Technical Memo

WENCK ASSOCIATES

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To: Leslie Stovring
City of Eden Prairie

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Subject: 2016 Minnesota River Erosion Monitoring

The purpose of this technical memo is to summarize the 2016 Minnesota River erosion monitoring results.

INTRODUCTION

Wenck Associates, Inc. (Wenck) installed a series of bank pins to monitor bank erosion along the Minnesota River near Riverview Road (Figure 1). Two bank pins were installed at nine locations along the outside bend (Figure 2). At each location, the lower pin was set approximately 2-3 feet above the water surface and the upper pin was installed approximately 2-6 feet directly above the lower pin depending on bank conditions at each location. Each pin is made of #4 rebar cut to length (4 feet) and ground to a conical point on one end. The purpose of the bank pins is to set a fixed point to measure the rate at which the river banks are eroding. This information is used to determine if bank re-enforcement is needed to prevent future failures and protect the City stormwater pond at this site.

This stretch of the river was analyzed for stability in 2010 by Wenck following significant erosion of the streambank. As part of the analysis, two inclinometers were installed on top of the bluff to monitor major movement of the slope between the Minnesota River and the houses along Riverview Road (see Attachment B). The purpose of the inclinometers is to monitor the global stability of the embankment. Bank pins described above monitor the localized streambank erosion.

The bank pins were installed on June 9, 2016, and were visited on November 29th, 2016 to measure changes at each bank pin. This memo summarizes the results of the 2016 bank pin measurements.

RESULTS

A comparison of the June and November site visits is summarized in Table 1. Wenck staff recorded the changes to the upper and lower bank pins and also made notes in cases where bank pins were lost, buried, and/or damaged. The photo log in Appendix A further illustrates bank pin locations and changes to the streambank.

Location #2 lost its lower pin while its upper pin was twisted almost 90 degrees to downstream. It is likely that soil erosion, river velocity and floating debris had a significant impact on this site location. Location #5 appeared to have significant bank failure which resulted in the bank pins being buried and/or displaced. Location #6 was subjected to a large sand deposit that appeared to have buried the lower bank pin.

Locations #7, #8, and #9 showed moderate bank erosion in 2016. These locations are located along a previous bank stabilization project that is intended to protect a City stormwater pond (see Figure 2). It should be pointed out that the end caps were missing at Locations #7 and #9 during the November site visit, suggesting a significant amount of force was exerted on the banks at these locations, likely high channel velocities and/or floating debris.

Table 1. Summary of 2016 bank recession rates based on bank pin monitoring results.

Site	Upper Pin Lateral Bank Loss (ft)	Lower Pin Lateral Bank Loss (ft)	Average Bank Loss (ft)	Notes
1	-1.3	-2.2	-1.8	
2	-1.4	-4.0 (gone)	-2.7	Upper pin was bent sideways, lower pin gone
3	0.0	0.0	0.0	
4	-2.0	-0.9	-1.5	
5	-4.0 (gone)	-4.0 (gone)	-4.0	Bank collapsed and pins gone/buried.
6	-0.2	Pin buried	-0.2	Sand deposited, lower pin buried.
7	-0.3	-0.3	-0.3	Lost end cap.
8	-0.1	-0.1	-0.1	
9	-0.7	-0.8	-0.8	Lost both end caps.

DISCUSSION OF CITY STORMWATER POND

The average bank erosion rate in 2016 is approximately 2 ft/yr in the unprotected areas upstream of the City stormwater pond (Sites #1 through #6). Figure 6 (See Attachment B) from a Lower Minnesota River Watershed District report titled Summary of Historical Aerial Photograph Analysis from 1937 to 2008 further confirms the average bank loss of approximately 2.2 ft/yr. Near the City stormwater pond (locations #7, #8, #9) the rate of erosion was approximately 0.5 feet per year in 2016, however photographs for bank pins #7, #8 and #9 show that the coir fabric along the banks is deteriorating, soil is falling through the openings and vegetation is dead and/or never established. In addition the City pond is on an outside bend and clearly within the meander belt indicating the channel according to river geomorphological tendencies will migrate into the pond. Therefore, because the closest edge of the city storm water pond is located approximately 80 feet to 100 feet from the 2016 river bank there is a need to further reinforce the Minnesota River bank in this vicinity to protect the pond.

It is evident that the work completed from the 11/28/2013 plan set which included installation of soil lifts with coir and willow live stakes did not adequately protect the bank.

The data, photographs and flow records show the following:

1. The city pond is located on a bench within 80' to 100' of the river on an outside bend in the meander belt showing that under natural conditions the river will move into the pond.
2. The city pond is on an outside bend that receives an impinging flow and an undercutting of the bank further showing the bank will continue to erode and the pond is in danger of being overrun by the river.
3. The Minnesota River discharge recorded at Jordan, MN shows 2016 had a peak flow of over 40,000 cfs. From the period of record from 2008 to 2016 this has occurred four times. Since the 11/29/2016 photos show the embankment was inundated for a long enough period to drown the newly planted sandbar willows, the loss of vegetation indicates the water was at this stage for two to four weeks. The flow records also show this is a relatively frequent occurance.
4. The photos show the coir fabric to be stressed such that the openings are stretched and larger than at installation. This is most likely due to the fabric stretching while holding saturated soil, degradation due to sunlight exposure and deterioration caused by impact by the impinging water flow.

SUMMARY AND RECOMMENDATIONS

Over some period of time the City stormwater pond will be overrun by the Minnesota River considering the direction of the river meander and assuming bank loss at Sites #7, #8, and #9 revert back to the 2 ft/yr erosion rate as the coir fabric continues to degrade. Based on the 2 ft/yr rate, this could happen in 40 to 50 years. Based on past projects on the Minnesota River to protect infrastructure there are two general approaches: 1) armor the bank with a revetment possibly in combination with bend way weirs or 2) establish a vegetated bank that even though the bank erodes the erosion is at an acceptable rate. Prior experience has shown the armoring approach to be substantially more expensive than the vegetated approach.

The vegetated approach that was installed post 2013 was a good solution relative to the cost of hard armor but essentially unlucky in having the water high enough for long enough that the willow stakes died. The lack of vegetated cover then exposed the coir fabric allowing it to degrade from sunlight and an impacting river flow. Generally, sandbar willow need three to five years of growth to establish their roots and get tall enough to be above flood waters to survive and provide the root mass to hold the bank.

It is our recommendation to consider re-establishing the coir fabric/vegetated bank with the following observations, options and changes:

1. The City is willing to chance the site would be flooded again and the vegetation drowned and the area would need to be replanted.
2. Do a field reconnaissance to measure the as-built elevation of the constructed coir bank, determine the surrounding vegetation to see if there is sandbar willow and estimate if there is enough harvestable sandbar willow to use in the repair. The

sandbar willows would be cut as poles approximately 6’ in length. The added height relative to sandbar willow cuttings has the advantage of surviving higher and longer flood inundation so the plants could grow for three years to get established.

3. Determine the risk frequency of bank inundation relative to the as-built condition.
4. Do a calculation to determine the velocity, shear stress and duration of the impinging flow to select the fabric to cover the existing slope.
5. If possible survey cross sections from the top of bank into the river so an estimate of rock quantities could be made to provide an armoring cost estimate.
6. Provide a cost estimate of reestablishing the coir and sandbar willow live poles.
7. Prepare a summary construction memorandum for the City’s consideration.

Figure 1: Site Location

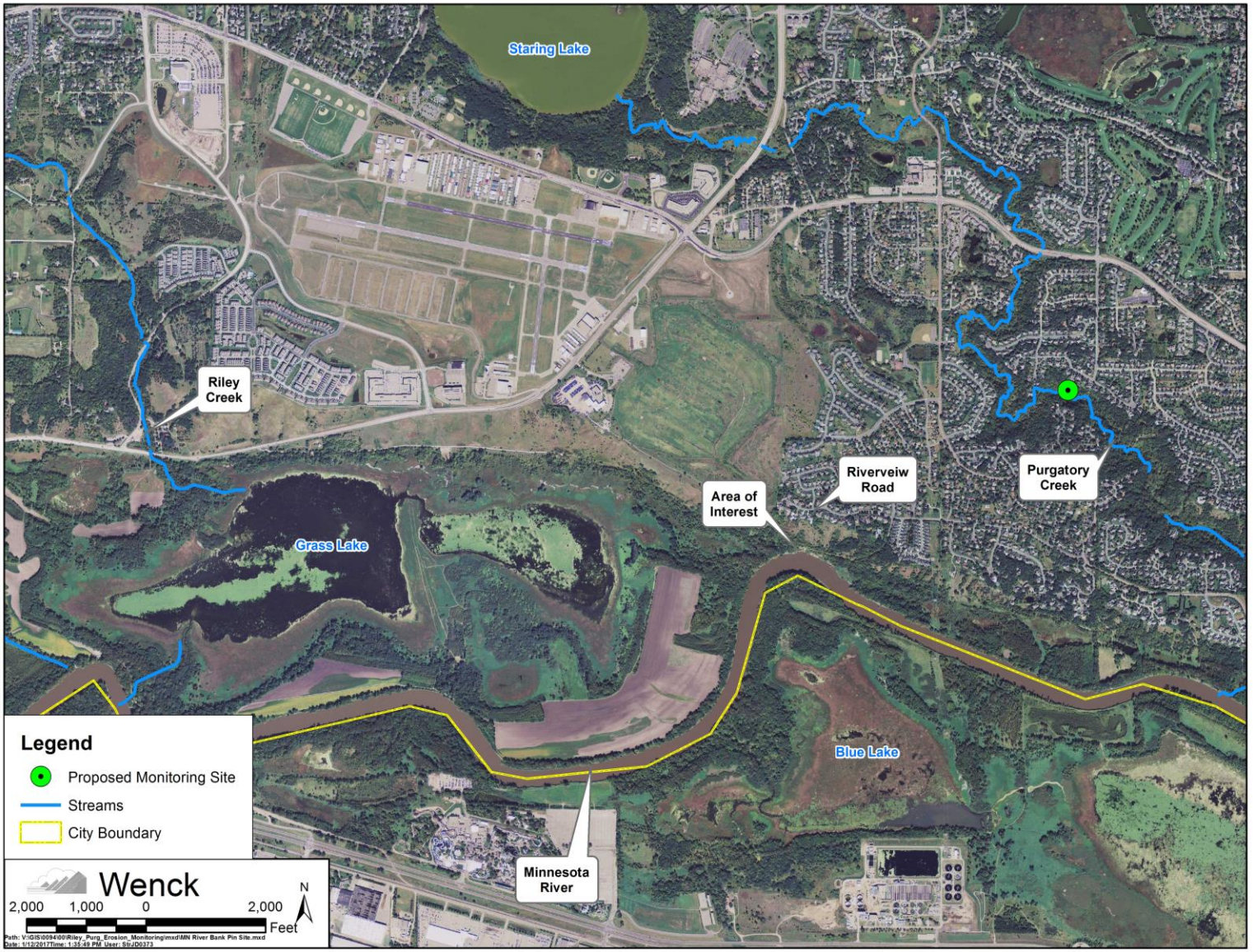


Figure 2: Bank Pin Locations

Attachement A: Photo Log

Bank Pins #1

6/09/2016

11/29/2016

Summary: Approximately 1.8 feet of bank loss between June and November site visits

Bank Pins #2

6/09/2016

11/29/2016

Summary: Upper pin was gone and lower was bent sideways and experienced approximately 1.4 feet of bank loss between June and November site visits

Bank Pins #3

6/09/2016

11/29/2016

Summary: No changes/bank loss noted between June and November site visits

Bank Pins #4

6/09/2016

11/29/2016

Summary: Approximately 1.5 feet of bank loss between June and November site visits

Bank Pins #5

6/09/2016

11/29/2016

Summary: Site experienced significant erosion as both upper and lower pins were lost between June and November site visits

Bank Pins #6

6/09/2016

11/29/2016

Summary: Upper pin experienced approximately 0.2 feet of bank loss between June and November site visits and lower pin was buried by sand

Bank Pins #7

6/09/2016

11/29/2016

Summary: Approximately 0.3 feet of bank loss between June and November site visits

Bank Pins #8

6/09/2016

11/29/2016

Summary: Approximately 0.1 feet of bank loss between June and November site visits

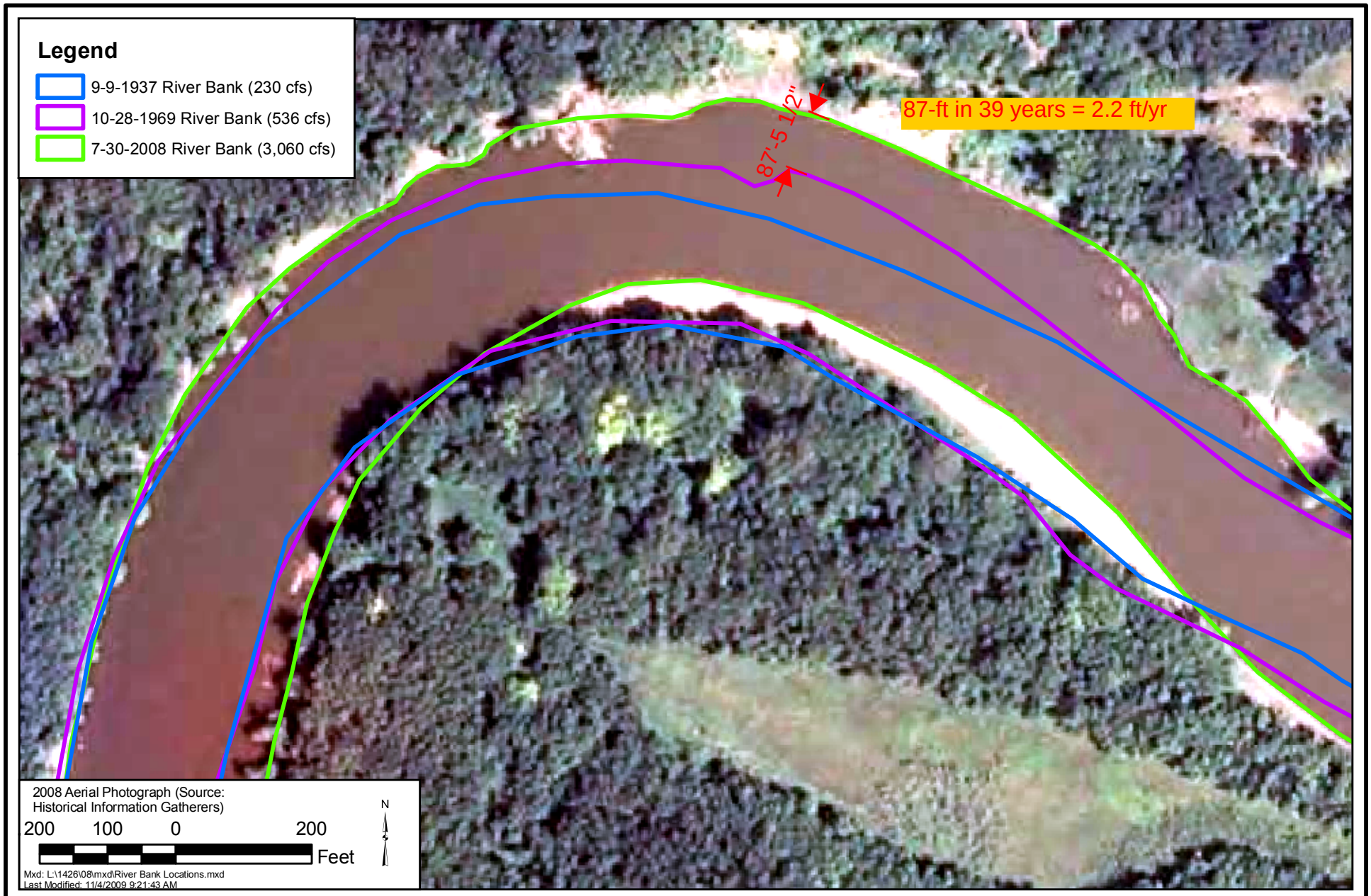
Bank Pins #9

6/09/2016

11/29/2016

Summary: Approximately 0.8 feet of bank loss between June and November site visits

Attachement B: Historic Aerial Photograph Analysis



LOWER MINNESOTA RIVER WATERSHED DISTRICT

Summary of Historical Aerial Photograph Analysis

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Figure 6