Young Environmental Consulting Group, LLC

Technical Memorandum

To: Board of Managers
Lower Minnesota River Watershed District (LMRWD)

From: Katy Thompson, PE, CFM
Della Schall Young, PMP, CPESC

Date: July 14, 2021

Re: Area 3 Minnesota Riverbank Stabilization Project Update

Since the May 19, 2021, Area 3 Minnesota Riverbank Stabilization Project (Project) update to Board, Inter-Fluve conducted the additional approved site investigations, which included collecting detailed bathymetry to determine if the proposed design solution of a launchable rock toe would be appropriate. Inter-Fluve presented its findings to Linda Loomis, LMRWD administrator and Young Environmental staff (Della Young and Katy Thompson), on May 26, 2021, and they subsequently followed up with a revised design memorandum on June 3, 2021. A summary of Inter-Fluve's findings and our recommended next steps follow.

Inter-Fluve Findings

Confirmed by the detailed bathymetric data, Inter-Fluve proposes that the Area 3 site is subject to a unique set of circumstances that are affecting the normal river processes. The Area 3 site is located on the outside bend of a river meander, where erosion is typically driven by the river, undermining the toe of the riverbank. In a typical situation, one would expect to find steep, near-vertical slopes under the water surface as the river migrates north (**Figure 1**). The 2020 bathymetric data at Area 3 instead show mild slopes that gradually slope away from the bluff toward the river bottom and confirmed during Inter-Fluve's site visits (**Figures 2** and **3**).

The flat slope under the water surface indicates that riverine erosion may not be the main driver for the overall Area 3 bluff erosion and may be protecting the bluff from the river, and this affected Inter-Fluve's design recommendations. Inter-Fluve's recommendations, like the previous consultants' recommendations in 2008 and 2010, were intended to arrest the migration of the outside bend caused by river migration;

however, with the accumulated sediment at the toe, river scour is not currently the leading factor in the bluff erosion. Inter-Fluve believes that the erosion at Area 3 is primarily being driven by the armoring at the downstream City of Eden Prairie (City) stormwater pond and by groundwater seeps, which, combined with the Minnesota River's variable high water events, will likely continue to cause bluff erosion.

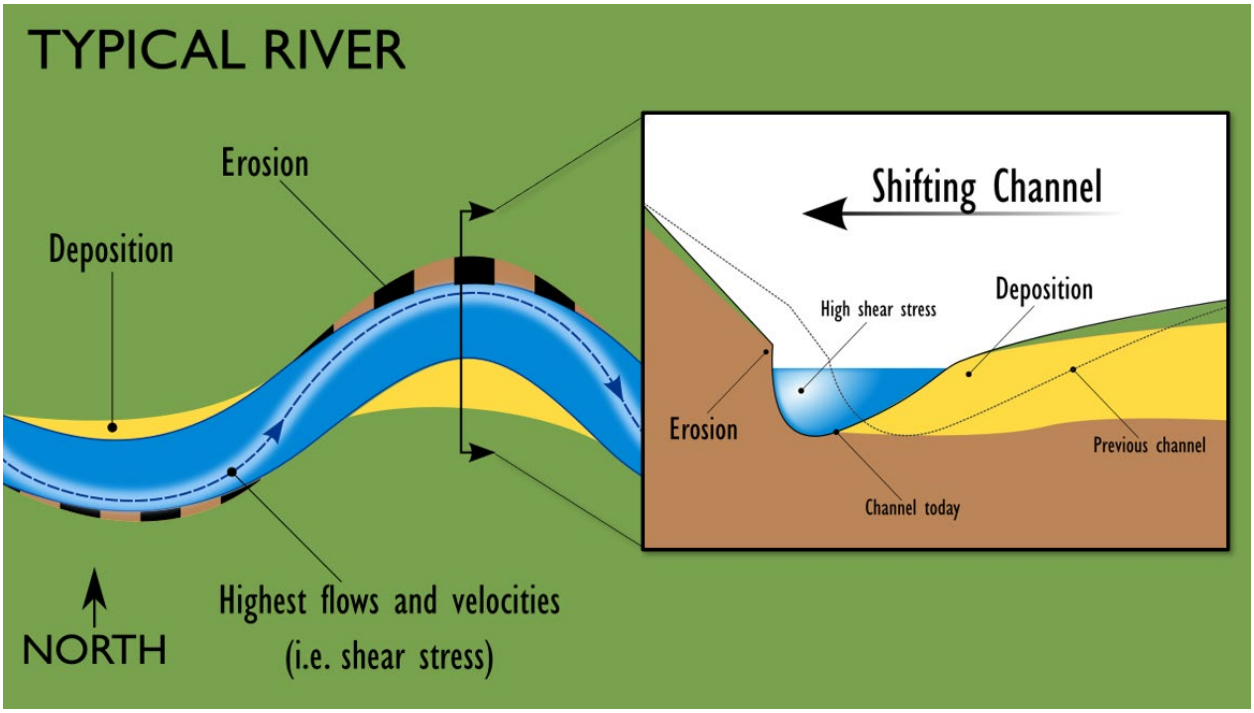


Figure 1. Typical river migration caused by river scour and shear stress.

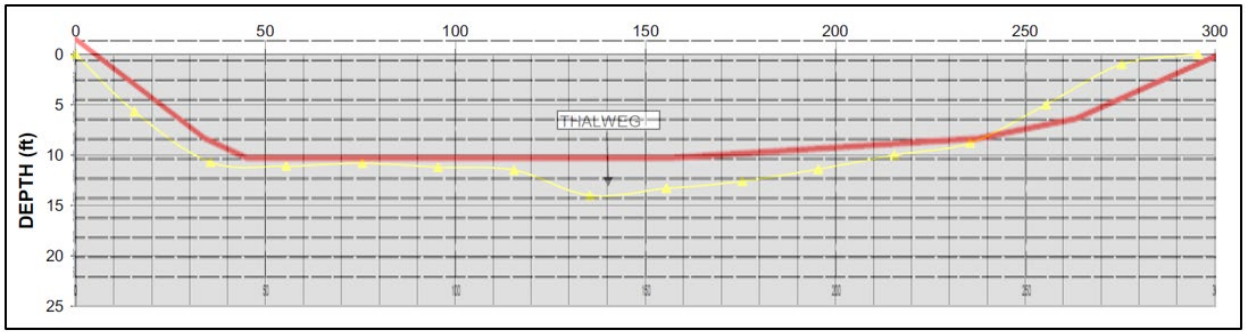


Figure 2. Cross-section at Area 3 looking downstream, yellow line is from the 2009 survey; red line is from the 2020 survey.

Figure 3. Inter-Fluve site photo looking downstream at Area 3 erosion on May 6, 2021.

It is not known when the river will eventually transport the accumulated sediment downstream, but it is expected that river migration will continue and will pose more of a threat to long-term bluff stability in the future. Inter-Fluve hypothesized that the Area 3 bluffs may currently be depositing sediment at a faster rate than the river can transport downstream, resulting in the outside bend accumulating sediment rather than developing a typical scour hole. This prompted Inter-Fluve's request to complete the detailed bathymetry now, rather than after the 90 percent designs.

Inter-Fluve has provided two alternatives for the LMRWD to consider:

1. Launchable Rock Toe: Inter-Fluve provided two similar rock revetment options that would protect the bluff from high-flow events now and when the accumulated sediment at the toe is scoured away. This design utilizes riprap to protect the riverbank up to the two- or 100-year flood and ranges in cost from $1.8M to $2.3M. This option only protects Area 3 from further erosion caused by the river and does not address or prevent future erosion caused by the groundwater seeps.

2. No Action and Monitoring: Because the accumulated sediment provides some temporary protection of the bluff from river erosion, Inter-Fluve proposes annual monitoring to quantify the amount of sediment loading caused by the exposed bluff faces by collecting detailed topographic and bathymetric survey data that could also be used to refine future project designs.

Although Inter-Fluve presented two options, it did not make a recommendation for the Board and instead has posed this question to the managers: How does the LMRWD want to manage this site in the future?

Barr Engineering Review

Following the meeting with Inter-Fluve, Young Environmental coordinated with our technical partner, Barr Engineering (Barr), to review Inter-Fluve's report from a geotechnical and river hydraulics perspective and to provide an independent technical review. Barr staff visited the site on June 15, 2021, and reviewed Inter-Fluve's assessment of Area 3. Barr's site observations were consistent with Inter-Fluve's in that the exposed bluff soils are highly susceptible to erosion, seepage is an ongoing process at several levels of the exposed bluff face, and the seeps are contributing to the bluff instability. The details of Barr's site visit are presented in the attached memo. Barr also reviewed Inter-Fluve's recommendations and had similar recommendations, summarized in **Table 1**.

Table 1. Summary of Interfluve and Barr findings

Inter-Fluve's Findings	Barr's Assessment
Bluff erosion is influenced by several factors: river erosion, groundwater seepage at the bluff toe, and the City stormwater pond.	Concur
The bank armoring protecting the City stormwater pond is impeding normal river migration and contributing to the persistent erosion at Area 3.	Concur
Upland development and stormwater detention ponds are contributing to bluff erosion.	Need more information
Sediment accumulation at the bluff toe is due to bluff slope sloughing and not river scour, but the process is cyclical, and river scour will continue in the future.	Concur
Accumulated sediment and river migration are not presently contributing to bluff erosion, but river migration will continue in the future if nothing is done.	Concur
Recommend Conceptual Alterative 1: Launchable Rock Toe is a viable option to address river scour at Area 3.	Disagree; self-launching riprap may not protect the bank as intended
Construction of toe protection by itself will not address bluff slope instabilities, which are also being driven by groundwater seepage.	Concur
Recommend that any toe stabilization project be coordinated with measures to address groundwater seepage.	Concur
Recommend decommissioning the City stormwater pond and removing bank armoring to allow the river to freely migrate.	Concur
The recommended design from 2010 may be difficult or infeasible to construct because of the scale of the system and may create more instability upstream and downstream of the treatment area.	Disagree; the vanes may be another option to protect the toe, especially after the city pond is removed

Recommendations

Based on the alternatives Inter-Fluve presented and the review Barr conducted, the original scope of work to protect the toe of the Area 3 bluff from riverine erosion no longer makes financial sense. Inter-Fluve has established that the erosion at Area 3 is driven by three factors: the Minnesota River, the City stormwater pond, and groundwater seeps. The dynamic interplay between these components and the effects at Area 3 were not known in 2008 and 2010, but it does suggest that a different approach needs to be taken because of the complexity of the system. As such, we recommend the Board consider the following as next steps for the Area 3 project:

1. **Continue the current Area 3 scope of work to complete the two-dimensional (2D) modeling and environmental permitting tasks.**
    a. 2D model:
    Inter-Fluve included 2D modeling as part of its project scope. Young Environmental has directed Inter-Fluve to develop the existing conditions model to determine the existing velocities, shear stresses, and scour potential of the accumulated sediment at Area 3. This model will also be beneficial in evaluating impacts of the City pond removal and aid in designing toe protection solutions. Inter-Fluve anticipates completing the 2D modeling by July 20, 2021. Following the completion of the modeling and submittal of all project information completed to date, we recommend terminating the contract with Inter-Fluve because of the significant scope changes anticipated.

    b. Preliminary environmental review:
    Any project at Area 3 will face numerous permitting challenges. We recommend evaluating the potential for threatened and endangered species as well as State Historic Preservation Office (SHPO) review now to determine if there are any constraints that would affect the location or type of future project designs.

2. **Develop a comprehensive design for Area 3.**
    a. Present findings to stakeholders:
    The original intent of this project was to reduce the likelihood that riverine erosion would erode the bluff by stabilizing the riverbank. However, because of the complexity of this area, both Inter-Fluve and Barr agree that the LMRWD cannot successfully design a riverbank stabilization project to protect Area 3 from riverine erosion without concurrently addressing the impacts from the City pond and groundwater seeps.

    We recommend sharing these findings with the City and meeting to determine if there is interest and budget for a wholistic project that

encompasses riverbank stabilization, pond decommissioning, and upper slope repair.

The watershed-based funding the LMRWD has received from the Board of Water and Soil Resources (BWSR) could be used to develop a conceptual plan for the entire Area 3 site, which would have the benefit of providing a more significant reduction in sediment loading by addressing the continued inputs from the pond and seeps. Young Environmental will coordinate with Linda Loomis and Steve Christopher at BWSR to discuss the change in design and how that may affect the funding received.

b. Incorporate Area 3 into the LMRWD's Monitoring Plan update:
Based on the outcomes from the 2D modeling, develop a more detailed monitoring action plan for Area 3, including determining when it is necessary to collect detailed bathymetric data and if maintaining the inclinometers is necessary. Incorporate the Area 3 monitoring recommendations within the larger LMRWD Monitoring Plan updates this fall.

CC: Linda Loomis, LMRWD Administrator

Maren Hancock, Inter-Fluve

Jonathon Kusa, Inter-Fluve

Katie Turpin-Nagel, Barr

Karen Chandler, Barr

Attachments

Attachment 1—Board Update Memo, May 14, 2021

Attachment 2—Inter-Fluve Launchable Rock Toe Conceptual Design

Attachment 3—Barr Engineering Memo, July 1, 2021

ATTACHMENT 1
LMRWD BOARD UPDATE MEMO, MAY 14, 2021

Young Environmental Consulting Group, LLC

Technical Memorandum

To: Linda Loomis, Administrator
Lower Minnesota River Watershed District

From: Katy Thompson, PE, CFM
Della Schall Young, CPESC, PMP

Date: May 13, 2021

Re: Area 3 Minnesota Riverbank Stabilization Project Update

As discussed at the February 17, 2021, board meeting, the Lower Minnesota River Watershed District (LMRWD) approved awarding the Area 3 Minnesota Riverbank Stabilization Project contract to Inter-Fluve as the most qualified and responsive bid. Since the approval, Young Environmental staff have been working with Inter-Fluve as they reviewed the previous studies, completed a site investigation and drone survey, and completed an alternatives review analysis.

On May 6, 2021, Young Environmental and the LMRWD administrator met with Inter-Fluve to review its draft findings and alternative review memorandum. In its evaluation of the site, Inter-Fluve suggested that the riverbank erosion at Area 3 is likely being caused by several factors:

- Natural progression of the river meander is contributing to erosion.
- Several groundwater seeps are present at the base of the slope and have the potential to saturate the soils and weaken the integrity of the bluff, causing erosion.
- Land development on top of the bluff can cause increased runoff from rooftops and sump pump discharges in addition to creating infiltration opportunities from features such as pools and stormwater basins. Inter-Fluve has posited that the increased infiltration on top of the bluff could have increased groundwater pressure and increased the flow at the existing seeps, further destabilizing the riverbank.
- Previous bank stabilization attempts by the City of Eden Prairie to protect the stormwater pond in the floodplain are exacerbating the erosion at Area 3 by

preventing the river from migrating downstream. This armoring of the riverbank at the stormwater pond is pushing the river's forces north and into the Area 3 toe.

Inter-Fluve has not yet recommended a design solution because its findings have been inconclusive as to the primary cause of the erosion. The team has recommended moving up its detailed bathymetric survey from the 100-percent plan development phase to the week of May 17 in an effort to develop an appropriate solution to arrest the river's migration north. Following the collection of the bathymetric survey data, Inter-Fluve will present its findings and recommendations to the LMRWD administrator and Young Environmental on May 24.

Additionally, the LMRWD administrator and Young Environmental discussed the project with the City of Eden Prairie on April 13, 2021. The City indicated that the proposed Area 3 designs may encroach on private property and could require a temporary easement for construction. When Inter-Fluve makes its design recommendation on May 24, we will then know the extent of the construction and whether a temporary easement will be necessary.

Attachment

Inter-Fluve Site Photos, April 2 and 6, 2021

DRAFT

inter·fluve

Feet
0 500

N

Coordinate System : NAD 1963
HARN Adj MN Hennepin Feet

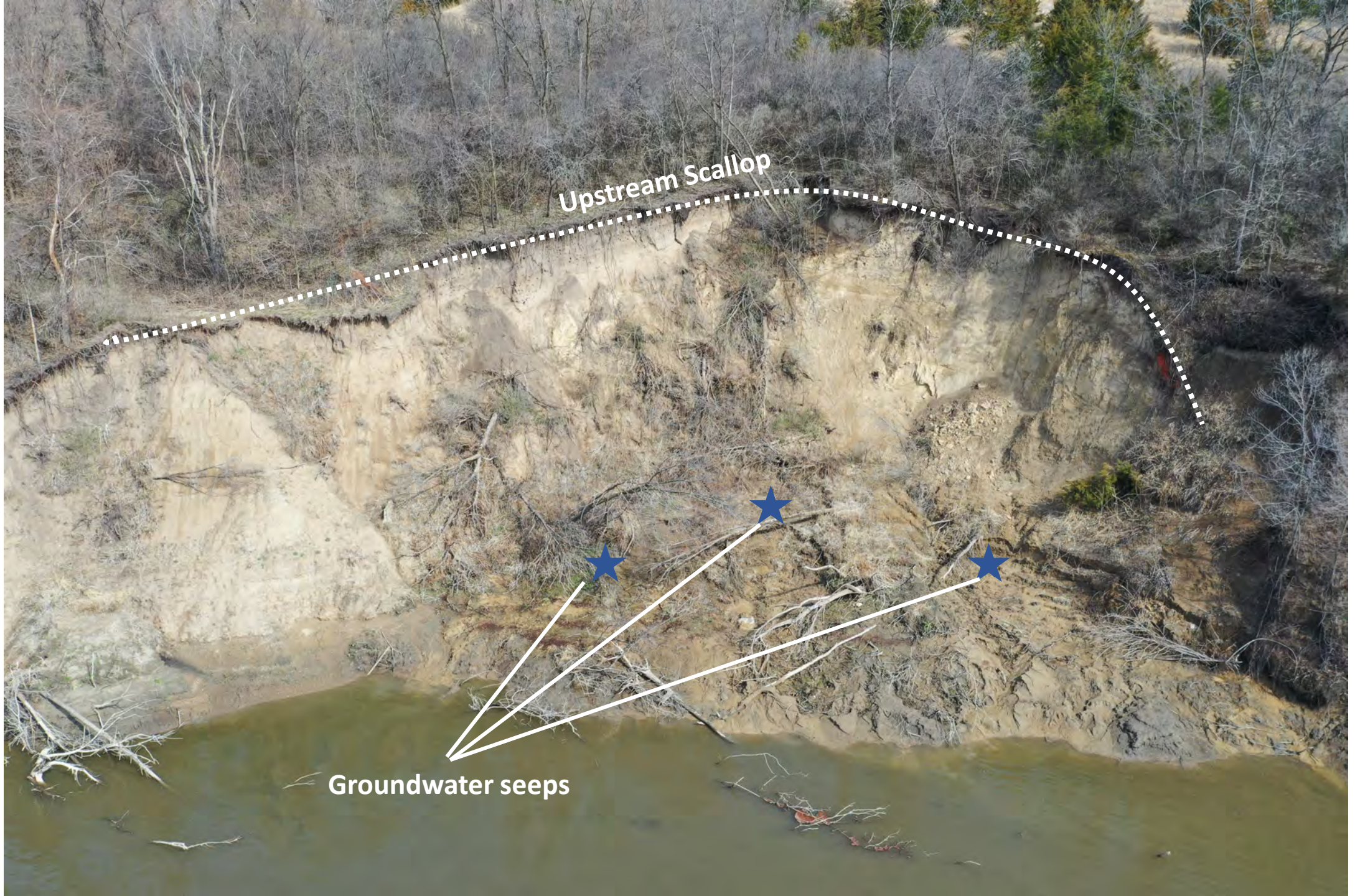
NOTES:
1. Aerial imagery from 2020.
2. Lidar derived slope data collected in 2011.
3. Parcel and road data downloaded from Hennepin County GIS, April 2021

Area 3 Minnesota River Bank Stabilization Project

Hennepin County
Minnesota

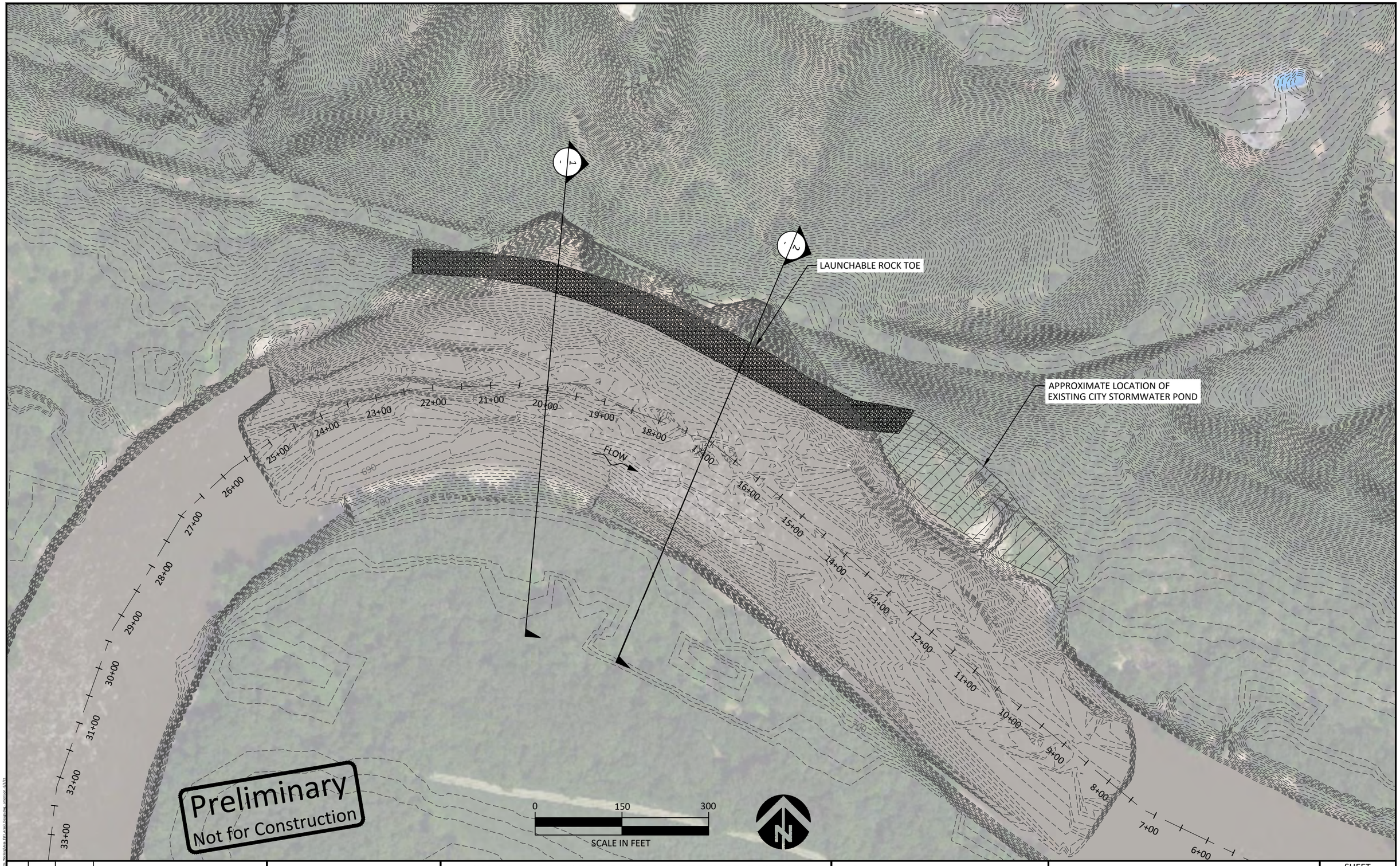

UPPER BLUFF
BLUFF
BLUFF-TOE
(EXTENDS TO CHANNEL BOTTOM)


Upstream Scallop


Upstream Scallop
Groundwater seeps


Stormwater
Outfall
Incised Channel

ATTACHMENT 2
INTER-FLUVE LAUNCHABLE ROCK TOE CONCEPTUAL DESIGN



NO.	BY	DATE	REVISION DESCRIPTION

DRAWN	DESIGNED	CHECKED
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APPROVED	**DATE**	**PROJECT**
----	6/3/2021	

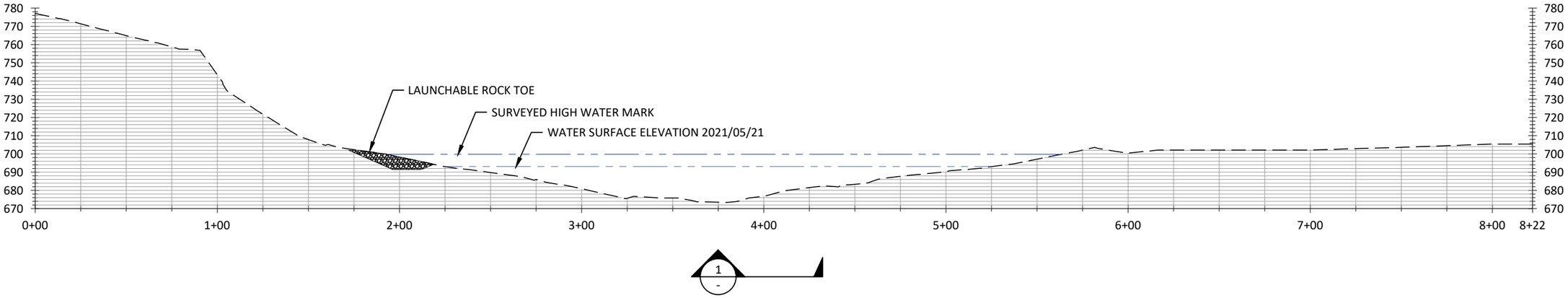
LOWER MINNESOTA RIVER WATERSHED DISTRICT
MINNESOTA RIVER AREA 3
CONCEPTUAL DESIGN

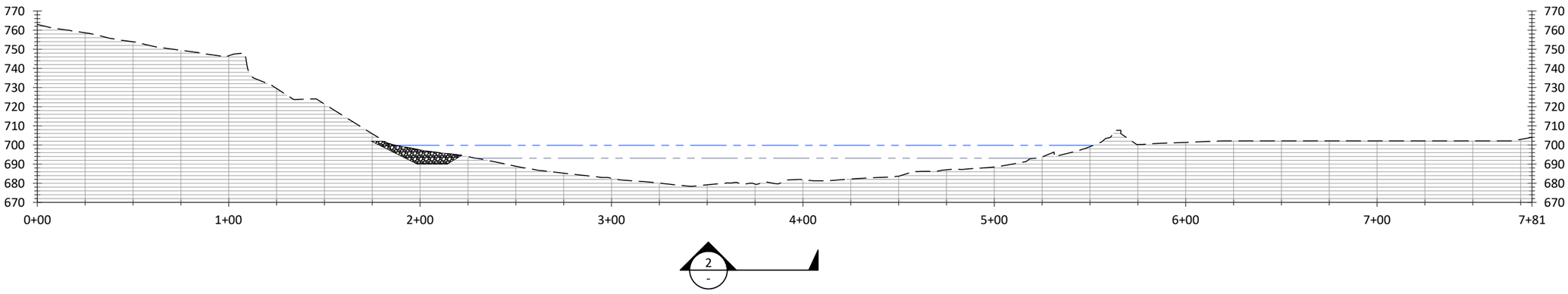
inter·fluve
1539 Grand Avenue, 2nd Floor
Saint Paul, MN 55105
651.243.9700
www.interfluve.com

CONCEPT ALTERNATIVE PLANVIEW

SHEET
1 OF 3

Figure 1: Concept alternative planview.





Preliminary
Not for Construction

NO.	BY	DATE	REVISION DESCRIPTION

DRAWN	DESIGNED	CHECKED
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APPROVED	DATE	PROJECT
----	6/3/2021	

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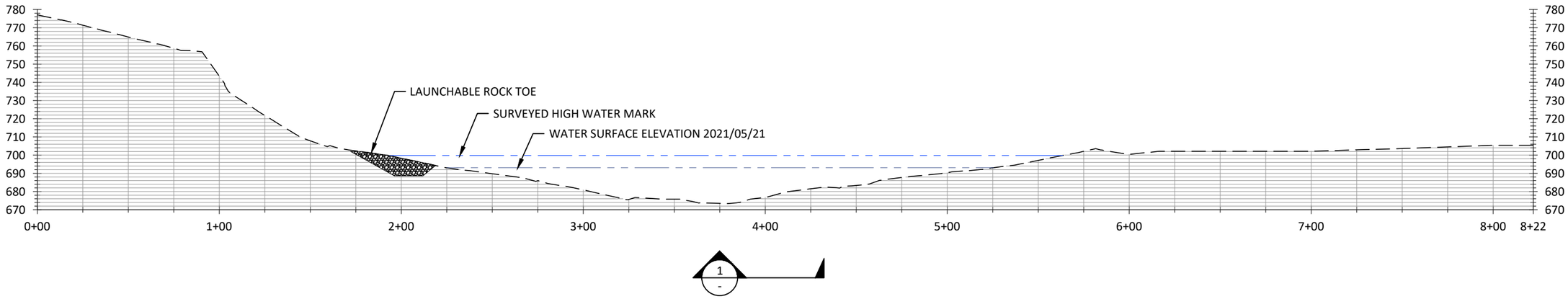
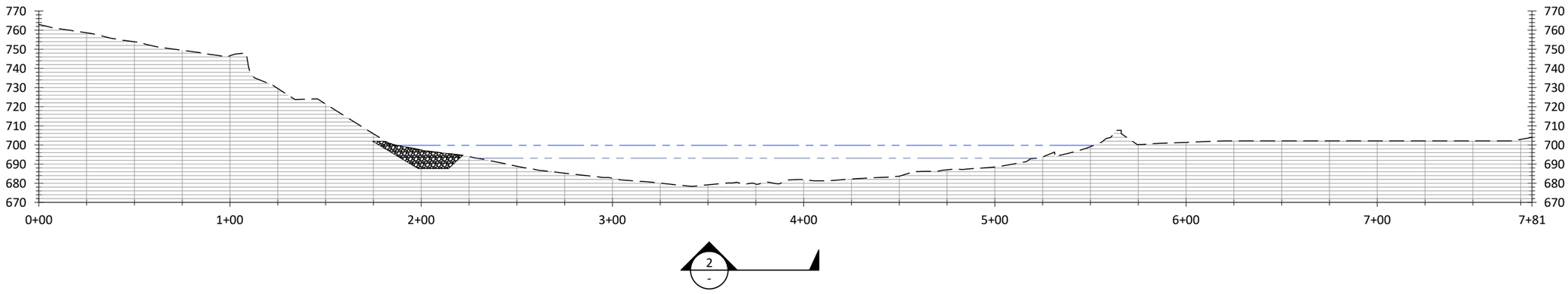
CONCEPT ALTERNATIVE 1

SHEET
2 OF 3

Figure 2: Concept alternative 1 typical cross-section estimated Q2 scour depth rock volume.





Preliminary
Not for Construction

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APPROVED	DATE	PROJECT
----	6/3/2021	

LOWER MINNESOTA RIVER WATERSHED DISTRICT
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CONCEPTUAL DESIGN

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CONCEPT ALTERNATIVE 2

SHEET
3 OF 3

Figure 3: Concept alternative 1 typical cross-section estimated Q100 scour depth rock volume.

ATTACHMENT 3
BARR ENGINEERING REVIEW MEMO, JULY 1, 2021

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engineering and environmental consultants

BARR

Memorandum

To: Della Young, Katy Thompson – Young Environmental
From: Tom MacDonald, Brent Theroux
Subject: Review of Area 3 Alternatives
Date: July 1, 2021
Project: Area 3 Lower Minnesota River Watershed District
c: Karen Chandler, Katie Turpin-Nagel – Barr Engineering

Young Environmental requested that Barr Engineering (Barr) review a recent memorandum submitted by Inter-Fluve, Inc. to the Lower Minnesota River Watershed District (LMRWD). The memorandum presented recommended alternatives for addressing on-going erosion of the riverbank at the toe of the existing bluffs along a segment of the Minnesota River designated as Area 3 within LMRWD. Young Environmental also provided to us Inter-Fluve's addendum to their original memorandum, as well as technical memorandums by Young Environmental summarizing the disposition of Area 3 prior to Inter-Fluve's work. Our scope consisted of reviewing the Inter-Fluve and Young Environmental memorandums, performing a site visit to Area 3 to observe existing conditions, and discussing our initial comments and observations with Young Environmental. This memorandum summarizes our comments and observations.

Credentials

Our review was performed by Brent Theroux and Tom MacDonald. Brent Theroux is a senior geotechnical engineer with 21 years of professional experience, including analysis and design experience in the bluffs area along the lower Minnesota River Valley. Tom MacDonald is a senior water resources engineer with 30 years of professional experience. Tom's focus includes river hydraulics, sediment transport and fluvial geomorphology.

Previous Involvement at Area 3

Brent, as a project engineer for Gale-Tec Engineering, participated in the 2008 study of Area 3 commissioned by the City of Eden Prairie. Gale-Tec worked under a subcontract to SRF to perform a geotechnical evaluation of Area 3.

Scope

Barr's review consisted of document review and a site visit. The site visit occurred on June 15, 2021. Young Environmental provided the following documents for review:

A. Inter-Fluve Technical Memorandum, Area 3 Findings and Alternative Review Memorandum, dated May 18, 2021
B. Inter-Fluve Addendum #1 to Technical Memorandum, Area 3 Findings and Alternative Review Memorandum, dated June 3, 2021

C. Young Environmental Technical Memorandum, Eden Prairie Area 3 and the Minnesota River (Meeting summary and recommendations), dated January 17, 2020
D. Young Environmental Technical Memorandum, Area 3 Slope Stability Project Update, October 16, 2020

Document Review

Barr reviewed the May 18, 2021 Inter-Fluve Technical Memorandum, *Area 3 Findings and Alternative Review Memorandum*. The memorandum described historical development at Area 3, summarized previous studies, presented Inter-Fluve's assessment of hydraulic processes affecting Area 3, and provided recommended alternative concepts for mitigation. We offer the following comments:

- Scope of memo focuses on "toe stabilization", and distinguishes this from bluff erosion and slope stabilization. Project objective is to minimize the effect of river processes on on-going bluff erosion, where bluff erosion is defined as material loss from slope above bluff toe.
- Inter-Fluve performed a drone survey and photogrammetry of Area 3. Topographic contours are based on matching photogrammetry to most recent LiDAR.
- Inter-Fluve findings, followed by our comments:
    - City pond is delaying down-valley river migration and contributing to persistent northward erosion at Area 3.
        - Concur
    - Bluff erosion is likely influenced mostly by factors other than river erosion. Recommend regular bathymetric and topographic surveys to document migration rate.
        - Concur
    - Seepage at toe is contributing to bluff erosion.
        - Concur
    - Upland development and/or stormwater management is contributing to bluff erosion.
        - Need more information
    - Mass wasting at bluff toe is currently due to slope sloughing and not river scour, but the process is cyclical and river scour will likely continue depending on the pattern of river flooding.
        - Concur
- Since mass wasting is primarily driven by slope sloughing (itself driven by persistent seepage), then any toe stabilization effort to mitigate mass wasting could be undermined at a future date if seepage is not addressed.
- Inter-Fluve recommendations, followed by our comments:
    - Recommends decommissioning City pond and removing bank material from inside bend.
        - Concur
    - Recommends toe stabilization be finalized in conjunction with addressing seepage.
        - Concur
- Conceptual Alternative 1: We are skeptical that Class II riprap would hold up as bank armor in the long term.

- Cost estimates should elaborate on assumptions for mobilization, access/staging, erosion/sediment control, limits of disturbance, permitting, and surface fabric.

Barr reviewed Inter-Fluve's June 3, 2021 Addendum #1 to Technical Memorandum. The addendum presented results of a bathymetric survey conducted at Area 3 and refined Inter-Fluve's alternative recommendations for mitigation. Below are the Inter-Fluve conclusions from their addendum, followed by our comments:

- Qualifies that Conceptual Alternative 1 would not prevent future mass wasting events. It would only prevent northern migration of the channel.
    - Concur
- Toe (sediment) entrainment and river migration are not presently contributing to bluff erosion, but could in the future depending on precipitation patterns and river flows.
    - Concur

Barr reviewed the January 17, 2020 Young Environmental Technical Memorandum, *Eden Prairie Area 3 and the Minnesota River (Meeting summary and recommendations)*. No Barr comments were generated in the review.

Barr reviewed the Young Environmental Technical Memorandum, *Area 3 Slope Stability Project Update*, dated 10/16/20. We offer the following comments :

- In-place inclinometer instrumentation is useful for measuring slope movement. However, it likely cannot provide any actionable warning of future slope failures due to the brittle, non-creep nature of slope movements in sandy soils (i.e., when slope failure occurs it will likely do so without warning).

Site Visit

Barr performed a site visit to Area 3 on June 15, 2021. Barr observed the City pond, the riverbank along the bluff toe, and the upland bluff area upslope of the failure. We offer the following observations:

a) Exposed bluff soils appear to be predominantly clean sand (very fine to medium grained). These soils are highly susceptible to erosion when exposed, regardless of whether they are saturated or unsaturated.
b) Observed seepage appears to be an on-going process generally independent of river levels. River levels were low and recent precipitation has been low. Some of the seepage appears to originate higher up the slope, well above the river level.
c) The seeps carry some soil (mostly very fine-grained sand and silt) out of lower bluff slopes, which then deposit on banks or in river.
d) Seepage appears to directly contribute to bluff instability.
e) Bluff failure appears more extensive than observed in 2008.
f) Bank stabilization measures adjacent to the city pond are failing

g) Discharge was observed from the city pond area via a defined channel

Conclusions

1. Recommend that LMRD establish and confirm the various project objectives and outcomes for bluff slopes, bluff toe, and river.
2. Recommend eliminating defunct city pond and remove failing stabilization measures.
3. Address these questions:
    - What is the overarching goal of LMRWD for this area?
    - What is the overarching goal of City? Is there an alleged threat to homes?
4. There are three basic processes at work at Area 3: river channel migration, bluff instability, and sedimentation. Sedimentation (C) is the result of river migration (A) and instability (B), i.e. A + B = C. One can address A or B, but to address C, one must address both A and B.
5. Self-launching riprap may not be a worthwhile option; it may not launch in a manner that protects against future toe erosion, and the protection may be short-lived.
6. Consider providing a means to allow the bank seepage areas to drain while minimizing the loss of material (possibly with a gravel or rock drainage layer).
7. Vanes, as proposed by the Wenck/Stanley team in 2010, may help protect Area 3 from continued river migration. The vanes could be prioritized at the upstream portion of the area to allow the river to continue migrating immediately downstream of the most vulnerable area.
8. Vanes and/or self-launching riprap would require evaluation for floodplain impacts since they would likely be installed in the floodway.
9. Recommend performing two-dimensional hydraulic modeling to evaluate placement of vanes and/or riprap.