White Bear Township Polar Lakes Park Water Reuse Feasibility Study

Prepared for
Vadnais Lake Area Water Management Organization

March 2024

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Certification

ENGINEER 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.

3/14/2024

Jennifer A. Koehler, PE
PE #: 47500

Date

Polar Lakes Park Water Reuse Feasibility Study

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Contents

List of Tables

List of Figures

List of Appendices

Abbreviations

BWSR	Board of Soils and Water Resources
ft	feet
GIS	geographic information system
GPM	gallons per minute
LGU	local government unit
MCES	Metropolitan Council Environmental Services
MnDNR	Minnesota Department of Natural Resources
MPCA	Minnesota Pollution Control Agency
MSL	mean sea level
MWMO	Mississippi Watershed Management Organization
NWL	normal water level
PSI	pound per square inch
RCP	reinforced-concrete pipe
SSURGO	soil survey geographic database
TMDL	total maximum daily load
TP	total phosphorus
TSS	total suspended solids
USACE	United States Army Corps of Engineers
UV	ultraviolet
VLAWMO	Vadnais Lakes Area Watershed Management Organization
WCA	Wetland Conservation Act

1 Introduction

Polar Lakes Park is an approximately 50-acre public park in White Bear Township located off Interstate I-35E in the Vadnais Lakes Area Watershed Management Organization (VLAWMO). The park was constructed in 2000 and includes numerous athletic fields, including baseball/softball (lower) and soccer (upper) fields. Several stormwater ponds and mitigation wetlands are within the park boundary, including a two-basin mitigation wetland system in the park's southwest corner. This basin conveys runoff from a significant watershed (~677 acres), including discharges from upstream Birch Lake and a portion of the township that drains through a wetland complex in Rotary Park just east of the lower baseball/softball fields.

Figure 1-1 shows the Polar Lakes Park and potential watershed areas. Flows through Polar Lakes Park ultimately drain to Wilkinson Lake via a private ditch. Wilkinson Lake is impaired for nutrients, and a TMDL was completed in August 2013. There is a required wasteload reduction of 561 pounds of total phosphorus (TP)/year from Wilkinson Lake drainage areas (or a 76% reduction in watershed loads).

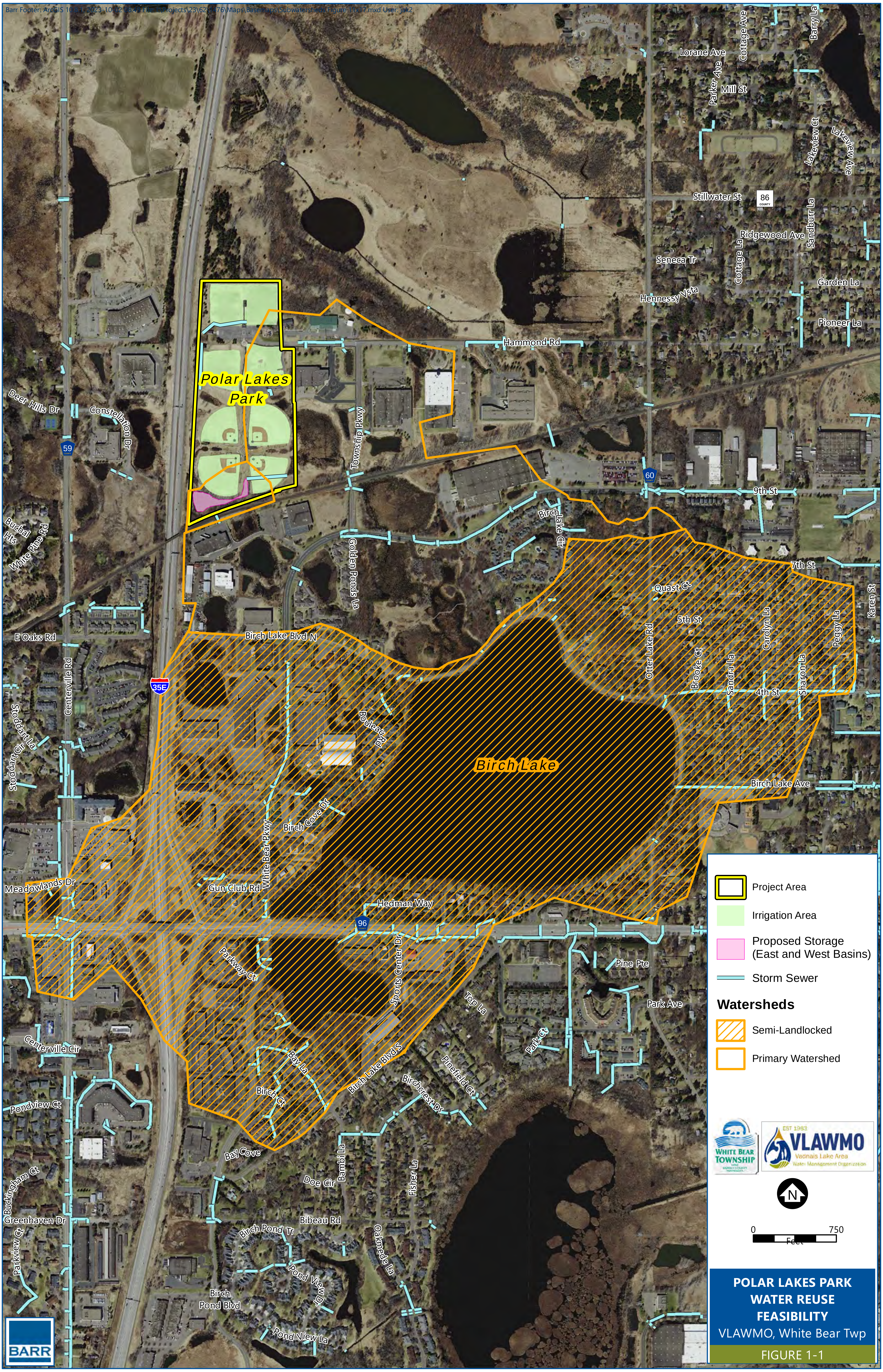
Additionally, Polar Lakes Park is within the Minnesota Department of Natural Resources (MnDNR) North and East Metro Groundwater Management Area, and because it is within 5 miles of White Bear Lake, it can be subject to MnDNR appropriations use restrictions. The athletic fields at Polar Lakes Park are currently irrigated by the township's potable water system. Because the potable water system relies on groundwater as the water supply source, it can be subject to use restrictions.

The purpose of this feasibility study was to determine the extent to which the constructed (mitigation) wetland basins in the southwest corner of the park site could be used to support the irrigation of the athletic fields rather than relying entirely on groundwater for irrigation purposes.

The project was completed in four tasks:

- Task 1 – Collect data and review existing information
- Task 2 – Develop the water reuse project concepts and planning level cost estimates
- Task 3 – Develop the feasibility report
- Task 4 – Present the feasibility report to VLAWMO and the White Bear Township Board

VLAWMO and White Bear Township will use the results of this study to determine if they would like to implement a water reuse project for irrigation within Polar Lakes Park.



Polar Lakes Park
Birch Lake
Project Area
Irrigation Area
Proposed Storage (East and West Basins)
Storm Sewer
Watersheds
Semi-Landlocked
Primary Watershed
WHITE BEAR TOWNSHIP
EST 1983 VLAWMO
Vadnais Lake Area Water Management Organization
N
0
750
Feet
POLAR LAKES PARK WATER REUSE FEASIBILITY
VLAWMO, White Bear Twp
FIGURE 1-1
BARR
Lorane Ave
Cottage Ave
Barry La
Parker Ave
Mill St
Lakeview Ct
Lakeview Ave
Stillwater St
86
Sandburr La
Ridgewood Ave
Cottage La
Seneca Tr
Garden La
Hennessy Vista
Pioneer La
Hammond Rd
Deer Hills Dr
Constellation Dr
59
Township Pkwy
60
9th St
Birch Lake Cir
Golden Ponds La
7th St
Quast Ct
Buchal Hts
White Pine Rd
5th St
Karen St
E Oaks Rd
Centerville Rd
Birch Lake Blvd N
Otter Lake Rd
Brooke Ct
Sandra La
Carolyn La
Sharon La
Peggy La
4th St
35E
Stoddart Ct
Stoddart La
Bonfield Rd
Birch Lake Ave
Birch Cove Dr
White Bear Pkwy
Meadowlands Dr
Gun Club Rd
Hedman Way
96
Parkway Ct
Sports Center Dr
Pine Pte
Top La
Park Ave
Park Ct
Centerville Cir
Bay La
Pinefield Ct
Birch Lake Blvd S
Birchcrest Dr
Birch Ct
Pondview Ct
Bay Cove
Bambi La
Fisher La
Doe Cir
Buckingham Ct
Greenhaven Dr
Bibeau Rd
Birch Pond Tr
Oakmede La
Parkview Ct
Pond View Ct
Birch Pond Blvd
Pond View La

2 Data Collection and Review

The data collection and review task included the following:

- Reviewing construction and grading plans and irrigation information for both the upper and lower systems
- Reviewing MnDNR appropriations/irrigation use data and estimate of irrigation rates
- Summarizing existing irrigation system pumping rates
- Reviewing and revising the most current GIS watershed/subwatershed data
- Compiling flow data to assess baseflows into the system, including reviewing Birch Lake water level data
- Reviewing water quality monitoring data for Birch Lake and grab samples from the mitigation wetland in Polar Lakes Park
- Installing piezometers to understand shallow groundwater interaction at the mitigation wetland

2.1 Existing Irrigation System

Based on data provided by White Bear Township from 2018–2021/2022, Polar Lakes Park has two separate irrigation systems: one that irrigates the lower fields (baseball/softball) and one that irrigates the upper fields (soccer). The lower irrigation area is approximately 8.95 acres, and the upper irrigation area is approximately 9.92 acres, with a total combined area of 18.87 acres. The lower irrigation system uses between 0.6 and 3.0 million gallons a year. The upper irrigation system uses between 1.0 and 3.0 million gallons a year. Each irrigation system has a booster pump that supplies irrigation flows at a pressure of 80 pounds per square inch (psi) with a flow rate of ~58 gallons per minute (gpm). If the two irrigation systems (upper and lower fields) were operating simultaneously and drawing from the same source of water, the combined flow rate would be ~120 gpm at 80 psi. The existing irrigation system includes smart controllers that operate off predicted rainfall (but do not operate off of measured soil moisture conditions).

The irrigation areas are shown in Figure 1-1. Weekly irrigation rates were calculated by dividing the total irrigation volume by the irrigation area and then dividing by a total of 22 weeks, the typical irrigation season (May 1–September 30). A summary of the minimum, average, and maximum weekly irrigation rates broken down by upper, lower, and upper and lower areas combined are summarized in Table 2-1.

Table 2-1 Existing Irrigation System Summary

	Total Water Use (MGY)	Total (Lower + Upper Fields) (Inches/Week)	Lower Field Water Use (MGY)	Lower Fields (Inches/Week)	Upper Field Water Use (MGY)	Upper Fields (Inches/Week)
Min	2.72	0.24	0.62	0.12	1.04	0.18
Average	3.76	0.34	1.94	0.36	2.08	0.35
Max	5.37	0.48	2.98	0.52	3.04	0.52

2.2 Birch Lake Water Level Analysis

Historical water levels in Birch Lake provided by the MnDNR and VLAWMO were examined to determine how frequently the lake discharges and contributes flows to the constructed wetlands within Polar Lakes Park. Lake level data are available from 1930 through 2023. A review of the data and the outlet control elevation provided by VLAWMO staff indicated that Birch Lake water levels are above the invert and discharging downstream only 37% of the time (Figure 2-1). As a result, Birch Lake would not be a constant water source for the southwest wetland basins; however, when discharging, it can provide significant volumes of water to the wetlands.

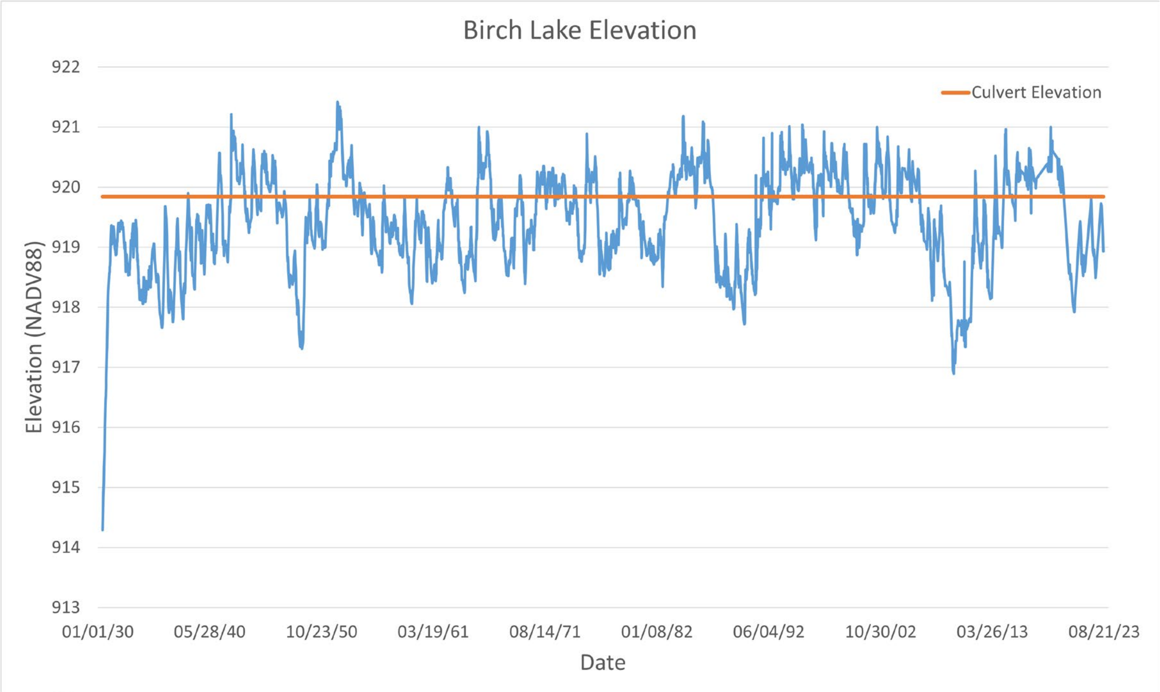


Figure 2-1 Birch Lake Water Levels (1930-2023)

2.3 Subwatersheds

The original watershed divides for the project area were provided by the VLAWMO. These watersheds were refined around the Polar Lakes Park area based on a review of the MnDNR 2011 LiDAR data, park construction plans, and available storm sewer data.

The watershed area downstream of Birch Lake is 178 acres and is the largest source of consistent runoff to the wetlands in the southwest corner of the park. The Birch Lake watershed has an additional 499 acres and is considered semi-landlocked since the lakes only discharge 37% of the time. The entire watershed area, including the Birch Lake watershed, is 677 acres (Figure 1-1).

For each subwatershed, we estimated the percent of imperviousness by using the 2015 Ramsey County imperviousness dataset. Additionally, the dominant hydrologic soils group was analyzed for the subwatersheds using SSURGO hydrologic soil groups. This information was used to estimate runoff generation from the watershed and water supply for reuse.

2.4 Water Quality Data

VLAWMO collected water quality grab samples on the following dates:

- June 7, 2023
- June 26, 2023.
- July 20, 2023 and
- September 6, 2023.

These were tested for alkalinity, boron, calcium, chloride, chlorophyll-*a*, E.coli bacteria, iron, magnesium, manganese, nitrogen, orthophosphate, sodium, and turbidity to identify any general or health-related concerns (e.g., bacteria) about using water for irrigation of turf/athletic fields.

Chloride measurements ranged from 135 mg/L to 159 mg/L. These levels are below the MPCA chronic and acute chloride standards (230 mg/L and 860 mg/L, respectively). According to the Penn State Irrigation Water Quality Guidelines (Landschoot, 2016), turfgrasses are not particularly sensitive to chloride. They can tolerate levels up to 100 mg/L but sustain injury when irrigated with water containing >355 mg/L of chloride. Some ornamental plants are sensitive to chloride concentrations above 70 mg/L.

Township staff confirmed that the irrigation area is primarily comprised of Kentucky Bluegrass and research has suggested that this is a salt tolerant species and minimum stress to turf would be expected based on the observed chloride levels (Liu et al. 2023) if the water was used for irrigation purposes.

Additionally, the concentrations for the other parameters, including boron, calcium, and nitrogen, all fell within the ranges from the Penn State Irrigation Guidelines, suggesting that the wetland water is acceptable to use on turfgrass (Landschoot, 2016).

E. coli levels ranged from 11.9 MPN/100 mL to 85.7 MPN/100mL. These concentrations fall below the MPCA chronic and acute E. coli standards. Additionally, the proposed irrigation system will use ultraviolet (UV) disinfection to treat the water before irrigation, and the timing of irrigation (overnight) will minimize the potential for contact with park users and reduce overall health risk.

Other tested parameters in the grab samples included total phosphate (TP) and total suspended solids (TSS), used to estimate potential pollutant load reductions by the proposed project.

A summary of these key pollutants are included in Table 2-2. A complete summary of the grab samples collected by VLAWMO are summarized in Appendix A.

Table 2-2 Summary of Polar Park Wetland Water Quality Data

Date	Total Phosphorus (TP) mg/L(1)	Total Suspended Solids (TSS) mg/L(1)	Chloride mg/L(1)	E.coli (MPN/100mL) (1)
6/6/2023	0.159	2.9	135	11.9
6/26/2023	0.076	1.7	145	24.3
7/20/2023	0.099	5.8	137	85.7
9/6/2023	0.27	14	159	30.1
Average	***0.151***	***6.1***	***144***	***38***

Note(s):
(1) Complete results from grab samples collected by VLAWMO are summarized in Appendix A.

2.5 Topographic Survey

A survey was conducted by Barr on July 28, 2023, to collect topographic and bathymetric data on the east and west basins of the southwest mitigation wetland in Polar Lakes Park along with the vegetated channel connecting the two wetland basins and the outlet channel/control elevation for the wetland (see Appendix B). The survey was completed in vertical datum NAVD88.

The bottom elevation of the main (west) wetland basin is ~910.1 feet (ft) mean sea level (MSL, similar to the original design elevation), and the outlet control elevation, or normal water level (NWL), is 914.9 ft MSL. The east basin has a bottom elevation of 913.1 ft MSL and NWL of 915.6 ft MSL.

To evaluate the storage available in the two basins for irrigation reuse, we assumed that the channel connecting the two basins would be modified such that the two basins would operate as one and that the NWL of the main (west) basin (914.9 ft MSL) would ultimately control the NWL of the entire system. The survey surface of the two basins was merged into the MnDNR 2011 LiDAR data. The depth within this channel would be lowered approximately 2 ft from the existing basins NWL. This combined surface was used to generate a storage curve for the two basins. Based on the NWL of the system at elevation 914.9 ft MSL, these storage curves for the combined wetland system were used to calculate the storage available for reuse, assuming wetland drawdowns of 0.5 ft, 1.0 ft, 1.5 ft, and 2.0 ft from the NWL (914.9 ft MSL).

However, review of as-built information for this mitigation wetland area suggests that the original NWL of the west basin was closer to 916.0 ft MSL and preliminary conversations with agency staff indicate that improvements to the outlet from the wetland system may be able to reestablish the NWL to this elevation. Based on the NWL of the system at elevation 916.0 ft MSL, these storage curves for the combined wetland system were used to calculate the storage available for reuse, assuming wetland drawdowns of 0.5 ft, 1.0 ft, 1.5 ft, and 2.0 ft from the NWL (916.0 ft MSL).

Table 2-3 summarizes the estiamted storage available for reuse in the wetland system at Polar Lakes Park, based on drawdown from NWL.

Table 2-3 Estimated Wetland Storage Summary

Elevation	Drawdown from NWL (feet)	Cumulative Storage Available for Reuse (acre-ft)	Cumulative Storage Available for Reuse (gallons)
Storage Estimates Assuming NWL is 916.0 ft MSL (1)			
916.0	0.0	0.0	0.0
915.5	0.5	0.500	162,925
915	1.0	0.923	300,760
914.5	1.5	1.297	413,831
914	2.0	1.609	524,294
Storage Estimates Assuming NWL is 914.9 ft MSL (2)			
914.9	0.0	0.0	0.0
914.4	0.5	0.441	143,700
913.9	1.0	0.743	242,107
913.4	1.5	0.997	324,873
912.9	2.0	1.208	393,628

(1) Depth of drawdown estimated from NWL at 916.0 ft MSL per 2013 as-built.

(2) July 2023 survey indicates NWL of 914.9 MSL.

2.6 Wetland Water Level and Flow Summary

To better understand the water levels in the southwest wetland and flows into the system, VLAWMO staff installed a water level staff gauge on the western basin of the mitigation wetland in Polar Lakes Park on July 26, 2023. Barr survey staff established the elevation of the gauge readings as part of the site survey conducted on July 28, 2023.

VLAWMO staff measured the approximate channel dimensions, approximate flow depths, and velocities of the inflow (east) and outflow (west) channels. Using this information, Barr estimated approximate flows into and out of the southwest wetland system.

A summary of observed water level and estimated flow are presented in Table 2-4.

Table 2-4 Wetland Water Level and Flow Summary

Date	Pond Water Level (ft MSL)(1)	Approximate East Channel Inflow (cfs)(2)	Approximate West Channel Outflow (cfs) (2)
5/16/2023	N/A	0.130	N/A
5/25/2023	N/A	0.019	N/A
6/7/2023	N/A	0	N/A
6/26/2023	N/A	0.030	N/A
7/20/2023	N/A	0	N/A
7/26/2023	N/A	0.030	N/A
7/28/2023	914.3	N/A	N/A
8/10/2023	914.05	0	N/A
8/15/2023	915.2	1.435	0.544
8/18/2023	914.8	NA (3)	0
8/24/2023	914.6	0	0
8/31/2023	914.45	0	0
9/6/2023	914.3	0	0
9/20/2023	914.09	0	0
9/25/2023	914.39	1.044	N/A(4)
9/26/2023	914.85	0.284	0.177
10/2/2023	915.26	0.257	N/A(4)

Note(s):

(1) The gauge was installed by VLAWMO on 7/26/2023 and surveyed by Barr staff on 7/28/2023.

(2) Flow was calculated by multiplying the measured velocity by the approximate channel width and flow depth (flow area) provided by VLAWMO staff. East Channel flow was measured only until 8/15/2023.

(3) Not able to measure velocity on this date due to low flow.

(4) VLAWMO staff unable to obtain a velocity measurement.

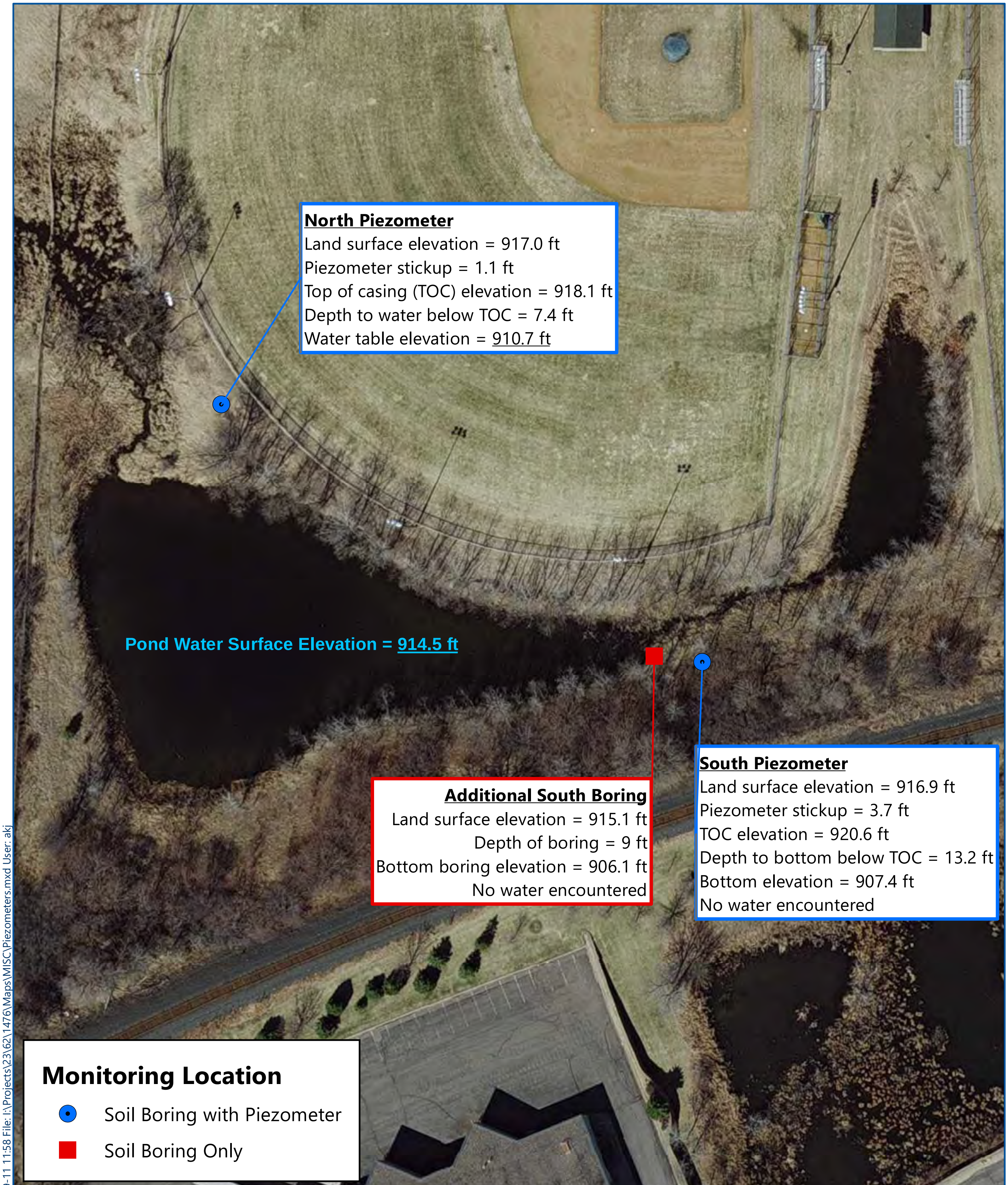
2.7 Piezometers

Barr staff installed two piezometers and an additional hand-augured boring around the southwest mitigation wetland at Polar Lakes Park on August 31, 2023. GPS points for the installed piezometer locations were collected, and the ground elevation at the installed piezometer locations was estimated based on the recent topographic survey. Based on these, we were able to estimate the elevation of the groundwater at each of the piezometer locations and determine if there is potential for groundwater interaction at the southwest wetland. Figure 2-2 summarizes the piezometer locations and elevation of the groundwater.

For the south piezometer, the initial piezometer was installed to a depth of ~907.4 ft MSL (approximate pond bottom is ~910.0 ft MSL)—below the bottom of the existing pond. No water was found at this first location, and the soil was primarily a damp, lean clay. Field staff tried to pull and move the piezometer to the north and west; however, the piezometer would not move, so we left it in place. We completed a second hand-augured boring approximately 20 ft north and west in the lower-lying area south of the pond. This hole was hand augured to 9 ft below the ground surface (bottom of hand-augured hole ~906.1 ft MSL). The same clay material was observed, and field staff could not auger past the clay. Similar to the south piezometer, water was not found in this augured hole. These locations were checked several times throughout the day to see if water had accumulated, and no water was observed.

We hand augured the north piezometer to 8 ft below the ground, and water was about 6 ft below the ground surface. The soil was primarily organic material down to 6 ft. At 7 ft, there was a small layer of poorly graded sand, and then at 7.5–8 ft, a layer of gray, lean clay that appeared to be dry/damp (possible confining layer). We placed the piezometer, and the well was developed. We then took a water level reading 2 hours later. The approximate ground elevation at the northern piezometer was 917.0 ft MSL, so the estimated groundwater elevation at this location was ~ 910.7 ft MSL (at or slightly above the existing pond bottom).

Based on these results, our general takeaway is that the pond in the southwest corner is not receiving groundwater inflow. Based on the observed soils from the piezometer installation, the southwest wetlands in Polar Lakes Park appear to be sitting on top of a clay layer in this low-lying area. There could potentially be some discharges from the pond to groundwater based on the observed head difference, but this discharge must be small, or the pond would not hold water as well as it does.



All measurements recorded on August 31, 2023

0 75
Feet

PIEZOMETER SUMMARY
Polar Lakes Park
Water Reuse Feasibility
VLAWMO, White Bear Twp

FIGURE 2-2

3 Water Reuse Concepts

Based on our conversations with VLAWMO and White Bear Township staff, two water reuse concepts for irrigation in Polar Lakes Park were examined to determine if it was feasible for the constructed wetland to meet the park's irrigation demands.

The two reuse concepts evaluated include:

(1) Concept 1: Irrigation of the lower fields.

(2) Concept 2: Irrigation of the upper and lower fields.

To develop the two reuse concepts, we used the information compiled and summarized in Section 2 to understand system demand, watersheds and contributing areas, and available storage for reuse.

3.1 System Optimization and Estimated Performance

Water reuse system performance is ultimately a balance of watershed area (e.g., water supply), irrigation demand, and storage for reuse. Using a long-term water balance, we can optimize the system storage to maximize performance while not oversizing the storage needed or overusing water from the natural wetland systems and potentially damaging the ecosystem. We used the Mississippi Watershed Management Organization's (MWMO's) reuse calculator to develop a variety of optimization curves to understand the reuse system performance during the most likely operating conditions and additional performance curves for various sensitivity scenarios considered at Polar Lakes Park.

The MWMO reuse calculator includes a daily water balance model that uses 50 years of observed daily precipitation data from the Minneapolis-St Paul (MSP) airport to estimate watershed runoff volumes and how much of that volume is captured within the targeted storage system and available for reuse. Key inputs into the calculator include watershed area and impervious percentage, irrigation area, irrigation rate and storage volume available for reuse.

To determine the optimal use of water from the southwest wetland for the two concepts, the most likely operating condition assumed that the primary watershed contributing to the system would only be the 178-acre watershed area downstream of Birch Lake, and the estimated irrigation rate during the season would be equivalent to an application rate of 0.5 inches/week (maximum observed weekly irrigation rate based on the data from White Bear Township) when considering rainfall.

In all cases, based on the results of the piezometer installation, we have assumed that shallow groundwater inflows are not a contributing factor to the wetland system and cannot be considered part of the available water for irrigation.

The various sensitivity scenarios were examined by:

- Varying the contributing watershed area assuming:
    - The entire watershed contributes, including Birch Lake (a total of 677 acres); this contributes flows ~37% of the time.

- Only half of the watershed downstream of Birch Lake contributes (89 acres). This represents dry conditions where portions of the primary watershed may not contribute due to wetlands in the direct watershed area being below their outlet elevations.

- Varying the weekly irrigation rate:
  - Average irrigation rate (~0.3 inch/week)
  - Maximum irrigation rate (~0.5 inch/week)

Figure 3-1 summarizes the Polar Lakes Park water reuse optimization curves for the two concepts. Storage is displayed on the X-axis, and the percent of average annual irrigation demand met by reuse is on the Y-axis.

Concept 1 (irrigation of the lower fields only) curves are shown by the orange/brown color scheme, with the most likely scenario represented by a solid orange line and the associated sensitivity scenarios in the other orange and brown colors and line types.

Concept 2 (irrigation of the upper and lower fields) curves are shown in the blue color scheme. The solid light blue line represents the most likely scenario; the associated sensitivity scenarios are represented by the other blue colors and line types.

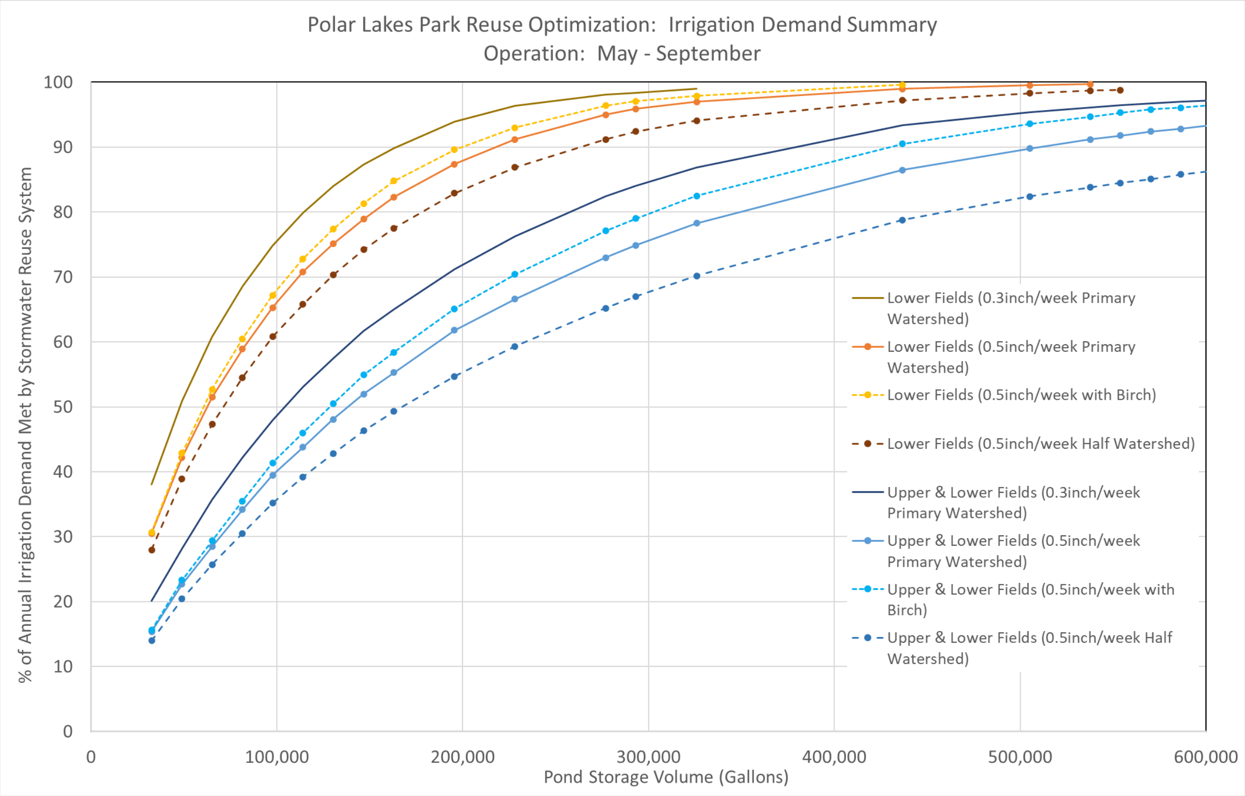


Figure 3-1 Reuse Optimization Curves

Table 3-1 summarizes results for each sensitivity scenario within the range of a 1.0- to 1.5-ft drawdown from NWL in the southwest wetland, assuming the NWL is reestablished to 916.0 ft MSL. The 1.0- and 1.5-ft drawdowns are recommended to optimize system performance, depending on whether the system irrigates only the lower fields or both the upper and lower fields, respectively. Based on preliminary conversations with agency staff, it may be possible to drawdown the water levels as much as 2.0 feet (to elevation 914.0 ft MSL), if NWL is restablished at 916.0 ft MSL.

In general, Concept 1 is estimated to provide 93%-99% of the average annual irrigation demand by the reuse system at a drawdown of 1.0 ft to 1.5 feet from NWL (assuming NWL = 916.0 ft MSL). The volume of water available in 1.0 ft of drawdown from NWL can provide sufficient irrigation supply for approximately 17-29 days of irrigation of the lower fields, depending on the irrigation rate of 0.5 and 0.3 inches per week, respectively. For 1.5 feet of drawdown, the wetland can provide water for 24-41 days of irrigation.

In general, Concept 2 can provide 68% - 93% of the average annual irrigation demand by the reuse system at a drawdown of 1.0 ft to 1.5 feet from NWL (assuming NWL = 916.0 ft MSL). The volume of water available in 1.0 ft of drawdown from NWL can provide sufficient irrigation supply for approximately 8-14 days of irrigation of the upper and lower fields, depending on the irrigation rate of 0.5 and 0.3 inches per week, respectively. For 1.5 feet of drawdown, the wetland can provide water for 11-19 days of irrigation.

The estimated volumes of stormwater reused for 1.0- and 1.5-ft drawdowns were generated using the MWMO reuse calculator. Pollutant load reductions were calculated by multiplying the total estimated reuse volumes per sensitivity scenario by the measured TP and TSS concentrations from the grab samples taken by VLAWMO staff.

The water balance model is used to understand average annual performance under a variety of conditions (varying watershed area, storage, and irrigation rates). Additionally, in the 50-year period of the water balance, we examined the system performance during some of the driest years versus some of the wettest years in the period. The amount of the water the reuse system will supply for irrigation demand will vary from year to year. However, during wet years, it is expected that the system may be able to meet nearly all irrigation demand due to supply of water and reduced irrigation needs. During dry years, the system may not be able to supply as much of the irrigation demand and may need to rely on the potable back-up water supply more frequently.

Table 3-1 Summary of Optimization Curve Sensitivity

Irrigation Area	Sensitivity Scenario	Irrigation Demand Met by Reuse[(1)]	Annual Volume Reused (gallons/yr) [(1)]	Estimated TP Reduction (pounds/yr)[(2)]	Estimated TSS Reduction (pounds/yr)[(2)]
Concept 1: Lower Fields Only	Lower fields 0.3 inches/week primary watershed	98–99%	1,896,681–1,922,016	2.4–2.4	96-97
	Lower fields 0.5 inches/week primary watershed	96-99%	2,558,021–2,648,981	3.2–3.3	130-135
	Lower fields 0.5 inches/week with Birch watershed	97-99%	2,432,291–2,487,358	3.1–3.1	124-126
	Lower fields 0.5 inches/week half watershed area	93-97%	2,498,552–2,613,004	3.1–3.3	127-133
Concept 2: Upper and Lower Fields	Upper and lower fields 0.3 inches/week primary watershed	85-93%	3,434,030–3,762,342	4.3–4.7	175–191
	Upper and lower fields 0.5 inches/week primary watershed	76-86%	4,138,378–4,735,478	5.2-6.0	210-241
	Upper and lower fields 0.5 inches/week with Birch watershed	80-90%	4,203,861–4,981,462	5.3-6.3	214-253
	Upper and lower fields 0.5 inches/week half watershed area	68-78%	3,843,596–4,427,519	4.8-5.6	195-225

Note(s):
(1) The irrigation demand and annual volume reused ranges are based on a 1.0- to 1.5-ft drawdown from NWL (assuming 916.0 ft MSL).
(2) Estimated pollutant load reductions are concentrations based on a 1.0- to 1.5-ft drawdown from NWL (assuming 916.0 ft MSL)

3.2 Concept Descriptions

The two stormwater reuse concepts evaluated for Polar Lake Park included the following:

(1) Concept 1: Irrigation of the lower fields

(2) Concept 2: Irrigation of the upper and lower fields

Table 3-2 summarizes the recommendations and performance of the two stormwater reuse concepts based on the optimization evaluation. These concepts are further discussed in the following sections.

Table 3-2 Summary of Stormwater Reuse Concepts

	Irrigation Area	Total Irrigation Area (acres)	Proposed Pond Drawdown (feet) (1)	Estimated Cost (-30% - +50%) (2)	Estimated Annual Volume Reused (gal/year)(3)	Estimated TP Removal (lbs/yr)(3)	Cost: Benefit ($/lbs TP/yr)
Concept 1	Lower fields	8.95	1.0	$814,000 ($570,000–$1,221,000)	1,896,681–2,648,981	2.4-3.3	$15,000-$26,400
Concept 2	Upper and Lower fields	18.87	1.5	$1,154,000 ($808,000–$1,731,000)	3,434,030–4,735,478	4.3-6.3	$11,500-$20,800

Note(s):

(1) Based on preliminary conversations with agency staff, it may be possible to drawdown the water levels as much as 2.0 feet if NWL is restablished at 916.0 ft MSL (similar to as-built conditions).

(2) Cost estimates are pulled from the planning level engineer's opinion of probable cost (Appendix C). These costs include engineering and design (20%), construction costs (and contingency [25%]), and construction oversight (5%).

(3) The estimated volume of stormwater reused for the 1.0 ft and 1.5 ft drawdown scenarios was generated using the MWMO reuse calculator, assuming drawdown from NWL 916.0 ft MSL. Pollutant load reductions were calculated by multiplying the reuse volumes by the measured concentrations from the grab samples taken by VLAWMO staff presented in Table 2-2.

3.2.1 Concept 1: Lower Ballfields Irrigation Only

Concept 1 assumes that water is reused for irrigation of the lower ballfields only and that the upper ballfields will continue to be irrigated by potable water. Figure 3-2 provides a summary of Concept 1.

This concept assumes that the water reuse system would use the top 1.0 ft of water in the southwest mitigation wetlands, including the east and west basins, for irrigation purposes. Potable water will be a backup source if water falls below this level.

The concept assumes that the channel connecting the eastern and western basins of the southwest mitigation wetland would be excavated and lowered to fully connect both basins. The existing overflow from the west basin would ultimately control the water levels in the fully connected wetland system. The concept also includes constructing a stabilized surface discharge from the western basin and improvements to the length of the shallow berm running along the north edge of the pond to minimize any seepage out of the pond system (e.g., sheetpile wall), to potentially restablish the NWL to approximately 915.9/916.0 ft MSL, based on the original as builts, to maximize storage capacity.

The conceptual reuse system would include an intake structure located on the western basin of the southwest mitigation wetland. There are various intake options that could be utilized for this system including:

- A shoreline structure connected to the pond that contains the pump intake,
- A floating intake that draws water from the top of the pond surface, or
- A sledded style intake system that rests on the pond bottom and draws water from the middle of the pond.

The type of intake preferred would be further discussed in future phases of design.

The pumping system would draw water from the pond, and the pumped water would pass through a treatment system that includes an automated backwashing filter system and UV disinfection system before connecting to the existing irrigation system mainline. Backwash discharges from the treatment system would be directed back to the wetland system. The system controls would include a water-level-monitoring system to determine if sufficient stormwater reuse water was available for irrigation, automated valving to switch to the potable backup supply, and communications with the existing irrigation system. The proposed system would provide water to the lower ballfields at 80 psi, with a flow rate of approximately 60 gpm. Additional electrical service would be needed to run the pumps and treatment system.

The concept includes a connection to the existing irrigation system mainline in the lower ball field area. Conversations with Township staff indicated that the systems already include a reduced pressure zone (RPZ) to prevent the potential for any cross-contamination between the reuse system and the potable water system and we have assumed this RPZ can be resused for this project

3.2.2 Concept 2: Upper and Lower Ballfields Irrigation

Concept 2 assumes water is reused to irrigate the lower and upper ballfields. Figure 3-3 provides a summary of Concept 2.

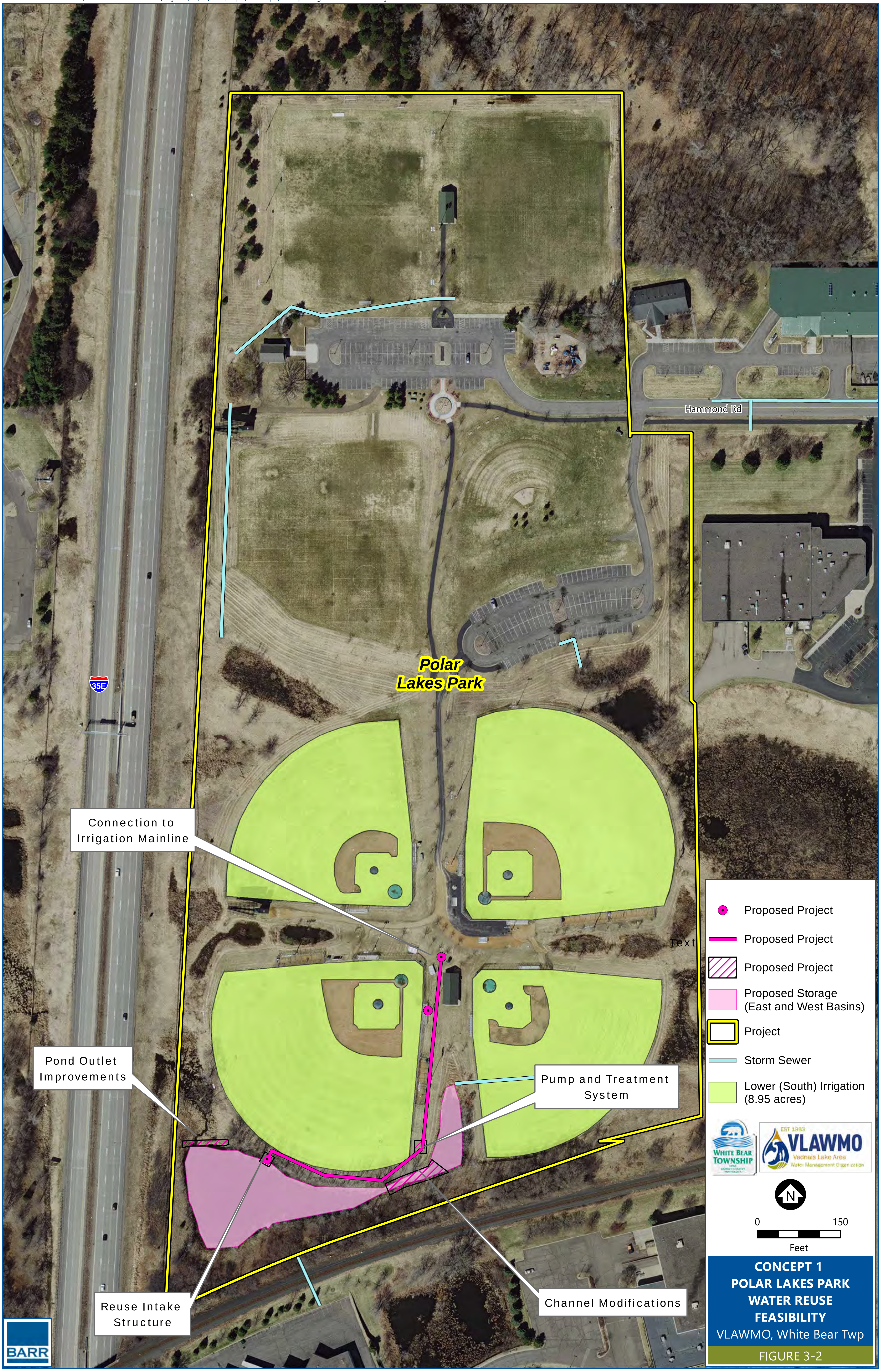
This concept assumes that the water reuse system would use the top 1.5 ft of water in the southwest mitigation wetlands, including the east and west basins, for irrigation purposes. Potable water will be used as a backup supply source if water levels fall below this level.

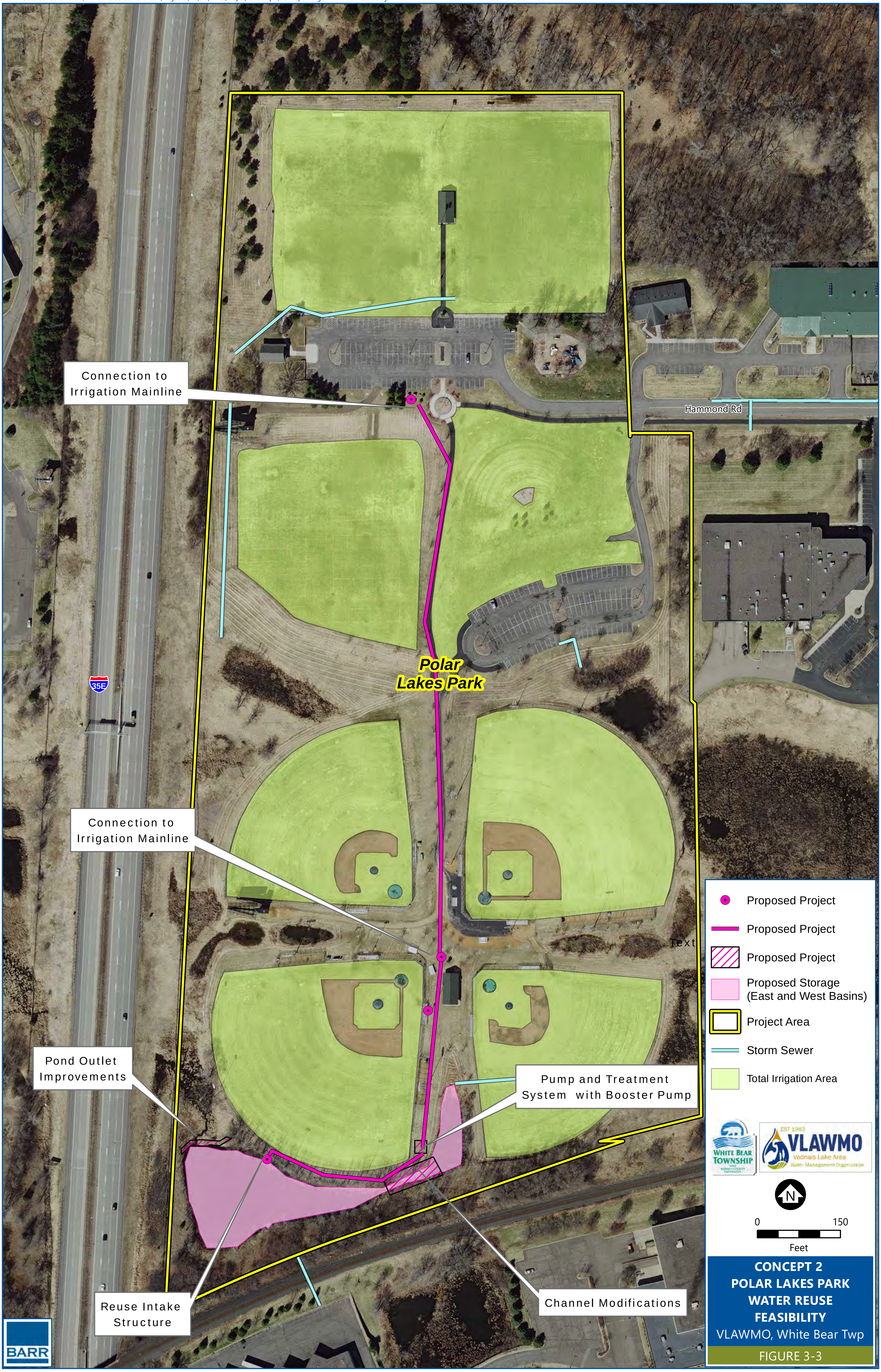
The concept assumes that the channel connecting the eastern and western basins of the southwest mitigation wetland would be excavated and lowered to fully connect both basins. The existing overflow from the west basin would ultimately control the water levels in the fully connected wetland system. The concept also includes constructing a stabilized surface discharge from the western basin and improvements to the length of the shallow berm running along the north edge of the pond to minimize any seepage out of the pond system (e.g., sheetpile wall), to potentially restablish the NWL to approximately 915.9/916.0 ft MSL, based on the original as builts, to maximize storage capacity.

The conceptual reuse system would include an intake structure on the western basin of the southwest mitigation wetland. The pumping system would draw water from the intake structure, and the pumped water would pass through a treatment system that includes an automated backwashing filter system and UV disinfection system before connecting to the existing irrigation system mainline. Backwash discharges from the treatment system would be directed back to the wetland system. The system controls would include a water-level monitoring system to determine if sufficient stormwater reuse water was available for irrigation, automated valving to switch to the potable backup supply, and communications with the existing irrigation system. The proposed system would provide water at 80 psi with a flow rate of approximately 120 gpm. We have assumed that a secondary booster pump would be needed downstream of the treatment system to provide the necessary flows and pressures to the upper fields. Additional electrical service would be needed to run the pumps and treatment system.

The concept includes two connections to the existing irrigation system mainlines in the upper and lower ballfield area. Conversations with Township staff indicated that the systems already include two reduced pressure zones (RPZ) to prevent the potential for any cross-contamination between the two separate systems. We have assumed the RPZ's can be reused for this project.

Barr Footer: ArcGIS 10.8.1, 2023-10-03 06:17 File: I:\Projects\23\62\1476\Maps\Basemaps\Concept 1 Figure 11x17.mxd User: jak2





CONCEPT 2
POLAR LAKES PARK WATER REUSE FEASIBILITY
VLAWMO, White Bear Twp
FIGURE 3-3

3.3 Opinion of Probable Costs

Barr developed feasibility-level opinions of probable costs for the two concepts by following cost-estimating guidance provided by the American Society for Testing and Materials (ASTM, 2019) and the Association for the Advancement of Cost Estimating (AACE, 2016). These estimates were based on limited engineering (Class 4, 0–15% design) and the use of parametric models to calculate estimated costs (i.e., making use of order-of-magnitude costs from similar projects) and uncertainty, with an acceptable range of between -30% and +50% of the estimated project cost.

The feasibility-level point opinion of probable cost includes the following:

- Capital construction costs, including contingency (25%)
- Planning, engineering, design, permitting, and construction administration (25% of construction cost).

We estimated quantities based on the conceptual designs and available information. Limited field assessments were performed as part of this study. Dimensions, areas, and volumes for construction were determined using park information provided by White Bear Township, aerial imagery, property boundaries, and site survey/2011 MnDNR LiDAR data. We used unit costs—based on recent bid prices, planning level quotes on the treatment and pumping system from WaterTronics, published construction cost-index resources, and similar stormwater reuse projects—and compared them to similar project prices. All costs are presented in 2023 US dollars.

We also estimated annual operations and maintenance costs for each concept to inform the annualized cost-benefit related to pollutant removals (TP and TSS). Annual O&M costs are estimated to be $3,000-$10,000 per year for Concept 1 and $5,000-$15,000 per year for Concept 2.

Because the project is on public land, we have assumed there are no easement costs to implement the project.

The costs for the two concepts are summarized in Table 3-2. Appendix C includes the details related to the planning level engineer's opinion of probable costs.

3.4 Permitting

The expected permitting for the two water reuse concepts is expected to be similar.

- For both concepts, the disturbance extents are less than 1 acre, so an MPCA/NPDES construction stormwater permit is not expected to be required.
- The southwest wetland in Polar Lakes Park is not mapped as an MnDNR public waters basin or watercourse, and an MnDNR public waters work permit would not be triggered.
- An MnDNR appropriations permit is required as both proposed concepts would withdraw more than 10,000 gallons of water per day or 1 million gallons per year.
- The southwest wetland basins are within FEMA mapped floodplain (Zone A). Floodplain permitting through the MnDNR will be required and further hydrologic and hydraulic analysis will be needed to demonstrate the impact (no rise) of the project on the flood elevations.

- We expect the project to exceed several thresholds triggering the VLAWMO water management policies (e.g., disturbing more than 10,000 square ft of land, surface water appropriations, alteration of a shoreline, potential work below the 100-year high-water elevation, Wetland Conservation Act [WCA] impacts). Except for WCA, these requirements are implemented by White Bear Township. Both reuse concepts may require:
    - Erosion and sediment control plans.
    - A demonstration of no filling/maintaining storage capacity below the 100-year flood elevation.
    - Completion of the Erosion Intensity Scoresheet to demonstrate impacts to shoreline modifications.
    - Stream and lake crossing requirements due to adding the more formal outlet structure and improvements to the berm.

  Concept 1 will not likely reconstruct more than 10,000 square ft (SF) of impervious area or trigger the stormwater management requirements. However, Concept 2 could potentially result in the reconstruction of more than 10,000 SF of impervious area, especially if aligned with a future trail reconstruction project by White Bear Township. This would trigger the linear stormwater management requirements.

- Both the east and west basins were constructed as mitigation wetlands. A wetland delineation will be needed as part of future design phases, and a jurisdictional determination will be needed to determine whether the USACE must be involved with permitting.
    - This project will likely trigger WCA requirements, and the VLAWMO is the local government unit (LGU) responsible for administering WCA. This project has been preliminarily discussed with the Board of Soils and Water Resources (BWSR) staff, and feedback has indicated that this project would likely be considered a WCA no loss project.
    - If the wetland is determined to be a USACE jurisdictional wetland, then a Section 404 permit may be required. VLAWMO staff had preliminary conversations with USACE staff regarding the project. Additional project documentation was compiled in response to questions from the USACE (see memo included as Appendix D). Preliminary response from the USACE indicates that the proposed project would likely be covered under the nationwide permit 3 for maintenance activities.

- There is a Metropolitan Council Environmental Services (MCES) sanitary interceptor pipe that runs from east to west through the southern two baseball fields of Polar Lakes Park. This is a 36-inch reinforced-concrete pipe (RCP) with a 40 ft utility easement (20 ft on each side of the pipe) owned by MCES. Typically, there are more than 15 ft of cover over the pipe through the park. The proposed reuse system is not expected to impact the MCES sanitary sewer system (pipes or manholes). A connection pipe from the proposed pump and treatment system to the existing irrigation system mainline will likely need to pass through the MCES easement area, likely to a depth less than 3 ft below the surface, similar to the existing irrigation system in the park. The concepts were provided to MCES staff. They agree that the reuse project will not likely impact the regional interceptor and do not have any major concerns. Any work within the MCES easement would need to be reviewed by MCES as a part of the Encroachment Agreement process. If modifications are needed to any manholes (e.g., rim elevations), an MCES connection permit will be required. Should the VLAWMO and White Bear Township continue to pursue the final design of the water reuse project, MCES staff will continue to work with the design team to minimize any project impacts on the MCES interceptor/regional facilities.

- The well testing data from the Minnesota Department of Health (MDH) for White Bear Township and White Bear Lake indicate PFAS levels are very low. Additional conversations with MDH staff indicate there are no known hot spots for PFAS in the area around Polar Lakes Park. Given this, the MDH/MPCA would not be expected to be involved in review or permitting of the proposed water reuse project for irrigation purposes. Baseline PFAS testing would not be required; however, samples from the wetlands could be collected during final design.

4 Conclusions

This feasibility study demonstrated that the constructed wetland in the southwest corner of Polar Lakes Park has the potential to be successfully used for the irrigation of the athletic fields in the park and offset potable water usage, whether irrigating only the lower fields or irrigating both the upper and lower fields.

- If irrigating the lower fields (Concept 1), using the top 1.0 ft of water from the wetland system could provide 93–98% of the average annual irrigation demand, offsetting potable water usage by 1.9 to 2.7 million gallons per year.
- If irrigating both the upper and lower fields (Concept 2), using the top 1.5 ft of water from the system could provide 78-93% of the average annual irrigation demand, offsetting potable water usage by 3.7 to 5.0 million gallons per year.

Polar Lakes Park is located within the Wilkinson Lake watershed, an impaired resource with an approved TMDL. The TMDL requires a wasteload reduction of 561 pounds TP/year from Wilkinson Lake drainage areas. The estimated TP reductions based on the potential water reused for irrigation and the observed TP concentrations in the pond for Concept 1 is between 2.4-3.3 pounds of TP per year, and for Concept 2 is between 4.3-6.3 pounds of total phosphorus per year.

Water quality grab samples collected in June, July and September of 2023 indicated that chloride levels in the pond (135–159 mg/L) were slightly above the concentration identified for turf grass sensitivity (100 mg/L) and other ornamental plantings (70 mg/L). However, further research into Kentucky Bluegrass suggests it is a fairly salt tolerant species and minimum stress to turf would be expected based on the observed concentrations (Liu et al. 2023).

Total estimated project costs, including engineering, design, permitting, and construction, could range from $814,000 (Concept 1) to $1.15 million (Concept 2). And annual operations and maintenance costs could range from $3,000 - $15,000 per year. Ultimately, Concept 2 is more cost effective than Concept 1.

Grant funding from various regional and state agencies has been used to implement other water reuse projects. Next steps could include identifying and investigating potential grant opportunities to help support the implementation of the water reuse system at Polar Lakes Park. In the past, grant opportunities have been available through the Metropolitan Council, the Minnesota Pollution Control Agency, or the Board of Water and Soil Resources.

5 References

American Society for Testing and Materials. (2019). ASTM E2516-06 Standard Classification for Cost Estimate Classification System. West Conshohocken, PA: ASTM International.

Association for the Advancement of Cost Estimating. (2016). AACE International Recommended Practice NO. 18R-97.

Landschoot, Peter. *Irrigation Water Quality Guidelines for Turfgrass Sites.* 2016. Irrigation Water Quality Guidelines for Turfgrass Sites (psu.edu). Accessed 20 September 2023.

Liu, H.; Todd, J.L.; Luo, H. Turfgrass Salinity Stress and Tolerance—A Review. *Plants* 2023, *12*, 925. https://doi.org/10.3390/plants12040925

Minnesota Department of Health. January 2022. *Reuse of Stormwater and Rainwater in Minnesota A PUBLIC HEALTH PERSPECTIVE.*

Mississippi Watershed Management Organization (MWMO). Stormwater Reuse Calculator.

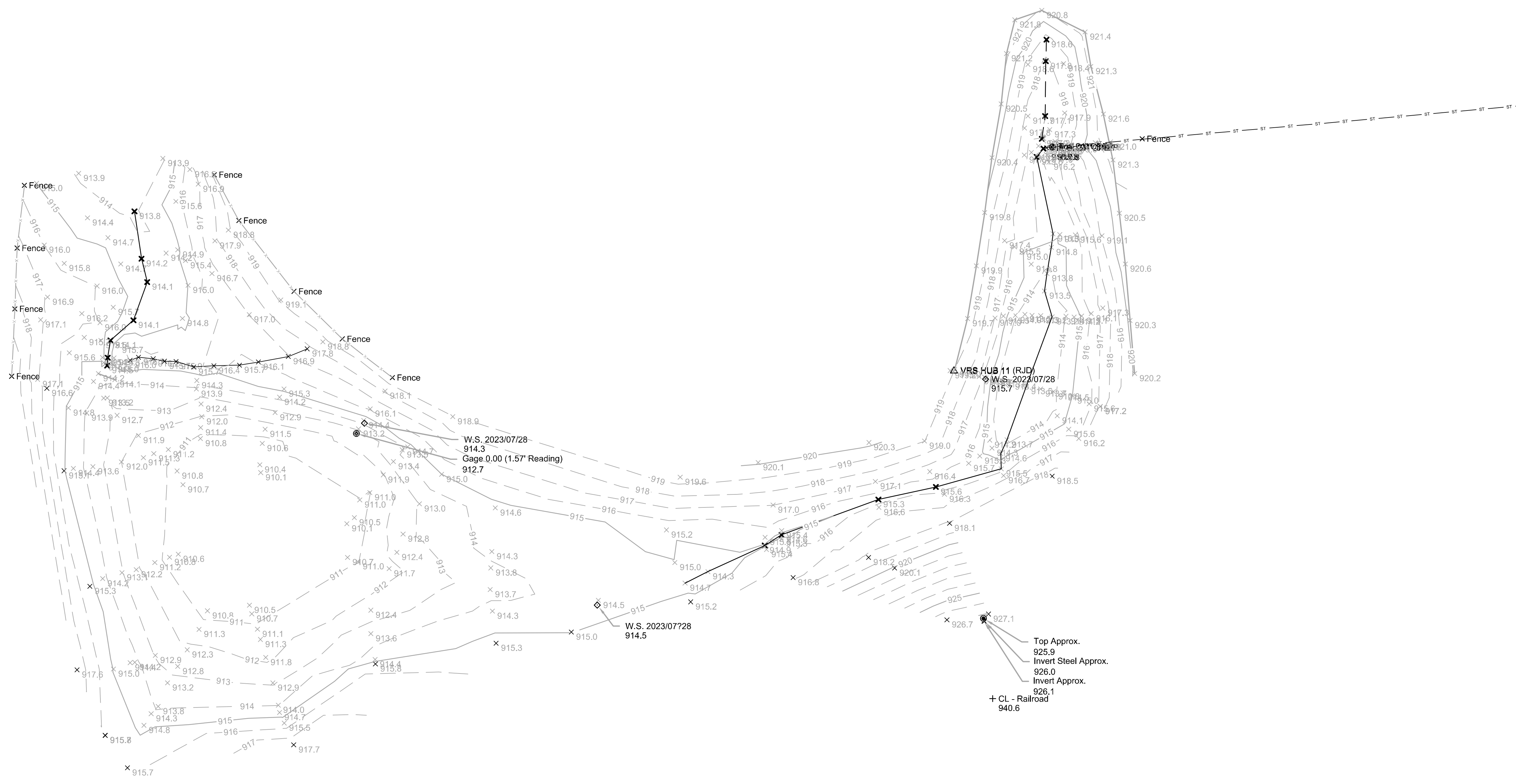
Appendix A

2023 Wetland Water Quality Results

Unique Lab code#	Client Name	Project Name	Laboratory	Sample Description	Sampled Date	Sampled Time	Units	Alkalinity, Carbonate (as CaCO3)	Biochemical Oxygen Demand (BOD)	Boron	Calcium	Chloride	Chlorophyll-a, Pheophytin Corrected	E_ Coli Bacteria MPN	Iron	Magnesium	Manganese	Nitrogen, Total Kjeldahl (TKN)	Orthophosphate as P (LF)	Phosphorus, Total as P	Residue - filterable (TDS)	Residue - nonfilterable (TSS)	Sodium	Turbidity	Storm event
B009143-01	Vadnais Lake Area WMO	Polar Park reuse project	RMB Environmental Laboratories, Inc. - Bloomington	Polar Reuse Station	6/7/2023 9:30	9:30	mg/L	< 5.0	3.2		35.1	135				12.7		1.27	0.054	0.159	400	2.9	83.2		
B009143-01	Vadnais Lake Area WMO	Polar Park reuse project	RMB Environmental Laboratories, Inc. - Bloomington	Polar Reuse Station	6/7/2023 9:30	9:30	MPN/100mL							11.9											
B009143-01	Vadnais Lake Area WMO	Polar Park reuse project	RMB Environmental Laboratories, Inc. - Bloomington	Polar Reuse Station	6/7/2023 9:30	9:30	NTU																	3.1	
B009143-01	Vadnais Lake Area WMO	Polar Park reuse project	RMB Environmental Laboratories, Inc. - Bloomington	Polar Reuse Station	6/7/2023 9:30	9:30	ug/L			< 100			1.48		953		163								
B009402-01	Vadnais Lake Area WMO	Polar Park reuse project	RMB Environmental Laboratories, Inc. - Bloomington	Polar Reuse Station	6/26/2023 10:00	10:00	mg/L	< 5.0	2.4	< 0.02	37.8	145			0.51	11.8	0.07	1.15	0.015	0.076	403	1.7	72.9		1.2inch rain
B009402-01	Vadnais Lake Area WMO	Polar Park reuse project	RMB Environmental Laboratories, Inc. - Bloomington	Polar Reuse Station	6/26/2023 10:00	10:00	MPN/100mL							24.3											
B009402-01	Vadnais Lake Area WMO	Polar Park reuse project	RMB Environmental Laboratories, Inc. - Bloomington	Polar Reuse Station	6/26/2023 10:00	10:00	NTU																	2.2	
B009402-01	Vadnais Lake Area WMO	Polar Park reuse project	RMB Environmental Laboratories, Inc. - Bloomington	Polar Reuse Station	6/26/2023 10:00	10:00	ug/L						16												
B009809-01	Vadnais Lake Area WMO	Polar Park reuse project	RMB Environmental Laboratories, Inc. - Bloomington	Polar Reuse Station	7/20/2023 0:00	10:00	mg/L	< 5.0	< 3.0	< 0.02	40.2	137			0.5	12.4	0.08	1.66	0.011	0.099	377	5.8	75.7		0.31 inch
B009809-01	Vadnais Lake Area WMO	Polar Park reuse project	RMB Environmental Laboratories, Inc. - Bloomington	Polar Reuse Station	7/20/2023 0:00	10:00	MPN/100mL							85.7											
B009809-01	Vadnais Lake Area WMO	Polar Park reuse project	RMB Environmental Laboratories, Inc. - Bloomington	Polar Reuse Station	7/20/2023 0:00	10:00	NTU																	5.6	
B009809-01	Vadnais Lake Area WMO	Polar Park reuse project	RMB Environmental Laboratories, Inc. - Bloomington	Polar Reuse Station	7/20/2023 0:00	10:00	ug/L						8.68												
B010480-01	Vadnais Lake Area WMO	Polar Park reuse project	RMB Environmental Laboratories, Inc. - Bloomington	Polar Reuse Station	9/6/2023 8:00	8:00	mg/L	480	9.4	0.03	35.2	159			3.73	9.4	1.7	2.3	0.049	0.27	420	14	93.1		
B010480-01	Vadnais Lake Area WMO	Polar Park reuse project	RMB Environmental Laboratories, Inc. - Bloomington	Polar Reuse Station	9/6/2023 8:00	8:00	MPN/100mL							30.1											
B010480-01	Vadnais Lake Area WMO	Polar Park reuse project	RMB Environmental Laboratories, Inc. - Bloomington	Polar Reuse Station	9/6/2023 8:00	8:00	NTU																	17	
B010480-01	Vadnais Lake Area WMO	Polar Park reuse project	RMB Environmental Laboratories, Inc. - Bloomington	Polar Reuse Station	9/6/2023 8:00	8:00	ug/L						55.2												

Appendix B

Topographic and Bathymetric Survey Results



LEGEND - - SURVEY

- CONTROL POINT
- FOUND IRON PIPE
- VERTICAL BENCHMARK
- CONTROL HUB\LATH
- DOWNSPOUT
- POWER POLE
- LIGHT POLE
- GUY WIRE
- HYDRANT
- VALVE
- SIGN
- BOLLARD
- ELECTRICAL BOX
- UTILITY BOX
- GAS METER
- ELECTRICAL METER
- MANHOLE
- SANITARY MANHOLE
- STORM MANHOLE
- CATCH BASIN
- STORM DRAIN
- CLEAN OUT
- CULVERT
- DECIDUOUS TREE
- CONIFEROUS TREE
- MONITORING WELL
- WELL
- RELIEF WELL
- BORING
- PIEZOMETER
- INCLINOMETER
- TEST PIT
- STAFF GAGE
- ANTENNA
- SPRINKLER HEAD
- IRRIGATION VALVE BOX
- 714.2 BATHYMETRIC ELEVATION
- SECTION LINE
- PROPERTY LINE
- RIGHT-OF-WAY
- EASEMENT
- 1380 MAJOR CONTOUR
- 1379 MINOR CONTOUR
- CENTERLINE
- FENCE
- FLOW LINE
- RAILROAD TRACKS
- EDGE OF VEGETATION
- SHORELINE
- EDGE OF ROAD
- CURB AND GUTTER
- GAS LINE
- OVERHEAD ELECTRIC
- UNDERGROUND ELECTRIC
- UNDERGROUND FIBER OPTIC
- SANITARY SEWER
- STORM SEWER
- WATER LINE
- BATHYMETRIC POINTS
- GRID LINES (25')

BASIS OF DRAWING FILE:

DATE OF SURVEY: 2023/07/28 JHS & RJD

ORIGIN/DATE OF BASE: MNDOT VRS

COORDINATE SYSTEM: Ramsey County projection

HORIZONTAL DATUM: NAD83 (2011/NO TRANS)

VERTICAL DATUM: NAVD88

ADDITIONAL FILE INFORMATION:

1 - PLAN: SURVEY FIGURE

0 30 60
SCALE IN FEET

PRELIMINARY DRAFT
NOT FOR CONSTRUCTION

NO.	BY	CHK.	APP.	DATE	REVISION DESCRIPTION
-	-	-	-	-	-

CLIENT							
BID							
CONSTRUCTION							
RECORD							
RELEASED TO/FOR	A	B	C	0	1	2	3
	DATE RELEASED						

BARR

Corporate Headquarters: Minneapolis, Minnesota
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Fax: (951) 832-2601
www.barr.com

Scale	AS SHOWN
Date	2023/07/28
Drawn	RJD
Checked	---
Designed	---
Approved	---

VLA-WMO
ST. PAUL, MN

POLAR LAKES PARK STORMWATER
WHITE BEAR LAKE, MN

SURVEY PONDS, BERM, CULVERTS
BATHYMETRIC SURVEY

BARR PROJECT No.	23/62-1476.00
CLIENT PROJECT No.	
DWG. No.	X-XX
REV. No.	-

CADD USER: BOB DICKSON FILE: M:\DESIGN\SURVEY\23621476\00\23621476000_BASE_SUR_SURVEY_POLAR PARK 2023 INITIAL SURVEY.DWG PLOT SCALE: 1:2 PLOT DATE: 7/28/2023

Appendix C

Concept Cost Estimates

PREPARED BY: BARR ENGINEERING COMPANY	SHEET:	1	OF	1	
BARR	BY:	KAK3	DATE:	11/6/2023	
FINAL DESIGN	CHECKED BY:	JAK2	DATE:	11/10/2023	
ENGINEER'S OPINION OF PROBABLE PROJECT COST	APPROVED BY:		DATE:		
PROJECT: Polar Lakes Park Stormwater Reuse	ISSUED:		DATE:		
LOCATION: White Bear Township	ISSUED:		DATE:		
PROJECT #: 23621476	ISSUED:		DATE:		
OPINION OF COST - SUMMARY	ISSUED:		DATE:		

Engineer's Opinion of Probable Project Cost - Concept 1 Feasiblity Study

Cat. No.	ITEM DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT COST	ITEM COST	NOTES
A	Mobilization/Demobilization	L.S.	1	$29,500	$29,500	1,2,3,4
B	Erosion Control	L.S.	1	$9,600	$9,600	1,2,3,4
D	Dewatering	L.S.	1	$15,000	$15,000	1,2,3,4
E	Clearing and Grubbing	Acre	0.03	$35,000	$1,125	1,2,3,4
F	Salvage, Stockpile, and Place Topsoil	C.Y.	259	$40	$10,370	1,2,3,4
G	Intake Structure (5'x5'), Complete	L.S.	1	$40,000	$40,000	1,2,3,4
H	Class III Rip Rap (Intake Structure)	TON	13	$130	$1,690	1,2,3,4
I	4" PVC Piping	L.F.	700	$50	$35,000	1,2,3,4
J	Package Pump and Treatment System & Shelter	L.S.	1	$212,728	$212,728	1,2,3,4
K	Concrete Foundation	L.S.	1	$20,000	$20,000	1,2,3,4
L	Connection to Existing Irrigation System & Pipe Modifications	L.S.	1	$30,000	$30,000	1,2,3,4
M	Electrical and Controls	L.S.	1	$40,000	$40,000	1,2,3,4
N	Restoration (Seeding and Hydromulch/ECB)	Acres	0.32	$32,000	$10,285	1,2,3,4
O	Tree Protection Fencing	L.F.	100	$5	$500	1,2,3,4
P	Outlet Improvements	L.S.	1	$50,000	$50,000	1,2,3,4
Q	Channel Modifications	L.S.	1	$15,000	$15,000	1,2,3,4
					$0	1,2,3,4
	CONSTRUCTION SUBTOTAL				$521,000	1,2,3,4,6
	CONSTRUCTION CONTINGENCY		25%		$130,000	1,4,6
	ESTIMATED CONSTRUCTION COST				$651,000	1,2,3,4,6
	PLANNING, ENGINEERING, DESIGN, PERMITTING		20%		$130,200	
	CONSTRUCTION OVERSIGHT		5%		$32,550	
	ESTIMATED TOTAL PROJECT COST				**$814,000**	1,2,3,4,5,6
	ESTIMATED ACCURACY RANGE	-30%			$570,000	4,5,6
		50%			$1,221,000	4,5,6

Notes

[1] Level of design work completed (0-15%).

[2] Quantities based on design work completed.

[3] Unit prices based on information available at this time.

[4] This design level (Class 4, 0-15% design completion per ASTM E 2516-11) cost estimate is based on concept designs, alignments, quantities and unit prices. Costs will change with further design. Time value-of-money escalation costs are not included. A construction schedule is not available at this time. Contingency is an allowance for the net sum of costs that will be in the Final Total Project Cost at the time of the completion of design, but are not included at this level of project definition. The estimated accuracy range for the Total Project Cost as the project is defined is -30% to +50%. The accuracy range is based on professional judgement considering the level of design completed, the complexity of the project and the uncertainties in the project as scoped. The contingency and the accuracy range are not intended to include costs for future scope changes that are not part of the project as currently scoped or costs for risk contingency. Operation and Maintenance costs are not included.

[5] Estimate costs are for construction. The estimated costs do not include maintenance, monitoring or additional tasks following construction.

[6] Estimate costs are reported to nearest thousand dollars.

PREPARED BY: BARR ENGINEERING COMPANY	SHEET:	1	OF	1
BARR	BY:	KAK3	DATE:	11/6/2023
FINAL DESIGN	CHECKED BY:	JAK2	DATE:	11/10/2023
ENGINEER'S OPINION OF PROBABLE PROJECT COST	APPROVED BY:		DATE:	
PROJECT: Polar Lakes Park Stormwater Reuse	ISSUED:		DATE:	
LOCATION: White Bear Township	ISSUED:		DATE:	
PROJECT #: 23621476	ISSUED:		DATE:	
OPINION OF COST - SUMMARY	ISSUED:		DATE:	

Engineer's Opinion of Probable Project Cost - Concept 2 Feasiblity Study

Cat. No.	ITEM DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT COST	ITEM COST	NOTES
A	Mobilization/Demobilization	L.S.	1	$41,800	$41,800	1,2,3,4
B	Erosion Control	L.S.	1	$13,700	$13,700	1,2,3,4
D	Dewatering	L.S.	1	$15,000	$15,000	1,2,3,4
E	Clearing and Grubbing	Acre	0.08	$35,000	$2,732	1,2,3,4
F	Salvage, Stockpile, and Place Topsoil	C.Y.	630	$40	$25,185	1,2,3,4
G	Intake Structure (5'x5'), Complete	L.S.	1	$40,000	$40,000	1,2,3,4
H	Class III Rip Rap (Intake Structure)	TON	13	$130	$1,690	1,2,3,4
I	4" PVC Piping	L.F.	1700	$50	$85,000	1,2,3,4
J	Package Pump and Treatment System & Shelter	L.S.	1	$257,576	$257,576	1,2,3,4
K	Booster Pump	L.S.	1	$5,000	$5,000	1,2,3,4
L	Concrete Foundation	L.S.	1	$20,000	$20,000	1,2,3,4
M	Connection to Existing Irrigation System & Pipe Modifications	L.S.	2	$30,000	$60,000	1,2,3,4
N	Electrical and Controls	L.S.	2	$40,000	$80,000	1,2,3,4
O	Restoration (Seeding and Hydromulch/ECB)	Acres	0.78	$32,000	$24,977	1,2,3,4
P	Tree Protection Fencing	L.F.	100	$5	$500	1,2,3,4
Q	Outlet Improvements	L.S.	1	$50,000	$50,000	1,2,3,4
R	Channel Modifications	L.S.	1	$15,000	$15,000	1,2,3,4
					$0	1,2,3,4
	CONSTRUCTION SUBTOTAL				$738,000	1,2,3,4,6
	CONSTRUCTION CONTINGENCY		25%		$185,000	1,4,6
	ESTIMATED CONSTRUCTION COST				$923,000	1,2,3,4,6
	PLANNING, ENGINEERING, DESIGN, PERMITTING		20%		$184,600	
	CONSTRUCTION OVERSIGHT		5%		$46,150	
	ESTIMATED TOTAL PROJECT COST				**$1,154,000**	1,2,3,4,5,6
	ESTIMATED ACCURACY RANGE	-30%			$808,000	4,5,6
		50%			$1,731,000	4,5,6

Notes

[1] Level of design work completed (0-15%).

[2] Quantities based on design work completed.

[3] Unit prices based on information available at this time.

[4] This design level (Class 4, 0-15% design completion per ASTM E 2516-11) cost estimate is based on concept designs, alignments, quantities and unit prices. Costs will change with further design. Time value-of-money escalation costs are not included. A construction schedule is not available at this time. Contingency is an allowance for the net sum of costs that will be in the Final Total Project Cost at the time of the completion of design, but are not included at this level of project definition. The estimated accuracy range for the Total Project Cost as the project is defined is -30% to +50%. The accuracy range is based on professional judgement considering the level of design completed, the complexity of the project and the uncertainties in the project as scoped. The contingency and the accuracy range are not intended to include costs for future scope changes that are not part of the project as currently scoped or costs for risk contingency. Operation and Maintenance costs are not included.

[5] Estimate costs are for construction. The estimated costs do not include maintenance, monitoring or additional tasks following construction.

[6] Estimate costs are reported to nearest thousand dollars.

Appendix D

Summary of USACE Follow-Up Items

Technical Memorandum

To: Phil Belfiori & Brian Corcoran, VLAWMO
From: Jennifer Koehler, PE
Subject: Polar Lake Park Stormwater Reuse Project – Summary of USACE Follow-up Items
Date: 1/10/2024
Project: 23/62-1476
c: Erin Anderson-Wenz

The following memo summarized the addition data requests resulting from the 12/11/23 conversation with the United States Army Corps of Engineers (USACE) as it relates to permitting for the stormwater reuse system utilizing the mitigation wetland located on the southwest side of Polar Lake Park.
Figures 1 through 4 were developed to support the USACE questions about the impact of the concepts on the Permittee Responsible Mitigation (PRM) area.

- Figure 1 shows the preconstruction aerial photo (1997) overlaid with the proposed Polar Lakes Park Stormwater Reuse Project Impact areas, based on the conceptual design to date. This area appears to have been upland and was not mapped as wetland for existing conditions during the original project design.
- Figure 2 shows the current aerial photo (2023) overlaid with the proposed Polar Lakes Park Stormwater Reuse Project Impact areas, based on the conceptual design to date.
- Figure 3 shows the post-construction as-built survey (2013) overlaid with the proposed Polar Lakes Park Stormwater Reuse Impact areas. The park was constructed in 2000 and included the created of numerous mitigation wetlands (Type 2/3), including the two wetland basins in the southwest corner of the park.
- Figure 4 shows the approximate wetland area based on the National Wetlands Inventory (NWI) as available for the area. The NWI maps these wetlands as freshwater pond and freshwater emergent wetland. Also shown is the approximate footprint of the wetland versus upland. This is not an official wetland delineation, just an estimate based on the topography (elevation 916.0 ft MSL) and review of aerial photos.

Based on the approximate footprint of the wetland and the estimated footprint of the project extents, the estimated wetland impact area for the reuse project is:

- 3826 SF using the NWI boundary, and
- 2355 SF using the approximate wetland boundary based on elevation 916.0 ft MSL.

These impacts area reflect a combination of temporary construction impacts (installation of the intake structure on shoreline, channel modifications (lowering) between basins) as well as potentially permanent impacts (improvements to the outlet/berm that may add material to the existing berm within the wetland).

Figure 5 was developed in response to questions about if the proposed project would indirectly impact any fringe wetlands in the area and if the proposed drawdowns would result in the wetland being converted from wetland to upland or if it would result in a change in community (e.g. shallow marsh to wet meadow). Using the 2023 survey data of the area around the southwest wetland in Polar Lakes Park, including the wetland bathymetry, Figure 5 shows the area for the following elevations:

- 916.0 ft MSL (historic Normal Water Level (NWL) of mitigation wetland per original design/as-built)
- 915.0 ft MSL (approximate current NWL (914.9 ft MSL)/outlet elevation of mitigation wetland per 2023 survey due to channel developing through the berm)
- 914.0 ft MSL (~1.0 ft of drawdown from current NWL, as originally proposed for Concept 1)
- 913.5 ft MSL (~1.5 ft of drawdown from current NWL, as originally proposed for Concept 2)

Additionally, based on the 2023 survey data, we performed an assessment of storage available for reuse within the two basins of the mitigation wetland located in the southwest corner of Polar Lakes Park (see Table 1). This includes the assumption that the NWL is elevation 916.0 ft MSL (per as-built survey/original design) versus NWL at elevation 914.9 ft MSL (per 2023 survey).

This storage summary was used to estimate how quickly the mitigation wetland volume would return to NWL if fully drawn down for reuse. Refilling of the wetland basins could be due to either:

- Birch Lake is discharging
- Precipitation/runoff events from the primary watershed only (i.e. Birch Lake is NOT discharging)

Table 1 Estimated Wetland Storage Summary

Elevation	Drawdown from NWL (feet)	Cumulative Storage Available for Reuse (acre-ft)	Cumulative Storage Available for Reuse (gallons)
Storage Estimates Assuming NWL is 916.0 ft MSL (1)			
916.0	0.0	0.0	0.0
915.5	0.5	0.50	162,925
915	1.0	0.92	300,760
914.5	1.5	1.30	413,831
914	2.0	1.61	524,294
Storage Estimates Assuming NWL is 914.9 ft MSL (2)			
914.9	0.0	0.0	0.0
914.4	0.5	0.44	143,700
913.9	1.0	0.74	242,107
913.4	1.5	1.00	324,873
912.9	2.0	1.21	393,628

(1) Depth of drawdown estimated from NWL at 916.0 ft MSL per 2013 as built.

(2) July 2023 survey indicates NWL of 914.9 MSL.

For this assessment, we assumed a drawdown of 1.5 feet from elevation 916.0 ft MSL (the proposed maximum drawdown for Concept 2), would result in the largest drawdown volume of 1.30 acre-ft. Based on this volume, the reuse system would take approximately 11-19 days to fully drawdown the wetland water levels for irrigation of the upper and lower fields (Concept 2), assuming no recharge from Birch Lake or runoff from the watershed and depending on the irrigation rate of 0.5 and 0.3 inches per week, respectively. Ultimately, we expect that to recharge the proposed drawdown of 1.5 feet would typically fully recharge to the NWL within hours to days; however, with constant discharges from Birch Lake or with rain events occurring every 3-5 days, it is unlikely under average conditions that the wetland water levels will be fully drawn down and will typically rebound within hours to a week or two, depending on if Birch Lake is discharging.

The two methods to evaluate the recharge of the wetland water levels from fully drawn down to normal water level are further discussed and summarized in more detail below.

Review of the historic lake level data for Birch Lake indicates that water levels are above the outlet invert ~30-40% of time during the historic lake level record. Using Manning's equation, information on the culvert outlet from the lake, and the historic lake level data for the irrigation season (May- September), the estimated discharges from Birch Lake ranges from 0.01 cfs (minimum) – 11.4 cfs (maximum), with an average discharge of 1.25 cfs,

At the average discharge rate (1.25 cfs) from Birch Lake, the wetland water levels would recharge from fully drawn down to NWL in approximately 13 hours. However, because the reuse system would take approximately 11-19 days to fully drawdown the wetland water levels for irrigation of the upper and lower fields, and the estimated recharge is on the order of hours to days when Birch Lake is discharging, we would not expect to see large fluctuations in the NWL of the wetland basins under these conditions, even with the reuse system operating.

When Birch Lake is not discharging, the reuse volume within the wetlands in Polar Lake Park will be replenished based only on runoff from the primary watershed downstream of Birch Lake which is approximately 178-acres. Using the 50-year water balance utilizing daily precipitation data from the Minneapolis-St Paul International Airport, we looked at the size and frequency of precipitation events during the irrigation season (May – September) that would generate enough watershed runoff to refill the volume used for park irrigation. Assessment of the daily precipitation data during the irrigation season suggests that rainfall is expected to occur approximately every 3 days (on average). The average rainfall event is 0.42 inches.

According to the correlation between daily precipitation totals and the estimated runoff volume generated from the primary watershed during the precipitation events, a precipitation event of approximately 0.3-inches would be needed to generate enough runoff to fully recharge the drawdown volume of 1.30 acre-ft. Based on the historic precipitation data, a 0.3-inch event is expected to happen, on average, every 9 days during the irrigation season; however, smaller rain events will happen more frequently (e.g. a 0.1-inch rainfall event is expected to happen every 5 – 6 days, with smaller events happening even more frequently). Again, for Concept 2 (resulting in the greatest proposed drawdown), the reuse system would take approximately 11-19 days to fully drawdown the wetland basins for irrigation of the upper and lower fields, assuming no recharge from Birch Lake or runoff from the watershed and depending on the irrigation rate of 0.5 and 0.3 inches per week, respectively. Based on the assessment of runoff from the primary watershed (assuming no discharges from Birch Lake), although we will expect the wetland water levels to fluctuate more than when Birch Lake is discharging, the water levels on the wetland basins should be partially recharged by smaller rain events every few days and filled back to the NWL every week or two.

Proposed Project
Proposed Project
Proposed Project
Project Area
Storm Sewer

N

0 30 60
Feet

WHITE BEAR TOWNSHIP

EST 1983 VLAWMO Vadnais Lake Area Water Management Organization

MITIGATION WETLANDS BASINS PRECONSTRUCTION CONDITIONS (1997)

Polar Lakes Park
VLAWMO, White Bear Twp

FIGURE 1

BARR

Proposed Project
Proposed Project
Proposed Project
Project Area
Storm Sewer

0 30 60
Feet

Imagery: Nearmap, 2023

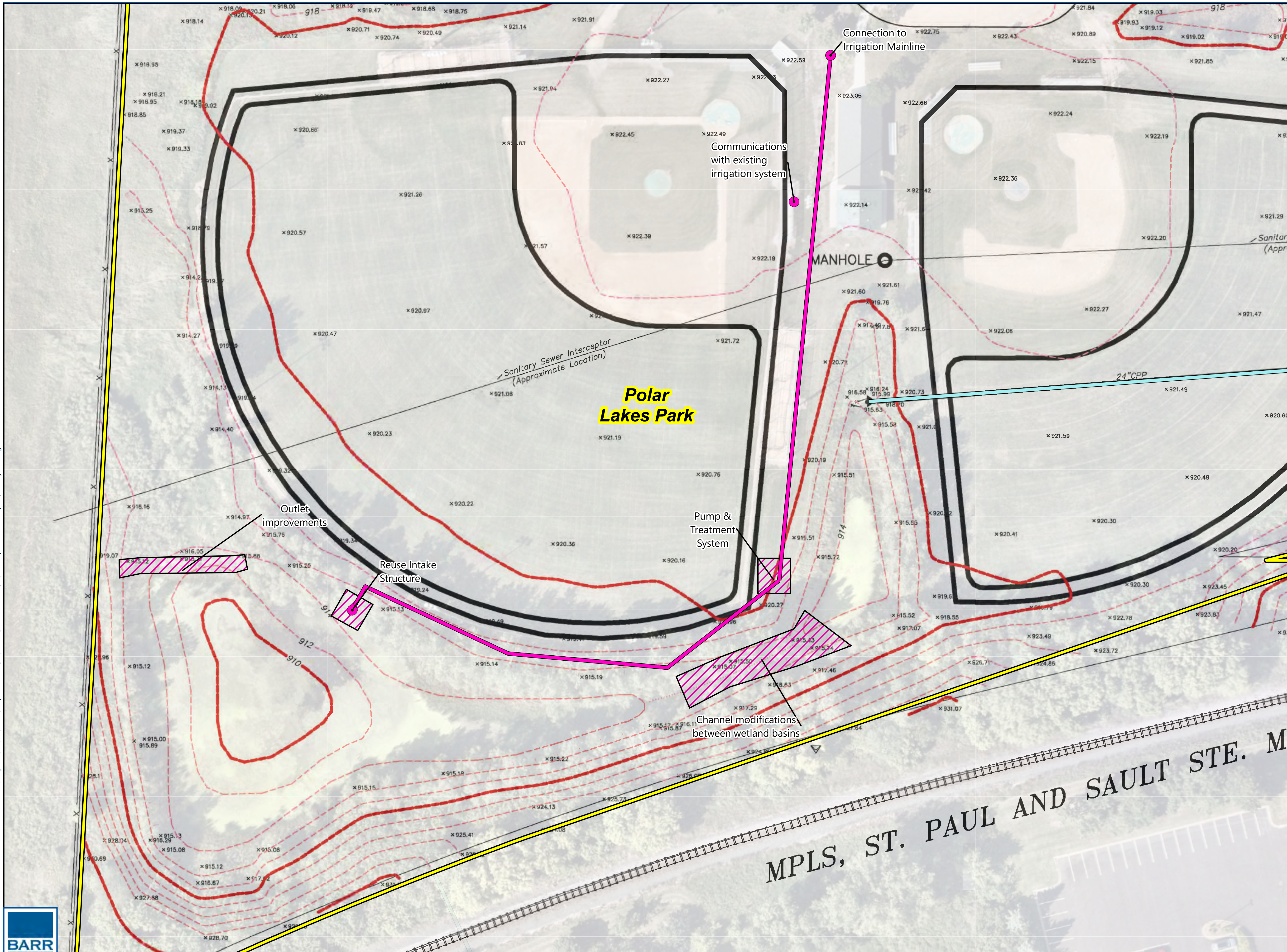
WHITE BEAR TOWNSHIP

EST 1983 VLAWMO Vadnais Lake Area Water Management Organization

MITIGATION WETLANDS BASINS EXISTING CONDITIONS (2023)
Polar Lakes Park
VLAWMO, White Bear Twp

FIGURE 2

BARR



- Proposed Project
- Proposed Project
- Proposed Project
- Project Area
- Storm Sewer

0 30 60
Feet

Imagery: Nearmap, 2023
As-Built Topography, 2013

WHITE BEAR TOWNSHIP

EST 1983 VLAWMO Vadnais Lake Area Water Management Organization

MITIGATION WETLANDS BASINS
AS-BUILT SURVEY (2013)
Polar Lakes Park
VLAWMO, White Bear Twp

FIGURE 3

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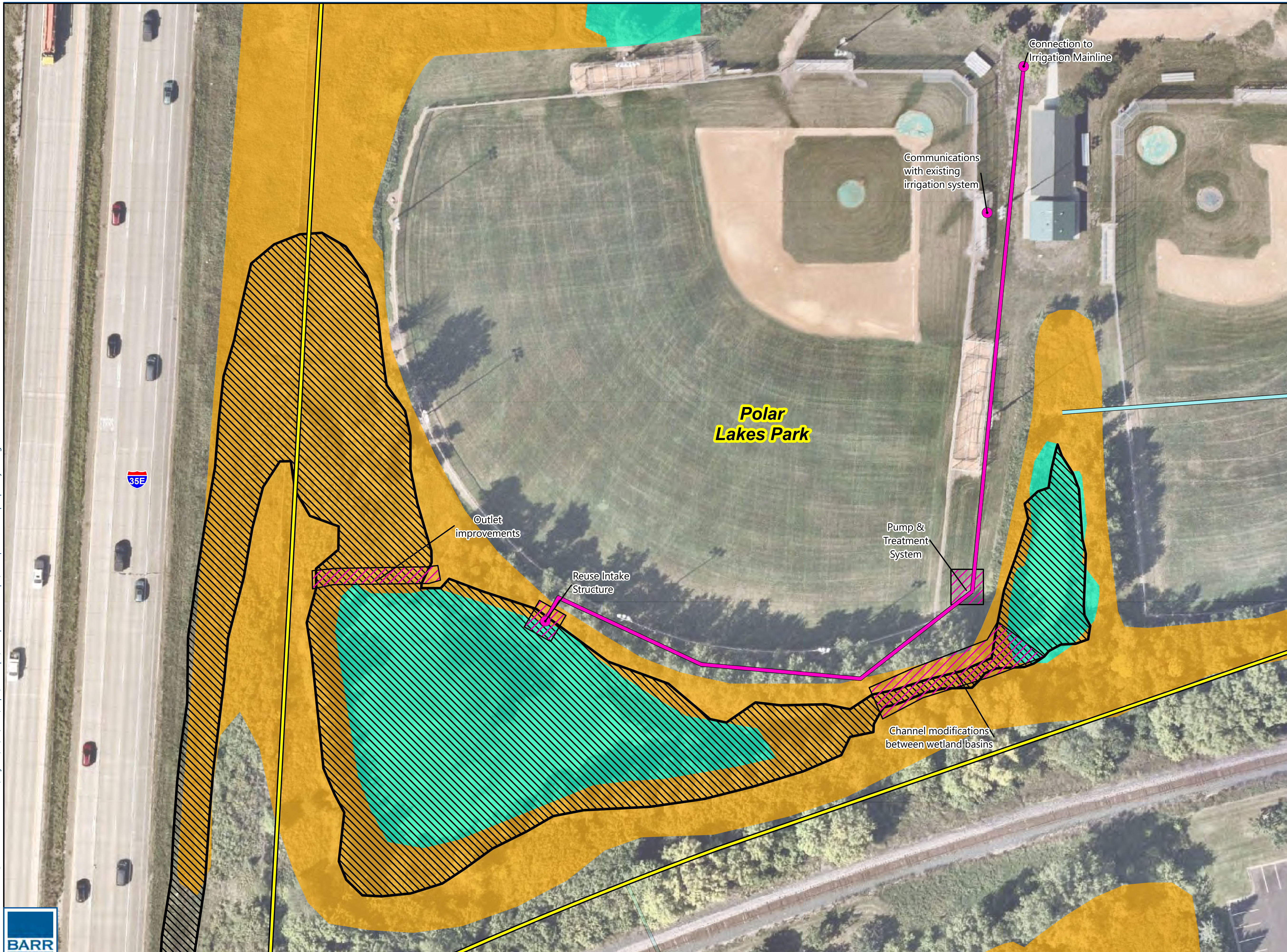

Proposed Project
Proposed Project
Proposed Project
Project Area
Storm Sewer
Approximate Wetland Area*

NWI Minnesota

Freshwater Emergent Wetland
Freshwater Pond

*Based on 916.0 ft MSL per 2023 survey

0 30 60
Feet

Imagery: Nearmap, 2023

WHITE BEAR TOWNSHIP

EST 1983 VLAWMO Vadnais Lake Area Water Management Organization

MITIGATION WETLANDS BASINS APPROXIMATE WETLAND AREA (NWI)
Polar Lakes Park
VLAWMO, White Bear Twp

FIGURE 4

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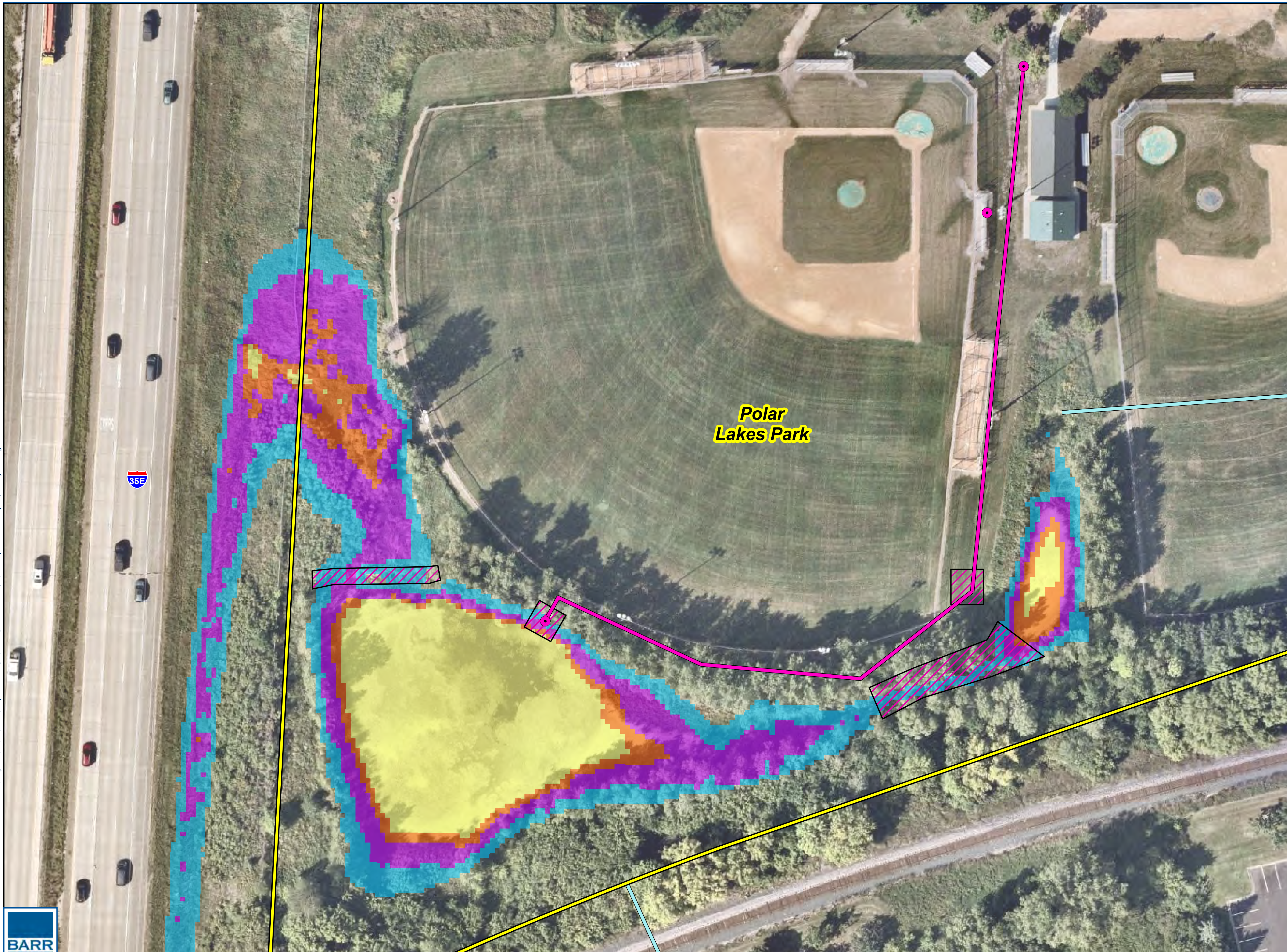

- Proposed Project
- Proposed Project
- Proposed Project
- Project Area
- Storm Sewer

Drawdown Elevations / Areas

- 913.5 ft MSL (0.48 acre)
- 914.0 ft MSL (0.58 acre)
- 915.0 ft MSL (0.80 acre)
- 916.0 ft MSL (1.07acre)
- Above 916.0 ft MSL

N

0 30 60
Feet

Imagery: Nearmap, 2023

MITIGATION WETLANDS BASINS DRAWDOWN AREAS
Polar Lakes Park
VLAWMO, White Bear Twp

FIGURE 5