Item 7E.
BCWMC 10-20-22

Sochacki Park Subwatershed Assessment

Prepared for
Three Rivers Park District

September 2022

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Sochacki Park Subwatershed Assessment

September 2022

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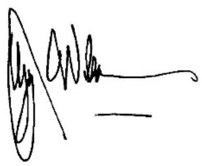
Certifications

I hereby certify that this plan, specification, or 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.



9/16/22

Greg Wilson
PE #: 25782

Date

Abbreviations

BCWMC	Bassett Creek Watershed Management Commission
BMP	Best Management Practice
Chl-a	Chlorophyll-a
LiDAR	Light Detection and Ranging
MSL	Mean Sea Level
MDNR	Minnesota Department of Natural Resources
MNRAM	Minnesota Routine Assessment Method for Evaluating Wetland Functions
NRCS	Natural Resources Conservation Service
OHW	Ordinary High Water
P8	Program for Predicting Polluting Particle Passage Thru Pits, Puddles, and Ponds
PWI	Public Waters Inventory
SD	Secchi Disc
SSURGO	Soil Survey Geographic Database
TRPD	Three Rivers Park District
TP	Total Phosphorus
USFWS	United States Fish and Wildlife Service

1 Executive Summary

Recent efforts to better understand the ecological health, and set appropriate goals for, the Sochacki Park wetlands (South and North Rice Ponds) has identified improvements that are likely necessary to improve the ecological health of the wetlands, improve aesthetics, and provide recreation and education opportunities. Many of the goals or metrics for ecological health are directly tied to improved wetland water quality (through nutrient reductions) and enhancements to vegetative diversity and integrity.

To better understand and evaluate the water quality treatment performance of the existing best management practices (BMPs) in the Sochacki Park subwatershed, Barr Engineering Co. (Barr) revised the existing Bassett Creek Watershed Management Commission's (BCWMC) P8 watershed model to reflect GIS subwatershed delineations and modeling inputs for each subwatershed and respective BMPs. We then updated the revised BCWMC P8 model with 2020 and 2021 growing-season climate data (hourly precipitation and daily temperatures) to develop the phosphorus (total and dissolved) and total suspended solids (TSS) loadings for the period. The available in-wetland water quality monitoring and watershed stormwater monitoring data of inflows and outflows were used to calibrate the watershed modeling, where possible.

We used the updated P8 modeling results and GIS mapping to identify high priority areas for implementing watershed BMPs. P8 modeling completed for the summers of 2020 and 2021 indicates that 20 and 17 percent of the current overall phosphorus load, in respective years, receives stormwater treatment before discharge to the three wetlands. Approximately 22 percent of the runoff phosphorus load in the Grimes Pond watershed receives stormwater treatment, while the respective levels of treatment in the direct drainage to North and South Rice Ponds are approximately 39 and 30 percent.

The calibrated watershed modeling was used to concurrently develop the water and phosphorus budgets to optimize the daily pond water quality modeling fit to the summer monitoring data associated with each pond. Subsequently, we used the water quality modeling results to assess the implications for the summer assimilation capacity (i.e., nutrient uptake and/or sedimentation) of each pond, and we used the water and phosphorus budgets to identify and develop implementation strategies for improving wetland water-quality. The short water residence times estimated for the watershed wetlands (averaging 38 days for Grimes Pond, 20 days for North Rice Pond and 8 days for South Rice Pond) limit the capacity to assimilate the summer runoff phosphorus loads from each direct drainage area, as well as the overall watershed.

A detailed analysis of the dissolved oxygen data, combined with the pond water quality modeling, confirmed that internal phosphorus loading can be an important source of phosphorus input to each pond during the summer. Internal phosphorus loading represented 32 percent of the summer phosphorus budget for Grimes Pond in 2020, as well as six and 24 percent of the respective summer phosphorus budgets for North Rice Pond in 2020 and 2021. Discharge from Grimes Pond represented 34 and 29 percent of the respective summer phosphorus budgets for North Rice Pond in 2020 and 2021. Internal phosphorus loading represented 8 and 9 percent of the respective summer phosphorus budgets for South Rice Pond in 2020 and 2021. Discharge from North Rice Pond represented 11 and 14 percent of the respective summer phosphorus budgets for South Rice Pond in 2020 and 2021.

Based on the calibrated watershed and pond water quality modeling, the following watershed BMPs and in-pond management options are recommended to substantially reduce the respective phosphorus loadings and enhance vegetative diversity and integrity for each pond:

- Install structural BMPs and/or pretreatment protection measures to prevent future sediment delivery and reduce nutrient loading into the wetland with design(s) intended to meet water quality goals. Untreated stormwater runoff from two discharge outfalls each to South Rice and Grimes Ponds, as well as one outfall to North Rice Pond, are prioritized for implementation.
- Complete in-pond alum treatments to control summer sediment phosphorus release following implementation of watershed BMPs.
- Clear clogged debris and develop annual maintenance plan for all inlet and outlet structures. Remove accumulated sediment and fill materials from BMPs and within, and adjacent to, each wetland. Reconfigure discharge outfall and stabilize erosion from stormwater conveyance entering northwest corner of Grimes Pond.
- Re-vegetate and control soil erosion from bare soil areas within the upland buffer area. If mountain bike activity in the adjacent upland area is currently supported, isolate potential soil disturbance and adjacent vegetation improvements to prevent erosion into surrounding wetland areas.
- Conduct controlled water level drawdowns in each wetland prior to the winter season to ensure that curly-leaf pondweed is decreased to less than 20 percent cover and to enhance overall vegetative diversity and integrity. Remove, treat, and control other non-native invasive species, where possible, and remove fill material and trash.
- Initiate, or increase the frequency of, street sweeping and fall leaf litter removal programs, with emphasis in subwatersheds that have direct drainage to the wetlands.

2 Introduction

Recent efforts to better understand the ecological health, and set appropriate goals for, the Sochacki Park wetlands (South and North Rice Ponds) has identified improvements that are likely necessary to improve the ecological health of the wetlands, improve aesthetics, and provide recreation and education opportunities. Many of the goals or metrics for ecological health are directly tied to improved wetland water quality (through nutrient reductions) and enhancements to vegetative diversity and integrity. Another goal involves stakeholder engagement throughout the development of the Sochacki Park subwatershed assessment.

2.1 Site and Wetland Description

Sochacki Park is surrounded by residential property, located within the City of Robbinsdale, west of the BNSF Railroad and east of June Ave N (Township 29, Range 24, and Sections 7 and 18) within Hennepin County. The park access road off 36th Ave N leads to a small parking lot at the north end of the park adjacent to an Xcel Energy utility line. A picnic structure and paved trails are located within the park. North Rice Pond, located south of the picnic structure, is identified in the Minnesota Department of Natural Resources (MN DNR) Public Water Inventory (PWI) as a Public Water Wetland 27-644W and South Rice Pond, located at the south end of the park, is identified as Public Water Wetland 27-645W. Grimes Pond, which shares the same PWI number as North Rice Pond, is located northeast of the railroad tracks. South Rice Pond extends beyond Sochacki Park to the south adjacent to Bassett Creek into the City of Golden Valley. A restored prairie is located near the upland edges between North and South Rice Ponds. In addition to the main paved trails, several unpaved paths are present throughout the park. Mounds and logs placed for mountain bike activity are present east of South Rice Pond. Figure 2-1 shows the pond bathymetry and provides the maximum depths of each pond.

2.2 Watershed Description

Figure 2-2 shows the subwatersheds and drainage for the Sochacki Park study area.

2.3 Water Quality Goals and Standards

Previously, the Bassett Creek Watershed Management Commission's (BCWMC) goal for Grimes, North Rice and South Rice Ponds was a management classification of Level III, meaning its water quality should support aesthetic viewing (BCWMC, 2004 and Barr Engineering, 2014). Level III goals were: (1) maximum total phosphorus (TP) concentration of 75 µg/L, (2) maximum chlorophyll *a* (Chl-a) concentration of 40 µg/L, and (3) minimum Secchi disc (SD) transparency of 1.0 meters (about 3 feet). Since Grimes and North Rice Ponds (27-644W) and South Rice Pond (27-645W) are considered wetlands, there are no MPCA water quality standards that apply, and BCWMC is currently managing water quality from the study watershed to improve biotic integrity and water quality in the main stem of Bassett Creek.

Based on literature and steering committee feedback, there was consensus that it was important to improve wetland water quality and ecology in all three ponds by making an initial harvest, followed by significant nutrient reductions to shift away from floating plant dominance and the resulting pond water anoxia (per Scheffer et al., 2003). As a result, the previous BCWMC water quality goals provide a benchmark for making this shift in wetland ecology that will also enhance vegetative diversity and integrity. It will also be important to control invasive species, both in wetland and upland areas, while controlling and/or removing sediment deposits.

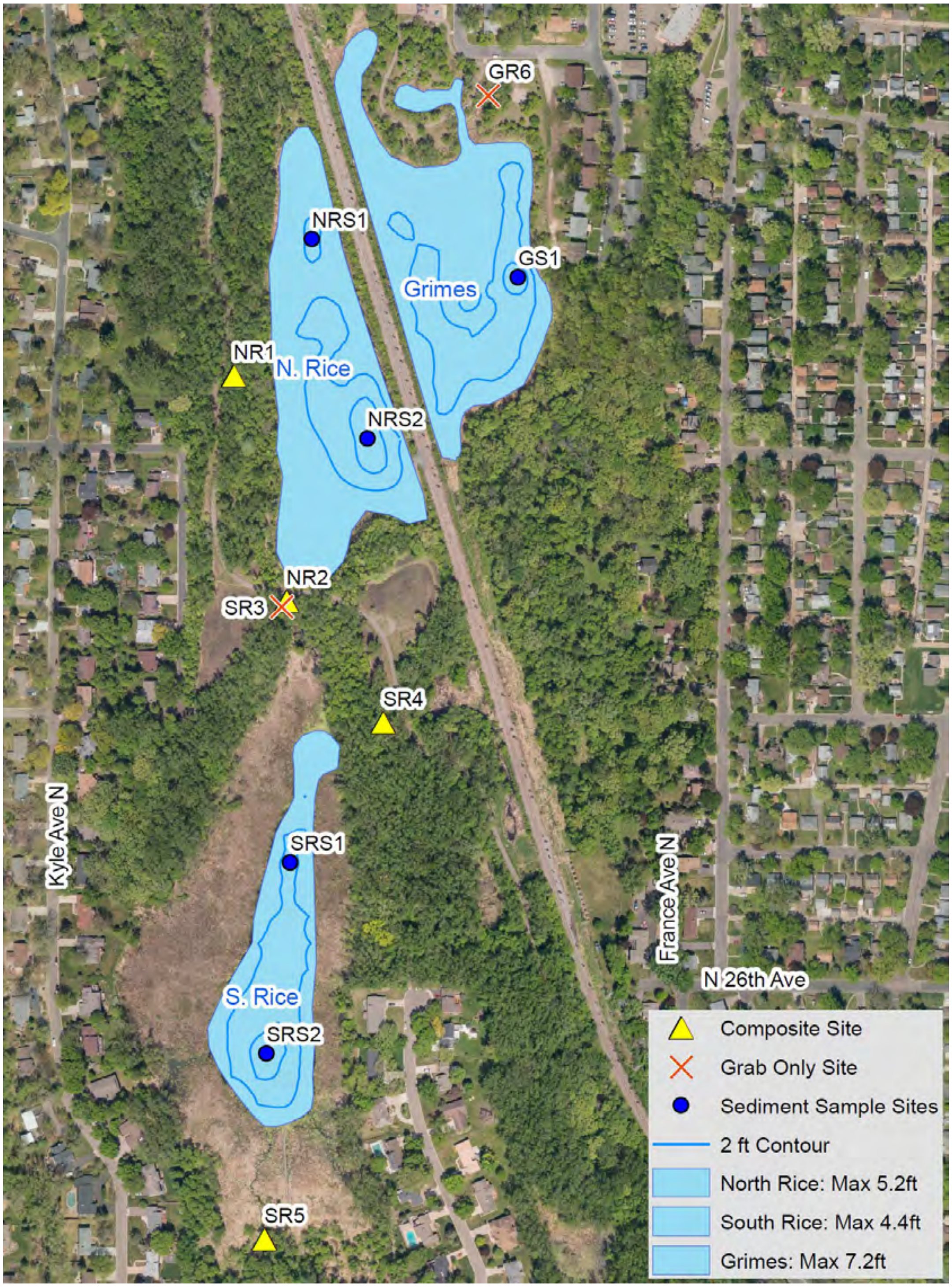
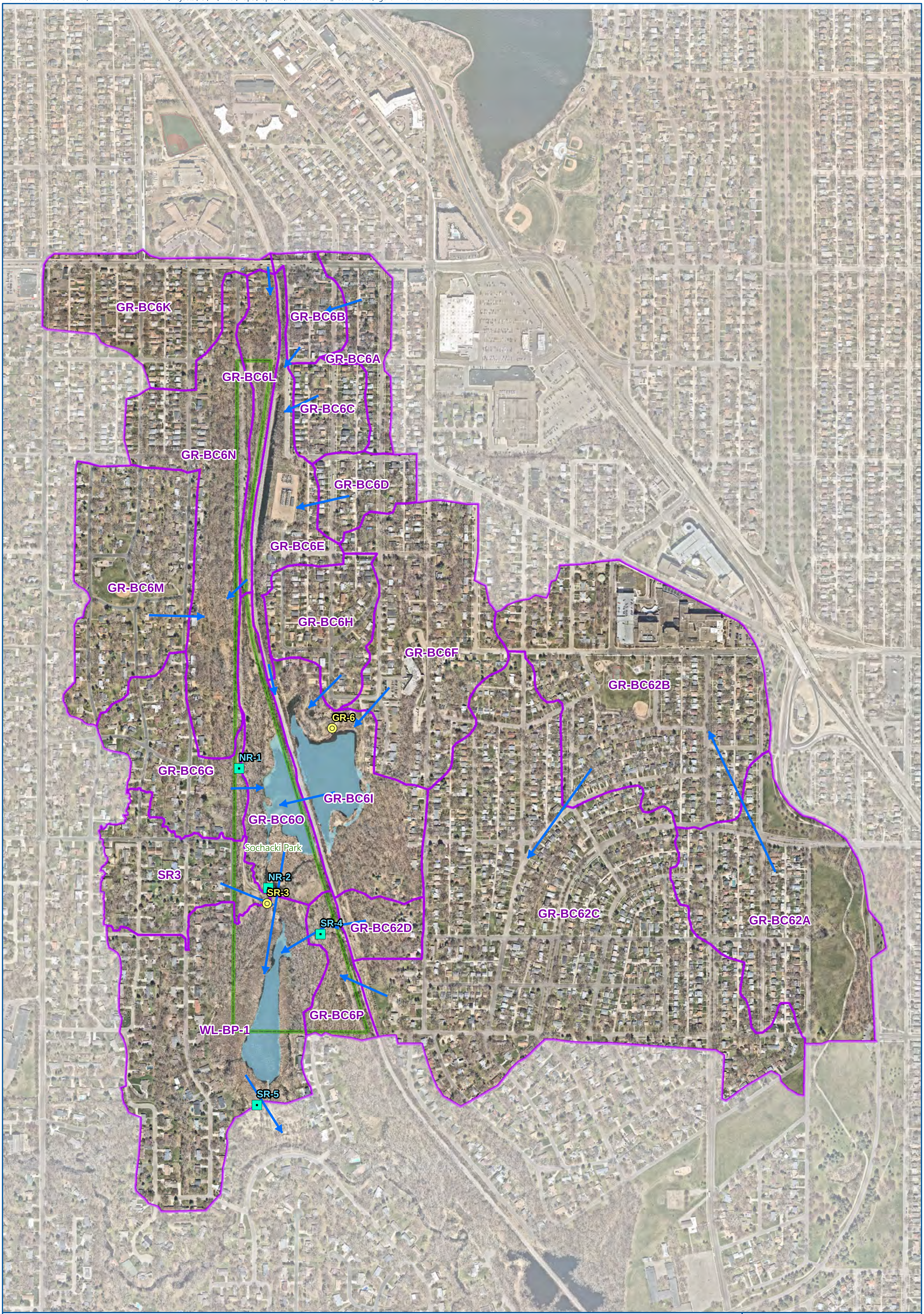


Figure 2-1 Sochacki Park Ponds, Bathymetry and Monitoring Sites



Automated Monitoring Site
Grab Sample Site
Pipe
Flow Direction
Waterbodies
Sochacki Park
Subwatersheds
Municipal Boundary

BARR

N

0 300 600
Feet

Imagery: NearMap; May 6, 2022

SUBWATERSHEDS & STORM SEWER
Sochacki Park
Subwatershed Assessment
Three Rivers Park District

FIGURE 2-2

3 Monitoring

Figures 2-1 and 2-2 shows the automated and grab sample sites for watershed water quality monitoring. The automated monitoring sites included flow monitoring equipment to facilitate the development of pollutant load estimates. Figure 2-1 shows the wetland water quality and sediment monitoring sites. Continuous water level measurements were also collected at all three wetlands. Except for the sediment monitoring and testing, Three Rivers Park District (TRPD) staff performed all of the field sampling and analytical testing for this assessment.

3.1 Pond Monitoring

3.1.1 Total Phosphorus, Chlorophyll-a and Secchi Disc Transparency

Figures 3-1, 3-2 and 3-3 show the summer average TP, Chl-a and SD transparency data for Grimes Pond, North Rice Pond, and South Rice Pond, respectively. The results for all three ponds generally show that summer average TP concentrations greatly exceed the Level III goal, while summer average Chl-a and SD transparencies correspond well with the respective Level III goals. This data, together with observations of heavy growth of free-floating plants (duckweed and watermeal) across the surface of all three ponds, indicates that algae growth is being limited by the amount of sunlight that can reach the water profile. This phenomenon will also limit the growth of submerged plant growth in each pond. Nutrient reductions will be needed to shift away from floating plant dominance in each pond.

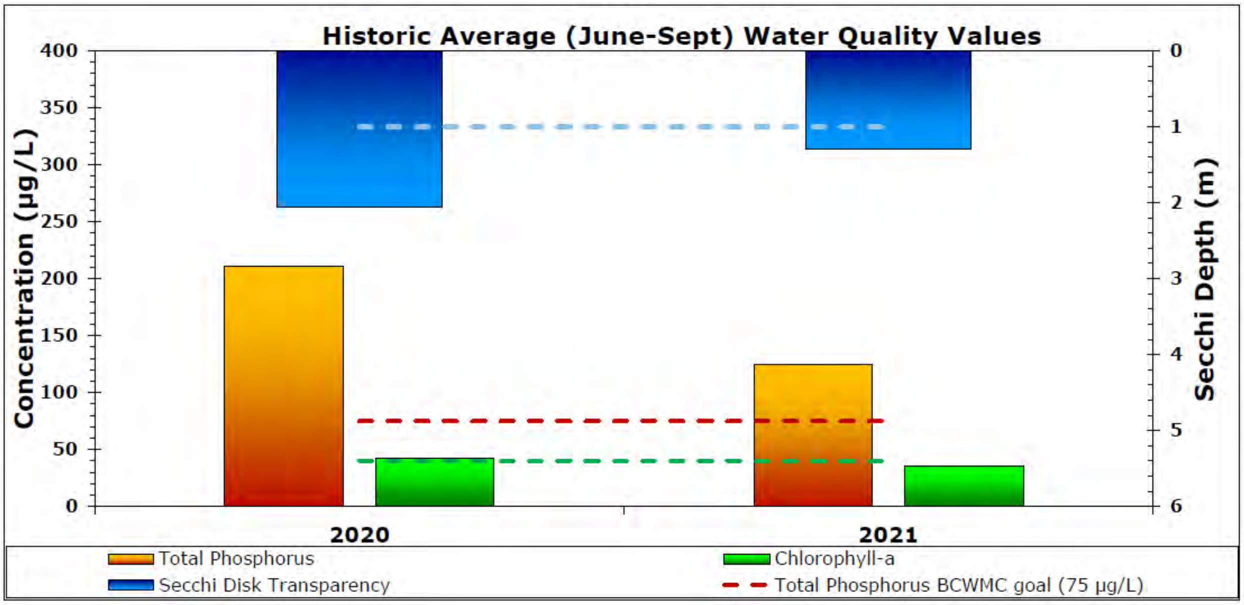


Figure 3-1 Grimes Pond Total Phosphorus, Chlorophyll-a, and Secchi Disc Transparency

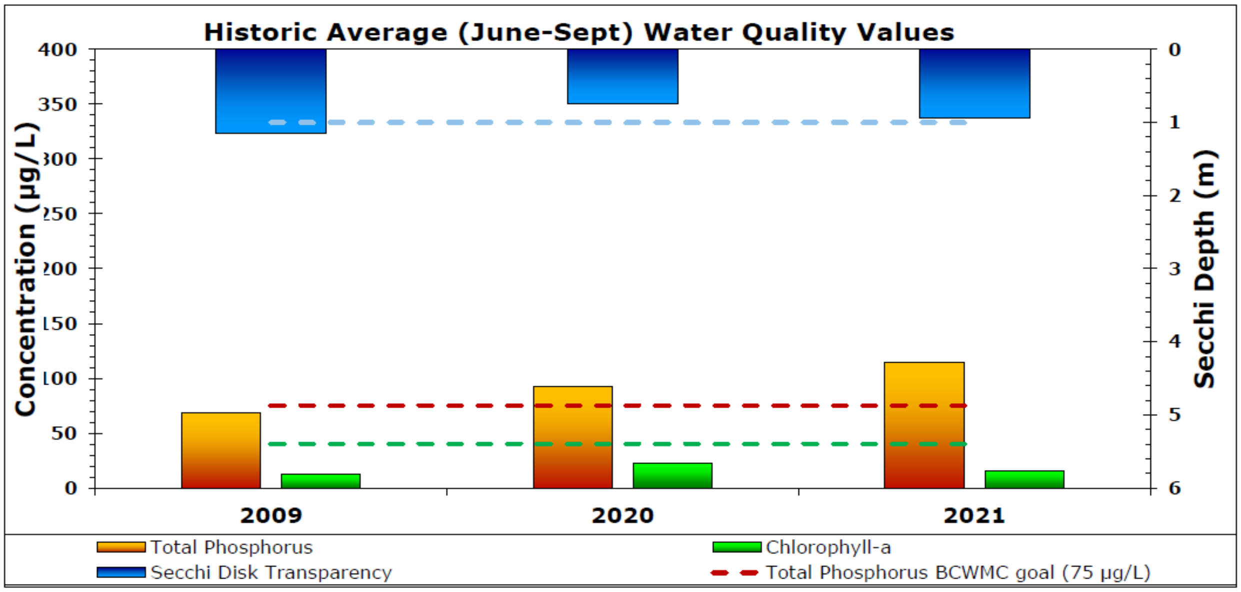


Figure 3-2 North Rice Pond Total Phosphorus, Chlorophyll-a, and Secchi Disc Transparency

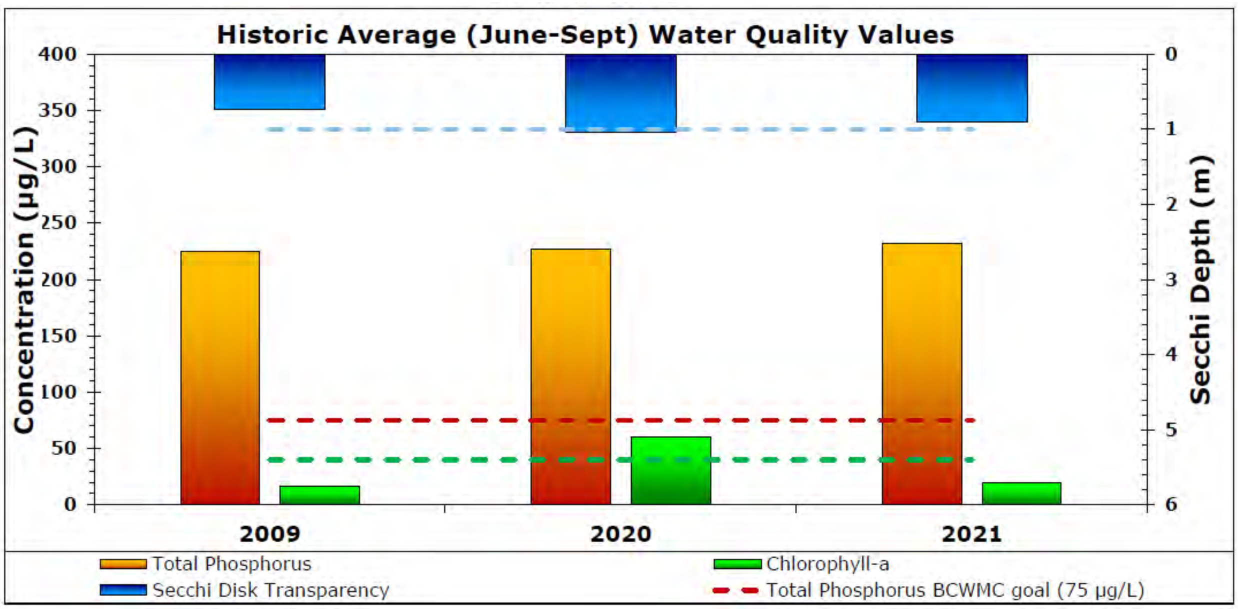


Figure 3-3 South Rice Pond Total Phosphorus, Chlorophyll-a, and Secchi Disc Transparency

3.1.2 Dissolved Oxygen

Continuous dissolved oxygen measurements were taken in all three ponds during July 2020, and again in July and early-August, 2021, as well as instantaneous measurements during each of the water quality sampling events. The continuous dissolved oxygen measurements showed that all three ponds were anoxic (completely devoid of oxygen) in 2020 and 2021. The instantaneous oxygen measurements indicated that April and June had higher levels, but rest of season was anoxic at all ponds. Due to low oxygen levels, bacteria do not efficiently break down decaying organic material and sediment chemistry will typically result in the release of phosphorus to the overlying pond water. In addition, anoxia under floating plant beds may boost the decline of submerged plants (Scheffer et al., 2003).

3.1.3 Sediment phosphorus

Figures 3-4 and 3-5 show how the respective mobile and organic fractions of phosphorus vary by depth in the sediment of each pond sampling location (shown in Figure 2-1). The mobile and organic fractions of sediment phosphorus are readily available for release under anoxic conditions and Figures 3-4 and 3-5 show that the concentrations at each sampling locations are elevated near the sediment-pond water interface. Results of the dissolved oxygen monitoring, combined with the pond sediment phosphorus data, confirmed that internal phosphorus loading, under anoxic conditions, can be an important source of phosphorus input to each pond during the summer months.

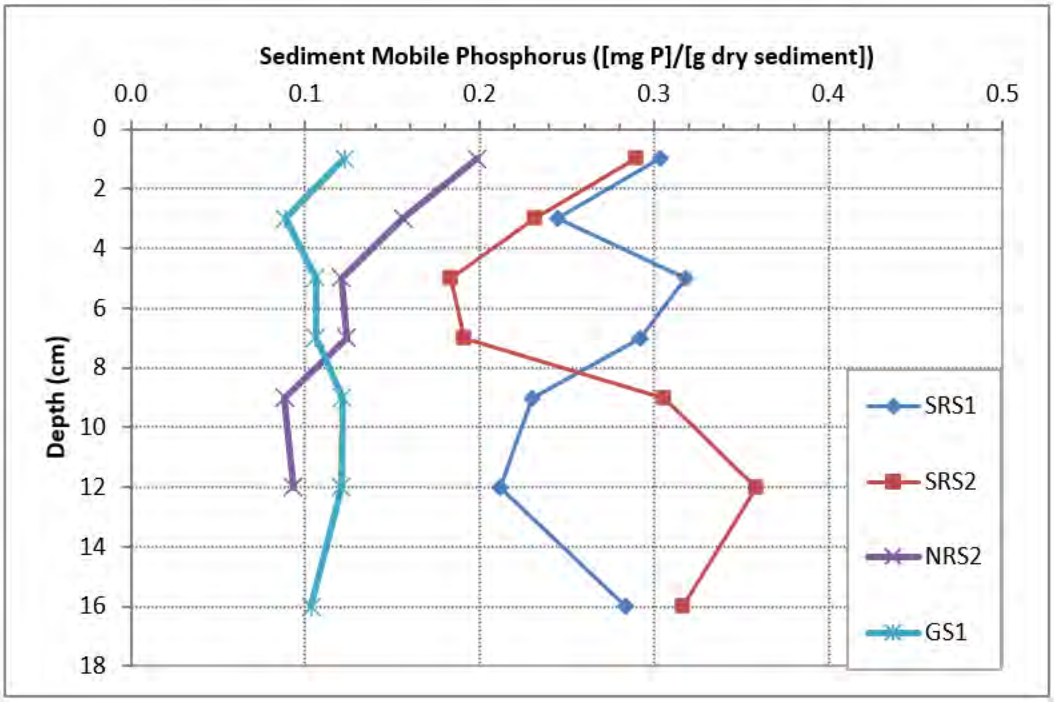


Figure 3-4 Sediment Mobile Phosphorus Concentrations

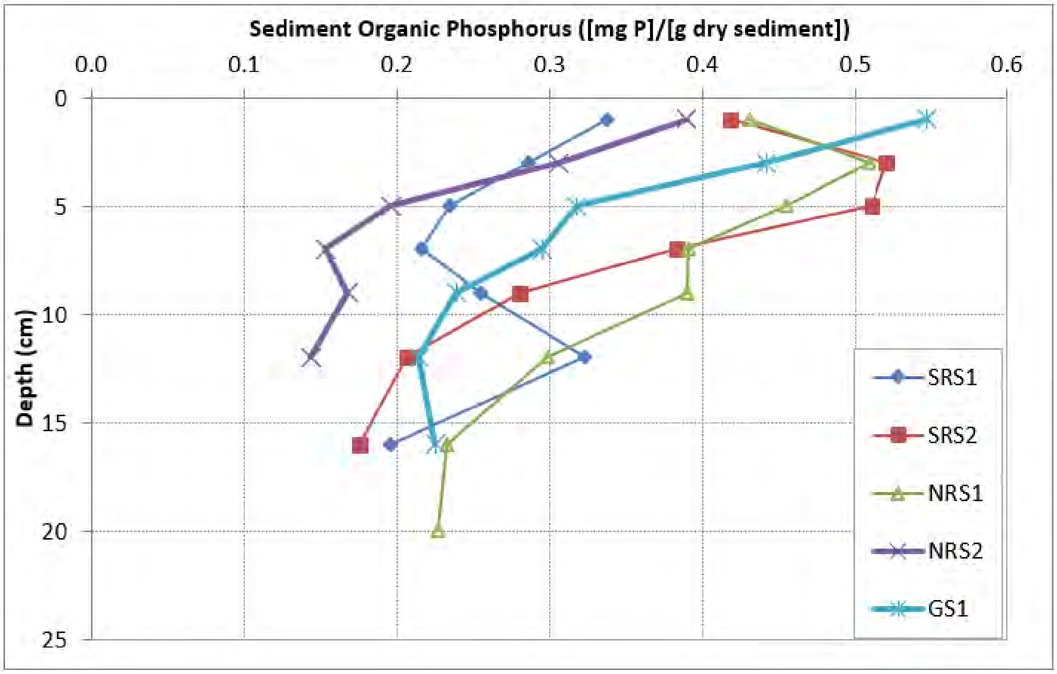


Figure 3-5 Sediment Organic Phosphorus Concentrations

3.1.4 Vegetation Surveys

TRPD conducted two surveys (early- and late-summer) each year of aquatic plants in all three ponds. Thick Coontail was noted, as well as large amounts of duckweeds and watermeal (see Figure 3-6). Invasive curly-leaf pondweed (CLP) was found in all 3 ponds, except in the spring, due to normal die off (see Figure 3-6).

Vegetation surveys 2020	% Frequency of Occurance					
	6/17/2020			8/26/2020		
	Grimes	North Rice	South Rice	Grimes	North Rice	South Rice
Ceratophyllum demersum (Coontail)	98	97	92	100	100	89
Potamogeton crispus (Culy-leaf Pondweed)	12	21	39			
Elodea canadensis (Elodea)			47			
Potamogeton spp (Narrow Pondweed spp)	28	45	68	9	14	5
Stuckenia pectinata (Sago Pondweed)	11	17		4	7	
Chara spp (Chara)	2					
Lemna trisulca (Star Duckweed)	30	48		16	80	
Lemna minor (Small Duckweed)	84	83	100	100	100	82
Spirodela polyrhiza (Greater Duckweed)	87	65	100	51	100	82
Wolffia columbiana (Watermeal)	96	89	100	100	100	89

Vegetation surveys 2021	% Frequency of Occurance					
	6/24/2021			9/1/2021		
	Grimes	North Rice	South Rice	Grimes	North Rice	South Rice
Ceratophyllum demersum (Coontail)	96	93	87	100	100	90
Potamogeton crispus (Culy-leaf Pondweed)	12	3	37			
Elodea canadensis (Elodea)			68			53
Potamogeton spp (Narrow Pondweed spp)	42	41	79	7		10
Stuckenia pectinata (Sago Pondweed)	9	10		2	3	
Chara spp (Chara)				2		
Lemna trisulca (Star Duckweed)	33	65		39	65	13
Lemna minor (Small Duckweed)	100	100	100	98	100	98
Spirodela polyrhiza (Greater Duckweed)	100	100	100	100	100	98
Wolffia columbiana (Watermeal)	100	100	100	100	100	98

Figure 3-6 2020 and 2021 Pond Vegetation Survey Results

3.1.5 Water Levels

Figure 3-7 shows the monitored water levels for each pond during the 2020 and 2021 monitoring seasons, as well as the corresponding precipitation amounts. The largest storm events during the monitoring period resulted in water level changes of about one foot in Grimes and North Rice Pond, while South Rice Pond experienced water level changes of about three quarters of a foot. The existing outlet infrastructure for Grimes Pond would accommodate a water level drawdown of approximately 2.5 feet using gravity flow into North Rice Pond, which in turn, could be drawn down by 3 to 3.5 feet through gravity flow to South Rice Pond. South Rice Pond can not be drawn down by gravity due to the tailwater conditions associated with Bassett Creek, so pumping would be required to draw the pond down.

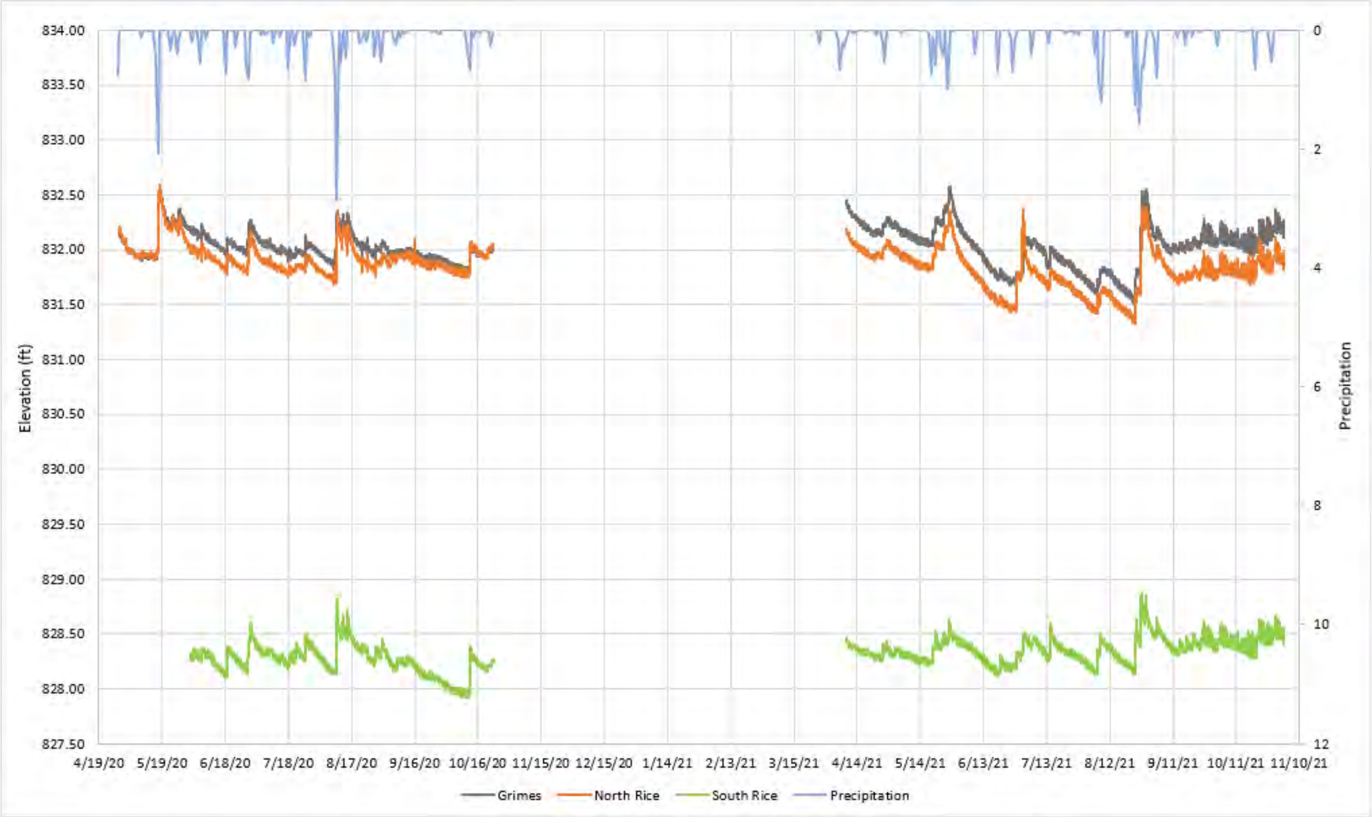


Figure 3-7 2020 and 2021 Pond Water Levels

3.2 Stormwater Monitoring

Stormwater water quality and flow monitoring data at each watershed station was used compute pollutant loadings. Table 3-1 show the respective annual pollutant loadings and flow-weighted mean concentrations for each watershed monitoring site (shown in Figure 2-1). Comparing the combined NR2 and SR4 TP loads to the SR5 TP load indicates that internal phosphorus load is significant in South Rice Pond during both years. This also confirmed by the high flow-weighted mean TP concentration at SR5 during each year. The high flow-weighted mean TP and SRP concentrations at SR4 also indicate that the existing stormwater treatment from Basin J is inadequate. The same corresponding data at NR2 confirms that North Rice Pond has significantly better water quality than the other two ponds.

Table 3-1 Stormwater Pollutant Loadings and Flow-Weighted Mean Concentrations

Site	Year	# of samples	Pollutant Loading					Flow-Weighted Mean Pollutant Concentration						
			TP (lbs/yr)	SRP (lbs/yr)	TN (lbs/yr)	TSS (lbs/yr)	Cl (lbs/yr)	TP (µg/L)	SRP (µg/L)	TN (mg/L)	TSS (mg/L)	Cl (mg/L)	Flow Volume (x 10^6 M3)	Annual Precipitation (inches)
NR1	2020	7	2	1	12	283	0	359	195	2.09	49	0	0.003	25.88
NR1	2021	8	4	2	21	994	27	396	229	2.22	105	3	0.004	23.43
NR2	2020	17	50	13	459	1,906	45,739	147	39	1.36	6	135	0.15	25.88
NR2	2021	13	63	36	546	2,307	92,479	119	68	1.03	4	174	0.24	23.43
SR4	2020	14	30	18	213	3,933	577	279	163	1.96	36	5	0.05	25.88
SR4	2021	8	64	49	253	1,769	2,531	367	282	1.44	10	14	0.08	23.43
SR5	2020	21	74	26	526	9,343	28,703	261	94	1.86	33	102	0.13	25.88
SR5	2021	13	57	23	379	8,522	25,625	315	124	2.09	47	141	0.08	23.43

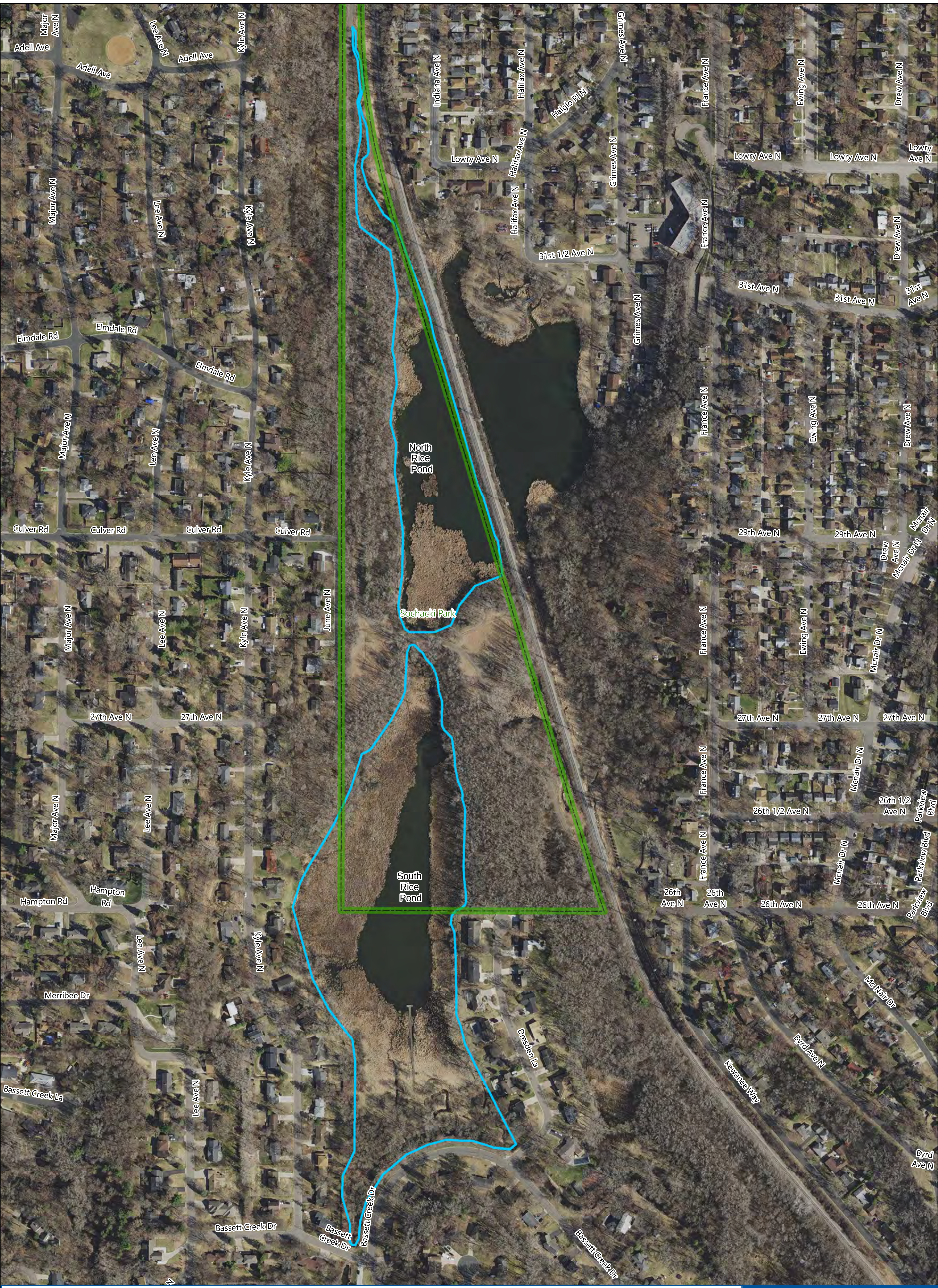
4 Wetland Ecological Health Assessment

To evaluate wetlands and wetland condition within North and South Rice Ponds, a wetland evaluation site visit was performed on August 17, 2020. A qualitative review of wetlands and vegetation communities was performed within each basin. A wetland delineation within this area was previously approved under the Minnesota Wetland Conservation Act and the U.S. Army Corps of Engineers in 2016, which is valid for five years. In 2020, the previous delineation information was used where the evaluation areas overlap and extrapolated the boundaries in locations to complete the wetland delineation needed for this subwatershed assessment (see Figure 4-1). The boundary extrapolation used available desktop information, including recent aerial photography, topographic maps, National Wetland Inventory maps, and soil survey information, along with spot field checks documenting soils, vegetation, and hydrology within the wetlands and in the adjacent upland to determine the presence and extent of North and South Rice Ponds. The wetland documentation presented in this report is not intended to comprise a complete wetland delineation report. Also, agency wetland boundary and type concurrence and approval will not be requested for the purposes of this subwatershed assessment.

4.1 Site Characteristics

Prior to the August 17, 2020 site visit, the following desktop data were reviewed:

- Site topography – The surface topography of the land surrounding North and South Rice Ponds within Sochacki Park varies from an elevation of 850 feet mean sea level (MSL) at the north end to 828 feet MSL within South Rice Pond based on LiDAR data as shown in Figure 4-2.
- Bathymetry – bathymetry data collected by TRPD in 2020 shows North Rice Pond at a maximum water depth of 5.2 feet and South Rice Pond at a maximum water depth of 3.3 feet (Figure 2-1).
- National Wetland Inventory – The MN DNR update of the National Wetland Inventory (NWI) map (Figure 4-3) identifies:
    - North Rice Pond as a Type 5 PUBH freshwater pond and Type 3 PEM1C shallow marsh fringed with Type 6 PSSC shrub and Type 1 PFO1A floodplain forested communities, and
    - South Rice Pond as a Type 5 PABH shallow open water community and Type 3 PEM1F shallow marsh fringed with a Type 1 PFO1A floodplain forested community.
    - Additional wetland areas are identified in the NWI within Sochacki Park, which were not evaluated as part of this assessment.
- Water resources - As described above, both North (27-644W) and South (27-645W) Rice Ponds are identified in the PWI as Public Water Wetlands (Figure 4-4). In addition, Bassett Creek is a Public Water Watercourse located south of South Rice Pond. The MN DNR regulates public waters above the Ordinary High Water (OHW) elevation. The MN DNR website does not list established OHW elevations for either North or South Rice Ponds.



Sochacki Park

2020 Wetland Delineation

N

0 300 600

Feet

BARR

WETLAND DELINEATION

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FIGURE 4-1

SITE TOPOGRAPHY

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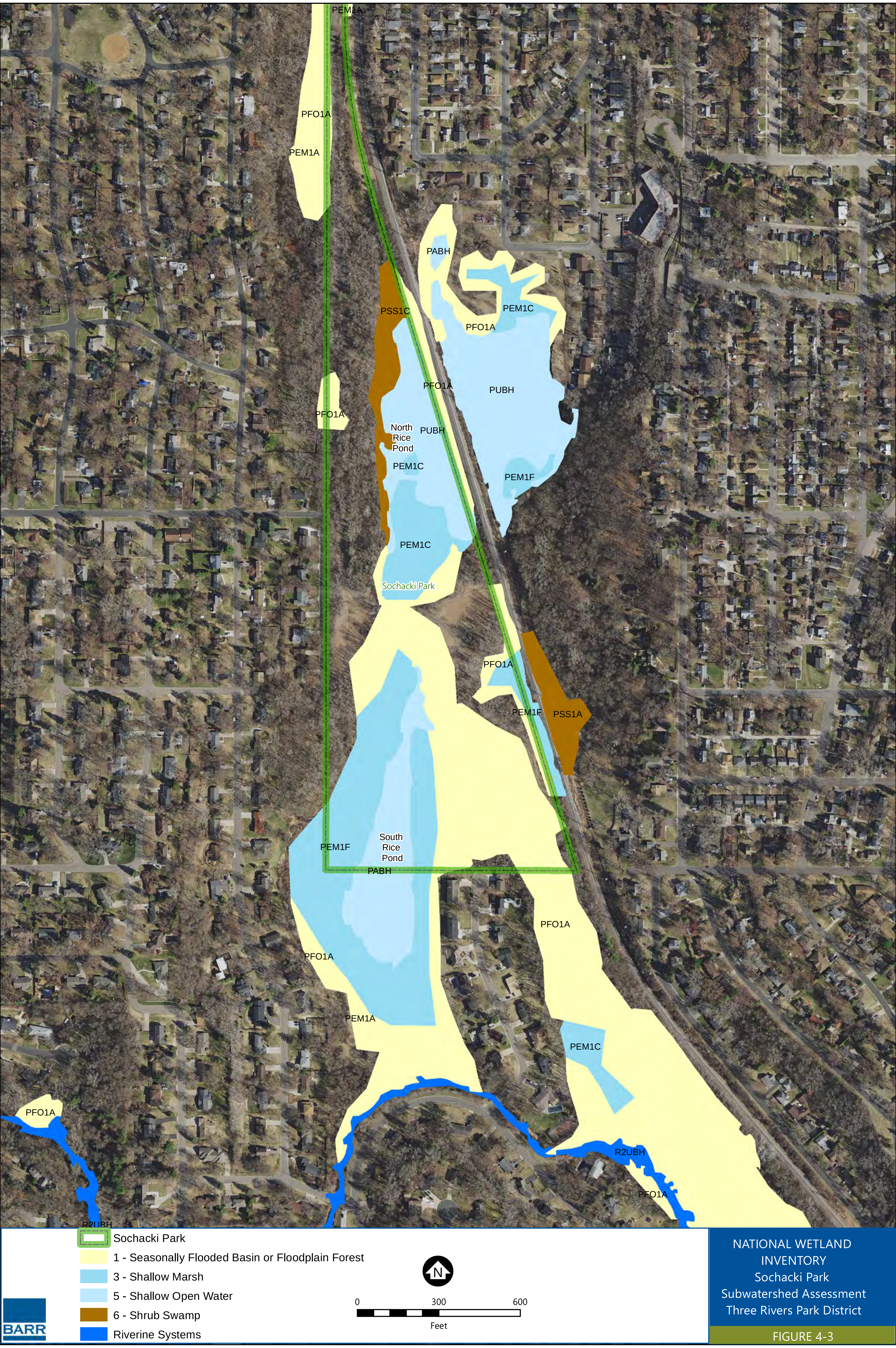
FIGURE 4-2



NATIONAL WETLAND INVENTORY
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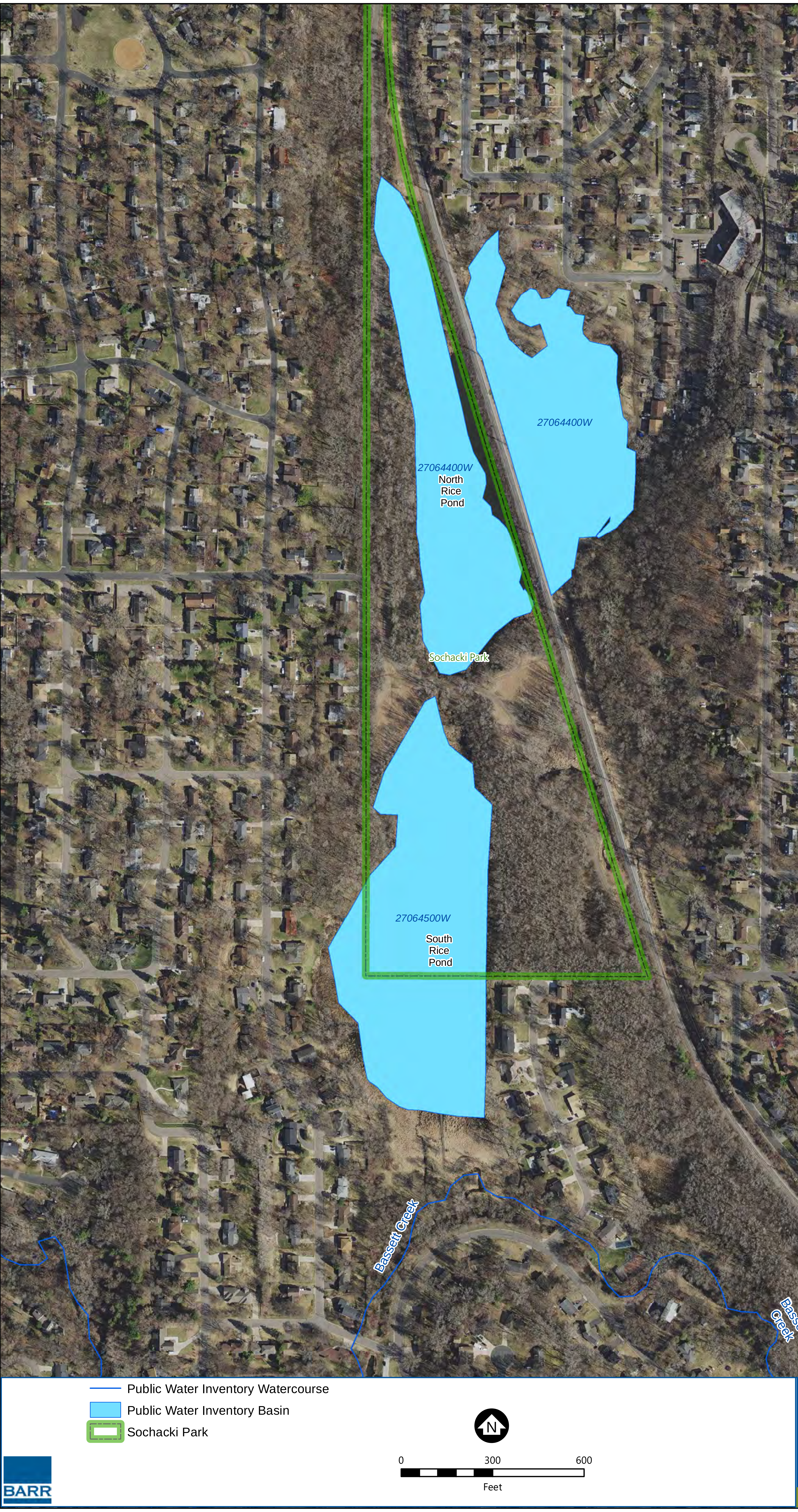
FIGURE 4-3



PUBLIC WATER INVENTORY

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FIGURE 4-4

The study area is located within the Grimes Lake subwatershed (GRL-001) of the Bassett Creek minor watershed (#20095), in the Mississippi River – Twin Cities Major Watershed #20.

- Soil resources – Soil information for the site was obtained from the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO). The soil map unit names and hydric classifications are labeled in Figure 4-5.
    - The northern fringe of North Rice Pond is mapped with Udorthents, wet substratum, 0 to 2 percent slopes. The southern portion of North Rice Pond is mapped with Houghton and Muskego soils, depressional, 0 to 1 percent slopes with a hydric classification presence of 100 percent. Muskego muck is very deep, very poorly drained soils formed in herbaceous organic material over sedimentary peat on glacial lake plains, flood plains, and till plains. Houghton muck is very deep, very poorly drained soil formed in herbaceous organic materials in depressions and drainageways on lake plains, out wash plains, ground moraines, end moraines, till plains, and floodplains.
    - Most of the South Rice Pond is similarly mapped with Houghton and Muskego soils. The southern edge of South Rice Pond is mapped with Suckercreek fine sandy loam, 0 to 2 percent slopes, occasionally flooded with a 90 percent hydric classification presence. Suckercreek loam is very deep, poorly drained and very poorly drained soils formed in alluvium on flood plains.

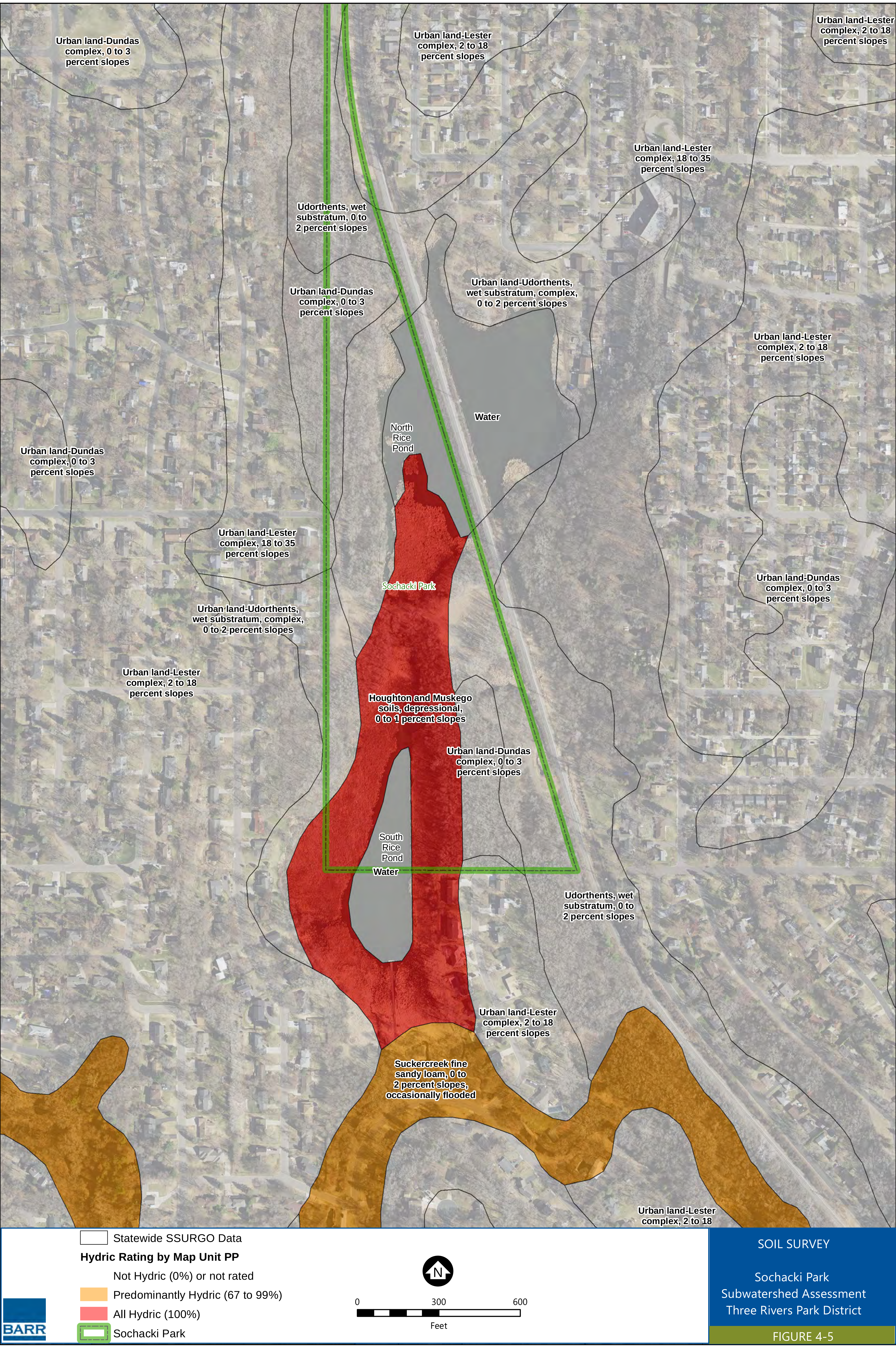
4.2 Wetland Descriptions

The wetland boundaries and types of North and South Rice Ponds were verified during the site visit on August 17, 2020. Wetland boundaries were documented using a global positioning system with sub-meter accuracy and community types were classified using the USFWS Cowardin System—*Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al., 1979), the *USFWS Circular 39 system* (Shaw and Fredine, 1956), and the Eggers and Reed Wetland Classification System—*Wetland Plants and Plant Communities of Minnesota and Wisconsin* (Eggers and Reed, 2015). Table 4-1 provides a summary of wetland classifications and sizes and is followed by narrative descriptions of each pond.

Table 4-1 Wetland Summary

Wetland ID	Approximate Area (acres)	Circular 39 Wetland Type [1]	Cowardin Wetland Type [2]	Eggers & Reed Wetland Community Type [3]
North Rice Pond	7.30	Type 5/3/6	PABH/EMC/SSC	Shallow open water/shallow marsh/shrub-carr
South Rice Pond	17.33	Type 5/3/1	PABH/EMC/FOA	Shallow open water/shallow marsh/floodplain forest

[1]Shaw and Fredine. 1956.
[2]Cowardin, L.M., V. Carter, F.C. Golet, and R.T. LaRoe. 1979.
[3]Eggers, S.D. and Reed, D.M. Version 3.2 July 2015.



SOIL SURVEY

Sochacki Park
Subwatershed Assessment
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FIGURE 4-5

The following is a narrative description of North and South Rice Ponds (see Figures 4-6 and 4-7, respectively). Descriptions highlight key findings from the desktop review, information obtained from TRPD's 2020 aquatic vegetation and bathymetric survey, as well as information obtained during the August 17, 2020 wetland evaluation site visit.

Figure 4-6 August 17, 2020 Photograph of North Rice Pond

Figure 4-7 August 17, 2020 Photograph of South Rice Pond

4.2.1 North Rice Pond

Based on the site review, North Rice Pond was identified as a Type 5/3/6 PABH/EMC/SSC shallow open water/shallow marsh/shrub-carr. This wetland receives hydrology from surrounding residential neighborhoods, through an inlet pipe at the northwest, and through a culvert from Grimes Lake located east of the railroad. The outlet is a channelized flow through a culvert under a paved trail between North and South Rice Ponds. The wetland was inundated with as much as 5.2 feet of surface water within the shallow open water community. Open water surrounding the shallow marsh floating mats was observed to be approximately one to two feet deep with saturated floating mats.

The shallow open water community of North Rice Pond contains native submergent vegetation including coontail (*Ceratophyllum demersum*), narrow pondweed (*Potomogeton spp*.), sago pondweed (*Stuckenia pectinata*), and floating native vegetation including star duckweed (*Lemna trisulca*), small duckweed (*Lemna minor*), greater duckweed (*Spirodela polyrhiza*), and watermeal (*Wolffia columbiana*) based on the results of point intercept surveys conducted by TRPD on June 17 and August 26, 2020. One non-native invasive species, curly-leaf pondweed (*Potomogeton crispus*) was documented within the shallow open water community of North Rice Pond.

The shallow marsh community is comprised of floating mats within and along the edge of the open water, dominated by narrow leaf cattail (*Typha angustifolia*) and purple loosestrife (*Lythrym salicaria*), both of which are non-native invasive species. Native species identified within the shallow marsh community include dark green bulrush (*Scirpus atrovirens*), pointed broom sedge (*Carex scoparia*), small duckweed, watermeal, sandbar willow (*Salix interior*), and red osier dogwood (*Cornus alba*) growing within the floating mats. Additional species on the floating mats were not identified due to lack of access.

The shrub-carr community is vegetated by sandbar willow, meadow willow (*Salix amygdaloides*), reed canary grass (*Phalaris arundinacea*), jewelweed (*Impatiens capensis*), clearweed (*Pilea pumila*) and common buckthorn (*Rhamnus cathartica*). Some buckthorn was observed to have been previously removed at the south end of North Rice Pond, though young shoots are coming back.

Soils documented within the wetland are muck soils consistent with mapped soils. Soils near the wetland boundary include clay loam below a shallow muck surface. Adjacent upland soils are clay loam and sandy loam along steep slopes. Steep slopes define the wetland boundary with saturated soils at the toeslope of the wetland boundary. Some soil erosion was observed at the north inlet location near the paved trail. The wetland boundary on the east edge is defined by the steep railroad grade.

Hydrophytic tree species were present in the adjacent forested upland area, though wetland soil and hydrology indicators were lacking. The wetland boundary documented for this study is consistent with the previously approved wetland boundary for the Blue Line LRT project.

Surrounding upland areas are forested with oak (*Quercus spp*.), elm (*Ulmus sp*.) cottonwood (*Populus deltoides*), boxelder (*Acer negundo*), green ash (*Fraxinus pennsylvanica*), gray dogwood (*Cornus racemosa*), sumac (*Rhus sp*.), honeysuckle (*Lonicera spp.*). The forested herbaceous layer includes burdock (*Arctium minus*), Kentucky bluegrass (*Poa pratensis*), sweet clover (*Melilotus officianalis*), and Virginia creeper

(*Parthenocissus quinquefolia*). A restored prairie area between North and South Rice Ponds includes bee balm (*Monarda fistulosa*), stiff goldenrod (*Solidago rigida*), Indian grass (*Sorghastrum nutans*), big bluestem (*Andropogon gerardii*), black eyed Susan (*Rudbeckia hirta*), and juniper (*Juniperus virginiana*).

4.2.2 South Rice Pond

Based on the site review, South Rice Pond was identified as a Type 5/3/1 PABH/EMC/FOA shallow open water/shallow marsh/floodplain forest. This wetland receives overflow from North Rice Pond and overland flow from surrounding residential neighborhoods and upland areas in the park. A cattail marsh located at the northeast of South Rice Pond has a low-lying outlet partially draining it to South Rice Pond, though the outlet was observed to be clogged with sticks and leaves.

South Rice Pond was inundated with as much as 4.4 feet of surface water within the shallow open water community. Surface water at the west and east edges of the pond was observed to be approximately one foot deep with saturated floating mats and one inch of surface water near the wetland boundary. Steps have been constructed on steep slopes for access to the wetland toward a dilapidated boardwalk within portions of the floating mats.

The shallow open water community of South Rice Pond contains native submergent vegetation including coontail (*Ceratophyllum demersum*), Canada waterweed (*Elodea canadensis*), narrow pondweed (*Potomogeton spp*.), and floating native vegetation including small duckweed (*Lemna minor*), greater duckweed (*Spirodela polyrhiza*), and watermeal (*Wolffia columbiana*) based on the results of point intercept surveys conducted by TRPD on June 17 and August 26, 2020. One non-native invasive species, curly-leaf pondweed (*Potomogeton crispus*) was documented within the shallow open water community of South Rice Pond.

The shallow marsh community is comprised of floating mats along pond edges, dominated by narrow leaf cattail (*Typha angustifolia*), purple loosestrife (*Lythrym salicaria*), and reed canary grass (*Phalaris arundinacea*), all of which are non-native invasive species. Native species identified within the shallow marsh community include lake sedge (*Carex lacustris*), nodding burr-marigold (*Bidens cernua*), and arrowhead (*Saggitaria latifolia*).

The floodplain forest vegetation includes red osier dogwood, willow, elm, green ash, boxelder, cottonwood, common buckthorn, and reed canary grass. The southern edge of the wetland boundary of South Rice Pond extends to Bassett Creek into a subwatershed beyond the study area.

Soils documented within the wetland are muck soils consistent with mapped soils. Soils near the wetland boundary include clay loam below a shallow muck surface. Adjacent upland soils are loam along steep slopes. Steep slopes define the wetland boundary with saturated soils at the toeslope of the wetland boundary. The wetland boundary documented for this study is consistent with the previously approved wetland boundary for the Blue Line LRT project.

Surrounding upland areas are forested with oak (*Quercus spp*.), black walnut (*Juglans nigra*), elm (*Ulmus sp*.) cottonwood (*Populus deltoides*), boxelder (*Acer negundo*), green ash (*Fraxinus pennsylvanica*), garlic mustard (*Allaria petiolata*), broad leaf nightshade (*Circaea lutetiana*), white snakeroot (*Ageratina altissima*), dandelion (*Taraxicum officianale*), common ragweed (*Ambrosia artimesiifolia*), sticktight (*Hackelia virginiana*), and purple bellflower (*Campanula sp.*). Dense buckthorn is present throughout the adjacent upland buffer. Well-travelled paths meander along the upland buffer. Chunks of concrete have also been dumped in the adjacent upland. Mounds and logs have been placed for mountain bike activity within the upland area of the park east of South Rice Pond.

4.3 MNRAM Functional Analysis

Functional assessments were conducted on both North and South Rice Ponds using the Minnesota Routine Assessment Method for Evaluating Wetland Functions (MNRAM) version 3.4. Comprehensive guidance with functional rating formulas, full text, and the wetland management classification flow chart are provided for reference in Appendix A. The results of this assessment are summarized in Table 4-2 for North Rice Pond and Table 4-3 for South Rice Pond. Appendix B provides the full summaries and site response forms.

4.3.1 North Rice Pond

Table 4-2 North Rice Pond MNRAM Summary

North Rice Pond Wetland functional ratings:	
Exceptional	• Groundwater interaction functional index
Moderate	• Flood and stormwater attenuation • Downstream water quality • Maintenance of characteristic wildlife habitat structure • Maintenance of characteristic fish habitat • Aesthetics/recreation/education/cultural values • Wetland sensitivity to stormwater and urban development
Low	• Overall weighted average vegetative diversity and integrity • Maintenance of wetland water quality • Maintenance of hydrologic regime • Maintenance of characteristic amphibian habitat • Additional stormwater treatment needs
Overall wetland management classification: Manage 2	

North Rice Pond was rated **moderate** for flood and stormwater attenuation, downstream water quality, maintenance of characteristic wildlife habitat structure, maintenance of characteristic fish habitat, aesthetic/recreation/education/cultural values, and wetland sensitivity to stormwater and urban development. The shallow open water community was also rated as **moderate** for vegetative diversity and integrity, while the shallow marsh and shrub-carr communities were rated as **low** quality due to a dominance of non-native invasive vegetation, making the overall weighted average vegetative diversity and integrity rating **low**. Other **low** ratings for North Rice Pond functions include maintenance of hydrologic regime, maintenance of wetland water quality, maintenance of characteristic amphibian habitat, and additional stormwater treatment needs. Since the groundwater interaction of this wetland is primarily recharge and the wetland is within a wellhead protection area, the ground water functional index is **exceptional**.

4.3.2 South Rice Pond

Table 4-3 South Rice Pond MNRAM Summary

South Rice Pond Wetland functional ratings:	
Exceptional	• Groundwater interaction functional index
Moderate	• Maintenance of hydrologic regime • Flood and stormwater attenuation • Downstream water quality • Maintenance of characteristic wildlife habitat structure • Maintenance of characteristic fish habitat • Aesthetics/recreation/education/cultural values • Wetland sensitivity to stormwater and urban development
Low	• Overall weighted average vegetative diversity and integrity • Maintenance of wetland water quality • Maintenance of characteristic amphibian habitat • Additional stormwater treatment needs
Overall wetland management classification: Manage 2	

South Rice Pond was rated **moderate** for maintenance of hydrologic regime, flood and stormwater attenuation, downstream water quality, maintenance of characteristic wildlife habitat structure, maintenance of characteristic fish habitat, aesthetic/recreation/education/cultural values, and wetland sensitivity to stormwater and urban development. The shallow open water community was also rated as **moderate** for vegetative diversity and integrity, while the shallow marsh and floodplain forest communities were rated as **low** quality due to a dominance of non-native invasive vegetation, making the overall weighted average vegetative diversity and integrity rating **low**. Other **low** ratings for South Rice Pond functions include maintenance of wetland water quality, maintenance of characteristic amphibian habitat, and additional stormwater treatment needs. Since the groundwater interaction of this wetland is primarily recharge and the wetland is within a wellhead protection area, the ground water functional index is **exceptional**.

4.4 North Rice Pond potential wetland improvements

Suggested improvements to North Rice Pond include:

- Remove, treat, and control non-native invasive species, including curly leaf pondweed, narrowleaf cattail, purple loosestrife, common buckthorn, and reed canary grass in the wetland. Common buckthorn, sweet clover, and honeysuckle in the upland buffer.
- Remove accumulated sediment and fill materials within and adjacent to the wetland.
- Install pretreatment protection measures to prevent future sediment delivery and reduce nutrient loading into the wetland.
- Encourage community involvement in the protection and appreciation of the wetland and surrounding park, which may include:
    - coordinating seasonal community clean up events and invasive species removal
    - native planting projects
    - educational signage documenting restoration areas in progress with inspiration for park users to pick up trash and prevent damage
    - hold community education events such as birding and wildlife observation, cultural education, etc.
- Control soil erosion and re-vegetate bare soil areas along shoreline and upland buffer including eroding soil found at the north inlet location near the paved trail.

Implementation of some or all proposed improvements could result in the overall wetland management classification increase from Manage 2 to Manage 1 and the following functional rating improvements:

- change in maintenance of hydrologic regime from low to moderate
- change in maintenance of wetland water quality from low to moderate

- change in maintenance of wildlife habitat structure from moderate to high
- change in aesthetics/recreation/education/cultural from moderate to high
- change in overall weighted average vegetative diversity and integrity from low to high

Table 4-4 summarizes the potential functional ratings with implementation of improvements. Appendix C provides the full summaries and site response forms for these proposed results.

Table 4-4 North Rice Pond Proposed Improvements MNRAM Summary

North Rice Pond wetland functional ratings for proposed improvements:	
Exceptional/ High	• Groundwater interaction functional index • Maintenance of characteristic wildlife habitat structure • Aesthetics/recreation/education/cultural values • Overall weighted average vegetative diversity and integrity
Moderate	• Flood and stormwater attenuation • Downstream water quality • Maintenance of characteristic fish habitat • Wetland sensitivity to stormwater and urban development • Maintenance of hydrologic regime • Maintenance of wetland water quality
Low	• Maintenance of characteristic amphibian habitat • Additional stormwater treatment needs
Overall wetland management classification: Manage 1	

The proposed wetland functional ratings for North Rice Pond are based on the following assumptions:

- The shallow open water community rating changes from moderate to high assuming curly-leaf pondweed is decreased to less than 20 percent cover.
- The shallow marsh community rating changes from low to moderate assuming purple loosestrife is reduced to 20-50 percent cover and cattails comprise 40 – 85 percent cover.
- The shrub-carr community rating changes from low to moderate assuming buckthorn, reed canary grass, and other non-native species comprise 20 – 50 percent cover.

- The wetland soil condition (Question #15) changes from low to moderate assuming fill material and sediment deposits are removed.
- The stormwater runoff (Question #20) rating changes from moderate to high assuming directed stormwater runoff is pre-treated and detained to approximately the standards of the National Urban Runoff Program (NURP).
- Bare soil areas within the upland buffer area are re-vegetated and soil erosion is controlled (Questions #24 and #25).
- Nutrient loading (Question #28) rating changes from low to moderate assuming nutrients are reduced to meet BCWMC water quality goals.
- Human influences (Question #53) changes from low to moderate with reductions in nutrient inputs, trash clean up, and vegetative diversity and integrity improvements as described in above assumptions.

4.5 South Rice Pond potential wetland improvements

Suggested improvements to South Rice Pond include:

- Remove, treat, and control non-native invasive species, including curly leaf pondweed, narrowleaf cattail, purple loosestrife, common buckthorn, and reed canary grass in the wetland. Common buckthorn, sticktight, and garlic mustard in the upland buffer.
- Remove accumulated sediment and fill materials within and adjacent to the wetland.
- Install pretreatment protection measures to prevent future sediment delivery and reduce nutrient loading into the wetland.
- Clear clogged debris from inlet and outlet structures.
- Re-build boardwalk and steps.
- If mountain bike activity in the adjacent upland area is intended to continue, consider isolating potential soil disturbance and adjacent vegetation improvements to prevent erosion into surrounding wetland areas.
- Control soil erosion and re-vegetate bare soil areas along shoreline and upland buffer. Consider defining designated specific trails and maintaining them to prevent bare soil and erosion disturbance from meandering undesignated trails along the slope of the pond buffer. These can be further defined with wood rails or designated rock placement to allow access to the water edge at specific locations.

- Encourage adjacent residential property owners to provide wider naturalized wetland buffer protection by avoiding mowing near the shoreline and establishing native vegetation in their back yards.
- Encourage community involvement in the protection and appreciation of the wetland and surrounding park, which may include:
    - coordinating seasonal community clean up events and invasive species removal
    - native planting projects
    - educational signage documenting restoration areas in progress with inspiration for park users to pick up trash and prevent damage
    - hold community education events such as birding and wildlife observation, cultural education, etc.

Implementation of some or all proposed improvements could result in the overall wetland management classification increase from Manage 2 to Manage 1 and the following functional rating improvements:

- change in maintenance of wetland water quality from low to moderate
- change in maintenance of characteristic fish habitat structure from moderate to high
- change in aesthetics/recreation/education/cultural from moderate to high
- change in overall weighted average vegetative diversity and integrity from low to high

Table 4-5 summarizes the potential functional ratings with implementation of improvements. Appendix C provides the full summaries and site response forms for these proposed results.

The proposed wetland functional ratings for South Rice Pond are based on the following assumptions:

- The shallow open water community rating changes from moderate to high assuming curly-leaf pondweed is decreased to less than 20 percent cover.
- The shallow marsh community rating changes from low to moderate assuming purple loosestrife is reduced to 20-50 percent cover and cattails comprise 40 – 85 percent cover.
- The floodplain forest community rating changes from low to moderate assuming buckthorn, reed canary grass, and other non-native species comprise 20 – 50 percent cover.
- The sediment delivery (Question #18) changes from moderate to high assuming fill material and sediment deposits are removed.

Table 4-5 South Rice Pond Proposed Improvements MNRAM Summary

South Rice Pond wetland functional ratings for proposed improvements:	
Exceptional/ High	• Groundwater interaction functional index • Maintenance of characteristic fish habitat • Aesthetics/recreation/education/cultural values • Overall weighted average vegetative diversity and integrity
Moderate	• Maintenance of hydrologic regime • Flood and stormwater attenuation • Downstream water quality • Maintenance of characteristic wildlife habitat structure • Wetland sensitivity to stormwater and urban development • Maintenance of wetland water quality
Low	• Maintenance of characteristic amphibian habitat • Additional stormwater treatment needs
Overall wetland management classification: Manage 1	

- The stormwater runoff (Question #20) rating changes from moderate to high assuming directed stormwater runoff is pre-treated and detained to approximately the standards of the National Urban Runoff Program (NURP).
- Nutrient loading (Question #28) rating changes from low to moderate assuming nutrients are reduced to meet BCWMC water quality goals.
- Upslope shoreline vegetation conditions (Question #34) rating changes from moderate to high assuming bare soil areas with erosion issues are revegetated and adjacent residential property owners avoid mowing to the shoreline and/or establish native vegetation along the shoreline buffer.
- Human influences (Question #53) changes from low to moderate with reductions in nutrient inputs, trash clean up, removal of fill material, and vegetative diversity and integrity improvements as described in above assumptions.

5 Watershed and Pond Water Quality Modeling

To better understand and evaluate the water quality treatment performance of the existing best management practices (BMPs) in the Sochacki Park subwatershed, the existing Bassett Creek Watershed Management Commission's (BCWMC) P8 watershed model was revised to reflect GIS subwatershed delineations and modeling inputs for each subwatershed and respective BMPs. The revised BCWMC P8 model was then updated with 2020 and 2021 growing-season climate data (hourly precipitation and daily temperatures) to develop the phosphorus (total and dissolved) and total suspended solids (TSS) loadings for the period. The available in-wetland water quality monitoring and watershed stormwater monitoring data of inflows and outflows were used to calibrate the watershed modeling, where possible.

The updated P8 modeling results and GIS mapping were used to identify high priority areas for implementing watershed BMPs. P8 modeling completed for the summers of 2020 and 2021 indicates that 20 and 17 percent of the current overall phosphorus load, in respective years, receives stormwater treatment before discharge to the three wetlands. Approximately 22 percent of the runoff phosphorus load in the Grimes Pond watershed receives stormwater treatment, while the respective levels of treatment in the direct drainage to North and South Rice Ponds are approximately 39 and 30 percent. Figure 5-1 highlights the subwatershed area that are currently receiving some level of stormwater treatment with structural BMPs. Most of the subwatersheds that drain directly into the three ponds are not receiving stormwater treatment that would substantially reduce annual total phosphorus loadings.

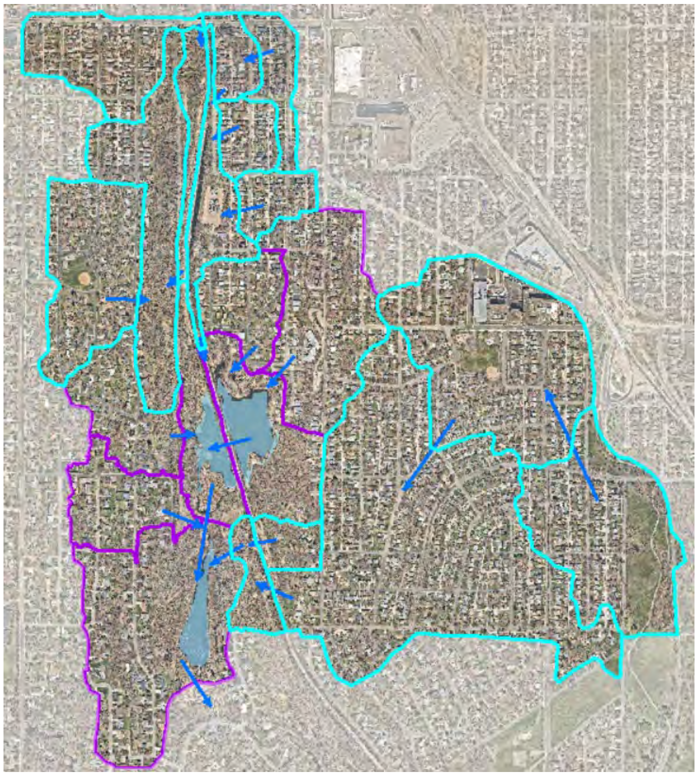

Figure 5-1 Existing Subwatersheds (Highlighted) Receiving Stormwater Treatment

The watershed modeling was calibrated and used to concurrently develop the water and phosphorus budgets that optimized the daily pond water quality modeling fit to the summer monitoring data associated with each pond. Figure 5-2 shows how the predicted pond water quality would ordinarily correspond with the water quality monitoring observations for each pond in 2020 and 2021, based on the calibrated watershed phosphorus load modeling, alone. Figure 5-2 shows that, except for Grimes Pond in 2021, each pond experienced two or more monitoring events where the monitored TP concentrations greatly exceeded the predicted TP concentration, based only on the watershed modeling. The difference in the TP concentrations during each of these pond monitoring events can be attributed to internal phosphorus loading from sediment phosphorus release. The mass balance modeling results were used to estimate and summarize the total internal phosphorus load during each summer for each pond.

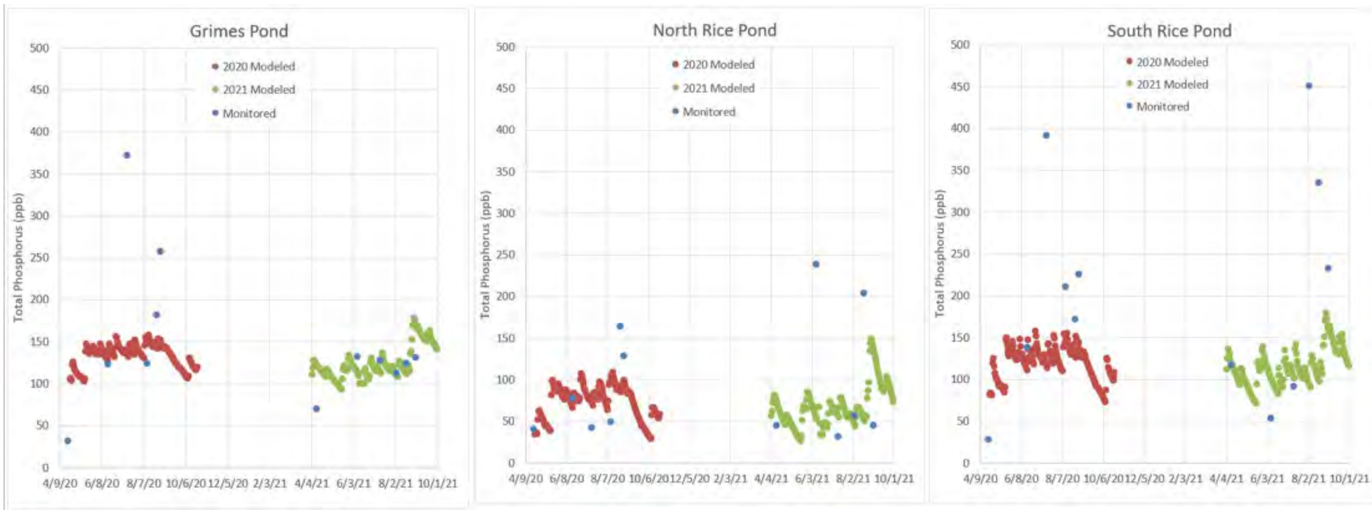

Figure 5-2 Calibrated Water Quality Monitoring and Modeling Results

A detailed analysis of the dissolved oxygen data, combined with the pond water quality modeling, confirmed that internal phosphorus loading can be an important source of phosphorus input to each pond during the summer. Internal phosphorus loading represented 32 percent of the summer phosphorus budget for Grimes Pond in 2020, as well as six and 24 percent of the respective summer phosphorus budgets for North Rice Pond in 2020 and 2021 (see Figure 5-3). Figure 5-3 shows that discharge from Grimes Pond represented 34 and 29 percent of the respective summer phosphorus budgets for North Rice Pond in 2020 and 2021. Internal phosphorus loading represented 8 and 9 percent of the respective summer phosphorus budgets for South Rice Pond in 2020 and 2021. Discharge from North Rice Pond represented 11 and 14 percent of the respective summer phosphorus budgets for South Rice Pond in 2020 and 2021.

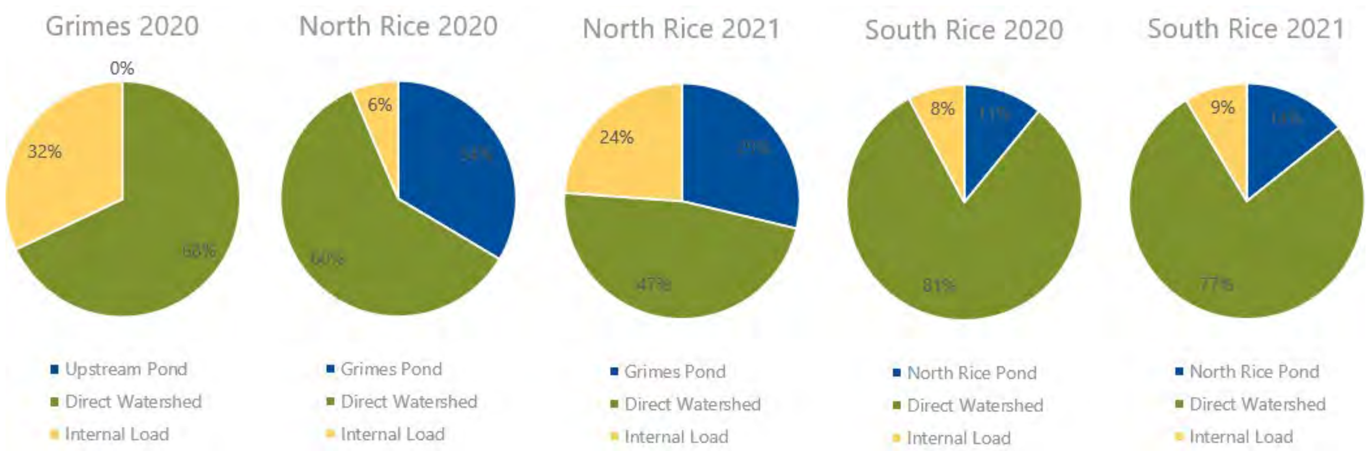

Figure 5-3 Modeled Annual TP Sources For Each Pond

The calibrated water quality modeling was used to assess the implications for the summer assimilation capacity (i.e., nutrient uptake and/or sedimentation) of each pond, and the water and phosphorus budgets were used to identify and develop implementation strategies for improving wetland water-quality. The short water residence times estimated for the watershed wetlands (averaging 38 days for Grimes Pond, 20 days for North Rice Pond and 8 days for South Rice Pond) limit the capacity to assimilate the summer runoff phosphorus loads from each direct drainage area, as well as the overall watershed.

The calibrated water quality modeling was used to simulate how implementation of watershed BMPs, combined with in-lake alum treatment, would improve water quality in each of the three ponds. Table 5-1 shows how much the average summer total phosphorus concentrations would improve following implementation of the recommended watershed structural BMPs and in-lake alum treatment in each pond (further discussed in Section 6).

Table 5-1 Average Summer Monitored and Modeled TP Following BMP Implementation

Monitoring/Modeling Scenario	Grimes Pond Avg. Summer TP	North Rice Pond Avg. Summer TP	South Rice Pond Avg. Summer TP
Existing 2020 and 2021 Summer Average TP (ppb)	168	104	230
Predicted TP Conc. Following BMP Implementation (ppb)	130	75	121
Percent TP Reduction Following BMP Implementation	23%	28%	47%

6 Wetland Improvement Options

6.1 Recommendations

Based on the wetland assessment and calibrated watershed and pond water quality modeling, the following watershed BMPs and in-pond management options are recommended to substantially reduce the respective phosphorus loadings and enhance vegetative diversity and integrity for each pond:

- Install structural BMPs and/or pretreatment protection measures to prevent future sediment delivery and reduce nutrient loading into the wetland with design(s) intended to meet water quality goals. Untreated stormwater runoff from two discharge outfalls each to South Rice and Grimes Ponds, as well as one outfall to North Rice Pond, are prioritized for implementation.
- Complete in-pond alum treatments to control summer sediment phosphorus release following implementation of watershed BMPs.
- Clear clogged debris and develop annual maintenance plan for all inlet and outlet structures. Remove accumulated sediment and fill materials from BMPs and within, and adjacent to, each wetland. Reconfigure discharge outfall and stabilize erosion from stormwater conveyance entering northwest corner of Grimes Pond.
- Re-vegetate and control soil erosion from bare soil areas within the upland buffer area. If mountain bike activity in the adjacent upland area is currently supported, isolate potential soil disturbance and adjacent vegetation improvements to prevent erosion into surrounding wetland areas.
- Conduct controlled water level drawdowns in each wetland prior to the winter season to ensure that curly-leaf pondweed is decreased to less than 20 percent cover and to enhance overall vegetative diversity and integrity. Remove, treat, and control other non-native invasive species, where possible, and remove fill material and trash.
- Initiate, or increase the frequency of, street sweeping and fall leaf litter removal programs, with emphasis in subwatersheds that have direct drainage to the wetlands.

6.2 Conceptual Design and Estimated Water Quality Benefit

Figure 6-1 shows the location of all the potential structural BMPs in the watershed. The proposed BMP located at SR-4 involves dredging and expansion of an existing stormwater pond (Basin J) and pretreatment cell, as well as downstream channel stabilization (see Figure 6-2), while the other proposed BMPs would involve implementation of new stormwater ponds at each of the other three locations shown in Figure 6-1.

Figure 6-3 includes a photo and schematic as examples of the important elements of the stormwater ponds envisioned for future implementation. The expectation is that the pretreatment provided by these two-cell pond systems will ensure that most of the ongoing operation and maintenance effort will not need to involve dredging, due to excess sedimentation in the main treatment cell. Both outfalls entering the GR-6 BMP location currently have CDS units that have recently been maintained and can be available for stormwater pretreatment of the respective subwatersheds.

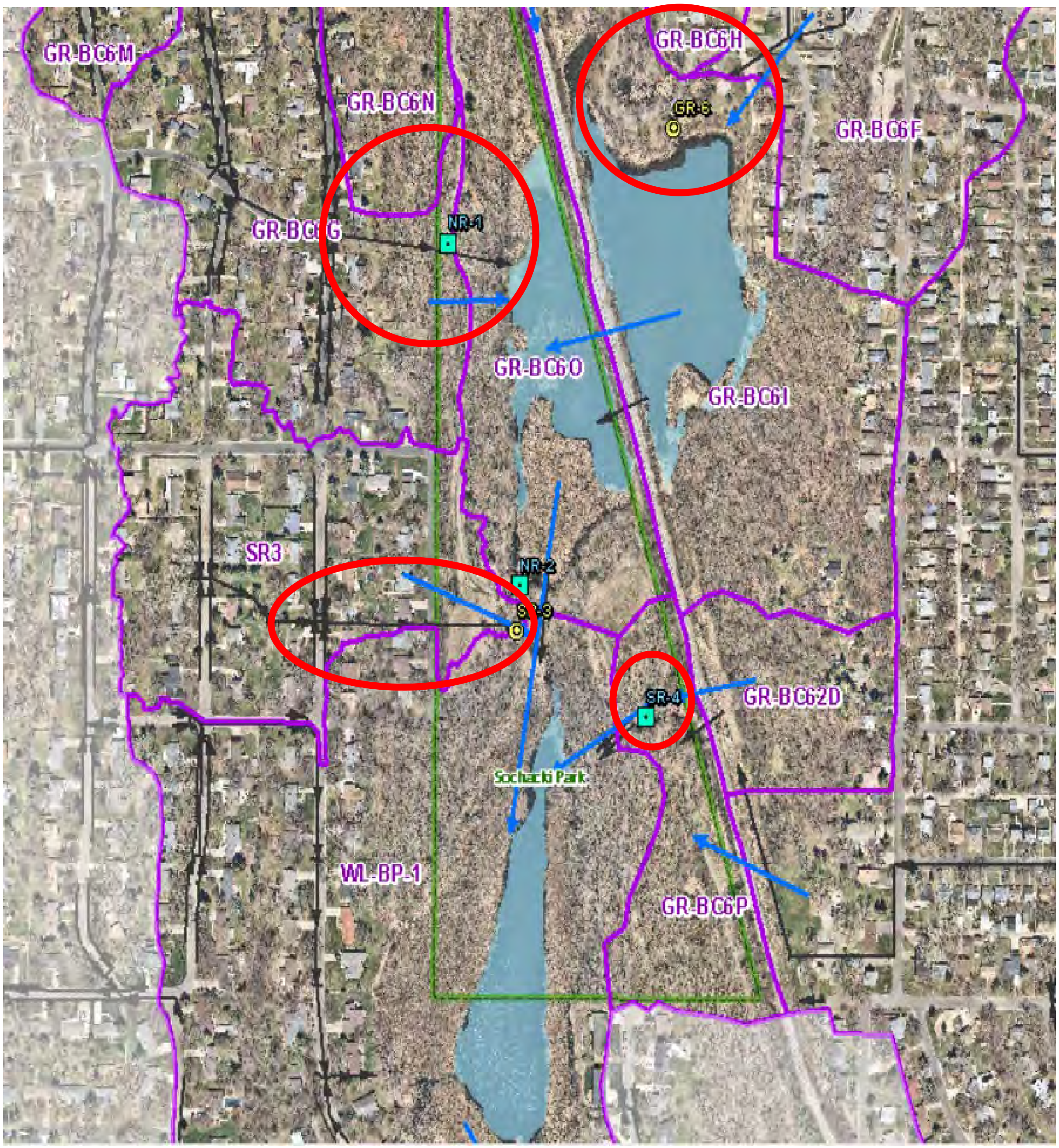

Figure 6-1 Recommended Sochacki Park Subwatershed Locations for Structural BMPs

For the majority of the BMPs evaluated, the updated P8 modeling was used to evaluate the proposed BMPs and estimate the annual total phosphorus removals. The model was run for the same water years that cover the monitored two-year consecutive climatic period (2020 and 2021 water years: 10/1/2019 – 9/30/2021). To evaluate the potential impact of an alum treatment, it was assumed that a combined alum and sodium aluminate treatment would reduce the estimated internal phosphorus load in each wetland by 80 percent.

Figure 6-2 Basin J Downstream Outlet Channel Erosion and Construction Debris

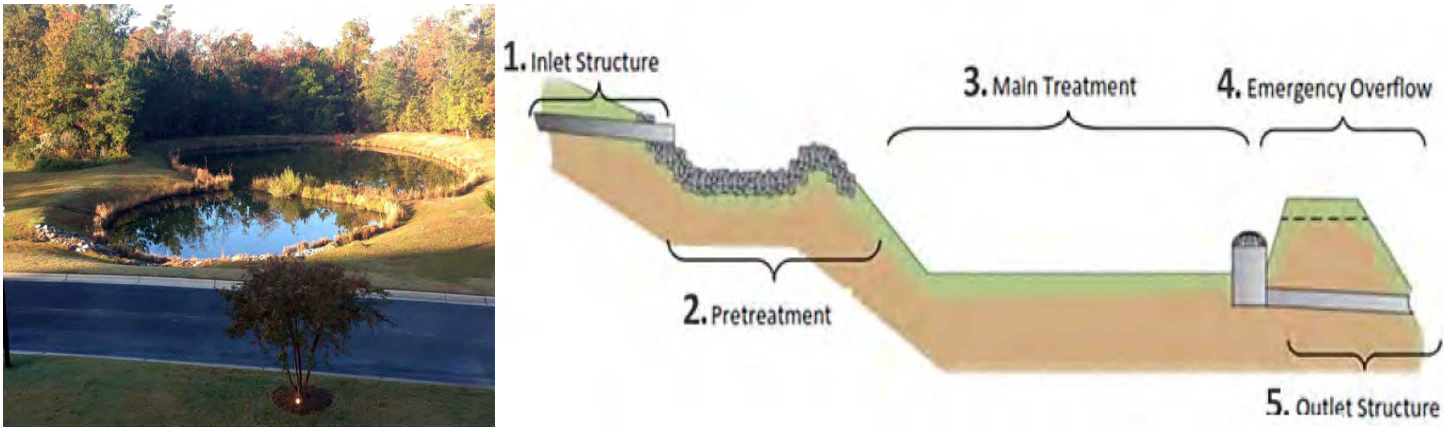

Figure 6-3 Example Stormwater Pond Treatment Elements

6.3 Estimated Cost-Benefit of Wetland Improvement Options

Planning level cost estimates were developed for the various BMPs based on the conceptual design of each project. Although the point estimate of cost was used for the cost-benefit analysis, there is cost uncertainty and risk associated with this concept-level cost estimate. The costs reported for the BMPs include engineering, design, and permitting (20 percent), construction management (15 percent), and estimated legal costs (5 percent). The costs do not include any wetland mitigation costs, assume that the excavated soils are not contaminated, and the projects do not require significant utility modifications or relocations. The range of probable costs presented reflects the level of uncertainty, unknowns, and risk due to the concept nature of the individual project designs. Based on the current level of design (planning level estimate), the cost range is expected to vary by -20 percent to +40 percent from the planning level point opinion of cost.

Appendix D includes the itemized planning level cost estimates for most of the water quality improvement options evaluated. These more detailed cost estimates should be reviewed and considered when planning and budgeting for the larger CIP projects and/or applications for grant funding.

A cost-benefit assessment was completed for each BMP to assist with prioritizing and select the preferred and most cost-effective BMPs to help achieve the necessary phosphorus load reductions. The capital costs (engineering, design, and construction) were annualized assuming a 20-year life span at a 4 percent interest rate. Although this timeframe is commonly used for these cost-benefit assessments, the actual lifespan of ponds, other BMPs, and infrastructure can be significantly longer if maintained regularly. Annual operation and maintenance costs were estimated for each project, assuming 1 percent of the capital cost. The benefit was estimated as an annualized cost per pound of total phosphorus removed per year.

Table 6-1 summarizes the potential wetland improvement options, estimated annual total phosphorus removal, planning level capital cost estimate, annualized cost-benefit, and recommended sequence for implementation of each improvement option. Items marked with “NA” in Table 6-1 are associated with options that are intended to address wetland habitat and are not applicable or quantified for TP load reductions. It is assumed that enhanced street sweeping in untreated subwatersheds would be incorporated into each City’s operations, so planning level costs for this improvement option were not estimated.

Table 6-1 Summary of Potential Improvement Option Benefit and Planning Level Costs

BMP ID/Location	Annual TP Removal (lbs/yr)	Planning Level Capital Cost Estimate	Annualized Cost-Benefit ($/lb TP Removed/yr)	Recommended Sequence for Implementation
Revegetate/control upland soil erosion	NA	$10,000	NA	1a
Street sweeping in untreated subwatersheds	NA	NA	NA	1b
Clear inlet/outlet debris, remove sediment deltas and stabilize erosion	NA	$100,000	NA	1c
Conduct pond water level drawdowns	NA	$154,000	NA	1d
Dredge/expand existing SR4 pond (Basin J) and stabilize outlet channel	33.5	$304,000	$760	2a
Construct stormwater pond at GR-6	14.9	$456,000	$2,600	2b
Construct stormwater pond at NR-1	3.8	$191,000	$4,200	2c
Construct stormwater pond at SR-3	3.7	$261,000	$5,900	2d
Alum treatment of Grimes, North and South Rice Ponds	11.2	$203,000	$1,500	3

It is expected that the following funding sources will be available for implementation of some of the recommended improvement options:

- BWSR Clean Water Funds
- Conservation Partners Legacy (for habitat components)
- Hennepin County Opportunity or Stewardship grants
- MPCA grants and MN Public Facilities Authority funds
- MnDNR short term action request grants
- Partner CIP funds (for potential grant match)

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