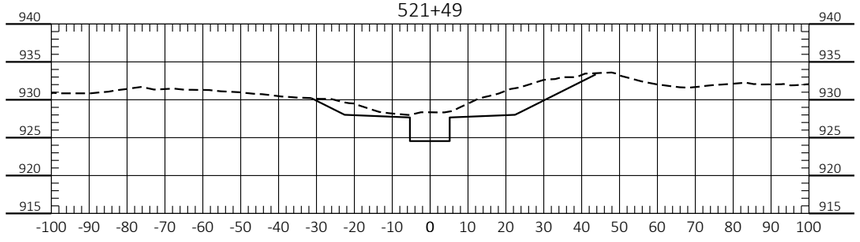

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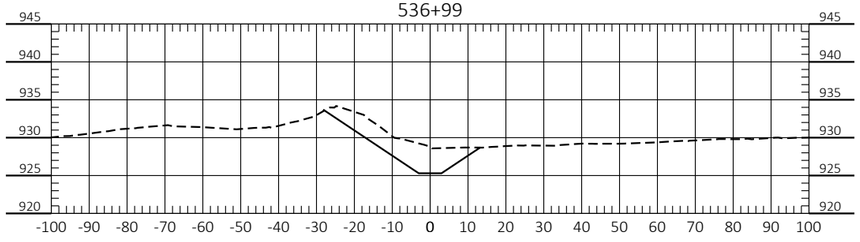

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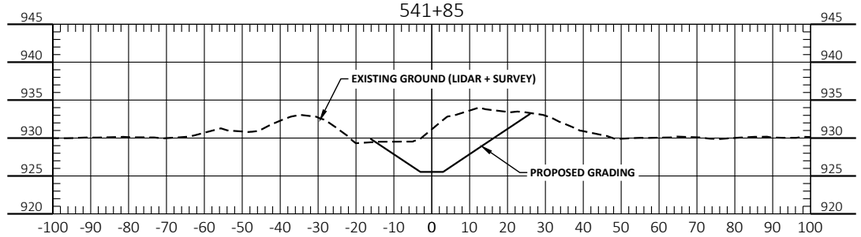
GLYNDON EAST TRIBUTARY RESTORATION PROJECT
BUFFALO-RED RIVER WATERSHED DISTRICT
BARNESVILLE, MINNESOTA

CROSS SECTIONS

PROJECT NO. 1915-0256

SHEET
22

541+85



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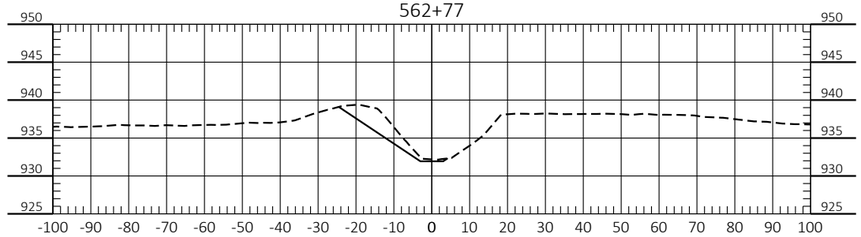

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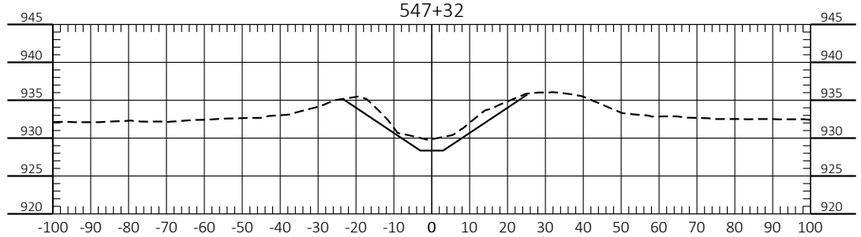

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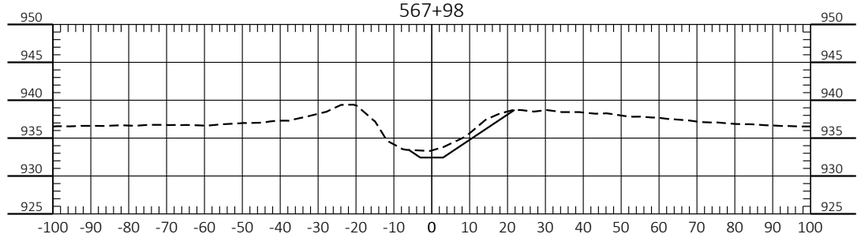

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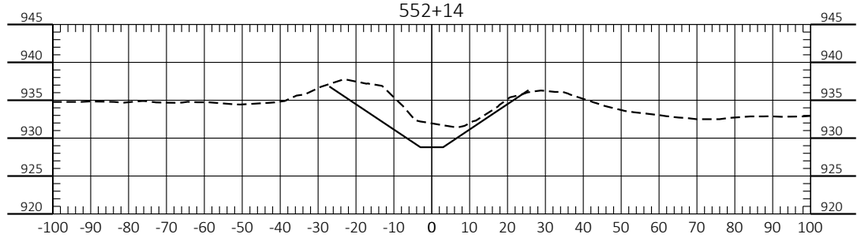

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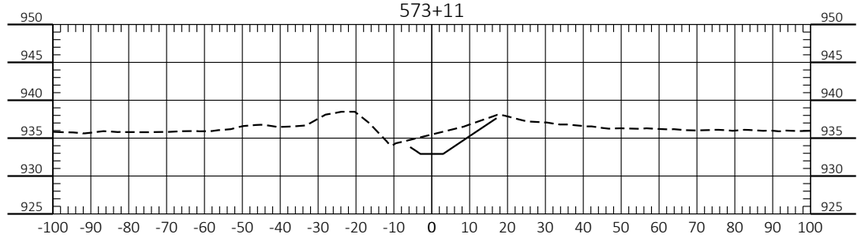

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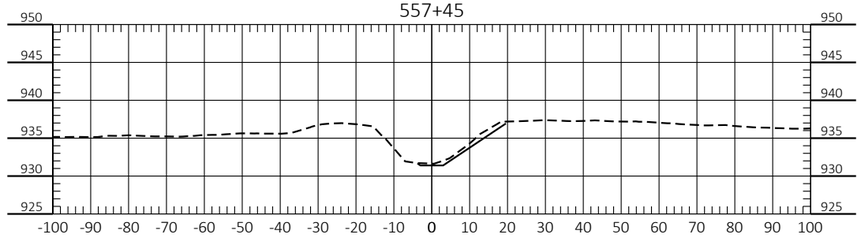

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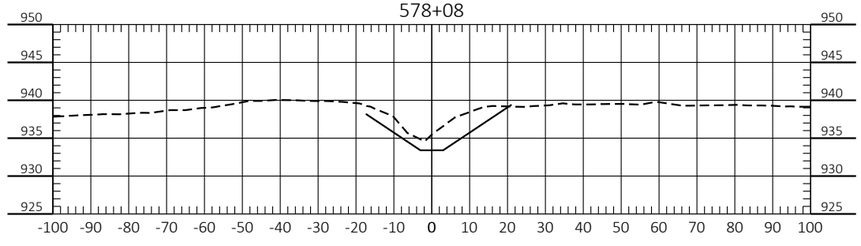

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GLYNDON EAST TRIBUTARY RESTORATION PROJECT
BUFFALO-RED RIVER WATERSHED DISTRICT
BARNESVILLE, MINNESOTA

CROSS SECTIONS

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SHEET 23

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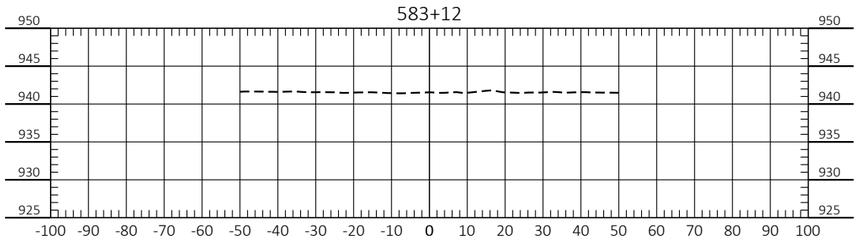

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GLYNDON EAST TRIBUTARY RESTORATION PROJECT
BUFFALO-RED RIVER WATERSHED DISTRICT
BARNESVILLE, MINNESOTA

CROSS SECTIONS

PROJECT NO. 1915-0256

SHEET
24

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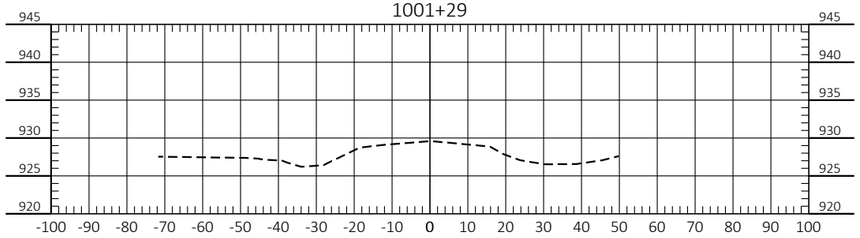

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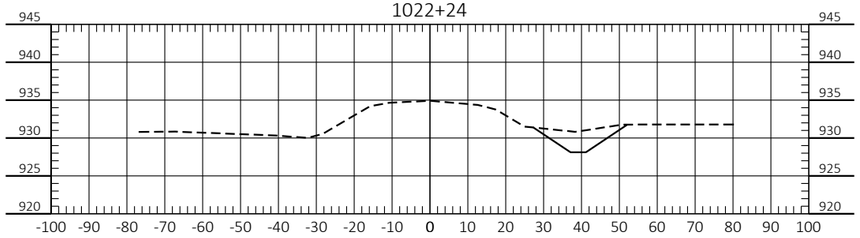

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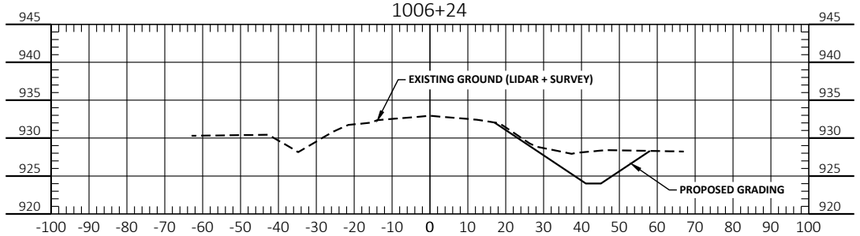

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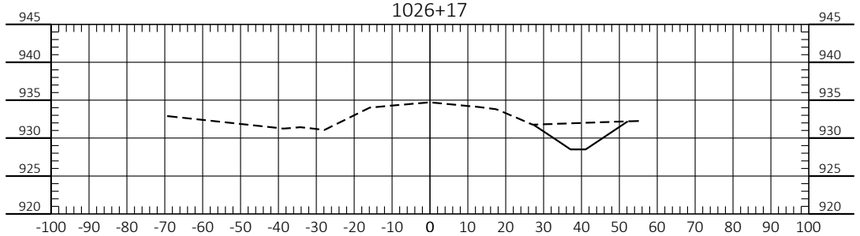

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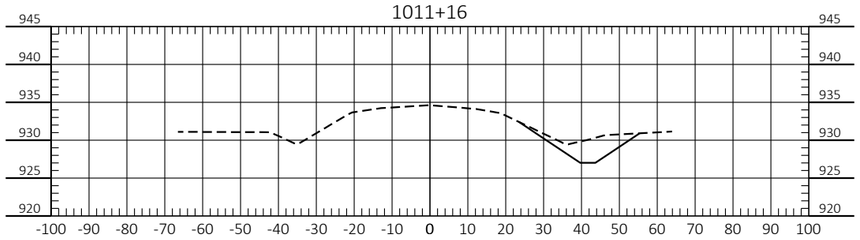

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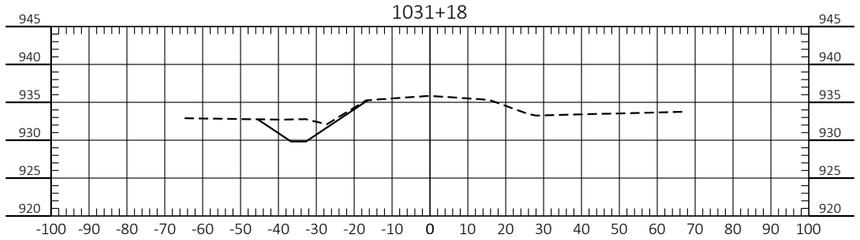

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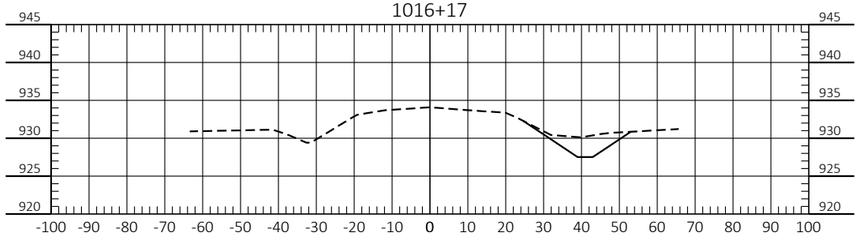

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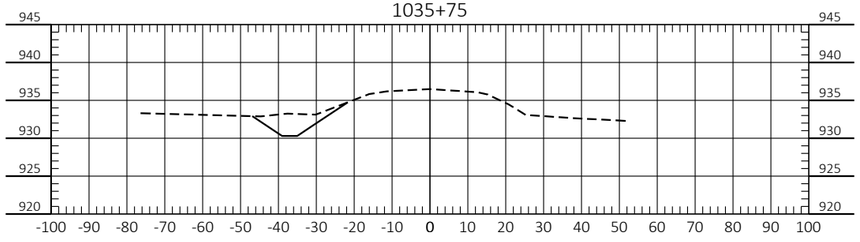

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GLYNDON EAST TRIBUTARY RESTORATION PROJECT
BUFFALO-RED RIVER WATERSHED DISTRICT
BARNESVILLE, MINNESOTA

CROSS SECTIONS
12TH AVE S
PROJECT NO. 1915-0256

SHEET
25