Plymouth Creek Stream Restoration Project (2025 CR-P) Feasibility Report

Plymouth, Minnesota

Prepared for
Bassett Creek Watershed Management Commission

May 2024

Appendices in Separate Document

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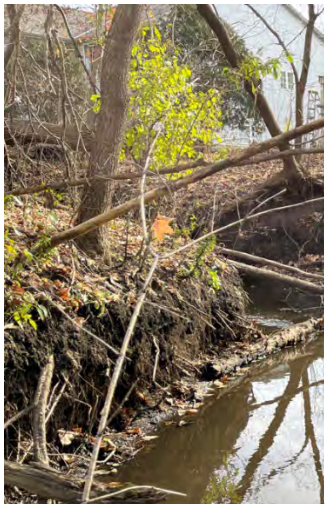
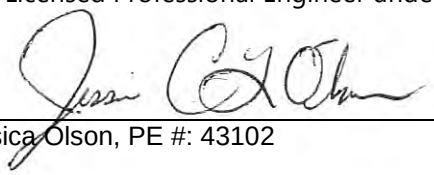


Certification

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



Jessica Olson, PE #: 43102

May 28, 2024

Date

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May 2024

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Abbreviations

BANCS	Bank Assessment for Non-Point Source Consequences of Sediment
BCWMC	Bassett Creek Watershed Management Commission
BWSR	Minnesota Board of Water and Soil Resources
BEHI	Bank Erosion Hazard Index
CIP	capital improvement program
CSW	construction stormwater
CWA	Clean Waters Act
EAW	Environmental Assessment Worksheet
FAA	Federal Aviation Administration
IPaC	Information, Planning, and Conservation System
LGU	local government unit
LUST	leaking underground storage tank
MCBS	Minnesota County Biological Sites
METC	Metropolitan Council
MnDNR	Minnesota Department of Natural Resources
MPCA	Minnesota Pollution Control Agency
NBS	near bank stress
NHIS	Natural Heritage Information System
NRCS	Natural Resources Conservation Act
NRHP	National Register of Historic Places
NWI	National Wetland Inventory
OSA	Office of the State Archaeologist
ROW	right-of-way
PWI	public water inventory
RMP	resource management plan
SHPO	State Historic Preservation Office
SNA	scientific natural areas
TP	total phosphorus
TRPD	Three Rivers Park District
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
WCA	Wetland Conservation Act
WMA	Wildlife Management Areas

1 Executive Summary

1.1 Background

The Bassett Creek Watershed Management Commission's (BCWMC) current Capital Improvement Program (CIP) (Table 5-3 in the 2015-2025 Bassett Creek Watershed Management Plan, as revised) includes the Plymouth Creek Stream Restoration Project from Dunkirk Lane North to 38th Avenue North behind Plymouth Ice Center (CIP 2025-CR-P). At their October 2023 meeting, the Commission approved the BCWMC Engineer's proposal to conduct a feasibility study for the Plymouth Creek Stream Restoration Project.

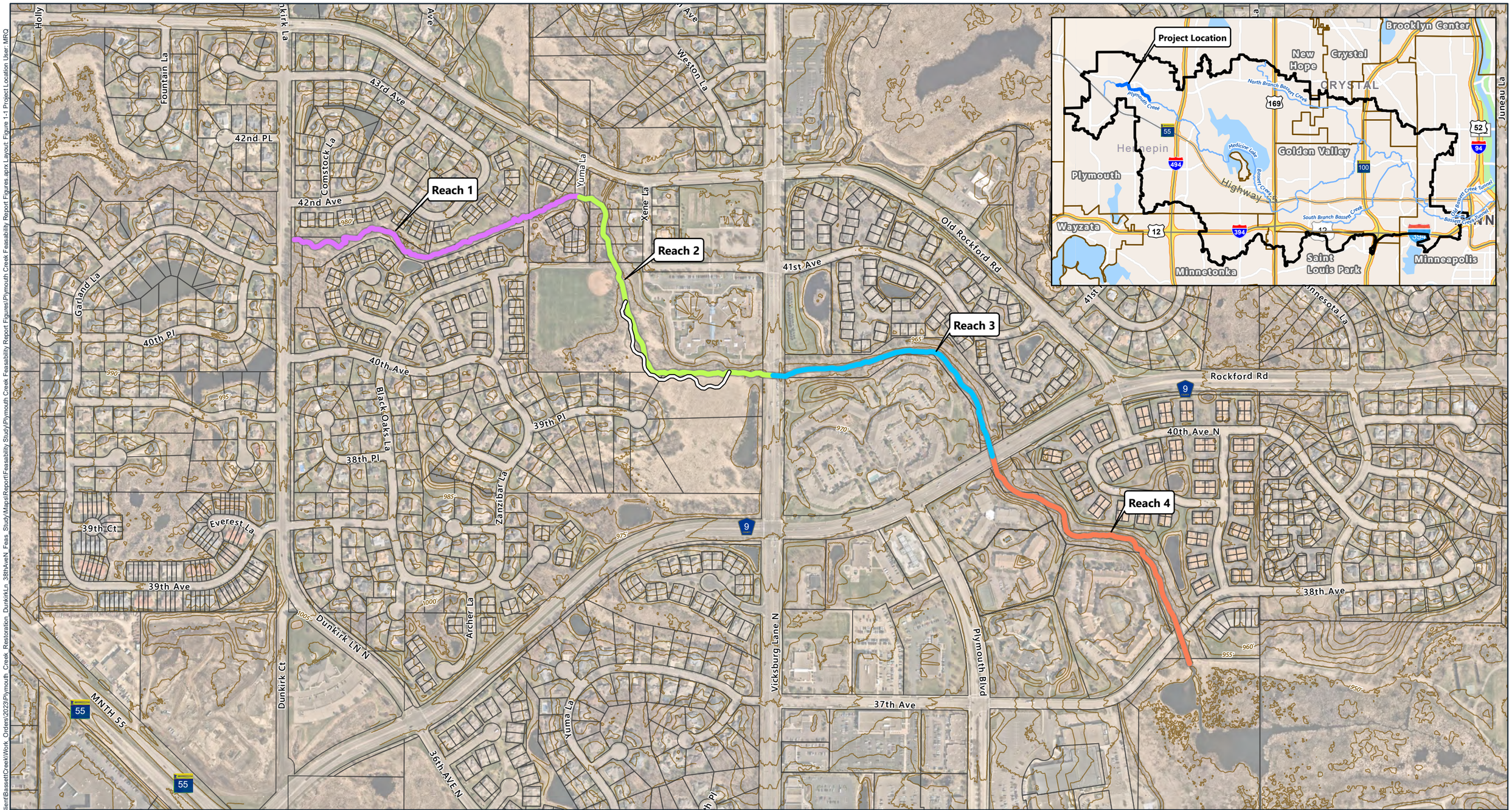
As is required for BCWMC CIP projects, a feasibility study must be completed prior to the BCWMC holding a hearing and ordering the project. This feasibility study examines methods to stabilize and restore areas of erosion within the corridor, as well as improve aquatic and riparian habitats. The Commission Engineer investigated three options during this feasibility study. The three options developed were based on restoring areas ranked low to high using prioritization metrics provided by the City of Plymouth and the Commission Engineer.

If ordered, the BCWMC will utilize the BCWMC CIP funds to implement the proposed project. The current CIP budget earmarks $2,000,000 for this project. The source of these funds is an ad valorem tax levied by Hennepin County over the entire Bassett Creek watershed on behalf of the BCWMC. In addition to BCWMC CIP funds, Plymouth plans to seek funds from the city's capital improvement program to contribute toward project implementation.

1.2 General Description and Site Characteristics

The Plymouth Creek Stream Restoration project area is located along Plymouth Creek between Dunkirk Lane North to 38th Avenue North behind Plymouth Ice Center (Figure 1-1). The project will focus on restoring eroding streambanks and improving aquatic and riparian habitats.

The approximately 7,000-foot reach is located on a combination of privately owned and publicly owned properties. The creek generally maintains a low flow, except during severe droughts, and meanders through neighborhoods and wooded backyards, behind Plymouth Creek Elementary school, and alongside a trail owned by the City of Plymouth. Erosion of the streambanks varies along the reach from mild to very high, with eroding bank heights varying from 1.5 feet to approximately 5 feet.



Barr Footer: ArcGISPro 3.1.5, 2024-05-08 13:59, File: I:\Client\Bassett\Creek\Work_Orders\2023\Plymouth_Creek_Restoration_DunkirkLn_38thAveN_Feas_Study\Maps\Report\Feasibility Study\Plymouth Creek Feasability Report Figures\Plymouth Creek Feasability Report Figures.aprx Layout: Figure 1-1 Project Location User: MRO

The 7,000-foot reach was broken into four separate reaches for mapping purposes. Reach 1 is located between Dunkirk Avenue and Yuma Lane, Reach 2 is between Yuma Lane and Vicksburg Road, Reach 3 is between Vicksburg Road and Rockford Road, and Reach 4 is between Rockford Road and 38th Avenue (see Figure 5-1 through Figure 5-4).. An alternative option for Reach 2 that includes a new meandering channel path is shown in Figure 1-1 and Figure 5-5.

The measures identified for potential implementation consist of the following:

- Removing trees and invasive vegetation (e.g., buckthorn) and planting native species to restore riparian areas and improve habitat
- Incorporating a variety of stream restoration measures to reduce erosion including streambank grading for improved floodplain connectivity and stability along with vegetation establishment; hard armoring like riprap; and bioengineering techniques such as installing root wads and toe wood, coir logs, vegetated reinforced soil stabilization (VRSS), rock or log j-hook vanes and cross vanes, brush mattresses, and live stakes
- Removing accumulated sediment in targeted areas near culvert crossings
- Constructing a new meandering channel segment to replace a straightened segment of channel near Plymouth Creek Elementary School
- Establishing new vegetation in areas disturbed by construction

This study identifies 26 restoration areas, defined as areas of similar erosion properties and prioritization metrics, within the approximate 7,000-foot assessed reach. The restoration areas are ranked from low to high priority. Figure 5-1 shows the potential restoration areas, and Table 5-3 details the proposed restoration methods for each area.

Depending on the option (1, 2 or 3), the estimated water quality improvements resulting from the project range from 43.6 to 148.4 pounds per year total phosphorus reductions and from 87,310 to 296,720 pounds per year total suspended solids reductions (Table 1-1 and Section 6). Tree removals also vary by option. All options presented in this study include vegetation management within the riparian zones of the proposed construction areas. Option 3 is the only alternative that includes sediment removal.

Table 1-1 Overview of Proposed Options for CIP 2025-CR-P

Option Description	Cost Estimate[1,4]	Annualized Cost[2]	TP Loading		TSS Loading		
			Load Reduction (lb/yr)	Cost/lb/yr Reduced[3]	Load Reduction (lb/yr)	Cost/lb/yr Reduced[3]	Tree Loss[5]
Option 1. High-ranked restoration areas only	$726,000 ($581,000–$944,000)	$50,000	43.6	$1,163	87,310	$0.57	35
Option 2. High- and medium-ranked restoration areas	$2,066,000 ($1,653,000–$2,686,000)	$145,000	148.4	$977	296,720	$0.49	75
Option 3. All proposed restoration areas and sediment removal	$2,196,000 ($1,757,000–$2,855,000)	$156,000	148.4	$1,051	296,720	$0.53	76
Option 1a. High-ranked restoration area and meander	$1,369,000 ($1,096,000-$1,780,000)	$88,000	85.2	$1,033	170,510	$0.52	35
Option 2a. High- and medium-ranked restoration areas and meander	$2,360,000 ($1,888,000-$3,068,000)	$162,000	148.4	$1,092	296,720	$0.55	71
Option 3a. All proposed restoration areas and meander	$2,420,000 ($1,936,000-$3,146,000)	$170,000	148.4	$1,146	296,720	$0.57	72

(1) A Class 4 screening-level opinion of probable cost, as defined by the American Association of Cost Engineers International (AACE International), has been prepared for these options. The opinion of probable construction cost provided in this table is based on the Commission Engineer's experience and qualifications and represents our best judgment as experienced and qualified professionals familiar with the project. The cost opinion is based on project-related information available to the Commission Engineer at this time and includes a conceptual-level design of the project. It includes 20% project contingency and 30% for planning, engineering, design, and construction administration. The lower bound is assumed at -15%, and the upper bound is assumed at +30%.

(2) Assumed to be 15% of the total project cost for annual maintenance, plus replacement cost associated with major repairs and the initial project cost distributed evenly over a 30-year project lifespan.

(3) Annualized cost divided by estimated annual pollution load reduction.

(4) Costs do not include easements or construction access routes

(5) Tree loss defined as loss of healthy coniferous trees that are 4 inches in diameter or greater and deciduous trees measuring eight inches in diameter or more, excluding the following species: buckthorn, box elder, green ash, and Siberian elm.

1.3 Recommendations

The Plymouth Creek Stream Restoration Project (CIP 2025-CR-P) will improve water quality and habitat by (1) repairing actively eroding sites by stabilizing streambanks; (2) providing and improving instream and riparian habitats; and (3) preventing erosion at other sites by installing preemptive measures to protect existing streambanks. Overall, this project will reduce erosion, total suspended solids, and phosphorous loading. The project is consistent with the goals (Section 4.1) and policies (Section 4.2.5) for stream restoration and protection in the *2015-2025 BCWMC Watershed Management Plan.*

As part of the feasibility study, the Commission Engineer evaluated three restoration options for eroding areas ranked from low to high throughout the creek corridor. If funding allows, we recommend implementing Option 3—completing all proposed restoration areas of high, medium, and low priority, plus sediment removal at two sites—but this option comes at a higher cost. Therefore, if a lower-cost project is desired, we recommend implementing (at a minimum) Option 1—completing high-priority areas—and completing medium-to-low-ranked areas as the budget allows. If Option 2 or Option 3 is selected, we also recommend installing a new meander path for the segment of the channel near the Plymouth Creek Elementary School (Option 2a or 3a). Once an option is selected, we recommend that the opinion of cost identified in this study be used to develop a levy request for this project and that it proceed to the design and construction phase.

2 Background and Objectives

The *BCWMC 2015 Watershed Management Plan* (Plan) addresses restoring stream reaches damaged by erosion or affected by sedimentation (1) Section 3.4 of the BCWMC Plan describes the issue and the benefits of stream restoration, and Section 4.2.5 describes the Commission's policies related to streambank restoration and stabilization. The Plan's 10-year Capital Improvement Program (CIP) includes streambank restoration and stabilization projects.

This feasibility study follows the protocols developed by the U.S. Army Corps of Engineers (USACE) and the BCWMC for projects included in the 2009 BCWMC Resource Management Plan (RMP) (2). Although this project is not included in the RMP, it is in close proximity and similar to other RMP projects.

This study examines the feasibility of restoring sites along Plymouth Creek in Plymouth from Dunkirk Lane North to 38th Avenue North behind the Plymouth Ice Arena (see Figure 2-1 through Figure 2-4). Restoration of sites along this reach is proposed to be included as a group for design and construction in the BCWMC's 2025 CIP (2025-CR-P).

2.1 Goals and Objectives

The objective of this study is to review the feasibility of implementing measures to protect and improve Plymouth Creek, including stabilizing eroding streambanks, removing accumulated sediment, and re-establishing desirable vegetation in the riparian zone on this reach of Plymouth Creek, and to provide conceptual designs and opinions of costs of measures that could potentially be used at each of the selected erosion sites.

2.1.1 Scope

The eroded 7,000-foot reach between Dunkirk Lane and 38th Avenue North behind Plymouth Ice Arena is scheduled to be restored in the winter of 2025-2026 and potentially winter 2026-2027 as part of this BCWMC CIP project (2025-CR-P). Prior to the BCWMC holding a hearing and ordering a CIP project, a feasibility study must be completed. The purpose of this feasibility study is to identify potential stream restoration concepts along the reach.

The first major component of the feasibility study was to complete field investigations to evaluate and prioritize unstable segments of the creek within the 7,000-foot reach. The Commission Engineer conducted field investigations in the Fall of 2023, including a creek walk and tree survey. The field investigation also included a drone flight that was conducted by the City of Plymouth. During the same time frame, we also performed desktop analyses that included wetland delineations, cultural and historical assessments, and environmental review.

The Commission Engineer utilized data gathered from the field and desktop analyses to develop concept stream restoration options. This report presents the options, including an evaluation of erosion prevention; the advantages and disadvantages of each option; cost estimates; life expectancy analysis; pollutant removals and annualized pollutant reduction cost estimates; and permitting requirements.

Creek Stationing
Significant Trees
Plymouth Creek
Reach Breakline
Bike and/or Pedestrian Trail
Gravity Storm Sewer
Sanitary Main

Parcel Boundary
Public Parcel
Easements

Near Bank Stress Rating (NBS)
Extreme
High
Moderate

Bank Erosion Hazard Index (BEHI)
Very High
High
Moderate
Low

0 100 200
Feet

Imagery Source: Hennepin County 2022

Existing Conditions and Erosion Extents
Reach 1
Plymouth Creek Stream Restoration Feasibility Study
BCWMC
FIGURE 2-1

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Creek Stationing
Significant Trees
Plymouth Creek
Reach Breakline
Bike and/or Pedestrian Trail
Gravity Storm Sewer
Sanitary Main

Parcel Boundary
Public Parcel
Easements

Near Bank Stress Rating (NBS)
Extreme
High
Moderate

Low

Bank Erosion Hazard Index (BEHI)
Very High
High
Moderate
Low

0 150 300
Feet

Imagery Source: Hennepin County 2022

Existing Conditions and Erosion Extents
Reach 2
Plymouth Creek Stream Restoration Feasibility Study
BCWMC
FIGURE 2-2

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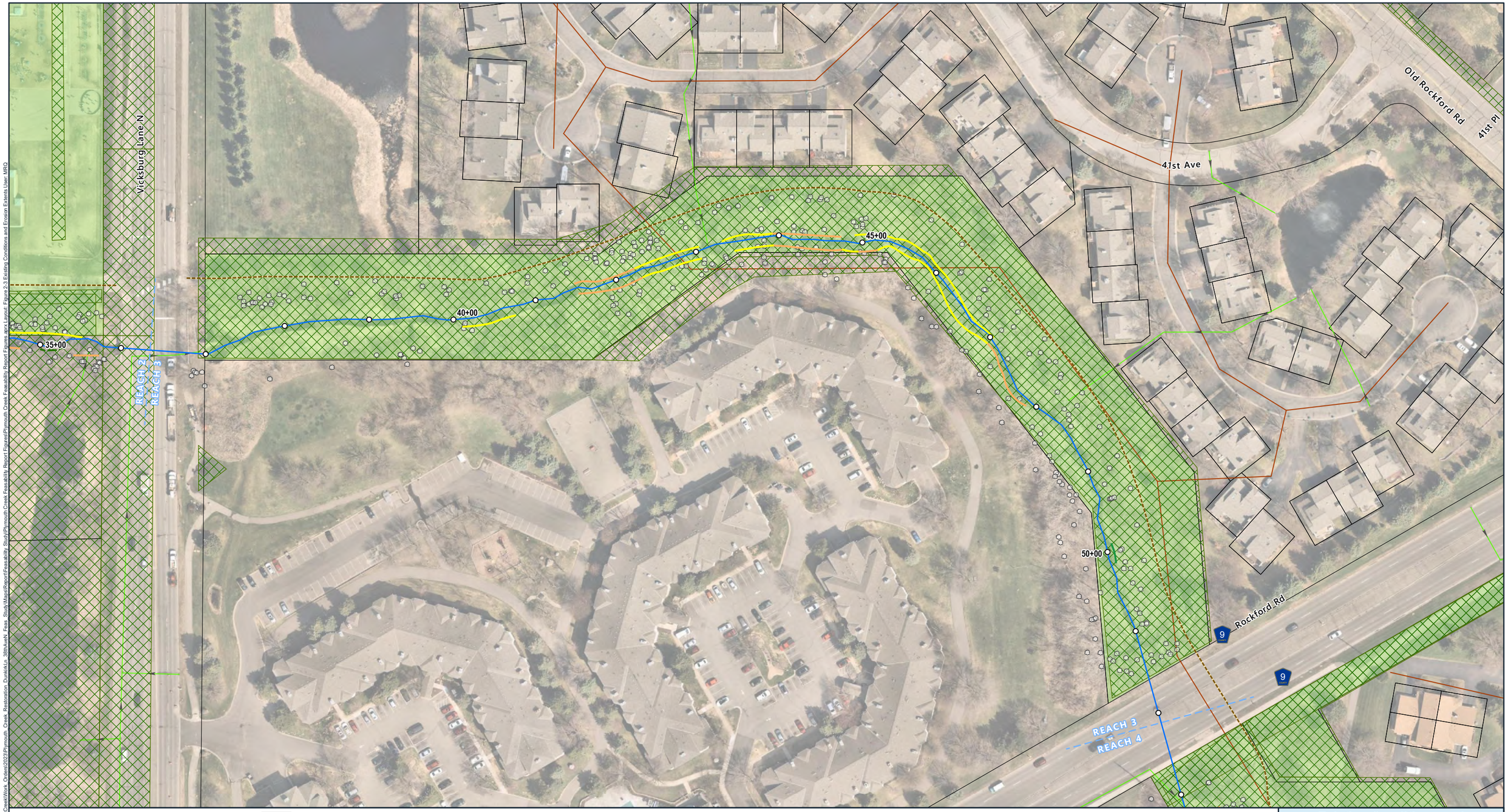

- Creek Stationing
- Significant Trees
- Plymouth Creek
- Reach Breakline
- Bike and/or Pedestrian Trail
- Gravity Storm Sewer
- Sanitary Main
- Parcel Boundary
- Public Parcel
- Easements

Near Bank Stress Rating (NBS)
- Low

Bank Erosion Hazard Index (BEHI)
- High
- Moderate
- Low

0 100 200
Feet

Imagery Source: Hennepin County 2022

Existing Conditions and Erosion Extents
Reach 3
Plymouth Creek Stream Restoration Feasibility Study
BCWMC
FIGURE 2-3

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Creek Stationing
Significant Trees
Plymouth Creek
Reach Breakline
Bike and/or Pedestrian Trail
Gravity Storm Sewer
Sanitary Main
Parcel Boundary
Public Parcel

Bank Erosion Hazard Index (BEHI)
Very High
High
Moderate

0 100 200
Feet

Imagery Source: Hennepin County 2022

Existing Conditions and Erosion Extents
Reach 4
Plymouth Creek Stream Restoration Feasibility Study
BCWMC
FIGURE 2-4

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2.1.2 Stream Restoration

The goals of the stream restoration project include the following:

- Reducing sediment loading and associated nutrient and contaminant loading to Plymouth Creek and improving downstream water quality by stabilizing eroding banks.
- Preserving natural features along Plymouth Creek and contributing to natural habitat quality and species diversity by planting native vegetation in eroded areas and areas disturbed by project construction activities.
- Preventing future channel erosion along the creek and subsequent degradation of water quality downstream by establishing a stable channel cross section and profile.
- Expanding buffers (conversion of turf grass to native plantings) adjacent to the stream on public property and on privately-owned property with willing owners.
- Enhancing buffers through removal of invasive species and replacing with native plantings adjacent to the stream on public and private property.
- Grading banks to improve channel access to floodplain

2.1.3 Considerations

- Avoid floodplain impacts; several residences are located near the creek, so it is critical that the proposed project does not increase flood elevations that impact these properties.
- Maintain existing floodplain storage by ensuring that project features do not increase flood elevations.
- Evaluate areas for sediment removal that could decrease flood potential for homes and stormwater infrastructure.
- Seek opportunities to enhance vegetation and habitat within the reach, including in riparian areas adjacent to streambank restoration areas.
- Utilize soft armoring (bioengineering) techniques as much as possible and where feasible.
- Protect adjacent utilities (sanitary and storm) and infrastructure (streets, trails, bridges).
- Improve the public’s physical or visual access to the creek where it runs through public property.
- Improve the stream reach by re-establishing stream meanders.
- Evaluate existing trees to determine the benefit of preserving or removing trees to construct stream stabilization methods.

2.2 Background

2.2.1 Reach Description

This reach of Plymouth Creek (Figure 2-1 through Figure 2-4) extends approximately 7,000 feet from Dunkirk Lane North to 38th Avenue North behind Plymouth Ice Arena. The reach flows through a combination of privately owned properties and publicly owned properties, including portions of land owned by Independent School District 284. Land use immediately adjacent to most of the reach is residential.

The Commission Engineer and Plymouth staff walked the reach in November 2023 and identified 26 eroding segments. The total length of the streambank identified for restoration and stabilization is 5,030 feet on the right bank (looking downstream) and 4,730 feet on the left bank (looking downstream). Photos of each of the erosion sites are found in Appendix A. The Commission Engineer selected the restoration areas based on those deemed to be the most critical for meeting the BCWMC goals and objectives while providing a cost-effective benefit.

Streambank erosion is a natural process that occurs at some rate on all stream channels. However, the natural erosion rate can be accelerated by local and regional changes in land use and hydrology. The bank erosion and bank failures present throughout the project area appear to be caused by a combination of natural stream erosion processes, problems associated with changing watershed hydrology, direct historical impacts on the stream channel, and effects of riparian land use. The sediment load from the erosion and scour increases phosphorus loads to downstream water bodies, decreases the clarity of water in the stream, destroys aquatic habitats, increases sedimentation in downstream wetlands, and reduces the flow capacity of the channel.

Stable stream channels are often said to be in a state of “dynamic equilibrium” with their watersheds, adjusting to changes in the watershed hydrology. It may take many years or decades for a stream to fully adjust to a rapid change in watershed hydrology. The use of stormwater best management practices (BMPs) helps reduce the impact of development projects on streams. Nonetheless, development and land-use alterations fundamentally change the hydrology of the watershed. These changes to hydrology often include increased magnitude and frequency of high-flow events, which subsequently increase erosion rates.

3 Site Characteristics

3.1 Plymouth Creek Watershed

The watershed area tributary to this reach of Plymouth Creek is approximately 1,870 acres and includes land solely within the City of Plymouth. Existing land use, according to the Metropolitan Council 2020 Land Use data, includes approximately 60 percent single-family residential; 19 percent undeveloped land; 7 percent commercial/industrial; 5 percent parks and recreation; 4 percent institutional; 3 percent multifamily, and highway over the remaining land area (Figure 3-1).

3.2 Stream Characteristics

This entire project reach of Plymouth Creek (Figure 2-1) extends for approximately 7,000 feet from Dunkirk Lane North to 38th Avenue North behind Plymouth Ice Arena. The stream is relatively shallow in most places except for a few deep pools. The riparian vegetation in this reach varies depending on adjacent land use. Most of the reach is adjacent to the backyards of private residential properties and a public pedestrian trail. In residential areas, vegetation varies and generally includes turf grass, shrubs, or woods to the top of the bank. Invasive species including buckthorn, reed canary grass, and burdock are present in riparian areas throughout the project reach. The project area also includes multiple pedestrian and street crossings.

The Commission Engineer walked the entire project reach to further investigate the scale and severity of the erosion problems for this feasibility study. Throughout the field investigation, the Commission Engineer photographed and assessed erosion using the Bank Erosion Hazard Index (BEHI) method (3), which estimates a streambank's susceptibility to erosion through evaluation of multiple elements, including bank height, bank angle, root depth and density, surface vegetation, and soil type. The City of Plymouth staff also utilized drone technology to capture images of the creek reach.

In addition to a site walk and drone flight, the Commission Engineer completed a desktop evaluation of near-bank stress (NBS) (3) along the reach, focusing on the Level II method, which evaluates the stream's radius of curvature in relation to the estimated channel bankfull width.

3.3 Site Access and Easements

Most of the proposed restoration areas can be accessed via the City of Plymouth's bike/pedestrian trail, City of Plymouth land, or existing easements. Restoration areas that are not accessible by public land or easements, will require temporary site access easements. Outreach to and coordination with landowners regarding temporary site access easements will occur during project design, primarily by City of Plymouth staff. The required number of construction access points will depend on the final number of areas selected for restoration.

Permanent easements may also need to be acquired in areas where the proposed restoration designs extend onto private land. There are 6 parcels (5 property owners, including 3 townhome associations) representing 1,670 linear feet of easements that may be required to complete work due to the channel, work area, or construction access extending beyond public parcels or existing easements. Further discussion of easements is found in Section 6.2.

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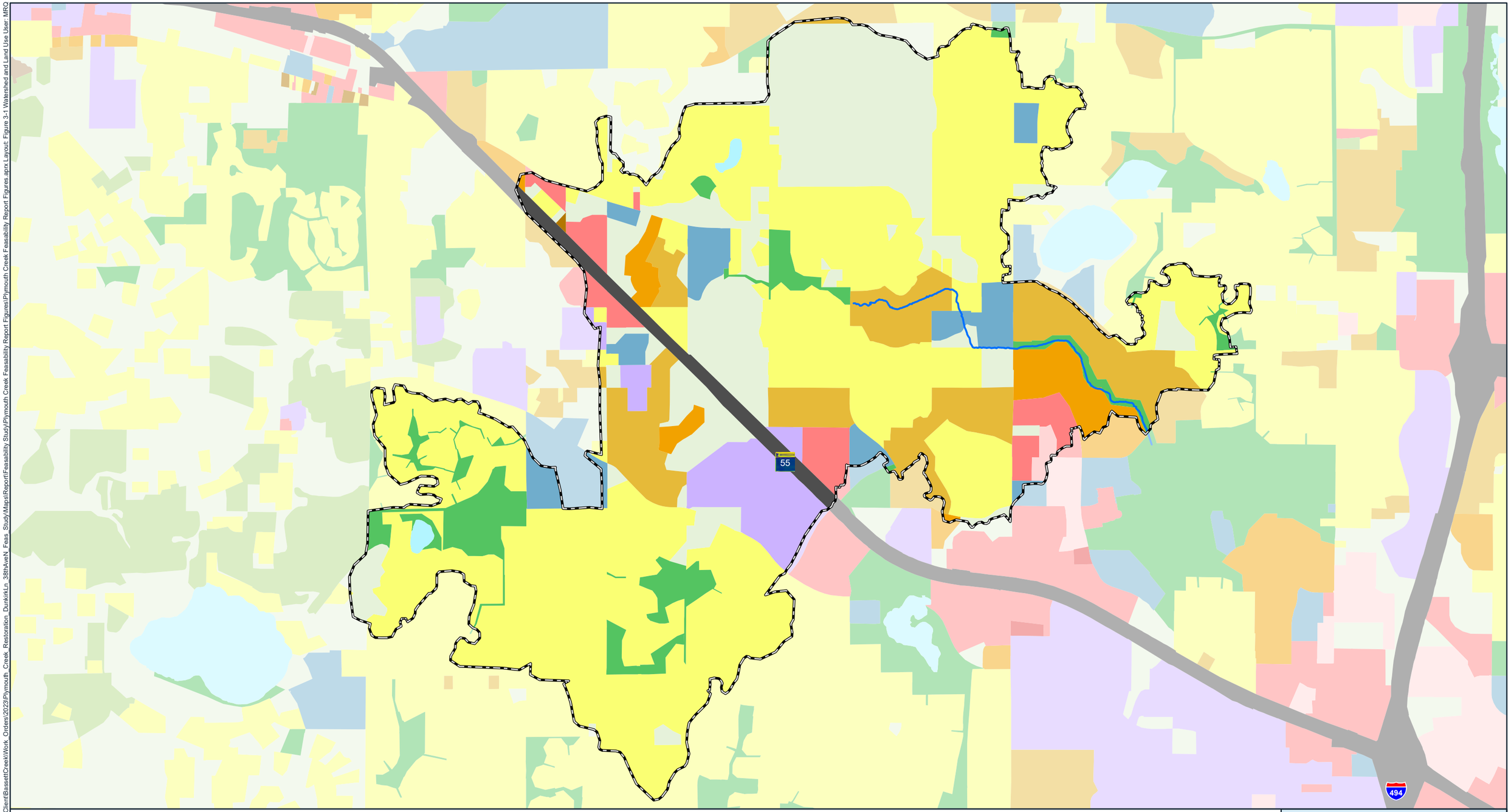

Contributing Drainage Area

Plymouth Creek

Metropolitan Council 2020 Generalized Land Use

- Farmstead
- Single Family Detached
- Single Family Attached
- Multifamily
- Retail and Other Commercial
- Office
- Mixed Use Residential
- Mixed Use Commercial and Other
- Industrial and Utility
- Institutional
- Park, Recreational or Preserve
- Golf Course
- Major Highway
- Agricultural
- Undeveloped
- Water

N

0 1,500 3,000

Feet

Land Use Source: Metropolitan Council, 2020

Bassett Creek Watershed Management Commission

Watershed and Land Use
Plymouth Creek Stream Restoration Feasibility Study
BCWMC

FIGURE 3-1

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3.4 Wetlands

The Commission Engineer completed a Level 1 desktop wetland assessment for the project area in November 2023. The level 1 review was completed for a 50 ft buffer from the Plymouth Creek channel centerline (100 feet wide total), referred to as the review area. The review included an assessment of multiple years of aerial imagery in addition to hydric soil indicators from the Natural Resources Conservation Service (NRCS) Web Soil Survey, LiDAR topography data, United States Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI), and the Minnesota Department of Natural Resources (MnDNR) Public Water Inventory (PWI).

According to the NRCS web soil survey (WSS) (4), there are 11 soil units mapped within the project area, which includes the channel and riparian area extending 50 feet left and right of the channel centerline (Table 3-1). The majority of the site is classified as having hydric soils. The USFWS NWI identified approximately 9.44 acres of wetland within the project area. In addition, the MnDNR classified this segment of Plymouth Creek as a public watercourse (PWI 27032a). There are no mapped public water wetlands or basins within the project area.

Table 3-1 Soils Located within the Project Area

Map Unit Symbol	Map Unit Name	Hydric Classification (%)	Percent of Area
L132A	Hamel-Glencoe complex, 0 to 2 percent slopes	Predominantly Hydric (90)	17.5
L22C2	Lester loam, 6 to 10 percent slopes, moderately eroded	Predominantly Non-hydric (2)	4.1
L22D2	Lester loam, 10 to 16 percent slopes, moderately eroded	Non-hydric (0)	0.7
L22E	Lester loam, 10 to 22 percent slopes	Non-hydric (0)	0.1
L26B	Shorewood silty clay loam, 3 to 6 percent slopes	Predominantly Non-hydric (5)	7.4
L36A	Hamel, overwash-Hamel complex, 0 to 3 percent slopes	Partially Hydric (45)	15.0
L37B	Angus loam, 2 to 6 percent slopes	Predominantly Non-hydric (5)	1.8
L49A	Klossner soils, depressional, 0 to 1 percent slopes	Hydric (100)	8.1
L50A	Muskego and Houghton soils, 0 to 1 percent slopes	Hydric (100)	29.3
L9A	Minnetonka silty clay loam, 0 to 2 percent slopes	Hydric (100)	6.1
U1A	Urban land-Udorthents, wet substratum, complex, 0 to 2 percent slopes	Non-hydric (0)	9.7

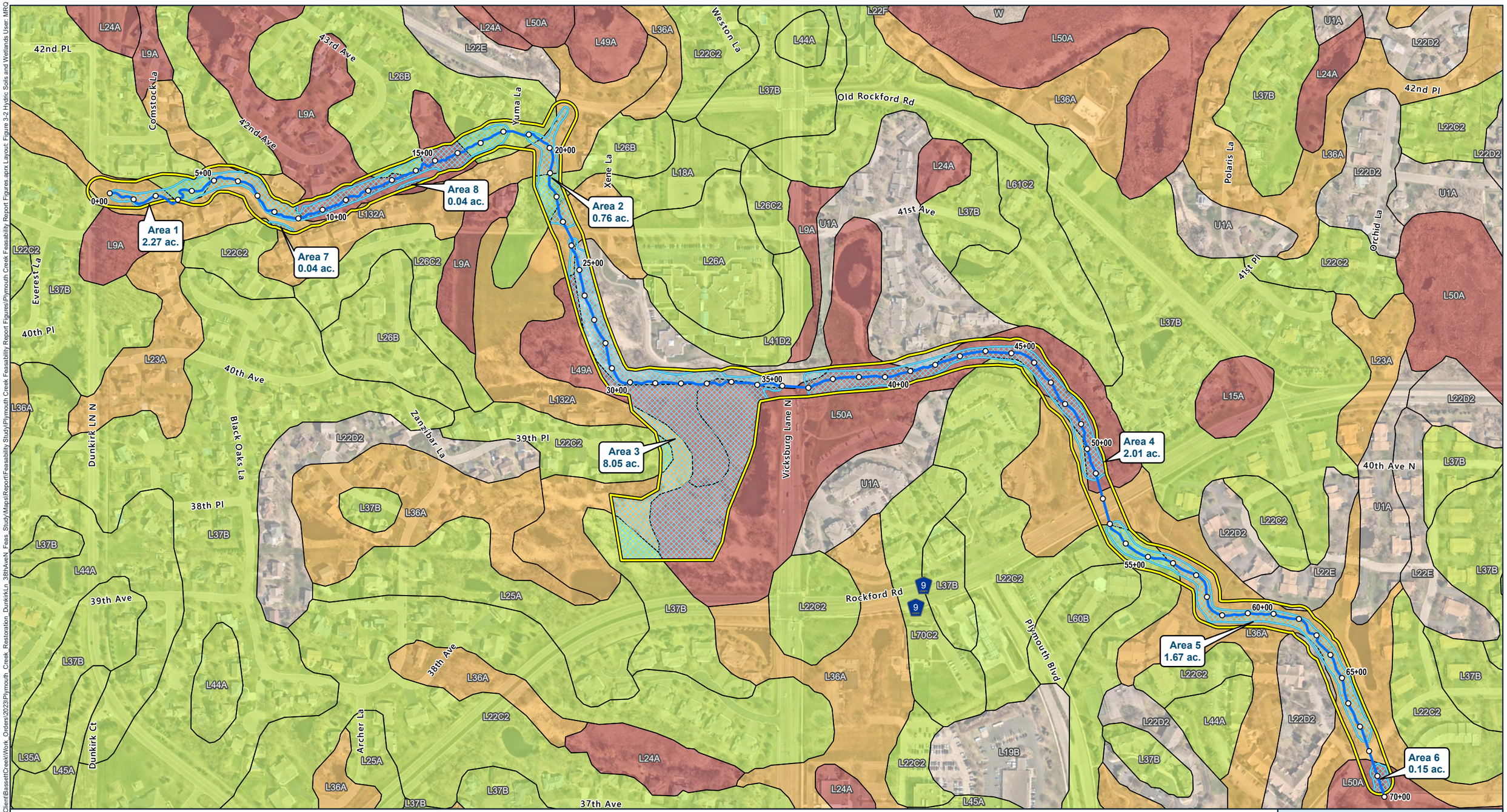
Our Level 1 review identified 17.02 acres of wetland area within the project area (Table 3-2 and Figure 3-2). This includes the area of the Plymouth Creek channel. The majority of the delineated wetlands are located adjacent to Plymouth Creek and are likely Type 1, Floodplain Forest wetlands. A large wetland complex (Area 3) is located at the northwest intersection of Rockford Road and Vicksburg Lane and is likely a combination of Type 2, Fresh (wet) meadow, and Type 3, Shallow marsh.

A field wetland delineation will be required during project design to confirm these wetland boundaries. The field wetland delineation would need to be completed according to the USACE 1987 Wetland Delineation Manual, the Regional Supplement to the USACE Wetland Delineation Manual, and the requirements of the Minnesota Wetland Conservation Act (WCA) of 1991.

Table 3-2 Summary of Desktop Delineated Wetlands (Level 1 Review)

Wetland ID	Plant Community*	Cowardin* Classification	Circular 39 Type*	Acres
Area 1	Non-Vegetated Aquatic Community, Hardwood Wetland, Shallow Marsh	PUBHx, PFO1Ad, PEM1C	1,3,5	2.43
Area 2	Shallow Open Water Community	PABH	5	0.78
Area 3	Seasonally Flooded/Saturated Emergent Wetland, Shrub Wetland, Hardwood Wetland, Shrub Wetland	PUBH, PEM1Ad, PFO1Ad, PSS1/EM1Ad	1,5,6	9.76
Area 4	None mapped	-	-	2.05
Area 5	None mapped	-	-	1.67
Area 6	Seasonally Flooded/Saturated Emergent Wetland	PEM1Ad	1	0.18
Area 7	Shallow Open Water	PABHx	5	0.06
Area 8	Non-Vegetated Aquatic Community	PUBHx	5	0.09
		Total		**17.02**

*Based on NWI mapping



Creek Stationing
Plymouth Creek
Study Area
Desktop Delineated Wetland

Hydric Soil Raiting (USDA SSURGO)
- Non-Hydric (0%)
- Predominantely Non-Hydric (1-32%)
- Predominantely Hydric (66-99%)
- Hydric (100%)

0 400 800
Feet

Imagery Source: Hennepin County 2022

Hydric Soils and Wetlands
Plymouth Creek Stream Restoration Feasibility Study
BCWMC

FIGURE 3-2

BARR

Barr Footer: ArcGISPro 3.1.5, 2024-05-08 13:59 File: I:\Client\BassettCreekWork Orders\2023\Plymouth_Creek_Restoration_DunkirkLn_38thAveN_Feas_Study\Maps\Report\Feasibility Study\Plymouth Creek Feasibility Report Figures\Plymouth Creek Feasibility Report Figures.aprx Layout: Figure 3-2 Hydric Soils and Wetlands User: MRQ

3.5 Cultural and Historical Resources

The Commission Engineer completed a cultural resources literature review in November 2023 of the project area and within a 1-mile buffer. The literature review was directed toward identifying previously recorded archaeological sites, historic structures, and other cultural resources. The Commission Engineer requested data from the Minnesota State Historic Preservation Office (SHPO), to identify previously recorded archaeological sites and historic structures located within one mile of the project area. We also reviewed the Minnesota Office of the State Archaeologist (OSA) Portal for archaeological sites (Figure 3-3).

The project area does not appear to have been previously surveyed for archaeological resources. If the project constitutes an undertaking subject to Section 106 of the National Historic Preservation Act, additional work to identify significant cultural resources may be required. In other words, if the project includes federal involvement (e.g., funding or permitting), then a federal agency may require additional cultural resources investigations, such as an archaeological survey, a historic architecture survey, and/or a traditional cultural properties survey. Because the project will include some level of federal review and/or permitting, the Commission Engineer recommends conducting an archaeological survey.

Although a Traditional Cultural Properties review is not within the scope of this cultural resources review, the project area is on the ancestral lands of the Dakota/Lakota tribes and the BCWMC may choose to initiate tribal consultation and/or a Traditional Cultural Properties Survey prior to proceeding with the next phase of this project. Additionally, if this project becomes an undertaking according to Section 106 of the National Historic Preservation Act, the lead federal agency may choose to do the same.

Data provided by the Minnesota SHPO was mapped at the section level; therefore, all cultural resources within the sections that contain the project area and the 1-mile study area are included in the following analysis. The data indicate that within sections 7, 8, 9, 10, 15, 16, 17, 18, 19, 20, 21 and 22 of Township 118N, Range 22W, 106 historic architectural resources have been documented, none of which are listed on the National Register of Historic Places (Table 3-3) (Figure 3-3). One of these resources (#HE-XXX-001/ Minneapolis, St. Paul & Sault St. Marie (SOO Line) Railroad), present in three sections (7, 17 and 21), has been recommended as eligible for listing on the NRHP.

Due to the nature of the data provided by the Minnesota SHPO, it is unknown if any of the previously documented historic architectural resources are in or adjacent to the project area, which is located in sections 16 and 17. There are nine historic architectural resources in section 17 (including the SOO Line Railroad) and five in section 16. In addition to the Soo Line Railroad, these resources include residences, farmsteads, a trunk highway, and a commercial building. The remaining 92 resources are located outside of sections 16 and 17 and consist primarily of residences, commercial buildings, farmhouses, and bridges. Historic architectural resources are most prevalent in sections 18 and 21. Aerial imagery shows that these sections contain concentrations of residences and commercial buildings, likely accounting for the higher number of cultural resources. The OSA Portal did not identify any archaeological sites within 1 mile of the project area.

T118 R23 S12
T118 R22 S7
12
T118 R22 S8
4
T118 R22 S9
1
T118 R22 S10
12
T118 R22 S11
T118 R23 S13
T118 R22 S18
21
T118 R22 S17
9
55
T118 R22 S16
5
9
T118 R22 S15
12
494
61
T118 R22 S14
T118 R23 S24
T118 R22 S19
5
101
24
T118 R22 S20
3
T118 R22 S21
22
T118 R22 S22
2
T118 R22 S23

Study Area
1-mile Buffer
Public Land Survey Sections
Section Contains NRHP Eligible Resource
(#) Number of Resources in Section

Historical Architectural Resources per Section
1
2 - 3
4 - 5
6 - 9
10 - 15
16 - 22

0 1,500 3,000
Feet

Imagery Source: Hennepin County 2022
Cultural Data Source: Minnesota State Historic Preservation Office (SHPO)

Cultural Resources
Plymouth Creek Stream Restoration Feasibility Study
BCWMC

FIGURE 3-3

BARR

Barr Footer: ArcGISPro 3.1.5, 2024-05-08 13:59 File: I:\Client\BassettCreek\Work_Orders\2023\Plymouth_Creek_Restoration_DunkirkLn_38thAveN_Feas_Study\Maps\Report\Feasibility Study\Plymouth Creek Feasability Report Figures\Plymouth Creek Feasability Report Figures.aprx Layout: Figure 3-3 Cultural Resources User: MRO

Table 3-3 Historical Architectural Resources/ Township 118N Range 22W

Section	Number of Historic Architectural Resources
7	12
8	4
9	1
10	12
15	12
16	5
17	9
18	21
19	5
20	3
21	22
22	2

We also reviewed the OSA Portal for unrecorded historic cemeteries and Native American burial grounds, as documented in Vermeer and Terrell (2011). This data indicates that three unrecorded cemeteries are documented in the project area. These include Gaspers Cemetery, Boucher Farm Cemetery and Medicine Lake Catholic Cemetery, as reported by Pope and Fee in 1998. The OSA Portal indicates that these cemeteries are mapped at the township level, and therefore could occur anywhere within the 36 sections of Township 118, Range 22, as the exact locations are unknown. The project area only spans sections 16 and 17 of this Township/Range. The cemeteries were not apparent on historic maps and aerials reviewed by Barr, 1913 Plat Map (5),1937/1945 aerials from the Regents of the University of Minnesota (6), and the 1955 USGS historical topographic map (7). However, a plat map from 1873 (8) shows land parcels owned by E. Boucher (Section 15) and E. Boucher Jr. (Section 22) (Figure 3-4). These parcels are outside of the project area, but within the 1-mile study area. Some of the first Euroamericans to settle in the area may have been buried in the Boucher cemetery (9). The potential presence of these unrecorded cemeteries slightly increases the potential for human remains to be present within the project area. The Minnesota Private Cemeteries Act (MS 307.08) requires that the OSA review development plans that may impact unrecorded burials. If human remains are encountered during construction, construction at that location must immediately be halted and local law enforcement and the OSA must be notified. Construction may not proceed until authorization from local law enforcement and the OSA is obtained.

No previous cultural resource management reports were identified within one mile of the project area. Barr requested cultural resource data from the Minnesota SHPO electronically. The data provided consists of a Microsoft Access database that includes only known archaeological sites and historic architectural resources, along with the survey report number that resulted in the identification of said resource(s). Negative survey report information is not included. As a result, the location of any previous investigations where survey results were negative for cultural resources is not included. Nevertheless, the data summarized here is believed to be adequate for the purposes of this investigation.

Study Area

Data Source:
Wright, George Burdick
1873 Minnesota Historical Society. Minnesota Digital Library. Electronic Document. Map of Hennepin County, Minnesota - Minnesota Digital Library (mndigital.org) Accessed November 2023.

0 2,000 4,000
Feet

1873 Plat Map
Plymouth Creek Stream Restoration Feasibility Study
BCWMC

FIGURE 3-4

BARR

Barr Footer: ArcGISPro 3.1.5, 2024-05-08 13:59 File: I:\Client\BassettCreek\Work_Orders\2023\Plymouth_Creek_Restoration_Dunkirk\Ln_38thAveN_Feas_Study\Maps\Report\Feasability Study\Plymouth Creek Feasability Report Figures\Plymouth Creek Feasability Report Figures.aprx Layout: Figure 3-4 1873 Plat Map User: MRO

3.6 Environmental Review

As part of our desktop environmental review, Barr reviewed historical imagery and the Minnesota Pollution Control Agency's (MPCA) What's In My Neighborhood (WIMN) database (Figure 3-5).

Barr reviewed historical aerial images for the following years: 1991-1992, 2003-2005, and 2008-2023. Historical aerial imagery shows the surrounding area as primarily residential. Prior to residential use, the area was farmed by European settlers. Prior to European settlement, the area was inhabited by Native American communities and the land was likely covered with deciduous forests..

A review of MPCA's WIMN database identified eight historical releases within half a mile of the project area:

- The Aca Management 370 leak sites (LS0012418, LS0013873) are located approximately 925 feet (0.18 mile) south of the creek. Leak LS0012418 occurred in January 1999 and involved an unknown volume of unleaded gasoline. The WIMN database does not specify whether groundwater contamination is present at this site. The leak was closed in November 2000. Leak LS0013873 occurred in December 2000 and involved an unknown volume of unleaded gasoline. The WIMN database identifies that there is no groundwater contamination at the site associated with this release. The site was closed in February 2003. Based on lack of identified release to groundwater and the closed regulatory status, it is unlikely that contamination from these releases will impact the project area.

- The Holly Creek Village brownfield site (VP10000) is located approximately 0.32 mile southwest of the project area. In 1998, buried landscape debris was discovered at the site. Four soil samples were collected and had concentrations of diesel range organics (DRO), semi-volatile organic compounds (SVOCs), carcinogenic polynuclear aromatic hydrocarbons (cPAHs), pentachlorophenol (PCP), metals, and agricultural chemicals present; however, concentrations were below the MPCA Soil Reference Values (SRVs). The site entered the MPCA Voluntary Investigation and Cleanup (VIC) program for approval to excavate debris-containing fill and characterize it for disposal. The MPCA closed the site in December 2000 and issued a Limited No Action Letter in January 2000. Based on lack of identified contamination to groundwater and documented regulatory oversight and closure, it is unlikely that contamination from this release will impact the project area.

- The US Postal Service Plymouth Branch leak site (LS0003973) is located approximately 0.45 mile south of the project area. An unknown volume of unleaded gasoline was released in May 1992. According to the WIMN database, groundwater contamination was identified, and presence of free product was reported to be unknown. Cleanup actions listed on the WIMN database include soil excavation and Remedial Investigation monitoring. The site was subsequently closed in January 1995. In 2022, the site was reviewed as part of the MPCA's Gasoline Additive Project. In 2023, the MPCA issued an assessment that determined that there was no concern with drinking water contamination associated with the release. Based on distance from the project area and regulatory closure, it is unlikely that contamination from this release will impact the project area.

- The Vicksburg Ridge leak site (LS0021782) is located approximately 0.45 mile north of the project area. An unknown volume of fuel oil was released in August 2022. The WIMN database does not specify whether groundwater contamination is present at this site; however, it noted that 10 cubic yards of soil were excavated and transported to the Dem-Con Recovery & Recycling

landfill. The site was closed in January 2023. Based on distance from project area, lack of evidence of impacts to groundwater, and regulatory closure, it is unlikely that contamination from this release will impact the project area.

- The Tri-State Drilling leak site (LS0020693), brownfield site (BF0000848), and non-NPL Superfund site (SR0001498) are located approximately 0.46 mile southwest of the creek. The listings are associated with a release of an unknown volume of diesel fuel in May 2018. According to the WIMN database, groundwater contamination was identified, presence of free product was reported to be unknown, and regional groundwater flow direction is to the east. No cleanup actions are listed on the WIMN database, but work including soil gas sampling, groundwater sampling, and soil boring sampling are identified. The site was closed in April 2021. Based on distance from project area, side-gradient location, and regulatory closure, it is unlikely that contamination from this release will impact the project area.

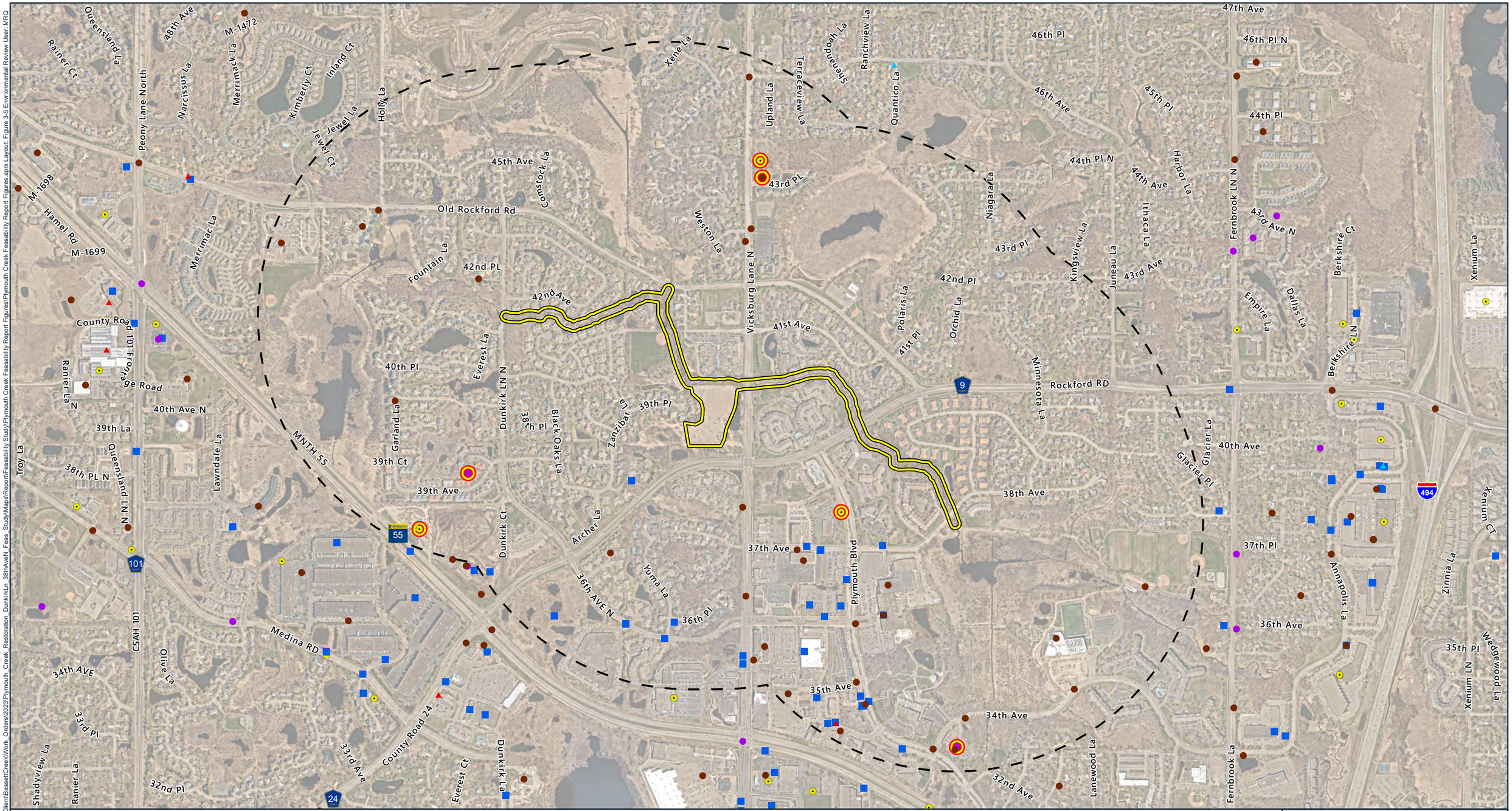
3.7 Threatened and Endangered Species Review

The Commission Engineer completed a desktop review for federal and state-listed species and associated habitats that may be found in the Plymouth Creek project area to evaluate potential project impacts on listed species. The federal government protects federally listed species under the Endangered Species Act (ESA) and requires consideration of the impacts on these species for projects involving federal permits. State-listed species are protected under Minnesota's Endangered and Threatened Species Law and the impacts on these species must be considered for state-level permitting requirements. We completed the desktop review in November 2023 using a combination of data available from the United States Fish and Wildlife Service (USFWS) and the Minnesota Department of Natural Resources (MnDNR), as further described below.

Federal Listed Species
The Commission Engineer queried the USFWS' Information, Planning, and Conservation System (IPaC) website to identify federally listed species that may occur within the project area. The IPaC identified the following species as potentially occurring in the project area:

- northern long-eared bat (*Myotis septentrionalis;* endangered);
- tricolored bat (*Perimyotis subflavus;* proposed endangered);
- whooping crane (*Grus americana;* experimental population);
- salamander mussel (*Simpsonaias ambigua;* proposed endangered*);*
- rusty patched bumble bee (*Bombus affinis;* endangered*);*
- monarch butterfly (*Danaus plexippus*, candidate species);

No designated critical habitat for any federally listed species is located within the project area.



Study Area
1/2 Mile Buffer
Historical Release Locations within 1/2 Mile of Study Area

What's in my Neighborhood

- Multiple Programs
- Air Quality
- Hazardous Waste
- Investigation and Cleanup
- Stormwater
- Tanks
- Water Quality

0 1,000 2,000
Feet

Imagery Source: Hennepin County 2022
WIMN Source: Minnesota Pollution Control Agency (MPCA), accessed November 2023

Environmental Review
Plymouth Creek Stream Restoration Feasibility Study
BCWMC

FIGURE 3-5

BARR

Barr Footer: ArcGISPro 3.1.5, 2024-05-08 13:59, File: I:\Client\BassettCreek\Work_Orders\2023\Plymouth_Creek_Restoration_DunkirkLn_38thAveN_Feas_Study\Maps\Report\Feasability Study\Plymouth Creek Feasability Report Figures\Plymouth Creek Feasability Report Figures .aprx Layout: Figure 3-5 Environmental Review User: MRO

The northern long-eared bat faces extinction primarily because of white-nose syndrome, which is a deadly disease affecting cave-dwelling bats across the continent. The northern long-eared bat hibernates in caves during the winter and utilizes forested areas for roosting and foraging during the bat's active season of April through September. Suitable roost trees for this species have trunks measuring greater than 3 inches in diameter at breast height with loose, peeling bark or crevices (10). According to data provided by the MnDNR, no known occupied roost trees or hibernacula are located within the project area. However, because the project occurs within the range of the northern long-eared bat and will require tree removal, impacts on the northern long-eared bat cannot be completely discounted. To avoid direct impacts on the northern long-eared bat, USFWS recommends that tree removal occur during the inactive period (October 15 to early April). Consultation with USFWS would be required if tree removal were to occur during the northern long-eared bat's active season (mid-April – October 14).

Similar to the northern long-eared bat, the tri-colored bat faces extinction primarily because of white-nose syndrome. To combat the large impact this disease has on tri-colored bat colonies, the USFWS proposed the species to receive endangered status on September 14, 2022 (11). Tri-colored bats are found in forested habitats in the spring, summer, and fall, which are their non-hibernating seasons. They primarily roost in trees, among leaves of live or recently dead deciduous hardwood trees. They have also been found in Spanish moss, pine trees, and occasionally human structures. During the winter hibernating season, tri-colored bats can mostly be found in caves and mines (10). The project area follows a creek that is lined with intermittent tree cover. Because there is not critical wintering habitat within the project area, it is unlikely that the project would affect the tricolored bat if tree removal was limited to their inactive period (October 15 to early April). However, the tricolored bat is proposed to be listed as endangered and is not currently protected under the ESA. No avoidance or minimization measure would be required for the tricolored bat.

The whooping crane is listed as an experimental population, non-essential, which means that the species population has been established within its historical range. Non-essential experimental populations are treated as threatened species on National Wildlife Refuge and National Park land and as a proposed species on private land. The whooping crane faces threats from alteration and destruction of their habitats, including both migratory and overwintering habitats. This can be a result of wetland drainage, increased development, and/or conversion of suitable habitat to agriculture. Both frequency and severity of drought due to climate change and reduction in river flows degrades their migration roost habitats. The ideal whooping crane habitat varies for migrating, foraging, and overwintering. These habitats can include coastal marshes and estuaries, inland marshes, lakes, open ponds, shallow bays, salt marsh and sand or tidal flats, upland swales, wet meadows and rivers, pastures and agricultural fields (10). Because the whooping crane is treated as a proposed species on private land, it is not currently protected under the ESA within the project area and no avoidance or minimization measures would be required.

The salamander mussel is a proposed endangered species. The species existence is threated by the infestation of non-native zebra mussels in the Mississippi River and its tributaries, as well as the increased siltation and physically altered habitat conditions from dams, channelization and dredging. The species is very habitat specific and lives only under flat rocks or under ledges of rock walls (12). The project location does not overlap in the critical habitat of the species. The salamander mussel is a proposed species and is not currently protected under the ESA, so no avoidance or minimization measures would be required.

The rusty patched bumble bee was listed as federally endangered in 2017. The specific cause of the species' decline is unknown, but evidence has shown that there are several stressors that can affect the rusty patched bumble bee. These can include pathogens, pesticides, habitat loss and degradation, non-

native and managed bees, the effects of climate change and small population biology. While the habitat for the rusty patched bumble bee can vary throughout the growing season, generally their habitats are split between nests and overwintering. They have been observed in a variety of habitats, including prairies, woodlands, marshes, agricultural landscapes and residential parks and gardens. Nests are assumed to be in upland grasslands, shrublands and as far as 30 meters into the edges of forests and woodlands. The nests are typically 1 to 4 feet underground in abandoned rodent nests or other mammal burrows, and sometimes found at the soil surface or aboveground. There is not much known about overwintering habitats of the rusty patched bumble bee queens. The assumption, based on other species, is that they overwinter in upland forests and woodlands. Recent literature has shown overwintering queens have been found mostly in shaded area, usually near trees and in banks without dense vegetation (10). The project area has the potential for nesting and overwintering habitat for the rusty patched bumble bee. To mitigate adverse impacts, the project should avoid using pesticides and revegetate the area with native plant species.

The monarch butterfly is listed as a candidate species and is not legally protected under the ESA. No avoidance or minimization measure would be required for the monarch butterfly.

State Listed Species

Through a license agreement (LA-898) with the MnDNR for access to the Natural Heritage Information System (NHIS) database, the Commission Engineer queried the NHIS database in November 2023 to evaluate if any rare species could potentially be affected by the proposed project. The NHIS review identified one state-listed special concern species as occurring within one mile of the project area, the trumpeter swan (*Cygnus buccinator*).

The trumpeter swans' habitat during the breeding season includes small ponds and lakes or bays on larger water bodies with extensive beds of emergent vegetation such as cattails, bulrushes, and sedges. Their ideal habitat includes around 100 m (328 ft) of open water to accommodate take-off, stable levels of unpolluted fresh water, emergent marsh vegetation, and low levels of human disturbance. Ideally there is a presence of muskrat (*Ondatra zibethicus*) houses and North American beaver (*Castor canadensis*) lodges to be used for nesting platforms (12). Trumpeter swans in Minnesota generally only migrate to central or southern Minnesota or nearby states to overwinter. It is unlikely that trumpeter swans would utilize the stream for breeding or overwintering habitat (10). The surrounding wooded plant and stream community is unlikely to be suitable nesting habitat for the trumpeter swan. Therefore, the project is anticipated to have no effect on the trumpeter swan.

Additional Sensitive Resources

According to GIS data obtained from the MnDNR, there are no Minnesota County Biological Survey (MCBS) sites located within one mile of the project area. Additionally, no state-owned wildlife management areas (WMA), Scientific Natural Areas (SNA), or native plant communities are present within one mile of the project area (13), (14).

3.8 Tree Survey

The Commission Engineer conducted a tree survey under leaf-off conditions in November of 2023. A Minnesota state-licensed landscape architect with extensive tree identification and survey experience collected tree location, species, general health, and diameter (at approximately 4.5 feet above the ground) data for trees greater than four inches in diameter within the survey limits. The survey area included a 50-foot buffer on either side of the stream centerline.

Based on the survey data collected, Barr classified trees in accordance with the City of Plymouth tree ordinance (15). See Table 3-4 for a breakdown of tree classifications within the survey limits, according to the city ordinance definitions. The survey showed that approximately 33% of the trees 4 inches and greater in diameter in the survey area are box elder, 19% are black willow, 18% are cottonwood, and 9.7% are green ash. Of the 165 green ash surveyed in the project area, 6 were dead and 16 were dying, most likely due to emerald ash borer. The Commission Engineer observed that green ash near residential yards or sidewalks had treatment tags, while those in wooded areas (i.e. near the school or further away from residential properties) did not have treatment tags. The remaining 20.1% consist of species such as apple spp., aspen, basswood, birch, black locust, buckthorn, cedar, elm, hackberry, poplar, maple spp., mountain ash, mulberry, oak spp., white pine, and spruce spp. See Table 3-5 for the full species count survey results, which includes 131 trees that were either dead or dying, approximately 8% of the surveyed trees. The Commission Engineer observed during the tree survey that a large percentage of trees under 4 inches in diameter that were not recorded were buckthorn and box elder. Section 6.4.1 discusses the anticipated tree impacts from the proposed project.

Table 3-4 Summary of Tree Survey with City of Plymouth Tree Definitions

Tree Type	Count	Significant Tree	Count
Deciduous	1,676*	Diameter ≥ 8”	1,227
Coniferous	17	Diameter ≥ 4”	17

*Includes all deciduous trees six inches or greater in diameter.

Table 3-5 Summary of Tree Survey by Species

Tree Species	Count	Species Percent of Total Survey
Apple/Spp.	5	0.3%
Ash/Green	165	9.7%
Aspen	3	0.2%
Basswood/American	15	0.9%
Birch/Paper	1	0.06%
Birch/River	6	0.4%
Black Locust	6	0.4%
Box Elder	561	33.0%
Buckthorn	69	4%
Cedar/Red	1	0.06%
Cottonwood	303	18%
Elm/American	92	5.4%
Elm/Siberian	8	0.5%
Hackberry	2	0.12%
Lombardy Poplar	33	1.9%
Maple/Spp.	1	0.06%
Maple/Norway	5	0.3%
Maple/Red	1	0.06%
Maple/Silver	14	0.8%

Tree Species	Count	Species Percent of Total Survey
Maple/Sugar	2	0.12%
Mountain Ash	6	0.4%
Mulberry	3	0.2%
Oak/Bur	31	1.8%
Oak/Pin	7	0.4%
Oak/Red	7	0.4%
Oak/Swamp White	2	0.12%
Oak/White	2	0.12%
Pine/White	2	0.12%
Spruce/Black	1	0.06%
Spruce/Blue	1	0.06%
Spruce/Norway	3	0.2%
Spruce/White	10	0.6%
Willow/Black	325	19.2%
Total	**1,693**	**100%**

3.9 Drone Flight

The City of Plymouth collected aerial imagery and videos using a drone (DJI Phantom 4 Advanced) and DJI software in accordance with Federal Aviation Administration (FAA) rules and regulations. Aerial imagery and videos largely followed the creek's thalweg (main flow path).

Drone flights are a useful tool for stream restoration studies. The drone's aerial imagery provides a unique perspective and view of the creek that is different than the imagery collected from the site walk. The drone imagery can also be helpful to recall the site walk and features identified along the 7,000-foot reach. For this feasibility study, the drone imagery was also used during the open house that was hosted by City of Plymouth. Open house attendees could view the drone imagery on multiple monitors located throughout the meeting room.

3.10 Topography and Utilities

An important consideration for stream restoration is the existing topography and proximity to utilities. The topography we used for this feasibility study was LiDAR from 2011, while the City of Plymouth provided the utility information. The utilities we reviewed as part of this feasibility study include storm sewer, sanitary sewer, watermain, and utility towers. Information about private utilities would need to be obtained and considered during the design phase. We included topographic and utility information on many of the figures throughout the report.

4 Stakeholder and Public Engagement

4.1 Kickoff Meeting with BCWMC Staff and City of Plymouth Representatives

A virtual project kickoff meeting with BCWMC (administrator, the Commission Engineer, and the Plymouth Alternate Commissioner) and City of Plymouth staff occurred on November 3, 2023. At this meeting, we reviewed the project scope and schedule, reviewed key tasks, and identified data needs. Discussions also included preferences regarding preliminary stream stabilization and water quality improvement concepts.

4.2 Technical Stakeholder / Agency Meeting

A technical stakeholder meeting was held virtually on December 5, 2023. Attendees included representatives from the City of Plymouth, BCWMC (administrator, the Commission Engineer), Hennepin County, USACE, MPCA, MnDNR, and Minnesota Board of Water and Soil Resources (BWSR). The attendees reviewed the restoration techniques and design concepts for the Plymouth Creek project and provided technical and permitting feedback. Items discussed included:

- Review of the project schedule and meeting objectives.
- Review of the erosion sites and other creek deficiencies.
- Review of water quality issues.
- Review and discussion of the design concepts.
- Discussion of potential habitat improvements.
- Discussion of threatened and endangered species.
- Discussion of permit requirements for potential wetland and stream impacts.

One of the permits that will be required for the project is a water quality certification under Section 401 of the Clean Water Act. Given the project scope and early feasibility stage, it is uncertain if a nationwide or regional general permit or individual permit would be required under Section 401. Representatives from the USACE mentioned that if there are wetland impacts due to the stream restoration project, wetland mitigation would mostly likely not be required under the Section 401 water quality certification. USACE representatives also noted that the Minnesota Stream Quantification and Debit Calculator (MNSQT) may be a helpful tool in their evaluation of the project and could be used to calculate stream credits if the BCWMC opts to pursue streambank credits with this project.

The second specific permit discussed during the meeting was a right-of-way permit from Hennepin County. If the proposed project includes work in the Hennepin County right-of-way, then a Hennepin County permit will be required.

A primary topic of the meeting was the potential new meander path of the channel west and south of the elementary school. The general opinion of the meeting attendees was that the new meander option may require additional permitting and there are a few obstacles this concept would need to overcome to obtain permit approval. The proposed new meander path is in an existing FEMA floodway and floodplain;

therefore, the project would need to adhere to floodplain requirements. A MnDNR representative suggested expanding the new meandered segment to include areas such as the channel area near the ball parks. Expanding the meander path area could potentially be more cost-effective for the project due to the permitting costs and permitting requirements not being dependent on the stream meander path length. In other words, the cost and turn-around time for permitting is the same for a short or a long new meander section. The USACE representatives noted that if the new meander could connect the floodplain to the wetlands, then the project may be eligible for wetland mitigation credits. Additionally, USACE representatives noted that the project could also be eligible for stream mitigation credit bank credits, but that the time involved to proceed with this effort would take longer than a typical stream restoration project.

The final topic of conversation during the meeting was whether the project would require preparation of an Environmental Assessment Worksheet (EAW). According to a MnDNR representative, in recent years watershed organizations proposing reshaping or re-meandering a channel have submitted an EAW. Minnesota Rules 4410.4300 sub-part 27 states that an EAW is required for projects that will "change or diminish the course, current, or cross-section of one acre or more of any public water" so an EAW will be necessary if a one-acre threshold of change is reached with the project. Restoration elements that could alter the course, current or cross-section of the channel include structures placed in the channel (such as cross-vanes and J-hooks), or alterations of the streambank configuration below the ordinary high water level.

4.3 Open House for Gathering Public Stakeholder Input

A public open house was held at Plymouth City Hall on March 11, 2024; 16 members of the public attended the meeting. The Commission Engineer developed display boards for the meeting to present the project background and preliminary design to local residents and users of Plymouth Creek, as seen in Appendix B. Attendees asked questions and shared observations about the creek. Attendees voiced support for the project and were interested in learning more about it. Residents expressed a general desire to remove invasive species, specific areas of sedimentation, and localized debris from the project area. They offered varying opinions on tree protection, tree removal, and vegetation. Some residents preferred protecting trees to maintain visual barriers around their properties while others preferred to remove trees and other vegetation to improve their view of the creek. In general, residents supported native vegetative establishment and a more natural approach to restoring the reach. They also noted an appreciation for the bike/walking trails and visibility/connection to the creek from the trails. Other discussion topics included site access, project costs, and concerns about nearby ponds that are outside of the project scope.

5 Potential Improvements

5.1 Description of Potential Improvements

As described in Section 1.2, the 2025 Plymouth Creek Stream Restoration project would consist of a variety of stream stabilization measures to address erosion problems along the reach. Figure 2-1 through Figure 2-4 shows the identified potential stream restoration areas, and Table 5-1 lists the potential stream stabilization measures considered for each restoration area. There are several stream restoration techniques that can be used, although not all of them would be practicable or applicable to the stream erosion problems on this reach of Plymouth Creek. The techniques discussed below and included in the conceptual design are among commonly used techniques. Those included in the concept design were selected for their functionality and the expectation that most contractors have had experience with installation of the technique or that it would be relatively easy to learn. During final design, the most appropriate measures to use at each individual site will be selected to meet the objectives of all parties involved. The final design could include techniques not included in these concept designs.

5.1.1 Hard Armoring and Bioengineering Stream Stabilization Techniques

Techniques for stream stabilization generally fall into two categories: hard armoring and bioengineering (also known as soft armoring). Hard armoring techniques include the use of engineered materials such as stone (riprap or boulders), gabions, and concrete to stabilize slopes and prevent erosion. 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 and bioengineering techniques present different challenges, costs, and benefits for stream stabilization design. Hard armoring methods are viewed as standard and time-tested and typically have a longer life span due to the permanence of the materials used. Hard armoring is usually effective in preventing erosion where it is installed; however, placement must consider downstream impacts, understanding that the armoring may push the erosive stresses downstream. Hard armoring typically requires little maintenance; however, if the armoring fails, maintenance or replacement can be expensive, particularly if the armoring materials need to be removed from the site.

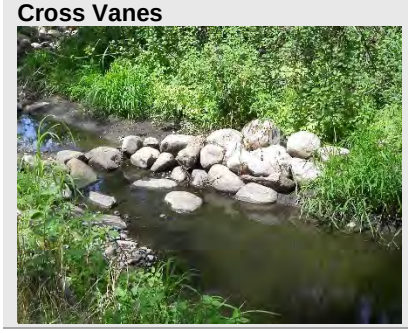
Bioengineering techniques maintain more of a stream's natural function and provide better habitat and a more natural appearance than hard armoring. With bioengineering, if vegetation is well-established, this approach can also be self-maintaining. Due to the biodegradation of construction materials and variable vegetation establishment success, it is typically assumed that bioengineering installations have a shorter life span and may need more frequent (if less expensive) maintenance, particularly as the vegetation is becoming established. Compared to hard armoring, the success of bioengineering techniques is more dependent on the skill of the designer and installer and the unique site and stream characteristics—sometimes making bioengineering construction more expensive. In some instances, bioengineering is not appropriate due to anticipated high velocities, proximity to infrastructure, and/or site conditions that are not conducive to vegetation establishment.

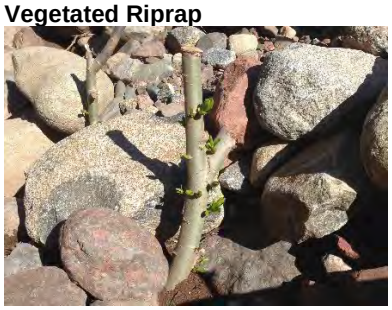
Technical stakeholders for this feasibility study, including the USACE, expressed a preference for bioengineering over hard armoring for stream stabilization where possible. In addition, the current BCWMC Watershed Management Plan (see Section 4.2.5 of Reference (1) states: “recognizing their benefits to biodiversity and more natural appearance, the BCWMC will strive to implement stream and streambank restoration and stabilization projects that use soft armoring techniques (e.g., plants, logs, vegetative mats) as much as possible and wherever feasible.” The BCWMC also recognizes that in some cases, soft armoring techniques can require significant tree removal, which can have negative consequences, depending on the type and condition of trees in the project area. Therefore, the BCWMC seeks to balance soft armoring with preserving desirable tree species.

5.1.2 Stream Stabilization Techniques Evaluated

We evaluated several techniques for stabilizing the stream within the project area. J-hook vanes or boulder cross vanes could be used to stabilize the channel banks and introduce flow variability and an improved riffle/pool sequence, with the structure shape maintaining deeper pools near the center of the channel. The deeper pools will improve habitat, especially during winter months. The use of grading, root wads, toe wood, coir logs, brush mattresses, and the establishment of vegetation on eroding banks will stabilize these areas, preventing further sediment loss and improving habitat adjacent to and within the channel. Root wads and toe wood, especially, will help create micro-scour zones and habitat diversity in the near-bank channel. Vegetation establishment on the streambanks will include enhanced buffers with native vegetation that have deeper roots to reduce erosion and improve riparian habitat. The evaluated reach of Plymouth Creek includes significant potential for vegetation enhancement through most of the riparian corridor. This could include treatment and/or clearing of invasive species, such as buckthorn, and the introduction of management practices aimed at promoting the growth of beneficial native species. These strategies could include the use of hand pulling, mowing, mulching, spot chemical treatments alongside active native planting and establishment efforts. Table 5-1 summarizes the stream stabilization techniques evaluated for this feasibility study. Additional stabilization techniques may be reviewed and implemented as part of the design phase.

Table 5-1 Potential Stream Stabilization Measures

Design Element	Purpose	Ecological Benefit
J-hook Vanes 	Logs and/or boulders installed in the stream bed to route flows away from outer streambanks and toward the center of the channel	Scour pools develop downstream of the low end of the vane near the center of the channel, while sediment and debris build up near the high end of the vane, protecting the bank and providing habitat diversity for aquatic species.
Cross Vanes 	Boulders buried in the stream bed and extending entirely across the stream ("cross vanes") to achieve one or more of the following goals: re-direct flows away from streambanks, encourage sediment deposition in selected areas, and control stream bed elevations	Scour pools develop over time downstream of the center of the vane, which provide habitat diversity for species that prefer pools to faster flowing in-channel habitat.
Root Wads 	Tree trunks with the root ball attached, installed either singly (root wads) or in conjunction with additional large woody debris and/or riprap to increase bank roughness and resistance to erosion, re-direct flows away from streambanks, and provide a bench for the establishment of riparian vegetation	Creates undercut/ overhanging bank habitat features
VRSS/Toe Wood Bank Stabilization 	Soil lifts created with a combination of root wads and long-lasting, biodegradable fabric and vegetated to stabilize steep slopes and encourage the establishment of root systems for further stabilization	Creates undercut/ overhanging bank habitat features and vegetated floodplain bench/riparian habitat

Design Element	Purpose	Ecological Benefit
Brush Mattresses and Riprap Toe (source: USDA-NRCS) 	Live cuttings are placed along a bank to protect the underlying soil and establish roots over time, preventing future bank erosion. The cuttings are anchored to the bank using dead stout stakes or string. The toe of the bank in this image is stabilized with bundled live cuttings (fascines) and riprap.	Vegetation placed on the bank creates riparian habitat and shading of the creek.
Riprap Toe with Bank Grading and Vegetation Establishment 	Riprap placed along the toe of the streambank prevents undermining of the bank. Vegetating the bank provides surface protection while establishing root systems, and grading to a flatter slope makes the streambank less susceptible to erosion.	Vegetation placed above the riprap enhances riparian habitat and provides shading of the creek.
Vegetated Riprap 	Vegetated riprap incorporates habitat enhancement with hard armoring to stabilize steep slopes.	Creates vegetated riparian habitat and enhances biological connectivity between the channel and riparian area.
Fascines and Coir Logs 	Fascines and coir logs can be placed along the toe of a streambank in low-velocity areas to help establish vegetation and associated rooting systems to stabilize the streambank.	Creates vegetated riparian habitat and adds roughness to dissipate energy at the toe of the slope.
Vegetated Buffer 	Established along a streambank or overbank area to stabilize bare soils and increase resistance to fluvial erosion	Using trees, shrubs, and a seed mix of grass and forbs provides a diverse array of vegetation strata and habitat types. Allows for more naturalized aesthetics, with emphasis on native species.

5.2 Concepts Evaluated

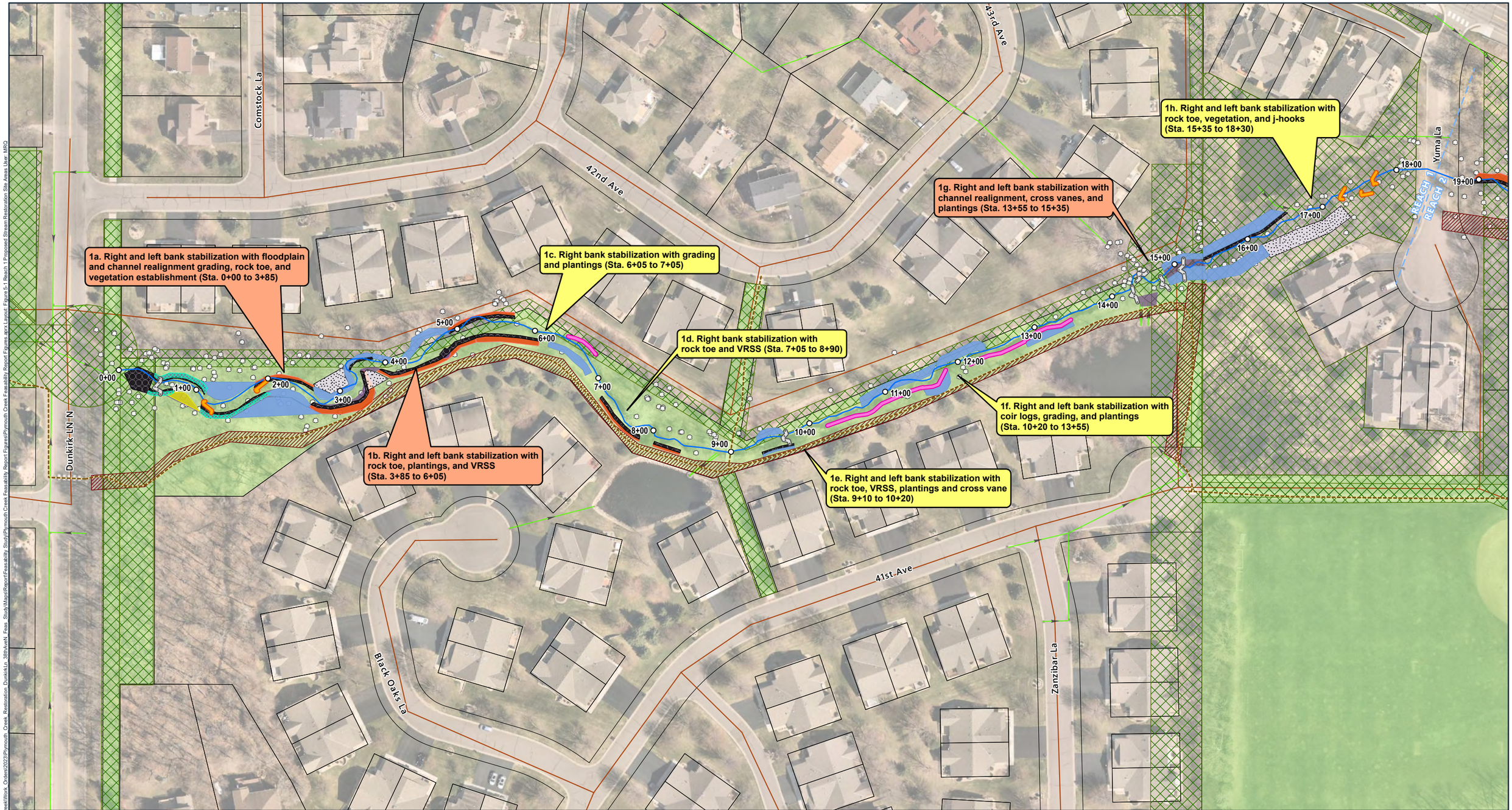
Considering feedback obtained from residents during the open house, the Commission Engineer developed a recommended restoration concept that incorporates bioengineering, hard armoring, and vegetation management. Recommended restoration measures along the reach include in-stream structures, toe stabilization, bioengineering methods, bank grading, riprap, and vegetation establishment.

The Commission Engineer reviewed the entire 7,000-foot reach and conceptually designed restoration methods for more than half of the evaluated creek length. The purpose of the proposed restoration was to select specific stabilization methods that would address varying erosion concerns, including bank sloughing, toe erosion, streambank undercutting, entrenched channels, and scour associated with existing infrastructure. Due to the extensive nature of the design, the proposed design concepts were broken down into restoration areas. Restoration areas for this study refer to proposed stream repair reaches that vary from 100 to 400 feet in length. The start and end of restoration areas were defined based on streambanks having similar erosion properties and prioritization metrics (defined in Table 5-2). The restoration areas and the specific proposed stream stabilization measures are shown in Figure 5-1 through Figure 5-4. To better organize the various stream restoration areas, they are labeled based on one of four broader reaches:

- Reach 1 is from Dunkirk Lane to Yuma Lane
- Reach 2 is from Yuma Lane to Vicksburg Road
- Reach 3 is from Vicksburg Road to Rockford Road
- Reach 4 is from Rockford Road to the Plymouth Ice Arena

The recommended restoration concept design would result in approximately 9,875 linear feet of bank stabilization, which includes approximately 4,340 feet of stabilization on the left bank (looking downstream) and 5,535 feet of stabilization on the right bank (looking downstream).

Due to the extensive length of the recommended stabilization measures, the Commission Engineer assigned a numeric score for the restoration areas based on the prioritization metrics noted below. The metrics are a combination of elements originally developed for the Bassett Creek Main Stem restoration project feasibility study and modifications by Plymouth staff and the Commission Engineer to better fit the Plymouth Creek project. Table 5-2 provides a summary of the scoring system used for this feasibility analysis.



Creek Stationing
Significant Trees
Bike and/or Pedestrian Trail
Gravity Storm Sewer
Sanitary Main
Plymouth Creek
Reach Breakline

Parcel Boundary
Public Parcel
Easements

Proposed Restoration
Coir Log
Cross-Vanes
J-Hook

Brush Mattresses
Construction Access
Grading
Live Staking
Plug Planting
Rock Riprap
Seeding

VRSS

Priority Level
Low
Medium
High

N

0 100
Feet

Imagery Source: Hennepin County 2022

Proposed Stream Restoration Site Areas
Reach 1
Plymouth Creek Stream Restoration Feasibility Study
BCWMC
FIGURE 5-1

BARR

Barr Footer: ArcGISPro 3.1.5, 2024-05-08 13:59 File: I:\Client\Bassett\Creek\Work_Orders\2023\Plymouth_Creek_Restoration_Dunkirk\Ln_38thAveN_Feas_Study\Maps\Report\Feasibility Study\Plymouth Creek Feasibility Report Figures.aprx Layout: Figure 5-1 Reach 1 Proposed Stream Restoration Site Areas User: MRO

2a. Right and left bank stabilization with rock toe, cross vanes, j-hook, and vegetation establishment (Sta. 18+70 to 21+00)

2b. Grading to improve channel definition (Sta. 21+00 to 23+30)

2c. Right and left bank stabilization with grading, rock toe, root wads, log vanes, and vegetation establishment (Sta. 23+40 to 25+40)

2d. Right and left bank stabilization with grading, root wads, log vanes, woody debris removal, and vegetation establishment (Sta. 25+40 to 29+30)

2e. Right and left bank stabilization with grading banks and side channels, log vanes, woody debris removal, and vegetation establishment (Sta. 29+30 to 33+90

2f. Right and left bank stabilization with grading, woody debris removal, log vanes, and vegetation establishment (Sta. 33+90 to 36+00)

42nd Ave
40th Ave
41st Ave
Zanzibar La
Yuma La
Xene La
Vicksburg Lane N
Plymouth Creek Elementary School
REACH 1
REACH 2
REACH 3
10+00
11+00
12+00
13+00
14+00
15+00
16+00
17+00
18+00
19+00
20+00
21+00
22+00
23+00
24+00
25+00
26+00
27+00
28+00
29+00
30+00
31+00
32+00
33+00
34+00
35+00
36+00
37+00
38+00
39+00

- Creek Stationing
- Significant Trees
- Bike and/or Pedestrian Trail
- Gravity Storm Sewer
- Sanitary Main
- Plymouth Creek
- Reach Breakline
- Parcel Boundary
- Public Parcel
- Easements

Proposed Restoration

- Coir Log
- Cross-Vanes
- J-Hook
- Root Wads
- Vanes
- Brush Mattresses
- Construction Access
- Debris Removal
- Grading
- Live Staking
- Plug Planting
- Rock Riprap
- Seeding
- VRSS

Priority Level

- Low
- Medium
- High

0 150 Feet

Imagery Source: Hennepin County 2022

Proposed Stream Restoration Site Areas
Reach 2
Plymouth Creek Stream Restoration Feasibility Study
BCWMC
FIGURE 5-2

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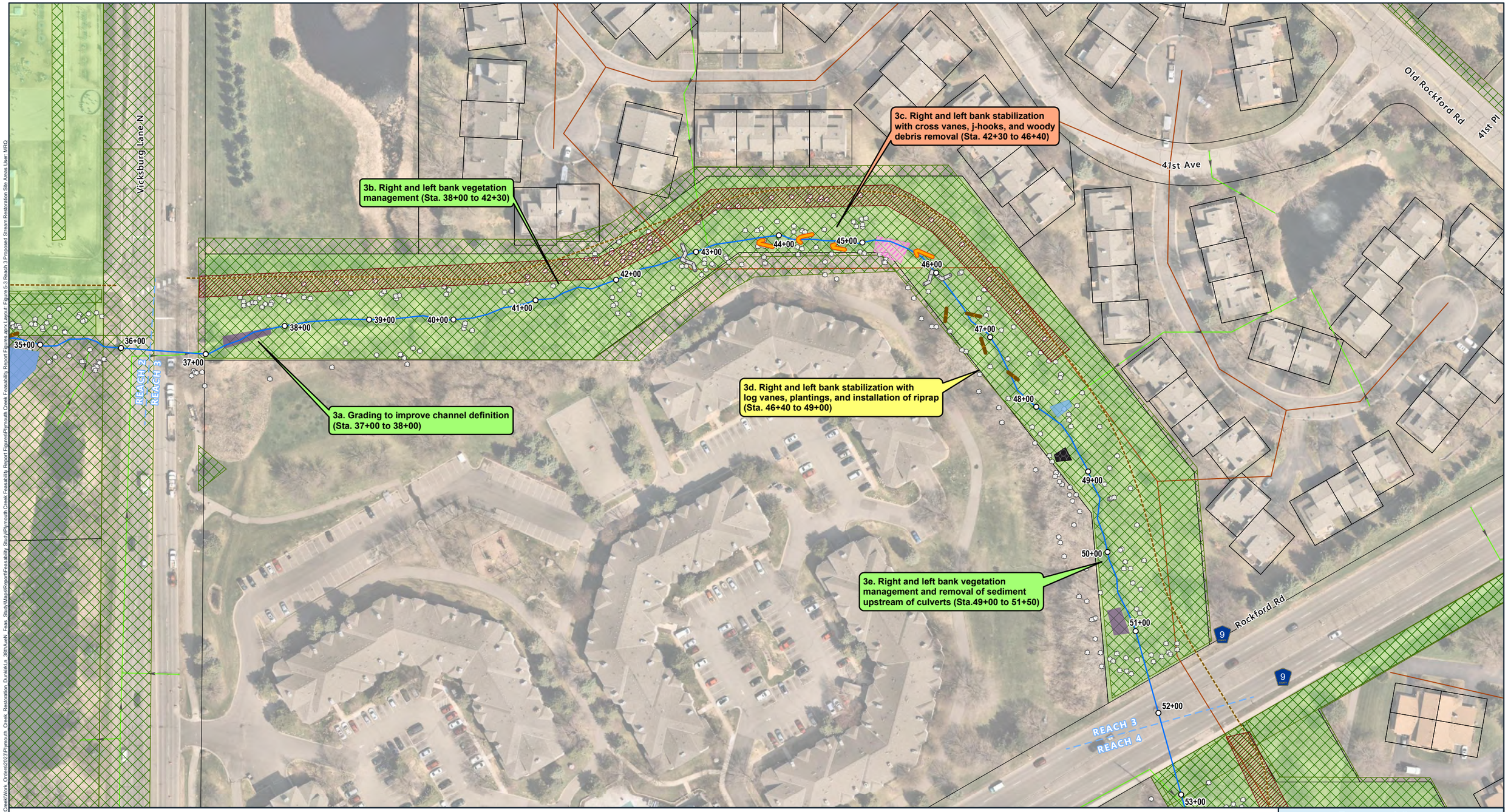


Creek Stationing
Significant Trees
Bike and/or Pedestrian Trail
Gravity Storm Sewer
Sanitary Main
Plymouth Creek
Reach Breakline

Parcel Boundary
Public Parcel
Easements

Proposed Restoration
Cross-Vanes
J-Hook
Vanes

Construction Access
Debris Removal
Grading
Plug Planting
Rock Riprap

Priority Level
Low
Medium
High

0 100
Feet

Imagery Source: Hennepin County 2022

Proposed Stream Restoration Site Areas
Reach 3
Plymouth Creek Stream Restoration Feasibility Study
BCWMC

FIGURE 5-3

BARR

Barr Foster ArcGISPro 3.1.5, 2024-05-29 21:48 File: I:\Client\Bassett\Creek\Work Orders\2023\Plymouth Creek Restoration Dunkirk Ln_36thAveN Feas Study\Maps\Report\Feasibility Study\Plymouth Creek Feasibility Report Figures\Plymouth Creek Feasibility Report Figure and Layout Figure 5-3 Reach 3 Proposed Stream Restoration Site Areas_User.mxd

Barr Foster ArcGISPro 3.1.5, 2024-05-29 16:21 File: I:\Client\Bassett\Creek\Work_Orders\2023\Plymouth_Creek_Restoration_Dunkirk\La_38thAve\N_Feas_Study\Maps\ReportFeasibility_Study\Plymouth Creek Feasibility Report Figures\Plymouth Creek Feasibility Report Figures.aprx Layout: Figure 5-4 Reach 4 Proposed Stream Restoration Site Areas User: MRO

REACH 3
REACH 4

Rockford Rd
Plymouth Blvd
40th Ave N
39th Ave
Orchid La
Niagara La
38th Ave
37th Ave

52+00
53+00
54+00
55+00
56+00
57+00
58+00
59+00
60+00
61+00
62+00
63+00
64+00
65+00
66+00
67+00
68+00
69+00
70+00

4a. Right and left bank stabilization with cross vanes, rock riffles, coir log, grading, and vegetation establishment (Sta. 53+00 to 56+75)

4b. Right and left bank stabilization with j-hooks and live staking (Sta. 56+75 to 58+60)

4c. Right and left bank stabilization with grading, rock toe, cross vanes, and plantings (Sta. 58+60 to 61+10)

4d. Right and left bank stabilization with riprap banks and live staking (Sta. 61+10 to 62+85)

4e. Right and left bank stabilization with coir log, j-hooks, cross vanes, and live staking (Sta. 62+85 to 65+00)

4f. Right and left bank stabilization with cross vanes, j-hook, and grading to remove accumulated sediment upstream of culverts (Sta. 65+00 to 67+70)

4g. Right and left bank stabilization with cross vane and grading (Sta. 68+50 to 70+00)

- Creek Stationing
- Significant Trees
- Bike and/or Pedestrian Trail
- Gravity Storm Sewer
- Sanitary Main
- Plymouth Creek
- Reach Breakline
- Parcel Boundary
- Public Parcel

Proposed Restoration
- Coir Log
- Cross-Vanes
- J-Hook
- Vanes

- Construction Access
- Grading
- Live Staking
- Plug Planting
- Rock Riprap
- VRSS

Priority Level
- Low
- Medium
- High

N

0 150
Feet

Imagery Source: Hennepin County 2022

Bassett Creek Watershed Management Commission

Proposed Stream Restoration Site Areas
Reach 4
Plymouth Creek Stream Restoration Feasibility Study
BCWMC
FIGURE 5-4

BARR

Table 5-2 Scoring Methodology for Stream Restoration Areas

Plymouth Prioritization Metric	Weight for Scoring
Severity of existing erosion	Varied based on Bank Erosion Hazard Index (BEHI) score. Moderate=1, High=2, Very high= 3
Creek ownership	3 points if construction occurs on city/public land, 2 points if public easement, and 1 point if private
Riparian ownership/access for stabilization	3 points if construction occurs on city/public land, 2 points if public easement, and 1 point if private
Riparian ownership/access for vegetation work	3 points if vegetation management occurs on city/public land, 2 points if public easement, and 1 point if private
Ease of construction access	3 points if the trail can be used, 2 points if public/city land can be used, 1 point if existing easement can be used, and no points if private land
Protection of existing structures/infrastructure (within 25 feet of streambank)	15 points if protecting sanitary sewer structures and 5 points if protecting other infrastructure such as the trail
Impact on surrounding areas	1 point if site requires minimal to no channel or bank grading
Potential for future erosion	Varied, based on summing BEHI and NBS values as described below. Moderate BEHI=1, High BEHI=2, Very high BEHI= 3, Very low NBS=1, Low NBS=2, Moderate NBS=3, High NBS= 4, Very high NBS=5, Extreme NBS=6
Opportunity for habitat creation or restoration	2 points if upland or stream habitat creation, based on stream restoration technique
Preservation of healthy trees, native significant trees	2 points if protecting significant trees
Vegetation establishment	2 points if vegetation establishment is part of stream restoration
Education potential	2 points if the proposed work could be viewed from the trail and 1 point if the proposed work is near the Plymouth Creek Elementary School

Specific details related to the exact locations of restoration and prioritization rankings are presented in Appendix C. Using the scoring criteria described above, each restoration area was given a ranking value of low, medium, or high, as shown below:

- Low: Score below 18
- Medium: Score between 18.1 and 31.9
- High: Score 32 and above

As a result of scoring and prioritization, the recommended restoration concept includes 6 high, 16 medium, and 4 low-priority restoration areas. If funding is available, the Commission Engineer recommends restoring all identified erosion areas. However, if costs for completing all of the restoration areas are prohibitive, the Commission Engineer recommends restoring areas based on their priority ranking. Estimated construction costs are presented in Section 7.1. Table 5-3 summarizes the restoration areas and proposed stabilization measures, the priority rankings for each restoration area, and the photo numbers for each restoration area (photos are in Appendix A).

Table 5-3 Proposed Restoration Areas (areas shown in Figure 5-1 through Figure 5-4)

Restoration Areas and Proposed Stabilization Measures	Priority	Photo numbers[1]
1a. Right and left bank stabilization with floodplain and channel realignment grading, rock toe, and vegetation establishment (Sta. 0+00 to 3+85)	High	1, 2
1b. Right and left bank stabilization with rock toe, plantings, and VRSS (Sta. 3+85 to 6+05)	High	3,4
1c. Right bank stabilization with grading and plantings (Sta. 6+05 to 7+05)	Medium	5
1d. Right bank stabilization with rock toe and VRSS (Sta. 7+05 to 8+90)	Medium	6,7
1e. Right and left bank stabilization with rock toe, VRSS, plantings and cross vane (Sta. 9+10 to 10+20)	Medium	8
1f. Right and left bank stabilization with coir logs, grading, and plantings (Sta. 10+20 to 13+55)	Medium	9, 10
1g. Right and left bank stabilization with channel realignment, cross vanes, and plantings (Sta. 13+55 to 15+35)	High	11, 12
1h. Right and left bank stabilization with rock toe, vegetation, and j-hooks (Sta. 15+35 to 18+30)	Medium	13, 14
2a. Right and left bank stabilization with rock toe, cross vanes, j-hook, and vegetation establishment (Sta. 18+70 to 21+00)	Medium	15, 16
2b. Grading to improve channel definition and improve settling capacity of basin (Sta. 21+00 to 23+30)	Low	17, 18
2c. Right and left bank stabilization with grading, rock toe, root wads, log vanes, and vegetation establishment (Sta. 23+40 to 25+40)	High	19, 20
2d. Right and left bank stabilization with grading, root wads, log vanes, woody debris removal, and vegetation establishment (Sta. 25+40 to 29+30)	Medium	21, 22
2e. Right and left bank stabilization with grading banks and side channels, log vanes, woody debris removal, and vegetation establishment (Sta. 29+30 to 33+90)	Medium	23, 24
2f. Right and left bank stabilization with grading, woody debris removal, log vanes, and vegetation establishment (Sta. 33+90 to 36+00)	Medium	25
3a. Grading to improve channel definition and remove accumulated sediment (Sta. 37+00 to 38+00)	Low	26
3b. Right and left bank vegetation management (Sta. 38+00 to 42+30)	Low	
3c. Right and left bank stabilization with cross vanes, j-hooks, and woody debris removal (Sta. 42+30 to 46+40)	High	27, 28
3d. Right and left bank stabilization with log vanes, plantings, and installation of riprap (Sta. 46+40 to 49+00)	Medium	29, 30
3e. Right and left bank vegetation management (Sta.49+00 to 51+50)	Low	
4a. Right and left bank stabilization with cross vanes, rock riffles, coir log, grading, and vegetation establishment (Sta. 53+00 to 56+75)	High	31, 32
4b. Right and left bank stabilization with j-hooks and live staking (Sta. 56+75 to 58+60)	Medium	33, 34
4c. Right and left bank stabilization with grading, rock toe, cross vanes, and plantings (Sta. 58+60 to 61+10)	Medium	35, 36
4d. Right and left bank stabilization with riprap banks and live staking (Sta. 61+10 to 62+85)	Medium	37
4e. Right and left bank stabilization with coir log, j-hooks, cross vanes, and live staking (Sta. 62+85 to 65+00)	Medium	38, 39

Restoration Areas and Proposed Stabilization Measures	Priority	Photo numbers[1]
4f. Right and left bank stabilization with cross vanes, j-hook, and grading (Sta. 65+00 to 67+70)	Medium	40, 41
4g. Right and left bank stabilization with cross vane and grading to remove accumulated sediment (Sta. 68+50 to 70+00)	Medium	42

1. Photos are in Appendix A
2. Right and left bank refer to looking downstream

Using the summary above, we developed three implementation options:

- Option 1: complete stream restoration solely in high-ranked areas.
- Option 2: complete stream restoration in high- and medium-ranked areas.
- Option 3: complete stream restoration in all 26 ranked areas.

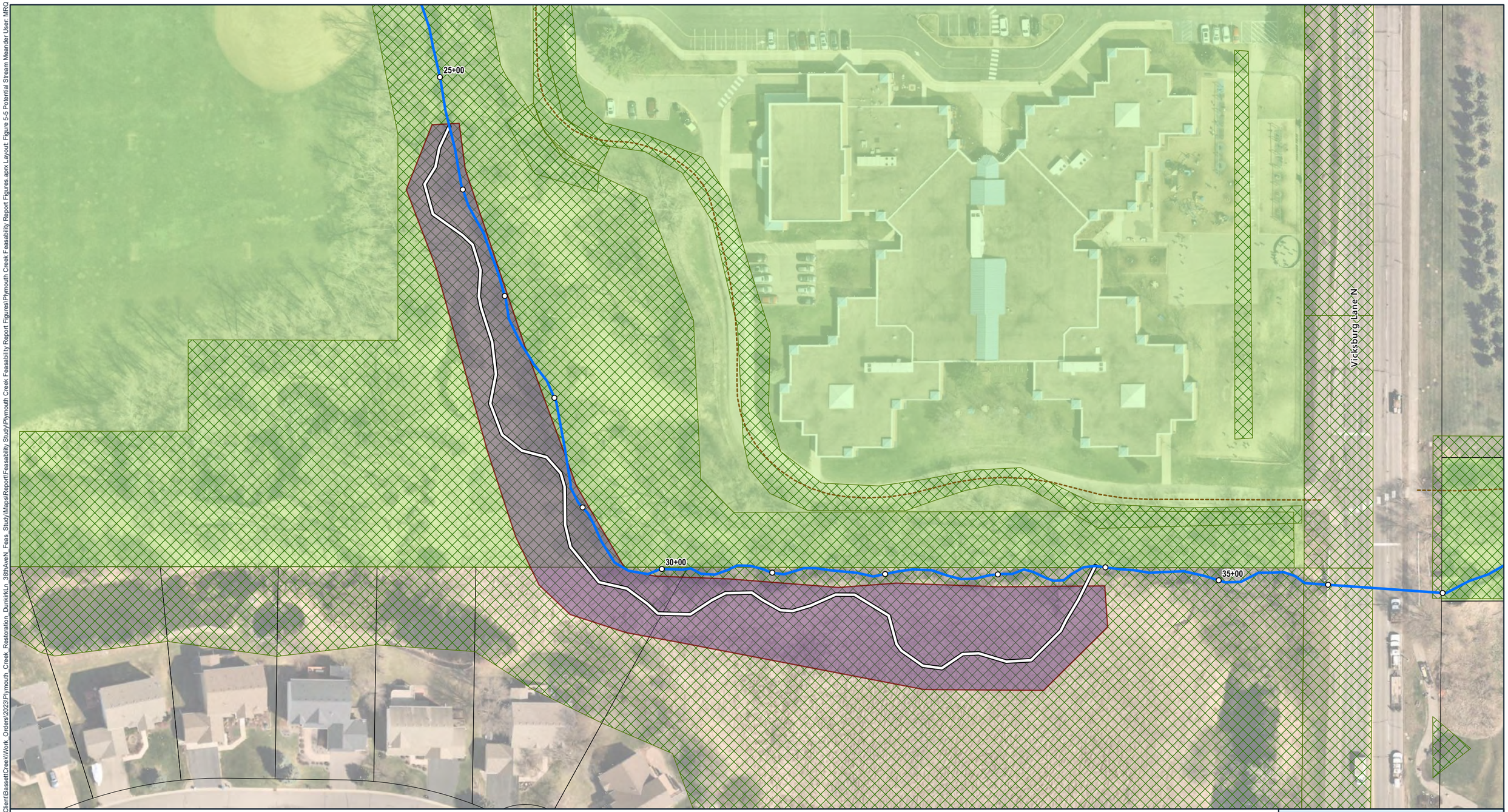
Option 1 primarily includes sites that have infrastructure at risk from erosion such as sanitary lines and the walking trail. Option 2 includes all of the Option 1 sites as well as additional sites with actively eroding banks that are contributing to total suspended solids and total phosphorus loading to stream. Option 3 includes all of the Option 1 and 2 sites along with proposed sediment removal (see Section 5.4), and additional areas of riparian vegetation management above the ordinary high water level.

5.3 Channel Meander

If funding allows, the Commission Engineer recommends an alternative to the proposed stream restoration described for areas 2d and 2e (near Plymouth Creek Elementary) in Table 5-3, to create a meandering channel as shown in Figure 5-5. In 1947, Plymouth Creek was ditched and straightened, possibly to improve access to agricultural fields. Natural channels are typically sinuous, and re-establishing a meandering pattern can be an important part of restoring a ditched and straightened stream. Potential benefits of a reestablishing a meandering pattern include:

- Increasing stream length and sinuosity
- Decreasing velocities and likelihood of bank erosion by allowing flows exceeding the bankfull event to spread out and disperse energy across the wider floodplain
- Increasing resiliency during higher flow storm events
- Enhancing in-stream, and riparian habitat
- Promoting groundwater connectivity if new channel bedding includes void spaces for sub-surface flow
- Enhancing geomorphic processes including sediment transport and deposition
- Enhancing floodplain connectivity if floodplain grading is incorporated into the design

Although reestablishing a meandering pattern could improve the stream as described above, the meander restoration alternative has a higher construction cost, which is discussed further in Section 7.



Potential Stream Meander
Plymouth Creek Stream Restoration Feasibility Study
BCWMC

FIGURE 5-5

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5.4 Sediment Removal

The City requested an evaluation of sediment accumulation and potential removal in three locations along the study reach:

- In the area upstream of the ballfields and downstream of Yuma Lane (approximate station 22+00 to 23+00)
- Downstream of Vicksburg Lane (approximate station 36+80 to 37+20)
- Downstream of 38th Avenue North (approximate station 68+70 to 69+20)

In addition to the three areas noted above, we noted three additional sediment accumulation zones during the site walk:

- Upstream of Rockford Road (approximate station 51+00 to 51+30)
- Downstream of Rockford Road (approximate station 53+00 to 53+40)
- Upstream of 38th Avenue North (approximate station 67+00 to 67+50)

Sediment has accumulated in each of these areas, likely related to reduced velocities in ponding areas upstream of culvert crossings and/or over-widening of the channel and associated reduced velocities downstream of culvert crossings.

Based on our review of the areas of accumulated sediment, we recommend removal of the sediment within 15 feet of the culverts in these two locations, as accumulated sediment partially impedes flow through culverts at these locations, and removal will allow the culverts to function at full capacity:

- Upstream of Rockford Road
- Upstream of 38th Avenue North

Removal of sediment at two historically-dredged locations identified in the restoration reach would alter what has become, effectively, a broad floodplain adjacent to the channel. The following well-vegetated deposition areas are functioning as floodplains for the channel (flood flows easily access these areas, velocities are reduced as water flows across floodplains, and sediment drops out in the floodplain). Removal of existing accumulated sediment would eliminate the functioning floodplain in these areas; therefore, we do not recommend removal in these locations:

- Upstream of the ballfields (station 22+00 to 23+00)
- Downstream of Vicksburg Lane (station 36+80 to 37+20)

Sediment accumulation is stable and vegetated at the following locations; therefore, we do not recommend removal:

- Downstream of Rockford Road
- Downstream of 38th Avenue North

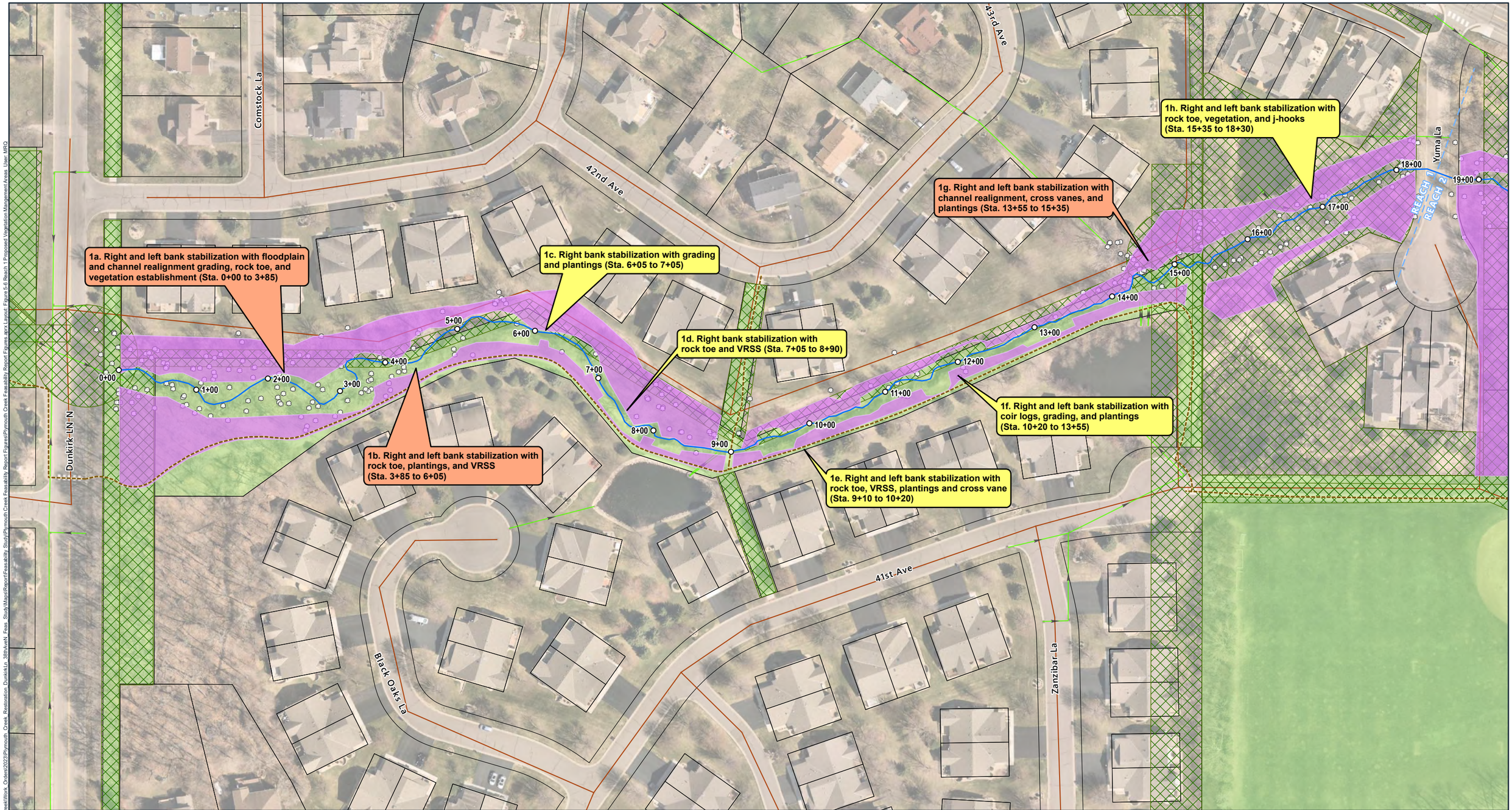
For this study, sediment removal is categorized as a low priority and included as a component of Option 3 only due to its minimal impact on water quality improvement.

5.5 Riparian Vegetation Management

The Commission Engineer proposes vegetation management for all options due to presence of buckthorn and other invasive species along the 7,000-foot reach. Vegetation management areas for the reach were defined starting from the top of streambanks to either mowed lawns or the biking/walking trail. The objective of the vegetation management areas is to remove unhealthy trees and invasive species and establish deep-rooting native trees, shrubs, sedges, grasses and forbs. Selective tree removals will open the tree canopy to allow understory vegetation to grow. Plantings and seeding will establish vegetation along the streambank and riparian area to stabilize bare soils and increase resistance to stream erosion while enhancing habitat and natural riparian function.

Riparian vegetation management adjacent to proposed in-stream and streambank restoration areas is a proposed component of every option in this feasibility study. Typically, the proposed vegetation management areas are 25 to 40 feet wide but can be as narrow as 15 feet and as wide as 80 feet. The vegetation management width changes due to the varying proximity of the creek to buildings and the bike/pedestrian trail Figure 5-6 through Figure 5-9.

According to the January 2023 BCWMC Requirements for Improvements and Development Proposals, a buffer is required for proposed projects along priority streams that will result in more than 200 yards of cut or fill, or more than 10,000 square feet of land disturbance. The stream buffer should be 10 feet wide or 25% of the distance between the ordinary high-water level (top of bank of the channel) and the nearest existing structure (impervious building or other object that is constructed or placed on the ground that is intended to remain in place for longer than a temporary period), whichever is less. Based on the locations of buildings along this section of Plymouth Creek, a 10-foot buffer would be required and can be provided as part of the proposed project.



Creek Stationing
Significant Trees
Bike and/or Pedestrian Trail
Gravity Storm Sewer
Sanitary Main
Plymouth Creek
Reach Breakline

Parcel Boundary
Public Parcel
Easements
Proposed Vegetation Management Area

Priority Level
Low
Medium
High

0 100
Feet

Imagery Source: Hennepin County 2022

Proposed Vegetation Management Areas
Reach 1
Plymouth Creek Stream Restoration Feasibility Study
BCWMC
FIGURE 5-6

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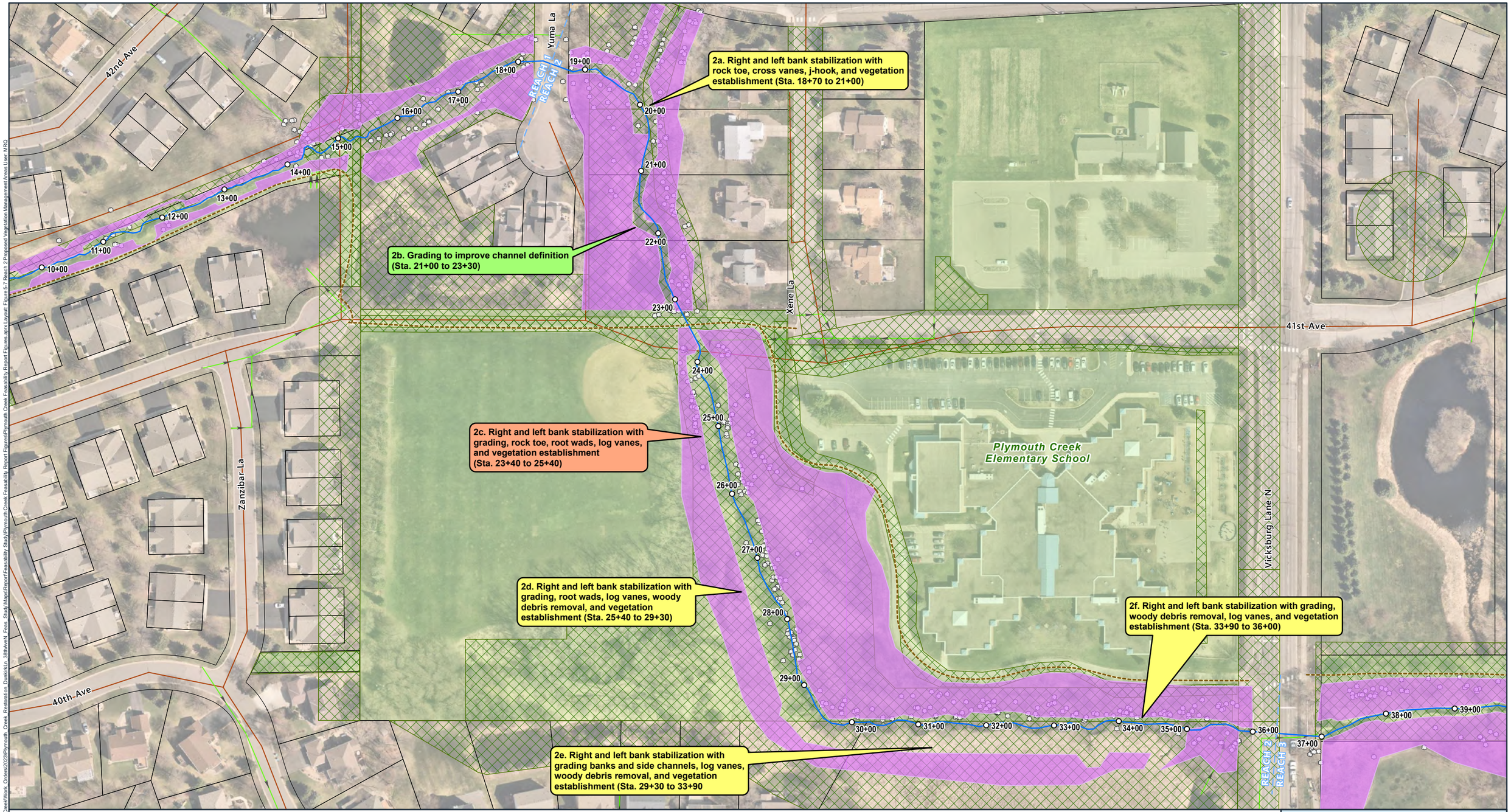

- Creek Stationing
- Significant Trees
- Bike and/or Pedestrian Trail
- Gravity Storm Sewer
- Sanitary Main
- Plymouth Creek
- Reach Breakline
- Parcel Boundary
- Public Parcel
- Easements
- Proposed Vegetation Management Area

Priority Level
- Low
- Medium
- High

0 150 Feet

Imagery Source: Hennepin County 2022

Proposed Vegetation Management Areas
Reach 2
Plymouth Creek Stream Restoration Feasibility Study
BCWMC
FIGURE 5-7

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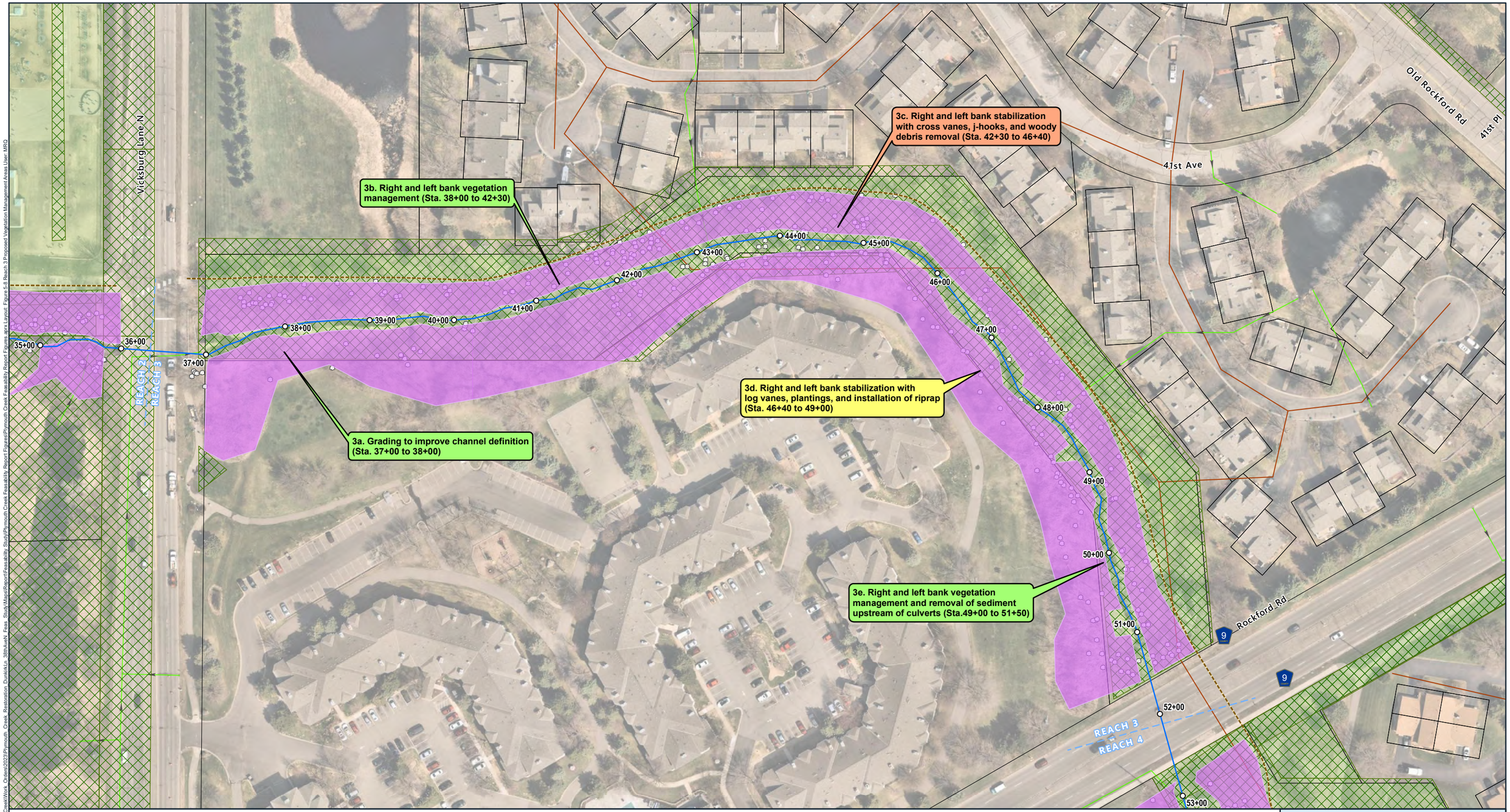

- Creek Stationing
- Significant Trees
- Bike and/or Pedestrian Trail
- Gravity Storm Sewer
- Sanitary Main
- Plymouth Creek
- Reach Breakline
- Parcel Boundary
- Public Parcel
- Easements
- Proposed Vegetation Management Area

Priority Level
- Low
- Medium
- High

0 100 Feet

Imagery Source: Hennepin County 2022

Proposed Vegetation Management Areas
Reach 3
Plymouth Creek Stream Restoration Feasibility Study
BCWMC

FIGURE 5-8

BARR

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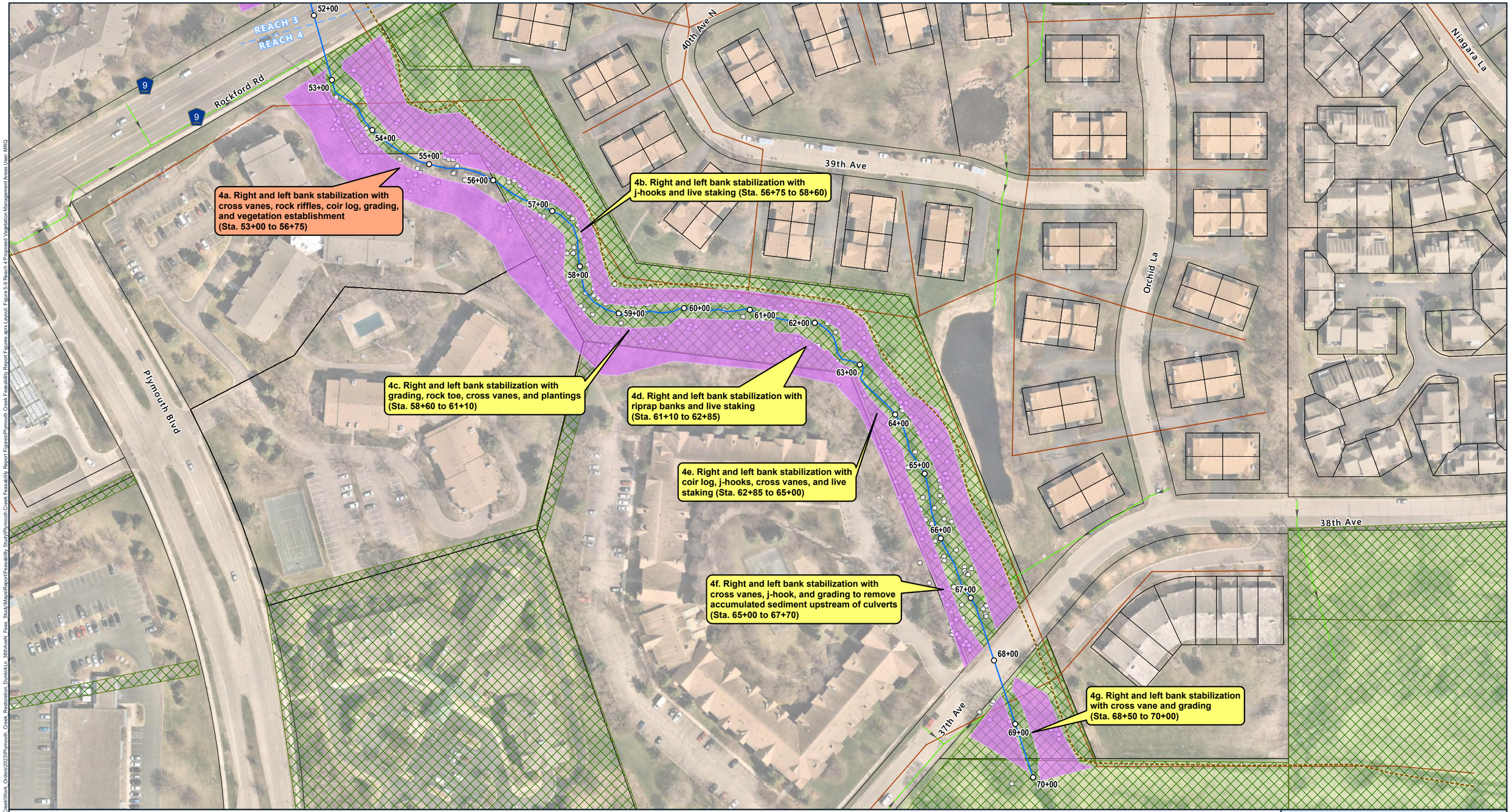

Creek Stationing
Significant Trees
Bike and/or Pedestrian Trail
Gravity Storm Sewer
Sanitary Main
Plymouth Creek
Reach Breakline

Parcel Boundary
Public Parcel
Proposed Vegetation Management Area

Priority Level
Low
Medium
High

0 150
Feet

Imagery Source: Hennepin County 2022

Proposed Vegetation Management Areas
Reach 4
Plymouth Creek Stream Restoration Feasibility Study
BCWMC
FIGURE 5-9

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6 Modeling Results and Potential Project Impacts

This section discusses the results of the hydrologic, hydraulic, and water quality modeling and provides information on potential project impacts, including permitting requirements.

6.1 Hydrologic, Hydraulic, and Water Quality Modeling

Hydrologic and hydraulic information is available for the approximately 7,000-foot reach. For this analysis, the Commission Engineer used the BCWMC 2021 XP-SWMM model, which is the most current version of the jurisdictional model. We used the model to evaluate the Atlas 14, 2-, 10-year, and 100-year, 24-hour design storm events to estimate flood elevations, flows, and velocities along the project reach. In addition to reviewing the hydrologic and hydraulic model results for the project area, we completed an analysis to estimate potential pollutant reductions for the proposed three options.

6.1.1 BCWMC XPSWMM Model Review

The Commission Engineer reviewed the XPSWMM model to understand the peak flow rates, velocities, and elevations throughout the project area. Table 6-1 summarizes the XPSWMM modeling locations along the project reach where model results showed velocities that exceeded 2 feet per second during the 2-, 10-, or 100-year 24-hour storm events. Velocities that exceed 2 feet per second are often associated with higher shear stresses that can impact the selection of the appropriate stream restoration techniques. For example, short native grasses are appropriate in areas with velocities up to 4 feet per second, coir logs can be used in areas with velocities up to 8 feet per second, and larger diameter riprap can be used in areas with velocities up to 12-16 feet per second.

Final design efforts will require additional refinements to the XP-SWMM modeling and a review of the final design water surface profile to ensure the project does not impact adjacent property and does not increase flood elevations. Similarly, the stream stability thresholds for the proposed features should be reviewed to ensure the final design will be stable. The constructed improvements should be incorporated into the next update of the BCWMC XP-SWMM model after project completion.

Table 6-1 Summary of BCWMC XPSWMM Model Results for Project Area under Existing Conditions

Station	2-year			10-year			100-year		
	Flow Rate (cubic feet per second)	Velocity (feet per second)	Flow Depth (feet)	Flow Rate (cubic feet per second)	Velocity (feet per second)	Flow Depth (feet)	Flow Rate (cubic feet per second)	Velocity (feet per second)	Flow Depth (feet)
0+05, downstream Dunkirk Lane culvert	46.2	2.1	1.8	56.2	2.1	2.0	144.8	2.1	3.3
2+25	46.2	4.4	2.1	56.2	4.7	2.2	144.8	5.3	3.3
4+90	46.2	4.0	3.5	56.2	4.3	3.9	144.8	5.3	5.4
6+20	46.2	1.6	3.5	56.2	1.8	4.0	144.8	2.7	5.4
7+35	46.3	1.2	3.5	56.3	1.4	4.0	144.9	2.3	5.3
8+60	51.5	1.4	3.4	65.9	1.6	3.9	145.6	2.6	5.1
13+50	59.4	2.7	3.0	79.2	2.9	3.4	103.8	3.1	4.0
18+00, upstream of Yuma Lane culvert	60.9	4.1	1.6	119.9	4.5	2.0	105.3	5.0	2.8
22+05, upstream pedestrian trail crossing near Plymouth Creek Elementary	53.4	2.0	2.8	85.1	2.6	3.3	206.3	5.8	4.8
30+05	53.4	2.1	3.3	85.8	2.4	3.9	206.2	3.2	4.4
34+50	72.7	2.3	3.9	135.2	2.2	5.1	312.2	2.2	7.5
35+50, upstream of Vicksburg Road culvert	90.2	1.2	4.5	170.3	2.2	5.6	397.0	5.1	7.5

Station	2-year			10-year			100-year		
	Flow Rate (cubic feet per second)	Velocity (feet per second)	Flow Depth (feet)	Flow Rate (cubic feet per second)	Velocity (feet per second)	Flow Depth (feet)	Flow Rate (cubic feet per second)	Velocity (feet per second)	Flow Depth (feet)
44+95	91.9	1.4	3.4	172.0	1.7	4.3	396.0	2.1	5.8
46+80	91.9	1.6	2.7	172.0	2.0	3.4	395.9	2.6	4.9
47+75	91.9	1.9	2.1	172.0	2.2	2.7	395.9	2.5	4.4
48+40	94.2	1.9	4.3	176.5	2.1	5.3	403.5	2.3	7.2
49+35	94.2	2.0	5.4	176.5	2.0	6.6	403.6	2.2	8.6
51+00, upstream of Rockford Road culvert	103.6	4.5	1.3	195.3	4.4	2.4	452.8	6.1	4.4
65+55, upstream of 37th Street culvert	124.7	3.4	0.3	249.5	2.1	1.4	559.4	4.7	3.8

6.1.2 Anticipated Pollutant Removals

The Commission Engineer estimated the pollutant (total phosphorus (TP) and total suspended solids (TSS)) removals that would result from the proposed Plymouth Creek Stream Restoration project using approaches developed by Rosgen et al. (3) and BWSR (16).

The proposed stabilization measures will result in reduced streambank erosion and, therefore, reduced sediment and phosphorus loading to Plymouth Creek and all downstream water bodies, including Medicine Lake, Bassett Creek, the Mississippi River and Lake Pepin. We estimated the existing streambank erosion rate (in units of feet per year) for each stabilization location based on a field assessment method known as the Bank Assessment for Non-Point Source Consequences of Sediment (BANCS) model (3)**.**

The BANCS model uses two erosion-estimation tools to develop risk ratings: Bank Erosion Hazard Index (BEHI) and near bank stress (NBS). The BEHI rating evaluates the susceptibility of a segment of streambank to erosion as a result of multiple processes: surface erosion, fluvial entrainment (movement of material that becomes suspended in the channel during high flows), and mass erosion (wasting). The NBS rating characterizes the energy distribution against a segment of streambank; disproportionate energy distribution in the near-bank region can accelerate bank erosion. The BEHI and NBS estimation tools are applied in a field assessment for each segment of streambank potentially contributing sediment to the stream channel. The Commission Engineer performed BEHI assessments for multiple segments of the Plymouth Creek project area during site visits in November 2023 and completed NBS ratings using aerial imagery from Google Earth dated 2018. Although it is not the newest aerial imagery, we used aerial imagery from 2018 because it provided the best imagery of the creek during leaf-off season.

The field-determined BEHI and NBS ratings for the Plymouth Creek project area are shown in Figure 2-1 and in tabular form in Appendix D. Approximately 16% of the eroding right banks (looking downstream) are in the moderate BEHI category, 66% are in the high BEHI category, and 18% are in the very high BEHI category. Approximately 35% of the left eroding banks (looking downstream) are in the moderate BEHI category, 51% are in the high BEHI category, and 14% are in the very high BEHI category. The majority of the right and left banks rated a very low NBS category, with only fourteen channel bends rated higher than a very low NBS category.

To convert BEHI and NBS ratings into a streambank erosion rate estimate, the BANCS model relies on measured bank erosion data to develop relationships applicable to various hydrologic and geologic conditions. No such relationship is currently available for Minnesota streambanks; this feasibility study uses bank erosion rates from the United States Department of Agriculture – Natural Resources Conservation Service (USDA-NRCS) (17) along with relationships developed from streambank erosion data collected in sedimentary and metamorphic geologic regions in North Carolina (18). Appendix D shows the estimated bank erosion rate for each stabilization location; estimated erosion rates range from 0.01 to 0.5 feet per year.

We calculated the estimated total sediment load from bank erosion using the approximate dimensions of the eroding streambanks at each restoration area. We estimated the impacts of the stabilization options on water quality based on the assumption that each stabilization measure successfully addresses erosion at the site and brings erosion to a low rate, representative of a stable stream in this geologic setting. For this analysis, we assumed a stable low erosion rate, which means there would be no change in NBS, and the BEHI erosion would be improved to half of the erosion rate of a moderate BEHI score. Appendix C shows the resulting estimated sediment load reduction for all proposed restoration areas. We calculated

the corresponding reduction of TSS and TP loads using an estimation tool developed by BWSR (16). The BWSR tool assumes that all eroded sediment becomes TSS, which is conservative because eroded sand and gravel are typically not suspended but transported as bedload. The BWSR tool also assumes that the TP load is equivalent to 1.0 pound of TP per ton of eroded sediment.

The total reduction in pollutant loading resulting from stabilization depends on the total linear feet of channel stabilization. Pollutant reduction estimates are not impacted by the amount of sediment removed nor invasive vegetation management. Table 6-2 summarizes the pollutant loading reduction estimates based on the approximate length of restoration. Option 2 and Option 3 have the same estimated pollutant reductions because the options repair the same length of eroding streambank. Option 3 has 1,160 more feet of restored stream length, but this includes banks that are solely restored with sediment removal and additional riparian vegetation management. The sediment removal and additional riparian vegetation management are not expected to reduce pollutant reductions because the work does not directly repair an eroding streambank, but will benefit habitat and enhance long-term stability of the reach.

Table 6-2 Pollutant Reduction Estimates by Proposed Option

Restoration Length, by Option	Total Suspended Solids Reduction (lb/yr)	Total Phosphorus Reduction (lb/yr)
Option 1: 2,800 linear feet[1] – High priority areas only	87,310	43.6
Option 1a: 4,205 linear feet[1] – High priority with meander	170,510	85.2
Option 2: 8,715 linear feet[1] – High and medium priority areas (same reductions with meander)	296,720	148.4
Option 3: 9,875 linear feet[1] – High, medium, and low priority areas (same reductions with meander)	296,720[2]	148.4[2]

[1]Linear feet = sum of right and left bank that is repaired
[2]The Commission Engineer assumes that sediment removal will not increase pollutant reductions.

6.2 Easement Acquisition

In general, most of the project reach is adjacent to the City of Plymouth bike/pedestrian trail, public land, and existing easements that can be used for construction of the stream restoration and construction access. However, there are multiple proposed construction locations that will require new easements. Temporary easements may be required in Reach 1 because there is minimal separation between the creek and the edge of existing easements and/or private parcel boundaries from station 3+00 to 12+00. Therefore, coordination with residents will be required for construction access and temporary construction easement acquisition in these areas. Also, permanent easements may need to be acquired for other restoration areas due to proposed channel work or riparian work occurring outside of publicly owned land or existing easements. Lastly, temporary or permanent easements may be required for vegetation management areas adjacent to the creek. Table 6-3 summarizes the length of easements required by design option and type of easement required.

Table 6-3 Summary of New Easements Required per Design Option

Design Option	Length of Permanent Easement for Stream Work (Channel or Riparian)	Length of Temporary Easement for Construction Access	Length of Temporary Easement for Vegetation Management	Total Length of Easement
Option 1	250	395	904	1,549
Option 2, without meander	250	806	2,412	3,468
Option 3, without meander	250	806	3,105	4,161
Meander	0	0	0	0

6.3 Permits Required for the Proposed Project

The proposed project is expected to require the following permits/approvals, regardless of the selected concept:

- Clean Water Act Section 404 and Section 401 Water Quality Certification
- Construction Stormwater General Permit from the MPCA
- Compliance with the Minnesota Wetland Conservation Act
- Environmental Assessment Worksheet (potentially required, see paragraph 6.3.4 for more detail)
- Public Waters Work Permit from the MnDNR
- Compliance with BCWMC requirements

6.3.1 Section 401 and 404 Permit

The USACE regulates the placement of fill into wetlands if they are hydrologically connected to a Water of the United States (WOTUS) in accordance with Section 404 of the Clean Water Act (CWA). The MPCA may be involved in wetland mitigation requirements as part of the CWA Section 401 water quality certification process for the 404 Permit. A joint state and federal application for a Section 404 Permit and a Section 401 Certification should be filed and submitted to the MPCA and the USACE.

Section 401 of the Clean Water Act ensures that the federal government does not issue a permit or license for a project that will result in a violation of the state water quality standards set under WOTUS. Minnesota requires a federal Section 404 permit when a project impacts a WOTUS. The MPCA will then review the project under Section 401 against their own water quality standards for that body of water. A 404 permit cannot be issued until the MPCA has either certified that the project impacting WOTUS will comply with the state water quality standards, or they have waived their review of the project. The BCWMC developed its Resource Management Plan (RMP) with the goal of completing a conceptual-level USACE permitting process for proposed projects. The RMP was submitted to the USACE in April 2009 and revised in July 2009. This feasibility study follows the protocols for projects within the BCWMC RMP.

The USACE Section 404 permit requires a Section 106 review for historic and cultural resources. The results of the archaeological reconnaissance study are included in Section 3.5. If the State Historic Preservation Office (SHPO) requests more detailed information, a Phase I Archaeological Survey may need to be completed. A Phase I Archaeological Survey can be completed in 45 days or less during a

frost-free period. Past project experience indicates that the Section 404 permit review and approval process could require 120 days to complete. These projects may fit under the USACE Nationwide Permit 13 for bank stabilization or Nationwide Permit 27 for restoration, a Regional General Permit, or may require an individual permit. Verification of the USACE Nationwide Permit requirements and comparison to the proposed project features/impacts will be necessary during the project design phase to determine which permit is most applicable. Coordination with the USACE will help to confirm specific requirements related to the project.

6.3.2 Minnesota Pollution Control Agency (MPCA) Permits

Construction of the proposed project will require a National Pollutant Discharge Elimination System/State Disposal System Construction Stormwater (CSW) General Permit issued by the MPCA. The CSW permit will require the preparation of a SWPPP that explains how stormwater will be controlled within the project area during construction.

Based on the findings of our desktop review of the MPCA's "What's In My Neighborhood?" database (see Section 3.6), we do not anticipate that environmental impacts such as contaminated soil and debris will be encountered during stream restoration activities; therefore, we do not anticipate that the project. will require minimization measures for disposing of contaminated soil. In the unlikely event that environmental impacts are encountered during the creek restoration earthwork, contaminated materials will need to be handled and managed appropriately. The response to the discovery of contamination typically includes entering the MPCA's voluntary program. A construction contingency plan could be prepared for the project, in accordance with MPCA guidance. This would include specifying initial procedures for handling potentially impacted materials, collecting analytical samples, and working with the MPCA to determine a method for managing impacted materials.

6.3.3 Minnesota Wetland Conservation Act

The Minnesota Wetland Conservation Act (WCA) regulates the filling and draining of wetlands and excavation within Type 3, 4, and 5 wetlands—and may regulate any other wetland type if fill is proposed. The WCA is administered by local government units (LGUs), which include cities, counties, watershed management organizations, soil and water conservation districts, and townships. The City of Plymouth is the LGU for the entire project area. The Minnesota Board of Water and Soil Resources (BWSR) oversees administration of the WCA statewide.

As described in Minnesota rules 8420, the WCA is applicable to the types of wetland impacts that could result from this project, and a permit related to wetland impacts may be required; however, the LGU will have the final determination.

6.3.4 Environmental Assessment Worksheet

The Minnesota Environmental Policy Act of 1973 (MEPA) established the Environmental Quality Board (EQB), which oversees the formal environmental review process for the state of Minnesota. An Environmental Assessment Worksheet (EAW) is a screening tool used to determine whether a full environmental impact statement is needed. Minnesota Rules 4410.4300 (Mandatory EAW Categories) identifies triggers that would require a project proposer to prepare an EAW. Minnesota Rules 4410.4300 Subp. 27A requires an EAW for projects that will change or diminish the course, current, or cross-section of one acre or more of any public water or public waters wetland. For this mandatory EAW category, the responsible government unit (RGU) would be the MnDNR or the LGU for the project. If an EAW is

required for the project, the MnDNR will require completion of the EAW before they would issue a Public Waters Work Permit for the project.

During the final design, it will be important to keep track of the size of the disturbance footprint below the ordinary high water level. The proposed meander addition would alter roughly 0.5 acre of a public water (Bassett Creek) by shifting the channel into a new footprint and the proposed sediment removal would alter 0.33 acre of a public water. Based on current high-level estimates commensurate with this conceptual phase of the project, an EAW would likely be required if Option 3a is selected (all proposed restoration areas, plus the meander and sediment removal). Options 3, 2, 2a and 1 are unlikely to reach the disturbance threshold of one acre or more that would trigger the need for an EAW.

6.3.5 Public Waters Work Permit

The MnDNR regulates projects constructed below the ordinary high water level of public waters, watercourses, or wetlands, which alter the course, current, or cross-section of the waterbody. Public waters regulated by the MnDNR are identified on published public water inventory (PWI) maps. Plymouth Creek is a public watercourse, so the proposed work will require a MnDNR public waters work permit.

6.3.6 BCWMC Requirements

The proposed project includes work in the BCWMC 100-year floodplain; therefore, the proposed project must adhere to the BCWMC's floodplain requirements. Due to the nature of the proposed work, the main requirements from the BCWMC are that:

- the project must maintain no net loss in floodplain storage, and
- no increase in flood level at any point along the trunk system.

The flood levels for the BCWMC are managed to a precision of 0.00 feet.

If the proposed project disturbs more than one acre of land, the BCWMC erosion and sediment requirements must also be met and reviewed for compliance. The BCWMC erosion and sediment control specifics are outlined in the January 2023 BCWMC Requirements for Improvements and Development Proposals.

6.4 Other Impacts

6.4.1 Tree Loss

The estimated removals of healthy trees resulting from the implementation of the proposed project depend on the proposed restoration length (i.e., which design option is selected). Appendix E includes a summary of the estimated healthy tree removal by species. The tree removal estimates resulting from grading or construction access for each stream restoration option are:

- Option 1: 107 total trees, 35 of which are not buckthorn, box elder, green ash, or Siberian elm (species that are invasive or prone to disease or infestation).
- Option 2: 233 total trees, 75 of which are not buckthorn, box elder, green ash, or Siberian elm (species that are invasive or prone to disease or infestation).
- Option 2a (with meander): 193 total trees, 67 of which are not buckthorn, box elder, green ash, or Siberian elm (species that are invasive or prone to disease or infestation).

- Option 3: 248 total trees, 76 of which are not buckthorn, box elder, green ash, or Siberian elm (species that are invasive or prone to disease or infestation).
- Option 3a (with meander): 208 total trees, 68 of which are not buckthorn, box elder, green ash, or Siberian elm (species that are invasive or prone to disease or infestation).

The number of trees removed could be reduced during design and construction by modifying construction access points and bank grading to protect trees. In addition to the tree removal estimates above, the proposed restoration work would include the removal of dead and dying trees and the removal of additional trees, such as buckthorn, as part of the invasive species management. As a result, the cost estimates presented in Section 7 include a higher number of tree removals than listed above.

6.4.2 Water Quality Impacts

The proposed stabilization measures will result in a reduction of the sediment and phosphorus loading to Plymouth Creek and all downstream water bodies, including Medicine Lake. We estimated total suspended sediment and total phosphorus loadings prior to and after stabilization using BEHI and NBS ratings from the field, described in further detail in Section 6.1.2.

6.4.3 Utility Considerations

One of the important considerations for implementing this stream restoration project is the stream's proximity to infrastructure, such as sanitary and storm sewer lines. Throughout the 7,000-foot reach, sanitary lines are present, crossing the creek channel and running along creek banks. If a sanitary line were to break, there is the potential for a release of sewage into the creek, which would drastically decrease the creek's water quality. Throughout the reach, grade control structures (cross vanes) are proposed to maintain cover over sanitary lines at all crossing locations.

7 Cost Considerations

7.1 Opinion of Cost

The Commission Engineer's cost estimate is a Class 4 feasibility-level cost estimate as defined by the American Association of Cost Engineers International (AACE International) and includes the assumptions listed below and detailed in the following sections.

- The cost estimate assumes a 20% construction contingency.
- Costs associated with design, permitting, and construction observation (collectively "engineering") are assumed to be 30% of the estimated construction costs (excluding contingency).
- Construction easements may be necessary to construct the project.; however, the costs were not estimated as part of this study
- Additional work may be required to determine if cultural and/or historical resources are present at any project site.

The Class 4 level cost estimates have an acceptable range of between -15% to -30% on the low range and +20% to +50% on the high range (19). Based on the development of concepts and initial vetting of the concepts by the City of Plymouth, BCWMC, and MnDNR, it is not necessary to use the full acceptable range for the cost estimate. We assume the final costs of construction may range between -15% and +30% of the estimated construction budget. The assumed contingency for the project (20%) incorporates the potential high end of the cost estimate range.

Table 7-1 summarizes the feasibility-level total construction cost estimates, the 30-year annualized total construction cost estimates, and the annualized costs per pound of TSS and TP removed for the Plymouth Creek Stream Restoration Project. Table 7-1 presents the cost for each of the prioritized preferred options described in Section 5.2. Appendix F provides detailed cost-estimate tables for each option.

Table 7-1 Plymouth Creek Stream Restoration Options Cost Summary

Option Description	Cost Estimate[1,4]	Annualized Cost[2]	TP Loading		TSS Loading	
			Load Reduction (lb/yr)	Cost/lb/yr Reduced[3]	Load Reduction (lb/yr)	Cost/lb/yr Reduced[3]
Option 1. High-ranked restoration areas	$726,000 ($581,000–$944,000)	$50,000	43.6	$1,163	87,310	$0.57
Option 2. High- and medium-ranked restoration areas	$2,066,000 ($1,653,000–$2,686,000)	$145,000	148.4	$977	296,720	$0.49
Option 3. All proposed restoration areas	$2,196,000 ($1,757,000–$2,855,000)	$156,000	148.4	$1,051	296,720	$0.53
Option 1a. High-ranked restoration area + meander	$1,369,000 ($1,096,000-$1,780,000)	$88,000	85.2	$1,033	170,510	$0.52
Option 2a. High- and medium-ranked restoration areas + meander	$2,360,000 ($1,888,000-$3,068,000)	$162,000	148.4	$1,092	296,720	$0.55
Option 3a. All proposed restoration areas + meander	$2,420,000 ($1,936,000-$3,146,000)	$170,000	148.4	$1,146	296,720	$0.57

(1) A Class 4 screening-level opinion of probable cost, as defined by the American Association of Cost Engineers International (AACE International), has been prepared for these options. The opinion of probable construction cost provided in this table is based on the Commission Engineer's experience and qualifications and represents our best judgment as experienced and qualified professionals familiar with the project. The cost opinion is based on project-related information available to the Commission Engineer at this time and includes a conceptual-level design of the project. It includes 20% project contingency and 30% for planning, engineering, design, and construction administration. The lower bound is assumed at -15%, and the upper bound is assumed at +30%.
(2) Assumed to be 15% of the total project cost for annual maintenance, plus replacement cost associated with major repairs and the initial project cost distributed evenly over a 30-year project lifespan.
(3) Annualized cost divided by estimated annual pollution load reduction.
(4) Costs do not include easements or construction access routes

7.2 Funding Sources

The BCWMC will use its CIP funds to implement this project. The source of these funds is an ad valorem tax levied by Hennepin County over the entire Bassett Creek watershed on behalf of the BCWMC. The BCWMC CIP currently includes $2 million earmarked for this project. In addition to BCWMC CIP funds, the City of Plymouth and the BCWMC plan to seek out grant opportunities to assist with funding the project.

7.3 Schedule

The BCWMC will hold a public hearing for this project in September 2024. Pending the outcome of the hearing, the BCWMC will consider officially ordering the project, entering into an agreement with the City of Plymouth to design and construct the project, and certifying to Hennepin County a final 2025 tax levy

for this project. As an alternative, the BCWMC could design and construct the project instead of entering into an agreement with the City of Plymouth for the design and construction phase.

The construction work would likely begin in winter 2025/2026, as tree removal should occur in the period from October 15 to early April, outside of the northern long-eared bat's active season (mid-April – October 14). Additionally, excavation during the winter would be appropriate to complete the major earthwork during periods with less frequent runoff events. Construction could potentially continue in winter 2026/2027. Final restoration would be completed either in the spring/summer of 2026 or spring/summer 2027, pending the progress of winter construction.

For project construction to begin winter of 2025/2026, project design should occur the winter of 2024/2025 to spring of 2025. If project construction is scheduled for winter 2025/2026, summer 2025 bidding is recommended. This will give contractors adequate scheduling time to complete the project at a reasonable price. In the intervening time, the City (or the BCWMC if the Commission decides to design and construct the project) would gather public input, prepare the final design, and obtain permits.

8 Recommended Option

The Commission Engineer recommends implementing Option 3—completing restoration in all high, medium, and low priority areas, plus sediment removal. If funding allows, the channel meander alternative could also be included as part of the restoration project. Because Option 1 does not include restoration of the stream between stations 25+00 and 34+00, the cost of the construction of a new meander in this vicinity would be a stand-alone increase of $600,000 (including planning, design, engineering, permitting, and construction) beyond the base cost of Option 1. Installation of the new channel meander would increase the cost of Option 2 and Option 3 by approximately $300,000 because these options already include work in the area of the new meander section. All three options, including sub-options with the new meander include using a combination of stream stabilization methods discussed in Section 5.2. The three options for restoration are based on a low, medium, and high prioritization ranking of restoration areas. The high priority areas are included in Option 1, the medium and high priority areas are included in Option 2, and all of the restoration areas are included in Option 3, including removal of sediment upstream of Rockford Road and upstream of 38th Avenue North. Restoration areas were prioritized based on criteria developed for the Bassett Creek Main Stem Restoration feasibility study and modified for this project by City of Plymouth staff and the Commission Engineer (see Section 5.2). All three options would effectively stabilize eroding banks, contribute to habitat improvements, reduce the chance of potential future erosion, and protect existing infrastructure. Section 7.1 summarizes the costs of the three prioritized recommended concepts. The recommended option (Option 3) comes at a higher cost than the other options. Therefore, if funding is not available and a lower-cost project is desired, we recommend implementing (at a minimum) Option 1—completing high-priority areas—and completing medium- to low-ranked areas as budget allows.

Our recommendation also considers the economies of scale, and the ease of performing the work at all sites at once (permitting, public outreach, single contractor).

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