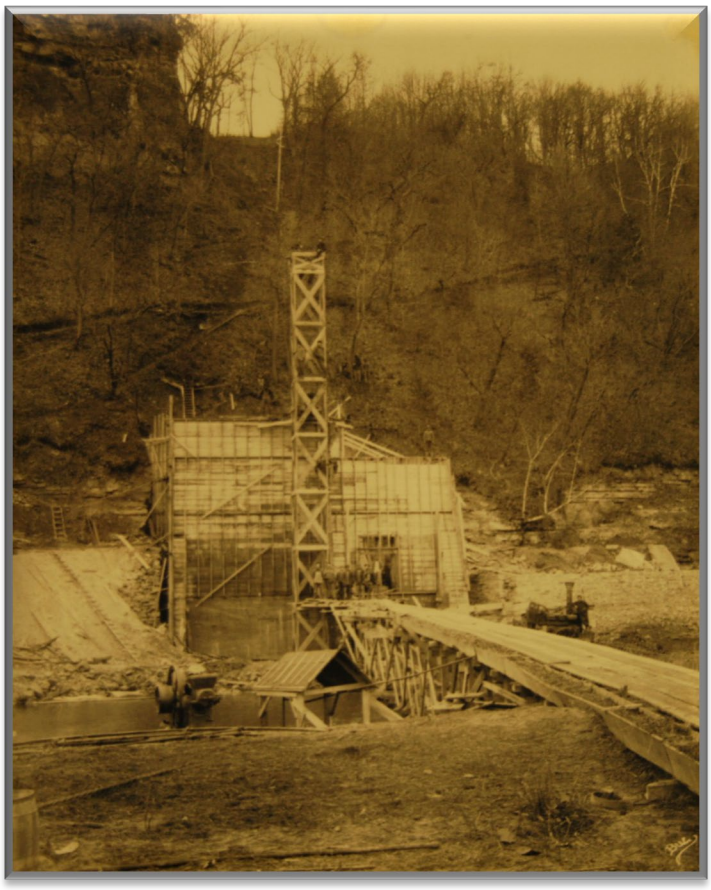
Brightsdale Dam Channel Restoration

North Branch Root River

Fillmore County



Project description and preliminary design in partnership with the Fillmore County Soil and Water Conservation District

By Nick Proulx and Jeff Weiss

Minnesota Department of Natural Resources

Root River at Eagle Bluff/Brightsdale Dam
May 9, 2022

Introduction

The Root River near Eagle Bluff Environmental Learning Center is experiencing an increase in streambank erosion and loss of land. Landowners are interested in reducing the erosion and maintaining the CRP easement on the north side of the river (Figure 1). The likely underlying cause of the streambank erosion is channel instability created initially by a hydroelectric dam and its subsequent breach and removal. According to historical accounts and LiDAR, the channel used to flow near the right bank bluff prior to dam construction (Figure 2). The dam was built in 1913-1914 with two dams on the main channel that funneled a portion of the flow through a constructed channel into a 1,750 feet tunnel through the bluff to the downstream meander (Hanning A.H., 1940) (Figure 3).

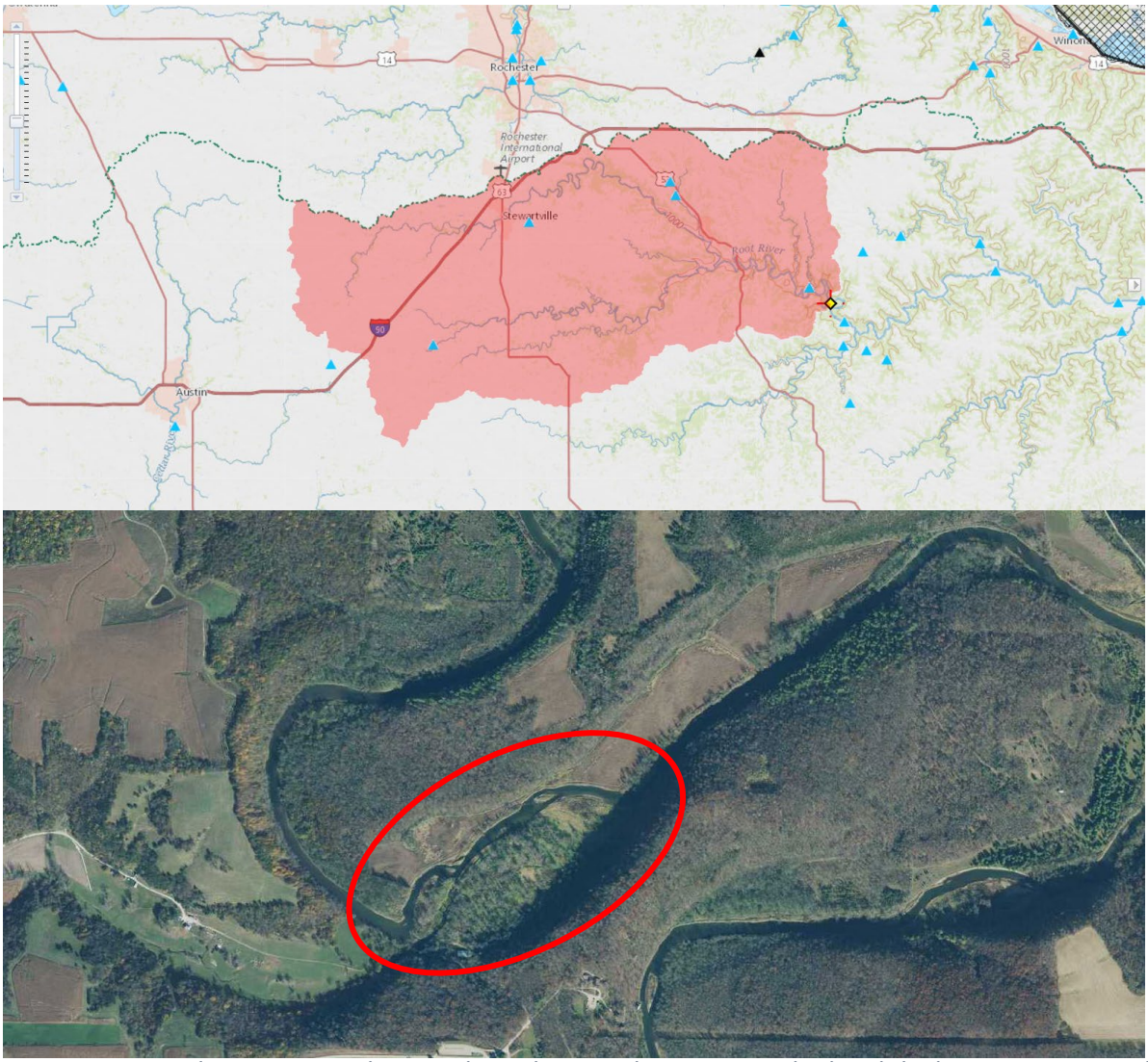


Figure 1. Project location. Top photo outlines the contributing watershed and the bottom is an aerial photograph zoomed in on the site.

Figure 2. Historic channel location prior to the construction of the hydroelectric dam.

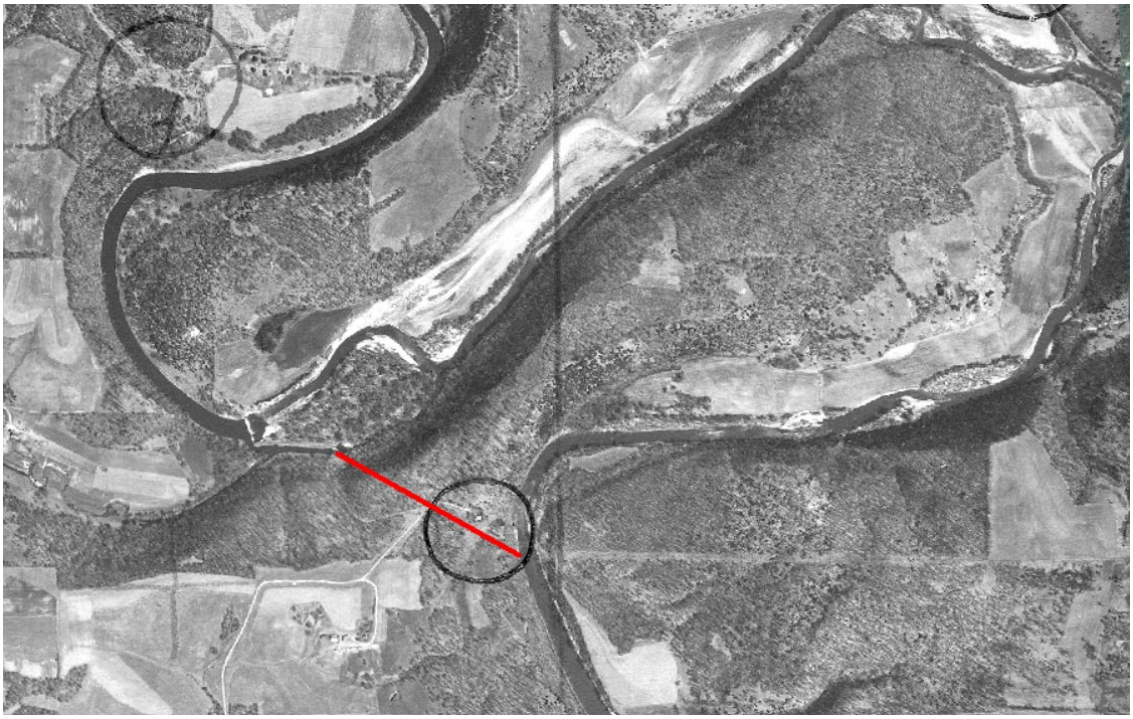


Figure 3. The 1951 aerial photograph with the approximate location of the tunnel dug between the upper and lower meander.

The Root River Power Company was sold in 1928 however, it's not clear how much longer it produced electricity. Due to the lack of yearly historical aerial photos the best estimate of when the dam was partially breached is between 1950 and 1991 and completely blown out between 1995 (Figure 4) to 2003 (Figure 5).

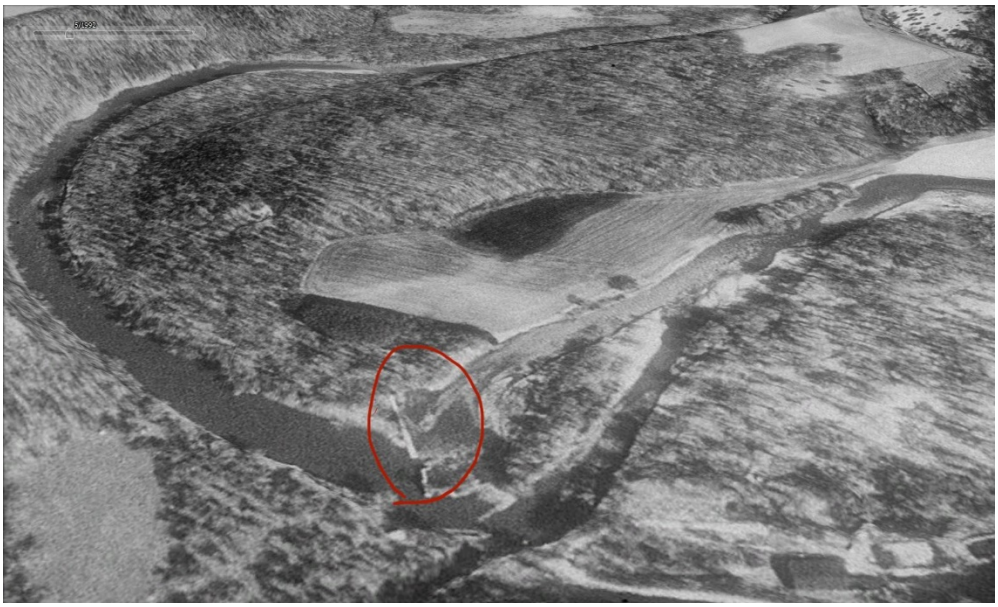


Figure 4. Aerial photograph from 1995, note the partial dam breach.

Figure 5. Aerial photograph from 2003 (FSA), dam is no longer visible.

Dam Legacy Impacts

Dams affect many aspects of river health. They alter hydrology, which is typically the primary purpose, but along with that comes unintended consequences. Dams interrupt sediment transport dynamics, reduce connectivity for aquatic life, destabilize stream channels, affect water quality and many other interrelated issues. Once removed, the dam's impacts remain. Upstream of the dam the channel was wider as water was impounded and once the dam breached, a headcut moved upstream (Figure 6). This headcut incised the channel, but also produced a lot of excess sediment (Figure 7), which

has contributed to the aggraded sediments in the proposed project area and subsequent channel destabilization. As a result, the channel continues to adjust to the excess sediment load.

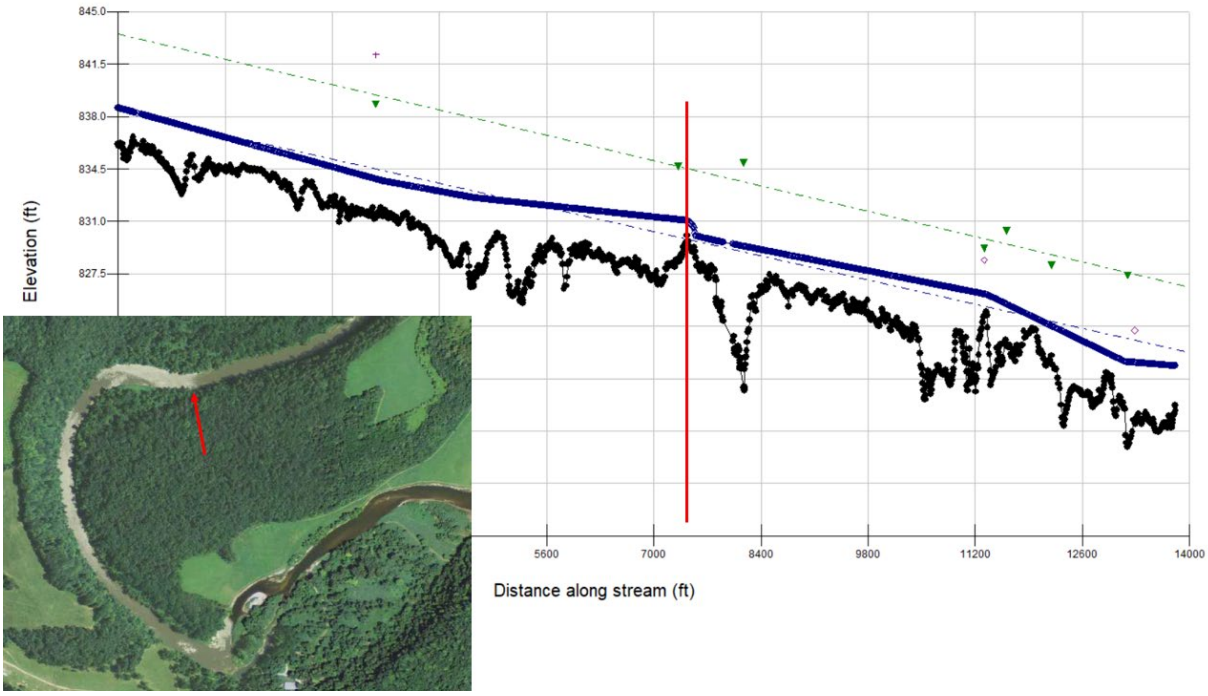


Figure 6. Channel profile for the Root River upstream and at the proposed project area. Red line indicates the current location of the headcut.

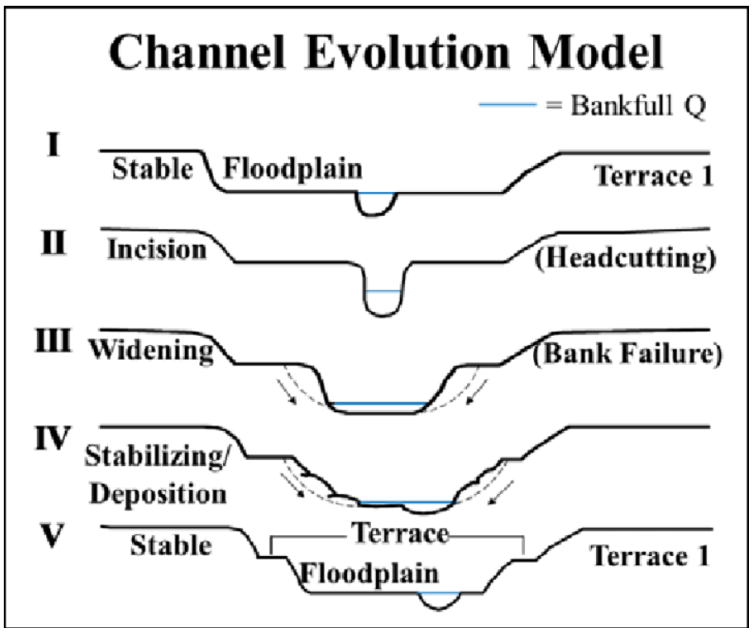


Figure 7. Schumm et al. 1984 channel evolution model.

Downstream of the dam, the excess sediment created by the head cut has increased the growth of the islands and the right bank of the river. Although this process has been occurring overtime, the building up of sediments and lateral channel migration, (streambank erosion) has increased recently (Figure 8). In the last twenty years, the lower channel segment migrated at twice the rate of the previous 40 plus years (1951 oldest aerial photo). The processes of channel stabilization and channel evolution are intertwined and are critical in assessing how quickly the channel may reach a sort of dynamic equilibrium and streambank erosion will decrease. Given the recent acceleration, it is not likely to stabilize any time soon.

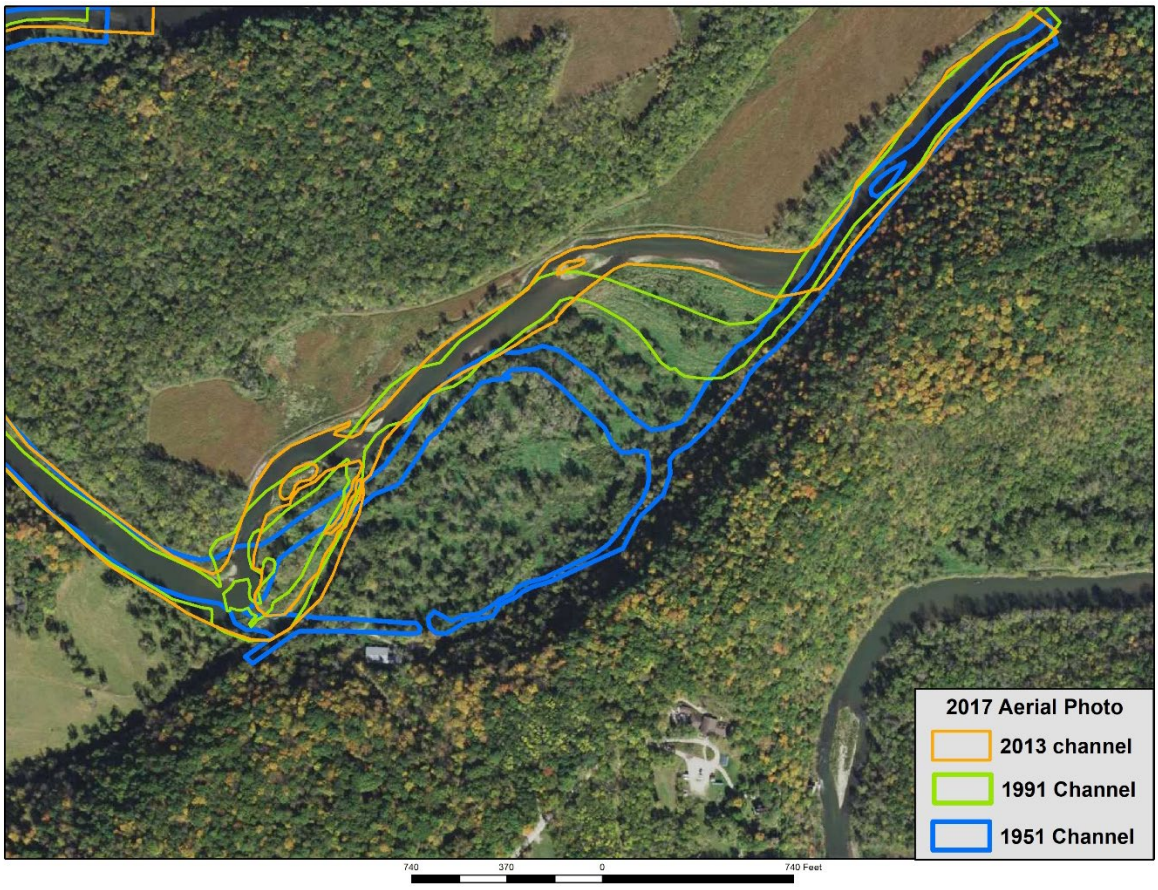


Figure 8. Channel changes between 1951 and 2013 using the 2017 aerial photograph as background.

Design Concept

In 2017, the DNR surveyed and developed three options to consider for streambank stabilization. There are significant constraints with the project, primarily funding, technical issues and landownership. The landownership constraint was addressed, but the funding and technical aspects of the project remain.

The project is being revisited in 2022 with a focus of pursuing grant funding to address the streambank erosion. This has provided an opportunity to evaluate and refine previous efforts.

Root River at Eagle Bluff/Brightsdale Dam
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Project Goals & Strategies

Goal - Reduce streambank erosion

- Currently losing CRP land on left bank – approx. 1,500' of active erosion and 800' moderate erosion
- Quick calculations indicate annual sediment loss at approximately 540 tons a year or 40 dump truck loads (see spreadsheet)
- Strategy
    - Channel shaping and toewood bank treatments
    - Grade control riffles will be elevated to reduce and match overall slope and reduce impacts from the headcut

Goal - Improve channel stability

- Channel pattern and dimensions are not in their stable form
    - Greater than 90 degree radius at the historic dam location
- Strategy
    - Channel shaping and re-meander upstream segment
    - Grade control riffles will be elevated to reduce and match overall slope and reduce impacts from the headcut

Goal - Improve/maintain habitat quality

- Design concept should not degrade in-channel or riparian habitats
- Strategy
    - Adding wood to the design will improve in-channel habitat as well as grade control riffles comprised of native materials

Hydrology

Four Root River gages were evaluated to help determine the target discharge. In this analysis, the Pilot Mound gage, which is the closest to the proposed site, was an outlier (Table 1). A likely explanation for this is the limited years of data (14), skewing the relationship higher due to the larger and in some cases record flood events that have occurred in the region over the recent period of record. As a result, Pilot Mound gage was removed from the watershed level regional curve (Figure 9).

Table 1. Discharge summaries for four Root River gages, Streamstats and a regional curve.

	Drainage Area (mi2)	# of years	Bkf Area (ft3)	Bkf Width (ft)	Discharge (cfs) Return Interval 1.5	Discharge (cfs) Return Interval 1.2
Regional Curve	602		485	120	2,149	
Streamstats	602				1,780 - 8,400	
South Branch near Houston	275	69			1,335	1,061
Pilot Mound	565	14			5,577	4,584
Root River above Rushford	981	31			5,627	4,663
Root River near Houston	1250	98			6,312	5,303

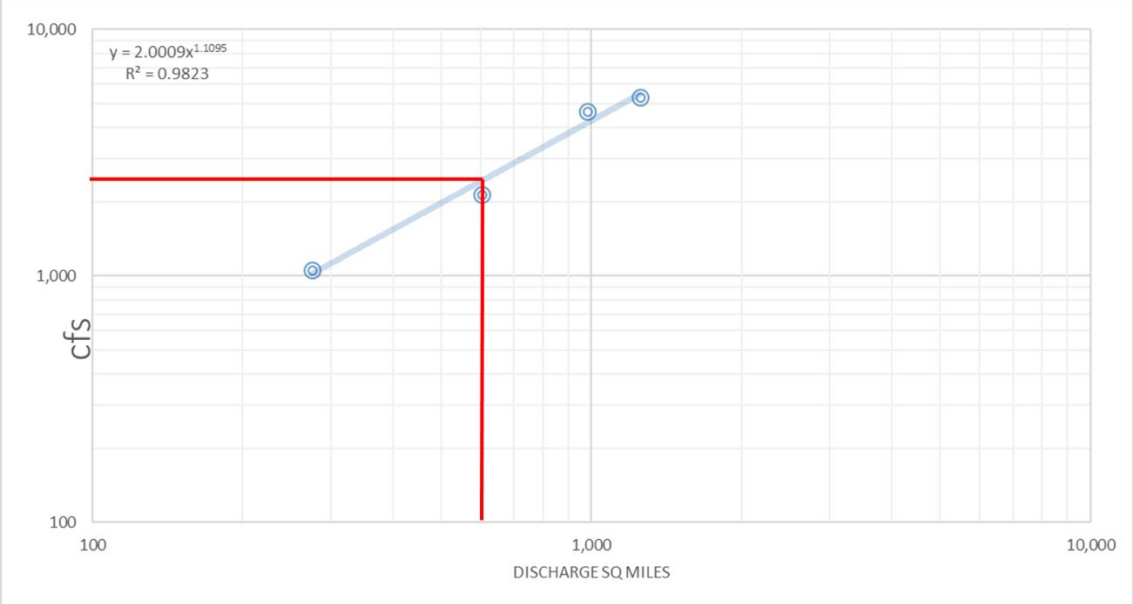

Figure 9. Regional curve using four gages in the Root River watershed, excluding Pilot Mound. Red line indicates the drainage area for the proposed site.

Reference Data

The strategy for achieving channel stability will be to use Natural Channel Design principals, which incorporate reference reach data. A stream is considered reference if it transports both the water and sediment of the upstream watershed and maintains its channel dimension, pattern and profile

overtime without aggrading or degrading. For the proposed location, no reference data were collected yet. Developing a budget for grant purposes, regional curves, aerial photographs and gages will be accurate enough to determine estimated discharge, channel dimensions, select channel pattern variables and adequate floodplain width (Table 2). Once funded, additional data collection efforts will be required including a reference reach survey, to refine the design.

Table 2. Initial reference reach dimensions, pool to pool spacing and slope based on regional curves, aerial photos and watershed gages.

facet	Abkf (ft2) min - max		Wbkf (ft) min - max		Dbkfmax (ft) min - max		Length (ft) min - max	
riffle	300	500	120	140	6	8	330	475
pool	400	700	130	180	8	13	620	900
Pool to Pool spacing ft (min, mean, max)			**Bankfull Slope**	**Beltwidth (min)**		**Floodprone width (min)**		
365	675	1114	0.0012	600'		300'		

The three potential concepts developed previously were to place the channel back to its original location along the bluff, move the upper portion of the channel into a connected side channel and stabilize the channel in its current location. Returning the channel to the original location was off the table due to economic constraints. Stabilize the channel in place is feasible, but has significant risks associated with it due to a very tight radius just downstream of the historic dam location. That leaves the option of activating the side channel and stabilizing the downstream end (Figure 10). Since the 2017 data work up, a couple of additional factors were reevaluated to help reduce risk and costs. As mentioned above, a headcut formed due to the dam breach and was located upstream roughly 4,000 feet. Addressing this is important because it is partially responsible for the excess sediment at the proposed site. Excess sediment continues to destabilize the channel as the pattern continues to adjust. One way to do this is to elevate the channel to reduce the slope, slowing the headcut from moving further upstream and creating more bed scour (excess sediment) (Figure 11). It also has the benefit of reconnecting more of the floodplain to the channel within the wider valley reducing near-bank stress. Finally, it reduces the amount of sediment needed to be moved, lowering the project costs.

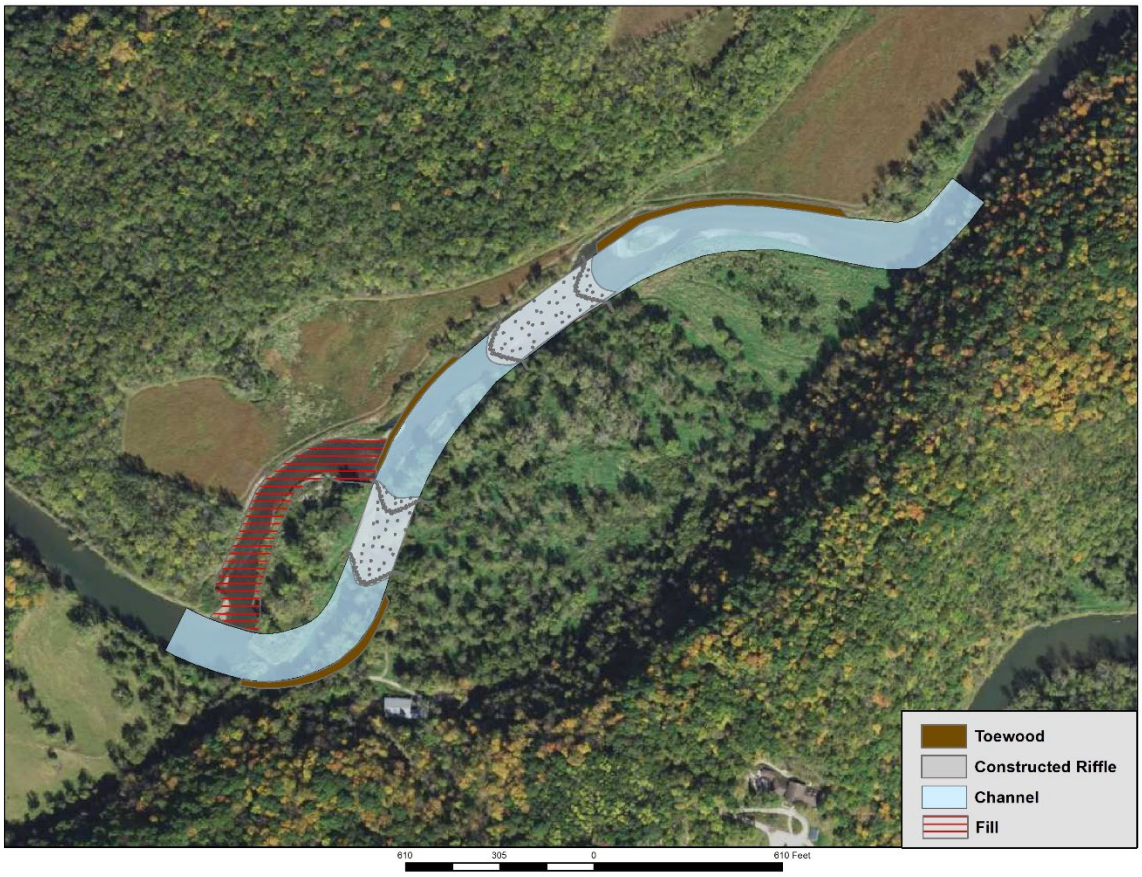

Figure 10. Plan form concept for Root River channel restoration.

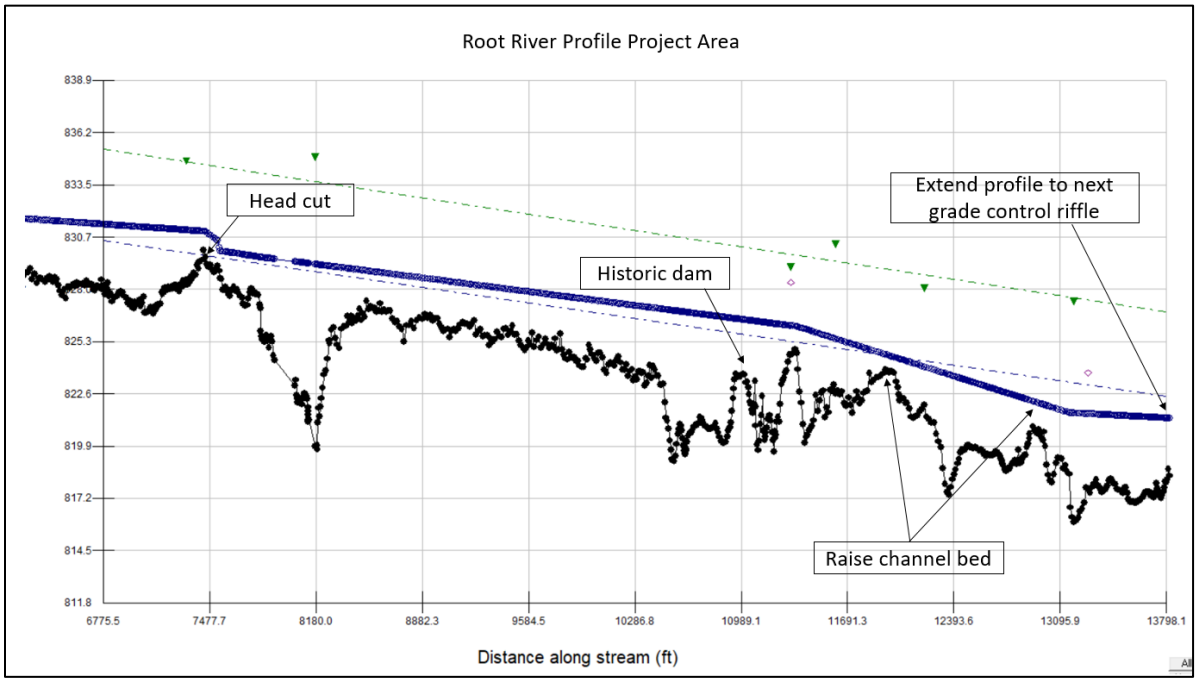

Figure 11. Profile covering the upstream and proposed restoration location.

To develop an estimated budget for this concept, the 2017 surveyed cross sections will be used (Figures 12-16). According to the landowners, the channel has widened since 2017 and will need to be resurveyed once funding is secure.

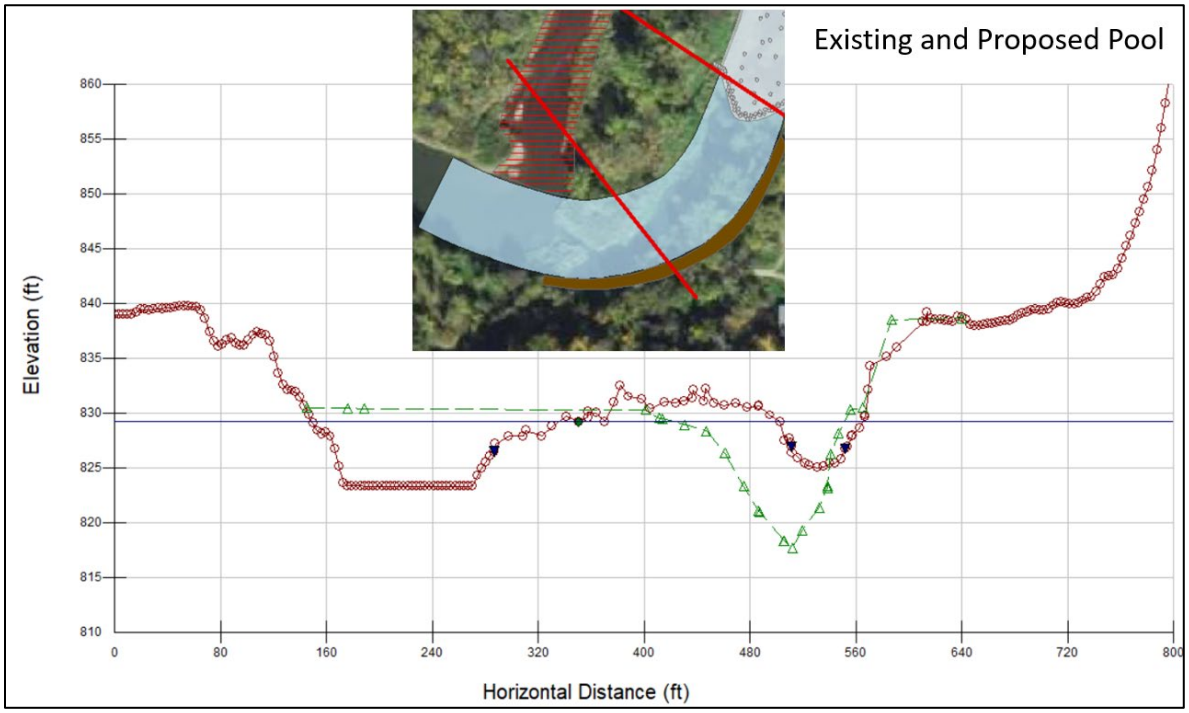

Figure 12. Existing channel and floodplain (red) and proposed pool and floodplain (green).

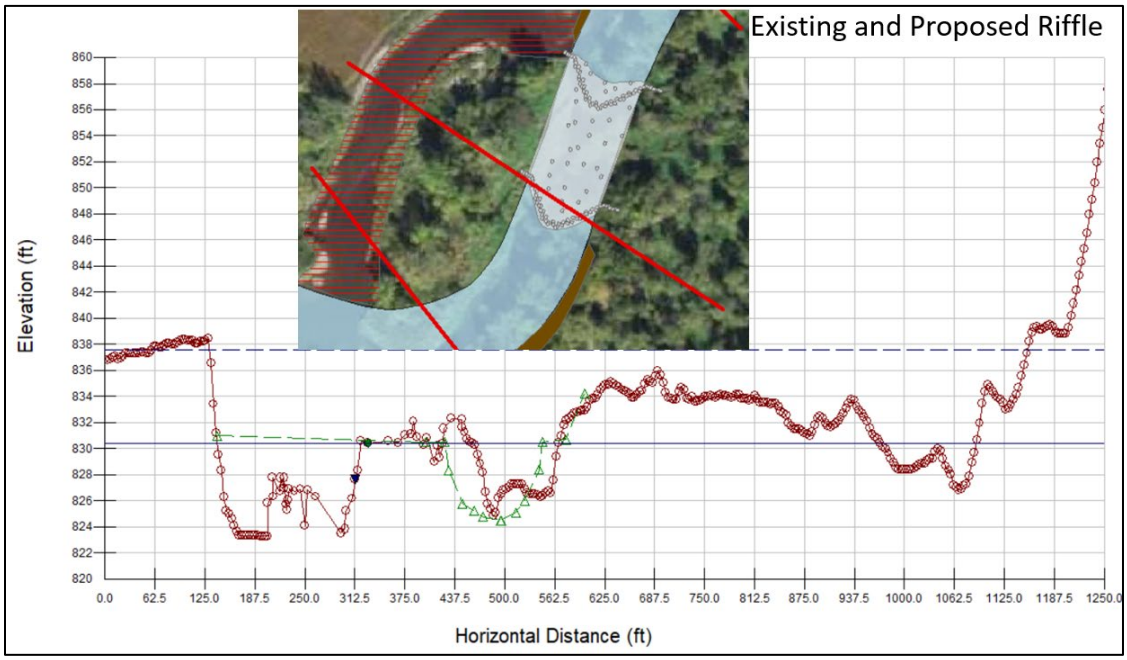

Figure 13. Existing channel and floodplain (red) and proposed riffle and floodplain (green).

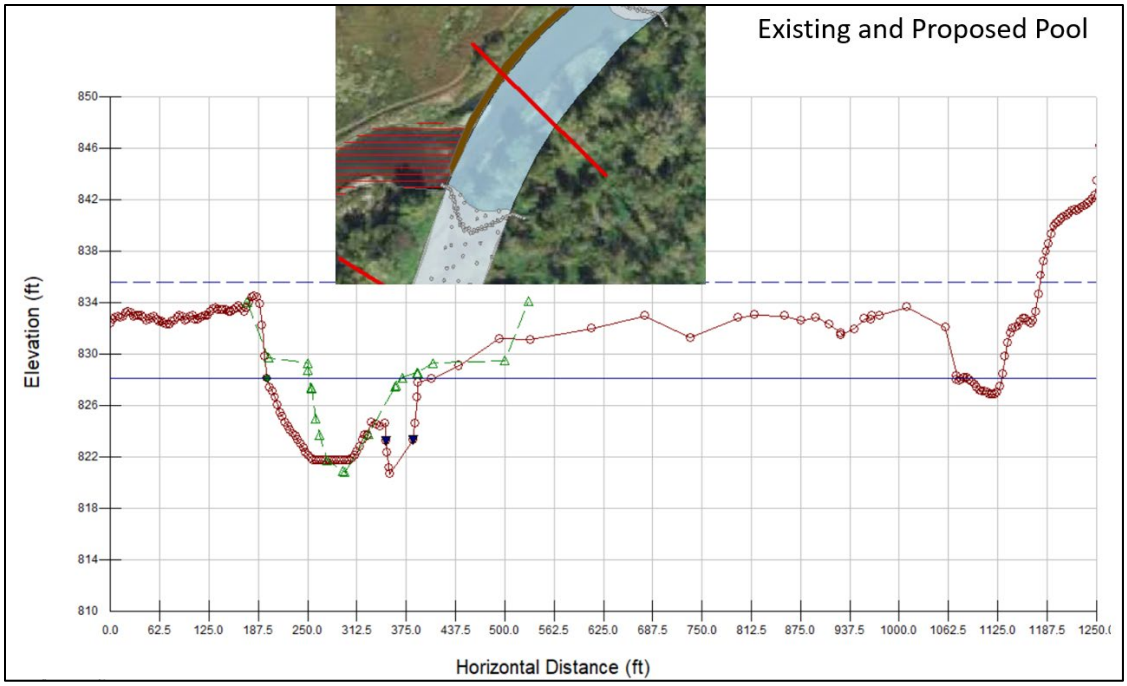

Figure 14. Existing channel and floodplain (red) and proposed pool and floodplain (green).

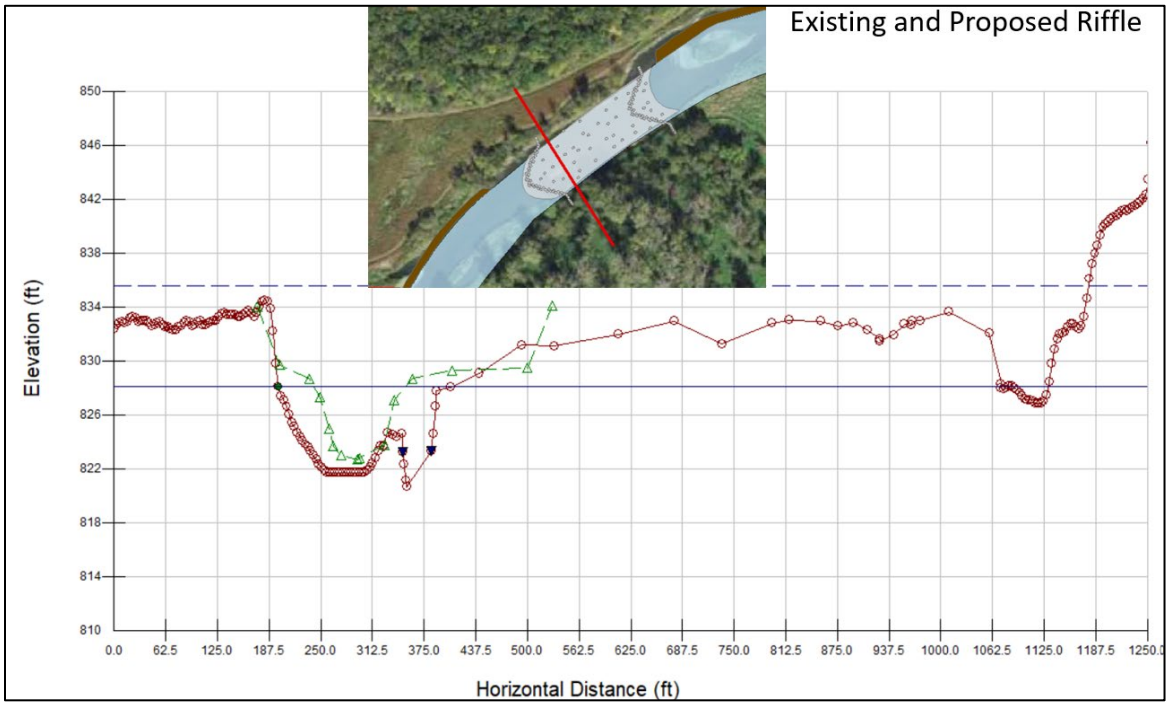

Figure 15. Existing channel and floodplain (red) and proposed riffle and floodplain (green).

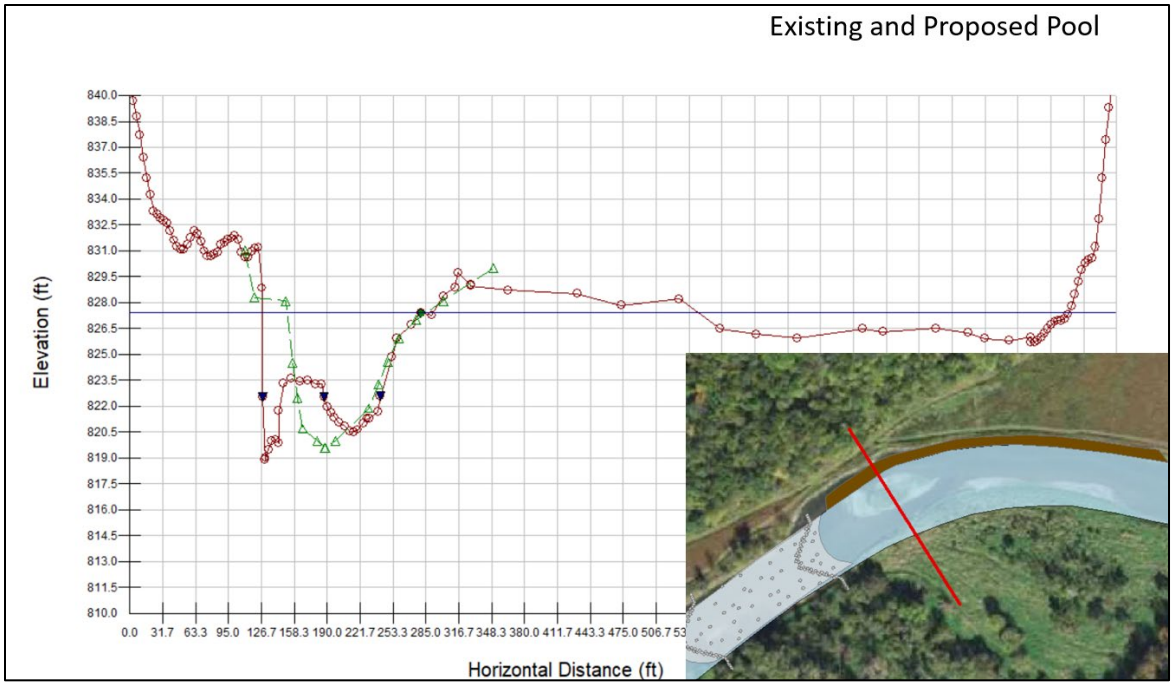

Figure 16. Existing channel and floodplain (red) and proposed pool and floodplain (green).

Budget Development

Raising the channel and adjusting the active floodplain to meet a typically stable entrenchment ratio for a C channel, reduced the amount of cut needed to shape a channel and floodplain. There will likely be more fill required using this strategy, however expanding the active floodplain will generate enough to balance the cut and fill. There are also other creative ways of dealing with the lack of fill, such as creating backwater habitat. Other cost saving options include harvesting rock on-site and allowing riffles to recruit bed material naturally.

The other potential complication with the concept was the historic dam and if any of the existing structure would influence the new channel. In 2017, when using the hydro-acoustic equipment to develop a profile, additional survey points were taken in and near the dam footprint and where the new channel will flow (Figure 17). There does not appear to be much of the dam still in place, at least within the existing and proposed channel. No additional work will be needed to remove dam remnants from the proposed site.

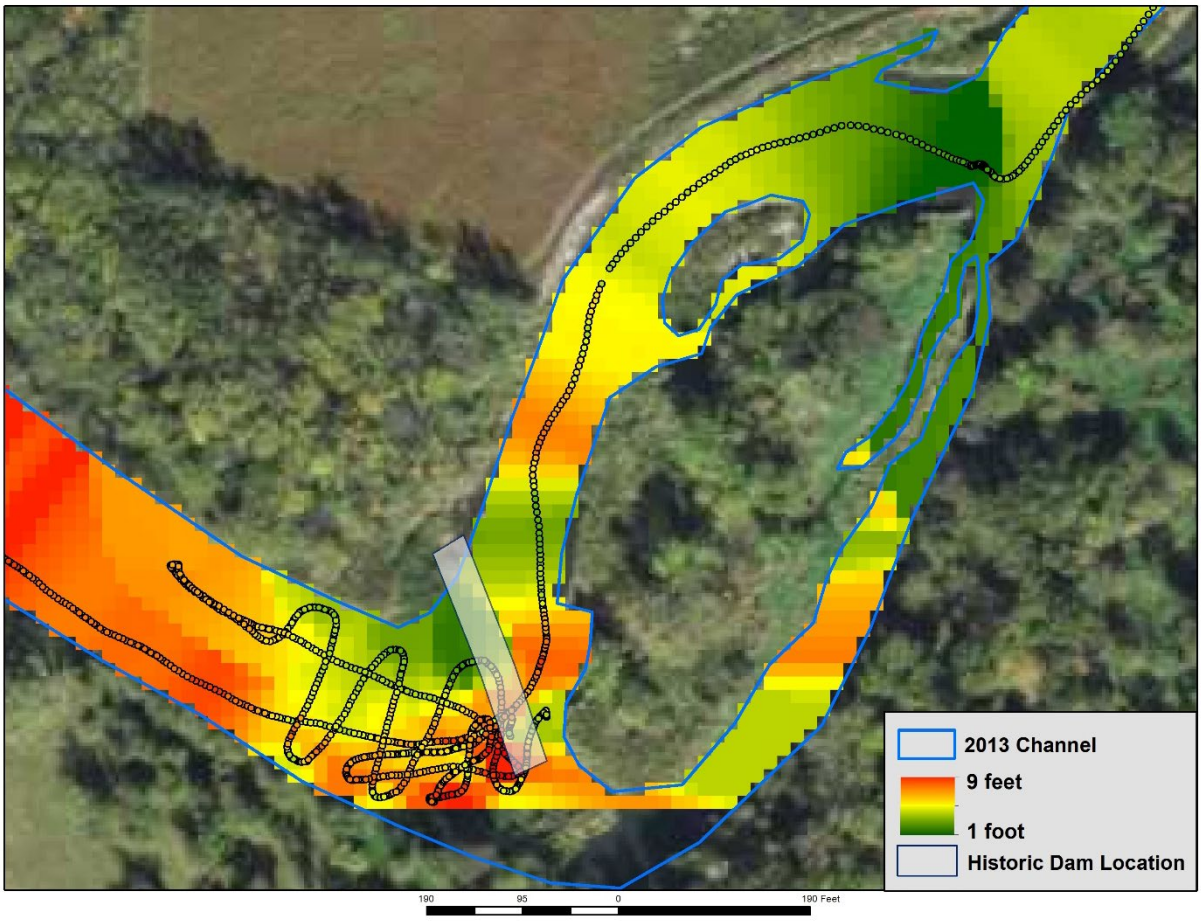

Figure 17. Hydro-acoustic survey points, depth survey map created using the survey points and the historic dam location.

The initial estimated cost for this project will be around $1M (see spreadsheet). The budget and estimated excess sediment quantities provide the information needed to complete a grant application with the exception of any match requirements.

Table 3. Cost estimate breakdown for materials and project administration.

BASE BID ITEM	UNIT	TOTAL QTY	UNITCOST	COST
MOBILIZATION	LS	1	$20,000	$20,000
TREE CLEARING/GRUBBING - HARVEST FOR ROOTWAD & ROOTWAD FOOTER	EA	250	$50	$12,500
CHANNEL & FLOODPLAIN EXCAVATION	CY	40000	$6	$240,000
ON-SITE CHANNEL FILL	CY	40000	$3	$120,000
RANDOM RIP-RAP, CLASS V (*BOULDER TOE & MID-RIFFLE INSTALL*)	TON	300	$110	$33,000
BOULDERS 34" - 45" (*CROSS VANES INSTALL FOR RIFFLE*)	TON	600	$120	$72,000
HARVEST BOULDER, COBBLE, & GRAVEL ON-SITE	TON	5000	$20	$100,000
SILT FENCE, HEAVY DUTY - INSTALLATION, MAINTENANCE & REMOVAL	LF	300	$3	$900
STABILIZED CONSTRUCTION EXIT	LS	1	$3,000	$3,000
SEDIMENT CONTROL LOG, TYPE STRAW	LF	2500	$3	$7,500
SEEDING (FLOODPLAIN)	AC	6	$650	$3,900
SEEDING (ACCESS ROUTE)	AC	1	$650	$650
SEEDING (FLOODPLAIN BENCH + ADJACENT RIPARIAN)	AC	4.5	$650	$2,925
SEED, MN STATE MIXTURE 32-241 (NATIVE CONSTRUCTION)	LBS	25	$25	$625
SEED, MN STATE MIXTURE 34-261 (RIPARIAN SOUTH & WEST) + COVER CROP	LBS	162	$80	$12,960
SEED, MN STATE MIXTURE 35-641 (MESIC PRAIRIE) + COVER CROP	LBS	216	$40	$8,640
STRAW MULCH & DISC ANCHORING	AC	10	$50	$500
EROSION CONTROL BLANKET (GEOCOIR®/DeKoWe® 700 OR SAME SPECIFICATION)	SY	2300	$5	$11,500
STRAW EROSION CONSTROL BLANKET	SY	15000	$2	$30,000
BARE ROOT SHRUBS (WILLOW SPP, OTHERS)	EA	4000	$2	$8,000
LIVE STAKE	EA	1200	$1	$1,200
BURIED LOG SILL	LF	500	$50	$25,000
TOEWOOD AND SOIL LIFT INSTALLATION	LF	2000	$75	$150,000
ENGINEERING/PROJECT MANAGEMENT	LS	1	15%	$137,000
TOTAL				**$1,001,800**

Root River at Eagle Bluff/Brightsdale Dam
May 9, 2022

[Document title]
900 Washington St NW, Preston, MN 55965
Phone: 507-765-3878 ext. 123
www.fillmoreswcd.org

May 9, 2022

RE: Request for DNR assistance

Dear MN DNR,

The Fillmore Soil and Water Conservation District (SWCD) would like to request the assistance of DNR for the Brightsdale Dam Channel Restoration proposed project. The SWCD would be looking for in-kind support with the project to complete such tasks as putting out requests for proposals for consulting firms to develop plans, bidding process with contractors, permitting of the proposed project, construction oversight and other reporting aspects as requested.

Along with the request for DNR assistance with in-kind support is also a request for partnership between Fillmore SWCD and the DNR on the proposed project. This project will meet goals of both the SWCD and the DNR and also ties in with the Root River One Watershed One Plan.

Thank you for your consideration of this request and the SWCD looks forward to hopefully being able to partner and work with DNR on this proposed project.

Sincerely,

Anne Koliha

Anne Koliha
Fillmore SWCD
District Administrator