RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

Feasibility Report

Kerber Pond Ravine Stabilization Project

Prepared for
Riley Purgatory Bluff Creek Watershed District

November 2020



Feasibility Report

Kerber Pond Ravine Stabilization Project

November 2020

Contents

List of Tables

List of Figures

List of Appendices, Attachments, or Exhibits

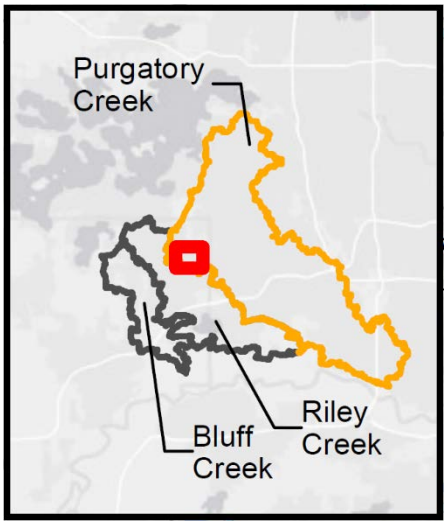
Certifications

I hereby certify that this 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.

Jennifer Koehler PE #: 47500	11/3/2020
	Date

Executive Summary

This study was completed in response to a request from the City of Chanhassen to reduce observed sediment (and ultimately nutrient) loads into Lotus Lake, an MPCA impaired water, from the Kerber Pond Ravine. The Kerber Pond Ravine originates at the outlet from Kerber Pond, within Kerber Pond Park, traversing ~1000 feet downstream to Frontier Trail while covering a vertical drop of ~30 ft. Feet. This site presents several design and maintenance challenges including, but not limited to dense tree canopy, erosive soils, steep topography, and an existing sanitary sewer running along the ravine.



Project location in Purgatory Creek watershed

Two stabilization concepts were evaluated for the existing ravine downstream of Kerber Pond. The stabilization concepts would be constructed on private property. Additionally, the culvert under Frontier Trail along with the storm sewer to the Lotus Lake discharge was reviewed for potential improvements.

Stabilization Concepts:

- Concept 1 – In-Channel Stabilization with Stabilization of Kerber Pond Outlet Discharge, Targeted Bank Armoring and In-Channel Stabilization Practices
- Concept 2 – Low-Flow Channel Conveyance, High-Flow Piped Conveyance System with Targeted Bank Armoring and In-Channel Stabilization Practices in the Channel Conveyance

An evaluation for the two concepts considered water quality benefits, regulatory approvals, affected property owners, wetland impacts, access to public sanitary sewer utilities, and cost to construct and maintain.

Based on the results of the engineering assessment, potential site impacts, and phosphorous removed, Concept 1 — In-channel stabilization measures is a more cost - effective stabilization method and less environmentally impactful than Concept 2.

Concept 1 is consistent with the 2020 TMDL for Lotus Lake. This Concept presents the lowest impacts to natural resources in the area while also helping improve and protect the water quality in Lotus Lake. The ravine restoration project would remove an average annual phosphorus load of 2.9 pounds per year (ranging from 0.8 - 3.8 pounds per year), achieving approximately 50% of the load reduction identified for erosion sources in the Lotus Lake TMDL.

The engineer's opinion of probable cost for the design, permitting, and construction of Concept 1 is $395,000 with a potential range of $280,000 to $590,000 based on the current level of design. Additionally, over a 30-year period, long term maintenance is estimated to an anticipated annual cost of $4,900 (estimated range from $3,400-$7,300). This translates to an annualized total phosphorus removal cost of $6,200 per pound of total phosphorus removal per year (ranging from $3,400 – $32,400 per pound of phosphorus per year).

Because this project is not currently part of RPBCWD's 10-year plan, a plan amendment would be needed if the Board decides to pursue this as an opportunity project. The project scored a 34 using the RPBCWD prioritization tool in the 10-year plan, above the threshold for projects that were carried forward into the 10-year plan.

If the Board elects to pursue the project, it is recommended that coordination with the City of Chanhassen continue as this project would most likely be implemented as part of the City's reconstruction of Frontier Trail. It is also possible that the City of Chanhassen may take the lead on the design and construction of this project. The City's Frontier Trail reconstruction would also likely include improvements to the storm sewer conveyance system between Frontier Trail and Lotus Lake at an estimated cost of $263,000. The RPBCWD will need to develop cooperative agreements with the City. Additionally, access and maintenance agreements with the private property owners for access and construction will be needed.

As plans and specifications for the recommended conceptual design are prepared, the RPBCWD should continue to collaborate with City of Chanhassen staff and impacted private property owners about plan details.

1.0 Context and Goals for this Plan

This report summarizes the potential actions within the Kerber Pond Ravine (subwatershed LL-A9.2) to stabilize a 1000 foot long eroding ravine, protect infrastructure, enhance habitat, and improve the water quality in Lotus Lake, located in the City of Chanhassen, Minnesota. Figure 1-1 illustrates the Lotus Lake watershed and drainage patterns of the contributing subwatersheds to Kerber Pond and the Kerber Pond Ravine. This report is prepared under the direction of the Board of Managers of the Riley-Purgatory-Bluff Creek Watershed District.

The Riley-Purgatory-Bluff Creek Watershed District (RPBCWD or District) was established by the Minnesota Water Resources Board in 1969, acting under authority of the Watershed Law. As charged by the law and the order establishing the District, the general purpose of the District is to protect public health and welfare and to provide for the provident use of natural resources through planning, flood control, and conservation projects.

The District is located in the southwestern portion of the Twin Cities Metropolitan Area, encompassing an area of nearly 50 square miles. There are three major subwatersheds within the District—Riley Creek, with a watershed area of 10.0 square miles; Purgatory Creek (31.4 square miles), and Bluff Creek (5.9 square miles). All three creeks discharge to the Minnesota River. Stormwater management and development were guided by the District's 1973 Overall Plan, revised in May 1996 and February 2011 in accordance with the Metropolitan Surface Water Management Act and Watershed Law (Minnesota Statutes Chapters 103B and 103D). In 2018 the District completed an extensive public and stakeholder engagement process to develop the new 10-year plan, *Planning for the Next Ten Years (2018-2027)* (Riley-Purgatory-Bluff Creek Watershed District, 2018), to guide the district.

The Lotus Lake Use Attainability Analysis (UAA) was updated in March 2017 as part of *the Lotus, Silver, Duck, Round, Mitchell, Red Rock Use Attainability Analysis Update; Lake Idlewild and Staring Lake Use Attainability Analysis; and Lower Purgatory Creek Stabilization Study* and includes recommended remedial measures to improve the water quality (Barr Engineering, 2017).

The UAA provides the scientific foundation for lake-specific management plans that will preserve existing—or achieve potential—beneficial uses of the lakes. The UAA is a structured, scientific assessment of the factors affecting attainment of a beneficial use under both current and ultimate watershed development conditions. "Use Attainment" refers to achievement of water quality conditions that support lake-specific uses such as swimming, fishing, wildlife habitat, and aesthetic viewing.

The 2017 UAA Update was completed with the goal of: (1) assessing the water quality of major lakes in the Purgatory watershed based on more recent physical, chemical, and biological data, (2) improving the understanding of current water quality concerns in the lakes, and (3) identifying best management practices (BMPs) to improve and protect the lakes' water quality and increase the likelihood of them being removed from the Minnesota Pollution Control Agency's (MPCA) impaired waters list for excess nutrients. The overarching purpose of the UAA update was to identify and evaluate BMPs that can be implemented to improve and/or protect the lakes' water quality and achieve the long-term vision of sustainable uses, as outlined in the District's Plan.

The District has established 13 goals as targets to achieve the District's Mission of protecting, restoring, and managing water resources within the district. The following goals are supported by this feasibility study and potential restoration project.

- Plan and conduct the District's implementation program to most effectively accomplish its vision with consideration for all stakeholders and resources. (Plan 1)
- Include sustainability and the impacts of climate change in District projects, programs, and planning. (Plan 2)
- Protect, manage, and restore water quality of District lakes and creeks to maintain designated uses. (WQual 1)
- Preserve and enhance the quantity, as well as the functions and values of District wetlands. (WQual 2)
- Preserve and enhance habitat important to fish, waterfowl, and other wildlife. (WQual 3)

- Protect and enhance the ecological function of District floodplains to minimize adverse impacts. (WQuan 1)

- Limit the impact of stormwater runoff on receiving waterbodies. (WQuan 2)

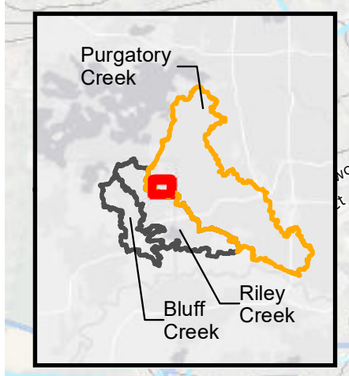
In February 2020, the MPCA released the Lower Minnesota River Watershed Total Maximum Daily Load (TMDL) Report (Minnesota Pollution Control Agency, 2020) which incorporates the 2016 UAA modeling and water quality data reported in the 2016 UAA. The TMDL utilizes the UAA to determine pollutant loading to the lake and estimate the required load reductions to meet the water quality goals. Actions stemming from this TMDL study and the District's management plan were incorporated into the MPCA's Lower Minnesota River Watershed Restoration and Protection Strategy Report (Minnesota Pollution Control Agency, 2020).

Although the Kerber Pond ravine stabilization project was not identified as part of the UAA project for Lotus Lake or specifically listed in the district's 10-year plan, the 10-year plan incorporates adaptive management strategies and flexibility to pursue opportunity projects as they arise. The City of Chanhassen approached the District shortly after the Plan was adopted in 2018 for a potential partnership opportunity project to restore the Kerber Pond ravine and storm sewer connection to Lotus Lake. The city indicated they have documented the release of large amounts of sediment into the lake after heavy rains. The city stated, "The sediment is so great that it clogs up our storm sewer system". In addition, the city provided a video showing of sediment/mud flowing out of the culvert at Frontier Trail.

A 2019 site walk revealed the channel is incised in several locations and appears to deliver a large amount of sediment toward Lotus Lake.

KERBER POND RAVINE WATERSHED AND FLOW PATTERNS

FIGURE 1-1



Ravine Thalweg

Purgatory Creek Watershed

Subwatersheds

Flow Directions

Storm Sewer

2 Foot Contours, Carver County, 2011

10-Foot Contour

2-Foot Contour

N

0 200 400 800 Feet

Lotus Lake

Kerber Pond

Canterbury Cir
Derby Dr
Belmont La
Bighorn Dr
Shadowmere Cir
Dakota Ave
Butte Ct
Saddlebrook Pass
Trotter's Cir
Conestoga Ter
Conestoga Ct
Sierra Ct
Sierra Tr
Kiowa Cir
Frontier Tr
Highland Dr
Cimarron Cir
Laredo Dr
Laredo La
Iroquois St
Del Rio Dr
Santa Fe Tr
Santa Fe Cir
Frontier Ct
Great Plains Blvd
Erie Ave
76th St W
Longview Cir
Saddlebrook Tr
Cactus Cv
Kerber Blvd
Saddlebrook Cv
Canyon Cv
Chippewa Ct
Chippewa Ter
Saratoga Dr
Saratoga Cir
Santa Vera Cir
Santa Vera Dr
Kimberly Ln
Nicholas Way
Kelly Ct

BARR

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

1.1 Vision, Approach and Kerber Pond Ravine Project Goals

The Lotus Lake UAA and the MPCA's Lower Minnesota River Watershed Total Maximum Daily Load (TMDL) Report concluded that Lotus Lake was not meeting the MPCA state water quality standards and does not meet the RPBCWD long-term vision.

The Kerber Pond ravine stabilization feasibility study focuses on feasibility options to restore the reach and reduce the pollutant loading to Lotus Lake, thus improving lake water quality, protecting public infrastructure, and protecting the district's investment in the 2019 Lotus Lake alum treatment. The feasibility study evaluates two (2) options for the project reaches.

The District ordered this feasibility study to evaluate the opportunities to stabilize the Kerber Pond ravine and reduce sediment and nutrient loads to Lotus lake while also considering other potential ecological enhancements in the corridor. The estimated sediment and total phosphorus pollutant load reductions and engineer's opinion of project costs were determined for two feasible concepts.

1.2 Lotus Lake Water Quality Goals and Current Lake Conditions

The MPCA lake eutrophication criteria establish water quality standards for lakes based on total phosphorus, chlorophyll a, and Secchi disc transparency (Minnesota Pollution Control Agency, 2017). The standards are based on the geographic location of the water body (and associated ecoregion) and its depth (shallow vs. deep lakes).

Lotus Lake, classified as a deep lake in the North Central Hardwood Forest ecoregion, is listed on the MPCA 303(d) Impaired Waters List for excess nutrients. It has typically exceeded the MPCA water quality standards for total phosphorus and chlorophyll-a concentrations. With regards to Secchi disc transparency, some years the transparency meets the state standards while other years, the transparency does not meet the standards. See Figure 1-2 for summer average water quality graphs for Lotus Lake. The red line represents the MPCA water quality standards for Lotus Lake.

Review of historic water quality data suggests there are no significant water quality improvement or degradation trends present in all three of the parameters for Lotus Lake.

As part of the UAA study and subsequent TMDL study, an in-lake model was used to determine TP load reductions needed to meet the water quality goal for Lotus Lake. Table 1-1, shows the existing conditions TP loads, the TP loading capacity, and the required percent reduction needed to meet the TP goal for both wasteload and load allocations. Also included in the TMDL summary is the Margin of Safety (MOS) included in TMDL analyses.(Minnesota Pollution Control Agency, 2020).

The TMDL relies on a recent 10-year average to assess if a waterbody is achieving the water quality goals. Under the 10-year average conditions, Lotus Lake is not meeting the MPCA's total phosphorus or chlorophyll *a* goals for a deep lake of 40 µg/L and 14 µg/L, respectively. Following the 2019 alum treatment n Lotus Lake, the phosphorus levels in 2019 achieved the MPCA's criteria but chlorophyll *a* remained above the criteria. The TMDL for Lotus Lake indicated that a total phosphorus load reduction of 47% is needed to achieve the MPCA water quality standards, addressing loads from stormwater runoff, erosion sources, and internal loads.

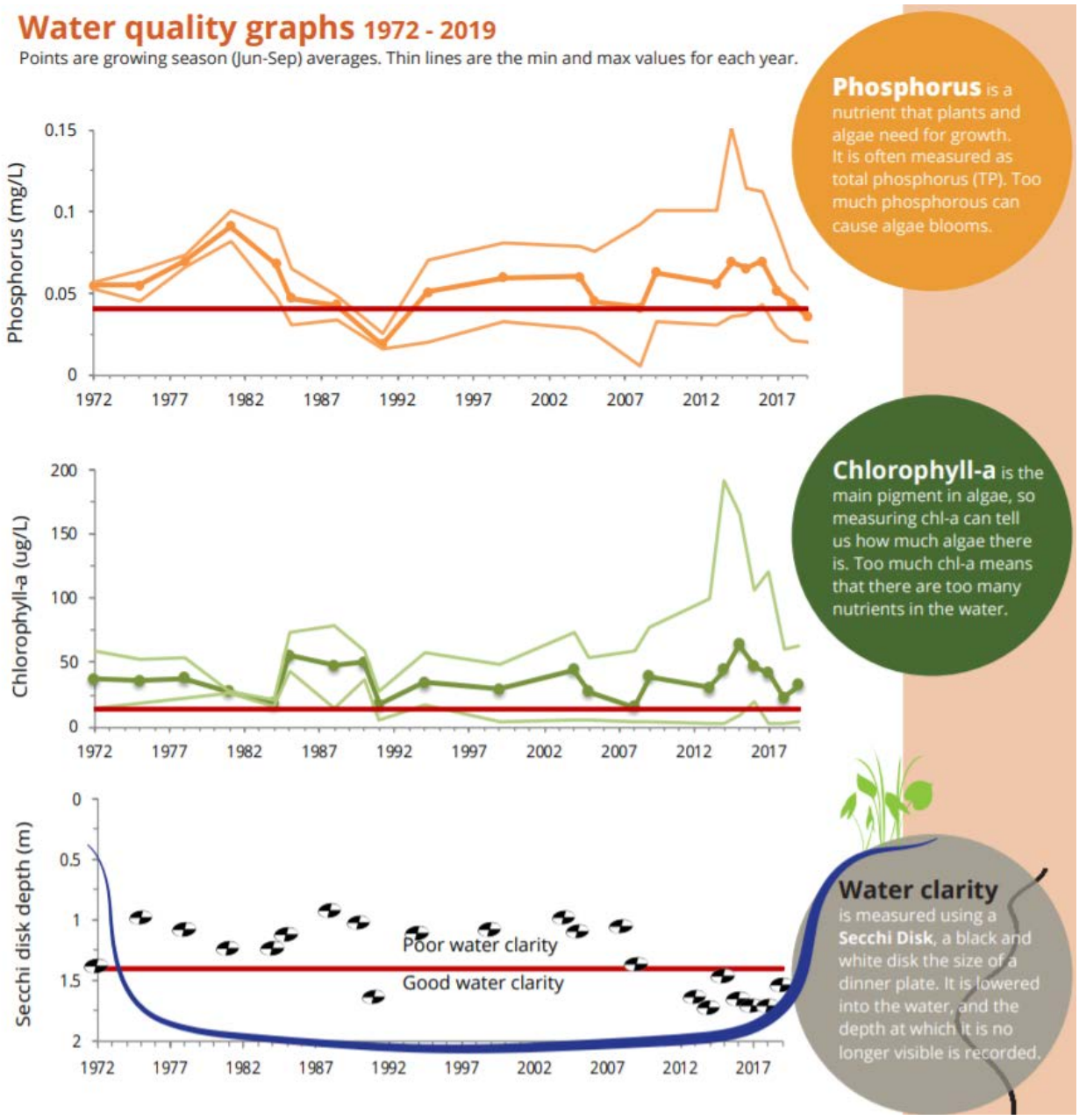


Figure 1-2 Lotus Lake Water Quality

Table 1-1 Lotus Lake TMDL to meet MPCA Water Quality Goals

		Existing TP Load		Allowable TP Load		Estimated Load Reduction	
		lbs/yr	lbs/day	lbs/yr	lbs/day	lbs/yr	%
TOTAL LOAD		**1,140**	**3.123**	**631**	**1.729**	**541**	**47**
Wasteload	**Total WLA**	**306**	**0.838**	**256**	**0.701**	**50**	**16**
	MnDOT (MS400170)	*3*	*0.008*	*3*	*0.008*	*0*	*0*
	Carver County (MS400070)	*2*	*0.005*	*2*	*0.005*	*0*	*0*
	Chanhassen (MS400079)	*291*	*0.797*	*241*	*0.660*	*50*	*17*
	Eden Prairie (MS400015)	*7*	*0.019*	*7*	*0.019*	*0*	*0*
	Construction/Industrial SW	*3*	*0.008*	*3*	*0.008*	*0*	*0*
Load	**Total LA**	**834**	**2.285**	**343**	**0.940**	**491**	**59**
	Atmospheric deposition	*88*	*0.241*	*88*	*0.241*	*0*	*0*
	Internal load	*732*	*2.005*	*247*	*0.677*	*485*	*66*
	Erosion sources	*7*	*0.019*	*1*	*0.003*	*6*	*86*
	Groundwater	*7*	*0.019*	*7*	*0.019*	*0*	*0*
MOS (5%)				**32**	**0.088**		

2.0 Existing Conditions

2.1 Lotus Lake Watershed and Lake Description

Lotus Lake is a headwater lake to Purgatory Creek. Lotus Lake lies entirely within the boundaries of the City of Chanhassen. The watershed area contributing runoff to Lotus Lake is 1,397 acres including the lake surface area of 248 acres. The majority of the Lotus Lake watershed is covered by single family residential land use (65%), including the watershed to the Kerber Pond ravine.

Lotus Lake has an open-water surface area of approximately 248 acres. The lake is deep, with a maximum depth of approximately 31 feet and mean depth of approximately 16 feet. The outlet of Lotus Lake is a manmade structure that conveys water to Purgatory Creek. The outlet is at elevation of 895.4 feet. At the control elevation of 895.4 feet the total water volume in Lotus Lake is 2500 acre-ft.

Table 2-1 provides a summary of the physical characteristics for Lotus Lake.

Table 2-1 Lotus Lake physical parameters

Lake Characteristic	Lotus Lake
Lake MDNR ID	10-0006-00
MPCA Lake Classification	Deep
Water Level Control Elevation (feet)	895.4
Average Water Elevation (feet) (1)	895.49
Surface Area (acres)	248
Mean Depth (feet)	16
Maximum Depth (feet)	31
Littoral Area (acres)	177
Volume (at normal water elevation) (acre-feet)	2,500
Thermal Stratification Pattern	Dimictic
Estimated Residence Time (years) – 2013-2015 climatic Conditions	2.7
Total Watershed Area	1,397(2)
Subwatershed Area (acres)	1,397(2)
Trophic Status Based on 2019 Growing Season Average Water Quality Data	Hypereutrophic

Note(s):
(1) Average water elevation 1910-2015.
(2) Watershed area includes surface area of lakes.

2.2 Project Area Watershed

The estimated drainage area to Kerber Pond is 54.2 acres and the watershed draining to the Kerber Pond ravine is 9.1 acres (ravine between Kerber Pond and Frontier Trail). Additionally, 8 acres are tributary to the storm sewer along Frontier Trail which convey untreated runoff directly into Lotus Lake. During this feasibility study, the drainage area was subdivided to better understand contributing flows as one moves down the ravine. The majority of the watershed is single family residential land use along with the open water area of Kerber Pond and the green open space covering the slopes and channel of the ravine. See Figure 1-1 for the project area watersheds and drainage patterns.

2.3 Ravine Description

The Kerber Pond Ravine originates at the outlet from Kerber Pond, within Kerber Pond Park, traversing ~1000 feet downstream to Frontier Trail while covering a vertical drop of ~30 feet. This site presents several design and maintenance challenges including, but not limited to dense tree canopy, erosive soils, steep topography, and an existing sanitary sewer running under the ravine.

Screen shot of the city provided a video showing of sediment/mud flowing out of the culvert at Frontier Trail.

2.3.1 Vegetation

The project site consists of sparse herbaceous vegetation with a dense tree canopy over the ravine limiting sunlight penetration to the ravine floor. The slopes to the ravine channel are steep (6-18%) with the slope of the ravine channel profile (in-channel) ranging from 2 to 4%. Because of the slopes, limited light penetration, and channel flows, vegetation is not well established on the slopes or channel banks. Figure 2-1 shows images of the ravine at the downstream end (near Frontier Trail) as well as closer to the upstream end (near the Kerber Pond outlet).

A. Project site looking upstream near Frontier Trail

B. Project site looking upstream near Kerber Pond Outlet

Figure 2-1 Site Vegetation

2.3.2 Flow Conditions

A portion of the District's hydrologic and hydraulic model was utilized to evaluate flow conditions within the Kerber Pond Ravine for existing conditions as well as pre-settlement conditions.

The outlet from Kerber Pond is a 12" RCP with an overflow weir structure. Additionally, the trail located east of the outlet can potentially be overtopped during extreme rain events. Because of the small diameter outlet pipe, the structure already provides fairly reduced discharge from Kerber Pond to the ravine.

The ravine was modeled as three segments from the Kerber Pond outlet to Frontier Trail (see Figure 2-2). Subwatershed LL-A9.2 was subdivided to better evaluate inflows along the length of the ravine. The hydrologic and hydraulic model was used to simulate four design storm events, including the Atlas 14 1-yr, 2-yr, 10-yr, and 100-year, 24-hour events.

The existing conditions results, including peak flows, velocities, flow depth, and shear stress for each of these segments is summarized in Table 2-2. Also summarized in Table 2-2 is the results of the pre-settlement conditions. To evaluate pre-settlement conditions, the existing conditions model was used with the following revisions:

1) No imperviousness used in the subwatersheds

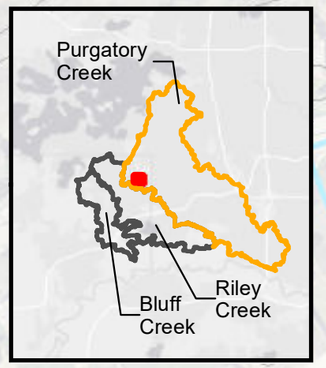
2) Pervious roughness coefficients were adjusted to reflect forested conditions.

The existing conditions peak velocities and shear stress levels indicate flow conditions in the ravine channel that often exceed the erosion thresholds for loam soils, especially those that are not stabilized with well-established vegetation. This supports that there is potential for erosion along the Kerber Pond ravine, especially in the upper and middle sections of the ravine.

Modeling of presettlement conditions suggests lower flow rates, flow depths, velocities, and shear stresses, suggesting that the ravine was more stable in presettlement conditions, especially during the more frequent, smaller storm events. However, during the larger events, it was possible that some erosion in the ravine could have occurred.

KERBER POND RAVINE
RAVINE REACHES

FIGURE 2-2



Storm Sewer from Frontier Trail to Lotus Lake

Lotus Lake

Conestoga Ter

Kiowa Cir

Sierra Ct

Sierra Tr

Frontier Tr

Laredo Dr

Kerber Pond Outlet

Kerber Pond

Ravine Reaches

- LL-9.1
- LL-9.2
- LL-9.3
- Purgatory Creek Watershed
- Subwatersheds
- Storm Sewer

2 Foot Contours, Carver County, 2011

- 10-Foot Contour
- 2-Foot Contour

N

0 75 150 300 Feet

BARR

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

Riley Purgatory Bluff Creek Watershed District

Table 2-2 Existing Conditions and Pre-settlement Flow Summary

Design Storm Event	Ravine Segment	Peak Flow (cfs)		Velocity (fps)		Flow Depth (ft)		Shear Stress (lb/sf)	
		Pre-Settlement	Existing	Pre-Settlement	Existing	Pre-Settlement	Existing	Pre-Settlement	Existing
1-yr, 24-hour Event	Kerber Pond Outlet	0.5	1.5	5.9	7.0	0.2	0.3	0.6	1.0
	LL-9.1	1.1	3.7	1.9	2.8	0.2	0.4	0.4	0.9
	LL-9.2	1.2	3.8	1.1	1.2	0.3	0.5	0.6	1.3
	LL-9.3	1.3	5	1.4	2.1	0.3	0.6	0.4	0.8
2-yr, 24-hour Event	Kerber Pond Outlet	1.0	2.0	6.6	7.2	0.2	0.4	0.8	1.2
	LL-9.1	1.9	5.1	2.3	3.2	0.4	0.5	0.9	1.3
	LL-9.2	2.3	5.4	1.4	1.3	0.5	0.5	1.3	1.3
	LL-9.3	2.7	7.3	1.8	2.4	0.3	0.6	0.4	0.8
10-yr, 24-hour Event	Kerber Pond Outlet	2.5	3.4	7.5	7.7	0.4	0.6	1.4	1.8
	LL-9.1	5.6	10.2	3.2	4	0.5	0.7	1.3	1.7
	LL-9.2	6.8	12.2	2.1	1.6	0.8	0.8	1.9	1.9
	LL-9.3	9.6	17.3	2.6	3.1	0.6	1	0.8	1.2
100-yr, 24-hour Event	Kerber Pond Outlet	5.8	7.5	9.2	9.7	0.8	1.5	2.7	3.2
	LL-9.1	15	24.3	4.1	5.3	0.9	1.1	2.1	2.6
	LL-9.2	18.8	29.3	1.9	2.3	1.1	1.1	2.6	2.6
	LL-9.3	27.6	43.1	3.6	4.2	1.3	1.3	1.6	1.6

2.3.3 Site Erosion

Kerber Pond and the Kerber Pond ravine fall within the high-risk erosion area identified by the RPBCWD.

Additionally, review of the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) SSURGO Soil Survey data suggests that soils along much of the Kerber Pond ravine are loams with moderate to high erosivity.

Table 2-3 SSURGO Soil Type and Erodibility Summary

Ravine Location	Soil Type	Erosivity due to Water
Upstream Portion of Ravine	Kilkenny-Lester loams, 2 to 6 percent slopes	Moderate Erosivity
Mid Ravine	Lester-Kilkenny loams, 12 to 18 percent slopes	High Erosivity
Lower Portion of Ravine	Hamel loam	Low Erosivity

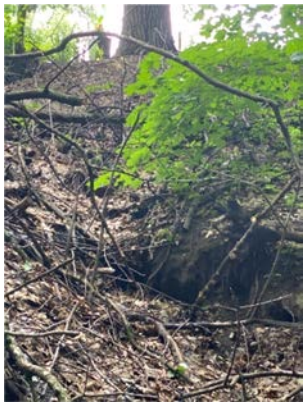
Based on observations from the 2020 site visit, the following is a summary of the current erosion conditions along the ravine.

- In the upstream portion of the ravine where the channel becomes steeper (approximately Reach LL-9.1), there is evidence of eroding banks ranging from 1-3 feet in height. Additionally, there are two side channels down the side slopes of the ravine where there is active erosion and head cutting due to runoff from the upslope watersheds (Figure 2-3B). The upper portion of the ravine, roughly the first 300 feet downstream from the Kerber Pond outlet has the most significant erosion including the eroded banks, downstream movement of the original riprap from around the outlet pipe, and scour of the banks and undercutting around the Kerber Pond outlet pipe flared-end section (Figure 2-3C).
- The middle portion of the ravine, which generally corresponds with Reach LL-9.2, seems fairly stable, with little evidence of bank erosion, head cutting, or actively moving sediment in the stream bed.
- The lower portion of the ravine near Frontier Trail (approximately Reach LL-9.3) is flatter and appears to have accumulated eroded sediment from upstream in the flat portions of the channel upstream of Frontier Trail (in Figure 2-3A.). The City

of Chanhassen has incorporated wooden check dams across portions of the channel to help collect sediment. There is some evidence of flows eroding the accumulated sediment in the stream bed in this area.

These characteristics of the existing ravine result in additional TP and TSS loading above the estimated watershed load.

A. Sediment Accumulation in Ravine and storm sewer at Frontier Trail



B. Side Channel Headcut (2-3') along Ravine

C. Erosion and Scour around discharge pipe from Kerber Pond at head of the ravine

Figure 2-3 Ravine Erosion

3.0 Ravine Stabilization Conceptual Design Alternatives

Techniques for stream stabilization generally fall into two categories: bioengineering and hard armoring.

- Bioengineering techniques employ biological and ecological concepts to control erosion, using vegetation or a combination of vegetation and construction materials, including logs and boulders. Techniques that do not use vegetative material but are intended to achieve stabilization of natural flow patterns and create in-stream habitat, such as boulder or log vanes, are generally included under the umbrella of bioengineering.
- Hard armoring techniques include the use of engineered materials such as stone (riprap or boulders), gabions, and concrete to stabilize slopes and prevent erosion.

Because of the dense tree canopy from mature trees primarily being located on the upslope portion of ravine slopes, there is limited sunlight penetration which limits vegetation establishment on the ravine slopes and channel banks. A proposed project that involves removal of mature trees on the side slopes to open up the canopy does not appear necessary, has the potential to adversely impact the ecosystem, has additional erosion potential, and could be met with public resistance.

As a result, utilizing vegetation establishment as a sole stabilization method through biological or bioengineering techniques is unlikely. Additionally, the existing peak velocities and shear stress levels indicate flow conditions in the ravine channel exceed the erosion thresholds for loam soils, especially those that are not stabilized with well-established vegetation. As such, the concepts outlined below use targeted hard armoring and/or piping to convey flows and stabilize the ravine and incorporate rock riffles or log drops within the channel to help stabilize the channel and dissipate energy. All concepts promote reestablishment of shade-tolerant vegetation along the channel banks and within the disturbed area as much as possible.

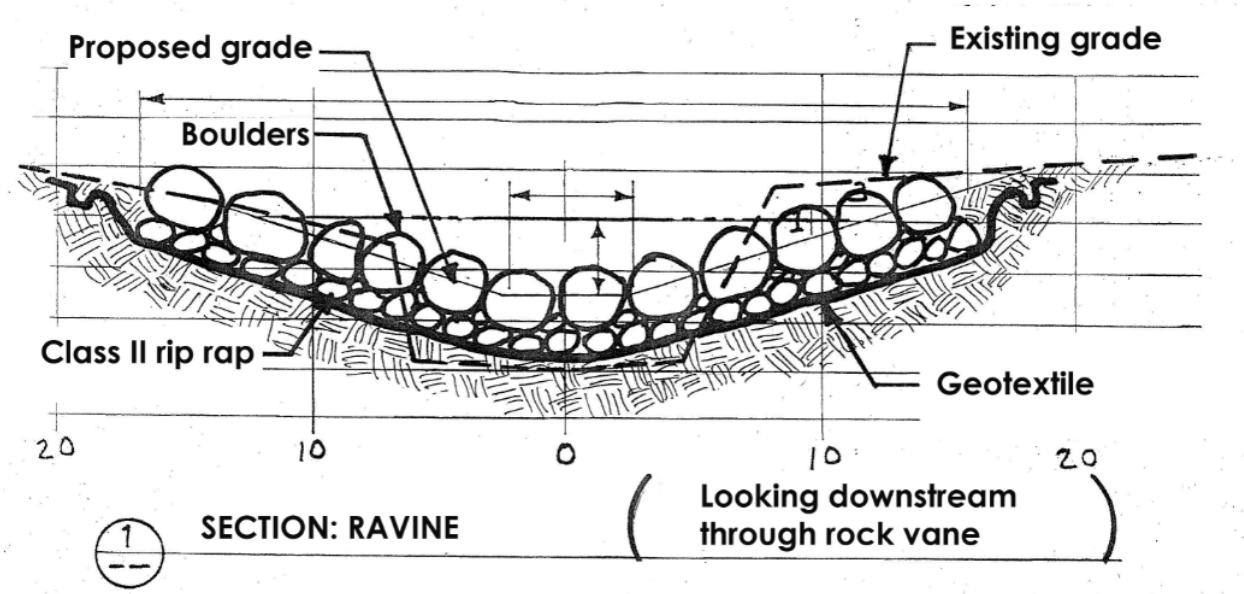
Two conceptual designs for ravine stabilization were considered:

- Concept 1: In-Channel Stabilization with Stabilization of Kerber Pond Outlet Discharge, Targeted Bank Armoring and In-Channel Stabilization Practices
- Concept 2: Low-Flow Channel Conveyance, High-Flow Piped Conveyance System with Targeted Bank Armoring and In-Channel Stabilization Practices in the Channel Conveyance

Figure 3-1 and Figure 3-2 show examples of cross-sections of what this type of restoration might look like along with precedent images or sketches to help visualize each concept. The concepts are further discussed in the following sections. In addition to the two conceptual stabilization options, the city also intends to improve the storm sewer system conveyance between Frontier Trail and Lotus Lake as part of the reconstruction of Frontier Trail; however, the proposed modifications to the storm sewer system do not impact the ravine stabilization project. Additionally, the Frontier Trail reconstruction project will need to meet the RPBCWD stormwater management requirements and this was not evaluated as part of this project.

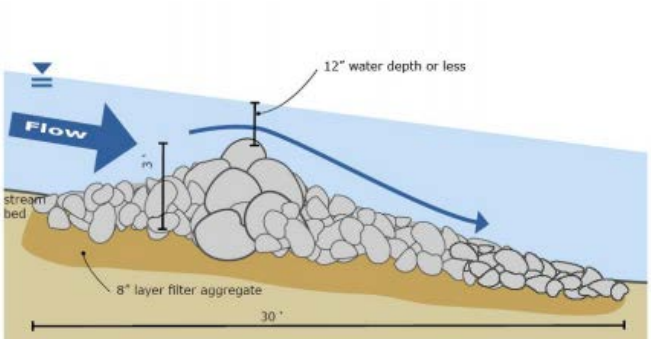
These concepts were selected based on conversation with RPBCWD, City of Chanhassen, Minnesota Department of Natural Resources (MnDNR), and United States Army Corps of Engineers (USACE) staff. The conceptual designs are discussed in more detail below. The goal for each of the conceptual designs was to identify remedial measures that would generally fit within existing drainage and utility easements so that new easements would not need to be purchased and minimize impacts to the ravine.

The engineer opinion of probable costs included in this feasibility study reflect costs associated with the stabilization of the Kerber Pond ravine and the improving the conveyance from the ravine/Frontier Trail to Lotus Lake. Road reconstruction, local storm sewer infrastructure, best management practices needed to achieve regulatory compliance, and other costs associated with the city's road reconstruction project are not included in the concept estimates.



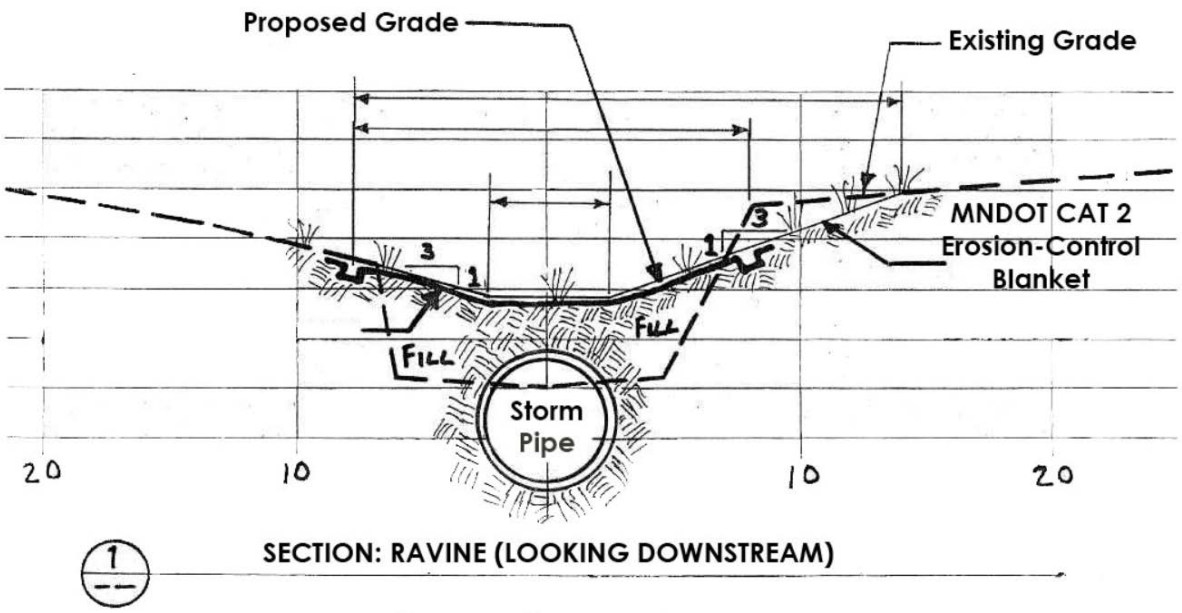
A. Example Cross-Section showing rock check dam across channel

B. Bank armoring & restored vegetation



C. Profile of rock check dam

Figure 3-1 Concept 1: In-Channel Stabilization Example Cross-Section & Images



A. Example Cross-Section showing a low-flow surface channel and high-flow storm sewer below channel

B. High-flow inlets to a storm sewer along an existing stream corridor (Source: RWMWD)

C. Bank armoring & restored vegetation

Figure 3-2 Concept 2: Low-Flow Channel, High-Flow Storm Sewer Example Cross-Section and Images

3.1 Concept 1: In-Channel Stabilization

Concept 1 involves in-channel ravine stabilization practices including the following:

- Modifications to the Kerber Pond outlet, including stabilizing the outlet pipe, flared end structure, and scour hole
- Installation of rock riffles, rock vanes, or log check dams, along the ravine profile, especially in steeper portions of the channel where actively eroding banks have been observed and at locations with existing head cuts and drops
- Stabilization of eroding banks with grading and use of targeted rock placement along banks, focusing on the steeper portions of the channel where active bank erosion has been observed
- Stabilization of two eroding side channels to the ravine with rock or drop structures
- Restoration of disturbed slopes utilizing shade tolerant vegetation due to the existing canopy cover

3.1.1 Anticipated Water Quality Improvements

Although P8 models are commonly used to estimate watershed pollutant loads and pollutant removals by stormwater best management practices (BMPs), the model cannot quantify sediment and pollutant loads resulting from stream bank and in-channel erosion processes.

The proposed stabilization measures will result in reduced stream bank erosion and, therefore, reduced sediment and phosphorus loading to the Kerber Pond ravine and Lotus Lake. The existing stream bank erosion rate (in units of feet per year) for the ravine was estimated based on a field assessment method known as the Bank Assessment for Non-Point Source Consequences of Sediment (BANCS) model (Rosgen (2006)).

The BANCS model uses two erosion-estimation tools to develop risk ratings for the Bank Erosion Hazard Index (BEHI) and Near-Bank Stress (NBS).

- The BEHI rating evaluates the susceptibility of a segment of stream bank to erosion as a result of multiple processes: surface erosion, fluvial entrainment, and mass erosion (wasting).

- The NBS rating characterizes the energy distribution against a segment of stream bank; disproportionate energy distribution in the near-bank region can accelerate bank erosion.

The BEHI and NBS estimation tools were applied using channel information from available LiDAR data, site visit and field notes, and photos of the ravine for each segment of ravine potentially contributing sediment to the channel. Table 3-1 summarizes the BEHI and NBS ratings along the Kerber Pond Ravine.

Table 3-1 Estimated Bank Erosion Hazard Index (BEHI) and Near-Bank Stress (NBS) along Kerber Pond Ravine

Reach	US Station	DS Station	Distance (ft)	BEHI	NBS
LL-9.1	0	50	50	Very High	High
	50	120	70	Very High	Low
	120	220	100	High	Low
	220	320	100	High	Low
LL-9.2	320	500	180	Moderate	Low
LL-9.3	500	920	420	Moderate	Low
	920	1010	90	Moderate	Moderate

The BEHI/NBS estimated erosion rate was for each segment of the ravine was compared to the typical erosion ranges presented in the Streambank Erosion section of the Natural Resource Conservation Service (NRCS), Wisconsin Field Office Technical Guide (August 2015). The BEHI/NBS estimated erosion indices for the Kerber Pond ravine reaches were compared to the NRCS guidance, falling within the moderately erosive category and the upper and lower bounds for this classification were used to establish the range in the estimated sediment and total phosphorus load reductions.

The annual erosion rates, estimated sediment and total phosphorus loads, and the ravine stabilization benefits (load reductions) are shown in Table 3-2. The reduction in total phosphorus load ranges from 0.8 lbs/yr to 3.8 lbs/yr, with the point estimate of 2.9 lbs/yr. These estimates are used to quantify the TP reduction benefit of stabilizing the ravine and demonstrate that stabilizing the Kerber Pond Ravine could help meet approximately 50% of the annual load reduction assigned to erosion sources in the

Lotus Lake TMDL. In addition to reduce the phosphorus load to the lake, stabilization of the ravine would reduce the sediment loading to the lake by rough 5,820 lbs/yr.

Table 3-2 Estimated Sediment and Total Phosphorus Removal by Ravine Stabilization

Reach	Stationing	Estimated Bank Erosion [1] (feet per year)	Estimated Average Bank Height (ft)	Estimated Eroding Ravine Length (ft)	Sediment Load Reduction [1] (lbs/yr)	TP Load Reduction [2] (lbs/yr)
LL-9.1	0+00 To 0+50	0.17 (0.06 – 0.20)	3	37.5	1,570 (430-1,950)	0.79 (0.22-0.98)
	0+50 To 1+20	0.17 (0.06 – 0.20)	2.5	52.5	1,840 (510-2,280)	0.92 (0.25-1.14)
	1+20 To 2+20	0.17 (0.06 – 0.20)	1.5	75	1,570 (430-1,950)	0.79 (0.22-0.98)
	2+20 To 3+20	0.17 (0.06 – 0.20)	0.5	75	520 (140-650)	0.26 (0.07-0.33)
LL-9.2	3+20 To 5+00	0.09 (0.06 – 0.20)	0.5	45	160 (90-390)	0.08 (0.04-0.20)
LL-9.3	5+00 To 9+20	0.09 (0.06 – 0.20)	0.5	0	0 (0-0)	0.00 (0.00-0.00)
	9+20 to 10+10	0.09 (0.06 – 0.20)	0.5	45	160 (90-390)	0.08 (0.04-0.20)
				Total	***5,820 (1,690-7,610)***	***2.9 (0.8-3.8)***

Note(s):

(1) High and low erosion estimates were based on comparison with the BEHI/NBS erosion rate point estimate in combination with the table in the Streambank Erosion section of the WI NRCS Field Office Technical Guide (Wisconsin Natural Resources Conservation Service, 2015). Erosion under existing conditions was estimated based on field visit.

(2) TP estimated based on conversion factor presented in the Minnesota Board of Water and Soil Resources Pollution Reduction Estimator for loam soils (September 2010)

In addition to the estimated water quality improvements, restoration provides opportunity to restore/create new habitat and improve ecological function of the ravine. Stabilization of actively eroding areas can also preserve the existing soil profile and can protect soil health. Because an existing sanitary sewer runs along the thalweg of the ravine, the stabilization of the ravine will protect this existing infrastructure and may provide better access to this infrastructure through the project design.

3.1.2 Engineer's Opinion of Probable Cost

The Engineer's opinion of probable cost is reported as a range of probable costs. The range reflects the level of uncertainty, unknowns, and risk associated with the level of conceptual design completed during feasibility.

Based on the current level of design, the cost range for construction, planning engineering and design, permitting, legal fees for agreement and easement acquisition, and construction management, and contingency for the ravine stabilization is estimated as $280,000 to $590,000. Cost to purchase additional easements as may be needed is not included in the costs listed above. However, we have estimated that purchase of a permanent easement for construction and access could be between $200,000 and $450,000 assuming a 20 to 40 ft wide easement along the length of the ravine at a cost of $10/SF.

Maintenance requirements for the ravine stabilization portion of Concept 1 include yearly site inspections and corrective actions on active erosion, as needed. Because this concept relies primarily on armoring and rock-based practices, the estimated lifespan for the concept is 30 years. To estimate the annual maintenance, we assumed that this would be equivalent to 30% of the original construction cost over that period, translated to an annualized cost at 4% interest.

Utilizing the point estimates of cost, this level of maintenance equates to an annual cost of approximately $4,900, which equates to a total 30-year estimated maintenance cost of $84,500. Considering both the principal and maintenance costs equates to a total annual project cost of $18,100 per year, translating to an annualized cost of $6,200 per pound of total phosphorus and $3.10 per pound of sediment prevented from entering Lotus Lake.

Appendix A includes a detailed cost breakdown to determine the Engineer's opinion of probable cost for Concept 1.

3.1.3 Wetland and Upland Impacts

Both Kerber Pond and Lotus Lake are mapped as national wetlands inventory (NWI) wetlands the ravine is mapped as part of the NWI as a riverine wetland. Additionally, Kerber Pond and Lotus Lake are mapped as MnDNR public waters inventory (PWI) basins; however, the ravine is not mapped as an MnDNR public water course. A wetland delineation has not yet been completed. However, conversations with city, district, and agency (MnDNR and USACE) indicate the lower portion of the ravine near Frontier Trail will likely be delineated as a wetland.

The City of Chanhassen is the wetland permitting authority responsible for administering the Wetland Conservation Act (WCA) for this project. At the time of the wetland delineation, a MnRAM assessment will need to be completed to determine the RPBCWD's wetland value and buffer requirements as well as the city's management strategy.

Based on available information, the proposed modification to the ravine in Concept 1 will stabilize areas of existing headcuts and drops, which is likely within a mapped wetland area (to be determined with a future wetland delineation). However, this disturbance is not anticipated to change the wetland type, functions, or wildlife habitat.

Some tree removal may be necessary for access and construction, especially along the upstream reach of the ravine. However, much of the existing canopy is located on the upper slopes of the ravine, so much of the work could be done without impacts to the main canopy. Exact numbers of tree removal would be quantified during final design and replacement of trees can be discussed as part of the restoration plan. The area also has many downed trees currently laying over the existing channel that would need to be removed for construction.

3.1.4 Regulatory Approval

Approval of the project under WCA will be required. Also, a grading permit for Conceptual 1 will be required by the City of Chanhassen. There may be temporary wetland impacts to stabilize and restore the ravine.

The MnDNR regulates work below the ordinary high-water level (OHWL) of public waters. A detailed topographic survey will need to be completed as part of project design. However, Concept 1 proposes changes to the Kerber Pond outlet including potential work below the OHWL for both Kerber Pond (OHWL not established). Because work will likely occur below the OHWL, approval under RPBCWD's regulatory framework is needed unless a project specific Public Water Work Permit is obtained from the MnDNR.

Additionally, conversation with the United States Army Corps of Engineers (USACE) staff indicated they will likely have jurisdiction over the Kerber Pond ravine based on the presence of NWI mapping along the ravine and the flow conditions in the channel. Based on the proposed Concept 1, agency staff indicated that this project will likely fall

under Nationwide Permit 13 (Bank Stabilization). However, if it is longer than 500 ft of stabilization along the bank, a waiver may be needed as well.

The MPCA regulates the National Pollutant Discharge Elimination System (NPDES) stormwater permitting program. A NPDES construction stormwater permit is required for construction projects disturbing 1 acre or more of soil. The MPCA will also require a stormwater pollution prevention plan (SWPPP). The estimated disturbance limits for this concept may be close to 1 acre and if paired with the City's CIP project for the reconstruction project for Frontier Trail, will likely require an MPCA NPDES construction stormwater permit and SWPPP.

RPBCWD regulates the control of floodwater to ensure the preservation of floodplains and flood storage areas, improve water quality, preserve vegetation, alleviate identified erosion problems, ensure the preservation of wetland and creek buffers, and prevent erosion of shorelines and stream banks. A RPBCWD permit will be required, although the applicable rules will depend on the final site design and configuration. It is anticipated that a permit for Rule B – Floodplain Management and Drainage Alterations, Rule C – Erosion and Sediment Control, Rule D – Wetland and Creek Buffers, Rule F – Shoreline and Streambank Stabilization, and Rule J – Stormwater Management may be required.

3.1.5 Affected Property Owners

Figure 3-4 shows the property ownership along the Kerber Pond Ravine. The project would impact city park property and 12 private parcels. The impacts would include clearing select trees, removal of some brush, excavation, installation of stabilization measures, site restoration, and buffer designations.

Kerber Pond and the outlet are located within City of Chanhassen park property. However, the Kerber Pond ravine channel is located on private property from the point downstream of the City of Chanhassen Park Property to Frontier Trail. There is a 40-foot-wide drainage and utility easement that follows the existing sanitary sewer alignment from the park property to Frontier Trail.

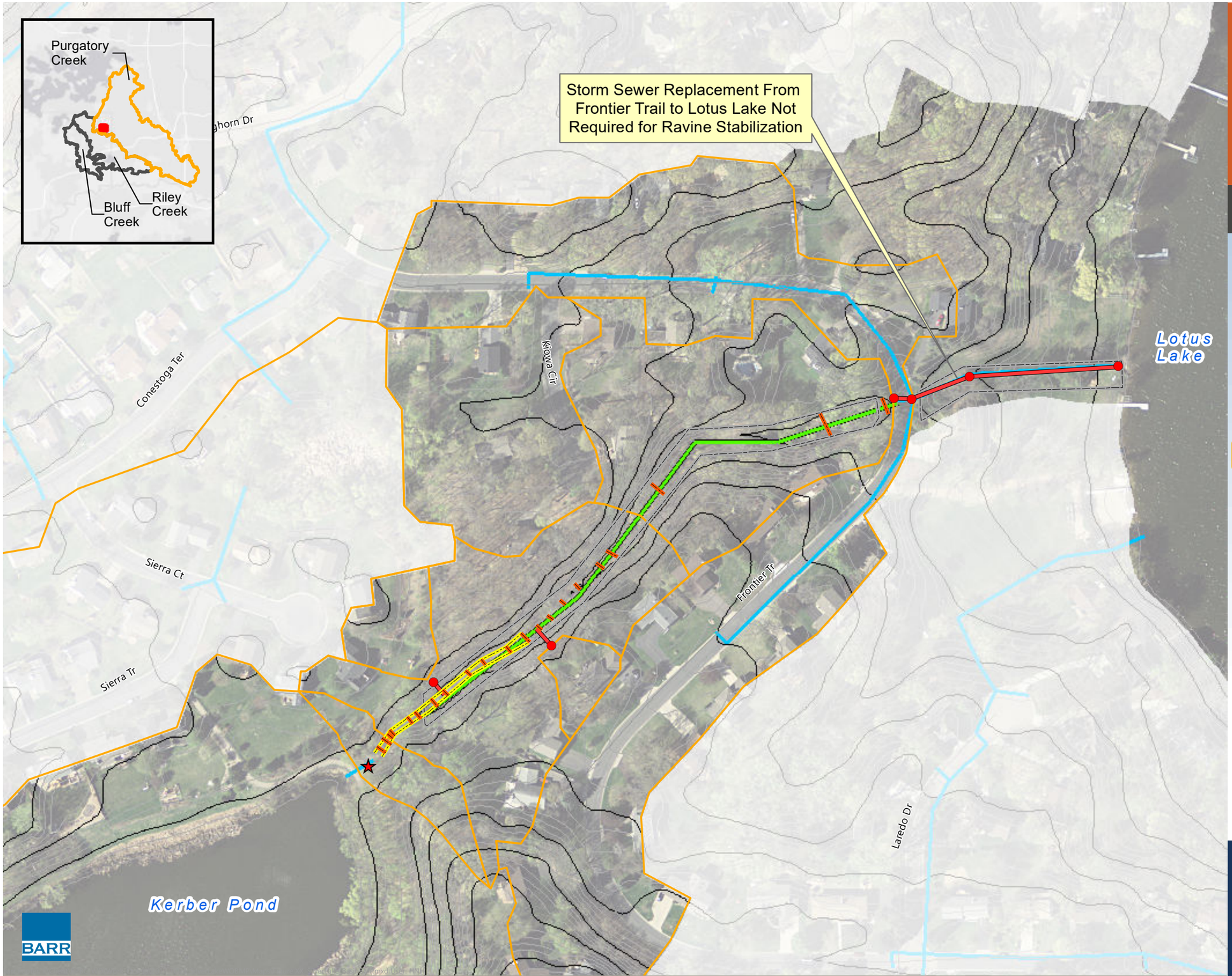
Most of the work associated with the proposed concept might be able to be completed within City of Chanhassen property or the existing drainage and utility easement areas. However, there may be locations where this work will extend outside the existing drainage and utility easements. Because drainage and utility easement do not convey

any property rights, easements will be needed to secure access, construction and maintenance easements covering all areas with potential land-disturbing activities. Although planning level easements costs have been estimated as part of this study, the actual easements will be further defined as part of final design, should the project move forward.

Additionally, the RPBCWD will need to enter into a cooperative agreement with the City to define the roles of each partner during the project development, construction, and maintenance periods. During construction, the likely construction entrance would be constructed off Frontier Trail through the backyard at 7200 Frontier Trail. A second access route could be via trail in the City of Chanhassen Park property at the head of the ravine, although access here will be narrow and require more significant removal of vegetation to access the ravine channel.

KERBER POND RAVINE CONCEPT 1: IN-CHANNEL STABILIZATION

FIGURE 3-3



Proposed Stabilization

- Targeted Rock Armoring
- Rock Riffle/Log Check Dams
- Outlet modification at Kerber Pond
- Proposed Storm Manhole/Structure
- Proposed Storm Sewer
- Existing Easement (Approx)
- Purgatory Creek Watershed
- Subwatersheds
- Storm Sewer
- Sanitary Sewer

2 Foot Contours, Carver County, 2011

- 10-Foot Contour
- 2-Foot Contour

N

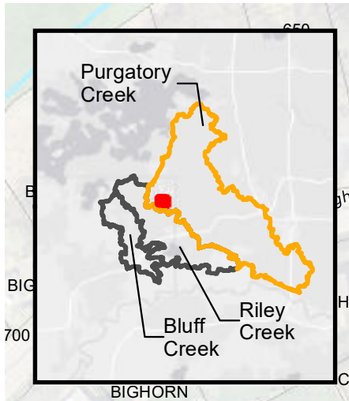
0 75 150 300 Feet

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

Riley Purgatory Bluff Creek Watershed District

KERBER POND RAVINE PROPERTY OWNERSHIP

FIGURE 3-4



- Existing Easement (Approx)
- Purgatory Creek Watershed
- Subwatersheds
- Storm Sewer
- Sanitary Sewer
- Parcels
- City Property

Private Parcels

- Impacted by Stabilization
- Impacted by Storm Sewer Improvements

N

0 75 150 300 Feet

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

Riley Purgatory Bluff Creek Watershed District

3.2 Concept 2: Low-Flow Channel, High-Flow Storm Sewer

Concept 2 includes ravine stabilization practices including the following:

- Creation of a low-flow surface channel that primarily conveys flows for small events entirely within the channel (e.g. up to the 2-year event) while allowing flows from larger events to flow into a high-flow pipe system (e.g. primarily conveying flows from the 2- to 100-year event) running below the surface channel
- Stabilization of banks in low-flow channel using of targeted rock placement along banks, focusing on the steeper portions of the channel where active bank erosion has been observed
- Installation of rock riffles or log check dams immediately downstream of the proposed inlet structures to the high-flow pipe system and at locations with existing head cuts and drops
- Stabilization of eroding side channels with drop structures
- Restoration of the low-flow channel and disturbed slopes utilizing shade tolerant vegetation due to the existing canopy cover

3.2.1 Anticipated Water Quality Improvements

Because both ravine stabilization concepts are intending to stabilize the same areas of the ravine (through different approaches), the estimated reductions in sediment and total phosphorus loading rates estimated for Concept 1 (see Section 3.1.1) is also applicable to Concept 2.

The reduction in total phosphorus load ranges from 0.8 lbs/yr to 3.8 lbs/yr, with the point estimate of 2.9 lbs/yr. These estimates are used to quantify the TP reduction benefit of stabilizing the ravine.

Similar, to Concept 1, Concept 2 provides opportunity to restore/create new habitat and improve ecological function of the ravine. Stabilization of actively eroding areas can also preserve the existing soil profile and can protect soil health. However, the installation of a storm sewer below the existing channel, the extents of disturbance during construction will be more significant than during Concept 1, thus increasing the potential to adversely impact the riparian areas. Additionally, although the stabilization of the ravine in Concept 2 will protect the existing sanitary sewer infrastructure, there are concerns about constructability and protection of the existing sanitary sewer

systems since the proposed storm sewer system will generally be following a similar alignment down the ravine.

3.2.2 Engineer's Opinion of Probable Cost

The Engineer's opinion of probable cost is reported as a range of probable costs. The range reflects the level of uncertainty, unknowns, and risk associated with the level of conceptual design completed during feasibility.

Based on the current level of design, the cost range for construction, planning engineering and design, permitting, legal fees for agreement and easement acquisition, and construction management, and contingency for the ravine stabilization is estimated as $470,000 to $1,020,000. Cost to purchase additional easements as may be needed is not included in the costs listed above. However, we have estimated that purchase of a permanent easement for construction and access could be between $200,000 and $450,000 assuming a 20 to 40 ft wide easement along the length of the ravine at a cost of $10/SF.

Maintenance requirements for Concept 2 include yearly site inspections and corrective action on active erosion, as needed. Because this concept relies primarily on storm sewer and bank armoring, the estimated lifespan for the concept is 30 years. To estimate the annual maintenance, we assumed that this would be equivalent to 30% of the original construction cost over that period, translated to an annualized cost at 4% interest.

Utilizing the point estimates, this level of maintenance equates to an annual cost of approximately $8,400, which equates to a 30-year estimated maintenance cost of $145,200. Considering both the principal and maintenance costs equates to a total annual project cost of $31,000 per year, translating to an annualized cost of $10,700 per pound of total phosphorus and $5.32 per pound of sediment prevented from entering Lotus Lake.

Appendix A includes a detailed cost breakdown to determine the Engineer's opinion of probable cost for Concept 2.

3.2.3 Wetland and Upland Impacts

Both Kerber Pond and Lotus Lake are mapped as national wetlands inventory (NWI) wetlands the ravine is mapped as part of the NWI as a riverine wetland. Additionally,

Kerber Pond and Lotus Lake are mapped as MnDNR public waters inventory (PWI) basins; however, the ravine is not mapped as an MnDNR public water course. A wetland delineation has not yet been completed. However, conversations with city, district, and agency (MnDNR and USACE) indicate the lower portion of the ravine near Frontier Trail will likely be delineated as a wetland.

The City of Chanhassen is the wetland permitting authority for this project. At the time of the wetland delineation, a MnRAM assessment will need to be completed to determine the wetland classification and city's preferred management strategy.

Based on available information, the proposed modification to the ravine in Concept 2 will potentially place storm sewer infrastructure and fill within a mapped wetland area (to be determined with a future wetland delineation) and is anticipated to change the wetland type, functions, or wildlife habitat, potentially requiring mitigation.

The extents of disturbance for Concept 2 would be larger than for Concept 1 for the access and installation of the high-flow storm sewer system, which will result in more tree removal. Exact numbers of tree removal would be quantified during final design and replacement of trees can be discussed as part of the restoration plan. The area also has many downed trees currently laying over the existing channel that would need to be removed for construction.

3.2.4 Regulatory Approval

Assuming the lower portion of the ravine is delineated as wetland, the City of Chanhassen is the wetland permitting authority for this project, administering the Wetland Conservation Act (WCA). Also, a grading permit for Concept 2 will be required by the City of Chanhassen. There may be temporary wetland impacts to stabilize and restore the ravine.

The MnDNR regulates work below the ordinary high-water level (OHWL) of public waters. A detailed topographic survey will need to be completed as part of project design. However, Concept 2 proposes changes to the Kerber Pond outlet including potential work below the OHWL for both Kerber Pond (OHWL not established). Because work will likely occur below the OHWL, approved under RPBCWD's regulatory framework is needed unless a project specific Public Water Work Permit is obtained from the MnDNR.

Additionally, conversation with the United States Army Corps of Engineers (USACE) staff indicated they will likely have jurisdiction over the Kerber Pond ravine based on the presence of NWI mapping along the ravine and the flow conditions in the channel. Based on the proposed Concept 2, agency staff indicated that this project will likely fall under the Utility Regional General Permit. However, given that the Concept will be creating a low-flow channel and a high-flow pipe system, this may also fall under Nationwide Permit 13 (Bank Stabilization), and as previously mentioned, if it is longer than 500 ft of stabilization along the bank, a waiver may be needed as well.

The MPCA regulates the National Pollutant Discharge Elimination System (NPDES) stormwater permitting program. A NPDES construction stormwater permit is required for construction projects disturbing 1 acre or more of soil. The MPCA will also require a stormwater pollution prevention plan (SWPPP). The estimated disturbance limits for this concept may be close to 1 acre and if paired with the City's CIP project for the reconstruction project for Frontier Trail, will likely require an MPCA NPDES construction stormwater permit and SWPPP.

RPBCWD regulates the control of floodwater to ensure the preservation of floodplains and flood storage areas, improve water quality, preserve vegetation, alleviate identified erosion problems, ensure the preservation of wetland and creek buffers, and prevent erosion of shorelines and stream banks. A RPBCWD permit will be required, although the applicable rules will depend on the final site design and configuration. It is anticipated that a permit for Rule B – Floodplain Management and Drainage Alterations, Rule C – Erosion and Sediment Control, Rule D – Wetland and Creek Buffers, Rule F – Shoreline and Streambank Stabilization, and Rule J – Stormwater Management maybe required.

3.2.5 Affected Property Owners

Figure 3-4 shows the property ownership along the Kerber Pond Ravine. The project would impact city park property and 12 private parcels. The impacts would include clearing select trees, removal of some brush, excavation, installation of stabilization measures, site restoration, and buffer designations.

Kerber Pond and the outlet are located within City of Chanhassen park property. However, the Kerber Pond ravine channel is located on private property from the point downstream of the City of Chanhassen Park Property to Frontier Trail and from Frontier

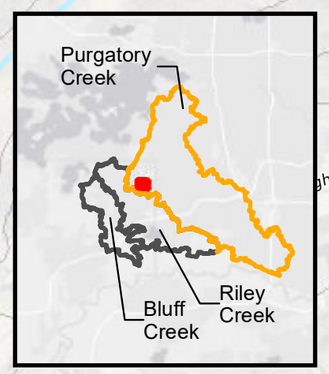
Trail to Lotus Lake. There is a 40-foot-wide drainage and utility easement that follows the existing sanitary sewer alignment from the park property to Frontier Trail.

A large portion of the work associated with the proposed concept might be able to be completed within City of Chanhassen property or the existing drainage and utility easement areas. However, there may be locations where this work will extend outside the existing drainage and utility easements, such as storm sewer alignment to avoid conflicts with the existing sanitary sewer. Because drainage and utility easement do not convey any property rights, easements will be needed to secure access, construction and maintenance easements covering all areas with potential land-disturbing activities. Although planning level easements costs have been estimated as part of this study, the actual easements will be further defined as part of final design, should the project move forward.

Additionally, the RPBCWD will need to enter into a cooperative agreement with the City to define the roles of each partner during the project development, construction, and maintenance periods. During construction, the likely construction entrance would be constructed off Frontier Trail through the backyard at 7200 Frontier Trail. A second access route could be via trail in the City of Chanhassen Park property at the head of the ravine, although access here will be narrow and require more significant removal of vegetation to access the ravine channel.

KERBER POND RAVINE CONCEPT 2: LOW-FLOW CHANNEL, HIGH-FLOW STORM SEWER

FIGURE 3-5



Storm Sewer Replacement From Frontier Trail to Lotus Lake Not Required for Ravine Stabilization

Lotus Lake

Kerber Pond

Conestoga Ter

Kiowa Cir

Sierra Ct

Sierra Tr

Frontier Tr

Laredo Dr

Proposed Stabilization

- Targeted Rock
- Rock Riffle/Log Check Dams
- Proposed Storm Manhole/Structure
- Proposed Storm Sewer
- Existing Easement (Approx)
- Purgatory Creek Watershed
- Subwatersheds
- Storm Sewer
- Sanitary Sewer

2 Foot Contours, Carver County, 2011

- 10-Foot Contour
- 2-Foot Contour

N

0 75 150 300 Feet

BARR

RILEY PURGATORY BLUFF CREEK WATERSHED DISTRICT

Riley Purgatory Bluff Creek Watershed District

3.3 Storm Sewer Improvements to Lotus Lake

In addition to the two conceptual stabilization options, the City also intends to improve the storm sewer conveyance system between Frontier Trail and Lotus Lake as part of the reconstruction of Frontier Trail. There is a 40-foot-wide drainage and utility easement from Frontier Trail to Lotus Lake generally following the existing storm sewer infrastructure from Frontier Trail. However, the existing storm sewer pipe conveying flows from the Kerber Pond ravine is a separate pipe system and it is unclear if there is an existing drainage and utility easement associated with this system.

Because the current storm sewer is comprised of two parallel systems, the proposed system would be sized to accommodate the 10-year flows from the ravine as well as the Frontier Trail watershed. A surface overflow would accommodate larger events. However, replacing the storm sewer from Frontier Trail to Lotus Lake is not required for the ravine stabilization measures. As such, the costs for the ravine stabilization versus the storm sewer replacement are presented separately.

The replacement cost of the storm sewer crossing at Frontier Trail and from Frontier Trail to Lotus Lake is estimated between $180,000 to $390,000. Additionally, the cost for the installation of the storm sewer from Frontier Trial to Lotus Lake does not include the cost of replacing the storm sewer infrastructure located along the portion of Frontier Trail that would be reconstructed as part of the City's street reconstruction CIP or any associated stormwater management that may be required to meet other regulatory requirements. Although there is a drainage and utility easement along the storm sewer from Frontier Trail to Lotus Lake, additional easements would be needed from 7201 Frontier Trail and 7203 Frontier Trail to allow access, construction, and ongoing maintenance.

3.4 Kerber Pond Ravine Prioritization Score

While the stabilization of this ravine was not specifically mentioned in the 2018 Plan as part of the 10-year capital improvement program, the potential stabilization was ranked using the District's prioritization metric which resulted in the score summarized in Table 3-3. The resulting score of 34 ranks the potential project above the threshold used (typically a score of 30 or higher) to identify when a project was carried forward into the district's 10-year capital improvement program in the 10-year plan. Figure 3-6

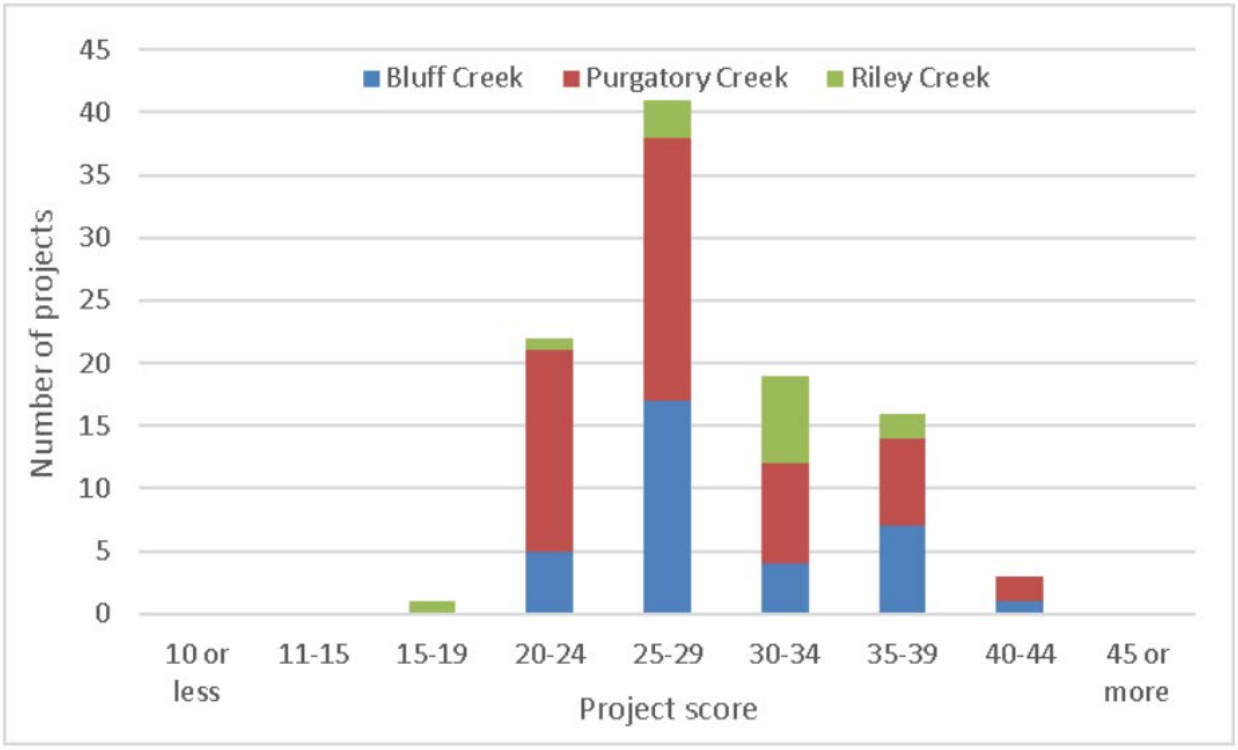
summarizes the prioritization scores of the project currently included the District's CIP, as summarized in Figure 4-3 of the 10-year watershed management plan.

Table 3-3 Kerber Pond Ravine Project Benefit Score(1)

Goal Index	Sustainability Index	Volume Management Index	Pollutant Management	Stabilization	Habitat Restoration	Partnership	Public Access & Education	Watershed Benefit	Total Benefit Score
2	7	1	1	5	5	5	3	7	**34**

Note:
(1) See Section 4 of 10-Year Watershed Management Plan for additional details about the RPBCWD prioritization methodology and associated descriptions for the variables used to assess multiple project benefits. Typically, projects scoring above a 30 are carried through the RPBCWD prioritization process although projects scoring less than 30 could be considered based on other logistical considerations.

Figure 3-6 Histogram of Project Score by Major Watershed



4.0 Conceptual Design Summary

Table 4-1 summarizes the estimated annual total phosphorus removal, site impacts, and Engineer's opinion of probable cost for each of concept design considered.

Table 4-1 Summary of Kerber Pond Ravine Stabilization Concepts

Conceptual Design	Estimated Annual TP Reduction (lbs/yr)[1]	Wetland Impacts (acre)[6]	Estimated Total Impact (acre)[6]	Engineer's Opinion of Probable Cost ($)[4]	Anticipated Maintenance Cost over 30-year lifecycle ($)[5]	Annualized Maintenance Cost ($/yr)[5]	Annual Cost per Pound TP Removed ($/lbs TP/yr)[2]
	A	B	C	D	E	F	G = ((D/30) + F) / A
Concept 1: Channel Stabilization	2.9 (0.8 - 3.8)	~TBD – Less [3]	0.5	$395,000 ($280,000 - $590,000)	$84,500 ($59,150 - $126,750)	$4,900 ($3,400- $7,300)	$6,200 ($3,400 – $32,400)
Concept 2: Low-Flow Channel, High-Flow Pipe	2.9 (0.8 - 3.8)	~TBD – More [3]	0.8	$678,000 ($470,000 - $1,020,000)	$145,200 ($101,640 - $217,800)	$8,400 ($5,900 - $12,600)	$10,700 ($5,800 – $55,100)
Replacement of Culvert Crossing and Storm Sewer	N/A[7]	N/A	0.5	$263,000 ($180,000 - $390,000)	N/A	N/A	N/A

Note(s):

(1) Estimated annual total phosphorus (TP) reduction is based on the reduction in pollutant loads resulting from stabilization of actively eroding areas of the ravine.

(2) Based on a 30-year period. Includes estimated costs for permitting, engineering, and construction; and estimated annual operation and maintenance costs.

(3) A wetland delineation, topographic survey, and tree survey will need to be completed as part of final design. However, more significant wetland impacts are expected from Concept 2.

(4) Estimate includes all ravine stabilization costs including permitting, engineering & design, construction oversight, and project construction. Does not reflect easement purchase cost.

(5) Anticipated annual maintenance cost assumes 30% of original construction cost annualized over a 30-year period at 4% interest.

(6) Wetland impacts area to be determined (TBD) during final design when wetland delineation is complete – listed as relative to each concept. Total impacts area is approximate and will be optimized during the next phase of design.

(7) The reconstruction of Frontier Trail will need to meet the RPBCWD stormwater management rules and will likely include water quality treatment; however, this was not evaluated as part of this project

5.0 Schedule of Activities

Conversations with City Staff indicate that reconstruction of Frontier Trail could potentially occur sometime between 2023-2025, although official dates have not been determined yet. If the RPBCWD managers were to proceed with the Kerber Pond Stabilization project, the city would like the timing of the design and construction to coincide with the upcoming road reconstruction project. RPBCWD staff should continue to coordinate with City of Chanhassen staff on the timing of the final design and construction of this project. It is possible the City of Chanhassen may take the lead on this project design and construction so close coordination with the City will be required based on the anticipated timing and leadership of this project. For example, if Frontier Trail Reconstruction were to occur in 2023, the easement discussions and design would need to occur in 2022 and budgeting for the project should occur during the 2022 budget cycle starting in mid-2021.

6.0 Agreements

Table 6-1 summarizes anticipated agreements required prior to construction of a water quality BMP.

Table 6-1 Summary of Anticipated Agreements

Description	Notes	Period
Cooperative agreement between RPBCWD and City of Chanhassen	Cooperative agreement between RPBCWD and City of Chanhassen for activities related to construction and operation and maintenance of the stabilization project. The agreement would establish procedures for performing specific tasks and define responsibilities of each organization. It is possible the City of Chanhassen may take the lead on this project design and construction so close coordination with the City will be required based on the anticipated timing and leadership of this project.	Based on City CIP for Frontier Trail Reconstruction
Access, construction, maintenance, and buffer agreements with private property owner(s).	Agreement with residential property owner(s) to access residential property to construct and maintain the proposed project.	Based on City CIP for Frontier Trail Reconstruction

7.0 Financing & Work Plan

The implementation of the Kerber Pond ravine stabilization project could be implemented jointly as part of the City of Chanhassen CIP project for the future reconstruction of Frontier Trail. Under this scenario, the project would be implemented as a joint partnership between the city and the RPBCWD.

Although the RPBCWD may lead the design of the Kerber Pond ravine stabilization project, the RPBCWD and the City would share the cost of final design, permitting, and construction. The City of Chanhassen would be responsible for the design and financing of infrastructure improvement along Frontier Trail and between Frontier Trail and Lotus Lake in addition to financing ongoing operation and maintenance activities following construction.

During final design RPBCWD would regularly coordinate with the City regarding design of ravine stabilization features that affect ongoing operation and maintenance of the stabilization including access to the key features for inspection along with modifications to Frontier Trail.

Following construction, City of Chanhassen staff would be responsible for annual operation and maintenance of the Kerber Pond ravine. The anticipated roles and responsibilities are clarified below:

- RPBCWD would take the lead in developing a cooperative agreement with the City of Chanhassen to allow RPBCWD staff and contractors to access the site to construct the Kerber Pond stabilization project. The necessary actions for the long-term operations and maintenance of the system would be laid out in this agreement.
- The City of Chanhassen would be responsible for the design, financing, operations and maintenance of all infrastructure along Frontier Trail and between Frontier Trail and Lotus Lake.
- Following construction, City of Chanhassen staff would be responsible for maintenance of the ravine including annual inspections and potential maintenance activities, including:
    - corrective action on active erosion, as needed, such as repairing bank armoring, addressing any rock placement issues or scouring around rock

riffles/log drop structures, or reestablishing vegetation if is being used to stabilize channel or bank areas.

The anticipated primary points of contact are summarized in Table 9-1.

Table 9-1 Anticipated Primary Points of Contact

Organization	Name	Phone
RPBCWD	Claire Bleser, District Administrator	952.607.6512
City of Chanhassen	Charles Howley, Director of Public Works/City Engineer	952.227.1169

8.0 Recommendation

Based on the results of the engineering assessment, potential site impacts, and phosphorous removed, Concept 1 — In-channel stabilization measures is a more cost-effective stabilization approach and is likely to produce more environmental benefits when compared to Concept 2. Additionally, there are concerns about the constructability of Concept 2 given the alignment over the existing sanitary sewer system. The engineering assessment was based on information collected during a review of available data and preliminary site characterization. However, full topographic, utility, and tree surveys as well as wetland delineations will be needed as part of final design.

Concept 1 is a feasible project, consistent with the 2020 TMDL for Lotus Lake. This Concept presents the lowest impacts to natural resources in the area (e.g. less impact on tree removals and anticipated wetland impacts when compared to Concept 2) while also helping improve and protect the water quality in Lotus Lake. The ravine restoration project would achieve approximately 50% of the load reduction identified for erosion sources in the Lotus Lake TMDL.

The engineer's opinion of probable cost for the design, permitting, and construction of Concept 1 is $395,000 with a potential range of $280,000 to $590,000 based on the current level of design. Utilizing the point estimates of project cost and an estimated maintenance cost over the 30-year life of the project, this translates to an annualized cost of $6,200 per pound of total phosphorus and $3.10 per pound of sediment prevented from entering Lotus Lake.

While this might be considered on the higher end of phosphorus reduction costs, the project would achieve about 50% of the nutrient reduction identified in the MPCA's TMDL from erosion source and provides other benefit as determined by the RPBCWD prioritization tool in the 10-year plan. The potential project scores a 34 and places the project above the threshold used to identify when a project was carried forward into the district's 10-year capital improvement program in the 10-year plan. While the stabilization of this ravine was not specifically mentioned in the 2018 Plan as part of the 10-year capital improvement program, the plan allows for the inclusion of opportunity projects as they arise.

If the Board elects to pursue the project, it is recommended that coordination with the City of Chanhassen continue as this project would most likely be implemented as part of the City CIP project for Frontier Trail Reconstruction. In preparation for the City CIP project, the RPBCWD should develop a cooperative agreement with the City in advance of the project implementation. Additionally, because much of the project would be implemented on and accessed through private property, the RPBCWD and the City should begin outreach and engagement efforts with the private property owners.

9.0 References

Minnesota Board of Water and Soil Resources (MN BWSR). (2010). Pollution Reduction Estimator - Water Erosion - Excel Version. [http://www.bwsr.state.mn.us/elinkupdate/Pollution_Reduction_Calculator_Manual.pdf].

Minnesota Pollution Control Agency. (2017, November 20). *Minnesota Administrative Rules: Chapter 7050, Waters of the State*. Retrieved from The Office of the Revisor of Statutes: https://www.revisor.mn.gov/rules/?id=7050&version=2017-12-14T11:07:06-06:00&format=pdf

Barr Engineering. (2017). *Lotus, Silver, Duck, Round, Mitchell, Red Rock Use Attainability Analysis Update; Lake Idlewild and Staring Lake Use Attainability Analysis; and Lower Purgatory Creek Stabilization Study*.

Drew C. Baird, L. F. (2015). *Bank Stabilization Design Guidelines*. Denver, Colorado: U.S. Department of the Interior, Bureau of Reclamation.

Engineers, U. S. (August 2010). *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Midwest Region*. s.l.: Wetlands Regulatory Assistance Program,.

Minnesota Pollution Control Agency. (2020). *Lower Minnesota River Watershed Restoration and Protection Strategy Report*.

Minnesota Pollution Control Agency. (2020). *Lower Minnesota River Watershed Total Maximum Daily Load Part 2: Northern Watersheds: Riley-Purgatory-Bluff Creek and Nine Mile Creek Watersheds*.

Riley-Purgatory-Bluff Creek Watershed District. (2018). *Planning for the Next Ten Years 2018-2027 Watershed Management Plan*.

Riley-Purgatory-Bluff Creek Watershed District. (2020, September 17). *Lotus Lake 2019 Fact Sheet*. Retrieved from Riley-Purgatory-Bluff Creek Waterhsed District website: http://rpbcwd.org/

Wisconsin Natural Resources Conservation Service. (2015). *Field Office Technical Guide: Streambank Erosion*.

Appendix A

Engineer's Opinion of Probable Cost

1.0 Cost Estimate

Engineer's opinions of probable costs for design, permitting, and construction were developed for each concept design. These opinions of costs, project reserves, contingency, documentation and discussion are intended to provide background information for feasibility alternatives assessment, analysis purposes and budget authorization by the RPBCWD. The cost of time escalation is not included in the opinions of probable cost. All costs are presented in 2020 US dollars.

Quantities were estimated with calculations based on available information presented in the feasibility report. Dimensions, areas, and volumes for construction were estimated using excel, GIS, and site photos and characterizations.

Unit costs are based on recent bid prices, published construction cost index resources, and similar stabilization projects. Unit prices were developed and compared to similar project prices. Costs associated with Base Planning Engineering and Design (PED) are based on percentages of estimated construction cost and are within a range similar to those used in past projects designed by Barr. The engineering estimates also include Permitting and Regulatory Approvals, which is intended to account for additional planning, coordination, and mitigation costs that are likely to be incurred as the project is permitted with environmental agencies. Costs associated with Construction Management (CM) are based on estimated costs to manage the construction process, based on Barr's experience with similar projects, but may change depending on the services that are provided during construction. Costs also include legal fees for the development and coordination of the cooperative agreements with the City of Chanhassen and the impacted private property owners. However, these costs assume that all work will be completed within City owned parcels or in private parcels where permission to work has been granted and that no purchase of additional easements will be required.

The opinions of cost include tasks and items related to engineering and design, permitting, and constructing each conceptual design. The opinions of cost do not include other tasks following construction of each alternative presented such as operations and maintenance, or monitoring.

Contingency used in these opinions of probable cost are intended to help identify an estimated construction cost amount for the minor items included in the current Project scope, but have not yet been quantified or estimated directly during the feasibility evaluation. Stated another way, contingency is the resultant of the pluses and minuses that cannot be estimated at the level of project definition that exists. The contingency includes the cost of ancillary items not currently itemized in the quantity summaries but commonly identified in more detailed design and required for completeness of the work. A 20% contingency is applied to the estimated construction cost to account for the costs of these items.

Industry resources for cost estimating (*AACE International Recommended Practice No. 18R-97, and ASTM E2516-06 Standard Classification for Cost Estimate Classification System*) provide guidance on cost uncertainty, depending on the level of project design developed. The opinion of probable cost for the alternatives evaluated generally corresponds to a Class 4 estimate characterized by completion of limited engineering and use of deterministic estimating methods. As the level of design detail increases, the level of uncertainty is reduced. Figure A-1 provides a graphic representation of how uncertainty (or accuracy) of cost estimates can be expected to improve as more detailed design is developed.

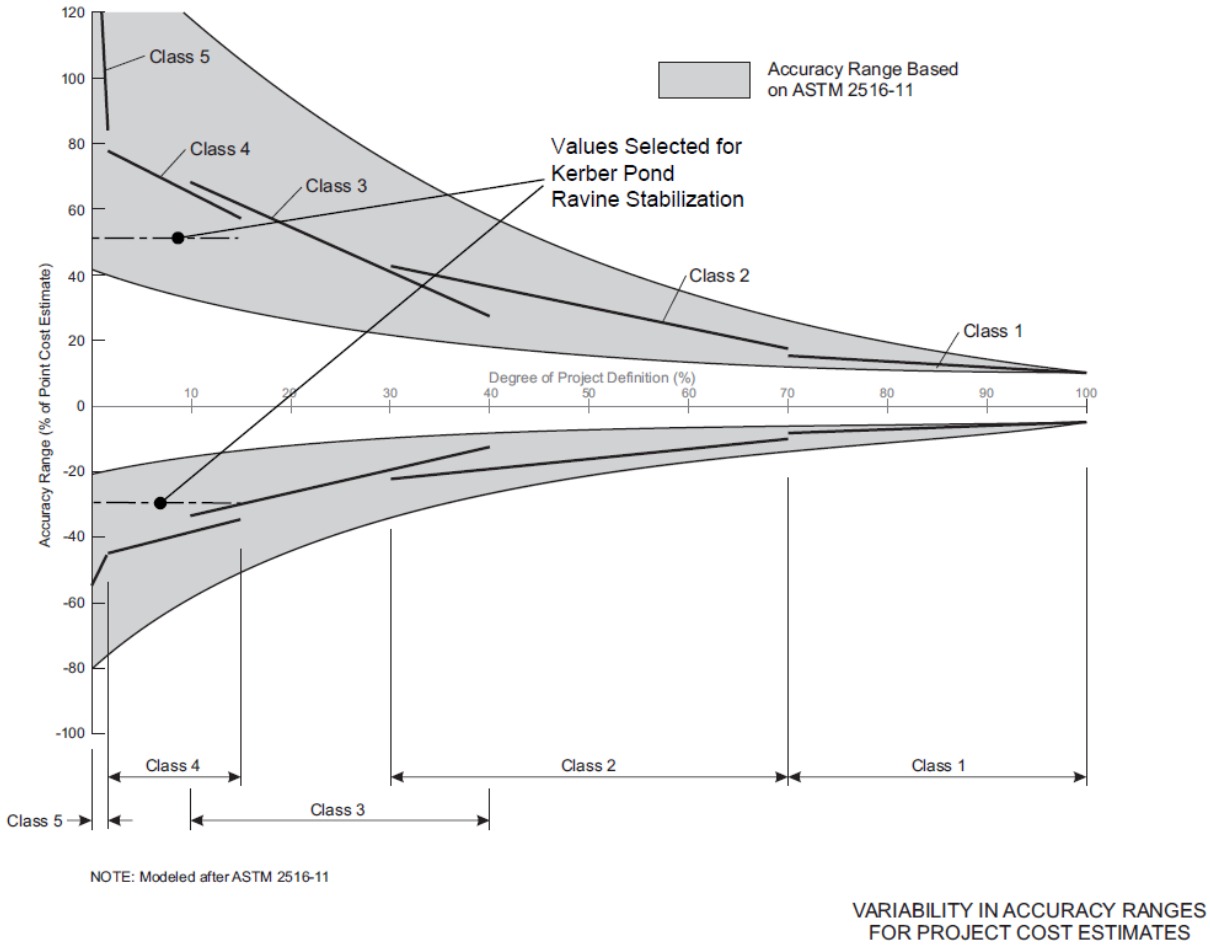


Figure A-1 Relationship between Cost Accuracy and Degree of Project Definition

At this early stage of design, the range of uncertainty of total project cost is high. Due to the early stage of design, it is standard practice to place a broad accuracy range around the point cost estimate.

The accuracy range is based on professional judgment considering the level of design completed, the complexity of the project, and the uncertainties in the project scope; the accuracy range does not include costs for future scope changes that are not part of the project as currently defined or risk contingency. The estimated accuracy range for this point estimate is -30% to +50%.

The opinion of probable cost provided in this memorandum is made on the basis of Barr Engineering's experience and qualifications and represents our best judgment as experienced and qualified professionals familiar with the project. It is acknowledged that additional investigations and additional site specific information that becomes available in the next stage of design may result in changes to the proposed configuration, cost and functioning of project features. This opinion is based on project-related information available to Barr Engineering at this time and includes a conceptual-level feasibility design of the project. The opinion of cost may change as more information becomes available and further design is completed. In addition, because we have no control over the eventual cost of labor, materials, equipment or services furnished by others, or over the contractor's methods of determining prices, or over competitive bidding or market conditions, Barr Engineering cannot and does not guarantee that proposals, bids, or actual costs will not vary from the opinion of probable cost presented in this memorandum. If the RPBCWD wishes greater assurance as to the probable project cost, the RPBCWD should authorize further investigation and design of a selected alternative.

Table A-1 provides a comparison of the opinion of costs for the two concept designs.

Table A-1 Engineer's Opinion of Probable Cost – Feasibility Estimate Summary

Conceptual Design	Engineer's Opinion of Probable Cost ($)[1]	Engineer's Opinion of Probable Maintenance Cost Over a 30-Year Lifecycle ($)[1]
Concept 1: Channel Stabilization	$395,000 ($280,000 - $590,000)	$84,500 ($59,150 - $126,750)
Concept 2: Low-Flow Channel, High-Flow Pipe	$678,000 ($470,000 - $1,020,000)	$145,200 ($101,640 - $217,800)

Note(s):

(1) Approximate values based on available information. Soil borings are required during the next phase of design to identify existing soil characteristics and estimate the groundwater elevation. Estimate includes all BMP and ravine stabilization costs. The estimated accuracy range for the Total Project Cost as the project is defined is -30% to +50%.

(2) Anticipated maintenance cost includes annual inspections and corrective actions on active erosion or movement of stabilization measures, as needed, over a 30-year period. This is estimated to be 30% of the total project cost. This total maintenance cost is annualized assuming 4% interest over 30-years.

2.0 References

American Society for Testing and Materials. 2006. ASTM E2516-06 Standard Classification for Cost Estimate Classification System. ASTM International, West Conshohocken, PA, DOI: 10.1520/E2516-06

Association for the Advancement of Cost Estimating. 2005. *AACE International Recommended Practice NO. 18R-97*, February 2, 2005

PREPARED BY: BARR ENGINEERING COMPANY	SHEET:	1	OF	1
	BY:	JAK2	DATE:	8/11/2020
	CHECKED BY:	PJH2	DATE:	8/17/2020
ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST	APPROVED BY:	SAS	DATE:	9/16/2020
PROJECT: RPBCWD Kerber Pond Ravine Stabilization	ISSUED:		DATE:	
LOCATION: City of Chanhassen/RPBCWD	ISSUED:		DATE:	
PROJECT #: 23/27-0053.14 TO31A	ISSUED:		DATE:	
OPINION OF COST - SUMMARY	ISSUED:		DATE:	

Engineer's Opinion of Probable Cost
Concept 1: Channel Stabilization Measures

Item	ITEM DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT COST	ITEM COST
1	Mobilization (10%)	LS	1	$21,373	$21,373
2	Erosion and Sediment Control (3%)	LS	1	$5,497	$5,497
3	Dewatering/Bypass Kerber Pond Flows	LS	1	$25,000	$25,000
4	Kerber Pond Outlet Modification	Each	1	$10,000	$10,000
5	Clearing and Grubbing	AC	0.4	$12,000	$4,959
6	Constructed Rock Riffle (2 ft tall)	Each	3	$5,000	$15,000
7	Constructed Rock Riffle (1 ft tall)	Each	18	$3,000	$54,000
8	Targeted Hard Armoring (assume 300 ft of channel (steep section), both sides, 2 ft tall banks))	Ton	178	$100	$17,778
9	Ravine Channel Grading, Restoration, and ECB	SY	2,583	$18	$46,500
10	Side Ravine Drainage Structure (MH, 12" RCP (30'), FES)	Each	2	$10,000	$20,000
11	Ravine Outlet at Frontier Trail (Structure to help trap sediment)	Each	1	$15,000	$15,000
	Construction Contingency (20%)	LS	1	$47,021	$47,021
				Subtotal	$282,128
				Legal Fees for Agreement and Easement Development (5%)	$14,106
				Engineering, Planning, Design, Permitting (25%)	$70,532
				Construction Management and Oversight (10%)	$28,213
				Total Project Cost	**$394,980**
				Total Project Cost (-30%, rounded)=	**$280,000**
				Total Project Cost (+50%, rounded)=	**$590,000**

BARR **PREPARED BY: BARR ENGINEERING COMPANY**		SHEET:	1	OF 1
		BY:	JAK2	DATE: 8/11/2020
		CHECKED BY:	PJH2	DATE: 8/17/2020
ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST		APPROVED BY:	SAS	DATE: 9/16/2020
PROJECT:	RPBCWD Kerber Pond Ravine Stabilization	ISSUED:		DATE:
LOCATION:	City of Chanhassen/RPBCWD	ISSUED:		DATE:
PROJECT #:	23/27-0053.14 TO31A	ISSUED:		DATE:
OPINION OF COST - SUMMARY		ISSUED:		DATE:

Engineer's Opinion of Probable Cost
Concept 2: Low-Flow Channel, High-Flow Storm Sewer

Item	ITEM DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT COST	ITEM COST
1	Mobilization (10%)	LS	1	$36,657	$36,657
2	Erosion and Sediment Control (3%)	LS	1	$9,949	$9,949
3	Dewatering/Bypass Kerber Pond Flows	LS	1	$25,000	$25,000
4	Clearing and Grubbing	AC	0.4	$12,000	$4,959
5	Ravine Storm Sewer Pipe - 24" RCPA (up to 100-year)	LF	1,100	$130	$143,000
6	24" RCPA FES & Trash Rack	Each	1	$4,000	$4,000
7	Storm Sewer/Manhole Structures (Assume 48" diameter, 10 depth)	Each	8	$5,000	$40,000
8	Fill over pipe (assume 2 ft of cover)	CY	500	$20	$10,000
9	Constructed Rock Riffle (2 ft tall)	Each	2	$5,000	$10,000
10	Constructed Rock Riffle (1 ft tall)	Each	4	$3,000	$12,000
11	Targeted Hard Armoring (assume 300 ft of reconstructed low flow channel (steep section), both sides))	Ton	67	$100	$6,667
12	Ravine Channel Grading, Restoration, and ECB	SY	3,667	$18	$66,000
13	Side Ravine Drainage Strucutre (MH, 12" RCP (30') FES)	Each	2	$10,000	$20,000
14	Ravine Outlet at Frontier Trail (Structure to help trap sediment)	Each	1	$15,000	$15,000
	Construction Contingency (20%)	LS	1	$80,646	$80,646
				Subtotal	$483,878
				Legal Fees for Agreement and Easement Development (5%)	$24,194
				Engineering, Planning, Design, Permitting (25%)	$120,969
				Construction Management and Oversight (10%)	$48,388
				Total Project Cost	**$677,429**
				Total Project Cost (-30%, rounded)=	**$470,000**
				Total Project Cost (+50%, rounded)=	**$1,020,000**

PREPARED BY: BARR ENGINEERING COMPANY

SHEET:	1	OF	1
BY:	JAK2	DATE:	8/11/2020
CHECKED BY:	PJH2	DATE:	8/17/2020
APPROVED BY:	SAS	DATE:	9/16/2020
ISSUED:		DATE:	
ISSUED:		DATE:	
ISSUED:		DATE:	
ISSUED:		DATE:	

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

PROJECT: RPBCWD Kerber Pond Ravine Stabilization

LOCATION: City of Chanhassen/RPBCWD

PROJECT #: 23/27-0053.14 TO31A

OPINION OF COST - SUMMARY

Engineer's Opinion of Probable Cost
Storm Sewer Replacement from Frontier Trail to Lotus Lake

Item	ITEM DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT COST	ITEM COST
1	Mobilization (10%)	LS	1	$14,188	$14,188
2	Erosion and Sediment Control (3%)	LS	1	$4,133	$4,133
3	Removal of existing storm sewer (Frontier Trail to Lotus Lake)	LF	750	$50	$37,500
4	Removal of structures (Frontier Trail to Lotus Lake)	Each	5	$1,500	$7,500
5	Frontier Trail Storm Sewer Pipe (Frontier Trail to Lotus Lake) - 24" RCP (10-yr)	LF	375	$110	$41,250
6	24" FES & Trash Rack	Each	1	$4,000	$4,000
7	Storm Sewer/Manhole Structures (Assume 48" diameter, 10 depth) (Frontier Trail to L	Each	4	$5,000	$20,000
8	Restoration and ECB along storm sewer alignment	SY	2,500	$11	$27,500
	Construction Contingency (20%)	LS	1	$31,214	$31,214
				Subtotal	$187,285
				Legal Fees for Agreement and Easement Development (5%)	$9,364
				Engineering, Planning, Design, Permitting (25%)	$46,821
				Construction Management and Oversight (10%)	$18,728
				Total Project Cost	**$262,199**
				Total Project Cost (-30%, rounded)=	**$180,000**
				Total Project Cost (+50%, rounded)=	**$390,000**