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MEMORANDUM

TO: Phil Belfiori, Administrator
Dawn Tanner, Program Development Coordinator
Vadnais Lake Area Water Management Organization (VLAWMO)

FROM: Mark Christenson, Water Resources Engineer
SEH

DATE: June 25, 2024

RE: Task Order No. 2023-02: Wilkinson Meander Concept Analysis
SEH No. VADNA 171749 14.00

BACKGROUND

A portion of the stream south of Wilkinson Lake is being considered for restoration. This memo will discuss the feasibility of restoring the channel to a more natural alignment with greater floodplain connectivity improving channel geomorphology, habitat, and water quality.

Wilkinson Lake discharges to Deep Lake via an outfall control structure which includes multiple weirs within a fish barrier. The outlet was constructed in 1994 with weir elevations ranging from 894.2 to 894.6 (NGVD 29). Wilkinson Lake's ordinary high water (OHW) elevation is 895.2 (NGVD 29). Lake level data collected by VLAWMO suggests that the average water level in the lake is about 895 (NAVD 88).

EXISTING CONDITIONS

Currently the stream runs straight from south to north through a wetland complex, ultimately discharging to Wilkinson Lake. The reach being considered for restoration is located between the local road located approximately 2,200 feet south of Wilkinson Lake and the boardwalk located approximately 890 feet south of Wilkinson Lake. The stream was straightened at some unknown point in the past and has maintained the current alignment. The earliest aerial imagery found (1938) show the straightened channel as it exists today, therefore the pre-altered stream alignment is unknown. Figure 1 shows the USGS StreamStats drainage area to the stream.

A site visit was performed on November 17, 2023. The upstream and downstream ends of the proposed meander were visited to assess existing conditions and take preliminary field measurements to aide in channel analysis. A 24" CMP with a flared end section crosses the local road and discharges to the existing channel on the upstream end of the study area. There is some erosion at the pipe outlet and the pipe is somewhat misaligned with the channel, discharging more northwest rather than straight north. Bankfull width was measured at 24 ft approximately 150 ft downstream (north) of the pipe outlet. The water in the stream on this day was visibly flowing at approximately 1 foot deep and 3 feet wide. Side slopes were measured approximately at 6:1 (H:V) and banks were dry.

The downstream location was visited via the boardwalk that crosses the wetland complex, south of Wilkinson Lake. Water in the stream on this day was approximately 3 feet deep and extended at least 100 to 150 on either side of the channel. The channel was visible but completely inundated with a bankfull width approximately 14 feet. The water was stagnant during this time and suspected to be approximately the same elevation as the lake level. Side slopes were measured at approximately 6:1 (H:V).

WATERSHED HYDROLOGY/BANKFULL DISCHARGE

There are various sources of data available for the Wilkinson Lake watershed, including VLAWMO's XPSWMM model and other studies, the Total Maximum Daily Load (TMDL) and Protection Study, and available USGS StreamStats and other Minnesota Department of Natural Resources (MnDNR) data. Peak flow rates from the existing XPSWMM model and StreamStats are summarized in **Table 1**. Note that the XPSWMM model shows much lower flow rates in comparison to the StreamStats regression equations.

Table 1: Summary of Peak Flow Rates to Wilkinson via Southern Stream

Flow Event	XPSWMM Model (cfs)	StreamStats (cfs)
1-yr	5.9	--
1.5-yr	--	26.3
2-yr	8.2	33.1
10-yr	19.9	63.4
25-yr	32.2	80
50-yr	35.1	92.8
100-yr	39.3	106

In stream analysis and restoration, the bankfull stage is important. It is the stage at which the stream connects with the floodplain; the water level reaches top of bank just before spilling out onto the floodplain, where flow is attenuated and subsequently receives water quality benefits. It is important to consider that the project area is downstream of homes and businesses and choosing the correct bankfull discharge is important to avoid any impacts, real or perceived, to existing infrastructure. In an idealized scenario, the bankfull discharge is thought to be between the 1- and 2-year event, generally closer to the 1-year event.

The Minnesota Department of Natural Resources (MnDNR) has regional curves that calculate bankfull statistics based on drainage area size for any given stream reach. For the nearby Lambert Lake meander project, the DNR suggested the Rosgen Stillwater, Minnesota curve is a good representation of the metro area, but the Eastern Minnesota Curve is also available for comparison. **Table 2** summarizes the bankfull discharge values across both DNR regional curves, the XPSWMM model, and the StreamStats regression equations. As **Table 2** shows, the StreamStats 1.5-year flowrate falls between the Rosgen Stillwater curve and the Eastern Minnesota curve and all three are on the same order of magnitude. Because there is general agreement between these three data sources, the StreamStats regression curve value was used for concept development of the potential meander. It is recommended that a more detailed analysis be performed prior to final design to ensure no adverse impacts would be caused by the project.

Table 2: Summary of Bankfull Discharge Values

	Eastern MN Regional Curve	Rosgen Stillwater MN Class	XPSWMM Model**	StreamStats*
Bankfull Flow Rate (cfs)	36.4	19.3	7.1	26.3

*1.5-yr recurrence interval flow rate

**Linearly interpolated 1.5-yr event from 1 and 2-year events

PROPOSED CHANNEL CONCEPT

Concept Channel Cross Section

Based on the field visit data, the current ditch on the upstream end has a bankfull carrying capacity of approximately 79 cfs. This is much higher than any of the calculated discharge rates for bankfull rate and may indicate that the bankfull stage in the field was overestimated due to channel incision on the upstream end. It is recommended that more precise survey and analysis be performed prior to final design. The concept typical cross section, as seen on Figures 2 and 3 along with the concept alignment options, is shown to meet the Streamstats 1.5-yr recurrence interval (26.3 cfs).

Concept Alignments

Two meander concept pathways were prepared for this analysis. Both will meet the entrenchment ratio, W/D ratio, and sinuosity of a stream type E. The first proposed alignment (Figure 2) follows the current alignment down the middle of the wetland complex meandering back and forth until rejoining the current alignment just upstream (south) of the boardwalk. The total meander length shown on Figure 2 is 2,600 feet.

The second alignment (Figure 3) initially veers to the east running around an elevated topographic feature within the wetland. This option also proposes an oxbow restoration to increase floodplain storage and aid in water quality treatment. As with option 1, this alignment rejoins the current channel just upstream of the boardwalk. Both alignments rejoin the existing channel alignment at an approximate elevation of 895 (NAVD 88). The total meander length shown on Figure 3 is 2,400 feet + 200 feet of oxbow area.

Construction becomes more challenging as the project moves north due to challenging soil conditions. Due to the potential challenges, a “third” option (Figure 4) is recommended that refines the second alignment and has it rejoining the centerline further south. From here it meanders along the centerline. An oxbow is proposed as part of this option. The northern portion would be considered an alternate and would only be constructed if conditions are favorable for construction.

It is recommended that any concept consider the lake levels within final design. As discussed further in the construction considerations portion of the memorandum, there is a transition point in the wetland complex where the stream is essentially equalized with the lake level.

ESTIMATED POLLUTANT REMOVALS

Pollutant removal estimates can be difficult to make for a stream meander project. Much of the documentation and methodologies available are for practices that are designed to detain water in any event. For the purposes of this feasibility study, several assumptions were made to calculate potential removals for TP and TSS. Because pollutant removal (TP and TSS) only occurs when the floodplain is actually engaged, the removal efficiencies are calibrated to the frequency of events that would do this.

The assumption is that the floodplain is engaged for events greater than the 1.5-year discharge. Each event greater than the 1.5-year will have a different proportion of the flow that is interacting with the floodplain and thus available for pollutant removal (i.e. a 2-year event has approximately 20% of flow available for removal whereas a 50-year event has approximately 72% of flow available for removal). For the analysis, a weighted average of the flow available to the floodplain was taken based on the percent of flow available in any given event and the likelihood in any given year of each event occurring. This yields a result of an estimated average of 35% of flows are available to the floodplain on any given year. The analysis is summarized in **Table 3**.

Table 3: Frequency of Flows Exceeding Bankfull

Design Event (yr)	Flow Rates [cfs]	Flow available to floodplain [cfs]	Flow available to floodplain [%]	Likelihood of event in any given year [%]
1.5	26.4	0	0%	n/a
2	33.2	6.8	20%	50
5	51.3	24.9	49%	20
10	63.7	37.3	59%	10
25	80.3	53.9	67%	4
50	93.2	66.8	72%	2
100	106	79.6	75%	1
500	138	111.6	81%	0.2

Removals within the floodplain were estimated to be consistent with typical wetland removal rates as published by the MPCA, summarized below:

Median pollutant removal: TSS = 73%, DP = 0%, PP =69%, TP = 38%

where TSS=Total suspended solids, TP=Total phosphorus, PP=Particulate phosphorus, and DP=Dissolved phosphorus.

Based on this, it is estimated that the project would remove an estimated average of 101.4 pounds of TP and 15 tons of TSS each year. It is important to note that these estimates could vary significantly year to year. In a drought year, one might see little to no removals whereas in a wet year the removals could be significantly higher. The estimated pollutant removals for each event are summarized in **Table 4**.

Table 4: Estimated Pollutant Removals

Design Event (yr)	TP Removal [lbs/yr]	TSS Removal [tons/yr]
1.5	0.0	0.0
2	59.3	8.8
5	140.5	20.8
10	169.6	25.1
25	194.4	28.8
50	207.5	30.8
100	217.4	32.2
500	234.2	34.7

It is recommended that sampling and monitoring be considered to better refine these removals and removal potential in the future. Should the cross-sectional area be increased and thus an increase in carrying capacity within the bankfull width, removal potential would decrease.

CLIMATE RESILIENCY

Another consideration for this project is how it could aide the system in becoming more climate resilient. Due to the nature of it's developed watershed, this stream is flashy and sees high flows during heavy rain events. With climate change, the system will expect to see an increased frequency in these high-intensity events. With more frequent, higher-intensity events, having a system that is able to engage its floodplain more readily will help pollutant removal as well as aide in slowing down the higher velocities as the water gets spread out over the floodplain.

ESTIMATION OF PROJECT IMPLEMENTATION COSTS

Project implementation costs were estimated for the final concept identified above at $550,000 as this option allows for the project to be split up if needed. With the limited information available, cost estimation should be considered budgetary and would be refined as projects continue to progress. Permitting fees were not included in the cost estimate.

It is recognized that the timing of implementation activities may vary depending on several factors including funding and weather conditions, for example. It is also important to note that construction costs have seen notable increases in recent years, making estimation challenging. To help project future conditions, an assumed inflation factor based on an evaluation of previous cost increases over the last five years was applied to the estimated cost for the next several years, as summarized in **Table 5**, below.

Table 5: Summary of Implementation Cost Estimation with Inflation Factor

Year	Estimated Cost
2025	$ 570,000.00
2026	$ 600,000.00
2027	$ 630,000.00
2028	$ 660,000.00

CONSTRUCTION CONSIDERATIONS

The biggest consideration that should be taken into account for this project is the constructability of the actual meander. The stream flows through a peat dominated wetland. When dry it can be fairly stable, but the peat material is suspected to have a low unit weight, which means when it gets saturated it becomes very unstable. Given the right conditions, the project is still constructable. The potential saturated soil conditions should be investigated further and considered within any final design. It may be necessary to terminate construction limits at equivalent lake levels to ensure constructability and long-term stability. It is recommended that additional soil investigation and survey collection be performed prior to any final design.

AGENCY/STAKEHOLDER CONSIDERATIONS

On April 17, 2024, VLAWMO and SEH staff had a meeting with Staff from Minnesota Department of Natural Resources (MnDNR), North Oaks Company, United States Army Corps of Engineers (USACE), and the Minnesota Land Trust to discuss the proposed project. A second meeting with the Board of Water and Soil Resources (BWSR) took place on April 23, 2024. The project was discussed with each of the agencies and feedback was provided on their individual requirements.

- MnDNR
  - Will need elevations shown to make a determination of the DNR's jurisdictional boundary.
  - Will need survey of the existing ditch to identify location of the OHWL (895.2 NGVD 29).
- Minnesota Land Trust
  - Because the Land Trust owns the land, they will need to approve the project.
  - Will need to have Land Trust's restoration team sign off on the plans.
- USACE
  - The Project could fall under a Nationwide Permit (NWP) 27 for restoration.
  - Will need to demonstrate functional lift of the stream to qualify for NWP 27.
  - Quantify the temporary and permanent impacts to the wetland.
  - Are there impacts related to 106, threatened and endangered species.
  - Quantify how much material would be hauled offsite.
- BWSR
  - Project could qualify for Category D no loss for wetland enhancement or habitat improvement.
  - Questions about what to do with excavated material.
    - Soil to the south was found to have higher levels of arsenic that was determined to be site specific. It was important to keep that material on site.
    - Could just assume the whole area is wetland but a level 2 wetland delineation to identify upland areas where excavated material could be deposited on site is likely needed.
  - Plans showing
    - Overall project area
    - Overall wetland area
    - Where ditch plugs are going or any other fill
    - Detailed plans
    - Pre and Post model showing water quality impacts
    - WCA impacts
    - A discussion of the purpose and need of the project.

RECOMMENDED NEXT STEPS

Ramsey County has indicated that it has extra funds available to support this project. It is recommended that this money be used to survey the existing ditch to locate the OHWL. Additionally, it is recommended to perform a preliminary geotechnical investigation, to determine the nature of the soils on site and how stable they are. These will help determine what kind of channel dimensions can be achieved as well as gain some understanding of the constructability of the project from an equipment point of view.

MC/EKJ/JJW

c: Brad Woznak, CSM

Attachments
Figure 1: Drainage Area
Figure 2: Meander Option 1
Figure 3: Meander Option 2
Figure 4: Meander Option 3

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SEH

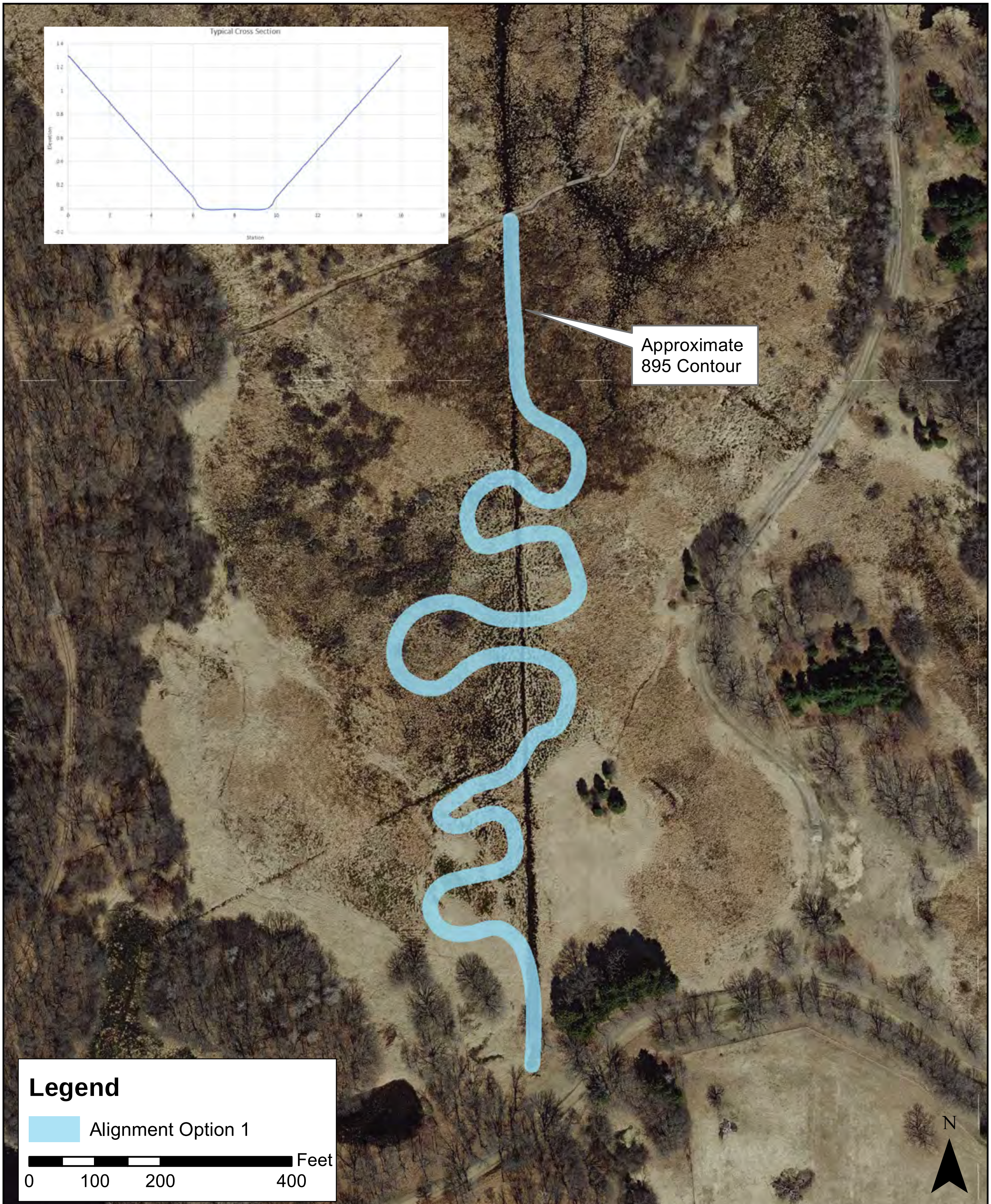
Project: VADLA 171749
Print Date: 2/21/2024

Map by: mchristenson
Projection: Ramsey County
Source: UMN, MnDNR

Drainage Area

Wilkinson Meander Feasibility
North Oaks, MN

Figure
1



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SEH

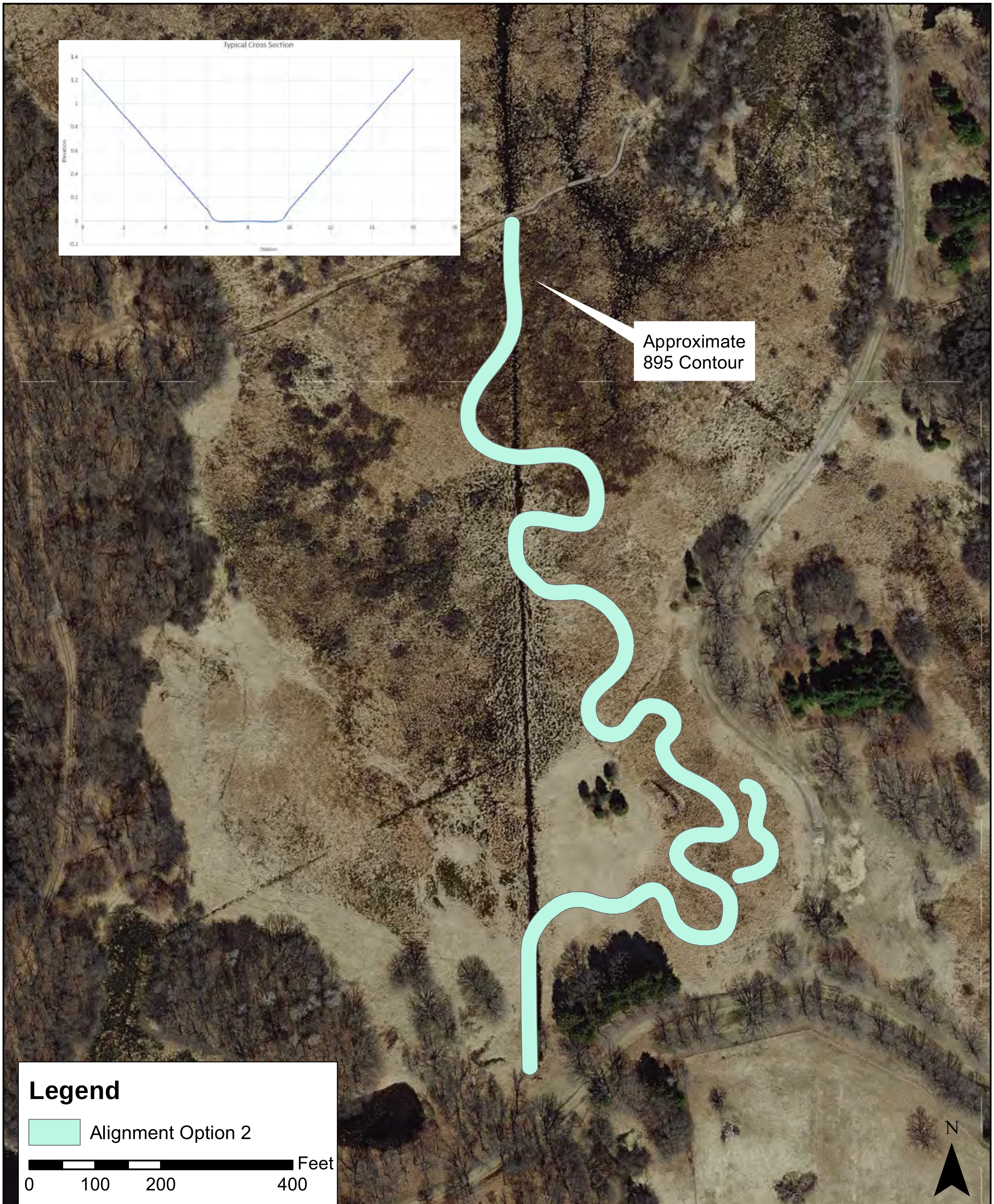
Project: VADLA 171749
Print Date: 2/16/2024

Map by: mchristenson
Projection: Ramsey County
Source: UMN, MnDNR

Meander Option 1

Wilkinson Meander Feasibility
North Oaks, MN

Figure
2



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SEH

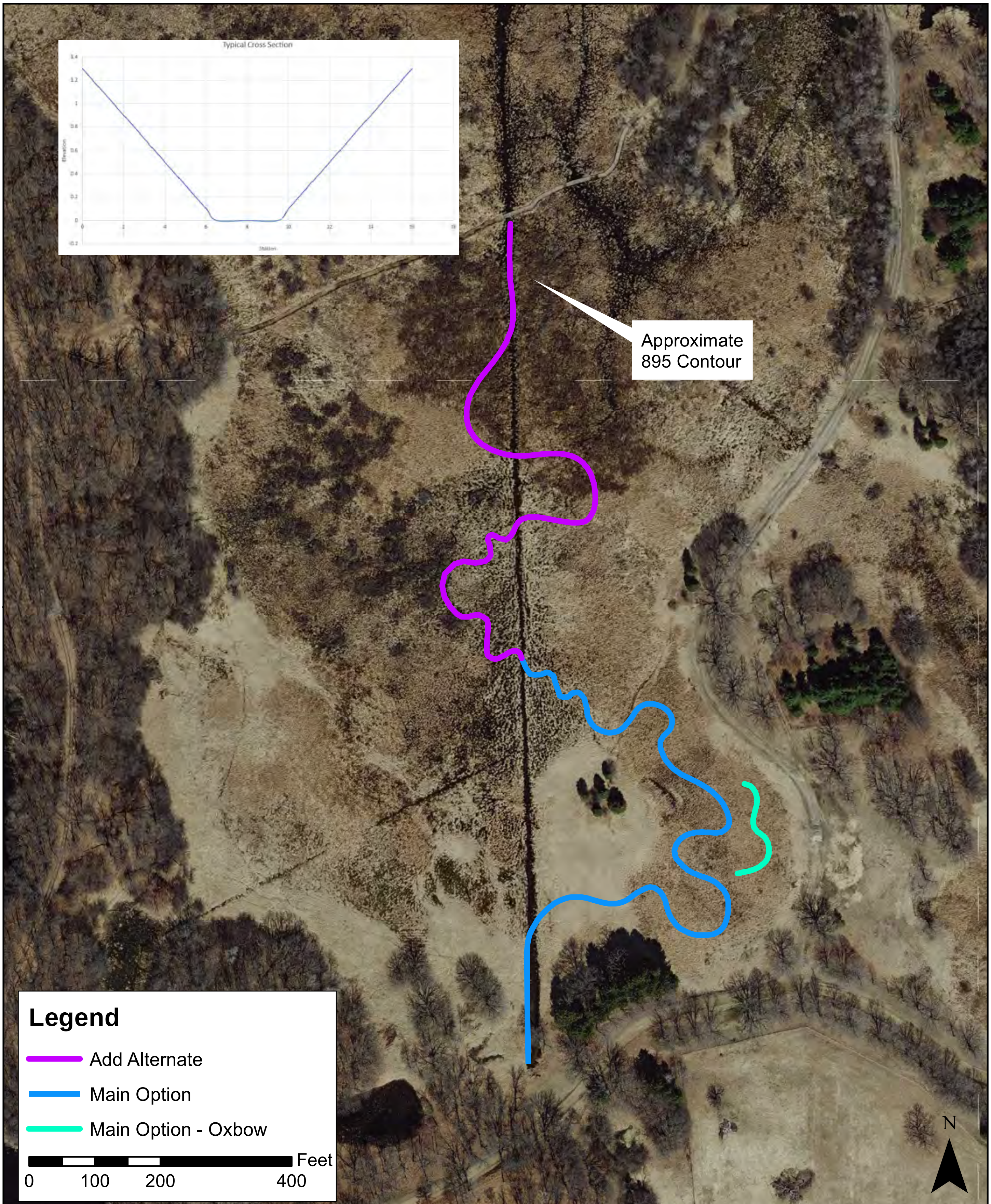
Project: VADLA 171749
Print Date: 2/16/2024

Map by: mchristenson
Projection: Ramsey County
Source: UMN, MnDNR

Meander Option 2

Wilkinson Meander Feasibility
North Oaks, MN

Figure
3



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SEH

Project: VADLA 171749
Print Date: 5/17/2024

Map by: mchristenson
Projection: Ramsey County
Source: UMN, MnDNR

Meander Option 3

Wilkinson Meander Feasibility
North Oaks, MN

Figure
4