MINNEHAHA CREEK WATERSHED DISTRICT

WATERSHED MANAGEMENT PLAN

January 11, 2018

MINNEHAHA CREEK
WATERSHED DISTRICT

ACKNOWLEDGMENTS

The development of the Minnehaha Creek Watershed District's 2018-2027 Watershed Management Plan relied on the valuable input of many policymakers, city and agency staff, and community members. Listed below are the formal groups the District regularly conferred with, all of which were crucial to the production of the District's Plan. For a summary of the full public input process, please see Appendix B.

MINNEHAHA CREEK WATERSHED DISTRICT BOARD OF MANAGERS

Name	Seat
Brian Shekleton	Vice President
James Calkins	Former Manager
Jeff Casale	Former Manager
Jessica Loftus	Manager
Kurt Rogness	Secretary
Pamela Blixt	Former Manager
Richard Miller	Treasurer
Sherry Davis White	President
William Becker	Manager
William Olson	Manager

POLICY ADVISORY COMMITTEE

Name	Organization
Councilor Bob Stewart	City of Edina
Mayor Marvin Johnson	City of Independence
Councilor/Mayor Marty Schneider	City of Long Lake
Administrator Scott Johnson	City of Medina
Councilor Linea Palmisano	City of Minneapolis
Councilor Patty Acomb	City of Minnetonka
Mayor Lisa Whalen	City of Minnetrista
Mayor Lili McMillan	City of Orono
Mayor Scott Zerby	City of Shorewood
Councilor Jeff Clapp	City of Tonka Bay
Mayor Tom O'Conner	City of Victoria
Councilor Sliv Carlson	City of Woodland
Central Region Manager Terri Yearwood	Department of Natural Resources
Commissioner Stephanie Musich	Minneapolis Park & Recreation Board
Commissioner Gene Kay	Three Rivers Park District

TECHNICAL ADVISORY COMMITTEE

Name	Organization
Terry Jeffery	City of Chanhassen
Ross Bintner, Jessica Wilson	City of Edina
Nate Stanley	City of Hopkins
Lois Eberhart	City of Minneapolis
Liz Stout	City of Minnetonka
Bob Bean	Cities of Deephaven, Greenwood, Orono, Mound, St. Bonifacius, and Woodland
Derek Asche	City of Plymouth
Erick Francis	City of St. Louis Park
Cara Geheren	City of Victoria
Mike Kelly	City of Wayzata
Kristin Larson	Carver County
Randy Anhorn	Hennepin County Environmental Services
Steve Christopher	Board of Water and Soil Resources
Kate Drewry	Department of Natural Resources
Karen Jensen	Metropolitan Council
Rachael Crabb, Deb Pilger	Minneapolis Park & Recreation Board
Rich Brasch, John Barten	Three Rivers Park District

CITIZEN ADVISORY COMMITTEE

Name	City of Residence	Terms Served
Bradley Coulthart	Minneapolis	2017
Brian Girard	Orono; Deephaven	2015, 2016, 2017
Cassandra Ordway	Long Lake	2017
Chris Dovolis	Minnetonka Beach	2015, 2016
Colin Cox	St. Louis Park	2015, 2016, 2017
Craig Wilson	Hopkins	2017
Cristina Palmisano	Minneapolis	2015
David Oltmans	Minneapolis	2015, 2016, 2017
Elizabeth Crow	Minneapolis	2017
Gerald Ciardelli	St. Louis Park	2015, 2016, 2017
Jacqueline Di Giacomo	Tonka Bay	2015, 2016, 2017
John Grams	Minnetonka	2017
Joseph Lofgren	Minneapolis	2015, 2016
Joseph Lutz	Minnetonka	2016
Linda Jahnke	St. Louis Park	2017
Marc Rosenberg	Minnetonka	2015, 2016, 2017
Neil Weber	Long Lake	2015, 2016, 2017
Peter Rechelbacher	Wayzata	2015, 2016, 2017
Richard Manser	Edina	2015, 2016, 2017
Richard Nyquist	Edina; Minneapolis	2016, 2017
Sliv Carlson	Woodland	2015, 2016, 2017
Steve Mohn	Eden Prairie	2015, 2016, 2017
Valerie McGruder	Minnetonka	2016
William Bushnell	Minnetrista	2015, 2016, 2017

SIX MILE CREEK-HALSTED BAY SUBWATERSHED PARTNERSHIP

Name	Organization
Thomas Funk	City of Victoria
Cara Geheren	City of Victoria
Sean Ruotsinoja	City of St. Bonifacius
Robert Bean	City of St. Bonifacius
Lisa Whalen	City of Minnetrista
David Abel	City of Minnetrista
Lane Braaten	City of Waconia
Mike Klingelhutz	Laketown Township
Angela Smith	Three Rivers Park District
Richard Brasch	Three Rivers Park District
Kristin Larson	Carver County
Mike Wanous	Carver County Soil and Water Conservation District
Randy Anhorn	Hennepin County

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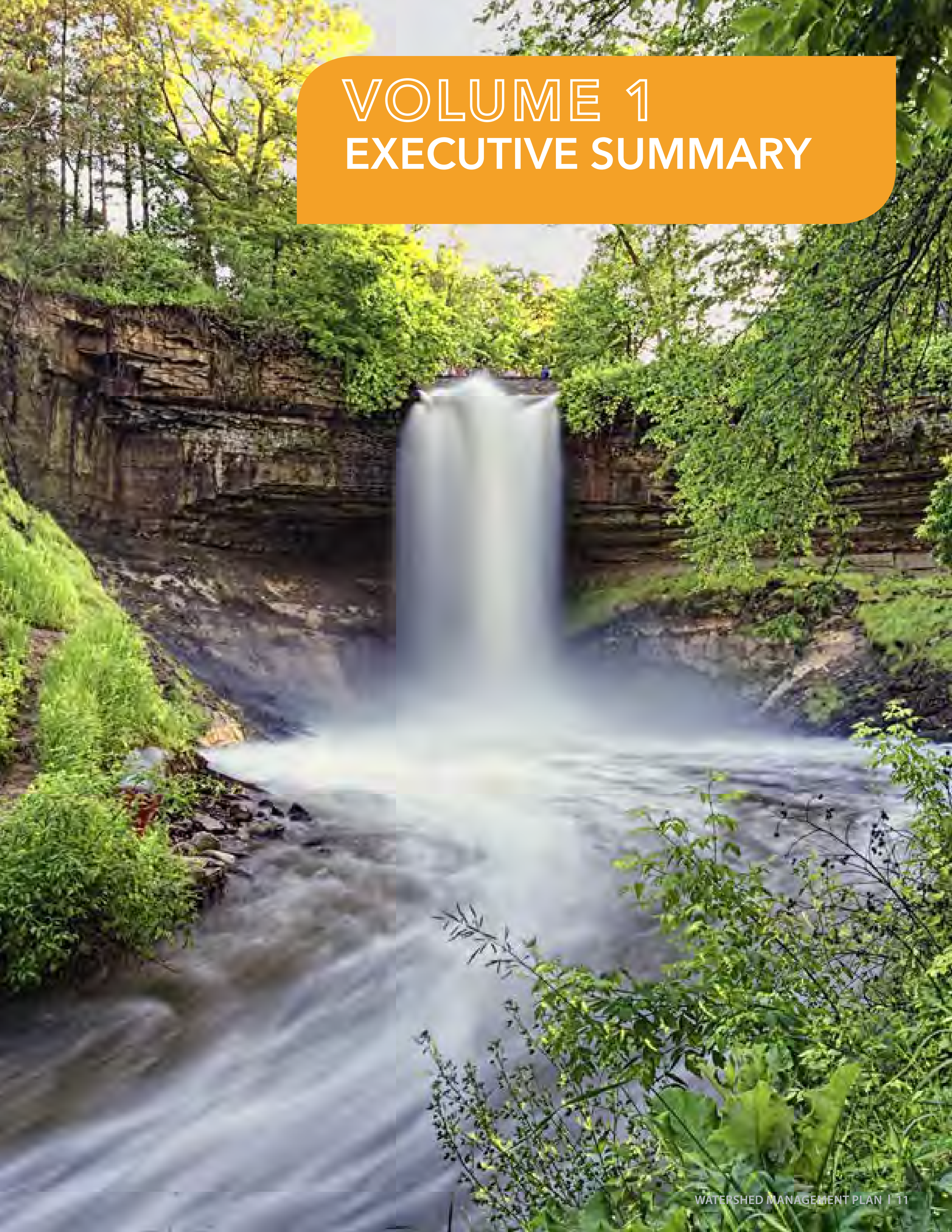
ACRONYMS AND ABBREVIATIONS

AIS	AQUATIC INVASIVE SPECIES
BMP	BEST MANAGEMENT PRACTICE
BWSR	BOARD OF WATER AND SOIL RESOURCES
CFS	CUBIC FEET PER SECOND
CHL-A	CHLOROPHYLL-A
CIP	CAPITAL IMPROVEMENT PROGRAM
CL	CHLORIDE
DNR OR MNDNR	MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DO	DISSOLVED OXYGEN
EPA OR USEPA	US ENVIRONMENTAL PROTECTION AGENCY
F-IBI	INDEX OF BIOTIC INTEGRITY FOR FISH
FAW	FUNCTIONAL ASSESSMENT OF WETLANDS
FWS	US FISH AND WILDLIFE SERVICE
FIS	FLOOD INSURANCE STUDY
FQI	FLORISTIC QUALITY INDEX
HHPLS	HYDRAULIC, HYDROLOGIC, AND POLLUTANT LOADING STUDY
HSG	HYDROLOGIC SOILS GROUP
LGU	LOCAL GOVERNMENT UNIT
LMCD	LAKE MINNETONKA CONSERVATION DISTRICT
MBS	MINNESOTA BIOLOGICAL SURVEY
MCRAM	MINNEHAHA CREEK ROUTINE ASSESSMENT METHOD
MCWD	MINNEHAHA CREEK WATERSHED DISTRICT
mg/L	MILLIGRAMS PER LITER
M-IBI	INDEX OF BIOTIC INTEGRITY FOR MACROINVERTEBRATES
MLCCS	MINNESOTA LAND COVER CLASSIFICATION SYSTEM
MNRAM	MINNESOTA ROUTINE ASSESSMENT METHOD
MPCA	MINNESOTA POLLUTION CONTROL AGENCY
MPRB	MINNEAPOLIS PARKS AND RECREATION BOARD
MS4	MUNICIPAL SEPARATE STORM SEWER SYSTEM

MU	MANAGEMENT UNIT
MUSA	2020 METROPOLITAN URBAN SERVICES AREAS
MWMO	MISSISSIPPI WATERSHED MANAGEMENT ORGANIZATION
NOAA	NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NPDES	NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
NWI	NATIONAL WETLAND INVENTORY
RFQA	RAPID FLORISTIC QUALITY ASSESSMENT
SD	SECCHI DEPTH OR SECCHI DISC
SWPPP	STORM WATER POLLUTION PREVENTION PROGRAM
TAC	TECHNICAL ADVISORY COMMITTEE
TN	TOTAL NITROGEN
TMDL	TOTAL MAXIMUM DAILY LOAD
TP	TOTAL PHOSPHORUS
TRPD	THREE RIVERS PARK DISTRICT
TSS	TOTAL SUSPENDED SOLIDS
µg/L	MICROGRAM PER LITER
WLA	WASTELOAD ALLOCATION



VOLUME 1
EXECUTIVE SUMMARY

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1 FIGURES AND TABLES

1.1 INTRODUCTION

This watershed management plan ("Plan") has been prepared pursuant to Minnesota Statutes §103B.231 and Minnesota Rules 8410. It describes how the Minnehaha Creek Watershed District ("District" or MCWD) will fulfill its responsibilities under the Metropolitan Surface Water Management Act (Minnesota Statutes §§103B.201 to 103B.255) over the ten-year planning period of 2018-2027.

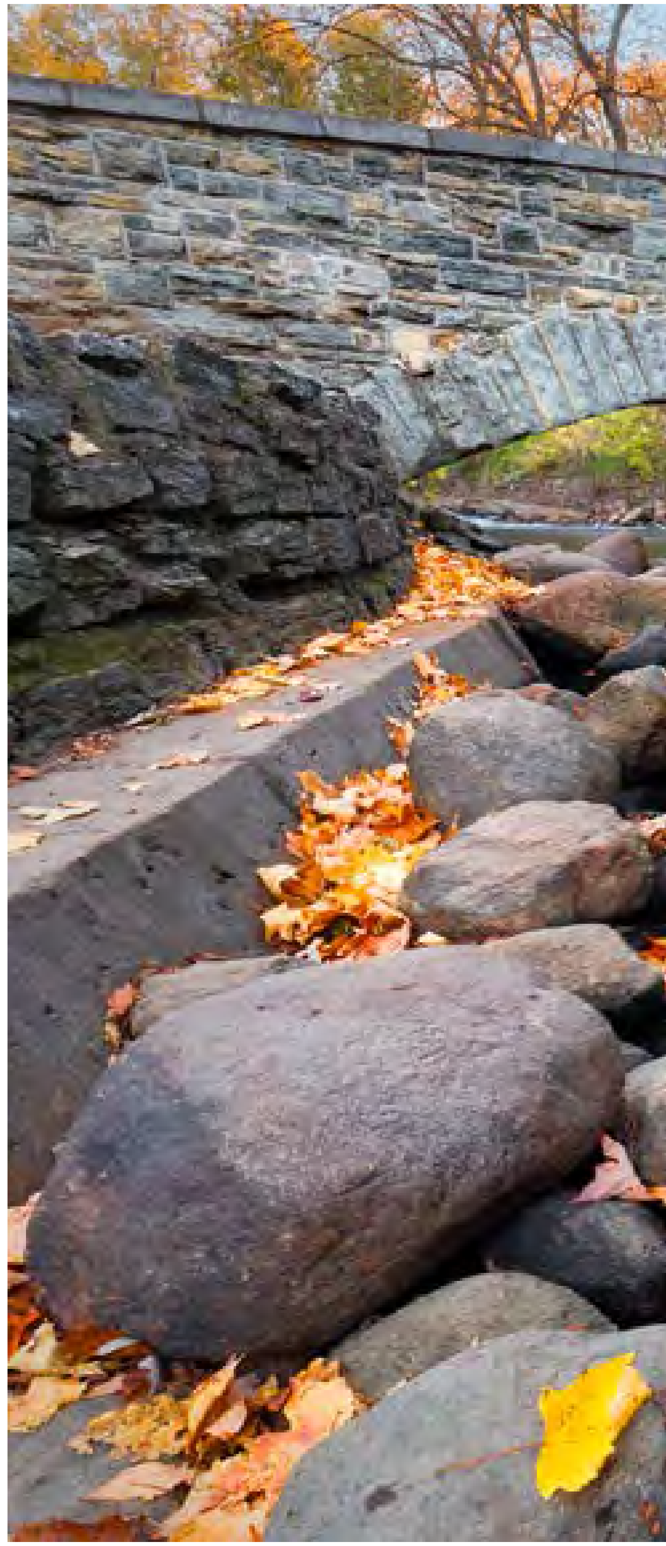
The Plan consists of three volumes:

The first volume is this **Executive Summary**. This volume briefly reviews the purpose, structure, and history of the MCWD; its philosophy and approach to fulfilling its water resource management responsibilities; the primary issues within its eleven subwatersheds; the programs and projects by which it will address these issues; and what it will ask of its cities and townships in order to achieve the water resource goals for the watershed.

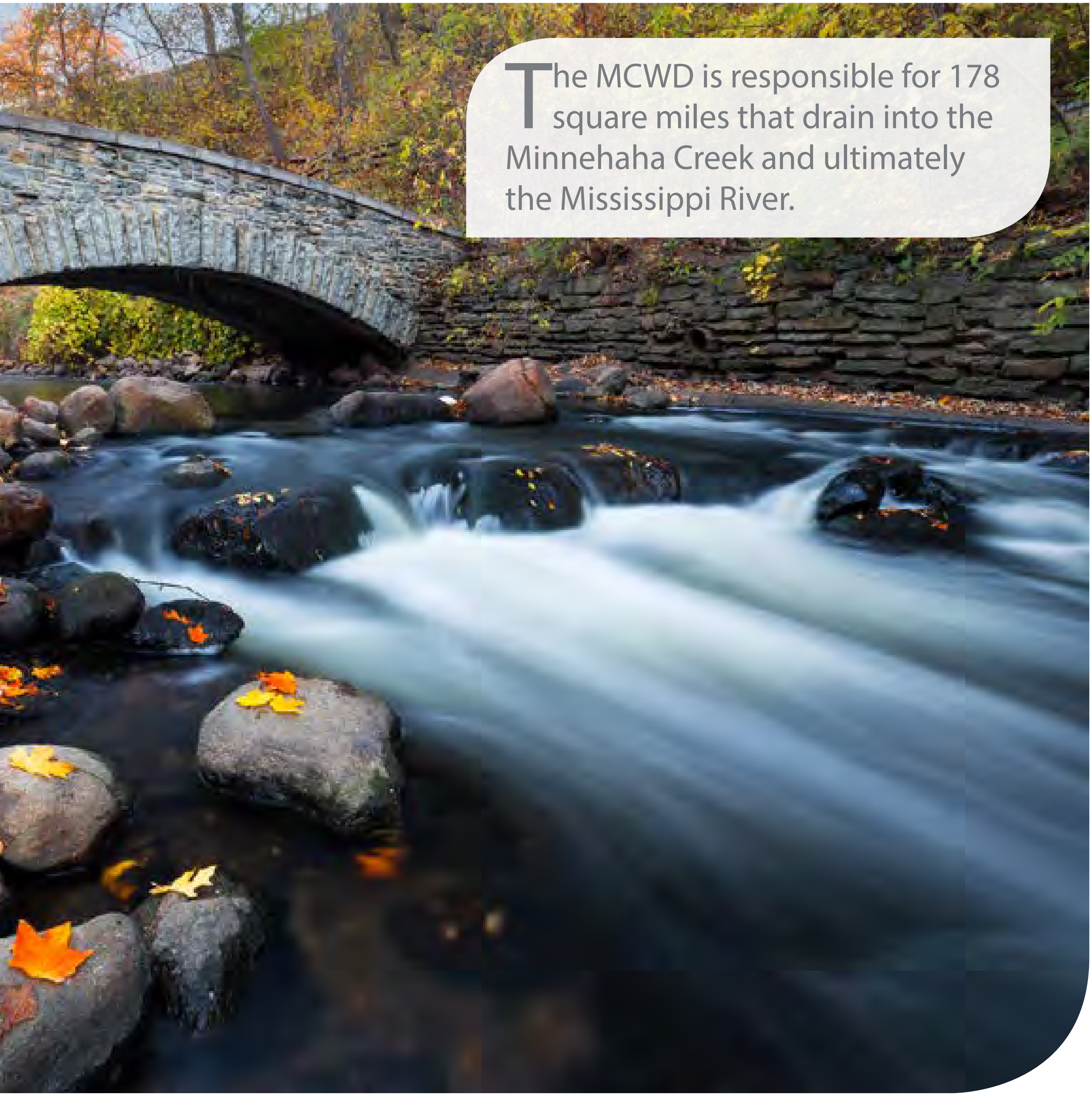
The second volume is the **Land and Natural Resources Inventory**. MN Rules 8410 requires the Plan to inventory watershed data on topography, soils, geology, precipitation, surface water resources, water quality and quantity trends, groundwater resources, hydraulic systems to convey stormwater, regulated pollutant sources, habitat, rare and endangered species, recreation areas, existing land uses and trends, and wetland preservation and restoration priority areas. The MCWD has substantial data from many years of careful monitoring and data acquisition. In this volume, the District provides a description of its data, reference to data locations, and a discussion of the data supporting the MCWD's identified water resource issues, goals, and strategies.

In addition, this volume describes the MCWD's Ecosystem Evaluation Program, or "E-Grade," a rubric that uses multiple parameters to characterize the health and function of the watershed. The purpose of E-Grade is to capture the condition of resources within the watershed in a way that is useful to the public and provides a uniform metric to set priorities and make resource investment decisions.

The third volume is the **Implementation Plan.** This volume is the roadmap that guides District action from planning to implementation. More specifically, it describes the planning path from issue identification to identifying the causes of issues, setting objectives and goals and, finally, defining management strategies to achieve identified goals. Objectives and management strategies rest on the MCWD's Balanced Urban Ecology approach to water resource planning and implementation. This approach



Minnehaha Creek below the falls, Ernesto Ruiz



The MCWD is responsible for 178 square miles that drain into the Minnehaha Creek and ultimately the Mississippi River.

recognizes the environmental, social and economic value created when built and natural systems work in harmony. It is described in this volume. The volume also describes each of the District's programs and the procedures that it will use to identify, fund, and implement them.

Finally, the Implementation Plan features a subsection for each of the MCWD's eleven subwatersheds. Each subwatershed plan follows the same sequence outlined above - from issues to identification of causes, objectives and goals, and management strategies. The implementation program for each subwatershed will identify specific, known projects and initiatives but also provide flexibility for future unknown projects and initiatives to arise through planning, collaborative processes, and opportunities. The MCWD intends subwatershed plans to be largely self-standing so they are useful resources for Local Government Units (LGUs) and other stakeholders within a given subwatershed.

1.2 MCWD OVERVIEW

1.2.1 MCWD PURPOSE

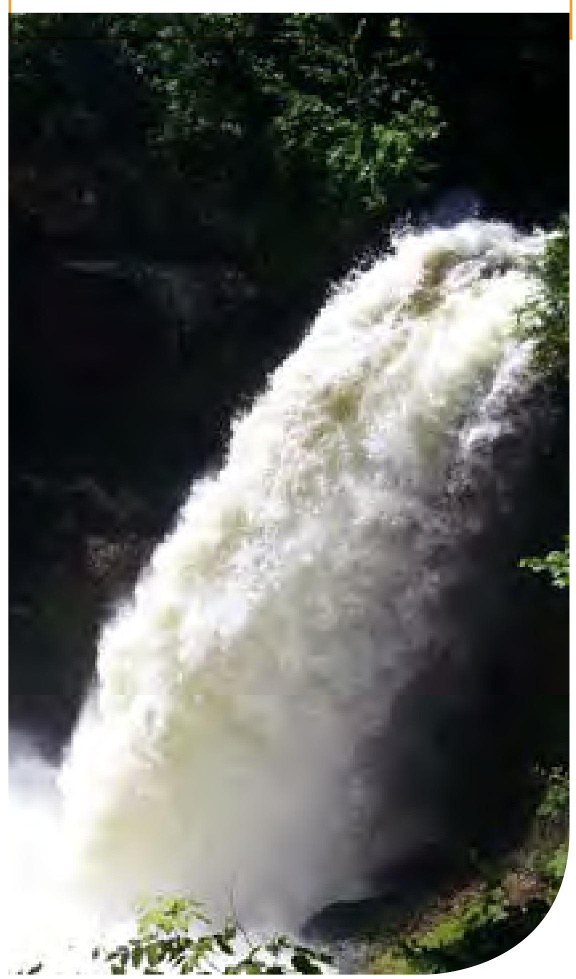
The MCWD believes that clean water and a healthy natural environment are essential to create and sustain vibrant communities. The lakes, streams, wetlands, and green space that make up our landscape create a sense of place that provides a local identity, adds economic value, and increases well-being.

As a political subdivision created under state law, the MCWD exists to pursue water resource management purposes set forth at Minnesota Statutes §§103B.201 and 103D.201. The listed purposes are many, but may be summarized as "secur[ing] the … benefits associated with the proper management of surface and ground water." Minn. Stat. §103B.201(8). The MCWD assumes a further mandate for water resource protection as a permittee under the federal National Pollutant Discharge Elimination System (NPDES) program for municipal separate storm sewer systems (MS4s).

Traditionally, the MCWD has pursued its purposes through several standard roles: gathering and assessing data; planning, constructing, and maintaining capital projects; regulating development and other land use disturbances to limit water resource impacts; supporting others' actions through grant or cost-share programs and technical assistance; conducting non-capital programs such as rough fish management and lake treatment for invasive aquatic species; and engaging in public communication and education.

In general, these remain the means by which the MCWD acts. This planning cycle, however, reflects an evolution from an independent program of

"The MCWD's approach to water resource planning recognizes the environmental, social, and economic value created when built and natural systems work in harmony."



Minnehaha Falls, Erdahl Aerial Photos

action toward one that derives from a more careful and active consideration of the MCWD's role and the roles of other public and private interests in the realm of water resource protection. As such, the MCWD sees its purposes not only as securing water resource benefits for the public, but also facilitating similar efforts by others.

The MCWD's particular role, then, includes:

- Acquiring, assessing, and maintaining watershed-wide water resource data.
- Performing special studies, and developing assessments and metrics, to provide for consistent resource evaluation and priority-setting across the watershed.
- Linking local units of government to statewide water programs, mandates, and funding.
- Leading or facilitating multi-partner water resource actions that cross local government boundaries within the watershed.
- Serving as a conduit of best practices and other specialized knowledge and resources to its general purpose units of government.
- Coordinating with local units of government to integrate water resource protection at site and regional scales into land use planning, land subdivision and development.
- Working with public and private partners to integrate water resource goals with other public and private goals in land and infrastructure development.

Clean water and a healthy natural environment are essential to create and sustain vibrant communities. The lakes, streams, wetlands and green space that make up our landscape create a sense of place that provides a local identity, adds economic value and increases well-being.

1.2.2 DISTRICT BOUNDARIES

The MCWD's legal boundary encompasses about 178 square miles within the western Twin Cities metropolitan area. Of this area, about 148 square miles lie within Hennepin County and about 30 square miles lie within Carver County.

The watershed comprises two distinct hydrologic basins. The "Upper Watershed" drains through 104 square miles of rural and suburban land to Lake Minnetonka, a 22 square-mile lake that is the tenth largest, and one of the most heavily recreated, waterbodies in Minnesota. Lake Minnetonka outlets through a dam controlled by the MCWD into Minnehaha Creek, which flows for roughly 23 miles and discharges into the Mississippi River in Minneapolis. About 52 square miles, constituting the "Lower Watershed," drain into Minnehaha Creek through the Minneapolis Chain of Lakes or directly by means of stormwater conveyances or overland flow.

Twenty-seven cities and two townships lie in whole or part within the watershed as shown in Figure 1.1. Table 1.1 lists the MCWD's cities and townships. Two regional park authorities exist within the MCWD: the Minneapolis Park and Recreation Board, and the Three Rivers Park District.

1.2.3 ORGANIZATIONAL HISTORY

On April 12, 1966, the Hennepin County Board of Commissioners petitioned the Minnesota Water Resources Board under authority of Minnesota Statutes Chapter 112 (now 103D) to establish the MCWD. The cited purposes for the MCWD were to conserve the watershed's waters and natural resources; improve lakes, marshes, and channels for water storage, drainage, recreation, and other public purposes; reduce flooding; keep silt from streams; control land erosion; reclaim wetlands; control stormwater; and preserve water quality in lakes and streams. The MCWD was established on March 9, 1967.

Since that time, the MCWD has implemented numerous policies, programs, and projects to advance its goals. It first adopted rules to regulate development in 1967. Since that time, it has exercised oversight of development to limit water resource impacts from erosion, stormwater flows, floodplain alteration, wetland disturbance, shoreline and streambank alterations, dredging, and other causes. In 1972, the MCWD accepted authority over eight county and judicial drainage systems located within the watershed. The MCWD developed watershed management plans in 1969, 1997, and 2007. This Plan represents the MCWD's fourth cycle of water resource planning and implementation.

The MCWD's 1997 plan featured a traditional emphasis on identified capital projects to address legacy water quality and flooding issues and, separately, regulation of new development to minimize new impacts. The

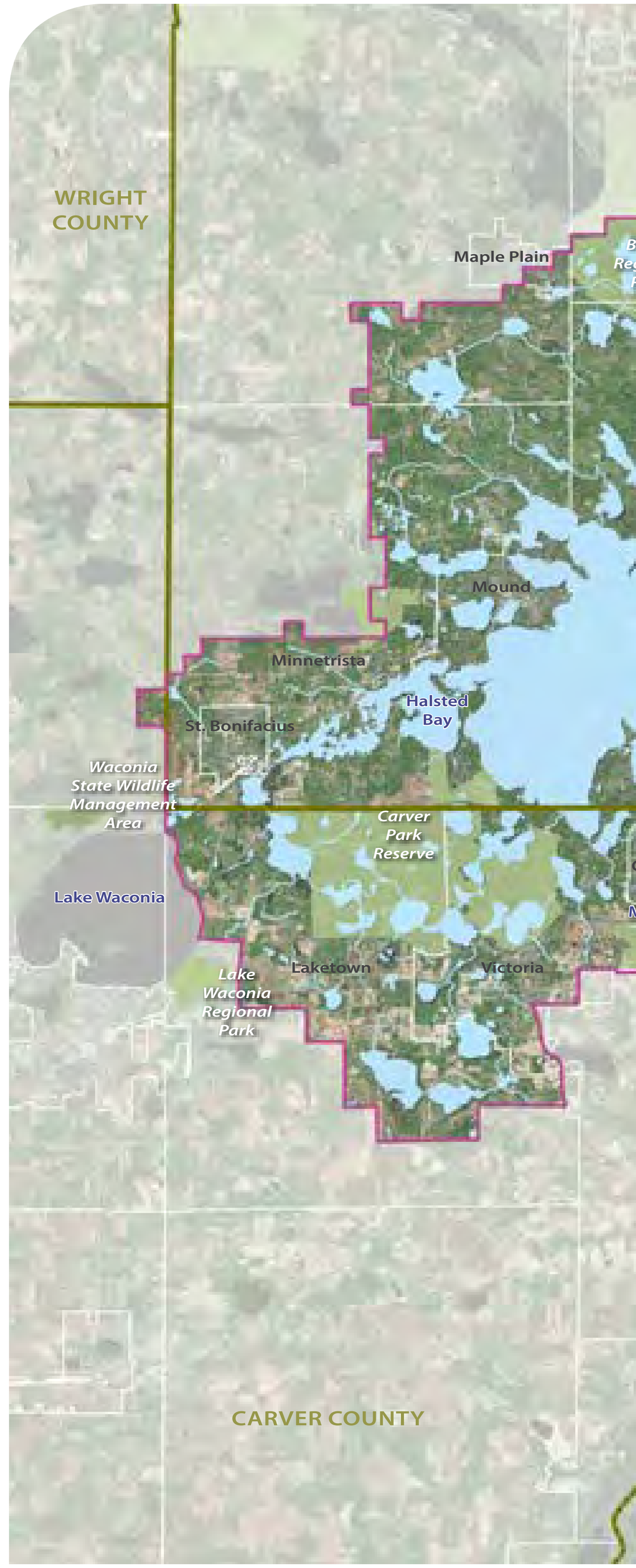


Figure 1.1 Minnehaha Creek Watershed District Boundary Map

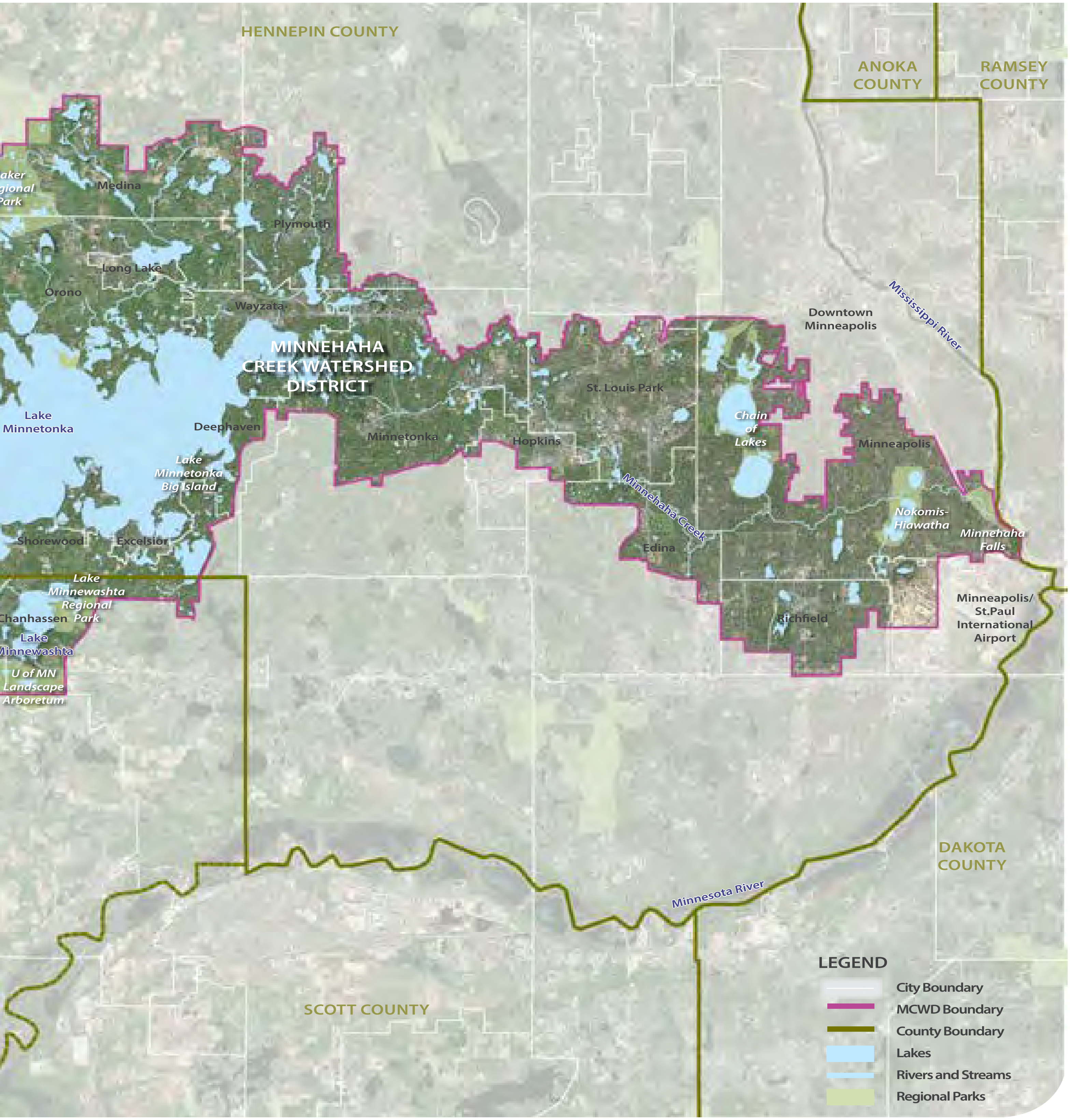

HENNEPIN COUNTY
ANOKA COUNTY
RAMSEY COUNTY
Medina
Plymouth
Long Lake
Orono
Wayzata
MINNEHAHA CREEK WATERSHED DISTRICT
Downtown Minneapolis
Mississippi River
St. Louis Park
Lake Minnetonka
Deephaven
Minnetonka
Hopkins
Chain of Lakes
Minneapolis
Lake Minnetonka Big Island
Minnehaha Creek
Nokomis-Hiawatha
Minnehaha Falls
Shorewood
Excelsior
Edina
Lake Minnewashta Regional Park
Chanhassen
Lake Minnewashta
Richfield
Minneapolis/ St.Paul International Airport
U of MN Landscape Arboretum
DAKOTA COUNTY
Minnesota River
SCOTT COUNTY
LEGEND
City Boundary
MCWD Boundary
County Boundary
Lakes
Rivers and Streams
Regional Parks

Table 1.1 Municipalities within the MCWD

HENNEPIN COUNTY	
Deephaven	Minnetrista
Edina	Mound*
Excelsior*	Orono*
Golden Valley	Plymouth
Greenwood*	Richfield
Hopkins	St. Bonifacius*
Independence	St. Louis Park
Long Lake*	Shorewood
Maple Plain	Spring Park*
Medina	Tonka Bay*
Minneapolis	Wayzata*
Minnetonka	Woodland*
Minnetonka Beach*	
CARVER COUNTY	
Chanhassen	Victoria*
Laketown Township	Watertown Township

Entirely in District

2007 plan began to move toward a more flexible framework. It set water quality standards for the MCWD's lakes and streams, and targets to reduce phosphorus loads to identified receiving waters in each of the MCWD's subwatersheds. The MCWD assumed responsibility for a part of these reductions and assigned a portion to its Local Government Units (LGUs), requiring that local water plans identify how the LGUs would achieve their assigned reductions through activities such as managing their properties, performing street sweeping, and implementing capital projects.

The plan, though, was static in several respects. It identified a specific list of MCWD projects, it directed LGUs to independently act, and it separated capital project work from regulation of development. As the MCWD implemented the plan, however, the approach evolved to a more flexible framework in which its LGUs, developers and other public and private parties have become partners in opportunity-based work that serves multiple goals. In 2014, the MCWD Board of Managers articulated and adopted this approach as its Balanced Urban Ecology policy. The policy

Cottageville Park Expansion

Minnehaha Creek re-meander, Erdahl Aerial Photos

Meadowbrook golf course flooding

A boardwalk at the Minnehaha Creek Preserve

prioritizes partnership with the land use community to integrate policy, planning, and implementation in order to leverage the value created when built and natural systems are in harmony.

The Balanced Urban Ecology policy emerged in 2014 as the MCWD reflected on its collaborative work along the urbanized Minnehaha Creek corridor within the Cities of St. Louis Park and Hopkins, now referred to as the Minnehaha Creek Greenway. There, over the course of several years, the MCWD worked with public and private partners - including a hospital, a large industrial employer, property owners, and the Cities of Hopkins and St. Louis Park - in a succession of projects to achieve mutual goals. This concerted effort resulted in an extensive stream restoration achieving both multiple water resource goals and other public and private goals of the many partners.

The hospital created a healing environment through connection with a restored natural setting and gained enhanced flood protection for a sensitive part of its facilities. The industrial employer gained real estate, stormwater management, and local land use approval for a large expansion.

An apartment complex property owner achieved trail access for its residents, while a commercial property owner was connected to city storm sewer improvements to address site flooding. The City of Hopkins turned a hidden, troubled pocket park into an open community space; gained regional stormwater treatment for redevelopment; and positioned a 17-acre industrial site for a shift in use consistent with the area redevelopment plan. The City of St. Louis Park gained natural and recreational amenities, connected residents to transit, and expanded its tax and employment base.

For the MCWD, outcomes of this partnered work included restoration of a substantial length of creek sinuosity, riparian wetland, and floodplain; treatment of runoff from several hundred fully-developed acres of urban land that previously discharged untreated to the creek; and the creation of both passive and active recreational sites connected to the water environment and integrated with public education about the natural environment. Furthermore, the public cost of the stormwater infrastructure work was reduced by working with Metropolitan Council Environmental Services to align public investments and incorporate the water resource improvement into concurrent sanitary sewer construction.

The MCWD realized that if it builds sound relationships with local partners, remains aware of partners' land use activities and goals, is mindful of subwatershed priorities, and is watchful and flexible, opportunities will present themselves to advance water resource goals cost-effectively and consistent with other local public and private goals. This Plan takes the next step in the evolution of the MCWD's philosophy and approach by adopting the Balanced Urban Ecology policy as its underlying organizational strategy.

1.3 MCWD APPROACH

1.3.1 DISTRICT PHILOSOPHY

The natural environment is an integral component of vibrant communities. It creates a sense of place, provides vital connections, and enhances social and economic value. The MCWD vision is a landscape of vibrant communities where the natural and built environments in balance create value and enjoyment.

This vision stems from the MCWD's 2014 adoption of the Balanced Urban Ecology policy, which now serves as the MCWD's underlying organizational strategy. It prioritizes partnership with the land use community to integrate policy, planning and implementation. The Balanced Urban Ecology policy developed from a series of policy analyses that identified the governance gap between land use and water resource planning. It responded to state, county, and non-profit assessments calling for increased integration of water resource planning and land use planning to improve the watershed management model in Minnesota and for treating land development and water resource protection as complementary rather than competing interests.

The Balanced Urban Ecology policy states:

Rather than viewing the natural and built environments as a clash of opposing forces, we recognize the inter-related and inter-dependent character of modern life; communities cannot thrive without healthy natural areas, and healthy natural areas become irrelevant without the interplay of human activity. This is the integrated setting in which we live... Indeed, our quality of life and our economic wellbeing are inextricably linked.

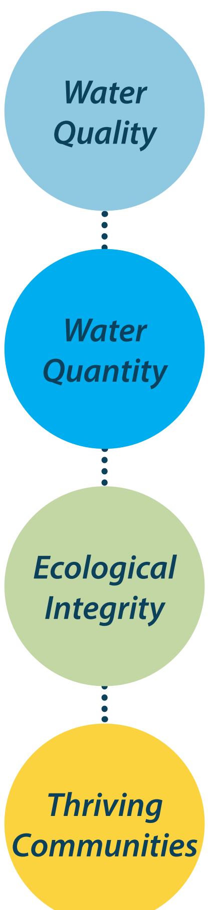
Successful, sustainable, livable communities are built on a foundation of integrated planning – planning that recognizes communities as living organisms and takes into consideration all components of the urban ecology.

Our work will be strengthened through these collaborative efforts. Not only will they offer greater community impact, they will produce creative public-private funding opportunities that will leverage scarce resources and maximize benefits. Going it alone is no longer the best path forward.

The Balanced Urban Ecology policy rests on the following three principles:

- Intensifying and maintaining focus on high-priority projects.
- Partnering with others to pursue watershed management goals.
- Being flexible and creative in adapting to the needs of partners.

Too often, watershed district ten-year implementation plans have been pursued independent of community planning and, as a result, have not been aligned with land use changes, new public infrastructure, and private development. This has led to isolated public expenditures to address existing systemic problems and an over-reliance on regulation to limit impacts from new development. The opportunity to partner with other public and private actors to achieve better water resource outcomes and increased public value has been missed. By working to understand the goals of others; applying sound science to creative solutions; and aligning investments, technical expertise, streamlined permitting, collaborative planning, and educational resources, the MCWD will seek to bring added value to partner initiatives across the watershed and cost-effectively achieve complementary public and private goals.



1.3.2 DISTRICT GOALS

The District has established four strategic goals to focus and guide its work:

- **Water Quality** - To preserve and improve the quality of surface and groundwater.
- **Water Quantity** - To manage the volume and flow of stormwater runoff to minimize the impacts of land use change on surface and groundwater.
- **Ecological Integrity** - To restore, maintain, and improve the health of ecological systems.
- **Thriving Communities** - To promote and enhance the value of water resources in creating successful, sustainable communities.

For purposes of Plan organization, all MCWD water resource issues nest within the three strategic goal areas of Water Quality, Water Quantity and Ecological Integrity. Example issues include excess nutrients (water quality), flooding (water quantity), and degraded habitat (ecological integrity). No issues are outlined under the Thriving Communities goal. This goal is an overarching organizing element to guide the MCWD in implementing its mission: the MCWD will implement its clean water objectives in ways that meaningfully contribute to the development of thriving communities.

1.3.3 IMPLEMENTATION MODEL

The Balanced Urban Ecology policy requires awareness, adaptation, and the capacity to pursue opportunities as they arise. The implementation model to support this approach is ongoing and iterative, but can be simplified into four basic steps:

Understanding Resource Needs

The first element is to understand water resource needs on a subwatershed basis. Each subwatershed plan within this Plan follows an issues, drivers, and strategies sequence. Issues are the specific needs to be addressed - where conditions fall short of strategic goals for the subwatershed. Drivers are the causes of, or factors that contribute to, these issues. Strategies are the means by which the issues may be addressed. Strategies are not defined programs or projects, but rather the different modes of action, approaches, and techniques that the MCWD may use within a described area to achieve a desired water quantity, water quality, or ecological integrity outcome.

Understanding Land Use Plans and Opportunities

The second element is to understand the land use setting. The MCWD maintains current knowledge of land use and capital planning by its LGUs and of potential land use development and redevelopment activity. Under this Plan, the MCWD will establish with each LGU a coordination protocol so that the MCWD and the LGU are aware of each other's planning activities, of pending development activity, and of applications received for regulatory review.

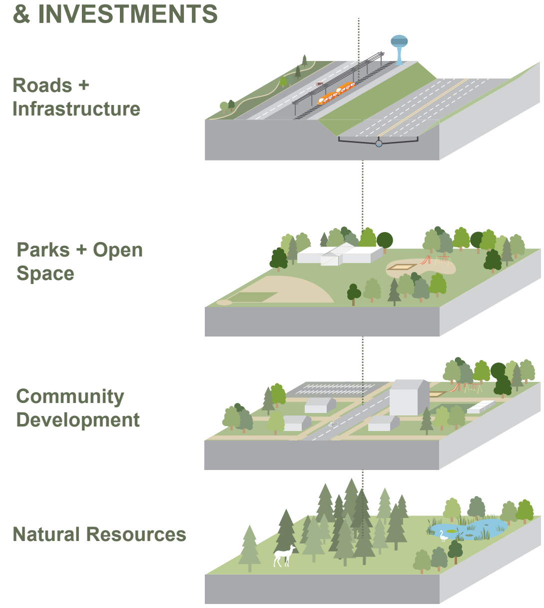
Integrating and Prioritizing

The third element is prioritization. By means of diagnostic data-gathering, the MCWD forms and adjusts implementation priorities to achieve MCWD goals on a subwatershed and watershed-wide basis. At the same time, the MCWD integrates its water resource priorities with the current land use context to look for the intersection of MCWD and partner interests, develop feasible and cost-effective project concepts, and initiate project planning and coordination with public and private partners.

Implementing

The last element is implementation. This involves formalizing public and private partner agreements that identify project roles and responsibilities, arranging necessary land rights, following required procedures to establish project funding and financing, and moving forward to implement. A project may involve capital construction or may involve one or more other modes

ALIGNING PLANS & INVESTMENTS



Staff and volunteers monitor water quality across the watershed

Heavy rains flooded Lake Hiawatha in 2014

of MCWD action including data collection/diagnosis, technical or planning assistance, permitting assistance, facilitation, and grants. After project completion, the MCWD assesses project performance with respect to desired outcomes of the MCWD and partners. Implementation also includes monitoring and maintenance of MCWD project assets over time to ensure their continued effectiveness.

1.4 IMPLEMENTATION PLAN SUMMARY

1.4.1 PRIMARY ISSUES

Water Quality

Within the watershed, pollutant discharge is primarily from non-point sources, carried to lakes, streams and wetlands by snowmelt or rainfall that runs across the landscape. Sediment, nutrient (particularly phosphorus), and other pollutant load in runoff exceeds what lakes, streams and wetlands would receive in an undeveloped watershed.

Within freshwater systems, excess nutrient content promoting eutrophication is the most common problem. Phosphorus affects algal and plant productivity, water clarity, fish habitat and aesthetics. Other pollutants stress freshwater systems, but phosphorus is used as standard indicator of system health.

The U.S. Environmental Protection Agency (EPA) and the Minnesota Pollution Control Agency (MPCA) define acceptable water quality as that which supports the designated use of the waterbody (e.g. fishable, swimmable, drinkable). The Plan defines good water quality as when the physical, chemical, biological and aesthetic characteristics of a waterbody support its designated use. Because water quality largely is regulated by total phosphorus concentration, the water quality emphasis of this Plan is on reducing phosphorus loads to lakes to achieve standards set by the state.

Water Quantity

As land use alters a watershed, the flow of water across the landscape changes. In an undeveloped watershed, rainfall largely infiltrates into the ground. As the watershed begins to include built components, channels are straightened, wetlands are filled, drainageways are piped, natural vegetation is removed, and hard surface is installed. These alterations reduce water infiltration and storage. As a result, larger volumes of water drain through the system faster.

Flooding occurs when a watershed is overwhelmed with rainfall or snowmelt that cannot infiltrate into the ground or be appropriately stored on the landscape. Flooding can occur across a watershed on major lakes and streams or more locally in ponds and street systems that cannot adequately store or convey the water being received during and after storm events.

Water quantity can also be an issue when there is not enough water. Water is essential for aquatic life and the health of aquatic systems. In an undeveloped watershed condition, water is stored in wetlands or infiltrated into the ground. It is slowly released to the stream channel, promoting long periods of stable water flow. In urban watersheds with extensive hard surface, water moves through the system quickly after rainfall events. This results in intermittent channel flow and periods where the channel is dry. This "flashy" stream behavior directly affects the ecological health of the stream, stressing fish, macroinvertebrates, plants, and other aquatic life. It also undermines stream channel stability and increases sediment loads through erosion and subsidence.

The Plan focuses on water quantity issues that stress the regional system. The MCWD will work with its partners to plan and implement solutions that return surface flow behavior as much as possible to natural behavior and that create a more resilient system to handle high and low flow behavior.

Ecological Integrity

The three primary elements of an ecological system are its structure, composition, and function. Structure is all of the living and non-living physical components that make up an ecosystem. Composition is the variety of living things within the ecosystem. Function is the assemblage of natural processes that occur within the ecosystem.

Ecological integrity exists when ecosystem composition and function are unimpaired by stress from human activity. It exists when natural ecological processes are intact, naturally evolving, and self-sustaining.

Within this Plan, ecological integrity seeks balance between the built and natural environments, with ecosystems providing the highest possible measure of structure, composition and function relative to the level of human impact within the system. The implementation plan seeks to improve structure, composition, and function at an individual resource level and connectivity between aquatic and terrestrial ecosystems at a regional landscape scale.

1.4.2 IMPLEMENTATION PRIORITIES

One of the guiding principles of the District's Balanced Urban Ecology policy is "intensifying and maintaining focus on high-priority projects." Through its work in the Minnehaha Creek Greenway, the District has found that it can more effectively achieve its mandate to manage and improve water resources, not when it seeks to apply its resources evenly across

Great Blue Heron

Through sustained focus, the District is able to develop a thorough understanding of a system's issues and drivers, build relationships, identify opportunities, and coordinate plans and investments with its partners for maximum natural resource and community benefit.

Kayaking Minnehaha Creek, Mark Krech

the watershed at all times, but rather when it coordinates its programs and capital investments so as to focus on specific areas of high need and opportunity.

Through sustained focus, the District is able to develop a thorough understanding of a system's issues and drivers, build relationships, identify opportunities, and coordinate plans and investments with its partners for maximum natural resource and community benefit.

This focused approach is best suited in areas where there are significant resource needs and a level of complexity that require sustained effort and coordination across multiple public and private partners. The other factors that drive the District to focus in a particular geography are the opportunities that exist, such as land use changes, partner efforts, or funding sources.

The District has identified three priority subwatersheds in which to focus its implementation efforts for the 2018-2027 plan cycle – Minnehaha Creek, Six Mile Creek-Halsted Bay, and Painter Creek. These three subwatersheds have been prioritized based on a combination of resource needs and opportunities, as summarized in the following sections.

The District's efforts in these priority areas will benefit some of the Twin Cities' most valued resources. The work in the Minnehaha Creek subwatershed will improve both the Creek and Lake Hiawatha of the Minneapolis Chain of Lakes. The focus on the Six Mile Creek and Painter Creek subwatersheds is part of the District's strategy for protecting and improving Lake Minnetonka by addressing its most degraded bays – Halsted and Jennings – through upstream and in-lake efforts.

Minnehaha Creek

As described in Section 1.2.3, the District's focused approach originated in the Minnehaha Creek Greenway and has produced significant natural resource and community benefits.

The Board identified this section of the Creek through Hopkins and St. Louis Park as a priority focus area because of its resource needs – this stretch of creek has been identified as contributing the Highest pollutant loads to Minnehaha Creek and downstream Lake Hiawatha, both classified as impaired; and its opportunities – the area is undergoing significant land use planning and redevelopment due in large part to the planned light rail transit system.

The District will continue its efforts in the Minnehaha Creek subwatershed under this Plan, completing projects that are underway in the Greenway and extending its stream restoration and stormwater management work downstream through partnerships with the cities of Edina and Minneapolis and the Minneapolis Park and Recreation Board.

Six Mile Creek-Halsted Bay

The Six Mile Creek-Halsted Bay focal geography is a complex system that spans four communities, two counties, and a significant portion of Three Rivers Park District land. It is resource-rich with 17 lakes Halsted Bay of Lake Minnetonka, and over 6,000 acres of wetlands. Six of these lakes are classified as impaired under Minnesota Pollution Control Agency standards, and Halsted Bay requires the largest load reduction of any waterbody in the District. The subwatershed is experiencing significant growth and development activity that creates opportunities, and urgency, for integrated land use and water resource planning.

In 2016, the District formed the Six Mile Creek-Halsted Bay Subwatershed Partnership to coordinate implementation activities with the communities and other subwatershed partners. From 2016-2017, the Subwatershed Partnership has established shared priorities for the geography and a framework for ongoing coordination to realize its goals around clean water and abundant natural resources integrated with the built environment.

The principal implementation strategies within the Six Mile Creek-Halsted Bay subwatershed include carp management to restore lake ecology, restoration of degraded wetlands, and the use of aluminum sulfate, or alum, to address internal phosphorus release. Given the geography's scale and complexity, priority implementation activities will be established in coordination with the Subwatershed Partnership on an ongoing basis based on an individual project's natural resource benefit, opportunity to leverage external investment, community support, and urgency.

Painter Creek

The Painter Creek Subwatershed contains a number of large wetlands, many of which have been ditched or otherwise altered, that are connected by Painter Creek. The system delivers high phosphorus loads to Jennings Bay on Lake Minnetonka, which is listed as impaired and requires the second largest load reduction in the District. Painter Creek is also impaired by excess E. coli bacteria. The subwatershed includes areas of high quality wetland and upland, including several regionally significant ecological areas.

The MCWD has previously established a partnership with the United States Army Corps of Engineers (USACE), which identified the potential restoration of four of the major wetland marsh systems under the Federal Section 206 Program, a program of federal-local cost-sharing and collaboration on habitat improvement work. Management strategies within the Painter Creek

Six Mile Creek

subwatershed will focus on restoring wetland and stream systems in ways that reduce nutrient loading downstream to Jennings Bay, while improving ecological integrity and corridor connectivity within the subwatershed. Before this work is advanced, MCWD will develop a specific systems plan for this subwatershed in partnership with local municipalities and landowners.

Watershed-wide

In addition to these focused implementation efforts, the District's approach watershed-wide is to remain responsive to opportunities created by land use change or partner initiatives. The Plan creates a coordination framework through which the District will seek to maintain current knowledge of land use and capital planning by its LGUs, and of potential land use development and redevelopment activity.

As opportunities arise, the District will evaluate them against the resource needs and priorities defined in the subwatershed plans in Section 3.9 and determine the appropriate response. The District has a wide range of services it can mobilize to address resource needs and support partner efforts, including data collection and diagnostics, technical and planning assistance, permitting assistance, education and capacity building, grants, and capital projects.

The District anticipates that the most likely capital project opportunities to arise through this approach will be in the area of stormwater management. For this reason, the capital improvement program (CIP) includes stormwater management projects in each subwatershed. Over the course of the 2018-2027 plan cycle, new opportunities and priorities may be identified that are beyond the scope of this CIP. As needed to pursue any such projects, the District first will amend the Plan to ensure a sound programmatic and fiscal basis to do so.

1.4.3 RESPONSIBILITIES OF LOCAL GOVERNMENTS

After the Plan is approved or amended, each LGU within the MCWD with land use planning and regulatory responsibility must prepare a local water management plan, capital improvement program, and official controls as prescribed in the Plan. An MCWD-approved local water plan is a required element of the LGU comprehensive land use management plan mandated by Minnesota Statutes §473.864.

This planning framework shows the link that the legislature has recognized between land use and water resource planning. As the regional water resource authority, the MCWD is responsible for understanding hydrologic systems on a watershed basis. In its review of local water plans, the MCWD seeks to engage its LGUs as partners in incorporating this basis of knowledge

Park Nicollet overlooks a restored wetland & boardwalk

Cottageville Park

District staff and partners co-develop plans and understanding into the exercise of land use planning, regulatory, capital, infrastructure maintenance, and related local authorities.

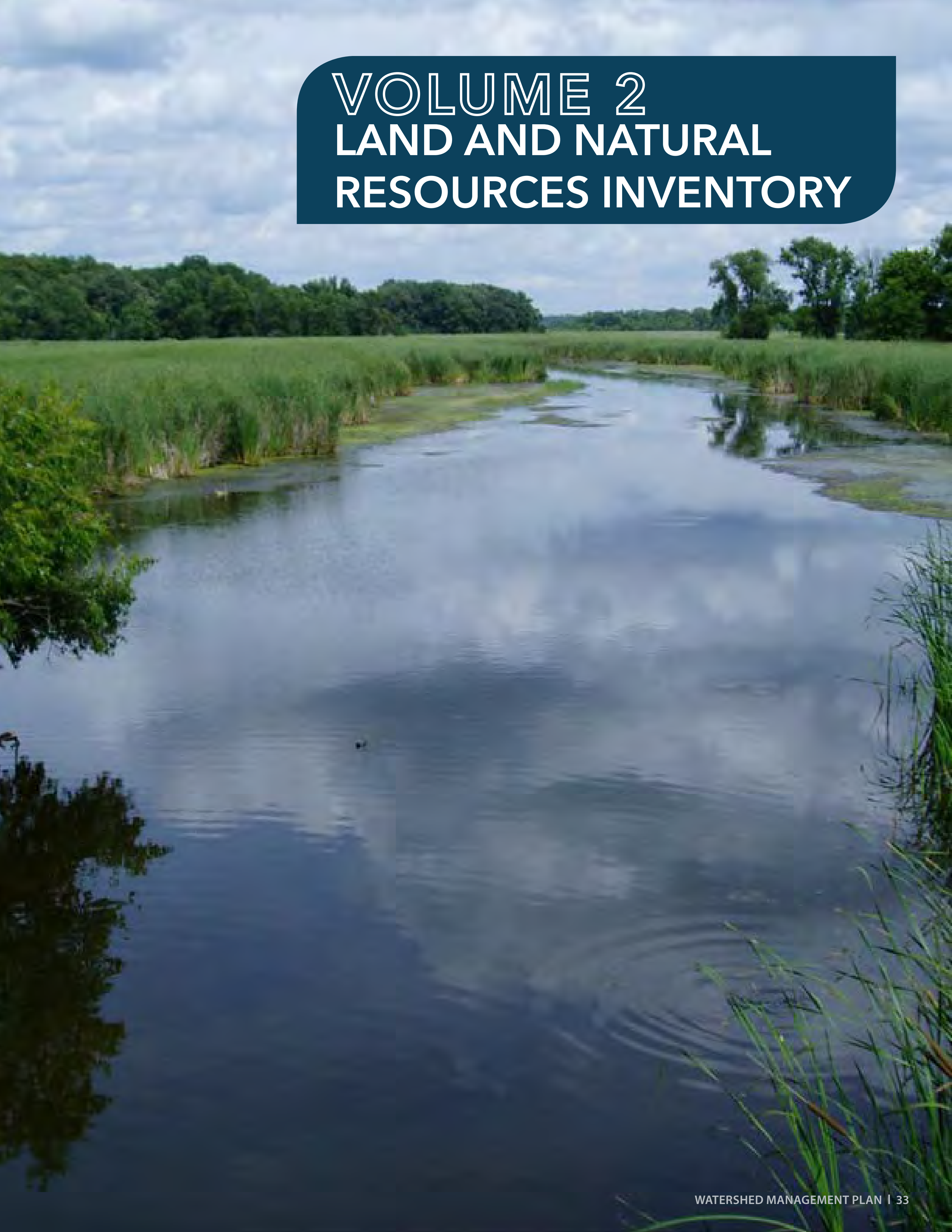
Although the watershed planning law gives watershed districts the authority to mandate LGU actions toward district-identified water resource goals, the MCWD's approach under this Plan relies to a limited extent on mandates and much more on support for a partnership approach. Since the MCWD's 2007 plan, LGUs have continued to develop water resource program capacity, and the MCWD has advanced its capacity to discern and facilitate projects and initiatives that serve the complementary goals of public and private interests. With these in mind, and with the broader concept of hydrologic function and beneficial public use reflected by the MCWD's development of the E-Grade program for measuring ecosystem health, the MCWD is judging that a collaborative approach will better achieve its water resource goals. The MCWD will gauge local partnership interest by the content of the local water plan: the local data content, the careful assessment of local issues and potential strategies, and the commitment to coordination. Local interest will prompt MCWD interest in collaboration and higher priority access to MCWD technical and financial resources.

Targeted areas of collaboration include:

- » Land use policy development and its implementation through planning activities including long-range land use and infrastructure plans, area-wide plans, and recreation and open-space plans
- » Capital improvement feasibility planning for public infrastructure including roads, sewer, and drinking water supply
- » Capital construction incorporating water resource goals with other public and private development goals
- » Land use and development regulation, from initial development feasibility through ongoing inspection and stormwater facility maintenance functions
- » LGU operations and facility maintenance

A chief element of the local plan is a proposed plan for LGU/MCWD coordination. The goal of the coordination plan is to maintain mutual awareness of needs and opportunities to foster programs and projects that: (i) develop out of coordinated, subwatershed-based planning; (ii) reflect the cooperation of other public and private partners; (iii) align investments; and (iv) secure a combined set of District, LGU and partner goals. The coordination plan provides for ongoing and periodic communications as to land use planning, infrastructure programming, and development regulation.

VOLUME 2
LAND AND NATURAL RESOURCES INVENTORY



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2.1 Introduction

This volume contains detailed information on the land and water resources within the Minnehaha Creek Watershed District (MCWD or District). These data are summarized and analyzed in this volume for ease of reference and to focus Volume 3 on implementation strategies. Section 2.2 of this volume looks at the geography of the watershed and includes information on climate, topography and drainage, water resources, geology and soils. Section 2.3 looks at the characteristics of the 11 individual subwatersheds and provides the data from studies and assessments conducted within each of the subwatersheds. This section can be referenced for the technical information used to develop the subwatershed implementation plans detailed in Volume 3. Section 2.4 provides a complete inventory of all available MCWD data and studies.

The data are presented following the four overarching strategic goals of the District:

- Water Quality
    - To preserve and improve the quality of surface and groundwater.
- Water Quantity
    - To manage the volume and flow of stormwater runoff to minimize the impacts of land use change on surface and groundwater.
- Ecological Integrity
    - To restore, maintain, and improve the health of ecological systems.
- Thriving Communities
    - To promote and enhance the value of water resources in creating successful, sustainable communities.

2.1.1 MCWD DATA SETS:

The District continues to maintain and develop a wealth of data to inform and guide implementation efforts within the watershed. Data available to characterize issues and inform watershed management can generally be broken into the following categories:

- Monitoring Program Data and E-grade Program
- Watershed Wide Studies
- Subwatershed Studies
- Waterbody Specific Studies or Total Maximum Daily Load Studies
- Project Feasibility or Small Area Plans

Most of these past data collection efforts included extensive public participation. This Plan integrates these data sets and public participation into a long-range strategic plan to guide implementation across the eleven subwatershed planning units.

2.1.2 MONITORING PROGRAM DATA:

The District maintains a Research and Monitoring Program to collect water quality, water quantity and ecological integrity data across the watershed. The program is a collaborative effort between the Three Rivers Park District (TRPD), the Minneapolis Park and Recreation Board (MPRB), the Minnesota Pollution Control Agency (MPCA), the United States Geological Survey (USGS), Metropolitan Council Environmental Services (MCES), the Citizen-Assisted Monitoring Program (CAMP), and the Minnesota Department of Natural Resources (DNR).

The program, which was initiated in 1968 and was expanded in 1997, 2004, and 2011 to provide a comprehensive view of water quality, is currently being expanded again to broaden its focus into ecosystem services. This expansion, characterized as E-Grade (summarized below), provides data regarding the physical, chemical and biological components of the District, divided into ecosystem services by lakes, streams, wetlands and upland systems.

District's Monitoring Priorities:

The primary objectives of the District's monitoring program are to:

- Diagnose issues and stressors to guide management strategies
- Broadly characterize ecological health through the E-Grade program
- Identify trends in water quality, water quantity, and ecological integrity
- Track the efficacy of implementation efforts across the watershed

E-Grade Program:

In 2014, the District began developing a new tool to evaluate and broadly characterize the health and function of the watershed. The Ecosystem Evaluation Program, or E-Grade for short, will provide a holistic assessment of ecosystem health.

Historically, water quality has been characterized by three measures: water clarity (i.e., Secchi depth measurements), chlorophyll-a, and total phosphorus concentrations. These measures are used to compute grades (ranging from A to F) on lakes. The public often uses the lake grades to assess which lakes to recreate upon, where to purchase lakefront property, and to request improvement of a waterbody from the District. However, the current grades are only a partial snapshot of a lake's health, because they exclude other indicators of a healthy ecosystem like flood control and habitat diversity. The current system does not differentiate between deep and shallow lakes, which function very differently. Furthermore, there are more types of waterbodies in the District than just lakes – such as wetlands and streams – yet the overall health and function of these waters has not been assessed to the same degree as lake systems, and the interaction amongst the many ecosystems has not been effectively studied and documented.

The E-Grade program will assess five landscape types: deep lakes, shallow lakes, streams, wetlands, and uplands. Each of the landscape types will be evaluated on six interdependent ecosystem services and the conditions that affect their performance. As it will more thoroughly assess waterbodies and uplands, E-Grade will lead to identification of more localized ecosystem issues and stressors, and better inform the management strategies of the District and its partners. As a result, project goals can be expanded beyond traditional metrics such as phosphorus reduction to include more complex metrics based on biological components. This science-based information will allow the District to better identify areas in highest need of improvement or protection, which in turn will inform priority-setting for District activities. The resulting E-Grade reports will also be a useful education tool for the public.

Program Design:

Ecosystem services are functions that natural systems perform to the benefit of the environment. Ecosystem services are key to sustainability, and how well services function affects the quality of ecosystems. Given this understanding, the United Nations (UN) Environment Programme began an integrated approach to ecosystem management that "focuses on sustaining ecosystems to meet both ecological and human needs" (*United Nations Environment* - web.unep.org/ecosystems/who-we-are/about-ecosystems). The UN's integrated ecosystem management approach identified about three dozen ecosystem services to manage.

The E-Grade Program is based on this integrated approach and is being developed as an integrated watershed management tool. For the District, six ecosystem services were selected to best characterize ecosystem quality. The E-Grade integrated watershed management tool will allow the District to preserve and improve water quality, water quantity, and ecological integrity while promoting and enhancing the value of water resources that will lead to thriving communities.

Development of E-Grade was performed by District staff and Wenck Associates, and included the participation of a Technical Advisory Committee (TAC). Members of the TAC included representatives of state, local, and regional agencies, as well as academics from the University of Minnesota. The TAC provided guidance and feedback on which ecosystem services to select as well as the metrics to be used in assessing ecosystem performance. The TAC also provided biological data collected by other agencies and schedules for collection of these data. Their effort fulfilled two goals – to maximize the use of existing data and to provide professional rigor to a scientific foundation for E-Grade.

Services, Functions and Measures:

As previously noted, E-Grade will assess six ecosystem services for each of the five landscape types. The E-Grades will be scaled from individual waterbodies and summarized up to the watershed level (Figure 2.1). The function and measures for each ecosystem service are listed in Table 2.1. The classification breakpoints for all the metrics is based on literature, widely accepted state agencies' standards, and/or recommendations by the TAC. The performance of the ecosystem services for each of the five landscape types will be graded using the terminology in Table 2.2.

Figure 2.1. Scale of E-Grade Assessment Tool.

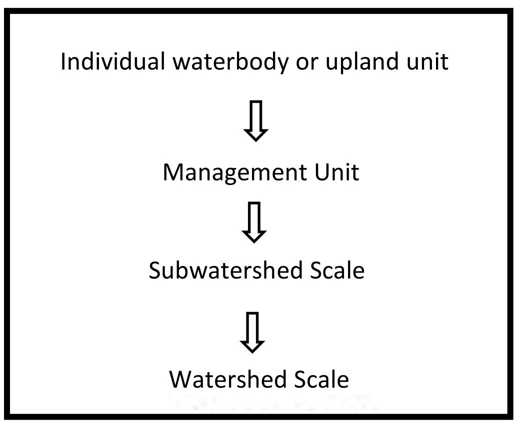

Table 2. 1. E-Grade Ecosystem Services, Functions and Measures.

Ecosystem Service	Functions	Measure	Landscape Types				
			Deep Lake	Shallow Lake	Stream	Wetland	Upland
Groundwater Supply	Groundwater Recharge	Groundwater Supply				X	X
Flood Control	Watershed Storage	Watershed Storage	X	X		X	
		Stormwater retention and detention					X
		Wetland Density				X	
	Floodplain Encroachment	Barriers in the Floodplain			X		
Biodiversity	Resilient Biological Community	Fish Community Quality	X		X		
		Aquatic Vegetation Quality	X	X		X	
		Macroinvertebrate Community Quality			X		
Habitat Diversity	Habitat for Fish, Macroinvertebrates, and Wildlife	Aquatic Vegetation Quality	X	X			
		Shoreline Quality	X	X			
		Stream Habitat Complexity			X		
		Connectivity			X	X	
		Stream Water Quality			X		
		Hydrology			X		
		Wetland Size				X	
Nutrient Cycling	Nutrient: Sink, Source, and/or Transformer	Eutrophication Indicators	X	X			
		Nutrient Concentrations in Stream			X		
		Wetland Soil Chemistry				X	
Recreation	Swimmability	Water Clarity	X	X	X		

Table 2. 2. E-Grade Technical Threshold Descriptions.

Technical Threshold Descriptions	
Exceptional	Community structure and species composition or ecosystem processes are near reference conditions. The most relatively pristine communities.
Good	Community structure and species composition or ecosystem processes are beginning to show signs of disturbance, but support the ecosystem service.
Poor	Community structure and species composition or ecosystem processes show obvious signs of disturbance.
Degraded	Community structure and species composition or ecosystem processes are showing high levels of disturbance.

Implementation Schedule:

As part of the development of the E-Grade program, from 2014-2016 the District collected data on the new E-Grade parameters in three "test" subwatersheds – Minnehaha Creek, Six Mile Creek, and Schutz Lake. The E-Grade reports for these three subwatersheds will be released in 2018. For the remaining eight subwatersheds, the District will produce preliminary E-Grade reports in 2019. These preliminary reports will be based on existing data compiled from the District and its partner agencies and may not include all E-Grade parameters. Additional parameters will be collected throughout the Plan cycle according to current District priorities and staff capacity. As additional data are collected, the reports will be updated with the new information.

Monitoring Locations, Frequency, and Parameters:

In 2017, the District updated its monitoring plan in order to meet the District's priorities and improve program efficiency. Some locations act as "anchor" stations that are monitored every year to assess long-term changes throughout the subwatershed. These stations are selected to be representative of the entire subwatershed and are typically major lakes or the furthest downstream station on the major streams. Other stations are monitored on a rotational basis through the E-Grade program as described in the previous section.

The following describes current monitoring locations, frequency, and parameters. These may be adjusted over the planning period to serve program purposes.

Anchor Stations Monitored By MCWD

Anchor Lakes

In 2017, the Research and Monitoring Program re-designated which lakes would be anchor stations (Table 2.3). Staff have chosen to have volunteers measure Secchi depth readings on additional upper watershed lakes to provide an effective warning system for detecting change (Table 2.4). If a significant negative change in the Secchi depth is noticed, Program staff can investigate further.

Sampling consists of three major procedures: measuring a lake's profile with multi-parameter sonde, Secchi disk depth (SD) measurements, and water sample collection. Temperature (temp), dissolved oxygen (DO), pH, and specific conductivity (cond) are measured at each lake station. Readings are collected from the water surface to the bottom of the lake at one meter increments. Water samples are analyzed for total phosphorus (TP), total suspended solids (TSS), and chlorides (Cl). Sampling season is from May-September. Deep lakes are monitored once a month, while shallow lakes plus Wassermann Lake, Halsted Bay, and Jennings Bay are monitored twice a month. Parameters sampled are listed in Table 2.5.

Table 2. 3. Lakes designated as anchor stations.

Subwatershed	Lake
Christmas Lake	Christmas Lake
Gleason Lake	Gleason Lake*
Lake Minnetonka	Carman Bay
	Crystal Bay
	Forest Lake
	Grays Bay
	Halsted Bay
	Jennings Bay
	Lower Lake South
	Stubbs Bay
Lake Virginia	Lake Virginia
Long Lake Creek	Long Lake
	Tanager Lake
Six Mile Creek	Parley Lake*
	Wassermann Lake

*Shallow lakes

Table 2. 4. Lakes with water clarity monitored by volunteers.

Subwatershed	Lake
Dutch Lake	Dutch Lake
Lake Virginia	Lake Minnewashta
Schutz Lake	Schutz Lake
Six Mile Creek	Piersons Lake

Table 2. 5. Lake parameters sampled.

<table>
<tr><th></th><th>Temp</th><th>DO</th><th>Cond</th><th>pH</th><th>SD</th><th>Cl</th><th>Chl-a</th><th>TP</th><th>TSS**</th></tr>
<tr><td>Surface</td><td colspan="4" rowspan="2">Profile</td><td rowspan="2">X</td><td></td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>Bottom*</td><td>X</td><td></td><td>X</td><td></td></tr>
</table>

*2 year rotation, **Only at Grays Bay, Halsted Bay, Jennings Bay, Wassermann Lake and shallow lakes

Anchor Streams

Many of the streams within MCWD are intermittent, meaning the flow is irregular and often dependent on precipitation. The streams in the western part of the District have been ditched and/or flow through wetlands. Minnehaha Creek, in the eastern part of the District, is the only stream in the District designated for recreational use. Minnehaha Creek drains the upper watershed and Lake Minnetonka and eventually flows into the Mississippi River. In 2017, the Monitoring Program re-designated which stream stations would be anchor stations (Table 2.6).

Sampling consists of four major procedures: using a multi-parameter sonde to measure basic water characteristics, using a flow tracker to measure discharge, recording stage or water level, and water sample collection. Sampling season is year round. During the winter, sampling occurs once a month. Once ice is off the streams, sampling occurs twice a month. During the spring, 6 to 10 additional samplings may occur to capture storm events. Parameters sampled are listed in Table 2.7. Additionally, the Monitoring Program has an ISCO automated sampler set up at the Hiawatha Ave station on Minnehaha Creek to capture storm events.

Table 2. 6. Stream stations designated as anchor stations.

<table>
<tr><th>Subwatershed</th><th>Stream Station</th><th>Station #</th></tr>
<tr><td>Dutch Lake</td><td>Dutch Creek Outlet (CR 110)</td><td>CDU01</td></tr>
<tr><td>Langdon Lake</td><td>Langdon Lake Outlet (CR 110)</td><td>CLA01</td></tr>
<tr><td rowspan="7">Minnehaha Creek</td><td>Grays Bay Dam</td><td>CMH07</td></tr>
<tr><td>McGinty Rd W./I-494 Ramps</td><td>CMH01</td></tr>
<tr><td>34th Ave/Aquila Ln</td><td>CMH02</td></tr>
<tr><td>Excelsior Blvd</td><td>CMH11</td></tr>
<tr><td>W. 56th St</td><td>CMH04</td></tr>
<tr><td>21st/Minnehaha Pkwy</td><td>CMH24</td></tr>
<tr><td>Hiawatha Ave</td><td>CMH06</td></tr>
<tr><td>Painter Creek</td><td>West Branch Rd.</td><td>CPA01</td></tr>
<tr><td>Schutz Lake</td><td>Lake Minnetonka: Smithtown Bay Inlet (N. of HWY 7)</td><td>CSC02</td></tr>
<tr><td rowspan="3">Six Mile Creek</td><td>Inlet to East Auburn Lake (HWY 5)</td><td>CSI05</td></tr>
<tr><td>Lundsten Lake N Outlet</td><td>CSI01</td></tr>
<tr><td>Mud Lake Outlet (Highland Rd)</td><td>CSI02</td></tr>
</table>

Table 2. 7. Stream parameters sampled.

	Discharge	Temp	DO	Cond	pH	Cl	TP	TSS	*E. coli**	Elevation
Biweekly Sampling	X	X	X	X	X		X	X		X
Storm Events							X	X		
Monthly						X				
Weekly, April- Oct.									X	

**E. coli* bacteria sampled only at Minnehaha Creek and Painter Creek stations; Note - Minnehaha Creek: Hiawatha Ave Station is also analyzed for NO2, NH3, total dissolved phosphorus (TDP), and total suspended volatile solids (TSVS)

E-Grade Parameters Monitored By MCWD

An E-Grade Assessment will focus on a subwatershed for three years. Anchor and non-anchor lake and stream stations will be assessed for the following ecosystem services: nutrient cycling, habitat diversity, and biodiversity, flood control and recreation. Wetland stations will be assessed for all ecosystem services, except for recreation. The measures and parameters for uplands will be defined by 2018. The Monitoring Program will incorporate the data into the E-Grade for each subwatershed.

The following describes the E-Grade parameters. Table 2.8 lists the E-Grade measures, parameters, timeframe, and frequency.

Field Collection - Water Samples

The following are needed to complete an E-Grade assessment: field collection for water samples (TP, Chl-a, total nitrogen, total Kjeldahl nitrogen, NO_3, and TSS), Secchi depth and DO readings, and flow. The collection of these parameters will follow the same procedures as outlined above for monitoring at anchor lake and stream stations.

Fish Community Surveys

For characterizing ecological health of lakes, fish community surveys are conducted on lakes with surface areas larger than 100 acres. The MnDNR will be conducting the majority of the fish surveys within MCWD for their watershed assessment of fish communities. The fish community surveys are actually three types of surveys - trap net, gill net and near shore seining surveys. The data are computed through the Fish Index of Biological Integrity (IBI) assessment created by the MnDNR.

Lake Vegetation Community Surveys

For characterizing ecological health of lakes, lake vegetation community surveys are conducted. District staff conduct the lake vegetation community surveys. The data collected are computed through the floristic quality index (FQI) assessment created by the MnDNR.

Stream Habitat Assessments and Macroinvertebrate Community Surveys

For characterizing ecological health of streams, stream habitat assessment and macroinvertebrate community surveys are conducted at E-Grade stream stations. MCWD staff will conduct the surveys following assessment protocols created by the MPCA.

Wetland Vegetation Community Surveys and Soils Analysis

For characterizing ecological health of wetlands, surveys of the wetland vegetation communities and collection of soil samples are conducted in a percentage of wetlands within a subwatershed. The wetland vegetation community surveys will follow the MPCA's rapid floristic quality assessment protocol. These surveys are for emergent and submergent vegetation. In conjunction with the field surveys, relevant McRAM questions also will be answered for the E-Grade assessment. Two soil samples will also be collected per surveyed wetland.

Upland Monitoring

Protocol for characterizing ecological health of uplands is still in development and will be finalized in 2018.

GIS/Aerial Photos/Modeling Analyses

Protocol for the GIS/aerial photos/modeling analyses are still in development and will be finalized in 2018.

Table 2. 8. E-Grade parameters, timeframe and frequency for each landscape type.

Landscape Types	Measure	Parameters*	Timeframe	Frequency (During an E-Grade Assessment)†
Lakes	Aquatic Vegetation Quality	Aquatic Vegetation Survey	July - Sept	One/Lake
Lakes	Eutrophication Indicators	Field Collection - Water Samples	June - Sept	Once/Month
Lakes, Streams	Fish Community Quality	Fish Survey (Deep Lakes and Minnehaha Creek only)	July - Aug	One/Lake
Streams	Nutrient Concentrations in Streams	Field Collection - Flow & Water Samples	April - Sept	Twice/Month
Streams	Macroinvertebrate Community Quality	Macroinvertebrate Survey	Aug - Sept	One/Stream Station
	Stream Habitat Complexity	MN Stream Habitat Assessment		One/Stream Station
Wetlands	Aquatic Vegetation Quality and Connectivity	Rapid Floristic Quality Assessment and Select McRAM Questions - in the Field	Aug - Early Oct	Once/Wetland
	Wetland Soil Chemistry	Field Collection - Soil samples		Once/Wetland
Lakes, Streams, and Wetlands	Connectivity, Shoreline Quality, Wetland Density and Size	Field Verification of GIS Analysis	July - Sept (Field Verf.)	If needed, One/Station
Lakes, Streams, Wetlands and Uplands	Shoreline Quality, Connectivity, Hydrology, Wetland Density and Size, and Groundwater Supply	Review of GIS data and/or Aerial Photos	Oct - March	One/Station
	Hydrology, Groundwater Supply, Watershed Storage	Review Existing Data, Modeling and Analysis		

*Will be incorporating existing data sets from cities/other agencies, †E-Grade Assessment is 3 years.

Other Parameters Monitored by MCWD

AIS Early Detection Surveys

The District conducts early detection monitoring for new infestations of aquatic invasive species. Monitoring typically involves a weekly check of a zebra/quagga mussel sampler plate attached to public access docks, weekly checks of substrate around the boat access for zebra mussels, and rake tosses at the public access to look for new invasive plants. Snorkel searches are also performed on high use lakes as time allows during the season, and typically in partnership with other agencies. The District also coordinates with other local agencies that perform early detection monitoring at District lakes, sharing information and coordinating our search efforts. Data collected through the AIS volunteer monitoring program are also included in the early detection results.

Lake Elevation Monitoring

Lake elevation is monitored on Lake Minnetonka in Grays Bay, just west of the Grays Bay Dam. The Grays Bay Dam is operated by MCWD staff in accordance with the Headwaters Control Structure Management Policy and Operating Procedures and Minnesota Department of Natural Resources (DNR) Permit #76-6240. The operating plan was developed by MCWD and approved by local municipalities and the DNR.

The operating range for the control of discharges at the Grays Bay Dam is when the lake level is between 928.6 and 930.0. Elevation 928.6 marks the legal natural runout elevation for Lake Minnetonka, and elevation 930.0 is the crest of the 202-foot long fixed-elevation emergency spillway located north of the dam structure itself. The Dam discharge is reported on the MCWD website at minnehahacreek.org/data-center/faq-water-levels-lake-minnetonka-and-minnehaha-creek.

Prior to 2017, Monitoring Program staff monitored 19 lakes throughout the District. As of 2017, 17 of the 19 lakes gages are being read by volunteers. Program staff monitor Parley Lake and Lydiard Lake. The lake elevation data are sent to the MnDNR. Ordinary High Water Level (OHW) and lake elevation data are available on the MnDNR website at dnr.state.mn.us/lakefind/index.html.

Continuous Elevation Monitoring

Continuous water level monitoring is conducted at 15-minute intervals by pressure transducers (i.e., TROLLS) on stream and lake stations throughout the watershed (Table 2.9). One station on Six Mile Creek (Mud Lake Outlet) monitors water elevation using a SonTek IQ (velocity beams profiler) to measure flow and volume.

Table 2. 9. Continuous water elevation monitoring stations.

Subwatershed	Station	Station #	Lake/Stream
Gleason Lake	Gleason Lake	LGL01	Lake
Lake Minnetonka	Grays Bay Dam	CMH07Lk	Lake
	Halsted Bay (Boat Landing)	RLHL01	Lake
Long Lake Creek	Long Lake Outlet	CLO01	Stream
	Holy Name Trib Outlet	CLO08	Stream
	Wolsfeld Lake Outlet	CLO09	Stream
	School Lake Outlet	CLO12	Stream
Minnehaha Creek	McGinty/I-494	CMH01	Stream
	Mill Pond	CMH03Up	Stream
	Hiawatha Ave (USGS)	CMH06	Stream
Painter Creek	West Branch Rd	CPA01	Stream
Six Mile Creek	Lundsten Lake outlet	CSI01	Stream
	Kings Point Rd	CSI17	Stream
	Mud Lake outlet	CSI02	Stream

Parameters Monitored by Other Agencies

Lake Stations Monitored by Other Agencies

There are additional lakes within MCWD that are monitored by the Minneapolis Park and Recreation Board (MPRB), Three Rivers Park District (TRPD), and the Metropolitan Council Environmental Services' Citizen-Assisted Monitoring Program (CAMP) as shown in Table 2.10.

Table 2. 10. Lakes monitored by other agencies.

Subwatershed	Lake	Agency
Lake Minnetonka	Lake Minnetonka: Libbs Lake*	City of Minnetonka
	Shaver Lake*	
Lake Virginia	St. Joe Lake	CAMP
	Lake Minnewashta: South Bay	
Minnehaha Creek	Brownie Lake	MPRB
	Cedar Lake	
	Diamond Lake**	
	Grass Lake**	
	Lake Calhoun/Bde Maka Ska	
	Lake Harriet	
	Lake Hiawatha	
	Lake of the Isles	
	Lake Nokomis	
	Powderhorn Lake*	
	Cobblecrest Lake*	CAMP
	Twin Lakes*	
	South Oak Lakes*	
	Windsor Lake**	City of Minnetonka
Six Mile Creek	Steiger Lake	TRPD
	Stone Lake	
	West Auburn Lake	
	Zumbra-Sunny Lake	

*Shallow lake, **Wetland

Stream Stations Monitored by Other Agencies

In 2005, MCWD partnered with the USGS to install and manage a gaging station at the Minnehaha Creek: Hiawatha Ave stream station (CMH06). In response to the Minnehaha Creek's chloride impairment, a conductivity and temperature probe was installed in 2010 to collect continuous data in 15-minute real-time intervals year-round. In 2012, an ISCO automated sampler was installed to collect storm events that will be used for defining loads, tracking trends, and modeling for TMDLs for Minnehaha Creek and the Mississippi River.

In 2015, MCWD again partnered with the USGS to install and manage a second gaging station at Lake Minnetonka: Grays Bay Dam. Water elevations at both locations are posted on the MCWD website. In 2017, the District discontinued monitoring the Gleason Lake inlet stream station. The City of Plymouth plans to monitor that station from 2017-2019. The Metropolitan Council managed a watershed outlet monitoring program (WOMP) station at 34th Avenue S on Minnehaha Creek from 1999-2013. Also, MPRB periodically monitors a station at Xerxes Ave on Minnehaha Creek.

Lake *E. Coli* Monitoring

MCWD does not monitor for *E. coli* in lakes. Hennepin County, MPRB, and some cities monitor the beaches for *E. coli* and are responsible for closing a beach if *E. coli* levels are elevated.

Lake Elevation Monitoring

Resident volunteers monitor lake elevations on 17 lakes throughout the District. MPRB also has been monitoring water levels on the Chain of Lakes. The lake elevation data are sent to the MnDNR. Ordinary High Water Level (OHW) and lake elevation data are available on the MnDNR website at dnr.state.mn.us/lakefind/index.html.

AIS Early Detection Surveys

Carver County, Minneapolis Parks and Recreation Board, and Three Rivers Park District also conduct AIS early detection surveys on lakes within the watershed. Surveys involve zebra/quagga mussel sampling plates and boat launch checks.

Precipitation Monitoring

The last year for the Monitoring Program to operate the precipitation gaging stations throughout the District was in 2016. The District uses precipitation data from two established stations, one located at the Minneapolis-St. Paul Airport and a NOAA-NWS station located in Chanhassen, MN. The data can be accessed at dnr.state.mn.us/climate/twin_cities/index.html.

Groundwater Monitoring

The Prairie du Chien-Jordan formations serve as major sources of municipal water in the western suburbs and as a major industrial water source in Minneapolis. The MnDNR has monitored groundwater elevations at seven deep wells within the watershed (Table 2.11). The Golden Valley well was discontinued in May 2009. The data from wells can be accessed at dnr.state.mn.us/waters/cgm/index.html.

MPRB collects piezometric well data. TRPD is working with the MnDNR to install groundwater monitoring wells at Carver Park Reserve.

Table 2. 11. Lakes monitored by other agencies.

MnDNR Well Number	Subwatershed	Location	Ground Elevation (AMSL)
27043	Lake Minnetonka	Mound	957 ft
27010	Lake Minnetonka	Orono	931 ft
27046	Lake Minnetonka	Minnetonka	938 ft
27012	Minnehaha Creek	Golden Valley	890 ft
27041	Minnehaha Creek	St. Louis Park	917 ft
27036	Minnehaha Creek	Minneapolis	830 ft
27044	Six Mile Marsh	St. Bonifacius	950 ft

2.1.3 WATERSHED-WIDE STUDIES:

The District has completed a number of watershed wide studies that inform the overall hydrology, water quality and ecological integrity of the District's natural resources. These studies are outlined throughout Volume 2 with a complete list included in Section 2.4. The studies will be made available and searchable on the District's website. Some of the key watershed wide studies include:

- Hydrologic, Hydraulic and Pollutant Loading Study (HHPLS)
- Functional Assessment of Wetlands
- Stream Assessments

Hydrologic, Hydraulic and Pollutant Loading Study (HHPLS):

In 2003, the District completed a two year effort to compile existing and new information on the water resources in the District, to identify existing water management issues, define the impact of future land use change on the system, and identify management strategies for the District and its partners. At the time, this effort represented one of the most ambitious watershed studies undertaken by a watershed District in Minnesota. The HHPLS study was initiated to:

- Document the nature of the physical, chemical, and biological characteristics of the watershed
- Quantify the amount of water moving through the watershed
- Gather public input to assist in problem identification and solution mapping
- Tailor implementation efforts on a subwatershed basis

Functional Assessment of Wetlands:

In 2003 the District completed a *Functional Assessment of Wetlands* (FAW), covering all wetlands in the District larger than one-quarter acre in size. This assessment used a variant of the Minnesota Routine Assessment Method, and was developed in partnership with the Hennepin Conservation District to assess the overall function and value of individual wetland systems.

The analysis has been consistently used by the District and its partners to guide land use decisions and natural resource management decisions by providing consistent, comprehensive wetland data.

Stream Assessments:

In 2003 the MCWD assessed the physical and biological condition of Minnehaha Creek, Long Lake Creek, Gleason Creek, Classen Creek, Painter Creek and Six Mile Creek. The assessments characterized the general condition of the streams and provided baseline information that assists the District and its partners in developing management strategies to improve and protect streams as a vital part of the watershed system.

In 2012 the District updated and expanded its stream assessment to include first and second order tributaries to mainstem streams. This assessment, coupled with the HHPLS, the FAW, and broad system monitoring, provides the MCWD with a thorough understanding of its lakes, streams, and wetland systems.

2.1.4 SUBWATERSHED STUDIES:

The District has also collected information and data at subwatershed scales which provide resource specific information regarding issues, the stressors driving those issues, and informs management strategies for the District and its partners. A complete list of subwatershed studies is included in Section 2.4 and will be made available and searchable on the District's website. Some of the notable studies conducted at a subwatershed scale include:

- Minnehaha Creek Visioning, 2005
- Baseflow Restoration in Minnehaha Creek Watershed with Stormwater Infiltration, 2014
- Six Mile Creek Diagnostic Study, 2013
- Painter Creek Feasibility Study, 2004
- Gleason Lake Management Plan, 2007

2.1.5 WATERBODY SPECIFIC STUDIES OR TMDLS:

The District has also collected information on specific waterbodies which provide resource specific information regarding issues and the stressors driving them, and informs management strategies for the District and its partners. Total Maximum Daily Load Studies (TMDLs) have also been conducted on specific impaired waters. Waterbody specific studies are summarized by subwatershed in Section 2.4 and will be made available and searchable on the District's website. Some of the studies conducted on specific waterbodies include:

- Preserving the Quality of Lake Minnetonka, 1971
- Blue Water Commission Report on Lake Nokomis and Lake Hiawatha, 1998
- MCWD Lakes TMDL – Lakes Nokomis, Parley, Virginia, and Wassermann, 2011
- Minnehaha Creek *E. Coli* Bacteria / Lake Hiawatha Nutrients TMDL, 2013
- Upper Minnehaha Creek Watershed Nutrient and Bacteria TMDL Study, 2014
- Effects of Curlyleaf Pondweed Control on Gleason Lake, 2015
- Twin Cities Metropolitan Area Chloride TMDL Study, 2016

2.2 Watershed Overview

The MCWD was established in 1967 and is responsible for managing and protecting the water resources of the Minnehaha Creek watershed drainage basin. The drainage basin extends for 178 square miles draining into the Minnehaha Creek and ultimately into the Mississippi River. The watershed district encompasses 11 subwatersheds which drain 12 creeks, 129 lakes, and thousands of wetlands throughout two counties, 27 cities, and two townships.

The watershed of Minnehaha Creek includes approximately 148 square miles in Hennepin County and 30 square miles in Carver County. The upper watershed includes Lake Minnetonka (est. 14,101 acres) and the land that drains into Lake Minnetonka. The lower watershed includes Minnehaha Creek (22 miles) and the land that drains into Minnehaha Creek east of Lake Minnetonka. The Lake Minnetonka outlet is located at Gray's Bay Dam, the headwaters of Minnehaha Creek. Each watershed feature provides unique recreational opportunities and aesthetic resources.

2.2.1 CITIES:

The Minnehaha Creek Watershed District encompasses all or parts of 27 cities, two townships, a portion of the unorganized area of Ft. Snelling, and a very small area within an unorganized area of Shorewood (Figure 2.2). Table 2.12 shows the cities and their area within the District's legal boundary.

Table 2. 12. Cities and townships in the Minnehaha Creek watershed.

City or Township	Area (sq mi)	% of MCWD	City or Township	Area (sq mi)	% of MCWD
Chanhassen	5.2	2.9%	Mound	3.6	2.0%
Deephaven	1.7	1.0%	Orono	25.1	14.2%
Edina	4.4	2.5%	Plymouth	5.8	3.3%
Excelsior	0.7	0.4%	Richfield	2.3	1.3%
Golden Valley	0.1	0.1%	Shorewood	12.1	6.8%
Greenwood	0.4	0.2%	Spring Park	0.4	0.2%
Hopkins	2.2	1.2%	St. Bonifacius	1.1	0.6%
Independence	4.8	2.7%	St. Louis Park	9.6	5.4%
Laketown Township	15.9	9.0%	Tonka Bay	1	0.5%
Long Lake	0.9	0.5%	Unorganized Territory of Fort Snelling Area	1.2	0.7%
Maple Plain	0.3	0.2%	Unorganized Territory of Shorewood	0	0.0%
Medina	10.2	5.7%	Victoria	8.5	4.8%
Minneapolis	20.8	11.7%	Watertown Township	0.2	0.1%
Minnetonka	13.8	7.7%	Wayzata	3.1	1.8%
Minnetonka Beach	0.5	0.3%	Woodland	0.6	0.3%
Minnetrista	21.1	11.9%	**TOTAL**	**177.5**	

2.2.2 CLIMATE:

Climate in the District is mid-continental. Both temperature and precipitation can vary widely and change abruptly. Table 2.13 shows the watershed's temperature averages for the last 30 years, at the National Weather Service's Chanhassen office.

Table 2. 13. Temperature averages in °F for the Minnehaha Creek watershed.

Twin Cities (1981-2010)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Maximum	23.7	28.9	41.3	57.8	69.4	78.8	83.4	80.5	71.7	58.0	41.2	27.1	55.3
Minimum	7.5	12.8	24.3	37.2	48.9	58.8	64.1	61.8	52.4	39.7	26.2	12.3	37.3
Mean	15.6	20.8	32.8	47.5	59.1	68.8	73.8	71.2	62.0	48.9	33.7	19.7	46.3

Source: Minnesota State Climatology Office and National Climatic Data Center.

In a normal year, approximately 30 inches of precipitation falls on the watershed. Table 2.14 shows the watershed's precipitation averages. Winter snowfall averages about 55 inches, and generally stays on the ground from mid-December to early March. Snow and rainfall data for the watershed is obtained at the National Weather Service's Chanhassen office.

Table 2. 14. Precipitation averages in inches for the Minnehaha Creek watershed.

Twin Cities (1981-2010)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation	0.90	0.76	1.89	2.65	3.36	4.25	4.04	4.29	3.07	2.43	1.76	1.15	30.57
Snow	11.7	8.5	10.8	2.8	0	0	0	0	0	0.6	8.9	12.2	55.5

Source: National Oceanic and Atmospheric Administration (NOAA) National Weather Service.

2.2.3 TOPOGRAPHY, SOILS, AND DRAINAGE:

Topography and Soils:

The topography of the watershed was formed by glacial action and is characterized by five distinct geomorphic units, each with its characteristic patterns of glacial drift. Following the glacial ice's retreat, physical, chemical and biological processes turned the upper 2 to 4 feet of drift material into the soil layer that today covers the watershed. Because traits of the soil directly influence runoff, they affect total water volumes generated in the watershed. To estimate and help manage this runoff, the Natural Resources Conservation Service (NRCS, formerly the Soil Conservation Service) has indexed over 4,000 soil systems into four major hydrologic soil groups. This classification relies on two major processes: infiltration rate and transmission rate. Table 2.15 lists the four major hydrologic soil groups defined by the NRCS and Figure 2.3 illustrates their distribution across the watershed. These landforms and the geology underlying them are well described in the *2007 MCWD Comprehensive Water Resources Management Plan*.

Table 2. 15. Soil characteristics and infiltration rates by Hydrologic Soils Group (HSG).

HSG	Infiltration Rate/Hour	Texture	Unified Soil Classification System
A	1.63"	Gravel, sandy gravel and silt gravels	GW – well graded gravels, sandy gravels GPO – Gap-graded or uniform gravels, sandy gravels GM – Silty gravels, silty sandy gravels SW – Well-graded, gravelly sands
	0.8	Sand, loamy sand or sandy loam	SP – Gap-graded or uniform sands, gravelly sands
B	0.45	Silt loam	SM – Silty sands, silty gravelly sands
	0.3	Loam	MH – Micaceous silts, diatomaceous silts, volcanic ash
C	0.2	Sandy clay loam	ML – Silts, very fine sand, silty or clayey fine sands
D	0.06	Clay loam, silty clay loam, sandy clay, silty clay or clay	GC – Clayey gravels, clayey sandy gravels SC – Clayey sands, clayey gravelly sands CL – Low plasticity clays, sandy or silty clays OL – Organic silts and clays of low plasticity CH – Highly plastic clays and sandy clays OH – Organic silts and clays of high plasticity

Source: Minnesota Stormwater Manual.

Drainage:

The watershed is divided into eleven principal subwatersheds (Figure 2.4). The upper watershed (upstream of Gray's Bay dam) is divided into ten principal subwatersheds. Nine of the upper principal subwatersheds drain directly into Lake Minnetonka via streams, channels, and storm sewer. Lake Minnetonka and some small drainage areas comprise the tenth of the upper principal subwatersheds. The upper watershed discharges through a control structure, the Gray's Bay dam, into Minnehaha Creek. The dam is managed to discharge water from Lake Minnetonka into Minnehaha Creek when the DNR-established runout elevation of the lake is exceeded.

The lower watershed (downstream of Gray's Bay) drains to Minnehaha Creek and is comprised of one principal subwatershed. Some land area within the lower subwatershed does not drain directly or indirectly to Minnehaha Creek, but drains directly or indirectly to the Mississippi River. The central portion of the subwatershed drains to the Minneapolis Chain of Lakes, which in turn discharges to Minnehaha Creek.

2.2.4 WATER RESOURCES:

Lakes and Streams:

The lake inventory for the District includes 65 basins over 10 acres in size. Numerous streams drain the watershed. Minnehaha Creek, for which the watershed is named, is formed at the outlet of Gray's Bay of Lake Minnetonka and flows 22 miles east to the Mississippi River. In the upper watershed, the primary streams include Long Lake Creek, Gleason Creek, Classen Creek, Painter Creek, and Six Mile Creek, although there are many other small streams and channels, named and unnamed. Data on these lakes and streams, including physical descriptions, current water quality and water quality trends, are provided in detail by subwatershed in Section 2.3.

Minnesota Statutes §103F.48, the Buffer Law, allows Soil and Water Conservation Districts (SWCDs) to provide a summary of watercourses and associated recommendations that must be incorporated into the watershed management organization's plan. Both Carver County SWCD and Hennepin County acknowledged that adequate protection of watercourses is being provided through the District's regulations and other implementation efforts and did not provide any additional recommendations. For the summary of watercourses, Carver County SWCD referenced Figure 23 from the District's 2007 Comprehensive Water Resources Management Plan. Hennepin County did not provide any additional watercourses beyond what is included in the DNR Buffer Protection Map.

Public Drainage Systems:

Throughout many parts of Minnesota, including lands now within the Twin Cities metropolitan area, surface drainage systems were established in the early 1900's to promote agricultural activities on lands that were marginally productive because of wet conditions or to enable other uses. These ditch and tile systems were constructed pursuant to a set of laws referred to as the Minnesota drainage code that date to the late 1800's and continue in force today at Minnesota Statutes chapter 103E. Section 103E.005, subdivision 12, defines "drainage system" as:

> A system of ditch or tile, or both, to drain property, including laterals, improvements, and improvements of outlets, established and constructed by a drainage authority. "Drainage system" includes the improvement of a natural waterway used in the construction of a drainage system and any part of a flood control plan proposed by the United States or its agencies in the drainage system.

The type of drainage system referenced by this definition and governed by Chapter 103E is a "public" system that typically provides a conveyance and outlet for surface drainage from multiple tracts of land. Public systems are differentiated from private drainage that a property owner may install to a natural outlet or connect to a public drainage system.

The eight public ditches for which the District is responsible are:

1. Judicial Ditch 2 – Six Mile Creek (mainly open channel)
2. County Ditch 10 – Painter Creek (mainly open channel)
3. County Ditch 14 – from St. Louis Park into Lake Calhoun (storm sewer)
4. County Ditch 15 – into Gleason Lake (open channel/sewer)
5. County Ditch 17 – from Edina to Lake Calhoun (storm sewer)
6. County Ditch 27 – part of Long Lake Creek (mainly open channel)
7. County Ditch 29 – from St. Louis Park into Lake Calhoun (storm sewer)
8. County Ditch 32 – out of Gleason Lake in Wayzata (open channel/sewer)

Figure 2.5 shows the general locations of County/Judicial Ditches within the District.
Under the drainage code, public drainage systems principally are managed by counties; however, by resolution of a county board, this responsibility may be transferred to a watershed district. In 1971, the District petitioned Hennepin County to transfer this responsibility for those county systems within the watershed. The authority for the seven Hennepin County systems was transferred by Hennepin County Board resolution on March 28, 1972. The authority for Judicial Ditch 2 (Six-Mile Creek) was transferred to the District by court order on March 27, 1972 (a judicial ditch is located in more than one county and therefore, under the earlier drainage code, was managed through the district court).

In areas served by public drainage systems that have since become urbanized, drainage for agricultural productivity has greatly declined and many systems either convey urban stormwater or have been replaced with, or rendered superfluous by, municipal storm sewers. Often the storm sewers were constructed in different locations and alignment than that of the drainage system they replaced and the old channels were filled in. County Ditches 14, 17 and 29 lie entirely within the Cities of St. Louis Park, Edina and Minneapolis, and are of this nature.

County Ditches 15 and 32 lie entirely within the City of Plymouth. The first is a series of ponds connected by pipe, and the second lies within Gleason Creek. These two systems, a combination of open channel and subsurface pipe, no longer serve agricultural drainage purposes but provide drainage for residential development and associated roads.

Judicial Ditch 2, County Ditch 10 and County Ditch 27 are located in the less-developed western portion of the District and consist entirely or almost entirely of altered natural channels. These systems continue to provide drainage for agricultural purposes as well as the development that has occurred in those areas.

Wetlands:

Wetlands are defined for regulatory purposes by the United States Army Corps of Engineers Wetland Delineation Manual (January 1987). In the 1980s, the US Fish and Wildlife Service (FWS) compiled wetland maps from aerial photo interpretation as part of the National Wetland Inventory (NWI). Wetland scientists use two common classification schemes to identify wetland type – the FWS's "Circular 39" system, and a replacement system developed by Cowardin et al., commonly referred to as the Cowardin system. The Circular 39 system was originally developed to classify wetlands for waterfowl habitat purposes. Eight of the Circular 39 freshwater wetland types are found in Minnesota. The Cowardin scheme is a hierarchical classification based on landscape position, substrate, flooding regime, and vegetation. While the Cowardin scheme has been officially adopted by the FWS and other agencies, the Circular 39 system is still commonly used because of its simplicity and ease of use. In 2013, the DNR completed an update to the NWI across the state using remote sensing imagery; the East-Central region of Minnesota, including Hennepin and Carver Counties, was reevaluated using 2010 and 2011 imagery.

In 2001-2003 the District undertook a *Functional Assessment of Wetlands* (FAW) on all wetlands greater than one-quarter acre in size. This assessment used a variant of the Minnesota Routine Assessment Method (MnRAM). Using the results of this analysis, individual wetlands were assigned to one of four management classes – Preserve, and Manage 1, 2, or 3. Wetlands that were evaluated as Exceptional or High on certain ecological or hydrologic values were assigned to the Preserve class. The balance of evaluated wetlands were assigned to a category based on this assessment of current functions and values, with Manage 1 wetlands exhibiting higher values and Manage 2 and 3 moderate or lower values. These management classifications are used in the regulation of wetland impacts within the District, with the level of protection dependent on the class of wetland. Refer to the *Functional Assessment of Wetlands* (2003) for details of methodology, classification, and management recommendations. Wetlands by Circular 39 type are shown in detail by subwatershed in Section 2.3.

Public Waters:

The Department of Natural Resources' Public Waters Inventory identifies numerous basins within the Minnehaha Creek watershed under the jurisdiction of the DNR. By statute, public waters wetlands include all type 3, 4, and 5 wetlands that are 10 acres or more in size in unincorporated areas or 2.5 acres or more in size in incorporated areas. Public waters watercourses include natural and altered watercourses with a total drainage area greater than two square miles, Minnesota Statutes §103G.005 defines several other categories of basins and watercourses as public waters. For more information regarding the Public Waters Inventory in the watershed, please refer to *the 2007 MCWD Comprehensive Water Resources Management Plan* or the DNR website at dnr.state.mn.us/waters/watermgmt_section/pwi/maps.html.

Floodplain:

Land use regulations define the floodplain as the area that has a one percent chance of a flood occurring in a given year, also known as the 100-year flood. The floodplain is divided into two zoning districts: the floodway and flood fringe. The floodway or other watercourse includes the river channel and nearby land areas which must remain open to discharge the 100-year flood. The flood fringe, while in the floodplain, lies outside the floodway. Regulations usually allow development in the flood fringe but require flood-proofing or raising to the legal flood protection elevation.

In 1968, Congress created the National Flood Insurance Program (NFIP) to make flood insurance available to property owners at federally subsidized rates. The NFIP required communities to adopt local laws to protect lives and future development from flooding. The Federal Emergency Management Agency (FEMA) first must formally notify a community that it has special flood hazard areas (SFHA) before it can join the NFIP. FEMA notifies communities by issuing a Flood Hazard Boundary Map (FHBM). This map shows the approximate boundaries of the community's 100-year flood plain. Each participating community has a special conversion study or a Flood Insurance Study (FIS). The FIS includes a flood plain map depicting the community's flood hazard areas. Flood mapping was updated in 2016 for all communities in Hennepin County.

Floodplain maps are available at each City Hall or online at msc.fema.gov/portal. Information on the state floodplain management program can be found on the DNR website at dnr.state.mn.us/waters/watermgmt_section/floodplain/index.html.

In 2003, the District completed a *Hydrologic and Hydraulic and Pollutant Loading Study (HHPLS)* to develop an updated hydrologic and hydraulic model for the watershed and update flood elevations in Minnehaha Creek and five upper watershed streams. Watershed hydrology and hydraulics were modeled using the XP-SWMM model platform. This XP-SWMM model was submitted to FEMA to produce updated Flood Insurance Study (FIS) Flood Maps for Minnehaha Creek, and in 2013 FEMA modified the XP-SWMM model and subsequently used this modified version to produce flood maps. The District currently uses this modified XP-SWMM model to establish regulatory elevations for permitting development and redevelopment. Cities within the watershed are responsible for using the FIS maps to inform property owners about floodplain elevations for purposes of the National Flood Insurance Program and to regulate floodplain elevations within their zoning codes.

2.2.5 POTENTIAL ENVIRONMENTAL HAZARDS:

Groundwater connections, hazardous waste, leaking above- and below-ground storage tanks, and feedlots can be potential sources of surface and groundwater contamination. The MPCA maintains a current on-line mapping tool with information about air quality, hazardous waste, remediation, solid waste, tanks and leaks, and water quality. This tool is available at www.pca.state.mn.us/udgx680.

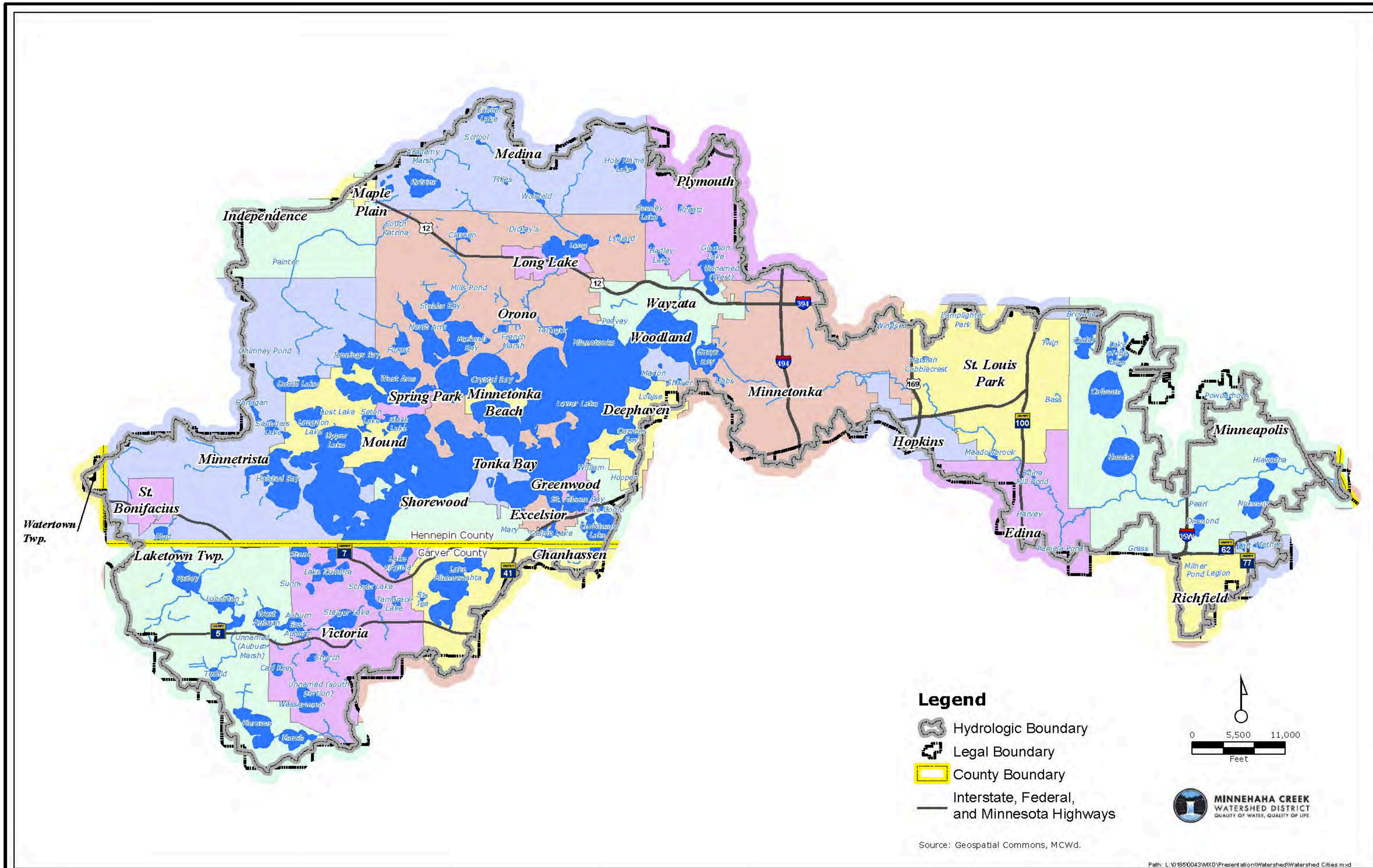

Figure 2. 2. The Minnehaha Creek Watershed District.

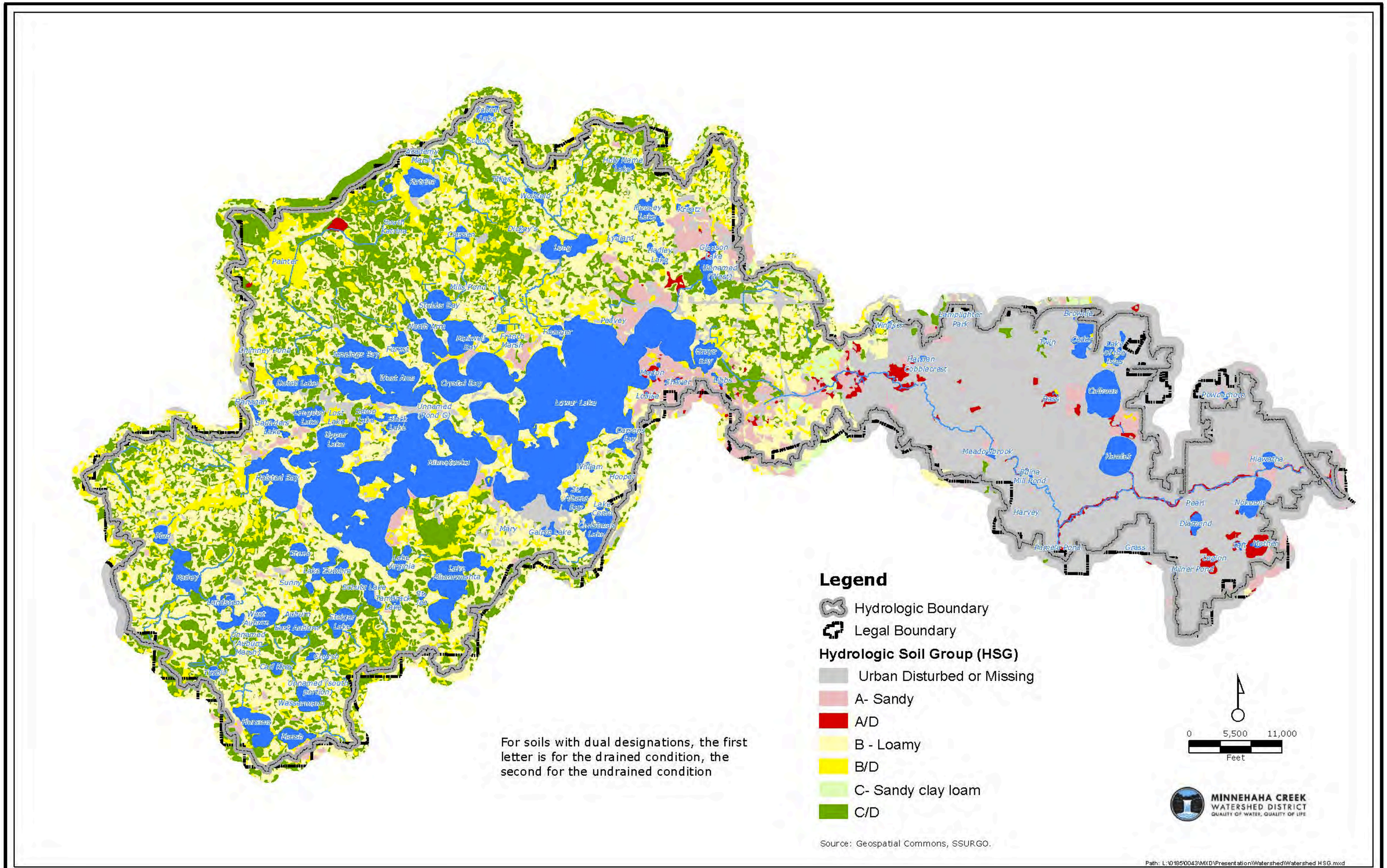

Figure 2. 3. Hydrologic Soil Groups in the Minnehaha Creek watershed.

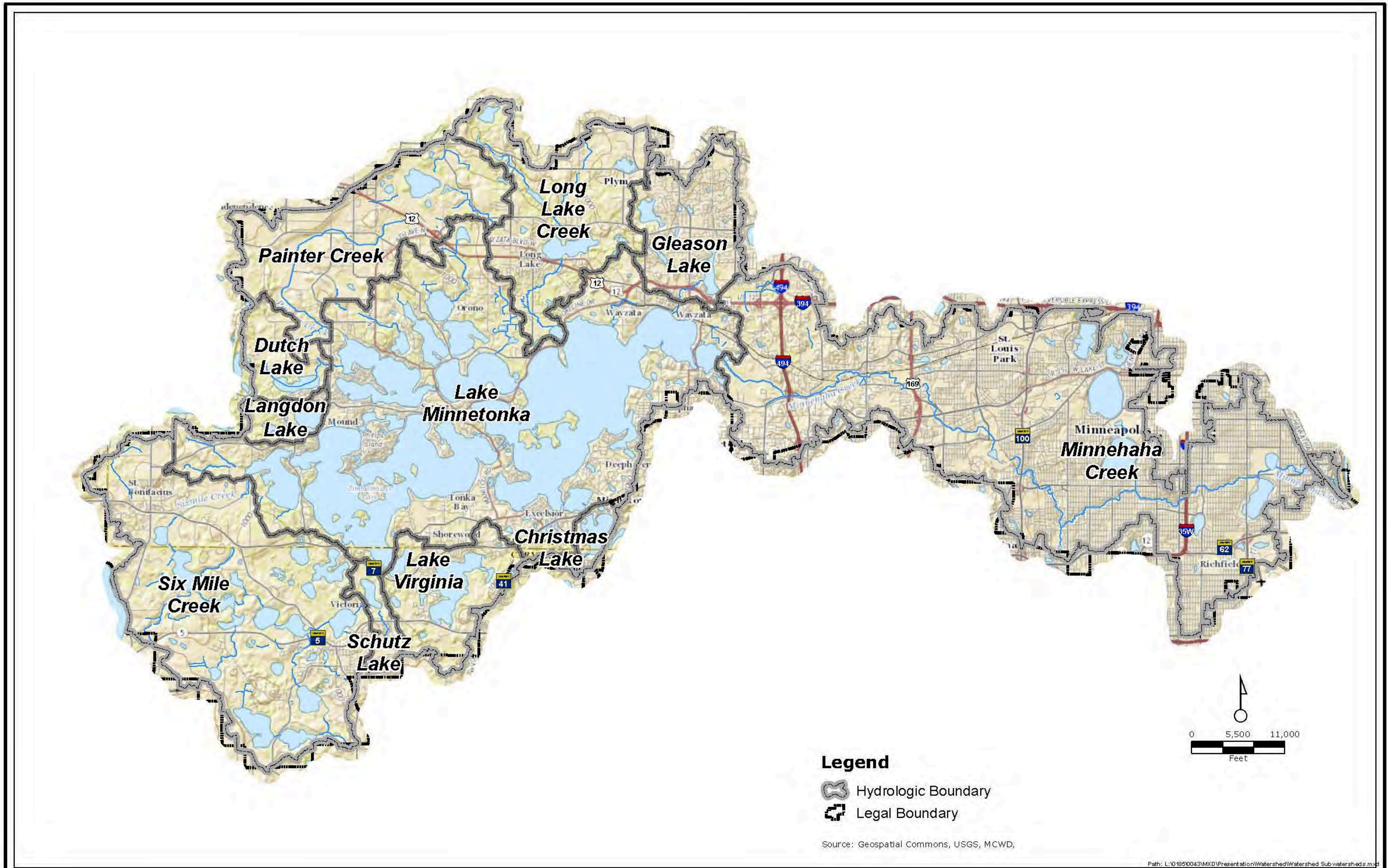

Figure 2. 4. Topography and subwatersheds within the Minnehaha Creek watershed.

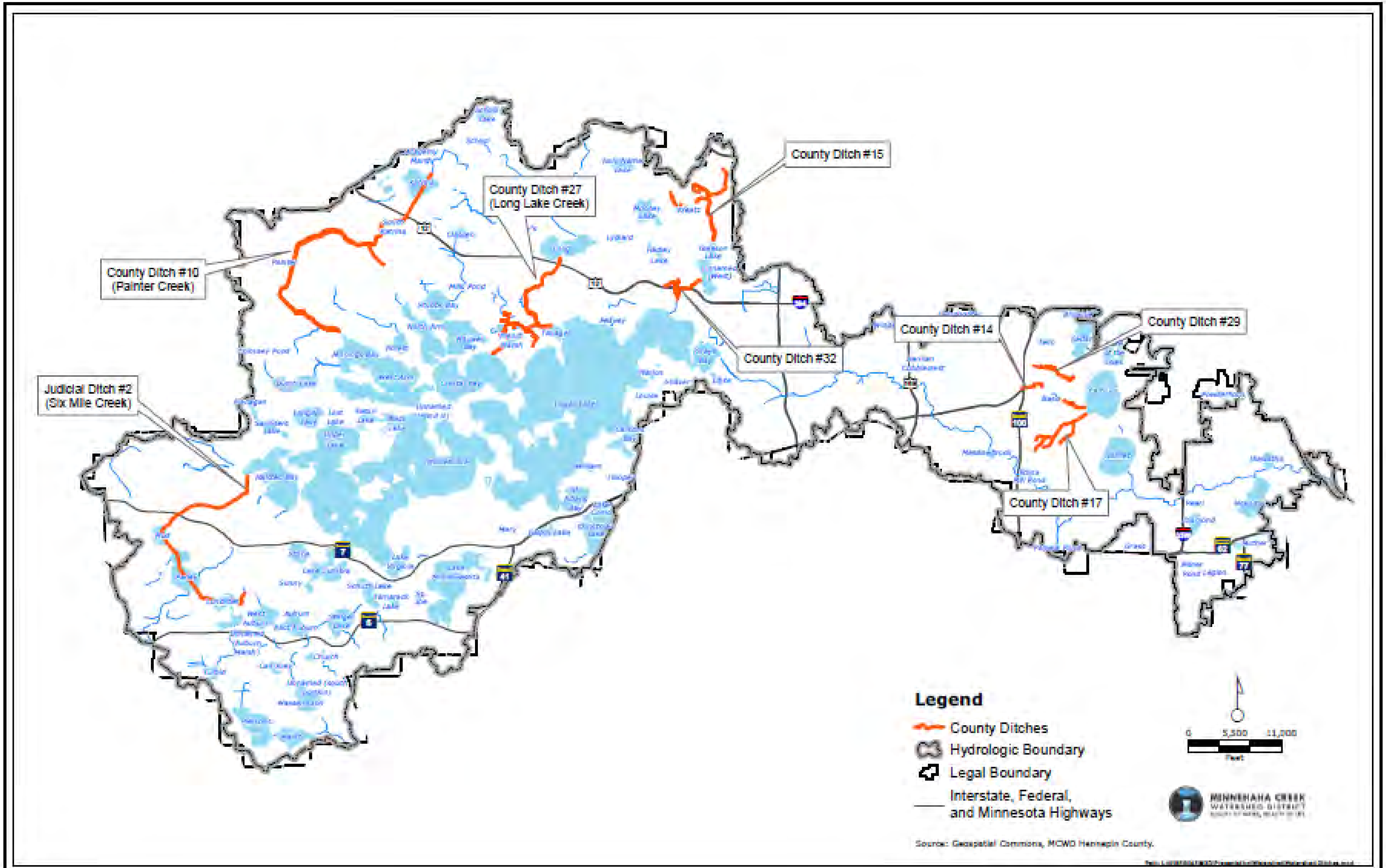

Figure 2. 5. County ditches in the Minnehaha Creek watershed.

2.3 Subwatershed Inventory

2.3.1 CHRISTMAS LAKE SUBWATERSHED

The Christmas Lake Subwatershed is the smallest in the watershed district. The subwatershed is dominated by a mix of residential/business and woodland/wetland land cover. The nutrient contribution to Lake Minnetonka is minimal due to the fact that Christmas Lake does not often flow into St. Albans Bay. There are four cities that lie within the Christmas Lake Subwatershed boundary. The area of the Christmas Lake subwatershed in acres by individual city, in total, and as a percentage of the total subwatershed is presented in Table 2.16 (Figure 2.6).

Table 2. 16. Cities in the Christmas Lake subwatershed.

City	Area (Acres)	% of Subwatershed
Chanhassen	253.0	34%
Excelsior	2.6	0.4%
Greenwood	0.2	<0.1%
Shorewood	486.5	65.5%
Total	742.5	100%

Source: MCWD.

Subwatershed Description and Hydrology:

The Christmas Lake subwatershed's topography is erratic surface relief and numerous depressed areas that form wetlands, small ponds and lakes. The eastern edge of the subwatershed is a highly sloped linear glacial formation that forms the bluffs on the east shore of Christmas Lake.

Land cover is classified by the Minnesota Land Cover Classification System (MLCCS) (Figure 2.7). Much of the subwatershed is developed to typical suburban densities with a low to medium degree of imperviousness. There are several small wetlands in the southern subwatershed, generally surrounded by small areas of woodland or grassland.

Soils within the watershed are predominantly classified as Natural Resources Conservation Service Hydrologic Soil Group B (loamy soils with moderate infiltration potential), with group D (clay soils with very low infiltration potential) soils found in low-lying areas and generally hydric, or showing indications of inundation.

Christmas Lake dominates the subwatershed. A small stream drains the upper part of the subwatershed and outlets into southwest Christmas Lake. The *2003 MCWD Hydrologic, Hydraulic, and Pollutant Loading Study (HHPLS)* subdivided the Christmas Lake subwatershed into five subwatershed units, designated CL-1 through CL-5 (Figure 2.8).

Figure 2. 6. The Christmas Lake subwatershed.

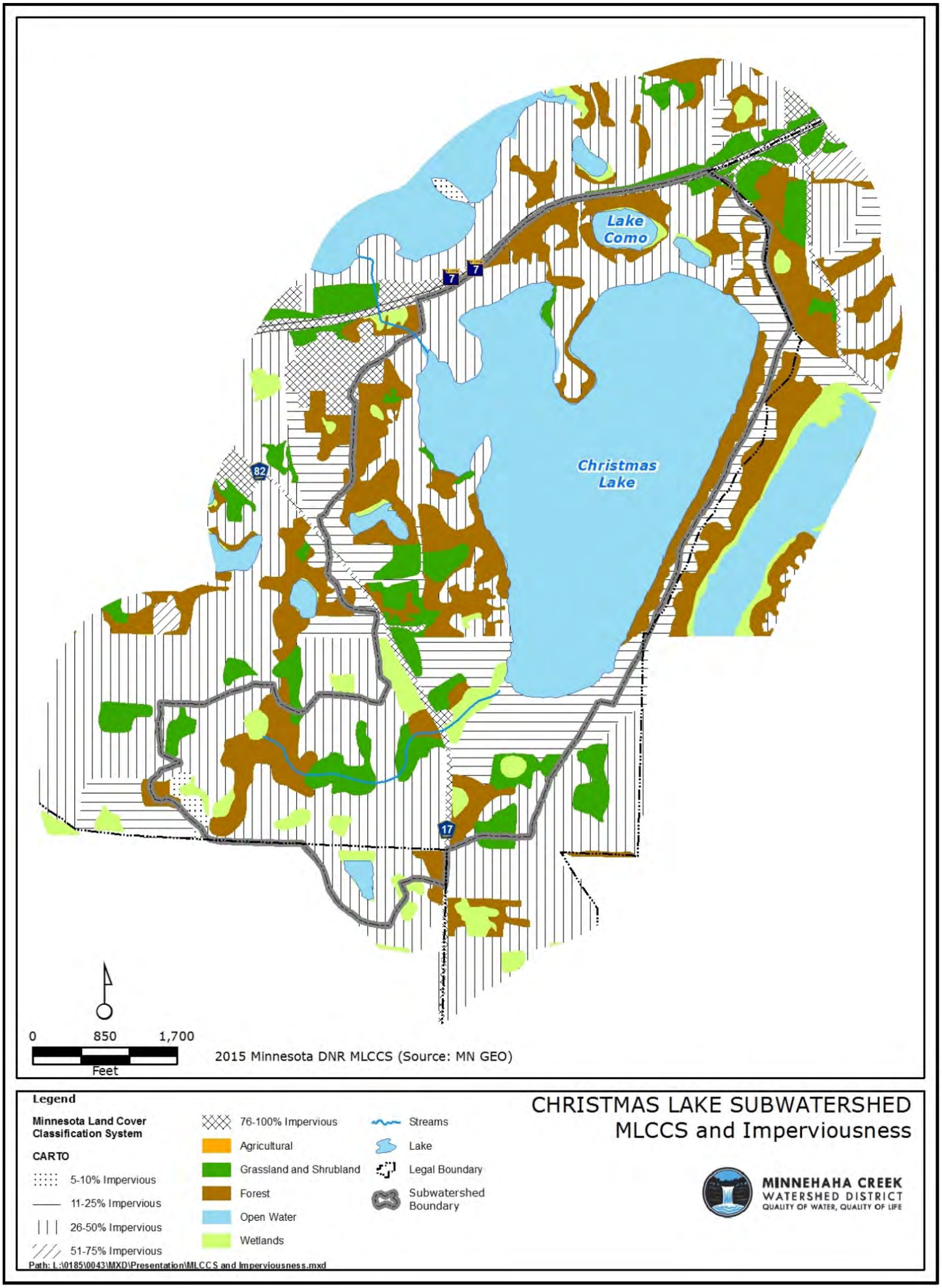

Figure 2. 7. Christmas Lake subwatershed MLCCS and imperviousness.

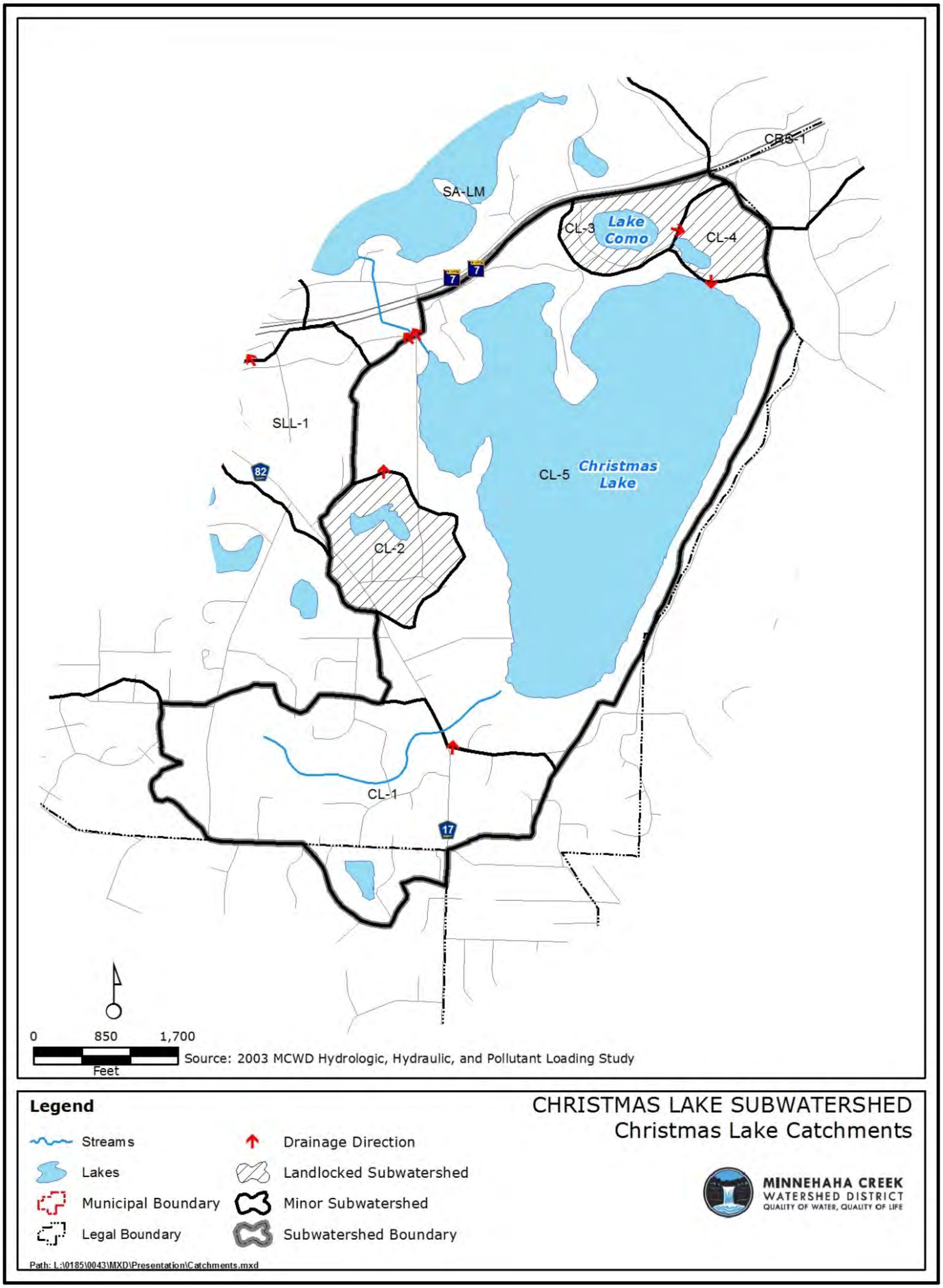

Figure 2. 8. Christmas Lake subwatershed catchments.

Water Quality:

The following are summaries of the characteristics and classifications of lakes, streams, and wetlands within the subwatershed including water quality goals and trends.

Lakes:

Christmas Lake is the primary receiving water within the subwatershed, and is classified by the DNR for shoreland management purposes as a Recreational Development lake (Table 2.17). Christmas Lake has the best water quality in the District and is one of the highest-quality lakes in the Metro area. The lake is listed by the MPCA on the draft 2016 303(d) list of Impaired Waters for excess mercury in fish tissue and is included in the statewide mercury TMDL. To assess long-term change in Christmas Lake, a Mann-Kendall statistical trend test was performed on total phosphorus (TP), chlorophyll-a (Chl-a), and Secchi depth from 2001-2015. There were no statistically significant changes in water quality in Christmas Lake over this period (Table 2.18).

Tables 2.17 and 2.18 below detail the physical and water quality characteristics of Christmas Lake. For more information regarding water quality in the subwatershed, please refer to the District's Water Quality (Hydrodata) reports.

Table 2. 17. Physical characteristics of lakes in the Christmas Lake subwatershed.

Lake	Surface Area (acres)	Maximum Depth (ft)	Watershed to Lake Area Ratio	DNR Classification
Christmas	267	87	3:1	Recreational Development

Source: Minnesota DNR.

Table 2. 18. Selected water quality goals and current conditions of lakes in the Christmas Lake subwatershed.

Lake	State TP Standard (µg/L)	2007 Plan Goal TP (µg/L)	Trend*	2001-2015 Average		
				TP (µg/L)	Chl-a (µg/L)	Secchi (m)
Christmas	40	15	No trend	14	2	5.7

*Statistically significant at ≤ 0.05.
Source: MCWD.

Streams:

There is a channel that conveys drainage from the southern part of the subwatershed to the lake. This channel is experiencing some erosion, possibly conveying sediment to the lake. No information is available to assess the potential causes or extent of this erosion (Figure 2.9).

Tables 2.19 and 2.20 below detail the physical and water quality characteristics of streams and tributaries within the subwatershed. At this time no streams are listed as Impaired Waters, although the Christmas Lake Inlet (CCH02) TP data are high relative to the State's river eutrophication standards. The Christmas Lake Inlet has an average TSS concentration of 14 mg/L, and the Christmas Lake outlet an average TSS concentration of 4 mg/L; both below the 30 mg/L state standard for this ecoregion. However, those standards also look at other indicators such as chlorophyll-a, diel oxygen flux, and biological oxygen demand that haven't been assessed in the stream. It is important to note that the number of samples collected for each parameter vary year to year depending on climate conditions.

To assess long-term change at the Christmas Lake outlet station, a Mann-Kendall statistical trend test was performed on flow-corrected TP and TSS data from 2005-2015. There were no statistically significant changes in water quality in the Christmas Lake outlet during this period (Table 2.20). For more information regarding water quality in the subwatershed, please refer to the District's Water Quality reports.

Table 2. 19. Major streams in the Christmas Lake subwatershed.

Stream	Length (mi)
Christmas Lake – Christmas Lake Inlet	0.71
Christmas Lake – Christmas Lake Outlet	0.26

Table 2. 20. Current conditions of streams in the Christmas Lake subwatershed.
See Figure 2.9 for monitoring locations.

Stream	Trend*	2005-2015 Summer Average**			
		TP (µg/L)	TN (mg/L)	TSS(mg/L)	Cl (mg/L)
Christmas Lake Inlet (CCH02)	n/a	236	1.99	12	55
Christmas Lake Outlet (CCH01)	No trend	43	0.54	4	26

TP = total phosphorus, TN =total nitrogen, TSS = total suspended solids, Cl = chloride.
*Statistically significant at ≤ 0.05, **Annual data not available for all years.
Source: MCWD.

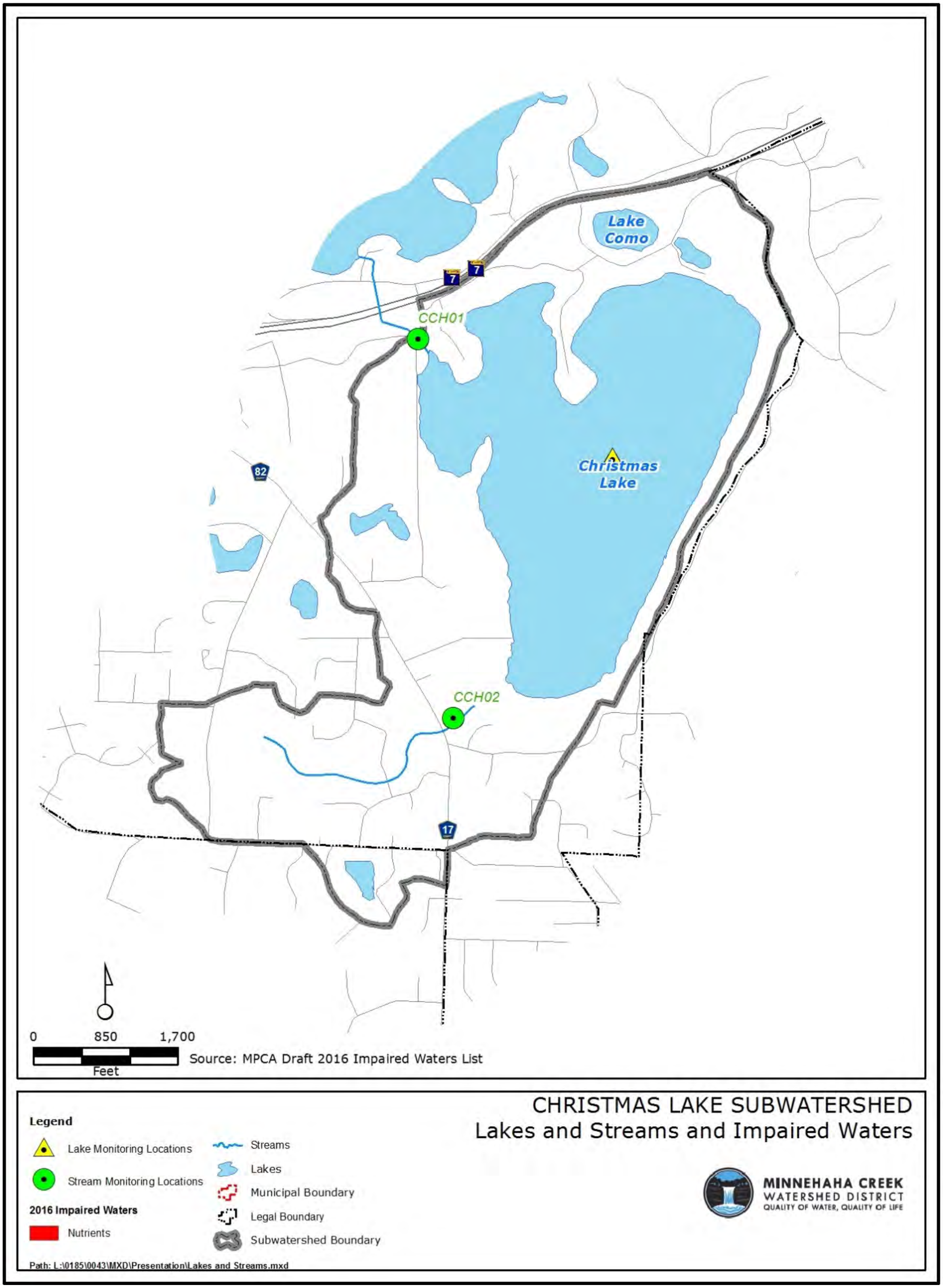

Figure 2. 9. Christmas Lake subwatershed lakes and streams and impaired waters.

Wetlands:

According to the FAW, wetlands, including lakes, cover 11 percent of the subwatershed's surface (Figure 2.10 and Table 2.21). A delineation of wetland boundaries is required to be completed any time development or other impacts may occur near or in a wetland. For more information regarding wetlands in the subwatershed, please refer to the *2007 MCWD Comprehensive Water Resources Management Plan*.

E-Grade will assess wetland soil chemistry, overall vegetative conditions, presence or absence of algal blooms, and condition of the buffer and area within 500 feet of the wetlands. Currently, no data are available.

Table 2. 21. Functional Assessment of Wetlands inventory of wetland types in the Christmas Lake subwatershed.

FAW Circular 39 Wetland Type	Area (acres)	Percent
1 - Seasonal	-	-
2 - Wet Meadow	3.7	0.75
3 - Shallow Marsh	21.6	4.37
4 - Deep Marsh	1.1	0.22
5 - Open Water	26.1	5.29
6 - Scrub Shrub	2.5	0.51
7 - Forested	0.8	0.16
8 - Bog	-	-
Riverine	-	-
Wetland Total	55.8	11.3
Upland	437.1	88.7
TOTAL	492.9	

Source: MCWD Functional Assessment of Wetlands.

Groundwater:

The District's roles in managing groundwater are to 1) promote surficial groundwater recharge to protect wetland hydrology and stream baseflow, and 2) assist in protecting deeper aquifers used for drinking water by limiting infiltration in sensitive recharge areas.

The infiltration potential of the upland areas within the subwatershed is described as moderate. Because of the organic or clayey nature of the soils in the wetland areas, the general infiltration potential there is low. The Carver *County Water Resource Management Plan* classifies the groundwater resources of the southern subwatershed area as being of medium to low sensitivity to pollution. The *Hennepin County Geologic Atlas* classifies the northern subwatershed as generally low sensitivity, except for a narrow band at the north end of Christmas Lake classified as medium sensitivity.

The entire subwatershed is within the Wellhead Protection Areas for Eden Prairie, Chanhassen, and Shorewood municipal drinking water wells. The Minnesota Department of Health classifies these Areas as Low Vulnerability for contamination. Figure 2.11 shows areas in the subwatershed with groundwater sensitivity and that are designated Wellhead Protection Areas.

Figure 2. 10. Christmas Lake subwatershed wetlands by type.

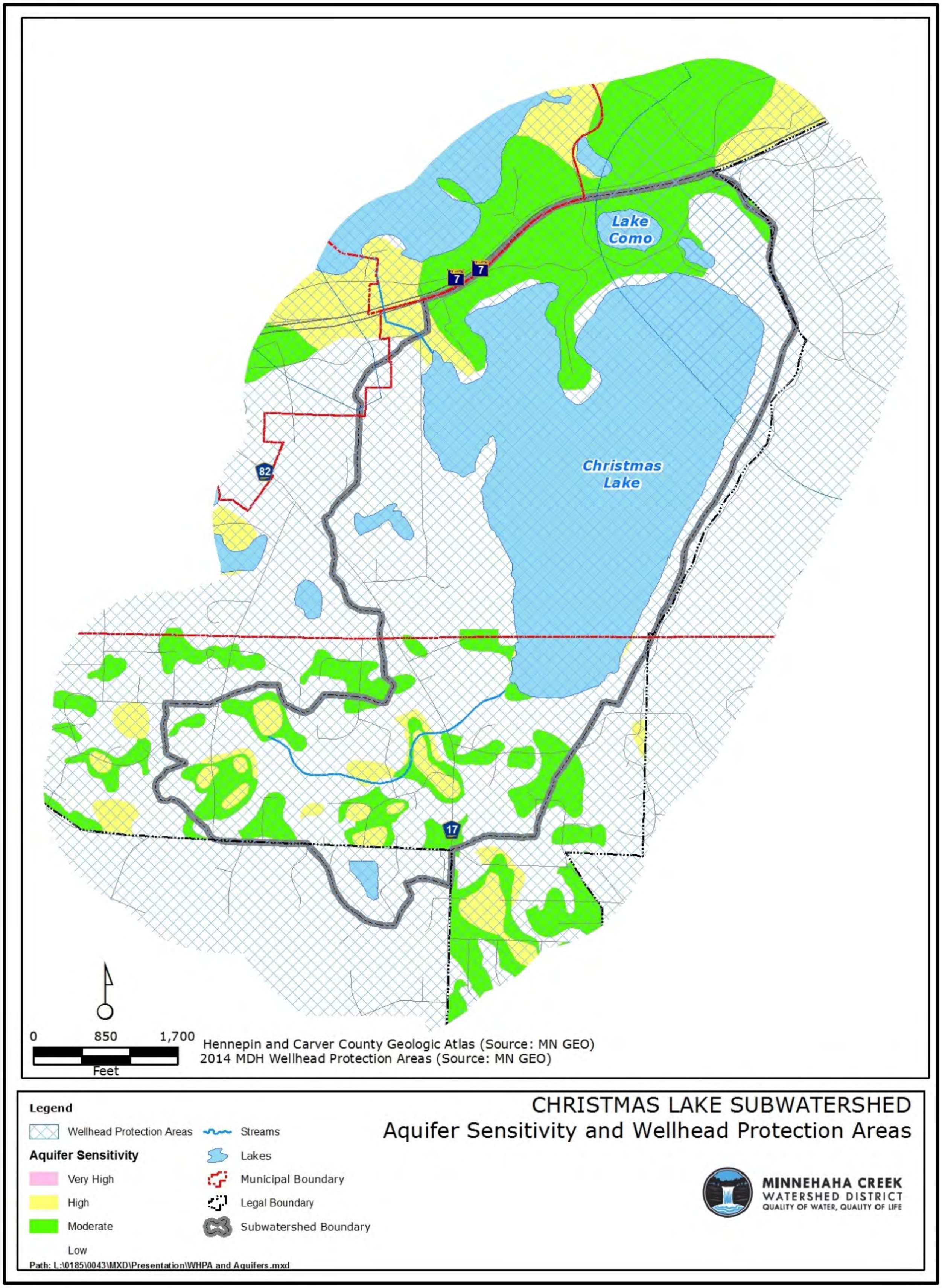

Figure 2. 11. Christmas Lake subwatershed aquifer sensitivity and Wellhead Protection Areas.

Water Quantity:

As detailed in the HHPLS, the subwatershed discharges into an outlet under Highway 7 into St. Albans Bay of Lake Minnetonka. Surface flows in the Christmas Lake subwatershed are routed primarily through a system of culverts connecting small depressions. Flows are received by small pocket wetlands (some landlocked) and then to Christmas Lake before ultimately discharging into St. Albans Bay. Although Christmas Lake is not landlocked, these water elevations are frequently below the crest of the outlet control structure meaning the lake does not always discharge. Water elevations of Christmas Lake indicate that the lake is significantly influenced by evaporation and that there is likely a strong groundwater interaction.

There are several landlocked and semi-landlocked units and several small pocket wetland and depressions that do not typically contribute to Christmas Lake. Landlocked basins are particularly sensitive to stormwater volumes. Strong volume control standards are recommended in all areas draining to landlocked areas (Figure 2.8).

To assess change in water yield, a Mann-Kendall statistical trend test was performed on annual water yield data for the Christmas Lake outlet. Water yield from 2006-2015 showed no statistically significant trend.

Ecological Integrity:

The E-Grade program defines watershed ecological integrity as the degree to which the watershed provides three key ecosystem services: biodiversity and habitat diversity and nutrient cycling. Nutrient cycling is described in the Water Quality section. The Christmas Lake subwatershed has not yet been evaluated by the E-Grade program. This section summarizes ecological integrity using existing data where available.

Lakes:

Biodiversity

Fish Community. No fish IBI data are available for the lakes in this subwatershed. Christmas Lake is stocked with rainbow trout and was last surveyed by the DNR in 2007. The DNR describes Christmas Lake as unique, because it is one of a few lakes in the Metro area that can support a two-story fishery. This means sufficient oxygen levels and cool water temperatures in deeper portions of the lake allow the over-summer survival of cold-water species, while warm-water species inhabit the warmer water above the thermocline. Christmas Lake is under a Fish Consumption Advisory for mercury, and was added to the state's Impaired Waters in 1998 for that reason.

Aquatic Vegetation Community. Biodiversity is determined by the number and variety of species, or richness. The most recent survey was conducted in 2015 and 26 species were observed. Floristic Quality Index (FQI) data from the 2015 survey was 28.8, which is considered good and supporting the ecosystem service, but beginning to show signs of disturbance.

Aquatic Invasive Species. Since 1992, Eurasian watermilfoil has been confirmed in Christmas Lake. Curlyleaf Pondweed and Zerba mussels are also present.. Zebra mussels were discovered in Christmas Lake in 2014. Initial treatments showed success at controlling zebra mussels within the treatment area by the access. However, more zebra mussels were found on the opposite end of the lake in 2015; the population is now established lakewide.

Habitat diversity

Aquatic Vegetation Community. Habitat diversity is determined by the percent occurrence of species or the extent to which it may be dominated by a few species. This has not been calculated yet but will be available once E-Grade is completed in the subwatershed.

Shoreline Health. Shoreline health is assessed by looking at shoreline vegetative cover and the relative human disturbance. The DNR uses the *Score the Shore* protocol to relate shoreline conditions to fish community structure using the fish IBI metric. No Score The Shore data are available for the subwatershed; however, aerial photos show that most of the lake is developed with turf grass, beach, and seawall/riprap, lacking in woodland or wetland fringes which are beneficial for controlling runoff and supporting emergent vegetation at the shoreline.

Streams:

Biodiversity

Fish Community. No fish data are available for the two unnamed streams within the subwatershed.

Macroinvertebrate Community. No macroinvertebrate data are available for the streams within the subwatershed.

Aquatic Invasive Species. No AIS data are available for the two unnamed streams within the subwatershed.

Habitat diversity

Habitat Complexity. No Minnesota Stream Habitat Assessment data are available to assess habitat complexity for the two unnamed streams within the subwatershed.

Connectivity. Connectivity is defined by two metrics: 1) presence or absence of barriers, and 2) access to floodplain. Barriers such as dams, weirs, and culverts limit or prevent organisms from moving freely in the stream. There are three barriers to the two unnamed streams in this subwatershed: two culverts along the inlet to Christmas Lake as the stream passes under Bretton Way and Powers Boulevard, and a small control structure on the outlet of Christmas Lake.

Water Quality. Water quality factors impacting stream habitat diversity include concentrations of TSS and DO. Higher TSS concentrations increase turbidity, which can interfere with aquatic predators seeking their prey and which can limit growth of aquatic vegetation. Refer to the Water Quality section for data.

Hydrology Indicators. Stream hydrology is an important factor in habitat diversity. The quick rising and falling of a stream in response to rain events can be stressful to organisms. In addition, streams that periodically are dry or have minimal flow are hostile to aquatic life. Continuous streamflow data are not available for the two unnamed streams in this subwatershed, although they are likely best characterized as minimal flow.

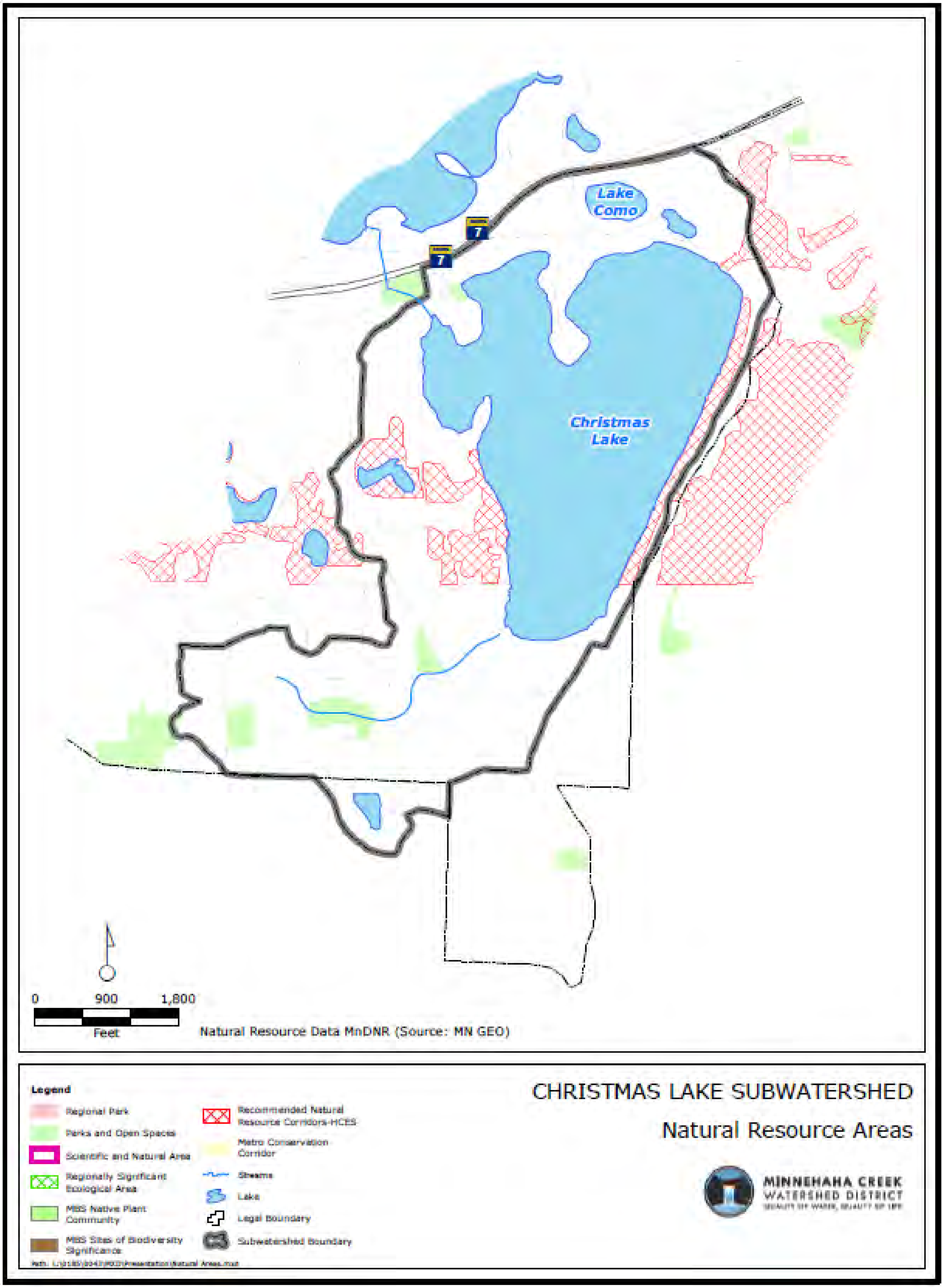

Figure 2. 12. Christmas Lake subwatershed natural resource areas.

Wetlands:

Biodiversity

Vegetation Community. No Rapid Floristic Quality Assessment (RFQA) data are available for the wetlands in this subwatershed. However the *Functional Assessment of Wetlands* identified one small wetland with exceptional vegetative diversity and another with high diversity. Three wetlands were classified as having exceptional aesthetic and fish habitat values.

Habitat diversity

Connectivity. There are limited opportunities to connect wetlands within this subwatershed.

Size. Larger wetlands are more likely to support a notable on-site diversity and/or abundance of wildlife species. There are few large wetlands within this subwatershed.

Shoreline Protection. Riparian wetlands can provide significant shoreline protection and support emergent vegetation at the shoreline. The *Functional Assessment of Wetlands* evaluated riparian wetlands for their ability to protect lake or stream shoreline. Wetlands are present on less than two percent of the shoreline, concentrated in one small, shallow bay on the west side of the lake.

Uplands:

The subwatershed is almost fully developed, there are only a few remaining patches of undeveloped landscape. Most of these areas are wetlands or are wooded portions of large residential lots. No area within the subwatershed has been identified by the DNR or the Minnesota Biological Survey (MBS) as being high-value or ecological areas (Figure 2.12).

Thriving Communities:

Land use:

Table 2.22 shows the land uses within the area of the Christmas Lake subwatershed in acres and as a percentage of the total subwatershed. The predominant land use in the subwatershed is single family residential with a small percentage of park and open space (Figure 2.13). Much of the subwatershed is identified as water, while the vacant or undetermined land use is characterized as wetland.

Table 2. 22. 2016 land use in the Christmas Lake subwatershed.

Land Use 2016	Acres	% of Subwatershed
Single - Family Residential	348.0	46.9
Water	273.0	36.8
Vacant or Undetermined	92.8	12.5
Parks and Open Space	14.6	2.0
Multi - Family Residential	6.2	0.8
Roads and Highways	5.0	0.7
Industrial	2.3	0.3
Institutional	0.4	0.1
Commercial	n/a	n/a
Agricultural	n/a	n/a

Source: Metropolitan Council.

Recreation:

Due to its clarity, Christmas Lake attracts snorkelers and SCUBA divers from across the Metro area. There are not any unique or scenic areas in this subwatershed. The Minnesota Historic features database lists three properties in the subwatershed: a former resort on Christmas Lake, and two farmhouses. There is a public boat launch on the north side of Christmas Lake (Figure 2.14). The water clarity of the Christmas Lake allows for swimming and other recreation activities.

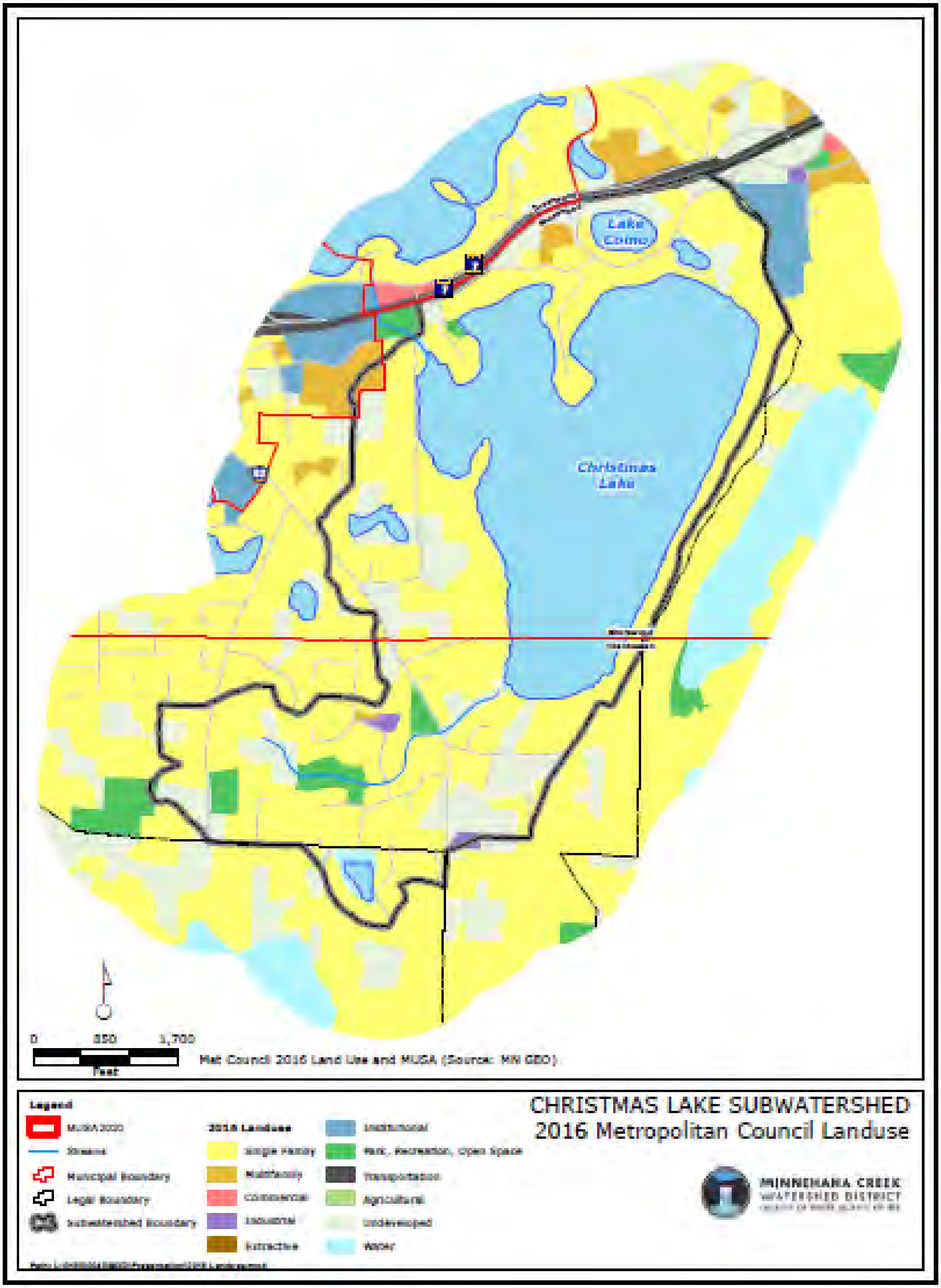

Figure 2. 13. Christmas Lake subwatershed 2016 Metropolitan Council land use.

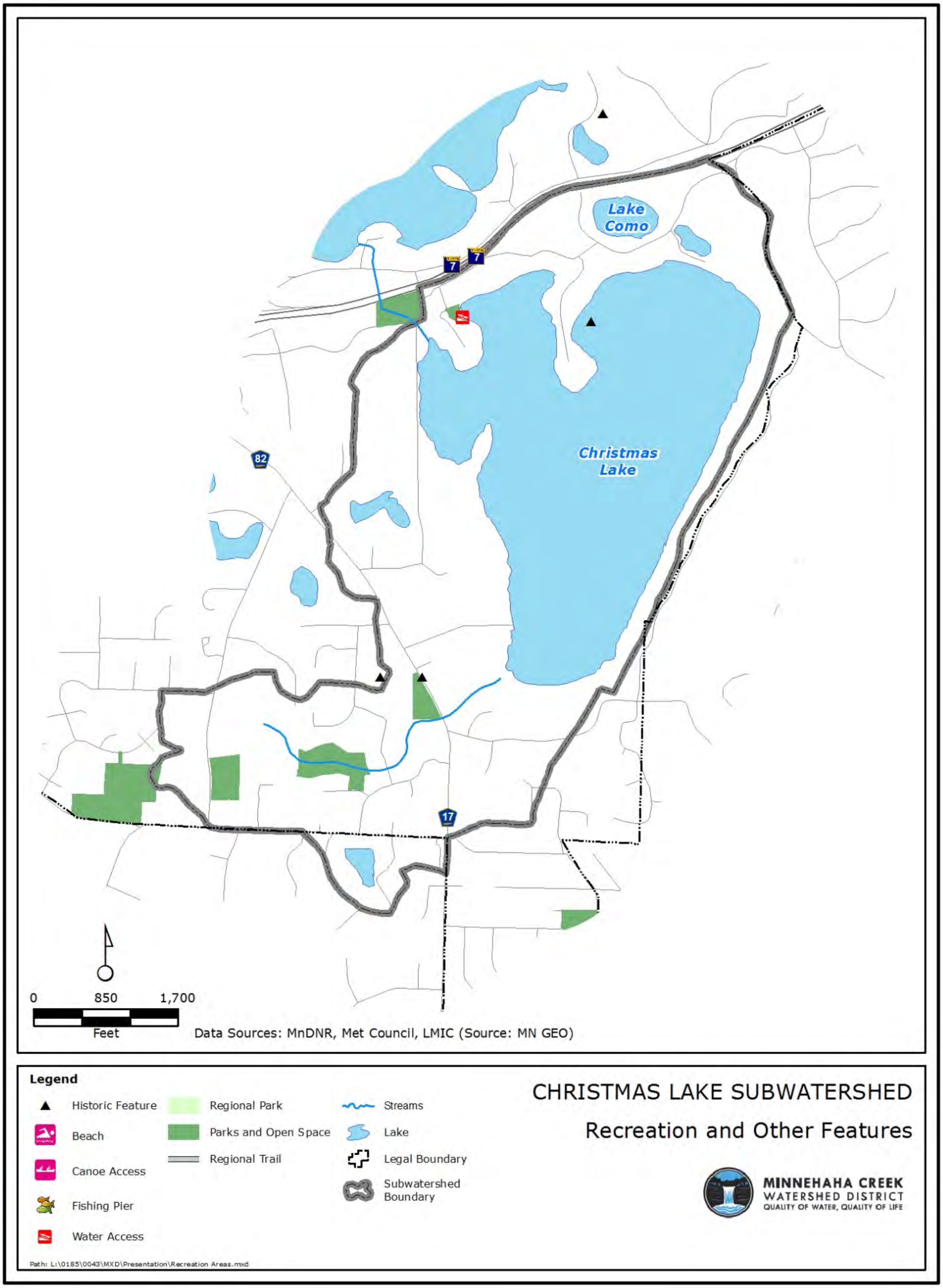

Figure 2. 14. Christmas Lake subwatershed recreational and other features.

2.3.2 DUTCH LAKE SUBWATERSHED

The Dutch Lake Subwatershed has a land cover mix of wetlands, woodlands, agriculture, horse farms and residential that surround Dutch Lake. Dutch Lake inlet (CDU02) drains the wetland to the north into Dutch Lake, and the lake outlet (CDU01) flows into Jennings Bay, Lake Minnetonka. There are ecological impacts from the Dutch Lake outlet loading nutrients into Jennings Bay. Below is the area of the Dutch Lake subwatershed in acres by individual city, in total, and as a percentage of the total subwatershed (Table 2.23, Figure 2.15).

Table 2. 23. Cities in the Dutch Lake subwatershed.

City	Area (Acres)	% of Subwatershed
Minnetrista	1,704.6	90%
Mound	183.8	10%
Total	1,888.4	100%

Source: MCWD

Subwatershed Description and Hydrology:

The Dutch Lake subwatershed is hummocky, rolling and hilly, with some steep slopes on the hillsides and along the southwestern shore of Dutch Lake and adjacent wetland.

Land cover is classified by the Minnesota Land Cover Classification System (MLCCS) (Figure 2.16). The subwatershed is primarily agriculture and open space in the north and grassland or turf with low to medium impervious surface typical of residential development in the south and east. The open space is dominated by wetland, forest and woodland.

Soils within the subwatershed are predominantly classified as Natural Resources Conservation Service Hydrologic Soil Group B (loamy soils with moderate infiltration potential) and D (clayey soils with very low infiltration potential. The Group D soils are found in low-lying areas and are generally hydric, or showing indications of inundation. For further information regarding geology and soils in the subwatershed, please refer to the *2007 MCWD Comprehensive Water Resources Management Plan.*

The *2003 MCWD Hydrologic, Hydraulic, and Pollutant Loading Study (HHPLS)* subdivided the Dutch Lake subwatershed into seven subwatershed units, designated DL-1 through DL-7 (Figure 2.17). Dutch Lake is the primary receiving water within the subwatershed. There is one primary stream, Dutch Creek, which serves as the outlet of Dutch Lake and flows to Jennings Bay**.** The Dutch Lake subwatershed has two large wetland systems: a wetland complex dominates the western half of the subwatershed and another on the upper portion of the watershed that drains to a large wetland complex in the central watershed, which in turn drains south and then east to Dutch Lake.

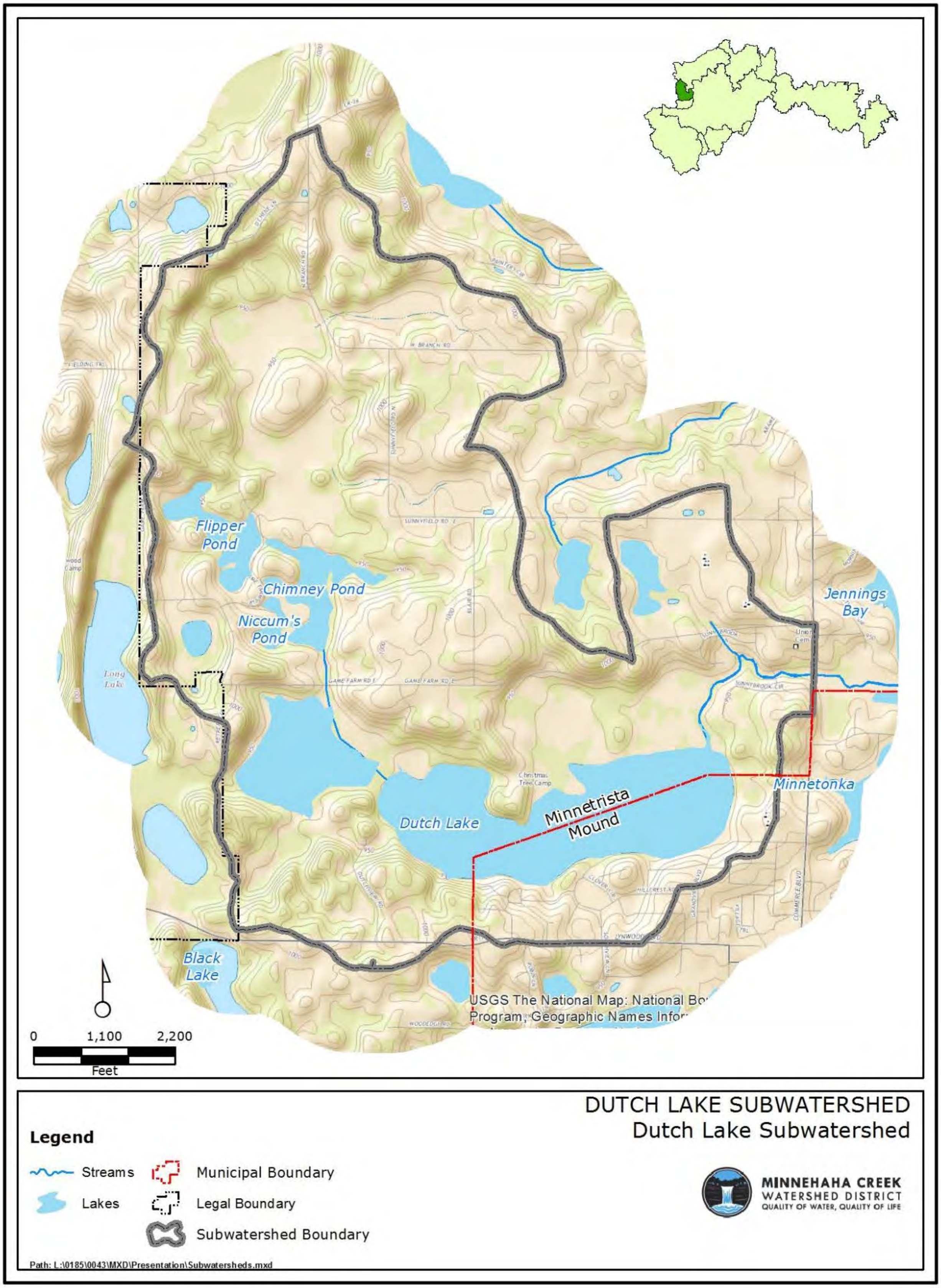

Figure 2. 15. The Dutch Lake subwatershed.

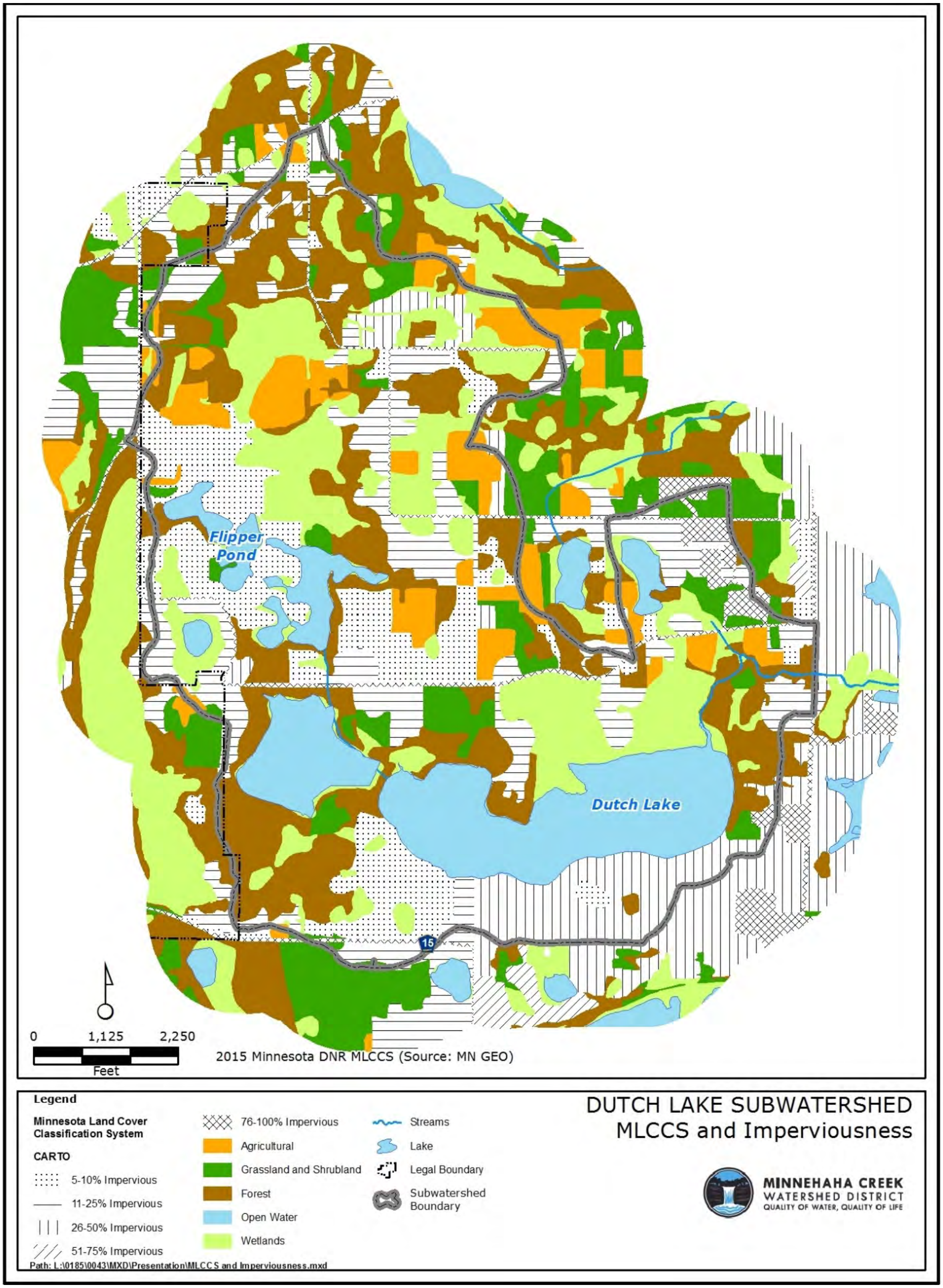

Figure 2. 16. Dutch Lake subwatershed MLCCS and imperviousness.

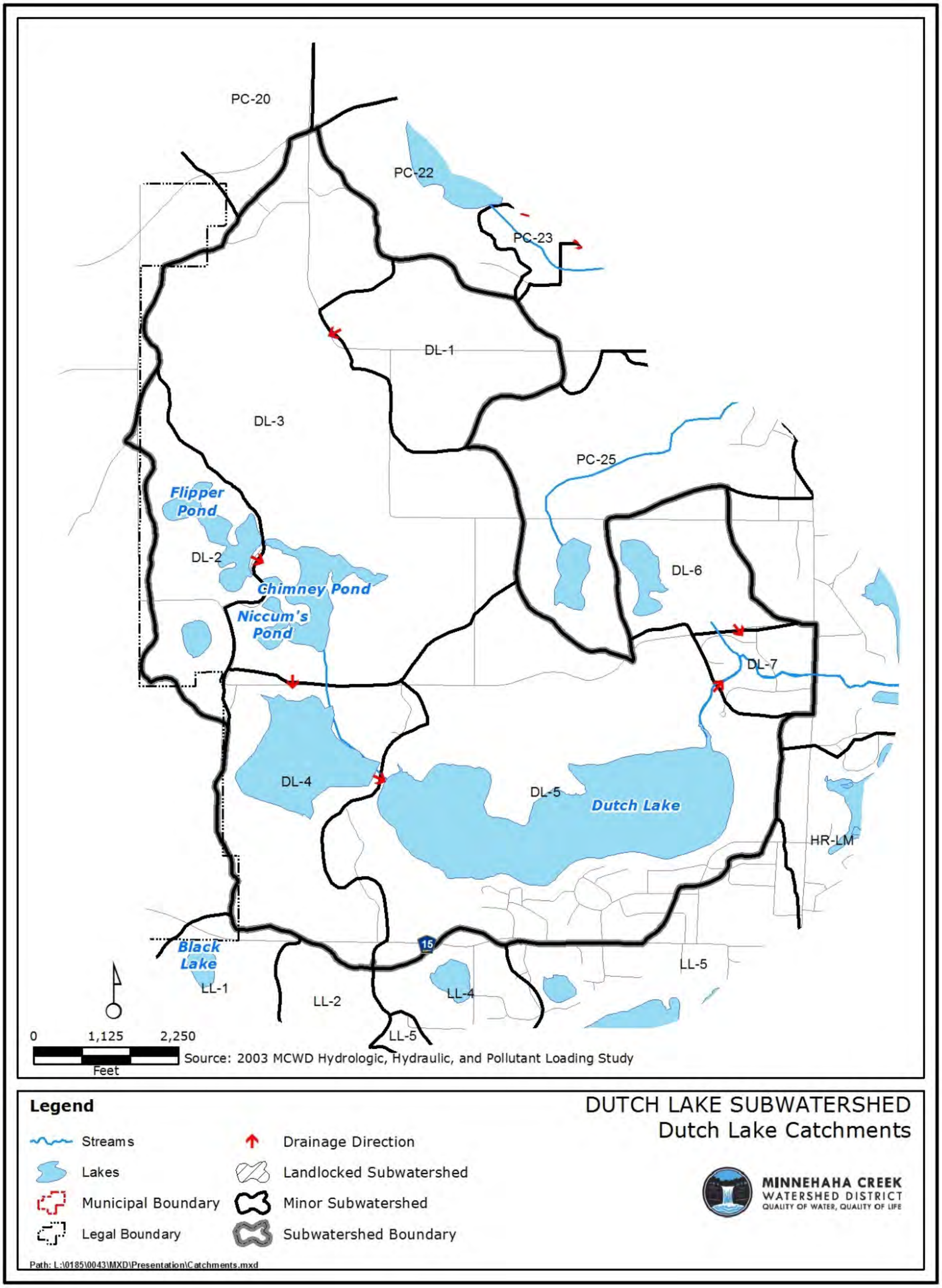

Figure 2. 17. Dutch Lake subwatershed catchments.

Water Quality:

The following are summaries of the characteristics and classifications of lakes and streams within the subwatershed including water quality goals and trends.

Lakes:

Dutch Lake is the primary receiving water within the subwatershed, and is classified by the MnDNR for shoreland management purposes as a Recreational Development lake (Table 2.24). Tables 2.24 and 2.25 below detail the physical and water quality characteristics of Dutch Lake.

Dutch Lake is listed on the State's Impaired Waters list for nutrient/eutrophication biologic indicators. Average summer nutrient concentrations are greater than the state standard. Algal blooms and poor water quality makes recreational activities undesirable at certain times of the year. To assess long-term change in Dutch Lake, a Mann-Kendall statistical trend test was performed on total phosphorus (TP), chlorophyll-a (Chl-a), and Secchi depth data from 2001-2015. There were no statistically significant changes in water quality in Dutch Lake over this period.

For more information regarding water quality in the subwatershed, please refer to the District's annual Water Quality Reports and the Upper Minnehaha Creek Watershed TMDL.

Table 2. 24. Physical characteristics of lakes in the Dutch Lake subwatershed.

Lake	Surface Area (acres)	Maximum Depth (ft)	Watershed to Lake Area Ratio	DNR Classification
Dutch	173	45	10:1	Recreational Development

Source: Minnesota DNR.

Table 2. 25. Selected water quality goals and current conditions of lakes in the Dutch Lake subwatershed.

Lake	State TP Standard (µg/L)	2007 Plan Goal TP (µg/L)	Trend*	2001-2015 Average		
				TP (µg/L)	Chl-a (µg/L)	Secchi (m)
Dutch	40	40	No trend	66	39	1.1

*Statistically significant at ≤ 0.05.
Source: MCWD and Minnesota DNR.

Streams:

There is one primary stream within the subwatershed; Dutch Creek, which serves as the outlet of Dutch Lake and flows to Jennings Bay. A small stream drains wetlands on the west side of Dutch Lake, which flows seasonally or intermittently. Flow in the stream is controlled by an outlet structure on Dutch Lake and is mainly runoff event-driven. Large events within the subwatershed can result in temporarily high flows into the Creek.

At this time no streams are listed as Impaired Waters; however, both streams have TP concentrations that are high relative to the state river eutrophication standards. However, those standards also look at other indicators such as chlorophyll-a, diel oxygen flux, and biological oxygen demand that haven't been assessed in the Creek. Tables 2.26 and 2.27 below detail the physical and water quality characteristics of streams and tributaries within the subwatershed.

Table 2.26 shows the average TSS concentrations at sites of the two unnamed streams in the subwatershed, Dutch Lake Inlet and Dutch Lake Outlet. The streams have an average TSS of 6 and 9 mg/L respectively, which is well below the 30 mg/L state standard. Maintaining sufficient dissolved oxygen (DO) is necessary to support aquatic life. The DO state standard requires the stream to never fall below 5 mg/L DO. Monitoring data show that both sites fall below the standard multiple times per year.

To assess long-term change in Dutch Lake Outlet station, a Mann-Kendall statistical trend test was performed on flow-corrected TP and TSS data from 2005-2015. There was a statistically significant improvement in TSS at the Dutch Lake outlet during this period. For more information, please refer to the District's Water Quality (Hydrodata) reports.

Table 2. 26. Major streams in the Dutch Lake subwatershed.

Stream	Length (mi)
Dutch Lake Inlet (CDU02)	0.16
Dutch Lake Outlet (CDU01)	0.92

Table 2. 27. Current conditions of streams in the Dutch Lake subwatershed.
See Figure 2.18 for monitoring locations.

Stream	Trend*	2005-2015 Summer Average			
		TP (µg/L)	TN (mg/L)	TSS(mg/L)	Cl (mg/L)
Dutch Lake Inlet (CDU02)	n/a	240	1.01	6	26
Dutch Lake Outlet (CDU01)	Imp TSS	118	1.26	9	31

TP = total phosphorus, TN =total nitrogen, TSS = total suspended solids, Cl = chloride.
*Statistically significant at ≤ 0.05, Imp = improving, Deg = degrading.
Source: MCWD.

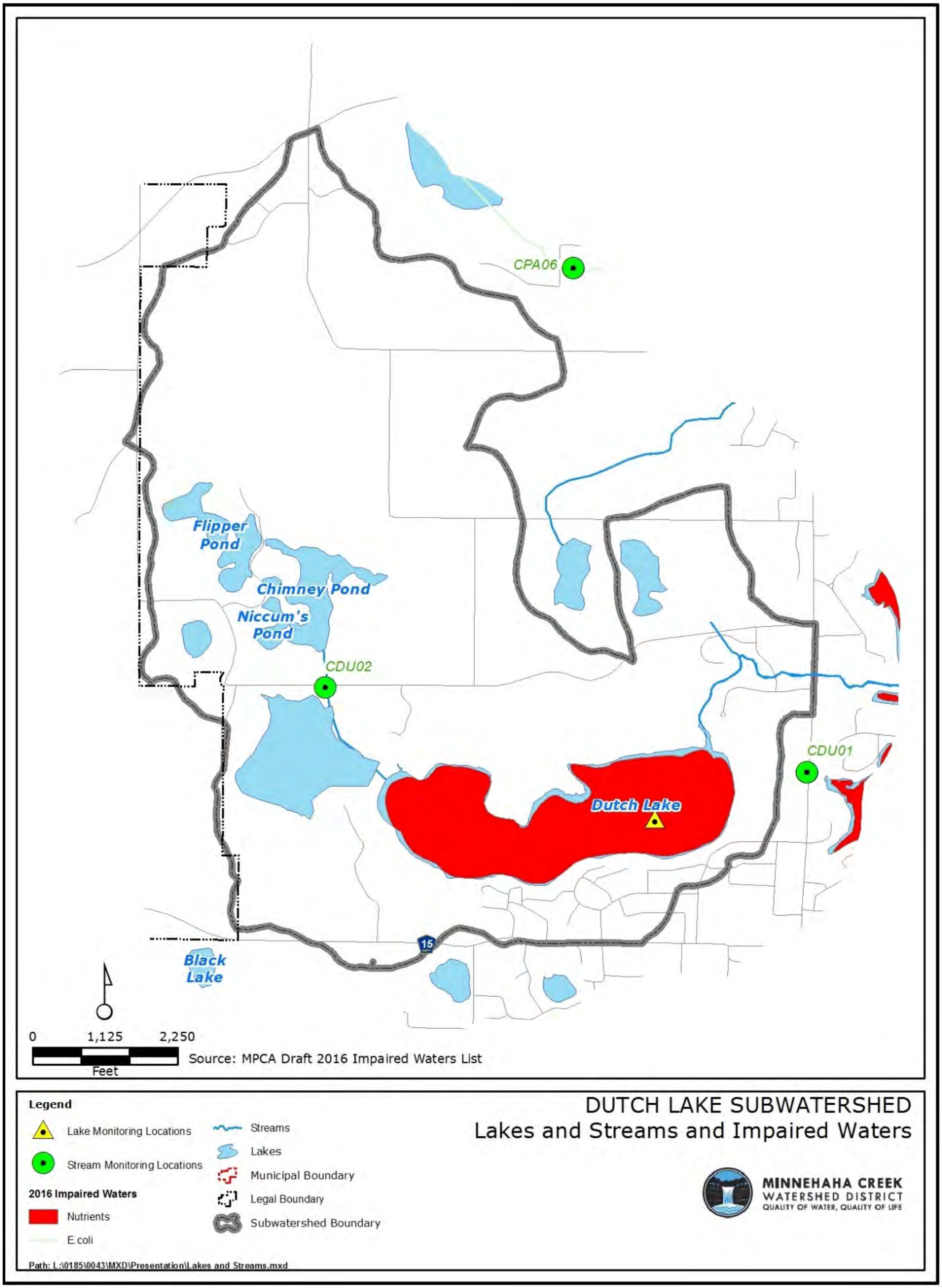

Figure 2. 18. Dutch Lake subwatershed lakes and streams and Impaired Waters.

Wetlands:

According to the FAW, wetlands, including lakes, cover 20 percent of the watershed's surface (Figure 2.19 and Table 2.28). A delineation of wetland boundaries is required to be completed any time development or other impacts may occur near or in a wetland. For more information regarding wetlands in the subwatershed, please refer to the *2007 MCWD Comprehensive Water Resources Management Plan*.

No data are available yet to evaluate the ability of the wetlands in the subwatershed to cycle nutrients to and from the subwatershed. E-Grade will assess wetland soil chemistry, overall vegetative conditions, presence or absence of algal blooms, and condition of the buffer and area within 500 feet of the wetlands.

Table 2. 28. Functional Assessment of Wetlands inventory of wetland types in the Dutch Lake subwatershed.

FAW Circular 39 Wetland Type	Area (acres)	Percent
1 - Seasonal	3.4	0.21
2 - Wet Meadow	41	2.5
3 - Shallow Marsh	280.2	17.09
4 - Deep Marsh	2.8	0.17
5 - Open Water	-	-
6 - Scrub Shrub	0.4	0.02
7 - Forested	0.3	0.02
8 - Bog	-	-
Riverine	-	-
Wetland Total	328	20.0
Upland	1,313.1	80.0
TOTAL	1,641.1	

Source: MCWD Functional Assessment of Wetlands.

Groundwater:

The District's roles in managing groundwater are to 1) promote surficial groundwater recharge to protect wetland hydrology and stream baseflow, and 2) assist in protecting deeper aquifers used for drinking water by limiting infiltration in sensitive recharge areas.

The infiltration potential of the upland areas in the subwatershed are described as low to medium. Because of the organic nature of the soils in the central wetland area, infiltration potential there is variable. The *Hennepin County Geologic Atlas* classifies most of the upland areas as being of low sensitivity to pollution, and the central wetland area as highly sensitive.

Part of the Dutch Lake Subwatershed has been designated by the Minnesota Department of Health as a Drinking Water Supply Management Area (DWSMA) and a wellhead protection area for a City of Minnetrista public well. While the aquifer sensitivity is high, the MDH has designated this area to be of low risk and low vulnerability to contamination of the drinking water supply. Figure 2.20 shows areas in the subwatershed with groundwater sensitivity and that are designated wellhead protection areas.

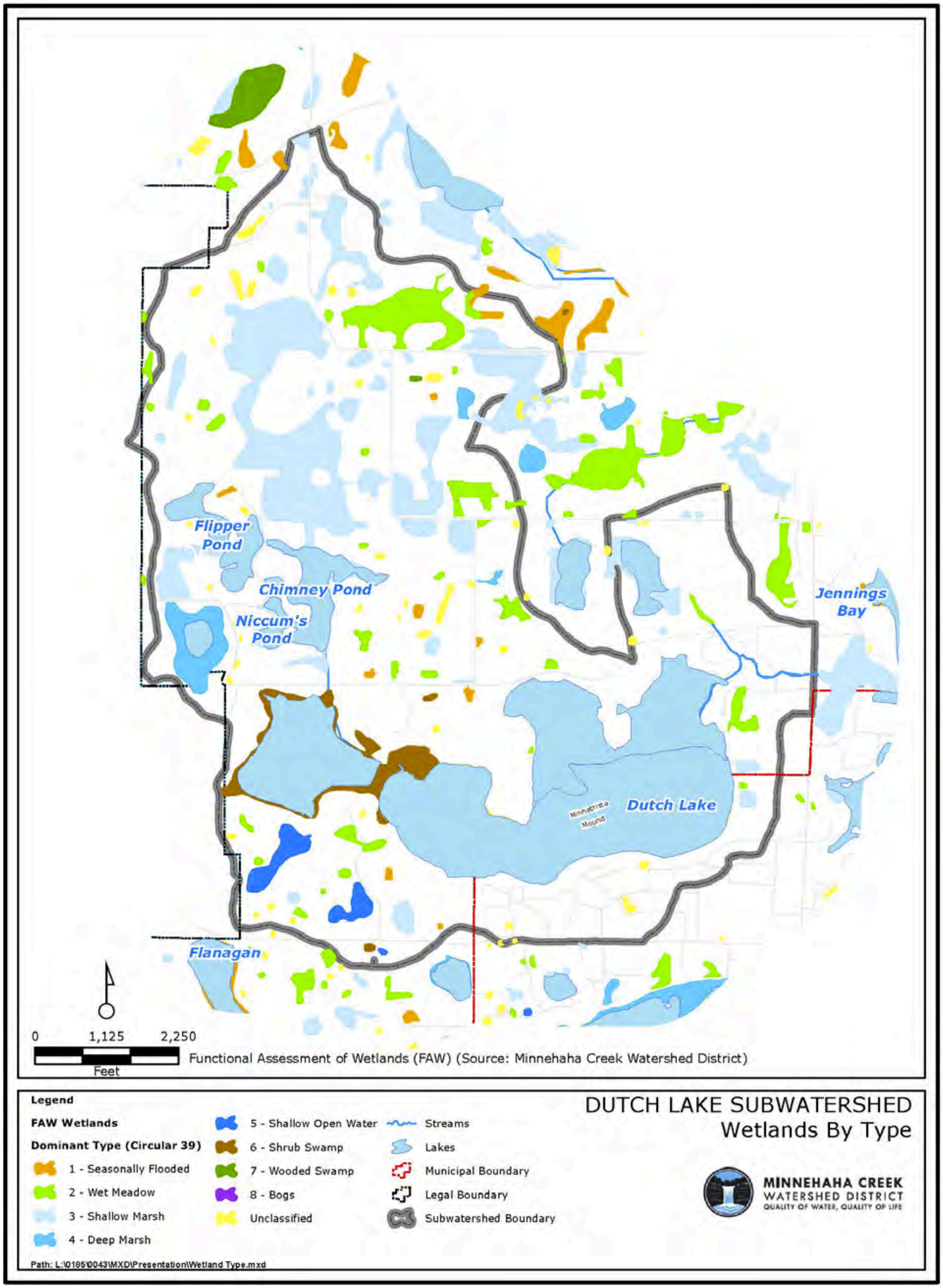

Figure 2. 19. Dutch Lake subwatershed wetlands by type.

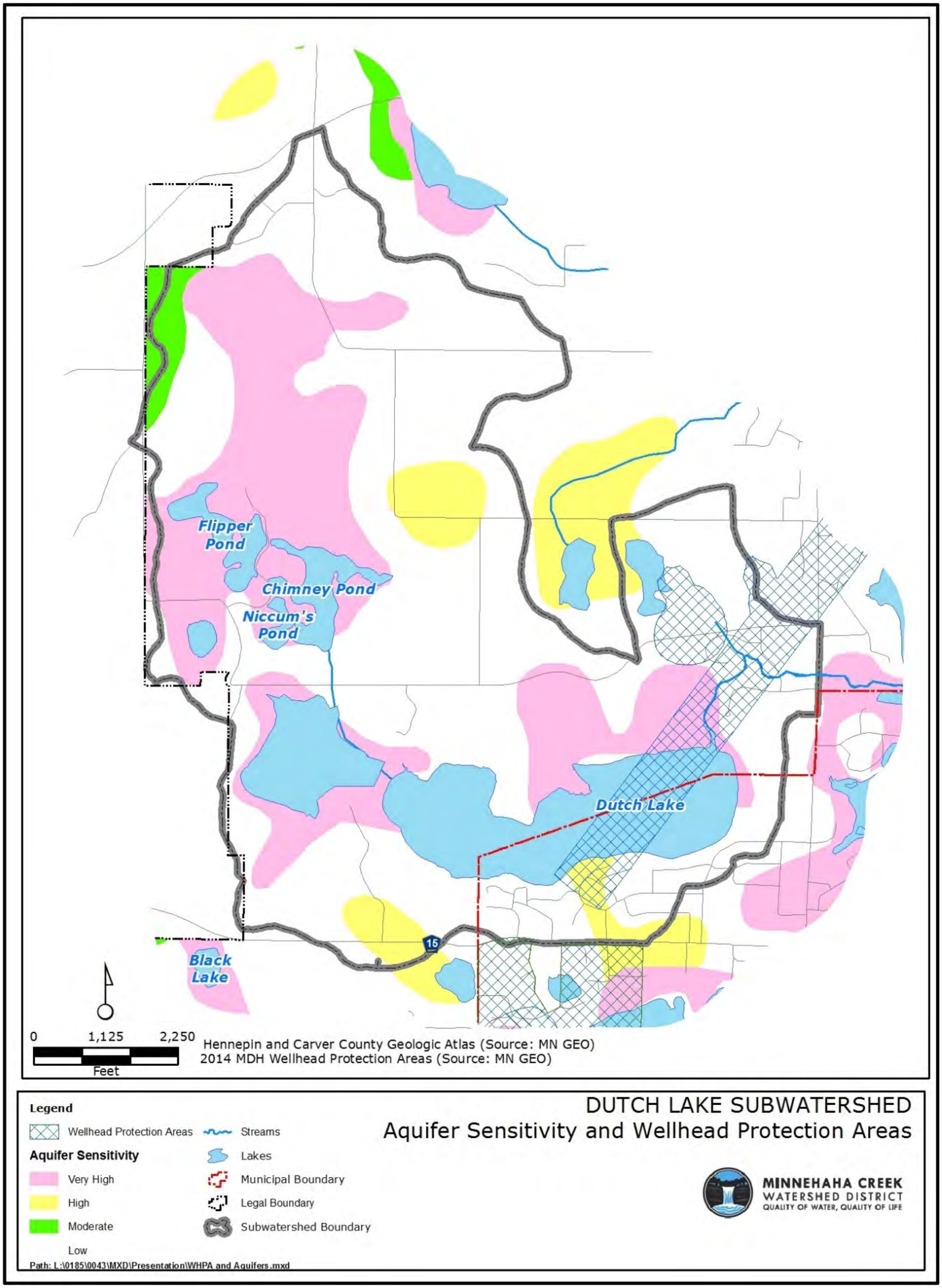

Figure 2. 20. Dutch Lake subwatershed aquifer sensitivity and Wellhead Protection Areas.

Water Quantity:

A small stream drains wetlands on the west side of Dutch Lake, which flows seasonally or intermittently. The Dutch Lake subwatershed is characterized by a system of ditches and culverts conveying water into the main water bodies of the subwatershed.

To asses change in water yield, a Mann-Kendall statistical trend test was performed on data for the Dutch Lake outlet station. The period of record for the Dutch Lake outlet station was 2006-2015. Water yield did not exhibit any statistically significant trend upward or downward.

Ecological Integrity:

The E-Grade program defines watershed ecological integrity as the degree to which the watershed provides three key ecosystem services: biodiversity, habitat diversity, and nutrient cycling. The Dutch Lake subwatershed has not yet been evaluated by the E-Grade program. This section summarizes ecological integrity using existing data, where available (Figure 2.21).

Lakes:

Biodiversity

Fish Community. No fish IBI data are available for the lakes in this subwatershed. Dutch Lake was last stocked by the MnDNR in 2011 for bluegill and was last surveyed in 2014. At the time of that survey (late July) water clarity was 1.2 feet and the lake was strongly stratified with poor (<2 mg/l) dissolved oxygen below 8 feet. That survey found that Northern Pike abundance was relatively low compared to other similar lakes in the state; however, typical of lakes with low density, mean size was larger than average. The pan fish community appears healthy. Yellow Perch have never been abundant in Dutch Lake and have always been sampled at a rate below average.

Aquatic Vegetation Community. Biodiversity is determined by the number and variety of species, or richness. Floristic Quality Index data were collected in 1996. The FQI was 15.1, which is considered Poor. Dutch Lake is infested by Eurasian watermilfoil.

Aquatic Invasive Species. Eurasian watermilfoil has been confirmed in Dutch Lake.

Habitat diversity

Aquatic Vegetation Community. Habitat diversity is determined by the percent occurrence of species or the extent to which it may be dominated by a few species. This has not been calculated yet, but will be once E-Grade is completed in the subwatershed.

Shoreline Health. Shoreline health is assessed looking at shoreline vegetative cover and the relative human disturbance. The MnDNR is using the Score The Shore protocol to relate shoreline conditions to fish community structure using the fish IBI metric. No Score The Shore data are available; however, aerial photos show that much of the west, north and east side of Dutch lake as well as many of the wetlands in the subwatershed have significant woodland or wetland fringes, which are beneficial for controlling runoff and supporting emergent vegetation at the shoreline.

Streams:

Biodiversity

Fish Community. No fish IBI data are available for the streams in this subwatershed.

Macroinvertebrate Community. No macroinvertebrate data are available for the streams in this subwatershed.

Aquatic Invasive Species. No AIS data are available for the streams in this subwatershed.

Habitat diversity

Habitat Complexity. No Minnesota Stream Habitat Assessment data are available to assess habitat complexity on either the inlet and outlet streams of Dutch Lake.

Connectivity. Connectivity is defined by two metrics: presence or absence of barriers, and access to floodplain. Barriers such as dams, weirs, and culverts limit or prevent organisms from moving freely in the stream. There are several barriers on the streams in this subwatershed, most of them culverts at road crossings. There are no stream cross-section data available for either the inlet or outlet streams.

Water Quality. Water quality factors impacting stream habitat diversity include concentrations of TSS and DO. Higher TSS concentrations increase turbidity, which can interfere with aquatic predators seeking their prey and which can limit growth of aquatic vegetation. Refer to Water Quality section for data.

Hydrology Indicators. Stream hydrology is an important factor in habitat diversity. A stream that is very flashy, that is, one that rises and falls very quickly in response to rain events, can be stressful to organisms. In addition, streams that periodically are dry or have minimal flow are hostile to aquatic life. Continuous streamflow data are not available, but based on observation, the average flow of both the inlet and outlet streams is low, which would be indicative of the low DO levels mentioned above.

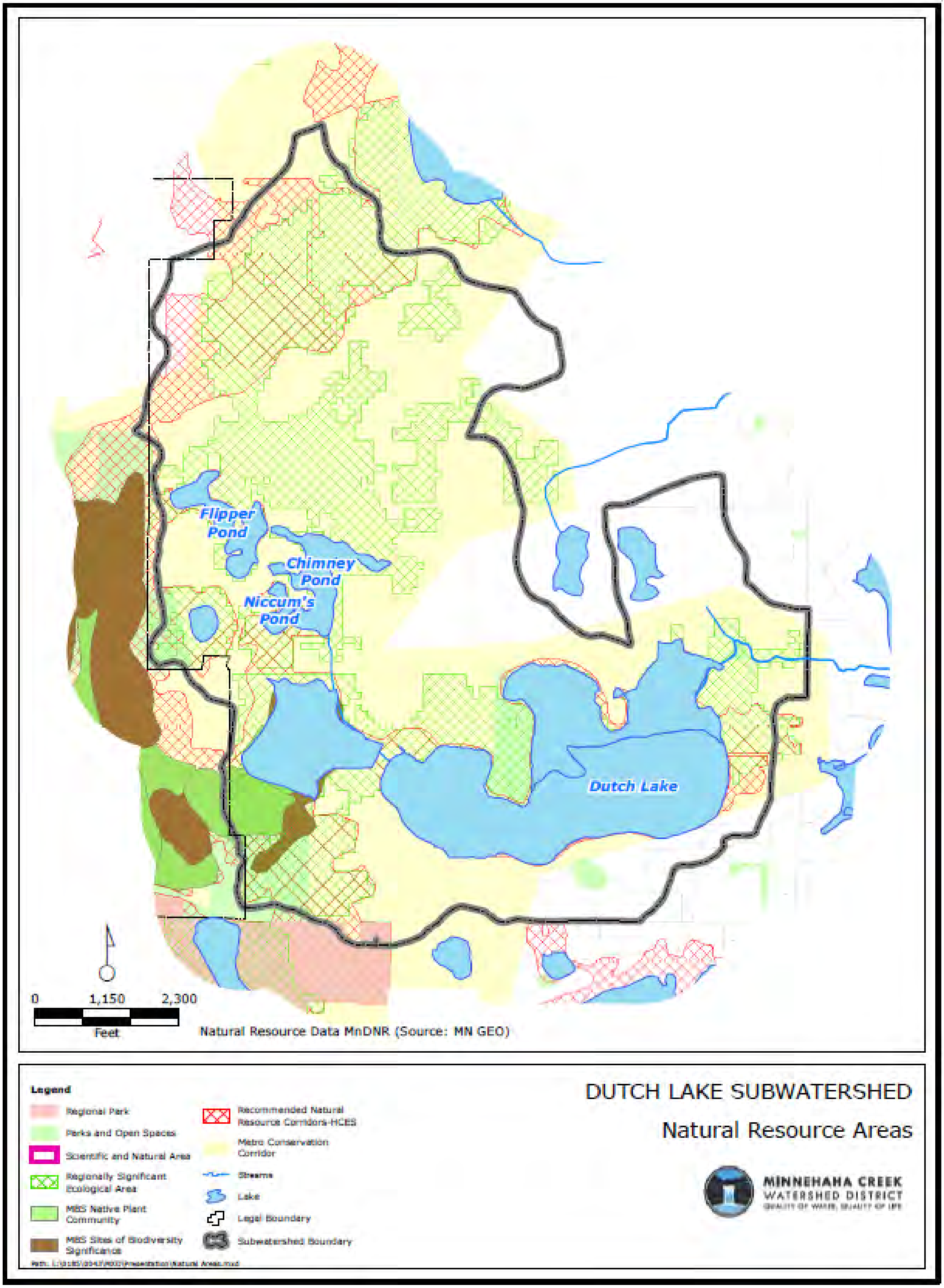

Figure 2. 21. Dutch Lake subwatershed natural resource areas.

Wetlands:

Biodiversity

Vegetation Community. No Rapid Floristic Quality Assessment data are available for the wetlands in this subwatershed. However the *Functional Assessment of Wetlands* scored two large riparian wetlands highly – on the north side and west side of the lake - on vegetative diversity, fish and wildlife habitat, or aesthetics. There is one wetland in the subwatershed with high restoration potential. Numerous other small wetlands or moderate restoration potential are located throughout the subwatershed.

Uplands:

Biodiversity

Existing data sources do not highlight any unique or scenic areas in this subwatershed. However, much of the subwatershed has been identified by the DNR as a Metropolitan Conservation Corridor and by the City of Minnetrista as a natural resources corridor due to the predominance and contiguity of wetlands (Figure 2.21).

Habitat diversity

Regionally significant ecological areas are places where larger tracts of minimally disrupted land provide habitat complexity. Much of the subwatershed has been identified by the MnDNR as a Metropolitan Conservation Corridor and by the City of Minnetrista as a natural resources corridor due to the predominance and contiguity of wetlands.

The Minnesota Biological Survey (MBS) has identified both terrestrial and aquatic locations in the watershed with intact native plant communities, and those with biodiversity significance (Figure 2.21). Native plant communities are a group of native plants that interact with each other and the surrounding environment in ways not greatly altered by humans or by introduced plant or animal species. On the west side of Dutch Lake are two native plant communities classified as Imperiled or Imperiled/Vulnerable. A 25-acre Tamarack Swamp and a 32 acre Sugar Maple-Basswood-Bitternut Hickory Forest are part of a native plant corridor between Dutch Lake and Long Lake/Little Long Lake, which are both outside the watershed.

Thriving Communities:

Land use:

Table 2.29 below shows the land uses within the area of the Dutch Lake subwatershed in acres and as a percentage of the total subwatershed. The predominant land use in the subwatershed is vacant land, mainly wetland and forest or woodland (Figure 2.22). There are scattered low density single family residential uses in the upper watershed, mainly isolated homes and farmsteads. The south and eastern portion of the subwatershed are dominated by single family residential. Mound Westonka High School is a large, institutional use in the eastern subwatershed.

Much of the watershed is outside of the MUSA 2020 boundary, and is not served by regional wastewater facilities.

Table 2. 29. 2016 land use in the Dutch Lake subwatershed.

Land Use 2016	Acres	% of Subwatershed
Vacant or Undetermined	935.4	49.5
Single - Family Residential	379.9	20.1
Agricultural	192.6	10.2
Water	181.1	9.6
Parks and Open Space	112.4	6.0
Institutional	77.5	4.1
Multi - Family Residential	8.9	0.5
Commercial	0.6	<0.1
Industrial	n/a	n/a
Roads and Highways	n/a	n/a

Source: Metropolitan Council.

Recreation:

Existing data sources do not highlight any unique or scenic areas in this subwatershed. The Minnesota Historic Features database notes one historic site in this subwatershed, a farmhouse. There is one public boat access on Dutch Lake off of Grandview Boulevard, adjacent to Grandview Middle School (Figure 2.23). The YMCA operates Camp Christmas Tree on the north shore of the lake, with a wide variety of swimming, fishing and boating activities available to campers.

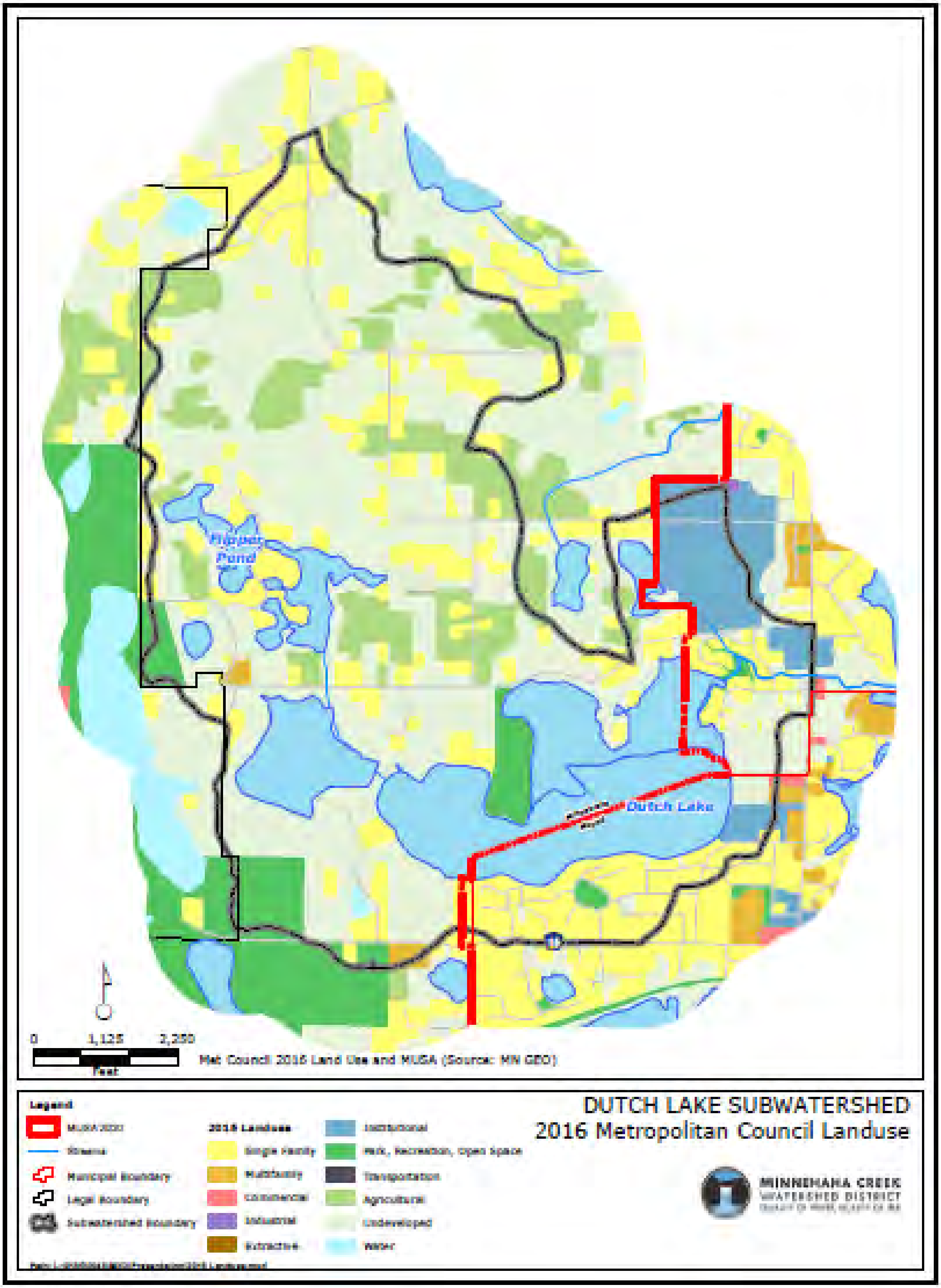

Figure 2. 22. Dutch Lake subwatershed 2016 Metropolitan Council land use.

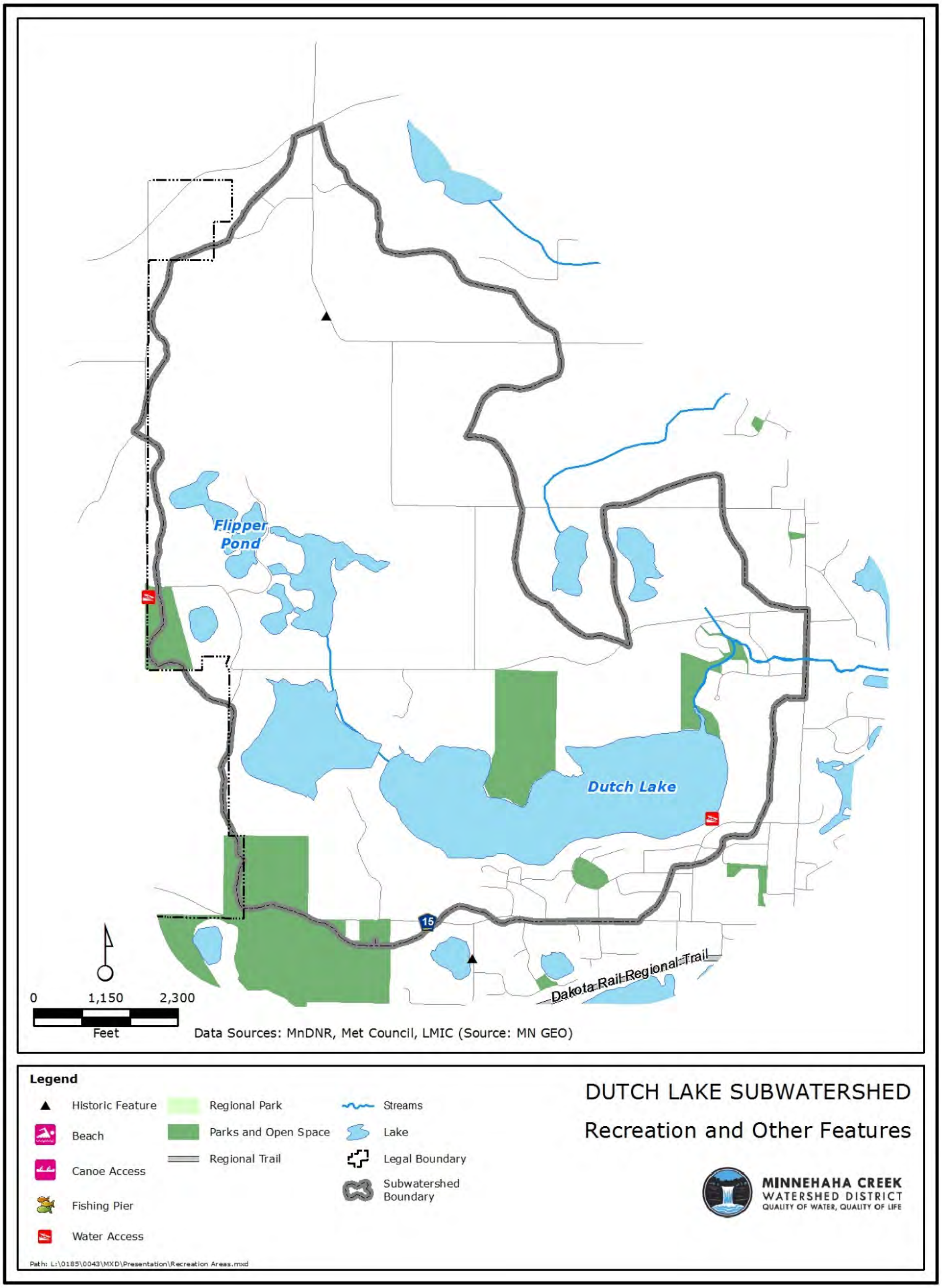

Figure 2. 23. Dutch Lake subwatershed recreation and other features.

2.3.3 GLEASON LAKE SUBWATERSHED

Gleason Lake Subwatershed is dominated by a mix of urban residential/business land cover with very little woodland and wetlands remaining. The subwatershed is drained in the west by Hadley Lake and in the east by Gleason Lake. All the water drains into Wayzata Bay, Lake Minnetonka. The nutrient loading into Wayzata Bay is not well understood. One of the outlets is piped and the other one drains into pond prior to discharging into Wayzata Bay. A 2013 Macroinvertebrate Assessment indicates poor water quality along the creek that discharges into Wayzata Bay. Table 2.30 shows the area of the Gleason Lake subwatershed in acres by individual city, in total and as a percentage of the total subwatershed (Figure 2.24).

Table 2. 30. Cities in the Gleason Lake subwatershed.

City	Area (Acres)	% of Subwatershed
Medina	130.8	3.0
Minnetonka	51.4	1.2
Orono	138.3	3.2
Plymouth	3,507.5	80.4
Wayzata	537.1	12.3
Total	4,365.2	100%

Source: MCWD

Subwatershed Description and Hydrology:

The Gleason Lake subwatershed is comprised of gentle rolling hills with an abundance of lakes and ponds. The eastern portion of the subwatershed drains through several wetlands including Kreatz and Snyder Lakes and then to County Ditch #15, which discharges into Gleason Lake. The western watershed drains through Hadley Lake and then south to Gleason Lake Creek, which outlets the south end of Gleason Lake and flows by channel and culvert to Glenbrook Pond. The Pond outlets to a storm sewer that discharges downstream to Wayzata Bay.

Land cover is classified by the Minnesota Land Cover Classification System (MLCCS) (Figure 2.25). The subwatershed is mostly developed areas with low to medium impervious surface typical of residential development. Pockets of wetlands and wooded areas (mainly park lands) are present.

Soils within the subwatershed are predominantly classified as Natural Resources Conservation Service Hydrologic Soil Group B (loamy soils with moderate infiltration potential) and D (clayey soils with very low infiltration potential). For further information regarding geology and soils in the subwatershed, please refer to the *2007 MCWD Comprehensive Water Resources Management Plan*.

The *2003 MCWD Hydrologic, Hydraulic, and Pollutant Loading Study (HHPLS)* subdivided the Gleason Lake subwatershed into 16 subwatershed units, designated GLC-1 through GLC-11, and HL-1 through HL-5 for that part of the subwatershed that is within the Hadley Lake drainage area (Figure 2.26).

Mooney Lake has no natural outlets; however, it is pumped out under certain agreed upon conditions to prevent flooding.

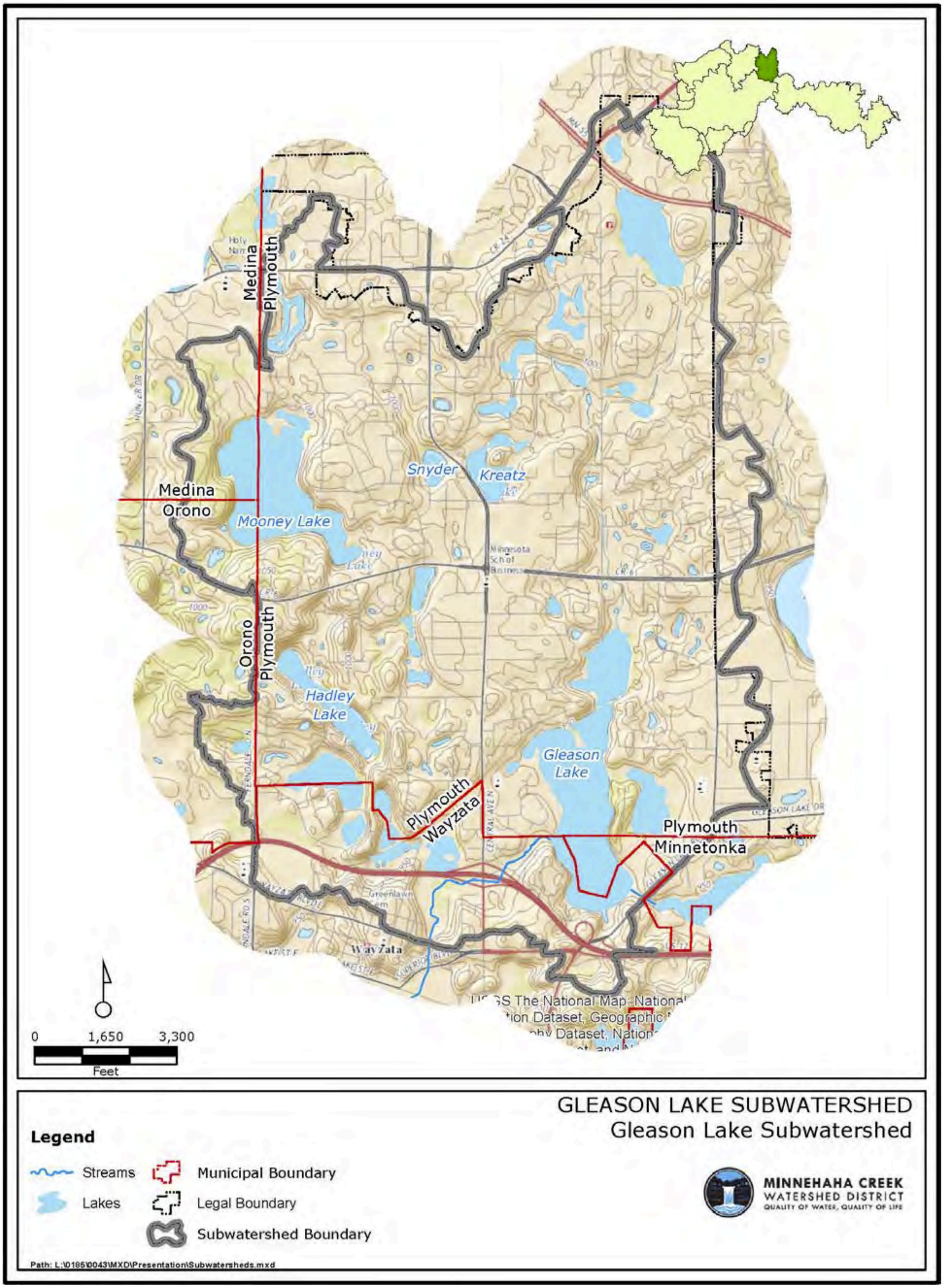

Figure 2. 24. The Gleason Lake subwatershed.

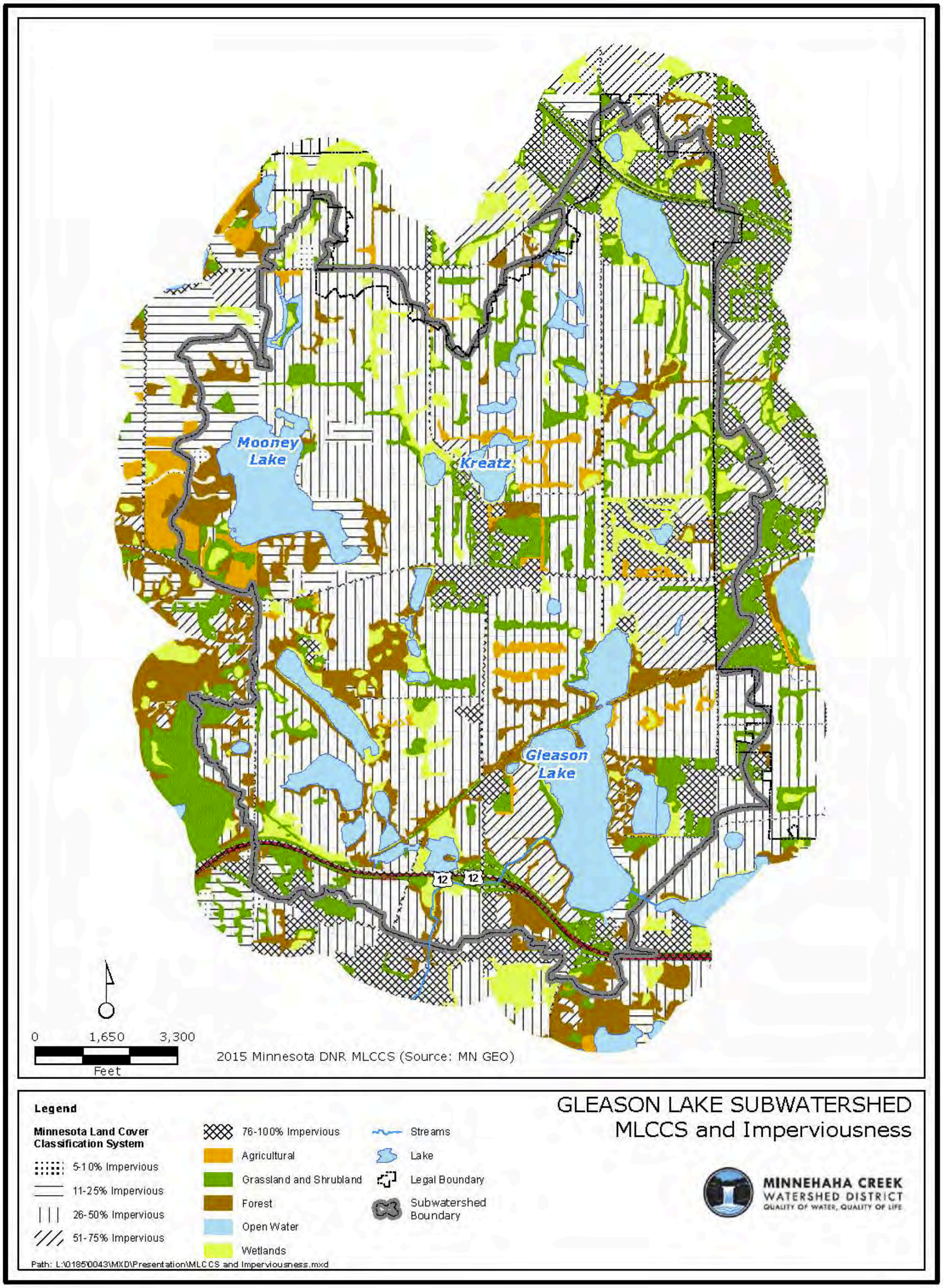

Figure 2. 25. Gleason Lake subwatershed MLCCS and imperviousness.

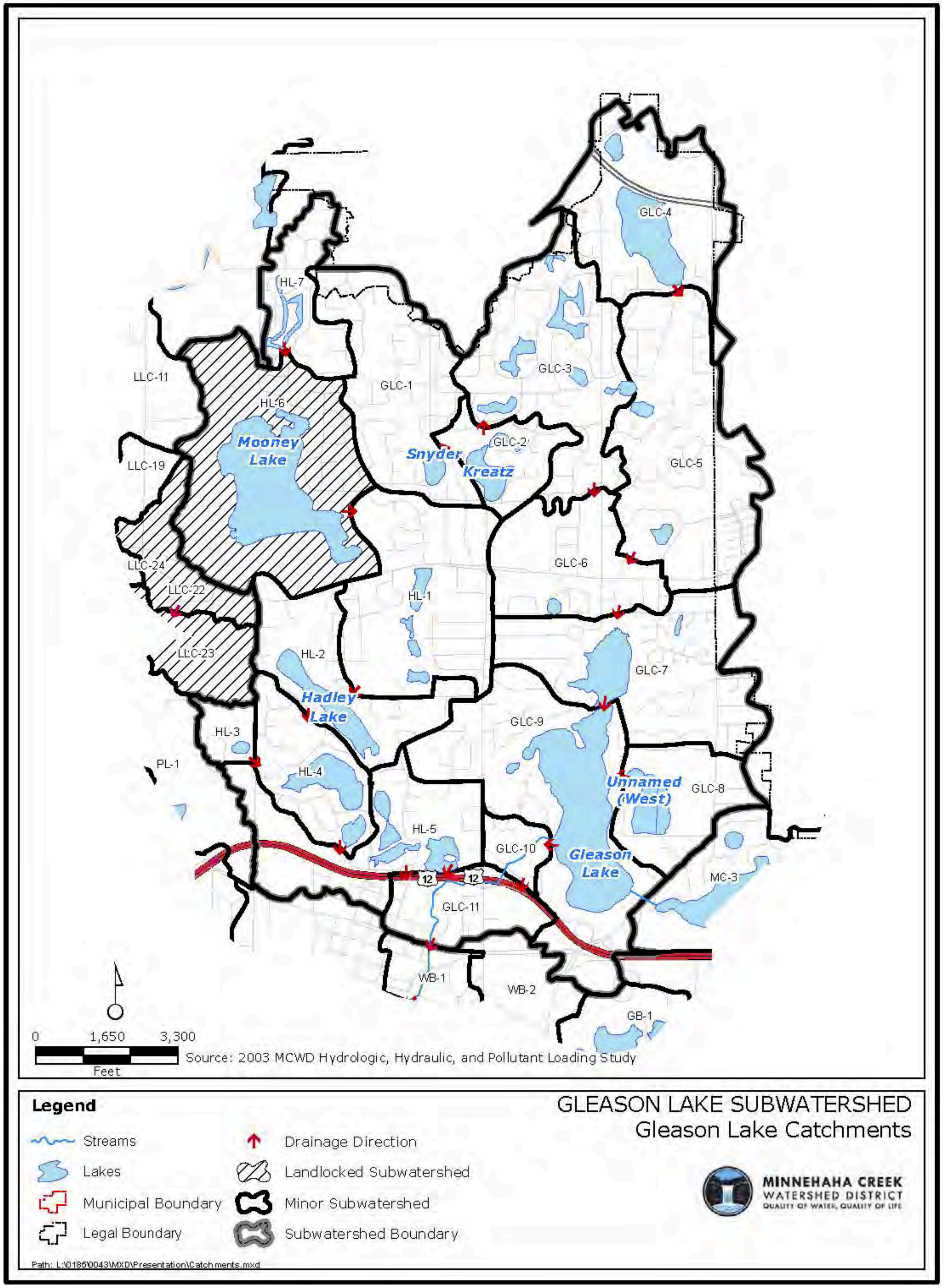

Figure 2. 26. Gleason Lake subwatershed catchments.

Water Quality:

The following are summaries of the characteristics and classifications of lakes and streams within the subwatershed including water quality goals and trends.

Lakes:

Gleason Lake is the primary receiving water within the subwatershed, and is classified by the DNR for shoreland management purposes as a Recreational Development lake (Table 2.31). Other large water resources in the subwatershed are Hadley, Kreatz, Mooney and Snyder Lakes (Figure 2.27).

Four lakes in the subwatershed are listed on the State's Impaired Waters list, with average summer nutrient concentrations greater than the state standard: Gleason, Hadley, Mooney and Kreatz (Snyder) Lakes. There are discrepancies in the naming of Kreatz and Snyder lakes between the MCWD, DNR, and MPCA that are being resolved. The larger lake to the east is Kreatz but is listed as Snyder in the impaired waters list and the Upper Minnehaha Creek Watershed Lakes TMDL.

To assess long-term change in Gleason Lake, a Mann-Kendall statistical trend test was performed on total phosphorus (TP), chlorophyll-a (Chl-a), and Secchi depth data from 2001-2015. There were no statistically significant changes in water quality in Gleason Lake during this period. Tables 2.31 and 2.32 below detail the physical and water quality characteristics of Gleason Lake and other lakes within the subwatershed. For more information regarding water quality in the subwatershed, please refer to the District's annual Water Quality Reports and the Upper Minnehaha Creek Watershed Lakes TMDL.

Table 2. 31. Physical characteristics of lakes in the Gleason Lake subwatershed.

Lake	Surface Area (acres)	Maximum Depth (ft)	Watershed to Lake Area Ratio	DNR Classification
Gleason	164	16	16:1	Recreational Development
Hadley	22	n/a	24:1	Recreational Development
Snyder	9	12	42:1	Recreational Development
Kreatz	16	7	18:1	Recreational Development
Mooney	117	12	5:1	Recreational Development

Source: Minnesota DNR, MCWD

Table 2. 32. Selected water quality goals and current conditions of lakes in the Gleason Lake subwatershed.

Lake	State TP Standard (µg/L)	2007 Plan Goal TP (µg/L)	Trend**	2001-2015 Average		
				TP (µg/L)	Chl-a (µg/L)	Secchi (m)
Gleason[1]	60	80	No trend	98	51	1.11
Hadley[2]	40	*	n/a	57	16	-
Kreatz[2]	60	*	n/a	72	41	1.0
Snyder	60	*	n/a	198	47	0.79
Mooney	60	n/a	n/a	78	51	1.0

*10% reduction from existing, provided it is greater than 25 µg/L; will require baseline data.
**Statistically significant at ≤ 0.05.
[1]Data are from 2005-2011, as shown in the Upper Watershed Lakes TMDL.
[2]Data are from 2006-2008, as shown in the Upper Watershed Lakes TMDL.
Source: MCWD, Upper Minnehaha Creek Watershed Lakes TMDL, MPCA.

Streams:

County Ditch #15 drains the upper watershed to Gleason Lake. Gleason Creek is the outlet of Gleason Lake and flows to Glenbrook Pond in Wayzata, which is discharged by storm sewer into Wayzata Bay of Lake Minnetonka. Part of the creek was channelized as County Ditch #32 at some unknown past date. Flow in the creek is controlled by an outlet weir on Gleason Lake and is mainly runoff event-driven. The creek flows through five culverts at the US Highway 12/TH 101 interchange (Figure 2.27).

At this time no streams are listed as Impaired Waters. Total phosphorus concentrations on CD #15 at the Gleason Lake inlet are high relative to the state river eutrophication standards. However, those standards also look at other indicators such as chlorophyll-a, diel oxygen flux, and biological oxygen demand that haven't been assessed in CD #15.

Table 2.33 shows the average TSS concentrations in Gleason Creek and CD #15 to be well below the 30 mg/L state standard for this ecoregion. Maintaining sufficient dissolved oxygen (DO) is necessary to support aquatic life. The DO state standard requires the stream to never fall below 5 mg/L DO. Monitoring data show that Gleason Creek can fall below this standard in summer during periods of no or low flows.

To assess long-term change in Gleason Lake Outlet station, a Mann-Kendall statistical trend test was performed on flow-corrected TP and TSS data from 2005-2015. There were no statistically significant changes in water quality in Gleason Lake Outlet during this period (Table 2.34). Tables 2.33 and 2.34 below detail the physical and water quality characteristics of streams and tributaries within the subwatershed. For more information please refer to the District's Water Quality (Hydrodata) reports.

Table 2. 33. Major streams in the Gleason Lake subwatershed.

Stream	Length (mi)
Gleason Creek	0.87
County Ditch #15	2.47
County Ditch #32	1.01

Table 2. 34. Current conditions of streams in the Gleason Lake subwatershed.
See Figure 2.27 for monitoring locations.

Stream	Trend*	2005-2015 Summer Average			
		TP (µg/L)	TN (mg/L)	TSS(mg/L)	Cl (mg/L)
Gleason Creek (CGL01) – lake outlet	No trend	53	0.69	5	101**
CD #15 (CGL03) – lake inlet	n/a	150	0.891	12	130***

TP = total phosphorus, TN =total nitrogen, TSS = total suspended solids, Cl = chloride.
*Statistically significant at ≤ 0.05, **Data are from 2009-2015; ***Data are from 2008-2015.
Source: MCWD.

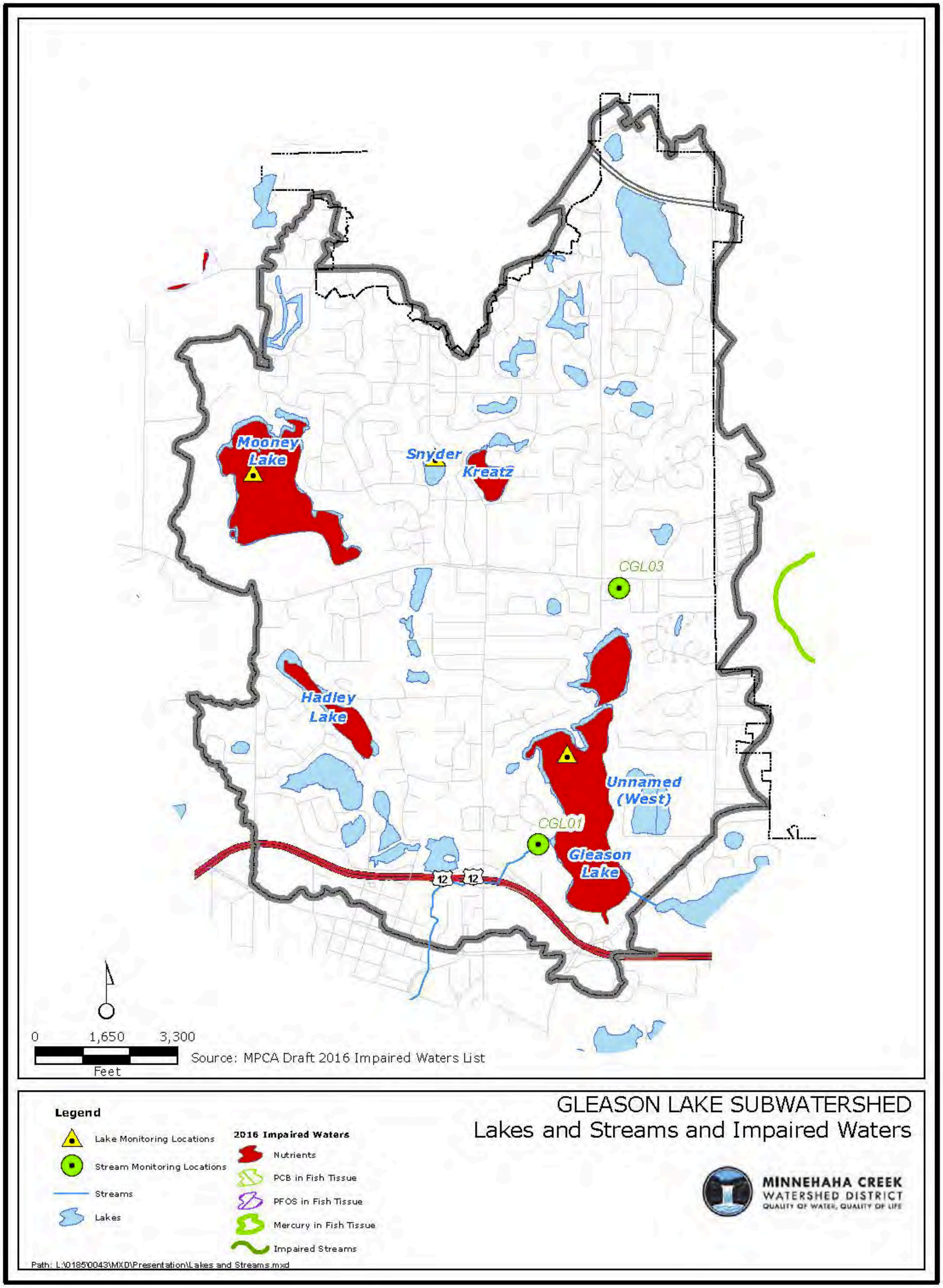

Figure 2. 27. Gleason Lake subwatershed lakes and streams and Impaired Waters.

Wetlands:

According to the FAW, wetlands, including lakes, cover 13.9 percent of the watershed's surface (Figure 2.28 and Table 2.35). A delineation of wetland boundaries is required to be completed any time development or other impacts may occur near or in a wetland. For more information regarding wetlands in the subwatershed, please refer to the *2007 MCWD Comprehensive Water Resources Management Plan*.

No data are available yet to evaluate the ability of the wetlands in the subwatershed to cycle nutrients to and from the subwatershed. E-Grade will assess wetland soil chemistry, overall vegetative conditions, presence or absence of algal blooms, and condition of the buffer and area within 500 feet of the wetlands.

Table 2. 35. Functional Assessment of Wetlands inventory of wetland types in the Gleason Lake subwatershed.

FAW Circular 39 Wetland Type	Area (acres)	Percent
1 - Seasonal	12.8	0.34
2 - Wet Meadow	15.4	0.41
3 - Shallow Marsh	231.6	6.22
4 - Deep Marsh	18.1	0.49
5 - Open Water	153.0	4.11
6 - Scrub Shrub	9.8	0.26
7 - Forested	76.6	2.06
8 – Bog	-	-
Riverine	-	-
Wetland Total	517.3	13.9
Upland	3,198.8	86.1
TOTAL	3,716.1	

Source: MCWD Functional Assessment of Wetlands.

Groundwater:

The District's roles in managing groundwater are to 1) promote surficial groundwater recharge to protect wetland hydrology and stream baseflow, and 2) assist in protecting deeper aquifers used for drinking water by limiting infiltration in sensitive recharge areas.

The infiltration potential of the upland areas within the subwatershed is described as medium to low with some areas of variability where the soils are organic in nature. The *Hennepin County Geologic Atlas* classifies area to the north of Gleason Lake as high infiltration potential and also high aquifer sensitivity due to the outwash nature of the underlying soil deposits.

The entire Gleason Lake subwatershed has been designated by the Minnesota Department of Health as a Drinking Water Supply Management Area (DWSMA) and Wellhead Protection Area (WHPA) for City of Plymouth public wells. The MDH has designated areas within the DWSMA as high to moderate risk and vulnerability to contamination of the drinking water supply. Figure 2.29 shows areas in the subwatershed with groundwater sensitivity and that are designated as higher Drinking Water Sensitivity.

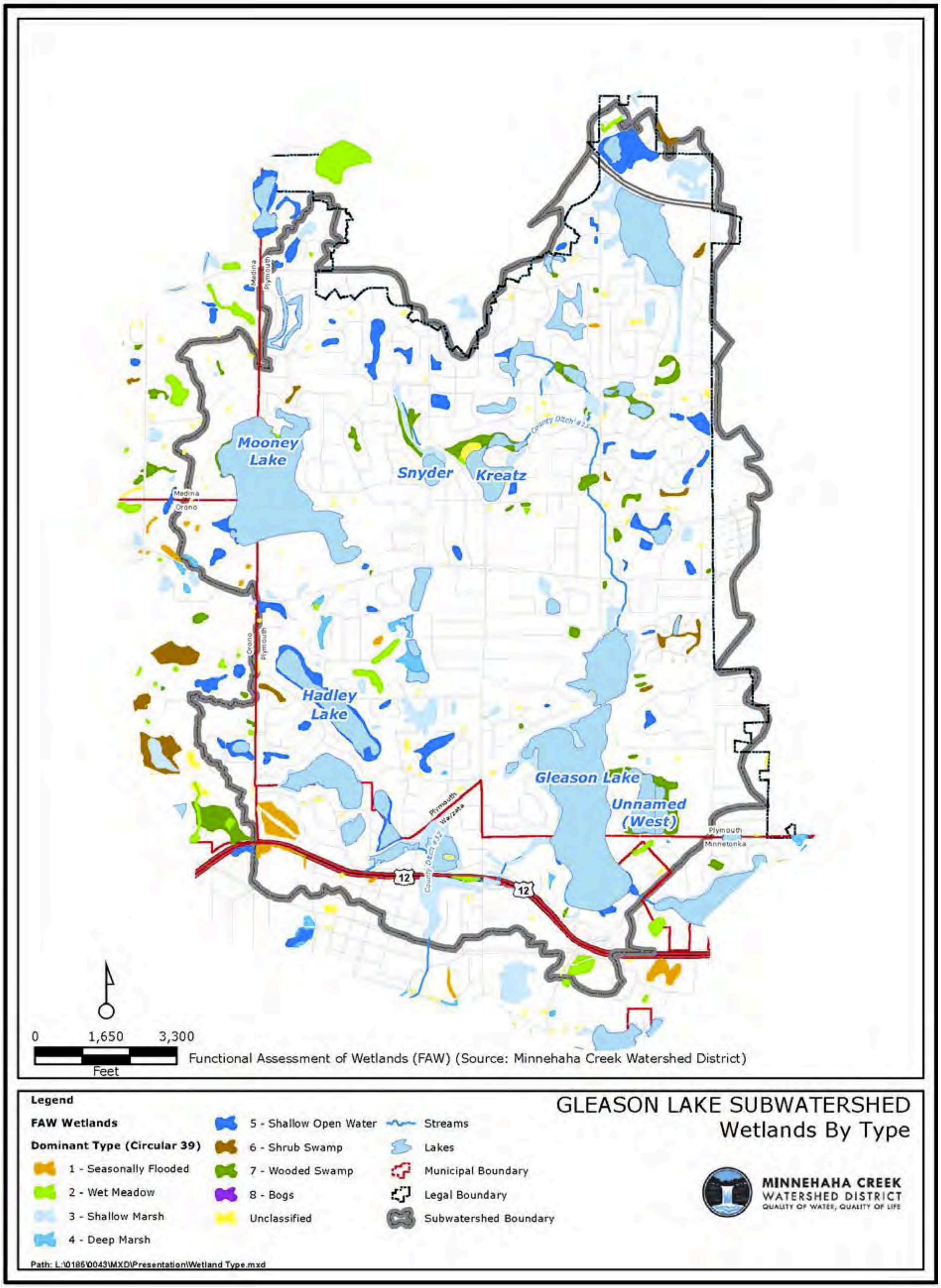

Figure 2. 28. Gleason Lake subwatershed wetlands by type.

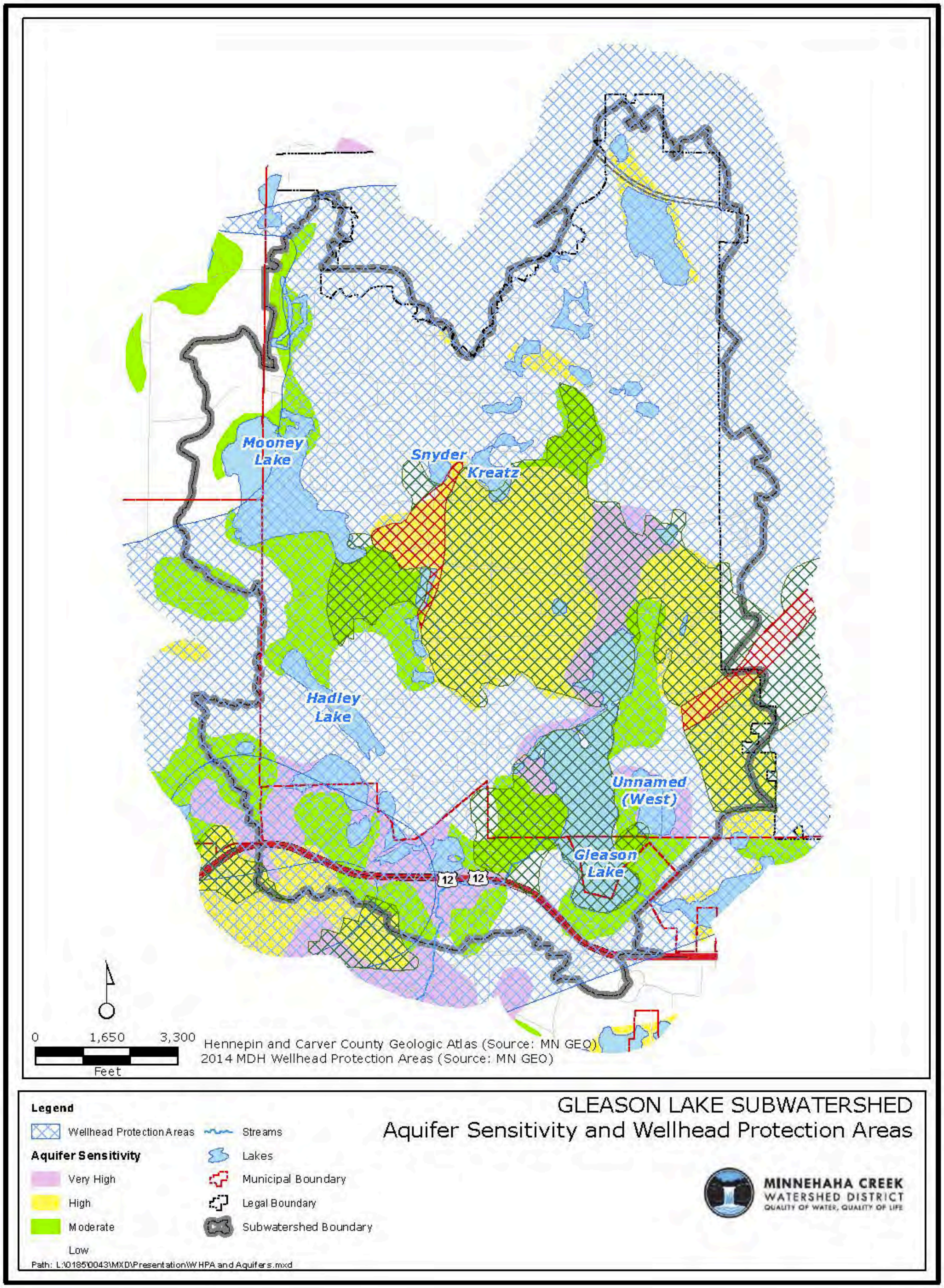

Figure 2. 29. Gleason Lake subwatershed aquifer sensitivity and Wellhead Protection Areas.

Water Quantity:

Mooney Lake basin is landlocked and pumps water out of the basin once the lake reaches a certain elevation towards HL-1 (Figure 2.26). No statistical assessment on water-yield was computed for the Gleason Lake Subwatershed.

Ecological Integrity:

The E-Grade program defines watershed ecological integrity as the degree to which the watershed provides three key ecosystem services: biodiversity, habitat diversity, and nutrient cycling. Nutrient cycling is described in the Water Quality section. The Gleason Lake subwatershed has not yet been evaluated by the E-Grade program. This section summarizes ecological integrity using existing data, where available (Figure 2.30).

Lakes:

Biodiversity

Fish Community. The most recent fish survey for Gleason Lake was conducted in 2011 for the City of Plymouth. It identified a fishery dominated by bluegills and yellow bullheads. Pumpkinseed sunfish and black crappies were also found in above-average numbers. In 2016, a fish survey indicated Mooney Lake has a healthy fish community. No fish survey data are available for the other lakes.

In 2007, the District completed fish and macroinvertebrate sampling on Gleason to assess the impact of whole-lake Curly leaf Pondweed treatments. Fish and invert IBI protocols were still in development at the time, so while IBI scores were computed they are similar to but not directly comparable to the current IBI protocols and metric scores used in the E-Grade program.

Fish sampling found bluegills to be the dominant species, with top predators underrepresented. Gleason Lake had a low IBI score based on the existing fish community. However the IBI score was within the expected range for lakes with similar trophic status and dominant watershed land use.

Aquatic Vegetation Community. Biodiversity is determined by the number and variety of species, or richness. No Floristic Quality Index data are available. An aquatic vegetation survey was completed in 2002 by Blue Water Science for the Gleason Lake Management Plan. Gleason Lake is almost entirely littoral (less than about 15 feet deep), with extensive aquatic vegetation dominated by coontail. Curly leaf pondweed was detected at one-third of the stations sampled in the lake at nuisance densities. A whole-lake treatment was applied to the lake in 2007, followed by spot treatments. Just prior to treatment curly leaf pondweed was found at 8 of the 27 sample stations in the small north basin and at 101 of the 127 sample stations in the main lake, at an average of 817 stems/m^2 before treatment, well above the nuisance threshold of 100 stems/m^2 . Following treatment, curly leaf pondweed was found at only 1 of 27 sample stations in the north basin and 1 of 127 stations in the main lake. Curly leaf has not been eradicated from the lake, but it has been substantially reduced. A more recent survey was performed in 2014, and a total of 6 species were found with coontail dominating the community.

Aquatic Invasive Species: Curlyleaf pondweed has been confirmed in Gleason Lake and Mooney Lake.

Habitat diversity

Aquatic Vegetation Community. Habitat diversity is determined by the percent occurrence of species, or the extent to which it may be dominated by a few species. Gleason Lake is almost entirely littoral (less than about 15 feet deep), with extensive aquatic vegetation dominated by coontail. Whole-lake and spot herbicide treatments appear to have controlled the previously nuisance-level of curly leaf pondweed.

Shoreline Health. Shoreline health is assessed looking at shoreline vegetative cover and the relative human disturbance. The MnDNR is using the Score The Shore protocol to relate shoreline conditions to fish community structure using the fish IBI metric. No Score The Shore data are available. Much of the shoreline around the lakes within this subwatershed is developed, with homes maintaining turf grass to the shoreline and scattered stands of emergent vegetation.

Macroinvertebrate Community. Macroinvertebrates were sampled in Gleason Lake in 2007 and 2012 using the MPCA's protocol for monitoring depression wetlands. At the time the MPCA's threshold of impairment was an IBI of 36 on a 100 point scale. The mean of four locations sampled on Gleason Lake was 47.5. In 2012, when sampling was repeated following whole-lake treatment of curly-leaf pondweed, the IBI threshold was 47. IBI scores at the four Gleason Lake locations ranged from a high of 50 to a low of 26, indicating impairment. It was hypothesized that following treatment the native plant community had not yet reestablished, and thus the lake lacked sufficient habitat to maintain a diverse invertebrate population.

Streams:

Biodiversity

Fish Community. No fish data are available for streams in the subwatershed.

Macroinvertebrate Community. Biological sampling on Gleason Creek was conducted as a part of the *2004 Upper Watershed Stream Assessment.* Two sites were sampled; only one yielded more than the 100 organisms typically needed to assure sample reliability. The H-IBI fell into the Poor category. Seven taxa of organisms were found, dominated by pollution-tolerant species. In 2013 the invertebrate sampling was replicated. The two sites scored 14 and 18 on a 100-point scale, falling well below the M-IBI impairment threshold of 43. The samples were dominated by pollution-tolerant species, and lacked representation from a broad range of functional feeding groups.

Aquatic Invasive Species: No AIS data are available for streams in the subwatershed.

Habitat diversity

Habitat Complexity. No Minnesota Stream Habitat Assessment data are available to assess habitat complexity. However, notes taken for the *2004 Upper Watershed Stream Assessment* were reviewed to better understand conditions in the in-stream zone and riparian zone, and to assess channel morphology. That survey divided the stream into 5 reaches. The survey found that the stream in some locations had moderately complex habitat and morphology, but in general the stream is less complex and more altered.

Connectivity. Connectivity is defined by two metrics: presence or absence of barriers, and access to floodplain. Barriers such as dams, weirs, and culverts limit or prevent organisms from moving freely in the stream. That survey divided the stream into 5 reaches, with the predominance of barriers located within reach 4. There are several barriers on the streams in this subwatershed, most of them are storm sewer outfalls, and culverts at road or trail crossings and where the stream crosses under Highway 12/101 interchange. There are no stream cross-section data available, but notes taken for the 2004 Upper Watershed Stream Assessment indicate the stream generally has low banks and direct access to ponds and wetlands.

Water Quality. Water quality factors impacting stream habitat diversity include concentrations of TSS and DO. Higher TSS concentrations increase turbidity, which can interfere with aquatic predators seeking their prey and which can limit growth of aquatic vegetation. Refer to Water Quality section for data.

Hydrology Indicators. Stream hydrology is an important factor in habitat diversity. A stream that is very flashy, that is, one that rises and falls very quickly in response to rain events, can be stressful to organisms. In addition, streams that periodically are dry or have minimal flow are hostile to aquatic life. Continuous streamflow data are not available, but based on observation, both Gleason Creek and CD #15 do run dry at times in the summer.

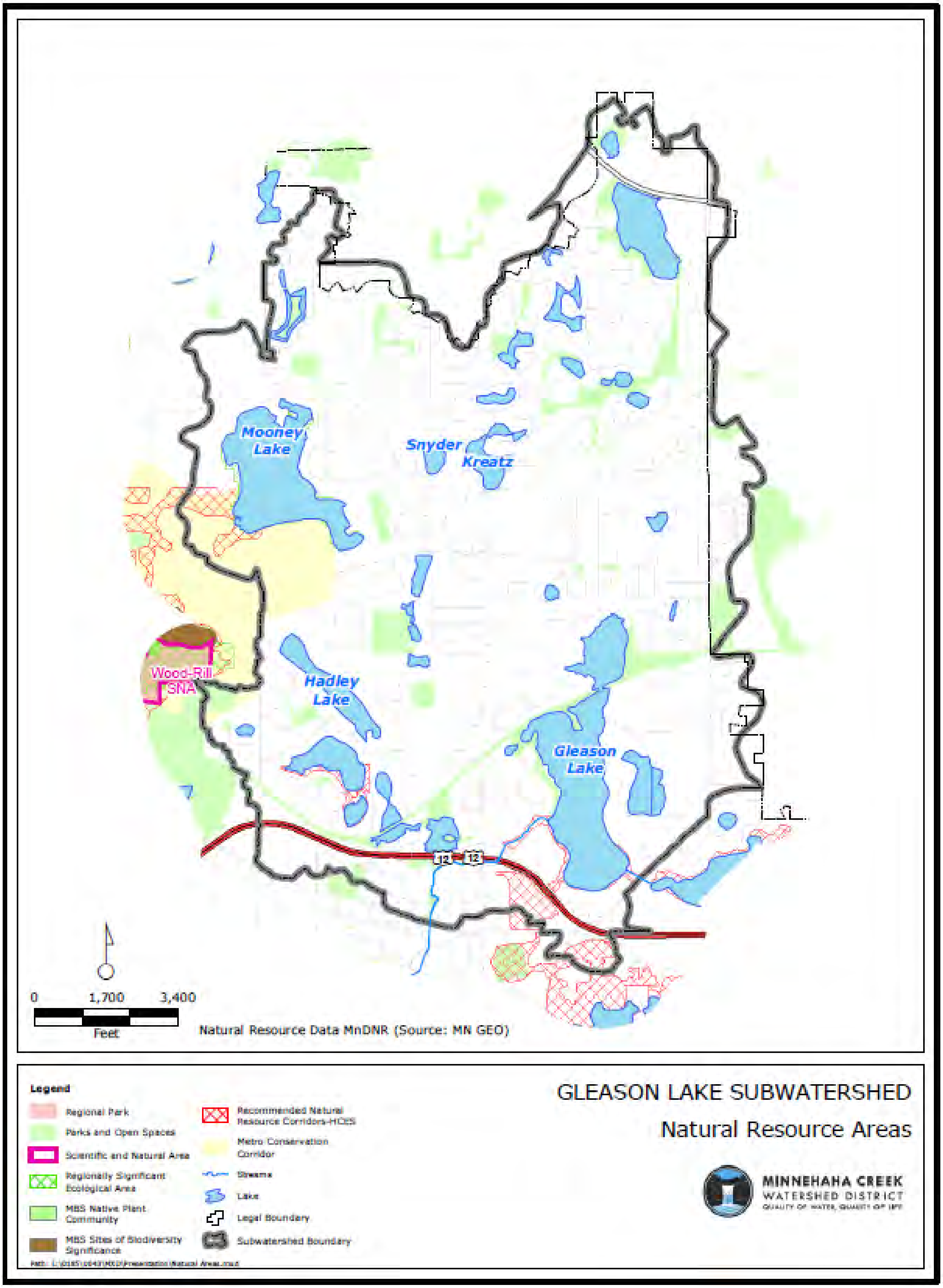

Figure 2. 30. Gleason Lake subwatershed natural resource areas.

Wetlands:

Biodiversity

Vegetation Community. No Floristic Quality Index data are available for the wetlands in this subwatershed. However some scattered wetlands were identified in the *Functional Assessment of Wetlands* as having high vegetative diversity and wildlife habitat potential as well as having high aesthetic values. Wetlands riparian to Gleason Lake were noted as important fish habitat.

Habitat diversity

Connectivity. Some scattered wetlands were identified in the 2003 MCWD *Functional Assessment of Wetlands* (FAW) as having high vegetative diversity and wildlife habitat potential as well as having high aesthetic values. Wetlands in this subwatershed have little to no connectivity.

Size. Larger wetlands are more likely to support a notable on-site diversity and/or abundance of wildlife species. There are a few large wetlands in the subwatershed, to the east and west of Gleason Lake and another south of TH 55.

Shoreline Protection. Riparian wetlands can provide significant shoreline protection and support emergent vegetation at the shoreline. The *Functional Assessment of Wetlands* evaluated riparian wetlands for their ability to protect lake or stream shoreline. Approximately half of the Gleason Lake shoreline is identified as probable wetlands under the National Wetland Inventory (NWI) however most of that area is residential development with a very narrow band of emergent vegetation at the shoreline.

Uplands:

Biodiversity

Existing data sources do not highlight any other unique or scenic areas in this subwatershed. The Gleason Lake Creek subwatershed is mostly developed, with few intact areas of minimal disturbance. The Minnesota Biological Survey (MBS) did not identify any landscape areas of biological significance in this subwatershed, although the Wood-Rill Scientific and Natural Area is just outside of this subwatershed in Orono. Some wooded and wetland areas around Hadley Lake and a few pocket wetlands and wooded areas elsewhere in the subwatershed provide the most significant areas of habitat and biological integrity (Figure 2.30).

Habitat diversity

Regionally significant ecological areas are places where larger tracts of minimally disrupted land provide habitat complexity. Most of the Gleason Lake subwatershed is fully developed with limited upland areas in a natural state. Some wooded and wetland areas around Hadley Lake and a few pocket wetlands and wooded areas elsewhere in the subwatershed provide the most significant areas of habitat and biological integrity.

Thriving Communities:

Land use:

Table 2.34 below shows the land uses within the area of the Gleason Lake subwatershed in acres and as a percentage of the total subwatershed. The predominant land use in the subwatershed is single-family residential (Figure 2.31). There is a commercial/industrial corridor along TH 55 and Vicksburg Lane in the upper subwatershed, and another commercial node at TH 101 and County Road 5. Some small pockets of undeveloped area remain, mainly large lots.

A small corner of the subwatershed in the City of Orono is outside the MUSA 2020 area.

Table 2. 36. 2016 land use in the Gleason Lake subwatershed.

Land Use 2016	Acres	% of Subwatershed
Single - Family Residential	2,525.5	57.9
Water	402.4	9.2
Parks and Open Space	341.6	7.8
Multi - Family Residential	326.9	7.5
Vacant or Undetermined	299.0	6.8
Institutional	193.5	4.4
Commercial	125.9	2.9
Roads and Highways	101.4	2.3
Industrial	24.9	0.6
Agricultural	24.2	0.6

Source: Metropolitan Council.

Recreation:

The Luce Line Regional Trail passes through this subwatershed, crossing the north end of Gleason Lake. Existing data sources do not highlight any other unique or scenic areas in this subwatershed. The Minnesota Historic Features database notes 15 historic features in this subwatershed, all farmhouses or residences (Figure 2.32). There is no public boat access, beach or parks on Gleason Lake other than the regional trail crossing and none on the other lakes in the subwatershed.

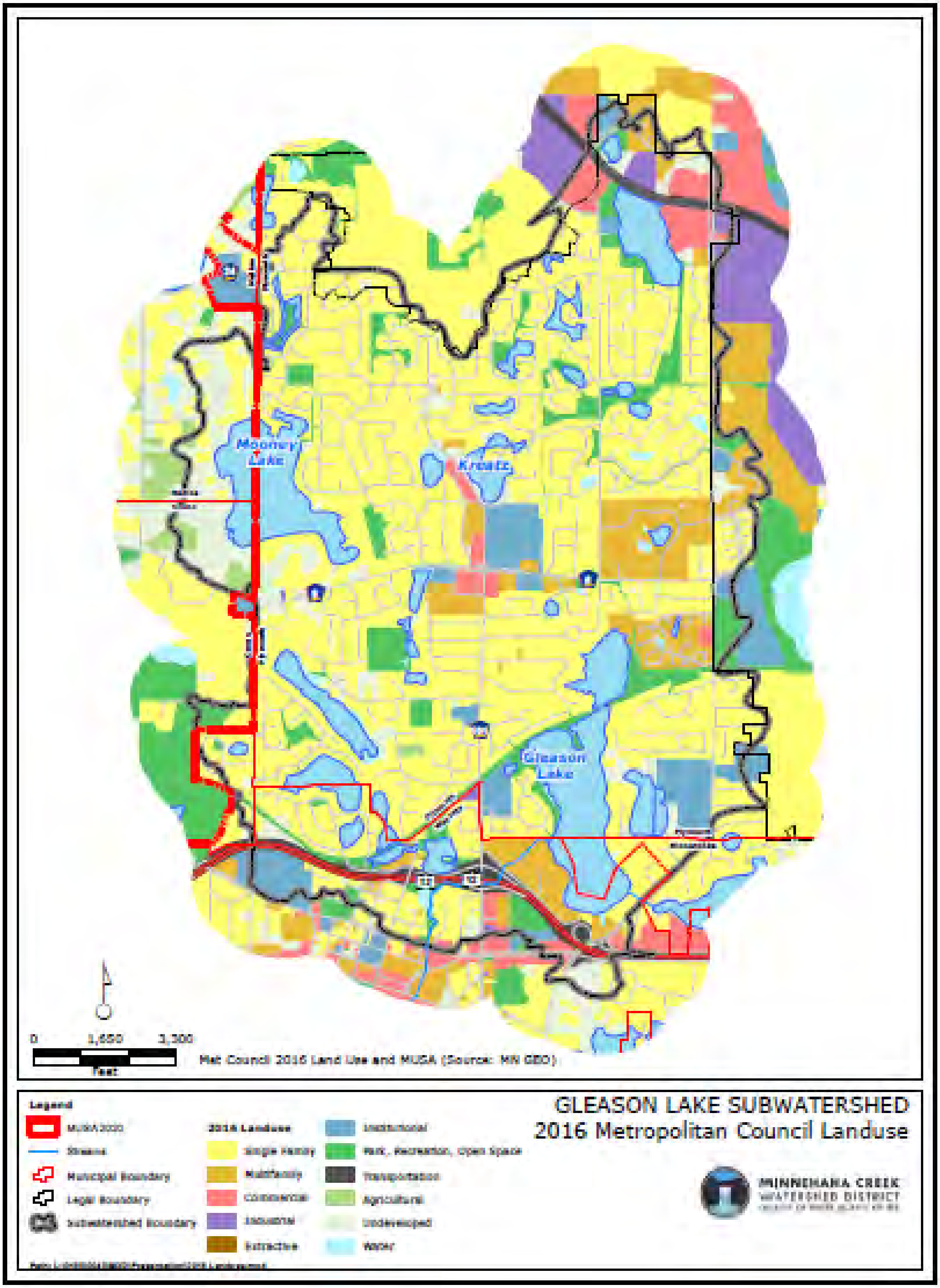

Figure 2. 31. Gleason Lake subwatershed 2016 Metropolitan Council land use.

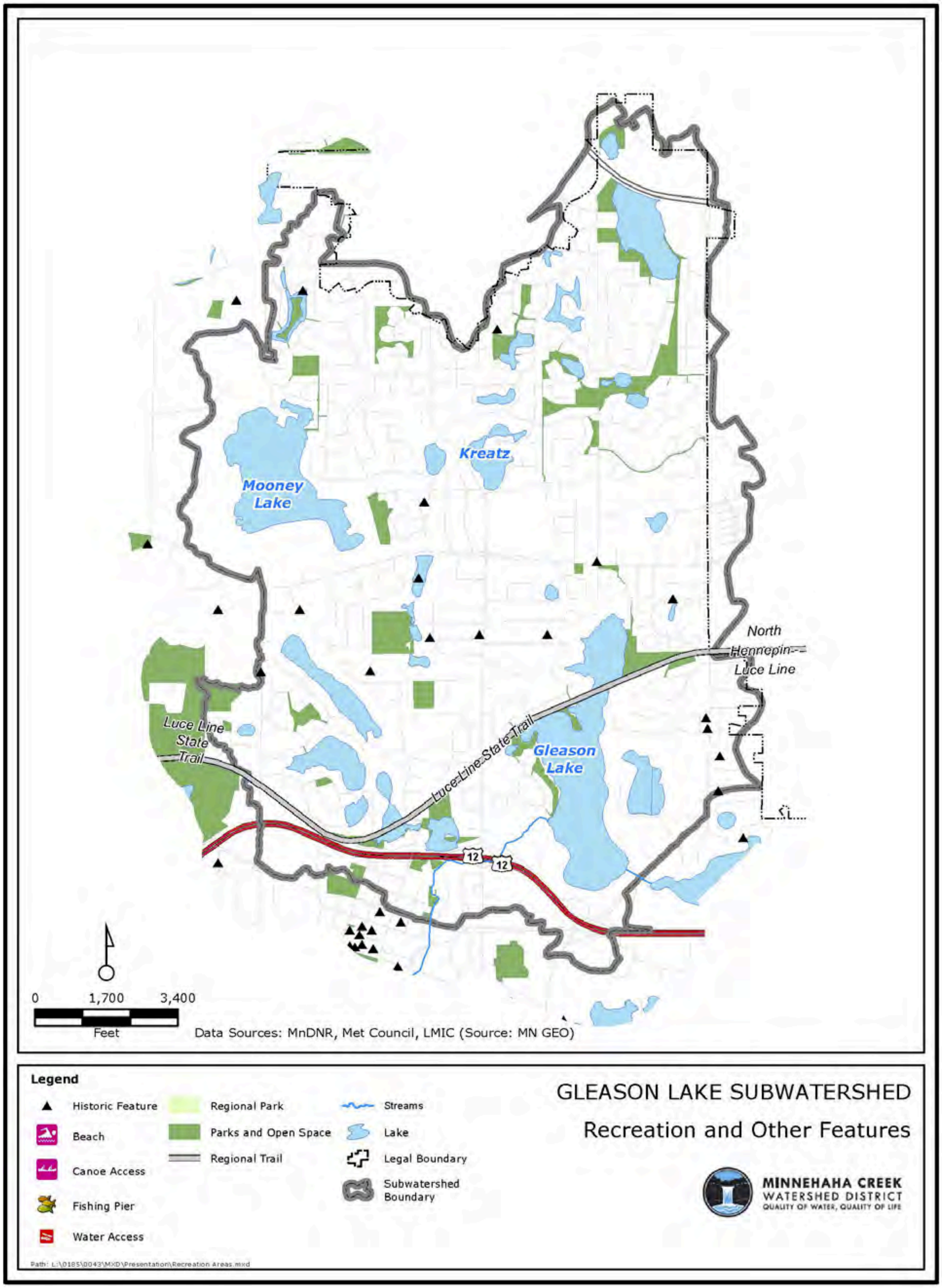

Figure 2. 32. Gleason Lake subwatershed recreation and other features.

2.3.4 LAKE MINNETONKA SUBWATERSHED

The land cover in the Lake Minnetonka Subwatershed is comprised of lakes, wetlands and scattered pockets of forest, woodlands and grasslands. Single-family residences, marinas, sailing schools, and restaurants are concentrated along the shorelines. Agricultural uses exist on the western boundary of the subwatershed in the vicinity of Halsted Bay, Jennings Bay, North Arm and Stubbs Bay.

Unlike the other subwatersheds in the MCWD, the Lake Minnetonka Subwatershed receives direct drainage from nine major sources. The health and function of Lake Minnetonka is not only affected by these creek inlets, but also affected by aquatic invasive species. Lake Minnetonka was one of the first lakes in the Watershed District to be infested with Eurasian watermilfoil and zebra mussels.

Table 2.37 shows the area of the Lake Minnetonka subwatershed in acres by individual city, in total, and as a percentage of the total subwatershed (Figure 2.33).

Table 2. 37. Cities in the Lake Minnetonka subwatershed.

City	Area (Acres)	% of Subwatershed
Chanhassen	146.8	0.4%
Deephaven	1,993.6	6.1%
Excelsior	551.5	1.6%
Greenwood	660.7	2.0%
Long Lake	4.5	<0.1%
Minnetonka	722.0	2.2%
Minnetonka Beach	981.4	3.0%
Minnetrista	5,153.8	15.8%
Mound	2,543.2	7.8%
Orono	10,740.1	33.0%
Shorewood	3,912.2	12.0%
Spring Park	387.2	1.1%
Tonka Bay	1,346.2	4.1%
Victoria	293.2	0.9%
Wayzata	2,336.4	7.1%
Woodland	741.8	2.2%
Total	32,515.6	

Source: MCWD.

Subwatershed Description and Hydrology:

Rugged hills or knobs and deep irregular depressions called “kettles” dominate this subwatershed. The many bays, points and islands of Lake Minnetonka are formed from submerged knobs and kettles formed by melted glacial ice. The northwestern subwatershed is identified by thinly spread glacial drift and circular, level-topped hills with low slopes, small streams and numerous lakes and peat bogs. The dominant water feature in this subwatershed is Lake Minnetonka.

Land cover is classified by the Minnesota Land Cover Classification System (MLCCS) (Figure 2.34). Most of the subwatershed is fully developed, although the upper subwatershed includes some large agricultural and forested areas. Wetlands are scattered throughout the subwatershed. For more information regarding geology and soils in the subwatershed, please refer to the *2007 MCWD Comprehensive Water Resources Management Plan*.

Drainage is conveyed from the watershed to the lake through several streams, including Gleason Creek, Long Lake Creek, Classen Creek, Painter Creek, and Six Mile Creek, as well as through smaller channels or storm sewers. The *2003 MCWD Hydrologic, Hydraulic, and Pollutant Loading Study (HHPLS)* subdivided the Lake Minnetonka subwatershed district into 26 subwatershed units and the minor subwatersheds into 19 drainage areas that include from one to six subwatershed units (Figure 2.35).

The subwatershed outlets through a control structure on Grays Bay into Minnehaha Creek. The dam is operated by the District in accordance with the limitations set forth in the Headwaters Control Structure Management Policy and Operating Procedures and Minnesota DNR Permit #76-6240.

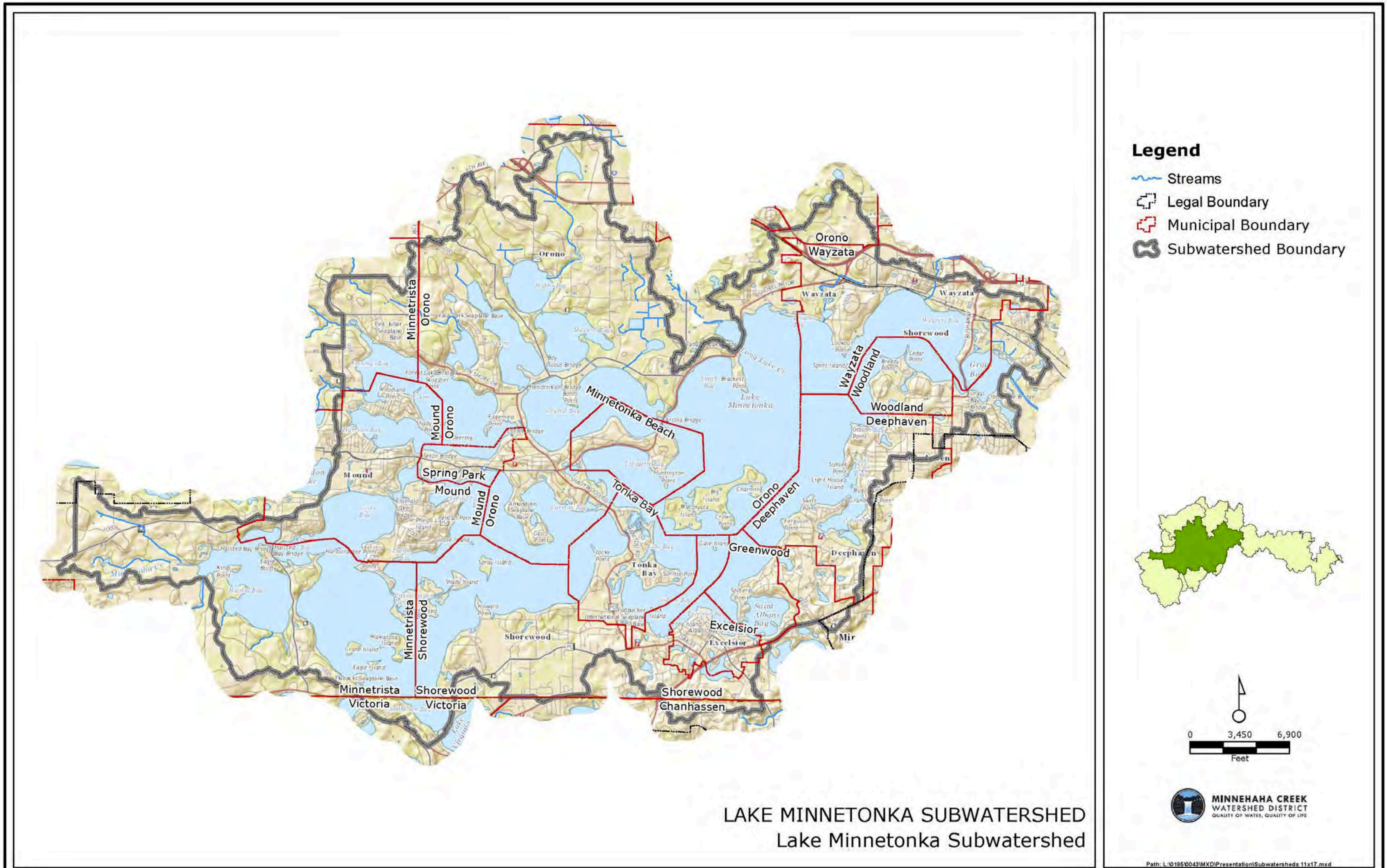

Figure 2. 33. The Lake Minnetonka subwatershed.

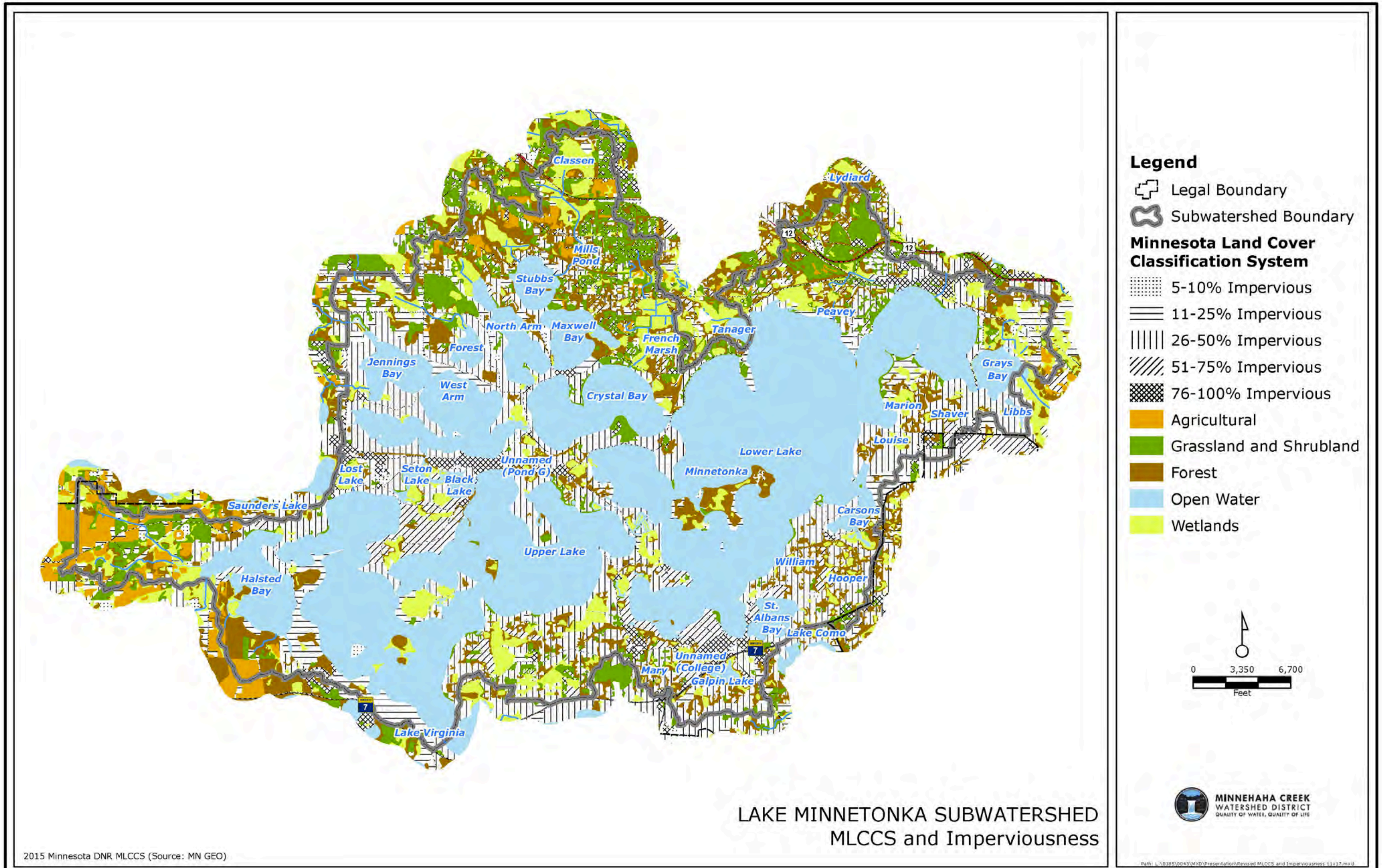

Figure 2. 34. Lake Minnetonka subwatershed MLCCS and imperviousness.

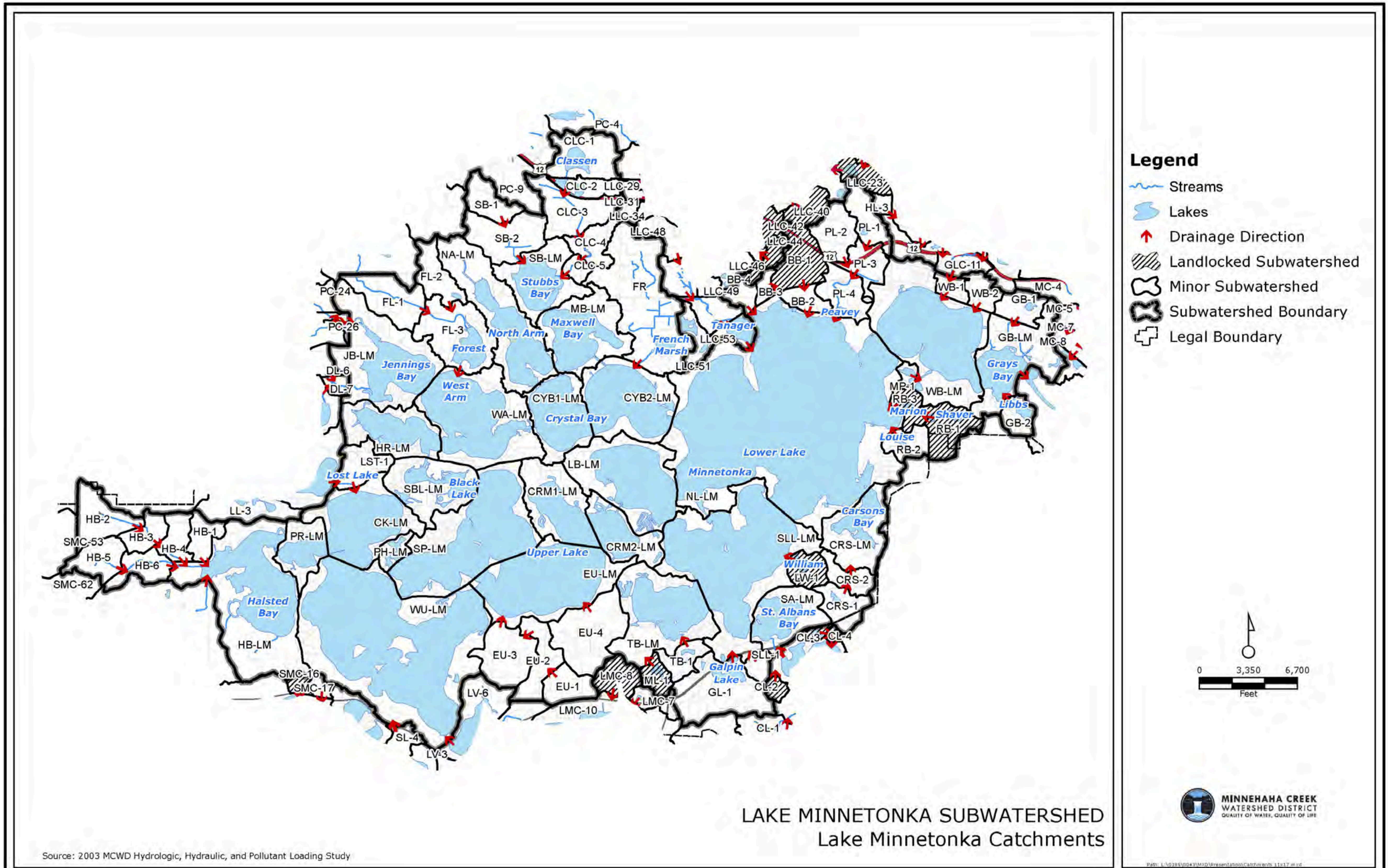

Figure 2. 35. Lake Minnetonka subwatershed catchments.

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Water Quality:

The following are summaries of the characteristics and classifications of lakes and streams within the subwatershed including water quality goals and trends.

Lakes:

The subwatershed is dominated by Lake Minnetonka with its complex configuration of bays and channels. The lake is classified by the DNR for shoreland management purposes as a Recreational Development lake (Table 2.38). There are numerous other smaller lakes in the subwatershed. The District monitors Lake Minnetonka and some small lakes, while several of the small lakes are monitored by trained volunteers. Tables 2.38 and 2.39 below detail the physical and water quality characteristics of Lake Minnetonka and other lakes within the subwatershed.

Four Lake Minnetonka bays (Halsted, Jennings, Stubbs, and West Arm) and Forest Lake exceed the state standard for total phosphorus, and are listed on the State's Impaired Waters list for nutrient/eutrophication biologic indicators. A TMDL completed for those impairments identified a significant amount of excess nutrients discharged into those water bodies from the watershed, as well as load contributed from internal sources such as lake sediments. To assess long-term change, a Mann-Kendall statistical trend test was performed on total phosphorus (TP), chlorophyll-a (Chl-a), and Secchi depth on lakes/bays that had 8 or more years of data. Statistically significant changes in water quality are listed in Table 2.39. For more information regarding water quality in the subwatershed, please refer to the District's annual Water Quality Reports and the Upper Minnehaha Creek Watershed Lakes TMDL.

Table 2. 38. Physical characteristics of lakes in the Lake Minnetonka subwatershed.

Lake	Surface Area (acres)	Maximum Depth (ft)	Watershed to Lake Area Ratio	DNR Classification
Classen Lake	53	3	6:1	Natural Environment
Forest Lake	90	42	10:1	General Development
Lake Galpin	46	13	11:1	Recreational Development
Lake Marion	13	45	26:1	Recreational Development
Lake Minnetonka	14,004	113	5:1	General Development
Libbs Lake	22	8	5:1	Natural Environment
Peavey Pond	9	63	86:1	n/a
Shavers Lake	19	7	12:1	Recreational Development
Lake William	16	12	8:1	Recreational Development

Source: Minnesota DNR.

Table 2. 39. Selected water quality goals and current conditions of waterbodies in the Lake Minnetonka subwatershed.

Waterbody	State TP Standard (µg/L)	2007 Plan Goal TP (µg/L)	Trend**	2001-2015 Average			Years Monitored
				TP (µg/L)	Chl-a (µg/L)	Secchi (m)	
Classen Lake	n/a	n/a	n/a	107	80	0.5	2009-2010
Forest Lake	40	n/a	No trend	63	49	0.9	1996-2015
French Marsh	n/a	n/a	n/a	48	11	0.9	2011-2012
Lake Galpin	60	60	n/a	n/a	n/a	1.4	2011
Hooper Lake	n/a	n/a	n/a	29	10	1.8	2010-2011
Lake Marion	n/a	*	n/a	14	3	3.6	2009-2012
Libbs Lake	60	30	n/a	22	5	1.5	2011-2012
Lake Louise	n/a	*	n/a	47	16	1.8	2006-2008
Peavey Pond	n/a	*	Deg Secchi, TP	89	20	1.9	1999-2015
Shavers Lake	60	*	n/a	42	8	1.2	2001-2015
Lake William	n/a	n/a	n/a	38	8	1.1	2009-2015
Lake Minnetonka Bays							
Black Lake	40	45	No trend	32	14	2.1	2006-2015
Browns	40	20	n/a	n/a	n/a	n/a	n/a
Carman	40	50	No trend	22	8	2.7	2004-2013
Carsons	40	50	Imp Secchi	22	4	3.5	2004-2015
Cooks	40	30	No trend	29	13	2.1	1997-2015
Crystal	40	25-30	Imp Secchi	26	10	2.6	1997-2015
Grays	40	20	Imp Secchi, TP	21	4	3.6	2004-2015
Halsted	40	50-60	No trend	104	62	0.9	1997-2015
Harrisons	40	50	No trend	58	48	0.9	2001-2013
Jennings	40	50-70	No trend	114	69	0.8	2005-2015
Lafayette	40	20	Imp Secchi, Chl-a	21	5.4	3.5	1997-2015
Lower Lake North	40	20	No trend	20	5	4	2005-2013
Lower Lake South	40	20	All Imp	19	5	3.7	1997-2015
Maxwell	40	40	No trend	32	14	1.9	1997-2015
North Arm	40	30	No trend	31	13	1.9	2001-2013
Phelps	40	20	n/a	24	7	3.3	2006-2013
Priests	40	30	Deg Chl-*a*	27	38	1.4	2006-2016
Robinsons	40	30	n/a	n/a	n/a	n/a	n/a
St. Albans	40	20	All Imp	20	4	4	1997-2015
St. Louis	40	50	n/a	n/a	n/a	n/a	n/a
Smithtown	40	n/a	No trend	22	8	2.5	2004-2013
Spring Park	40	20	Imp Secchi, TP	22	7	3.2	2006-2015
Stubbs	40	50-55	No trend	47	52	0.9	2006-2015
Wayzata	40	20	Imp Secchi	21	4	3.7	1997-2015
West Arm	40	50	No trend	72	54	1	1997-2015
West Upper	40	25	No trend	26	8.7	2.6	1997-2015

*10% reduction from existing, provided it is greater than 25 µg/L; will require baseline data
*Statistically significant at ≤ 0.05, Imp = improving, Deg = degrading.
Source: MCWD, MPCA, City of Minnetonka.

Streams:

There is one primary stream within the subwatershed: Classen Creek, which flows 1.9 miles from Classen Lake to Stubbs Bay. Two other small streams flow out of wetlands and into Stubbs Bay and Forest Lake. Several other small streams and channels provide drainage and local conveyance within the subwatershed.

At this time Classen Creek is not listed as an Impaired Water, but does exhibit TP concentrations that are high relative to the state river eutrophication standards. However, those standards also look at other indicators such as chlorophyll-a, diel oxygen flux, and biological oxygen demand that haven't been assessed. CST01 and CFO01 are both short wetland outlet channels discharging into Stubbs Bay and Forest Lake, respectively, and would not likely be assessed by the MPCA for potential impairment. Each of these streams is likely contributing significant nutrients loads to their respective receiving waters. Table 2.40 below details the water quality characteristics of streams and tributaries within the subwatershed.

The average TSS concentrations at monitoring stations in the subwatershed are well below the 30 mg/L state standard. Maintaining sufficient dissolved oxygen (DO) is necessary to support aquatic life. The DO state standard requires the stream to never fall below 5 mg/L DO. Monitoring data show that DO at the Classen Wetland and Forest Lake inlet stations both fall below the standard multiple times per year, as does the Classes Creek upstream station .

To assess long-term change, a Mann-Kendall statistical trend test was performed on flow-corrected TP and TSS data from 2005-2015. There is a statistically significant increase in TP concentrations during this period at Classen Wetland Creek (CST01) that drains into Stubbs Bay. For more information, please refer to the District's Water Quality reports.

Table 2. 40. Current conditions of streams in the Lake Minnetonka subwatershed.
See Figure 2.36 for monitoring locations.

Stream	Trend*	2005-2015 Summer Average			
		TP (µg/L)	TN (mg/L)	TSS (mg/L)	Cl (mg/L)**
Classen Creek (CCL04)	n/a	163	1.46	8	59
Classen Creek at Stubbs Bay Inlet (CCL01)	No trend	193	1.34	20	60
Classen Wetland Cr at Stubbs Bay Inlet (CST01)	Deg TP	277	1.47	7	48
Forest Lake Inlet (CFO01)	No trend	232	0.97	6	91

*Statistically significant at ≤ 0.05, Deg = degrading, **Data from 2008-2015
Source: MCWD.

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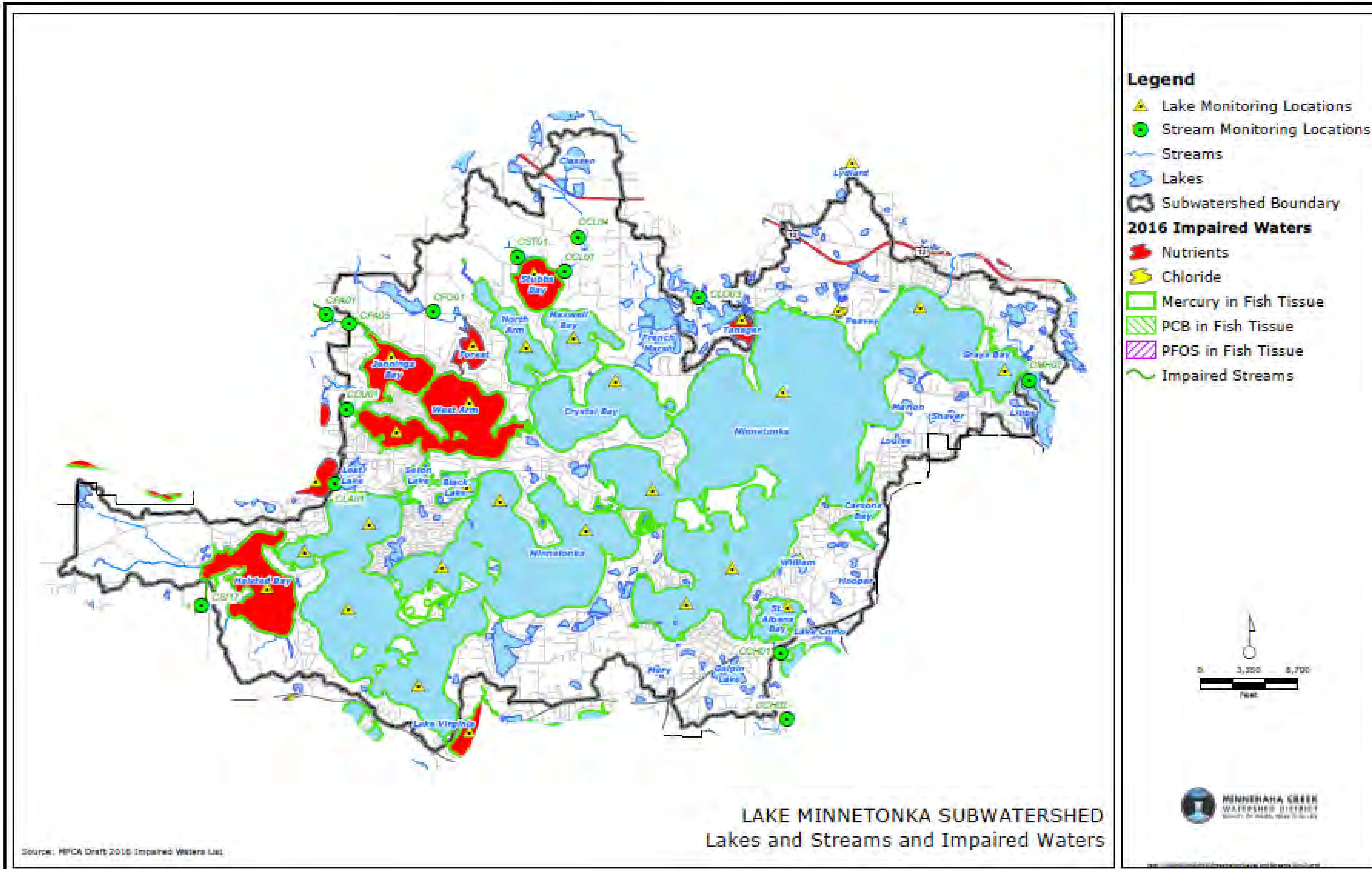

Figure 2. 36. Lake Minnetonka subwatershed lakes and streams and Impaired Waters.

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Wetlands:

According to the FAW, wetlands, including lakes, cover nearly 13.7 percent of the watershed's surface (Figure 2.37 and Table 2.41). A delineation of wetland boundaries is required to be completed any time development or other impacts may occur near or in a wetland. For more information regarding wetlands in the subwatershed, please refer to the *2007 MCWD Comprehensive Water Resources Management Plan*.

No data are available yet to evaluate the ability of the wetlands in the subwatershed to cycle nutrients. E-Grade will assess wetland soil chemistry, overall vegetative conditions, presence or absence of algal blooms, and condition of the buffer and area within 500 feet of the wetlands.

Table 2. 41. Functional Assessment of Wetlands inventory of wetland types in the Lake Minnetonka subwatershed.

FAW Circular 39 Wetland Type	Area (acres)	Percent
1 – Seasonal	71.9	0.40
2 - Wet Meadow	269.1	1.49
3 - Shallow Marsh	1,148.3	6.35
4 - Deep Marsh	562.6	3.11
5 - Open Water	181.3	1.00
6 - Scrub Shrub	163.2	0.90
7 – Forested	72.8	0.40
8 – Bog	2.5	0.01
Riverine	6.9	<0.1
Wetland Total	2,478.5	13.7
Upland	15,661.8	86.3
TOTAL	18,140.3	

Source: MCWD Functional Assessment of Wetlands.

Groundwater:

The District's roles in managing groundwater are to 1) promote surficial groundwater recharge to protect wetland hydrology and stream baseflow, and 2) assist in protecting deeper aquifers used for drinking water by limiting infiltration in sensitive recharge areas.

The infiltration potential of the upland areas in the subwatershed are described as low to medium. A large area of high infiltration potential in the eastern subwatershed is associated with an area of sandy till and glacial outwash deposits. The *Hennepin County Geologic Atlas* classifies that till and outwash area, which is most of the area south of Wayzata Bay and much of the city of Wayzata, as well as the south side of the lower lake as being highly or very highly sensitive to pollution. Most of the upland areas are of low sensitivity to pollution.

Parts of the subwatershed have been designated by the Minnesota Department of Health as Drinking Water Supply Management Areas (DWSMA) and Wellhead Protection Areas for various municipal wells. While there are areas of high aquifer sensitivity in these DWSMAs, the MDH has generally designated them to be of low risk and low vulnerability to contamination of the drinking water supply, with only a few areas designated as moderately vulnerable. Figure 2.38 shows areas in the subwatershed with groundwater sensitivity, designated Wellhead Protection Areas, and areas with moderate vulnerability.

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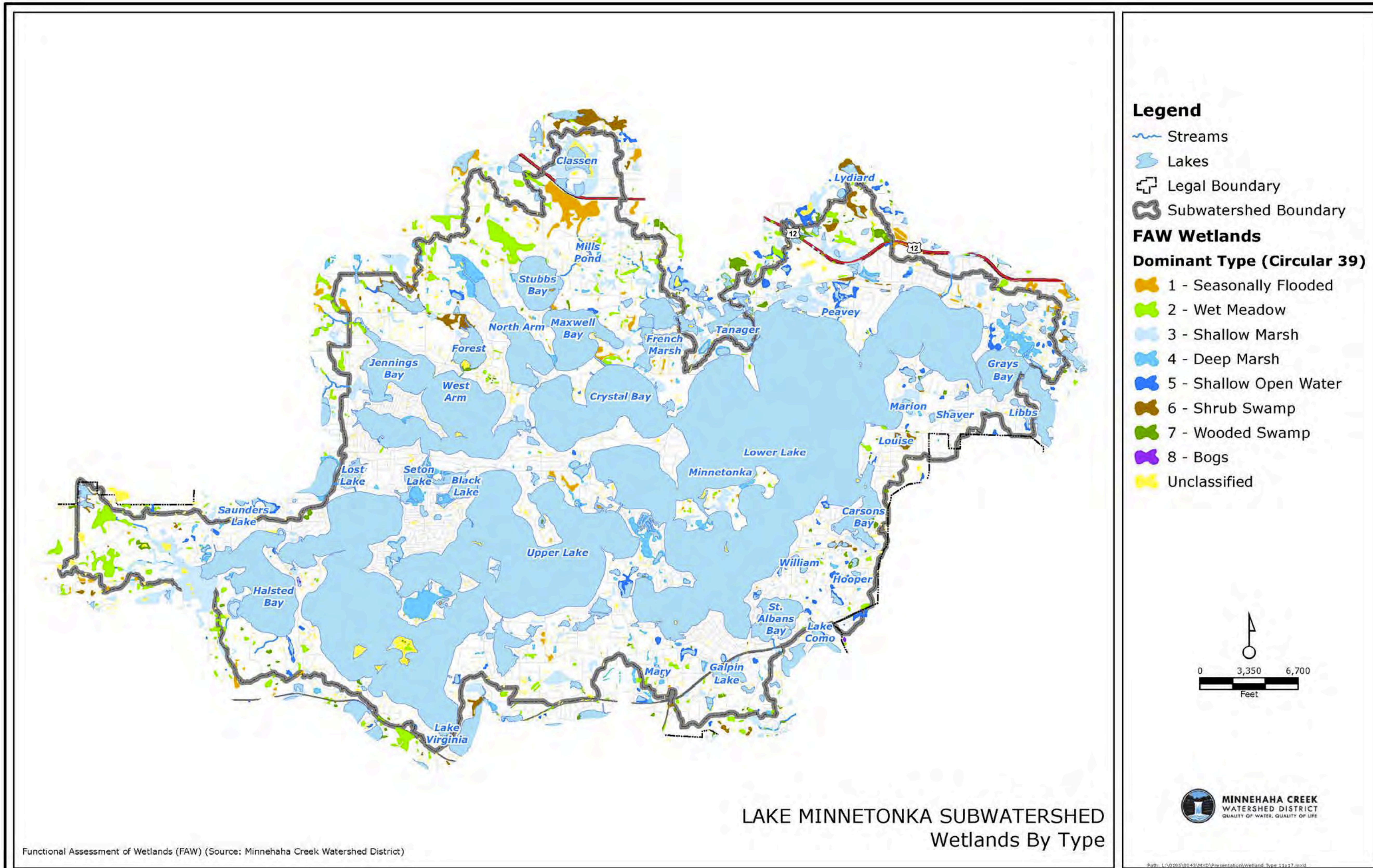

Figure 2. 37. Lake Minnetonka subwatershed wetlands by type.

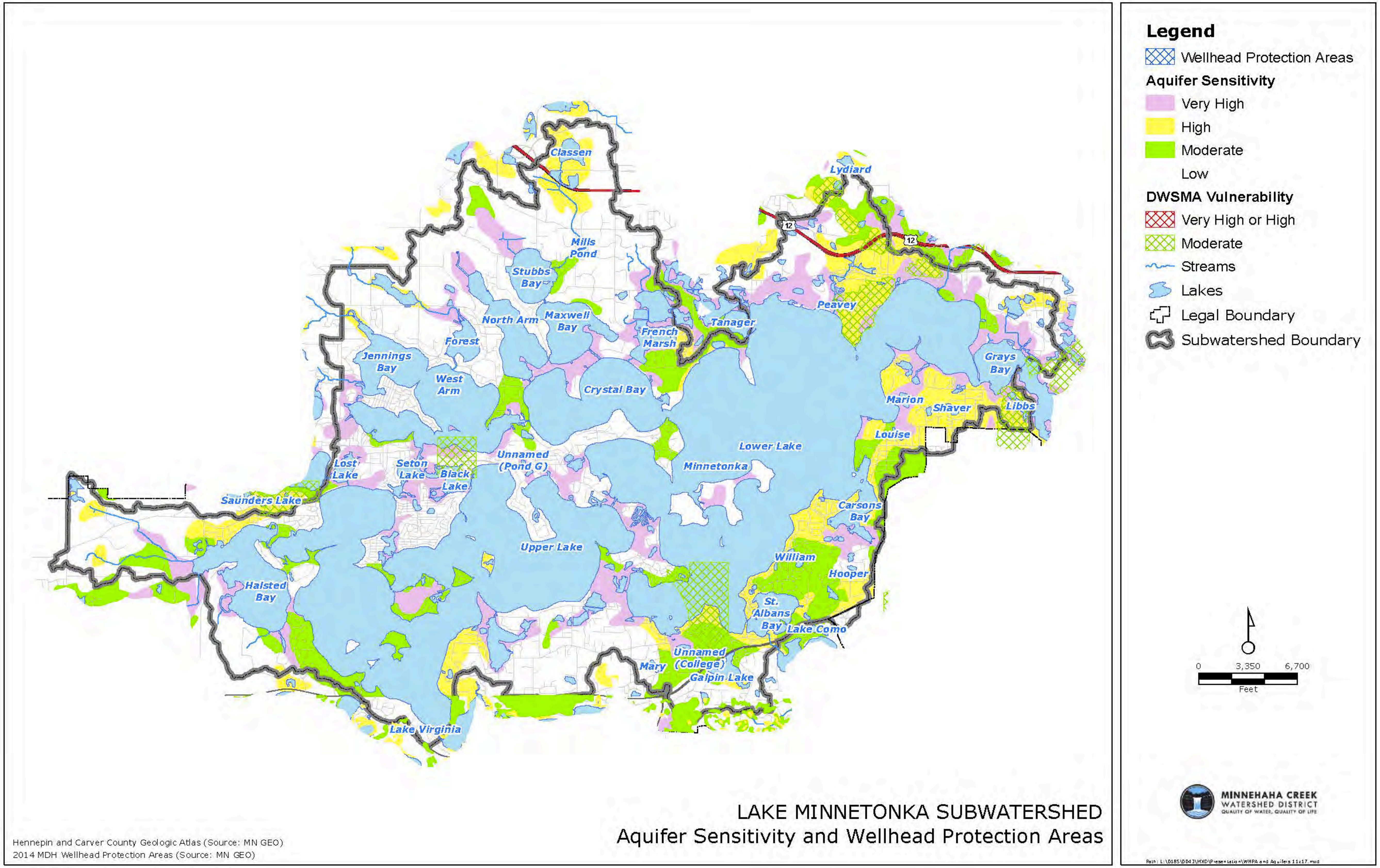

Figure 2. 38. Lake Minnetonka subwatershed aquifer sensitivity and Wellhead Protection Areas.

Water Quantity:

The minor subwatersheds are drainage areas that are small relative to the 11 major subwatersheds, and do not contain lakes that were modeled for water quality purposes. Many of these minor subwatersheds include smaller lakes or ponds. There are several landlocked basins and subwatershed units, including Marion Lake, Mary Lake, Shavers Lake and William Lake.

No statistical assessment on water-yield was computed on the Classen and Forest systems in the Lake Minnetonka Subwatershed.

Ecological Integrity:

The E-Grade program defines watershed ecological integrity as the degree to which the watershed provides three key ecosystem services: biodiversity, habitat diversity, and nutrient cycling. Nutrient cycling is described in the water quality section. The Lake Minnetonka subwatershed has not yet been evaluated by the E-Grade program. This section summarizes ecological integrity using existing data, where available (Figure 2.39).

Lakes:

Biodiversity

Fish Community. The DNR conducts extensive fish surveys in Lake Minnetonka every other year, and has found a diverse fish community (14 species) dominated by northern pike, bluegill, and walleye. Several bass tournaments are held on Minnetonka each year and the lake has a reputation for quality fishing for largemouth bass and muskellunge. Walleye and muskellunge are stocked nearly annually. Forest Lake, Peavey Pond, and Libbs Lake were last surveyed by the DNR in 1992, which found them to be dominated by panfish and rough fish.

Aquatic Vegetation Community. Biodiversity is determined by the number and variety of species, or richness. Generally, aquatic vegetation is more abundant and diverse in the eastern bays of Lake Minnetonka, which tend to have better water clarity. The far western bays tend to be more algae dominated, poorer clarity, and less aquatic vegetation.

Aquatic Invasive Species. Zebra mussels, Eurasian Watermilfoil, Curlyleaf Pondweed, Flowering Rush and Common carp are all present in Lake Minnetonka. Eurasian Watermilfoil was first discovered in 1987, and can be found in varying densities across the lake. Zebra mussels were confirmed in Lake Minnetonka August 2010, are present in most of the bays, and have been found to be influencing water quality in several areas of the lake. Common carp are present throughout the lake, but over abundant populations can be found in many of the receiving bays of the lake, such as Halsted Bay, and contribute towards ecological degradation in those bays. Flowering rush is present, but not abundant, and is typically found around Big Island, Crystal Bay, Maxwell Bay, Lafayette Bay and Browns Bay.. Eurasian watermilfoil and zebra mussels are also present in Forest Lake, Peavey Lake and Libbs Lake. Eurasian Watermilfoil is present in Galpin Lake.

Habitat diversity

Aquatic Vegetation Community. Habitat and diversity is determined by the percent occurrence of species, or the extent to which they may be dominated by a few species. This has not yet been calculated for Lake Minnetonka, but will be available once E-Grade is completed in the subwatershed.

Shoreline Health. Shoreline health is assessed looking at shoreline vegetative cover and the relative human disturbance. The MnDNR is using the Score The Shore protocol to relate shoreline conditions to fish community structure using the fish IBI metric. No Score The Shore data are available; however, aerial photos show that many of the smaller lakes in the subwatershed have emergent wetland fringes, which are beneficial for controlling runoff and supporting emergent vegetation at the shoreline. Much of the shoreline of Lake Minnetonka is developed and maintained as turf grass and with a riprap shoreline.

Streams:

Biodiversity

Fish Community. No fish IBI data are available for the streams in this subwatershed.

Macroinvertebrate Community. Two sites on Classen Creek were sampled for macroinvertebrates in 2013. The M-IBI scores were 16 and 17, well below the impairment threshold for its stream type. The community was dominated by pollution-tolerant species and lacking in some functional groups.

Aquatic Invasive Species. No AIS data are available for the streams in this subwatershed.

Habitat diversity

Habitat Complexity. No Minnesota Stream Habitat Assessment data are available to assess habitat complexity on Classen Creek. However, notes taken for the *2004 Upper Watershed Stream Assessment* were reviewed to better understand conditions in the in-stream zone and riparian zone, and to assess channel morphology. The survey found that the stream in some locations had moderately complex habitat and morphology, but in general the stream is less complex and more altered. There is a small impoundment created by a small earth dam and concrete weir. Several areas of significant streambank erosion were noted.

Connectivity. Connectivity is defined by two metrics: presence or absence of barriers, and access to floodplain. Barriers such as dams, weirs, and culverts limit or prevent organisms from moving freely in the stream. There are several barriers on the streams in this subwatershed, culverts at road crossings as well as a small dam and weir creating an impoundment. There is some access to floodplain, but also segments where the banks are steep.

Water Quality. Water quality factors impacting stream habitat diversity include concentrations of TSS and DO. Higher TSS increases turbidity, which can interfere with aquatic predators seeking their prey and which can limit growth of aquatic vegetation. Refer to Water Quality section for data.

Hydrology Indicators. Stream hydrology is an important factor in habitat diversity. A very flashy stream, that is, one that rises and falls very quickly, can be stressful to organisms. Streams that periodically are dry or have minimal flow are hostile to aquatic life. Continuous streamflow data are not available, but the average flow in all these streams is low, which would be indicative of low DO levels.

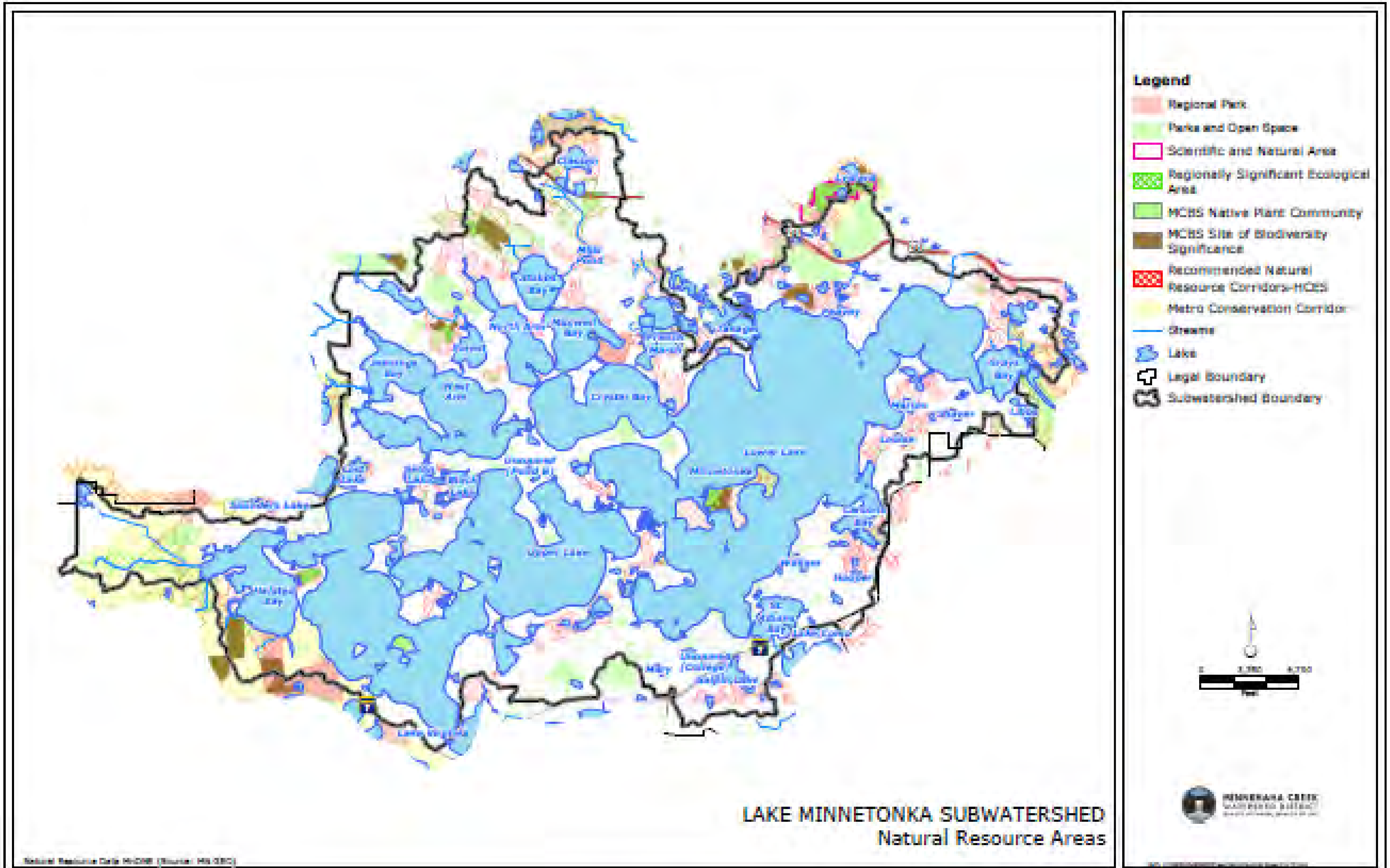

Figure 2. 39. Lake Minnetonka subwatershed natural resource areas.

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Wetlands:

Biodiversity

Vegetation Community. No Rapid Floristic Quality Assessment data are available for the wetlands in this subwatershed. The *Functional Assessment of Wetlands* score only a few scattered wetlands as having exceptional or high vegetative quality. The most notable is Classen Marsh on both sides of Highway 12, which was rated high on vegetative quality.

Habitat diversity

No data are available yet to evaluate the ability of the wetlands in the subwatershed to cycle nutrients. E-Grade will assess wetland soil chemistry, overall vegetative conditions, presence or absence of algal blooms, and condition of the buffer and area within 500 feet of the wetlands.

Uplands:

Biodiversity

A native plant community is a group of native plants that interact with each other and with their environment and are minimally altered by modern human activity or by introduced organisms. The Minnesota Biological Survey has identified several native plant communities in the subwatershed (Figure 2.39), including patches of sugar maple forest, southern mesic maple-basswood forest, a sedge meadow on Big Island, and sedge meadows in the small corner of Wood-Rill Scientific and Natural Area that is within the subwatershed. The Minnesota Biological Survey also assesses sites for biodiversity significance. That rank is based on the presence of rare species populations, the size and condition of native plant communities within the site, and the landscape context of the site. The subwatershed includes areas of moderate significance, including Ferndale Marsh, Big Island, Hardscrabble Woods, and one of high significance – Lowry Woods, which is a wooded/wetland complex upstream of Stubbs Bay.

Habitat diversity

Regionally significant ecological areas are places where larger tracts of minimally disrupted land provide habitat complexity. They are rated by examining important ecological attributes of the ecological patches including size, shape, cover type diversity, and adjacent land use. Several locations within the subwatershed have been designed by the DNR as being of ecological significance in the Metro area (Figure 2.39). Many of these areas contain intact native plant communities and are within DNR Metro Conservation Corridors. Hennepin County has also designated areas within the subwatershed as Recommended Natural Resources Conservation Corridors.

Thriving Communities:

Land use:

Table 2.42 below shows the land uses within the area of the Lake Minnetonka subwatershed in acres and as a percentage of the total subwatershed. The subwatershed is nearly one-half covered with water. Single family residential is the predominant non-water land use, with vacant or undetermined and parks and open space are also significant land uses (Figure 2.40). Much of the vacant land is large wetland or woodland tracts or grass and shrubland. Some large agricultural uses and forested tracts are present in the western subwatershed.

Parts of the western and northern subwatershed are outside of the MUSA 2020 boundary, and are not served by regional wastewater facilities.

Table 2. 42. 2016 land use in the Lake Minnetonka subwatershed.

Land Use 2016	Acres	% of Subwatershed
Water	14,641.8	45.0
Single - Family Residential	9,540.0	29.3
Vacant or Undetermined	4,184.9	12.9
Parks and Open Space	2,011.4	6.2
Agricultural	572.7	1.8
Multi - Family Residential	492.5	1.5
Institutional	448.0	1.4
Commercial	378.2	1.2
Roads and Highways	178.1	0.5
Industrial	68.1	0.2

Source: Metropolitan Council.

Recreation:

Two Three Rivers Park District regional parks are located within the subwatershed: Noerenberg Memorial Gardens in Orono and Lake Minnetonka Regional Park. The Park District also owns property on Big Island, Wawatasso Island, and Goose Island. Several regional trails, including the Luce Line, the Southwest Hennepin LRT trail, and the Dakota Rail trail, cross the subwatershed.

The Minnesota Historic Features database notes about 460 historic features in this subwatershed, mostly residences, agricultural or commercial buildings, including over 300 buildings in historic Excelsior alone. The Crane Island Historic District in Minnetrista conserves 14 buildings that exemplify the type of seasonal residential lake cottages that served as retreats from city life in the early 20th century.

Lake Minnetonka offers a wide variety of opportunities for aquatic recreation (Figure 2.41), with numerous public and private boat accesses, beaches and fishing areas.

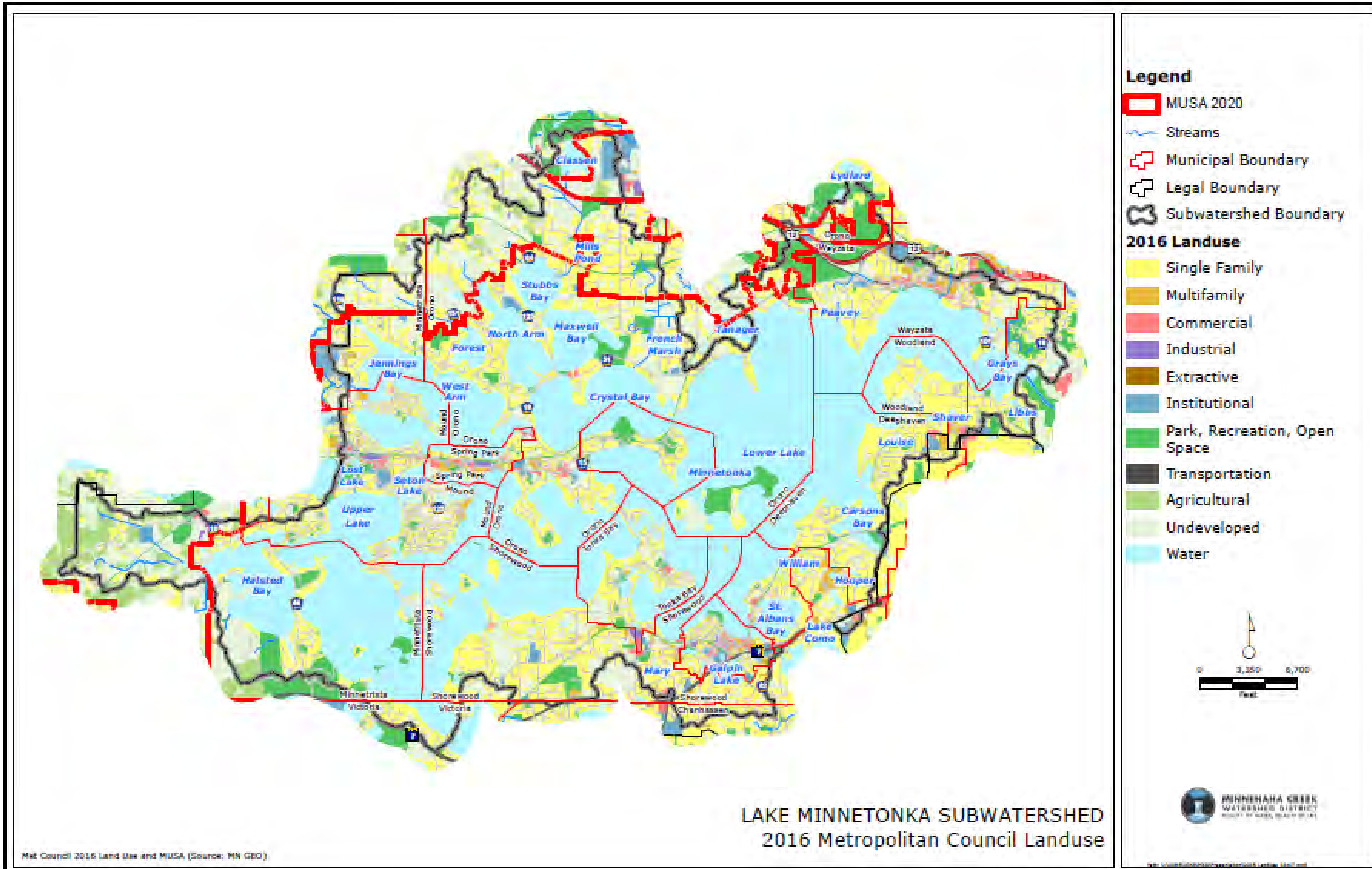

Figure 2. 40. Lake Minnetonka subwatershed 2016 Metropolitan Council land use.

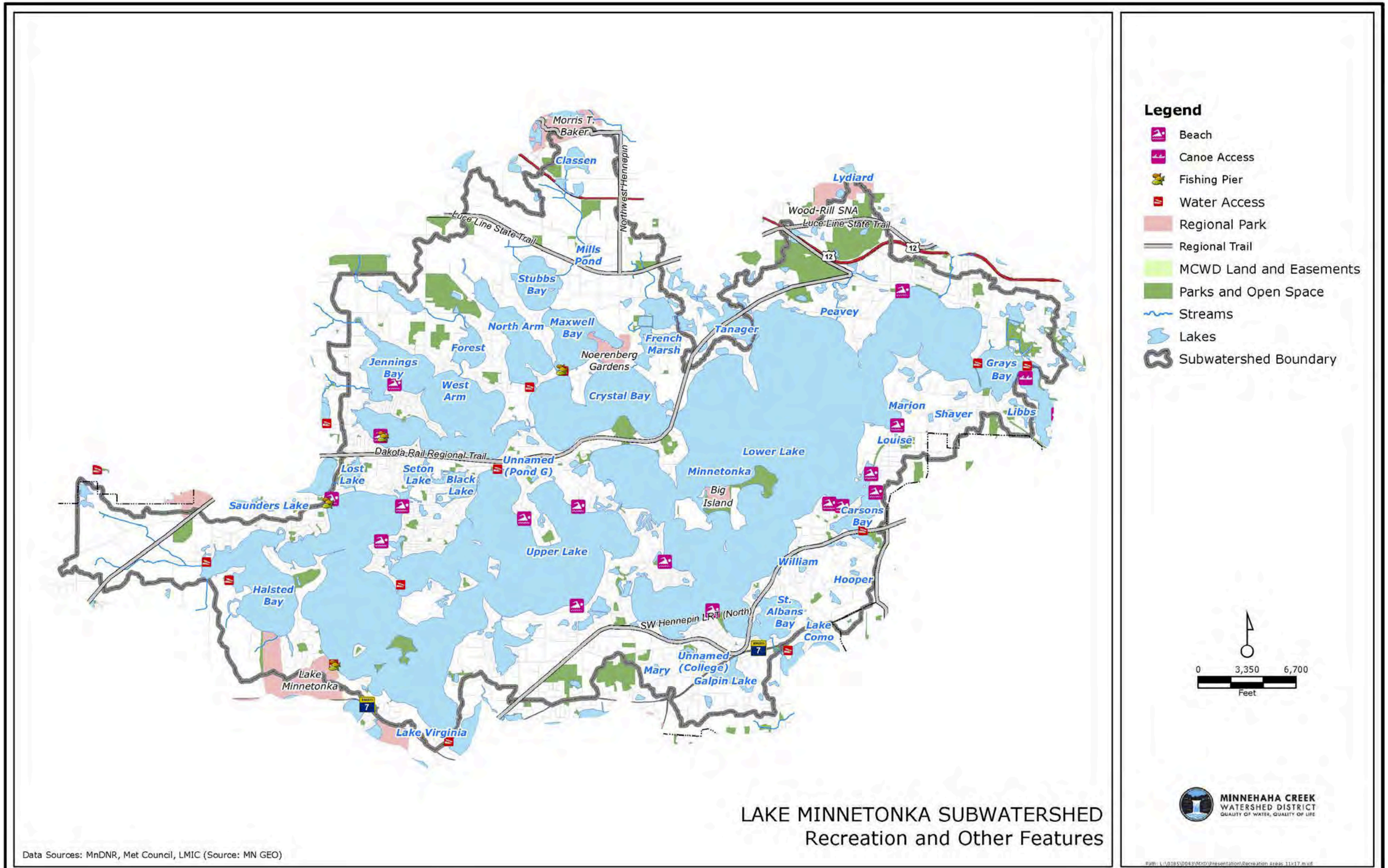

Figure 2. 41. Lake Minnetonka subwatershed recreation and other features.

2.3.5 LAKE VIRGINIA SUBWATERSHED

The Lake Virginia Subwatershed is dominated by four lakes and a mix of wetlands, agricultural, and residential land cover. The Lake Minnewashta Regional Park resides within this subwatershed and provides recreational access to Lake Minnewashta from the east. The park is dominated by forest, woodland, grassland and wetlands. The water drains into Lake Virginia from Lake Minnewashta and Tamarack Lake. The outlet of Lake Virginia is ditched, connecting the lake directly to Smithtown Bay, Lake Minnetonka. The outlet into Smithtown Bay is inaccessible, and therefore is not monitored. Table 2.43 shows the area of the Lake Virginia subwatershed in acres by individual city, in total and as a percentage of the total subwatershed (Figure 2.42).

Table 2. 43 Cities in the Lake Virginia subwatershed.

City	Area (Acres)	% of Subwatershed
Chanhassen	2,755.6	69%
Chaska	18.8	0.5%
Shorewood	344.1	8.6%
Victoria	872.4	21.8%
Total	3,991.2	

Source: MCWD.

Subwatershed Description and Hydrology:

The topography of the eastern subwatershed is rolling and hilly with areas of steep slopes along the eastern shore of Lake Minnewashta. The western subwatershed is distinguished by fewer steep slopes.
There are two major lakes within the subwatershed – Lake Minnewashta and Lake Virginia – and two other primary lakes – Lake St. Joe and Tamarack Lake. Lake Minnewashta is located in the upper subwatershed and discharges by Minnewashta Creek to Lake Virginia.

Land cover is classified by the Minnesota Land Cover Classification System (MLCCS) (Figure 2.43). Lake Minnewashta Regional Park is a dominant feature in the watershed. North of Highway 5, much of the watershed is developed to typical suburban densities with a low to medium degree of imperviousness. The Arboretum and Regional Park lands include wetland, wooded, and grassland cover, as well as some agricultural uses. The area around and between Lake St. Joe and Tamarack Lake includes a number of wetlands and wooded tracts.

Soils within the watershed are predominantly Natural Resources Conservation Service Hydrologic Soil Group B (loamy with moderate infiltration potential). Group C (loamy clay with low infiltration potential) and D (clayey with very low infiltration potential) soils are found in low-lying areas and are generally hydric, or showing indications of inundation. For further information regarding geology and soils in the subwatershed, please refer to the *2007 MCWD Comprehensive Water Resources Management Plan*.

Lakes Minnewashta and Virginia are the primary receiving waters within the subwatershed. Tamarack Lake and Lake St. Joe are additional lakes in the subwatershed. There is a small stream that conveys discharge from Lake Minnewashta to Lake Virginia known as Minnewashta Creek. The Lake Virginia subwatershed discharges by a small channel in Smithtown Bay, Lake Minnetonka. The *2003 MCWD Hydrologic, Hydraulic, and Pollutant Loading Study (HHPLS)* subdivided the Lake Virginia subwatershed into 16 subwatershed units, designated LMC-1 through LMC-10 in the Lake Minnewashta drainage area, and LV-1 to LV-6 in the downstream, Lake Virginia area (Figure 2.44).

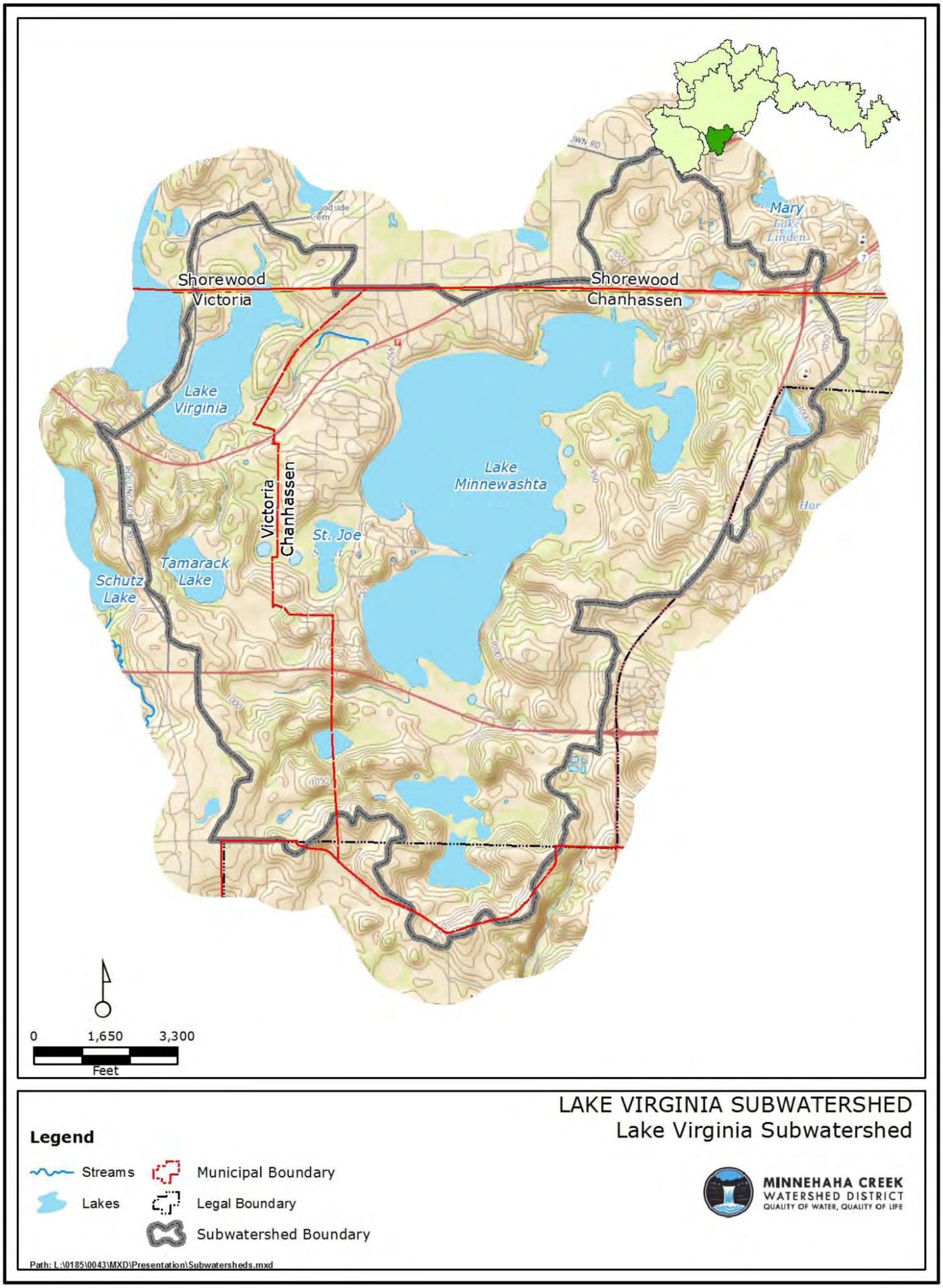

Figure 2. 42. The Lake Virginia subwatershed.

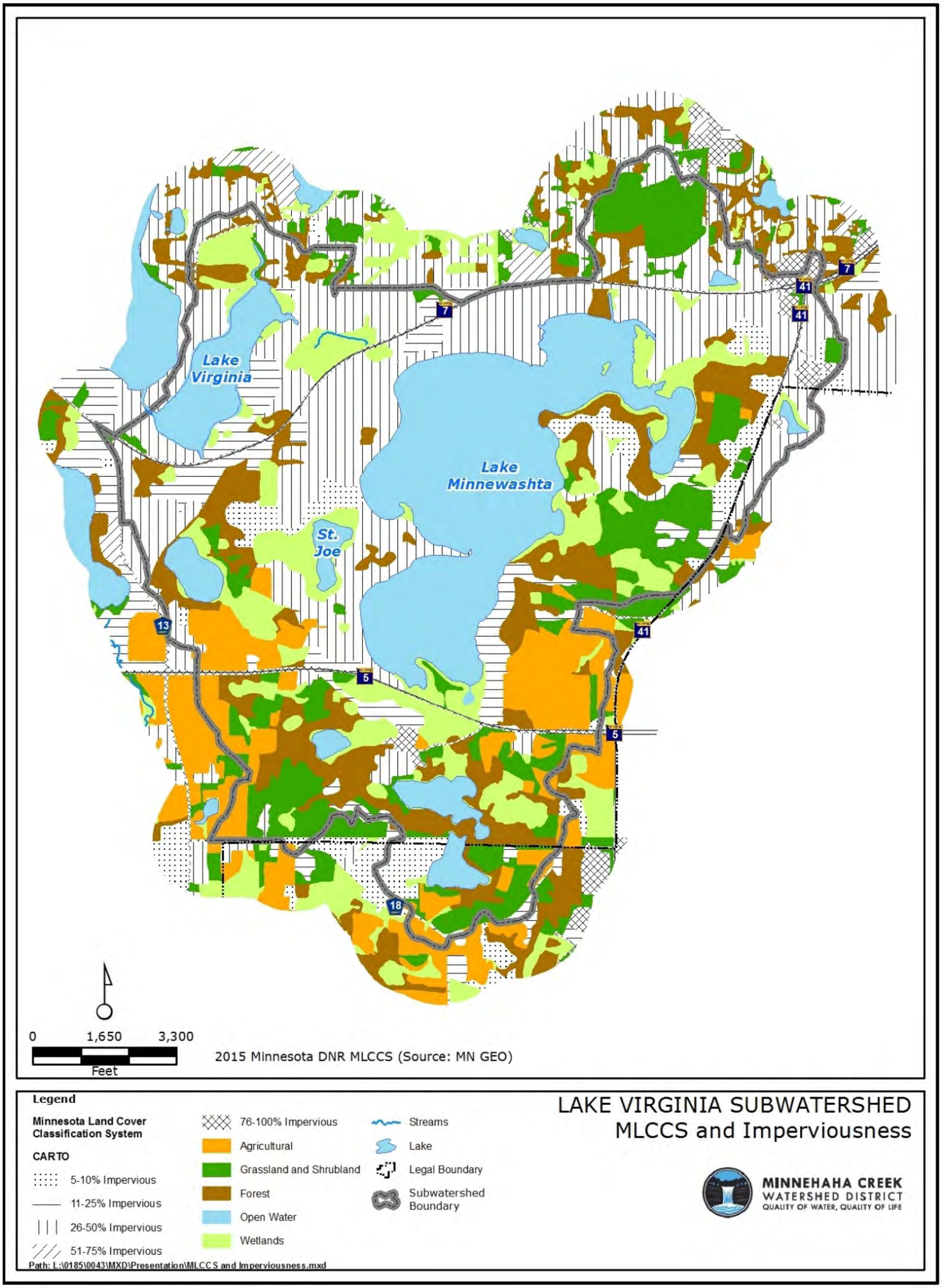

Figure 2. 43. Lake Virginia subwatershed MLCCS and imperviousness.

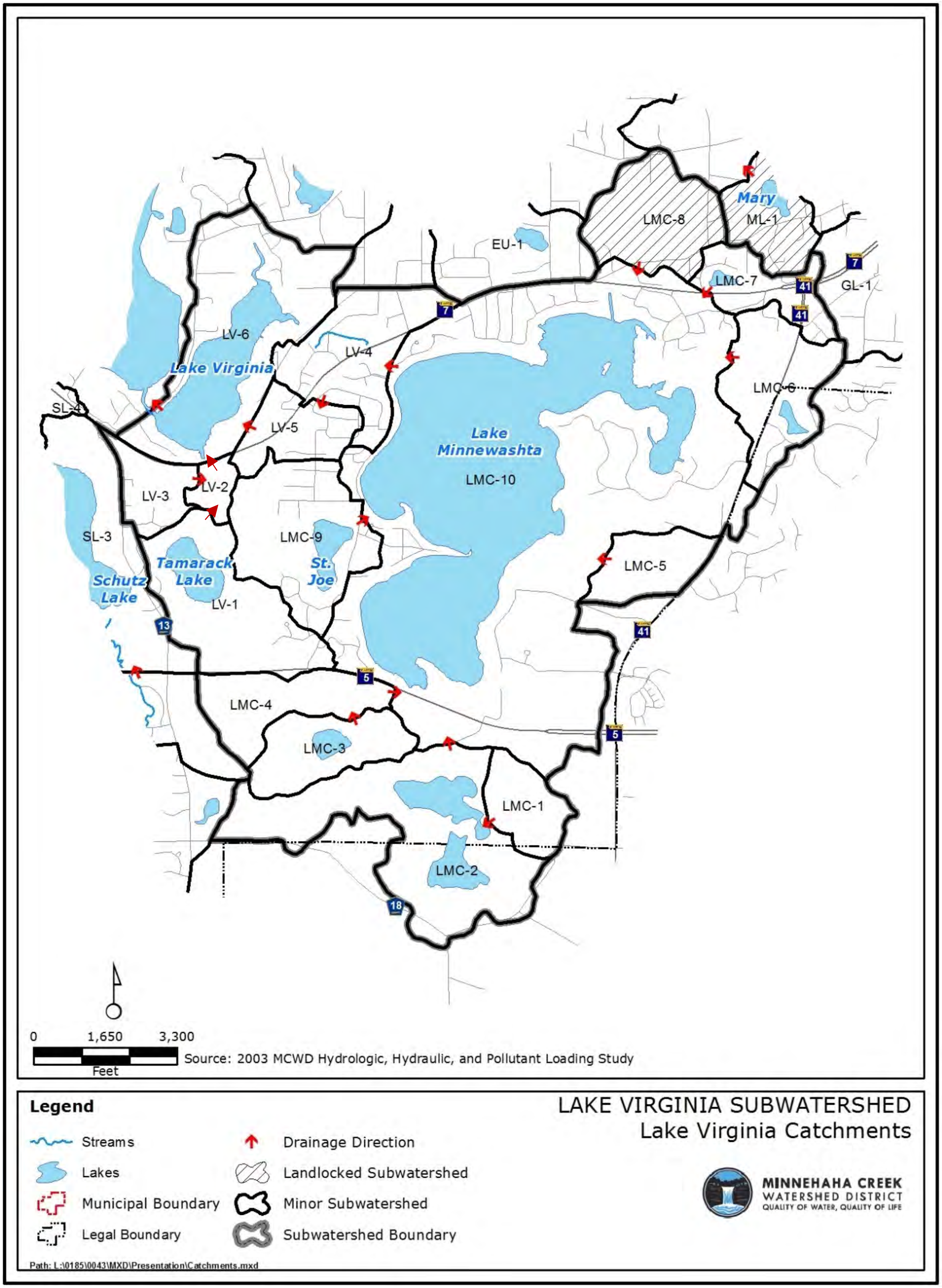

Figure 2. 44. Lake Virginia subwatershed catchments.

Water Quality:

The following are summaries of the characteristics and classifications of lakes and streams within the subwatershed including water quality goals and trends.

Lakes:

Lakes Minnewashta and Virginia are the primary receiving waters within the subwatershed, and are classified by the DNR for shoreland management purposes as Recreational Development lakes. Tamarack Lake and Lake St. Joe are additional resources within the subwatershed, and are classified by the DNR as Natural Environment lakes (Table 2.44). Lake Virginia and Tamarack Lake are listed as Impaired Waters for excess nutrient concentrations; however, Tamarack Lake varies just above to just below the impairment threshold (Figure 2.45). Minnewashta and St. Joe Lakes enjoy excellent water quality, although St. Joe can experience algal blooms as evidenced by the somewhat elevated average chlorophyll-*a* concentrations.

The *Minnehaha Creek Watershed Lakes TMDL* prepared a TMDL for Lake Virginia while the *Upper Minnehaha Creek Watershed Lakes and Bacteria TDML Project*, prepared a TMDL for Tamarack Lake. Both Minnewashta and Virginia are listed as Impaired Waters for excess mercury in fish tissue, and the State of Minnesota has completed a statewide TMDL for those impairments. For more information, refer to the TMDL reports and the District's Water Quality (Hydrodata) reports.

Tables 2.44 and 2.45 show the physical and water quality characteristics of the major lakes in the subwatershed. To assess long-term change on the four lakes within the Lake Virginia Subwatershed, a Mann-Kendall statistical trend test was performed on total phosphorus (TP), chlorophyll-a (Chl-a), and Secchi depth data from 2001-2015. There were no statistically significant changes in the water quality in the four lakes during this period.

Table 2. 44. Physical characteristics of lakes in the Lake Virginia subwatershed.

Lake	Surface Area (acres)	Maximum Depth (ft)	Watershed to Lake Area Ratio	DNR Classification
Minnewashta	677	70	5:1	Recreational Development
St. Joe	19	52	11:1	Natural Environment
Tamarack	28	82	8:1	Natural Environment
Virginia	105	34	38:1	Recreational Development

Source: Minnesota DNR.

Table 2. 45. Selected water quality goals and current conditions of lakes in the Lake Virginia subwatershed.

Lake	State TP Standard (µg/L)	2007 Plan Goal TP (µg/)	Trend*	2001-2015 Summer Average		
				TP (µg/L)	Chl-a (µg/L)	Secchi (m)
Minnewashta[1]	40	20	No trend	22	9	2.4
St. Joe[2]	40	n/a	No trend	26	5	2.7
Tamarack[2]	40	n/a	No trend	37	15	2.3
Virginia[3]	40	40	No trend	55	36	1.3

**Statistically significant at ≤ 0.05.

[1] (1997-2015) from MCWD.

[2] (2004-2015 irregularly monitored) from Citizen Assisted Monitoring Program (CAMP).

[2] (2004-2015) from Citizen Assisted Monitoring Program (CAMP) and MCWD Volunteer Program.

[3] (2005-2015) from MCWD.

Source: MCWD, Upper Minnehaha Creek Watershed Lakes TMDL, MPCA.

Streams:

There is a small stream that conveys discharge from Lake Minnewashta to Lake Virginia known as Minnewashta Creek (Figure 2.45). As an outflow channel, water quality in Minnewashta Creek is highly influenced by water quality in Lake Minnewashta. Average TP concentration in the Creek is well below the state river eutrophication standard. Depending on flow and concentration, the Minnewashta Creek outlet historically has relative lower TP concentrations and loading, though loading does show an increase during higher flow years.

Tables 2.46 and 2.47 detail the physical and water quality characteristics of streams and tributaries within the subwatershed. The stream has an average TSS concentration of 4 mg/L, which is well below the 30 mg/L state standard. Maintaining sufficient dissolved oxygen (DO) is necessary to support aquatic life. The DO state standard requires the stream to never fall below 5 mg/L DO. The most recent DO readings collected by the District were above the standard.

To assess long-term change in the Minnewashta Creek outlet, a Mann-Kendall statistical trend test was performed on flow-corrected TP and TSS data from 2006-2015. There was a statistically significant increase in TSS concentrations in the Minnewashta Creek outlet over this period. For more information please refer to the District's Water Quality (Hydrodata) Reports.

Table 2. 46. Major streams in the Lake Virginia subwatershed.

Stream	Length (mi)
Minnewashta Creek (CMW02)	1.03

Table 2. 47. Current conditions of streams in the Lake Virginia subwatershed.
See Figure 2.45 for monitoring locations.

Stream	Trend*	2006-2015 Annual Average			
		TP (µg/L)	TN (mg/L)	TSS (mg/L)	Cl (mg/L)
Minnewashta Creek (CMW02)	Deg TSS	36	0.58	4	29**

TP = total phosphorus, TN = total nitrogen, TSS = total suspended solids, Cl = chloride.
*Statistically significant at ≤ 0.05, Deg = degrading, **Cl data 2008-2014
Source: MCWD.

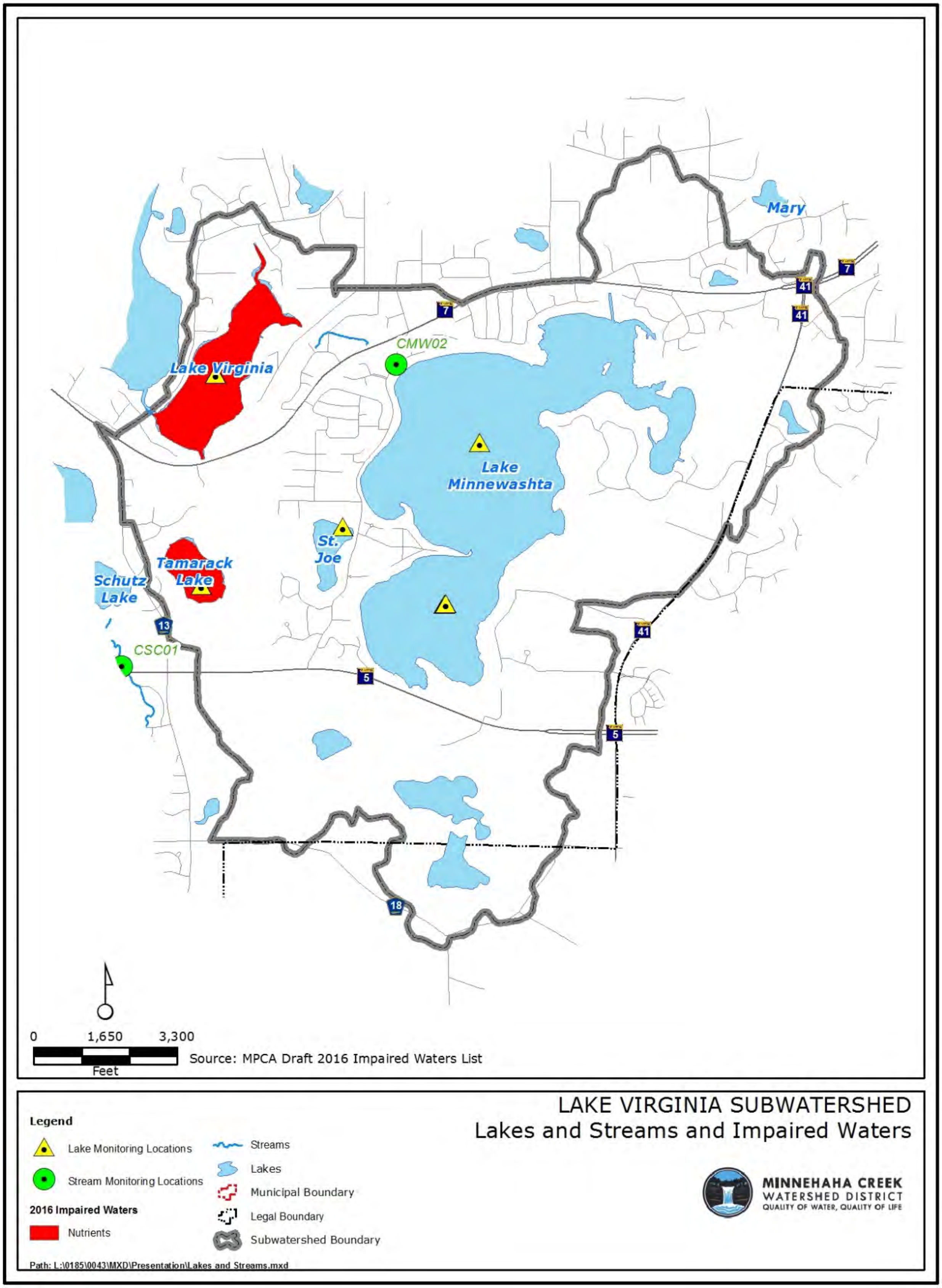

Figure 2. 45. Lake Virginia subwatershed lakes and streams and Impaired Waters.

Wetlands:

According to the FAW, wetlands, including lakes, cover 21.8 percent of the subwatershed's surface (Figure 2.46 and Table 2.48). A delineation of wetland boundaries is required to be completed any time development or other impacts may occur near or in a wetland. For more information regarding wetlands in the subwatershed, please refer to the *2007 MCWD Comprehensive Water Resources Management Plan*.

No data are available yet to evaluate the ability of the wetlands in the subwatershed to cycle nutrients to and from the subwatershed. E-Grade will assess wetland soil chemistry, overall vegetative conditions, presence or absence of algal blooms, and condition of the buffer and area within 500 feet of the wetlands.

Table 2. 48. Functional Assessment of Wetlands inventory of wetland types in the Lake Virginia subwatershed.

FAW Circular 39 Wetland Type	Area (acres)	Percent
1 - Seasonal	32.7	0.98
2 - Wet Meadow	167.3	5.00
3 - Shallow Marsh	191.2	5.71
4 - Deep Marsh	64.8	1.94
5 - Open Water	112.2	3.35
6 - Scrub Shrub	105.0	3.14
7 - Forested	56.1	1.68
8 - Bog	-	
Riverine	-	
Wetland Total	729.4	21.8
Upland	2,621	78.2
TOTAL	3,350.4	

Source: MCWD Functional Assessment of Wetlands.

Groundwater:

The District's roles in managing groundwater are to 1) promote surficial groundwater recharge to protect wetland hydrology and stream base flow, and 2) assist in protecting deeper aquifers used for drinking water by limiting infiltration in sensitive recharge areas.

Infiltration potential of the upland areas within the subwatershed as generally medium, with a number of pockets of low potential clayey soils. Because of the organic nature of the soils in the wetland areas, in general infiltration potential there is variable. The *Carver County Water Resource Management Plan* and *Hennepin County Geologic Atlas* classifies those organic soil areas as highly sensitive to aquifer impacts, with the balance of the subwatershed as being of medium to low sensitivity to pollution, and the major wetland areas on the north and in the south as being highly sensitive.

Much of the northeastern part of the subwatershed as well as Lake Minnewashta itself has been designated a Drinking Water Supply Management Area (DWSMA).Two Wellhead Protection Areas (WHPA) surrounding Chanhassen and Shorewood water supply wells are partly within this subwatershed. Figure 2.47 shows areas in the subwatershed with groundwater sensitivity and that are designated Wellhead Protection Areas.

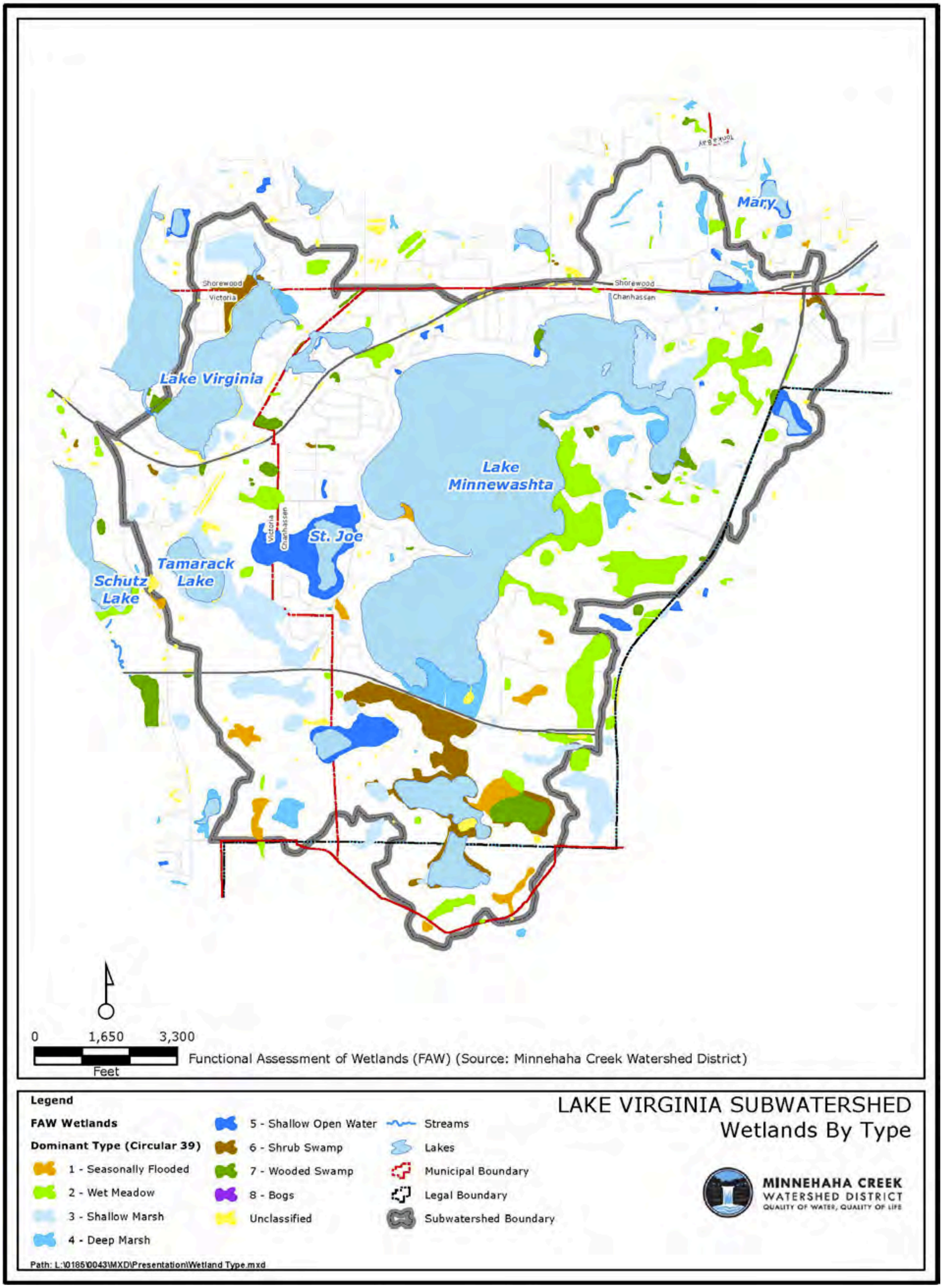

Figure 2. 46. Lake Virginia subwatershed wetlands by type.

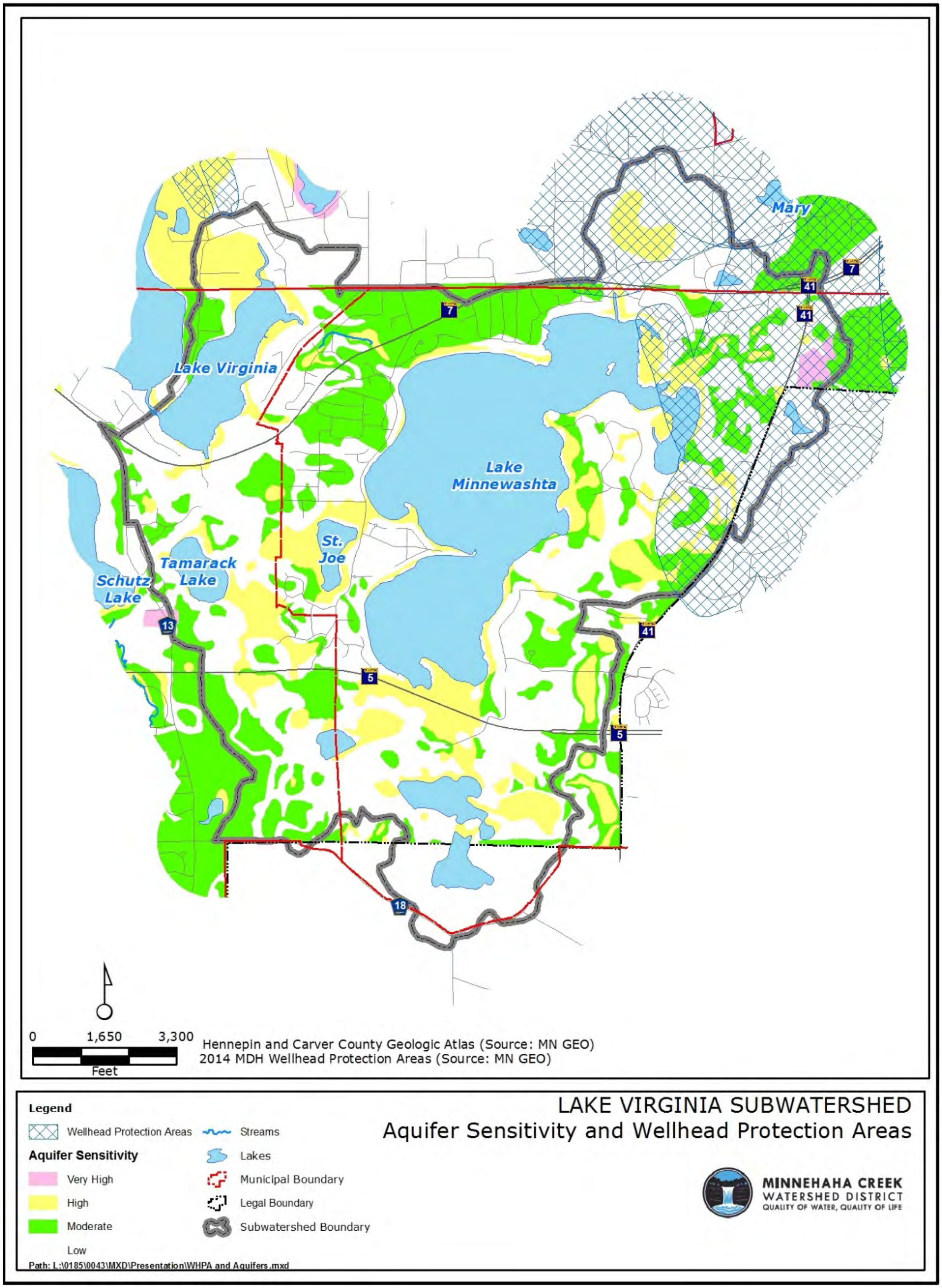

Figure 2. 47. Lake Virginia subwatershed aquifer sensitivity and Wellhead Protection Areas.

Water Quantity:

As detailed in the *HHPLS*, two subwatershed units in the Lake Virginia subwatershed are landlocked (Figure 2.44).

To assess change in water yield, a Mann-Kendall statistical trend test was performed on annual water yield data for the monitoring station on Minnewashta Creek. Water yield for 2006-2015 did not exhibit any statistically significant trend upward or downward, indicating that there has not been a significant change in outflow over the past ten years.

Ecological Integrity:

The E-Grade program defines watershed ecological integrity as the degree to which the watershed provides three key ecosystem services: biodiversity, habitat diversity, and nutrient cycling. Nutrient cycling is described in the Water Quality section. The Lake Virginia subwatershed has not yet been evaluated by the E-Grade program. This section summarizes ecological integrity using existing data, where available (Figure 2.48).

Lakes:

Biodiversity

Fish Community. No Fish IBI data are available for the lakes in the subwatershed. Lake Minnewashta is a popular bass/northern/panfish lake that was last surveyed by the DNR in 2011. A catch-and-release only regulation for largemouth bass is in effect. Lake Virginia maintains a bass/northern/panfish fishery with abundant bluegills. Dissolved oxygen levels in the deeper parts of the lake in late summer fall below the levels needed to sustain aquatic life, which may impact certain sensitive species. Common carp and other rough fish are abundant. Lake St. Joe has a fish population dominated by small black bullheads, northern pike and several species of panfish. Tamarack Lake has not been surveyed since 1994. The fish population at that time was primarily panfish, although there were fair numbers of northern pike.

Aquatic Vegetation Community. Biodiversity is determined by the number and variety of species, or richness. A Floristic Quality Index (FQI) is available for Lake Minnewashta, Tamarack and St. Joe lakes. Lake Minnewashta FQI score of 28.8 – Good. This grade indicates the lake has moderate species diversity and a mixed assemblage of tolerant and intolerant species, beginning to show signs of anthropogenic disturbance. Tamarack Lake and St. Joe, with a score of 14.1 and 18.09 respectively – both classified as Poor meaning the community in both lakes is showing obvious signs of anthropogenic disturbance, low species diversity often comprised of non-native and/or intolerant species. Eurasian watermilfoil and Curly leaf Pondweed are present in both Lakes Minnewashta and Lake Virginia.

Aquatic Invasive Species. Curlyleaf Pondweed is present in St. Joe Lake. Eurasian Watermilfoil, Curlyleaf Pondweed, and zebra mussels have been confirmed in both Lake Minnewashta and Lake Virginia. Zebra mussels were confirmed in 2014 for Lake Virginia and 2016 for Lake Minnewashta. A rapid response attempt to eradicate zebra mussels occurred on Lake Minnewashta in 2016. Monitoring and response continue as new zebra mussels were found at the public access in 2017. No zebra mussels have been found in the main body of the lake.

Habitat diversity

Aquatic Vegetation Community. Habitat diversity is determined by the percent occurrence of species, or the extent to which it may be dominated by a few species. The vegetation community has not been assessed yet for habitat diversity.

Shoreline Health. Shoreline health is assessed looking at shoreline vegetative cover and the relative human disturbance. The MnDNR is using the Score the Shore protocol to relate shoreline conditions to fish community structure using the fish IBI metric. No Score the Shore data are available for the lakes in this subwatershed. Aerial photos show that much of eastern shore of Minnewashta Lake has significant shoreland vegetation along Lake Minnewashta Regional Park. About 40 percent of the perimeter of Lake Minnewashta and 35 percent of Lake Virginia are protected by riparian wetlands. Both Lake St. Joe and Tamarack Lake have fully intact shoreland vegetation.

Streams:

Biodiversity

Fish Community. No fish IBI data are available for the streams in this subwatershed.

Macroinvertebrate Community. No macroinvertebrate data are available for the stream in this subwatershed.

Aquatic Invasive Species. No AIS data are available for the streams in this subwatershed.

Habitat diversity

Habitat Complexity. No Minnesota Stream Habitat Assessment data are available to assess habitat complexity for Minnewashta Creek. By observation, this stream is more like a channel between the two lakes.

Connectivity. Connectivity is defined by two metrics: presence or absence of barriers, and access to floodplain. Barriers such as dams, weirs, and culverts limit or prevent organisms from moving freely in the stream. There are culverts that intersect Minnewashta Creek along its 1.03 mile course to Lake Virginia.

Water Quality. Water quality factors impacting stream habitat diversity include concentrations of TSS and DO. Higher TSS concentrations increase turbidity, which can interfere with aquatic predators seeking their prey and which can limit growth of aquatic vegetation. Refer to Water Quality section for data.

Hydrology Indicators. Stream hydrology is an important factor in habitat diversity. A stream that is very flashy, that is, one that rises and falls very quickly in response to rain events, can be stressful to organisms. In addition, streams that periodically are dry or have minimal flow are hostile to aquatic life. Continuous streamflow data are not available, but instantaneous flow measured since 2006. Annual average flow for each year was computed first, and then all the years' averages were averaged together. Annual average flow at CMW02 was 3.54 cfs indicating generally low flow conditions at time of data collection.

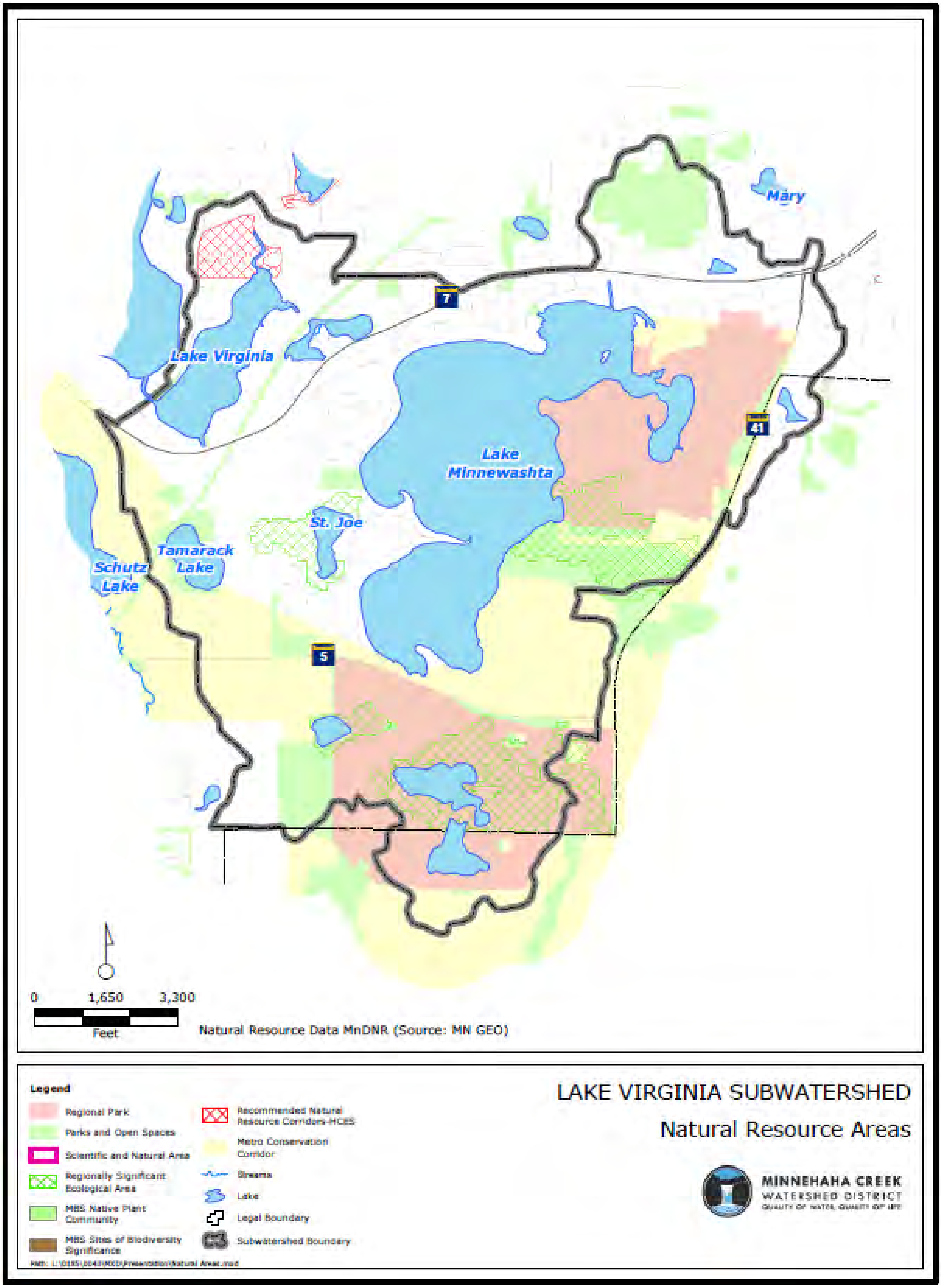

Figure 2. 48. Lake Virginia subwatershed natural resource areas.

Wetlands:

Biodiversity

Vegetation Community. No FQI data are available for the wetlands in this subwatershed. Over 39 percent of the wetlands in the subwatershed were classified as "preserve" due to their exceptional or high vegetative diversity, or fish or wildlife habitat value. Those wetlands described as exceptional are present on the east side of Lake Minnewashta, the northwest shore of Lake Virginia and all of Lake St. Joe.

Macroinvertebrate Community. No macroinvertebrate data are available for the wetlands in this subwatershed.

Habitat diversity

Connectivity. Connected wetland corridors are desirable as they provide a variety of habitats as well as protected areas for passage. Most of the connectivity between wetlands is already protected within the Lake Minnewashta Regional Park and/or the University of Minnesota Landscape Arboretum.

Size. Larger wetlands are more likely to support a notable on-site diversity and/or abundance of wildlife species. Much of eastern shore of Minnewashta Lake has large wetlands present within Lake Minnewashta Regional Park. Both Lake St. Joe and Tamarack Lake also have large wetlands around their respective perimeters.

Shoreline Protection. Riparian wetlands can provide significant shoreline protection and support emergent vegetation at the shoreline. The *Functional Assessment of Wetlands* evaluated riparian wetlands for their ability to protect lake or stream shoreline. About 40 percent of the perimeter of Lake Minnewashta and 35 percent of Lake Virginia is protected by riparian wetlands. Both Lake St. Joe and Tamarack Lake have fully intact shoreland vegetation.

Uplands:

Biodiversity

Much of the subwatershed has been identified by the DNR as a Metropolitan Conservation Corridor, including Lake Minnewashta Regional Park and the Minnesota Landscape Arboretum. Wetland and associated upland areas with high ecological value are present and should be conserved and connected to preserve their values, create larger areas of ecological value, and connect existing resources. The Minnesota Landscape Arboretum and Lake Minnewashta Regional Park lands include wetland, wooded and grassland cover as well as some agricultural uses.

Habitat diversity

Regionally significant ecological areas are places where larger tracts of minimally disrupted land provide habitat complexity. Figure 2.48 shows areas designated by the DNR as regionally significant within Lake Minnewashta Regional Park, the Landscape Arboretum, and riparian to Lake St. Joe. The Regional Park, University of Minnesota Horticultural Research Center, and Landscape Arboretum also preserve significant areas of lightly-disturbed woodlands and grasslands that provide significant habitat value to terrestrial and avian species in the subwatershed.

Thriving Communities:

Land use:

Table 2.49 shows the land uses within the area of the Lake Virginia subwatershed in acres and as a percentage of the total subwatershed. The principal land uses in the northern part of the subwatershed are parks and open space and single family residential (Figure 2.49). South of Highway 5 the subwatershed is mainly agriculture and vacant or undetermined area with some single family and the campus of southwest Metro Catholic High School.

Except for some very small areas in the south, the entire subwatershed is located within the 2020 Metropolitan Urban Services Areas (MUSA) boundary.

Table 2. 49. 2016 land use in the Lake Virginia subwatershed.

Land Use 2016	Acres	% of Subwatershed
Parks and Open Space	1,097.0	27.5
Single - Family Residential	1,054.3	26.4
Water	876.1	21.9
Vacant or Undetermined	485.5	12.2
Agricultural	297.1	7.4
Institutional	87.3	2.2
Roads and Highways	60.4	1.5
Commercial	21.5	0.5
Multi - Family Residential	9.0	0.2
Industrial	3.0	0.1

Source: Metropolitan Council.

Recreation:

Lake Minnewashta Regional Park encompasses most of the northeastern shore of Lake Minnewashta. Most of the subwatershed south of Highway 5 is part of the Minnesota Landscape Arboretum. The Southwest Hennepin LRT Regional Trail passes across the northwest corner of the subwatershed, to the east of Lake Virginia. The Minnesota Historic features database lists several properties in the subwatershed, including a home and farmhouse, and two clusters of buildings and sites associated with the Arboretum and its research activities.

There is one public boat launch in the Regional Park on Lake Minnewashta, and one on Lake Virginia (Figure 2.50). A canoe launch is available on Lake St. Joe. There is a beach and fishing pier on the east side of Lake Minnewashta in the Regional Park, and a beach on the west side of Lake Minnewashta in the City of Chanhassen’s Roundhouse Park.

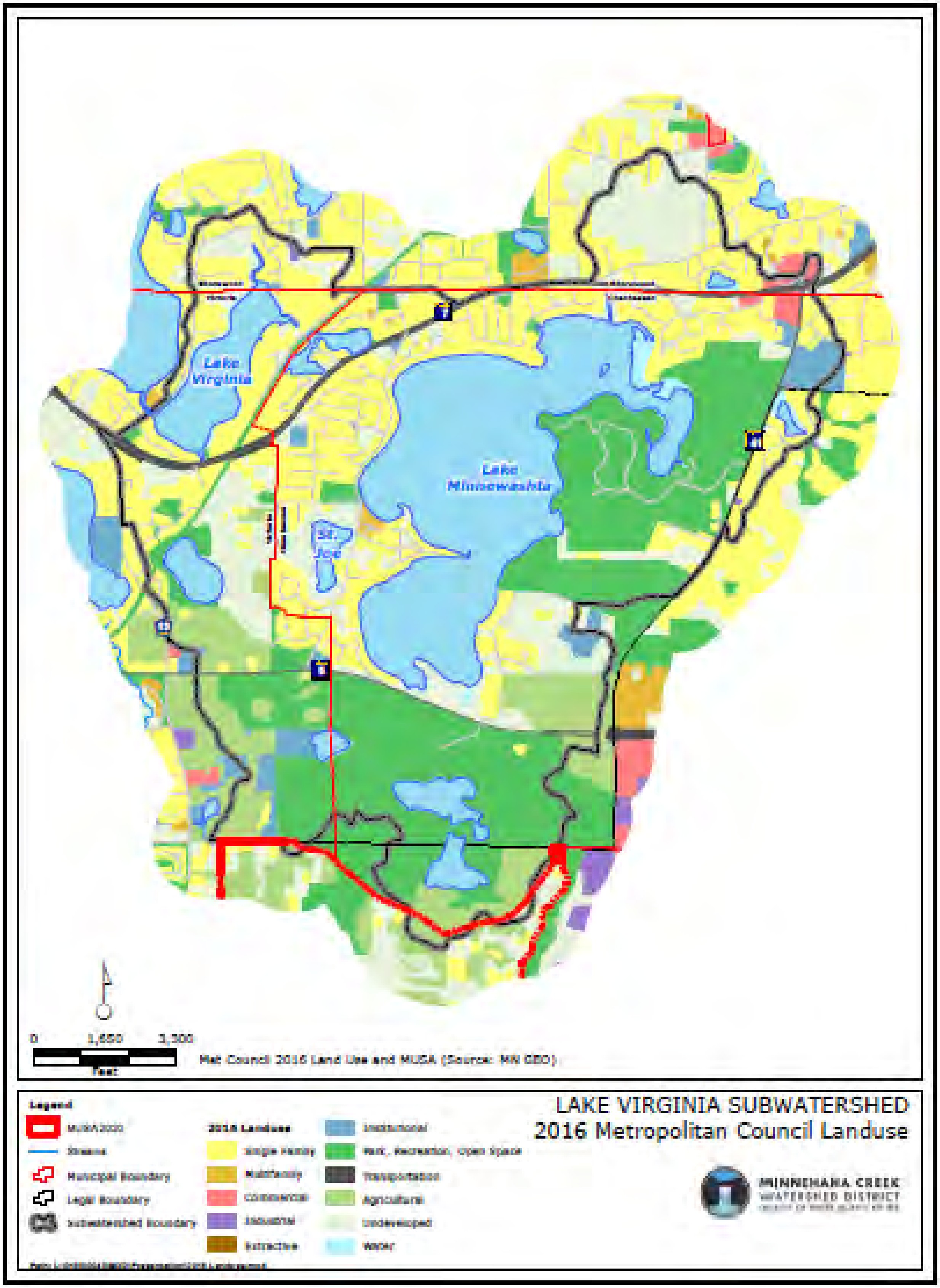

Figure 2. 49. Lake Virginia subwatershed 2016 land use.

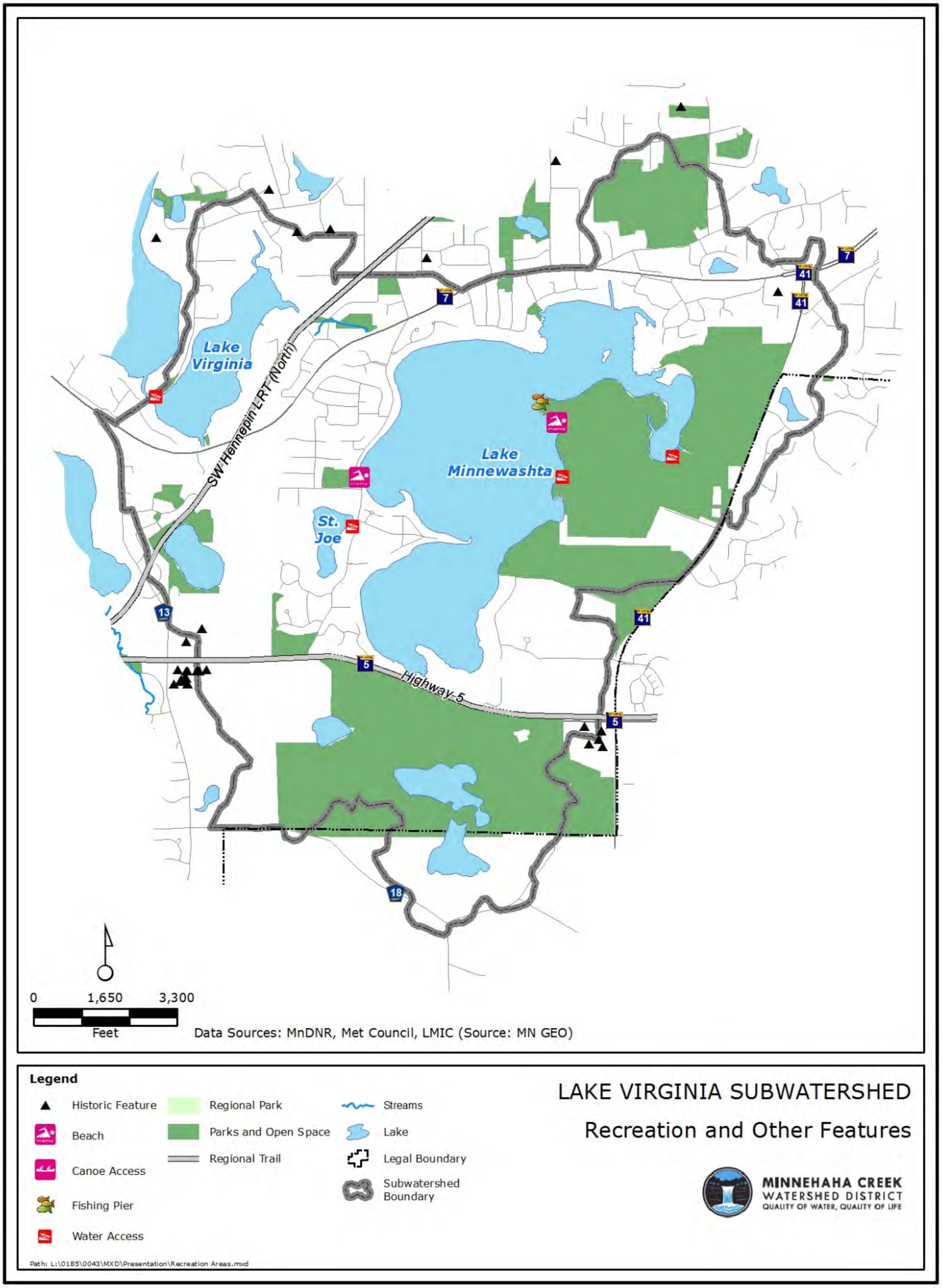

Figure 2. 50. Lake Virginia subwatershed recreation and other features.

2.3.6 LANGDON LAKE SUBWATERSHED

The land cover in the Langdon Lake Subwatershed is dramatically different between Minnetrista and Mound. In Minnetrista, the western portion of the subwatershed, there is a mix of woodlands, forests, grasslands, wetlands (Flanagan and Saunders), and agricultural land use. In Mound, the eastern portion of the subwatershed, there are wetlands adjacent to Langdon Lake with the remaining land cover dominated by residential and commercial/institutional use. The Dakota Rail line runs north of Saunders and Langdon lakes. Langdon Lake inlet (CLA02) drains the subdivisions around Saunders Lake and flows through a wetland before reaching Langdon Lake. The lake outlet (CLA01) flows into Lost Lake wetland complex and eventually into Cooks Bay, Lake Minnetonka. Table 2.50 below shows the area of the Langdon Lake subwatershed in acres by individual city, in total and as a percentage of the total subwatershed (Figure 2.51).

Table 2. 50. Cities in the Langdon Lake subwatershed.

City	Area (Acres)	% of Subwatershed
Minnetrista	539.3	51%
Mound	516.3	49%
Total	1,055.6	100%

Source: MCWD

Subwatershed Description and Hydrology:

The topography of the Langdon Lake subwatershed is rolling and hilly with steep slopes abutting Lake Flanagan and its associated wetlands and abutting the shores of Saunders Lake. The subwatershed is bisected by a railroad corridor, which influences its hydrology. The Langdon Lake subwatershed is notable for its ecological resources and large wetlands. The northwestern part of the subwatershed, which includes several areas of high-value woods, grassland, and wetland, has been acquired by the Three Rivers Park District and incorporated into Gale Woods Regional Park.

Land cover is classified by the Minnesota Land Cover Classification System (MLCCS) (Figure 2.52). The eastern subwatershed is mostly developed at typical suburban densities, and has varying degrees of imperviousness. The western half of the subwatershed is dominated by a mosaic of forest and woodland, wetland and open water, with some agriculture in the southwest and some scattered, large-lot residential development.

Soils within the watershed are predominantly well-drained Natural Resources Conservation Service Hydrologic Soil Group B (loamy soils with moderate infiltration potential), with pockets of poorly-drained soils of varying infiltration potential. Group D soils (clayey soils with very low infiltration potential) are found in low-lying areas and are generally hydric, or showing indications of inundation. For further information regarding geology and soils in the subwatershed, please refer to the *2007 MCWD Comprehensive Water Resources Management Plan*.

Langdon Lake is the primary receiving water within the subwatershed. Two other receiving waters within the subwatershed carry the informal designation of a lake: Saunders Lake and Lake Flanagan (note: has been known as Black Lake), both of which are classified as wetlands. There is a small channel that conveys discharge from the outlet of Saunders Lake to Langdon Lake.

The *2003 MCWD Hydrologic, Hydraulic, and Pollutant Loading Study (HHPLS)* subdivided the Langdon Lake subwatershed into five subwatershed units, designated LL-1 through LL-5 (Figure 2.53).

Figure 2. 51. The Langdon Lake subwatershed.

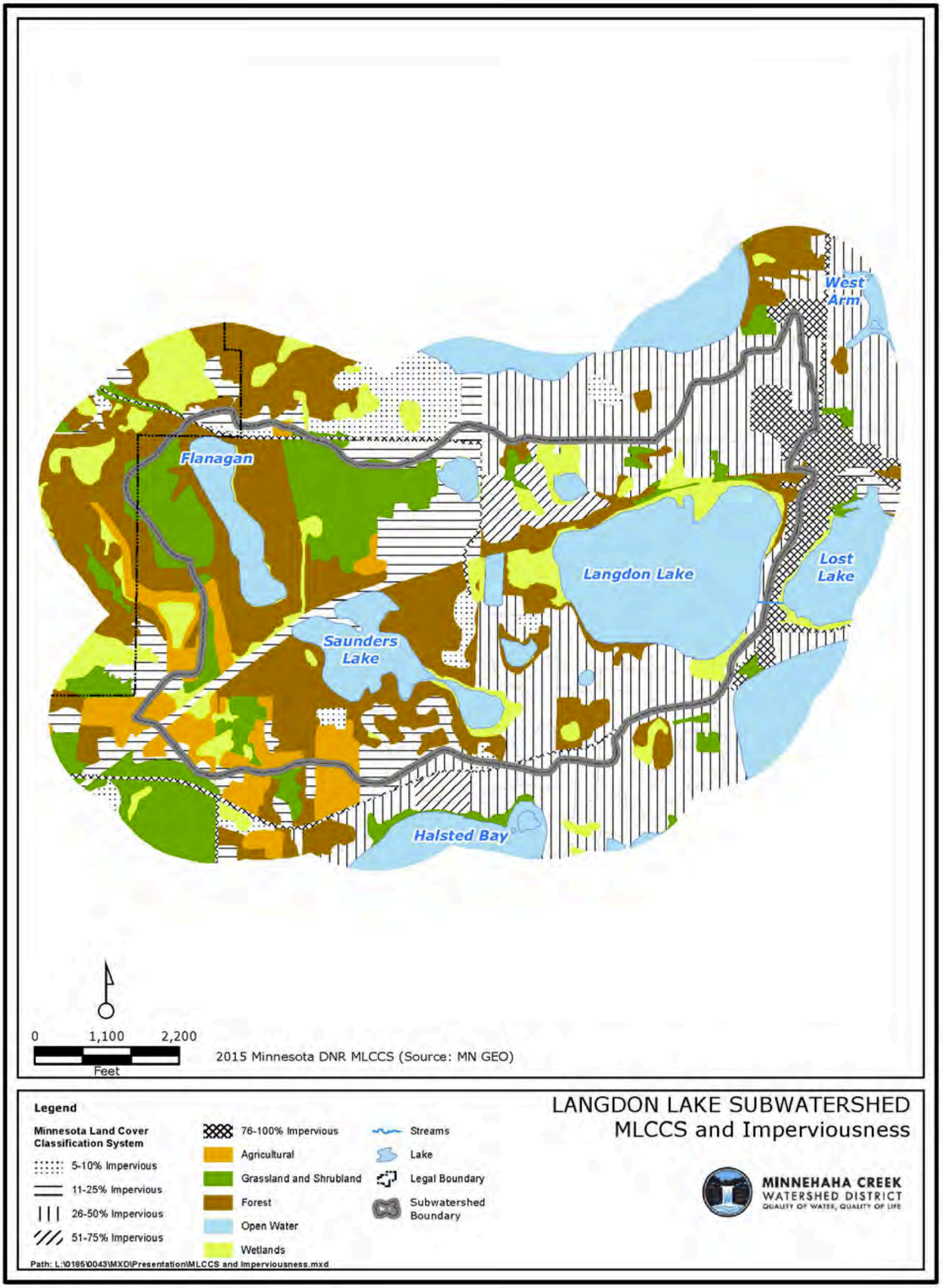

Figure 2. 52. Langdon Lake subwatershed MLCCS and imperviousness.

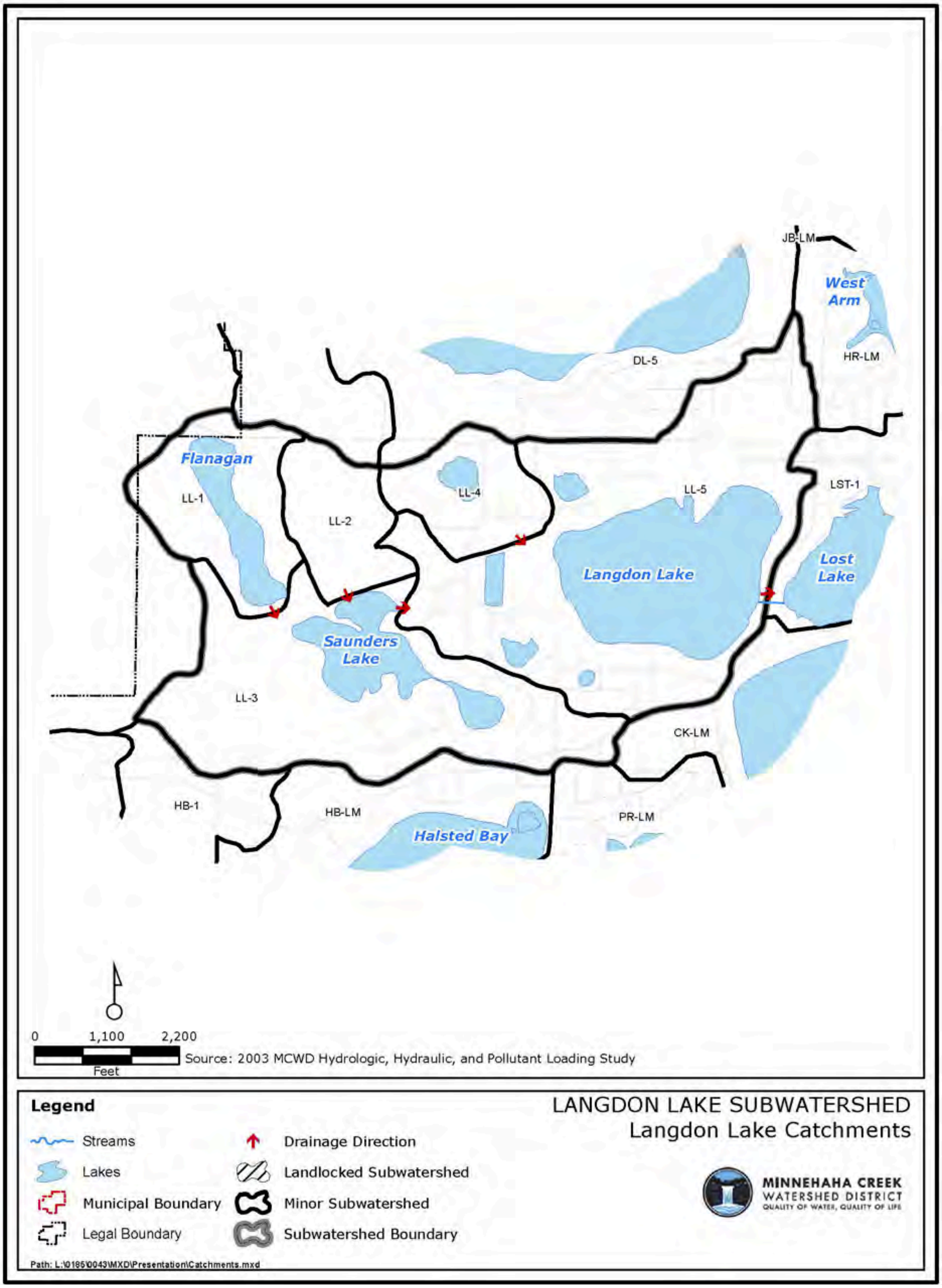

Figure 2. 53. Langdon Lake subwatershed catchments.

Water Quality:

The following are summaries of the characteristics and classifications of lakes and streams within the subwatershed including water quality goals and trends.

Lakes:

Langdon Lake is the primary receiving water within the subwatershed, and is classified by the DNR for shoreland management purposes as a Recreational Development lake (Table 2.51). Two other receiving waters within the subwatershed carry the informal designation of lake: Saunders Lake and Flanagan Lake. Saunders Lake is a large, Type 5 wetland, classified as a Natural Environment lake while Flanagan Lake is a multi-type wetland with a small area of Type 5 open water.

Langdon Lake is listed on the State's Impaired Waters list, with average summer nutrient concentrations greater than the state standard. To assess long-term change, a Mann-Kendall statistical trend test was performed on total phosphorus (TP), chlorophyll-a (Chl-a), and Secchi depth from 2001-2015. There were no statistically significant changes in water quality in Langdon Lake over this period. Tables 2.51 and 2.52 below detail the physical and water quality characteristics of Langdon Lake and other lakes within the subwatershed. For more information regarding water quality in the subwatershed, please refer to the District's Water Quality (Hydrodata) reports and the Upper Minnehaha Creek Watershed Lakes TMDL.

Table 2. 51. Physical characteristics of lakes in the Langdon Lake subwatershed.

Lake	Surface Area (acres)	Maximum Depth (ft)	Watershed to Lake Area Ratio	DNR Classification
Langdon	144	39	8:1	Recreational Development

Source: Minnesota DNR.

Table 2. 52. Selected water quality goals and current conditions of waterbodies in the Langdon Lake subwatershed.

Waterbody	State TP Standard (µg/L)	2007 Plan Goal TP (µg/L)	Trend*	2001-2015 Summer Average		
				TP (µg/L)	Chl-a (µg/L)	Secchi (m)
Flanagan [2]	n/a	n/a	n/a	17	3	3.5
Langdon[1]	40	40	No trend	99	57	0.7
Saunders[3]	n/a	n/a	n/a	27	5	1.2

*Statistically significant at ≤ 0.05.

[1]Data are from 2001-2015, from MCWD. [2]Data are from 2009-2010. [3]Data are from 2009-2012.

Source: MCWD, Upper Minnehaha Creek Watershed Lakes TMDL, MPCA.

Streams:

There is a small channel that conveys discharge from the outlet of Saunders Lake to Langdon Lake. No water quality or flow data are available for this channel. There is a small stream (Langdon Lake outlet) that conveys flow to Lost Lake: Lake Minnetonka (Figure 2.54). At this time no streams are listed as Impaired Waters. The Langdon Lake outlet stream is within the state river eutrophication standards. Tables 2.53 and 2.54 below detail the physical and water quality characteristics of streams and tributaries within the subwatershed.

Table 2.53 shows the average concentration of TSS at the one site on the Langdon Lake outlet stream to be 16 mg/L, below the 30 mg/L state standard for this ecoregion. Maintaining sufficient dissolved oxygen (DO) is necessary to support aquatic life. The DO state standard requires the stream to never fall below 5 mg/L DO. Monitoring data show that the site on the Langdon Lake outlet stream has stayed at or above the standard the last few years for the vast majority of samples; however, it has dipped below the standard intermittently. It is assumed based on the time of year that low DO values were due to low flow and high summer temperatures.

To assess long-term change in Langdon Lake Outlet, a Mann-Kendall statistical trend test was performed on flow-corrected TP and TSS. There were statistically significant improvements in both TP and TSS concentrations over time at the Langdon Lake Outlet (Table 2.54). For more information please refer to District's Water Quality (Hydrodata) reports.

Table 2. 53. Major streams in the Langdon Lake subwatershed.

Stream	Length (mi)
Langdon Lake Outlet (CLA01)	0.4

Table 2. 54. Current conditions of streams in the Langdon Lake subwatershed.
See Figure 2.54 for monitoring locations.

Stream	Trend*	2006-2015 Annual Average			
		TP (µg/L)	TN (mg/L)	TSS(mg/L)	Cl (mg/L)**
Langdon Lake Outlet (CLA01)	Imp TSS, TP	112	1.51	17	45
Langdon Lake Inlet (CLA02)	n/a	108	0.943	7	23

TP = total phosphorus, TN =total nitrogen, TSS = total suspended solids, Cl = chloride, Imp = Improving
*Statistically significant at ≤ 0.05, **Cl data from 2008-2015.
Source: MCWD.

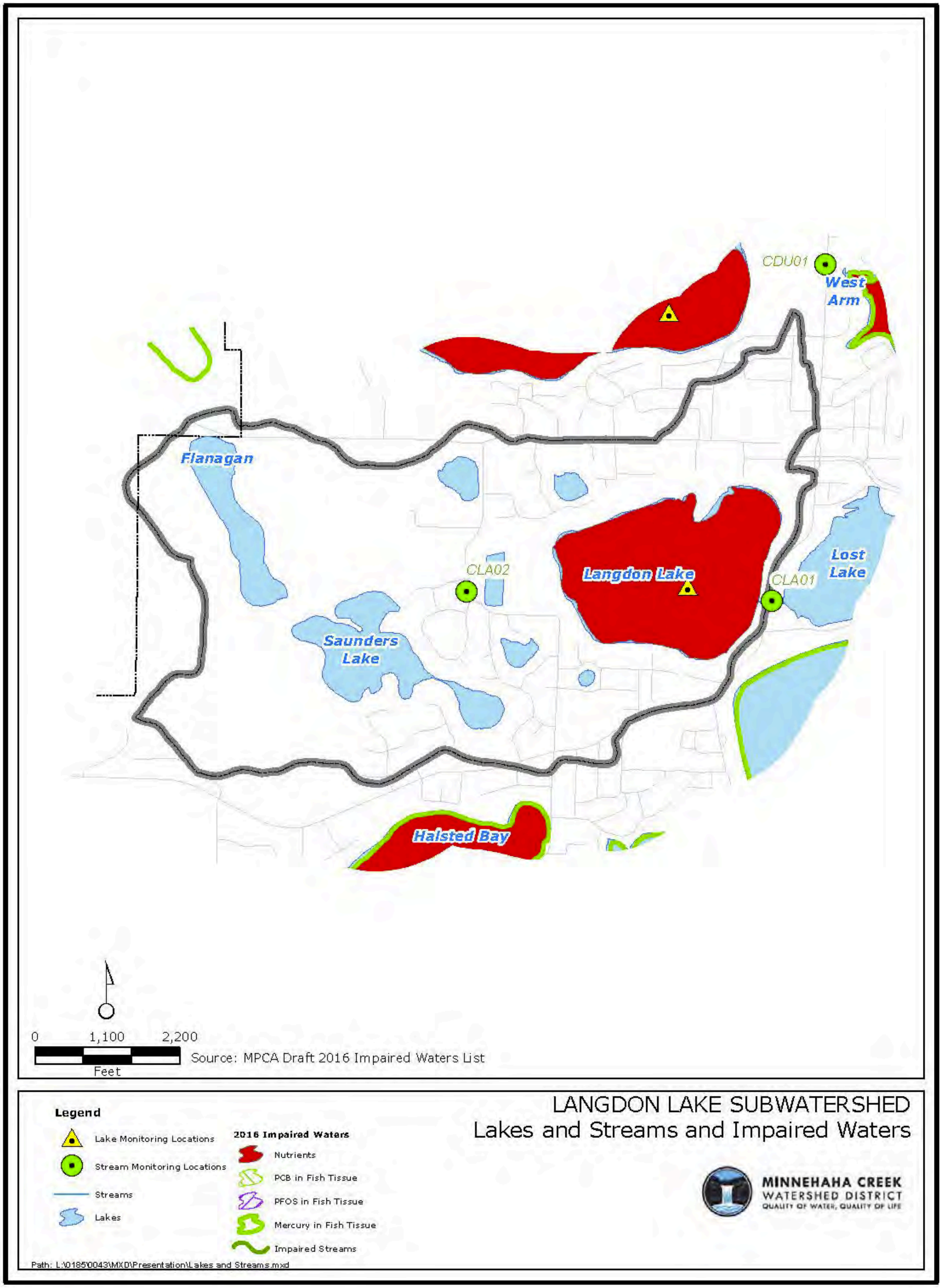

Figure 2. 54. Langdon Lake subwatershed lakes and streams and Impaired Waters.

Wetlands:

According to the FAW, wetlands, including lakes, cover 10.7 percent of the subwatershed's surface (Figure 2.55 and Table 2.55). A delineation of wetland boundaries is required to be completed any time development or other impacts may occur near or in a wetland. For more information regarding wetlands in the subwatershed, please refer to the *2007 MCWD Comprehensive Water Resources Management Plan*.

No data are available yet to evaluate the ability of the wetlands in the subwatershed to cycle nutrients. E-Grade will assess wetland soil chemistry, overall vegetative conditions, presence or absence of algal blooms, and condition of the buffer and area within 500 feet of the wetlands.

Table 2. 55. Functional Assessment of Wetlands inventory of wetland types in the Langdon Lake Creek subwatershed.

FAW Circular 39 Wetland Type	Area (acres)	Percent
1 - Seasonal	0.8	0.10
2 - Wet Meadow	6.2	0.75
3 - Shallow Marsh	16.7	2.02
4 - Deep Marsh	57.7	6.98
5 - Open Water	3.5	0.42
6 - Scrub Shrub	3.6	0.44
7 - Forested	-	
8 - Bog	-	-
Riverine	-	-
Wetland Total	88.4	10.7
Upland	735.3	89.3
TOTAL	823.7	

Source: MCWD Functional Assessment of Wetlands.

Groundwater:

The District's roles in managing groundwater are to 1) promote surficial groundwater recharge to protect wetland hydrology and stream baseflow, and 2) assist in protecting deeper aquifers used for drinking water by limiting infiltration in sensitive recharge areas.

Upland areas within the subwatershed have low to medium infiltration potential, with an area of high infiltration potential to the south and west of Langdon Lake in an area of ice-stratified sand and gravel till. The *Hennepin County Geologic Atlas* classifies most of the western subwatershed area as being of low sensitivity to pollution, while the area around Langdon Lake is variously medium to high to very highly sensitive, especially in the areas of gravel till deposits.

Part of the Langdon Lake subwatershed has been designated by the Minnesota Department of Health (MDH) as Drinking Water Supply Management Areas (DWSMA) and Wellhead Protection Areas (WHPA) City of Mound and City of Minnetrista municipal wells. The MDH has designated this area to be of low to moderate risk of contamination of the drinking water supply. Figure 2.56 shows areas in the subwatershed with groundwater sensitivity and that are designated Wellhead Protection Areas.

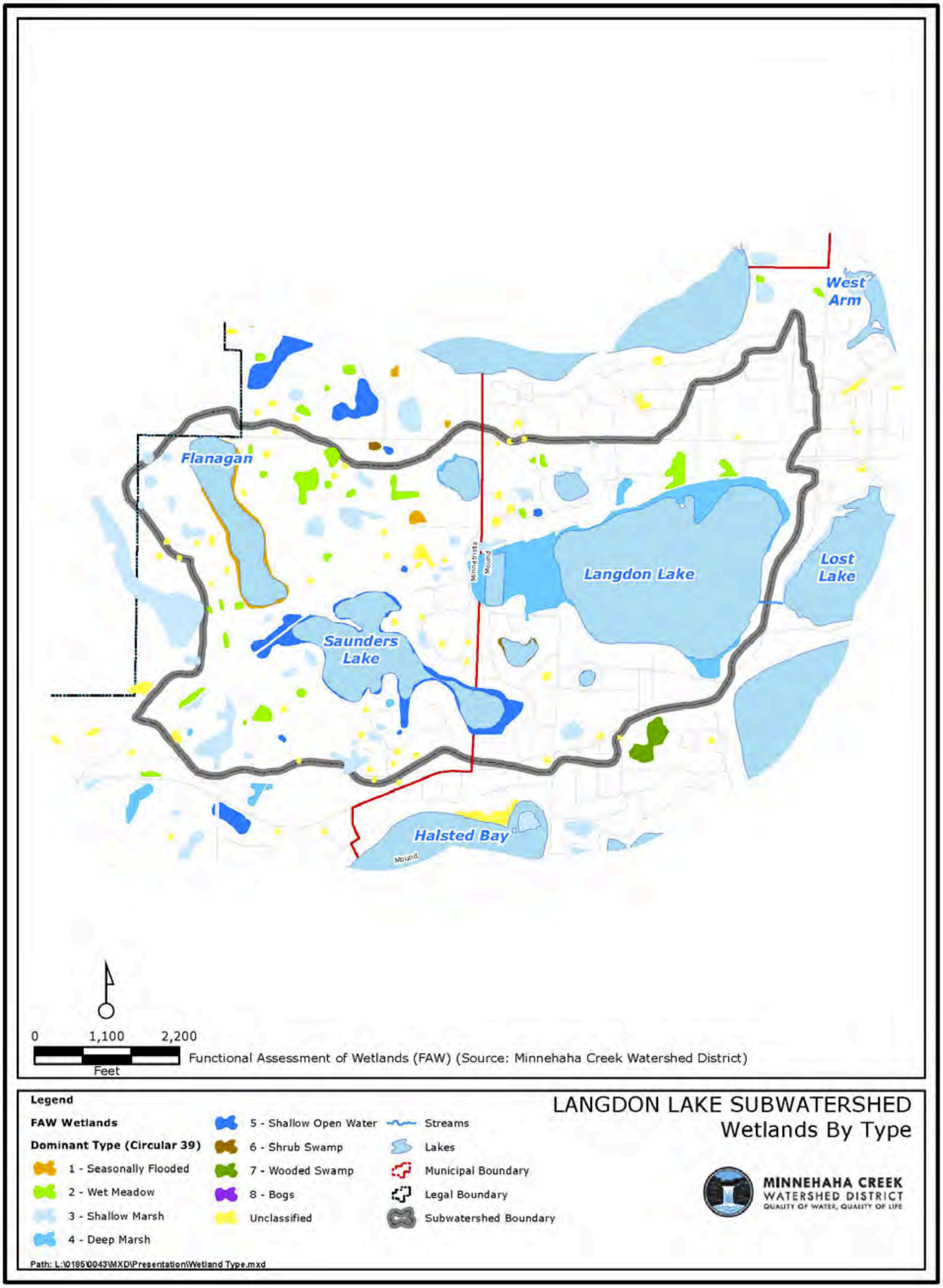

Figure 2. 55. Langdon Lake subwatershed wetlands by type.

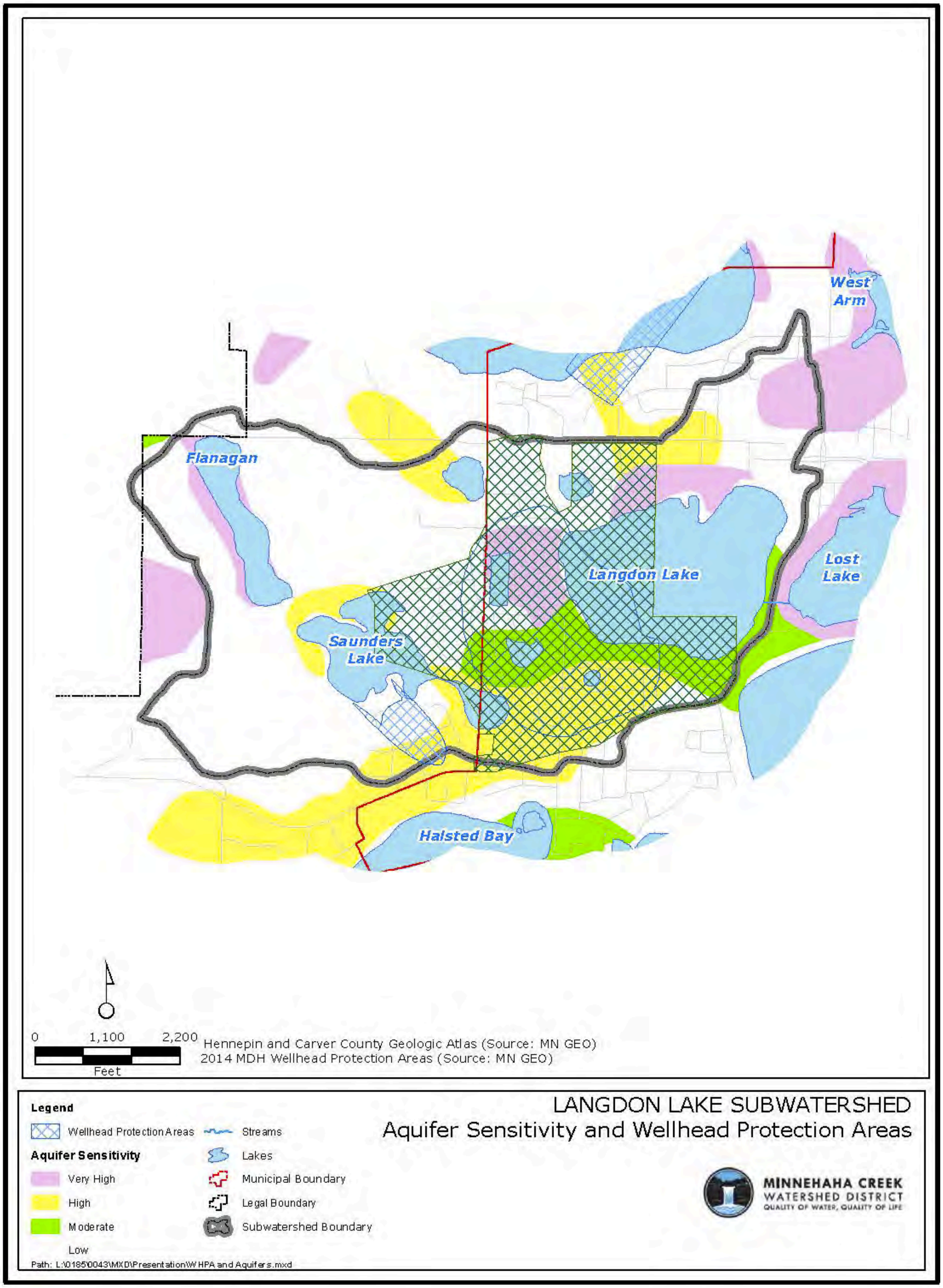

Figure 2. 56. Langdon Lake subwatershed aquifer sensitivity and Wellhead Protection Areas.

Water Quantity:

LL-1 and LL-2 drain to Saunders Lake, a large wetland complex that is discharged through a small channel to Langdon Lake. Langdon Lake discharges through a culvert under Highway 110 into Lost Lake, which outlets into Cooks Bay: Lake Minnetonka. The subwatershed is bisected by a railroad corridor, which influences its hydrology (Figure 2.53).

To assess change in water yield, a Mann-Kendall statistical trend test was performed on annual water-yield data for the monitoring station at the outlet of Langdon Lake. Water yield for 2006-2015 did exhibit statistically significant ($p = 0.03$) increasing trend indicating that there has been a significant change in outflow over the past ten years.

Ecological Integrity:

The E-Grade program defines watershed ecological integrity as the degree to which the watershed provides three key ecosystem services: biodiversity, habitat diversity, and nutrient cycling. Nutrient cycling is described in the Water Quality section. The Langdon Lake subwatershed has not yet been evaluated by the E-Grade program. This section summarizes ecological integrity using existing data, where available (Figure 2.57).

Lakes:

Biodiversity

Fish Community. No fish IBI data are available for the lakes in this subwatershed. The most recent DNR fish survey of Langdon Lake was conducted in 1993. At that time the fish population was dominated by black bullhead, a fish that is typical of turbid waters, and various species of sunfish.

Aquatic Vegetation Community. Biodiversity is determined by the number and variety of species, or richness. The most recent survey was conducted in 2015 with 6 species observed. The Floristic Quality Index (FQI) score from the 2015 survey was 12.7 – Degraded. The E-Grade indicates the aquatic vegetation community has very low species diversity with non-native and/or intolerant species, most disturbed communities present. By observation, the turbidity of the water limits the growth of aquatic macrophytes that in turn limits the fishery.

Aquatic Invasive Species. Curlyleaf Pondweed is confirmed in Langdon Lake. Eurasian watermilfoil is confirmed in Saunders Lake.

Habitat diversity

Aquatic Vegetation Community. Habitat diversity is determined by the percent occurrence of species, or the extent to which it may be dominated by a few species. The vegetation community has not been assessed yet for habitat diversity.

Shoreline Health. Shoreline health is assessed looking at shoreline vegetative cover and the relative human disturbance. The MnDNR is using the Score the Shore protocol to relate shoreline conditions to fish community structure using the fish IBI metric. No Score the Shore data are available; however, aerial photos show that around Saunders Lake the majority of the shoreline has wooded or wetland fringes as does the northern half of Langdon Lake. Flanagan Lake (a wetland) has a fully intact wooded or vegetated fringe. Fridge is beneficial for controlling runoff and supporting emergent vegetation at the shoreline.

Streams:

Biodiversity

Fish Community. There are no fish data for any of the streams in this subwatershed.

Macroinvertebrate Community. There are no macroinvertebrate data available for the streams in this subwatershed.

Aquatic Invasive Species. There are no AIS data for any of the streams in this subwatershed.

Habitat diversity

Habitat Complexity. No Minnesota Stream Habitat Assessment data are available to assess habitat complexity for the unnamed stream within the subwatershed. By observations, the creek is a straight ditch and is not deep or wide.

Connectivity. Connectivity is defined by two metrics: presence or absence of barriers, and access to floodplain. Barriers such as dams, weirs, and culverts limit or prevent organisms from moving freely in the stream. There are no identified barriers along the unnamed stream within the subwatershed.

Water Quality. Water quality factors impacting stream habitat diversity include concentrations of TSS and DO. Higher TSS concentrations increase turbidity, which can interfere with aquatic predators seeking their prey and which can limit growth of aquatic vegetation. Refer to Water Quality section for data.

Hydrology Indicators. Stream hydrology is an important factor in habitat diversity. A stream that is very flashy, that is, one that rises and falls very quickly in response to rain events, can be stressful to organisms. In addition, streams that periodically are dry or have minimal flow are hostile to aquatic life. Continuous streamflow data are not available, but instantaneous flow measured since 2006. Annual average flow for each year was computed first, and then all the years' averages were averaged together. Annual average flow at CLA01 was 1.18 cfs indicating generally low flow conditions at time of data collection.

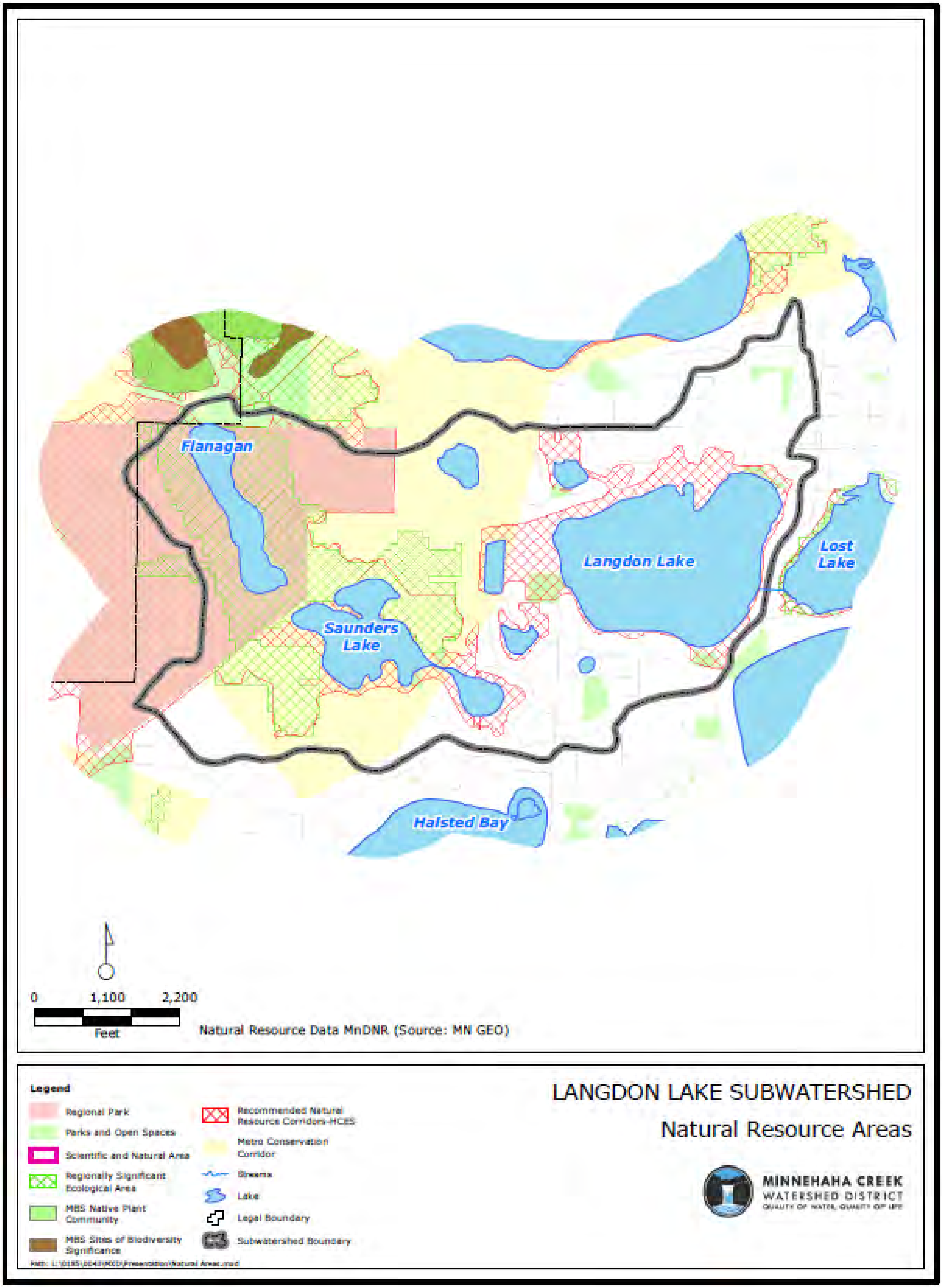

Figure 2. 57. Langdon Lake subwatershed natural resource areas.

Wetlands:

Biodiversity

Vegetation Community. No FQI data are available for the wetlands in this subwatershed. The *Functional Assessment of Wetlands* has classified several wetlands as having high vegetative diversity and wildlife habitat potential as well as having exceptional aesthetic and fish habitat values. The highest vegetative diversity was found in the wetland complex associated with Flanagan Lake within the Gale Woods Regional Park and the wetlands riparian to Saunders Lake. The wetlands riparian to Saunders and Langdon Lakes were evaluated as having high fish habitat values. There are four wetlands in the subwatershed that were identified as being of high restoration potential; three are located in Gale Woods Regional Park.

Macroinvertebrate Community. No macroinvertebrate data are available for the wetlands in this subwatershed.

Habitat diversity

Connectivity. While there are high quality wetlands within this subwatershed, the elevated Dakota Rail Regional Trail limits connectivity between the major wetlands.

Size. Larger wetlands are more likely to support a notable on-site diversity and/or abundance of wildlife species. There are several large wetland complexes in the subwatershed, including Flanagan Lake, a multi-type wetland with a small area of Type 5 open water, and Saunders Lake, a large Type 5 wetland.

Shoreline Protection. Riparian wetlands can provide significant shoreline protection and support emergent vegetation at the shoreline. The *Functional Assessment of Wetlands* evaluated riparian wetlands for their ability to protect lake or stream shoreline. Approximately 75 percent of the Langdon Lake shoreline is protected by wetlands, especially present in the west and north. About 60 percent of the shoreline around Saunders Lake, especially the southern eastern-most lobe is protected by wetlands, some of which front residential development. Lastly, Flanagan Lake itself is classified as a wetland.

Uplands:

Biodiversity

A portion of the western subwatershed is within Gale Woods Regional Park. The western half of the subwatershed is dominated by a mosaic of forest and woodland, wetland, and open water, with some agriculture in the southwest and some scattered, large-lot residential development. Existing data sources do not highlight any other unique or scenic areas in this subwatershed.

The Minnesota Biological Survey (MBS) did not identify any terrestrial or aquatic locations in the watershed with intact native plant communities, or those with biodiversity significance (Figure 2.57). However, the largely intact open space surrounding Flanagan Lake and the north and west sides of Saunders Lake are classified as a Regionally Significant Ecological Area.

Habitat diversity

Regionally significant ecological areas are places where larger tracts of minimally disrupted land provide habitat complexity. Nearly the entire western portion of the subwatershed has been identified as important conservation corridors worthy of protection by Hennepin County and the Metropolitan Council. The wide wetland areas along the western and northern areas of Langdon Lake have also been identified. The Dakota Rail Regional Trail may act as a barrier to wildlife migration between the north and south halves of the subwatershed.

Thriving Communities:

Land use:

Table 2.56 shows the land uses within the subwatershed in acres and as a percentage of the total subwatershed. The principal land use in the eastern part of the subwatershed is single family residential, with some vacant or undetermined land that is predominately wetland (Figure 2.58). The western watershed is dominated by Gale Woods Regional Park, Flanagan Lake and Saunders Lake and their associated wetlands, other wetlands, and some remaining agriculture and undeveloped land. The western subwatershed is outside the 2020 Metropolitan Urban Service Areas (MUSA).

Table 2. 56. 2016 land use in the Landon Lake subwatershed.

Land Use 2016	Acres	% of Subwatershed
Single - Family Residential	340.1	32.2
Water	234.8	22.2
Parks and Open Space	219.7	20.8
Vacant or Undetermined	188.9	17.9
Agricultural	18.8	1.8
Multi - Family Residential	15.8	1.5
Commercial	13.5	1.3
Industrial	12.2	1.2
Institutional	11.7	1.1

Source: Metropolitan Council.

Recreation:

The Langdon Lake subwatershed is notable for its ecological resources and large wetlands. The northwestern part of the subwatershed includes several areas of high-value woods, grassland, and wetland, and has been acquired by the Three Rivers Park District and incorporated into Gale Woods Regional Park. The Dakota Rail Regional Trail bisects the subwatershed, offering views of Langdon and Saunders Lakes.

There is no public boat access to Langdon Lake (Figure 2.59). There is City of Mound-owned open space on the west side of the lake, adjacent to a Metropolitan Council Environmental Services wastewater handling site, but there are no trails or other improvements. There are no public beaches on the lake; however, there is one small park. The City of Minnetrista operates Cusoke Park adjacent to Saunders Lake, a pedestrian trail and boardwalk which cross the "narrows" at the south end of the lake. Activities are limited to hiking/biking and viewing.

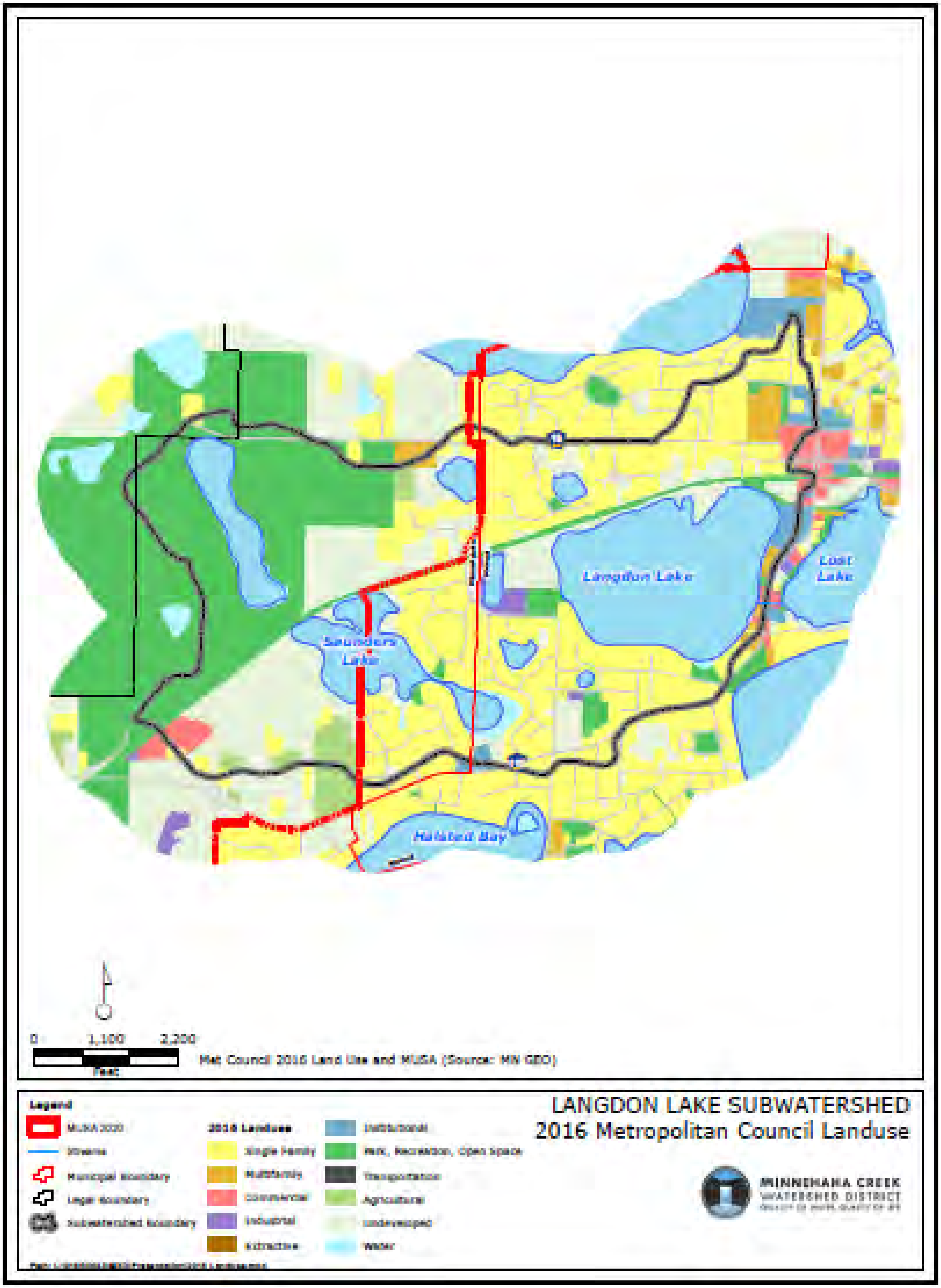

Figure 2. 58. Langdon Lake subwatershed 2016 Metropolitan Council land use.

Figure 2. 59. Langdon Lake subwatershed recreation and other features.

2.3.7 LONG LAKE CREEK SUBWATERSHED

The Long Lake Creek Subwatershed has a mix of land use with agricultural and open space and residential/business development in the south. The land cover is a mix of wetlands, forests, woodlands, grasslands and impervious cover. About 1600 acres drain into the primary inlet of Long Lake (CLO05). Long Lake drains south into wetland that discharges into Lake Minnetonka: Tanager Lake (CLO03). The creeks in the Long Lake Subwatershed are intermittent with loading influenced by precipitation and flow. Tanager Lake's inlet is also influenced by the water level of Lake Minnetonka, which produces backflow conditions. Table 2.57 below shows the area of the Long Lake Creek subwatershed in acres by individual city, in total and as a percentage of the total subwatershed (Figure 2.60).

Table 2. 57. Cities in the Long Lake Creek subwatershed.

City	Area (Acres)	% of Subwatershed
Long Lake	607.3	8.0
Medina	3,831.0	50.3
Orono	3,141.8	41.2
Plymouth	39.4	0.5
Total	7,619.4	100%

Source: MCWD

Subwatershed Description and Hydrology:

The eastern half of the subwatershed is gentle rolling hills with an abundance of lakes and ponds, reflected in the area's many wetlands. The western half is generally comprised of circular, level-topped hills.

Land cover is classified by the Minnesota Land Cover Classification System (MLCCS) (Figure 2.61). The subwatershed is mostly developed in the south with low to medium density impervious surface typical of residential development. The City of Long Lake is located along the southern shore of its namesake lake. The area north of Long Lake is much less densely developed, punctuated with agriculture – mostly pastures and orchards with some row crops - as well as large open areas of forest and wetlands.

Soils within the watershed are predominantly classified as Natural Resources Conservation Service Hydrologic Soil Group B (loamy soils with moderate infiltration potential) and D (clayey soils with very low infiltration potential). For further information regarding geology and soils in the subwatershed, please refer to the *2007 MCWD Comprehensive Water Resources Management Plan*.

Upstream of Long Lake, a series of channels and wetlands drain the western part of the subwatershed from School Lake through Wolsfeld Lake to Long Lake. Similarly, the eastern part of the upper subwatershed drains via a channel from Holy Name Lake through wetlands, where it discharges into the western channel just north of County Road 6. Long Lake Creek flows out of Long Lake south to Tanager Lake, which is connected by a short channel to Lake Minnetonka.

The *2003 MCWD Hydrologic, Hydraulic, and Pollutant Loading Study (HHPLS)* subdivided the Long Lake Creek subwatershed into 53 subwatershed units, designated LLC-1 through LLC-53 (Figure 2.62).

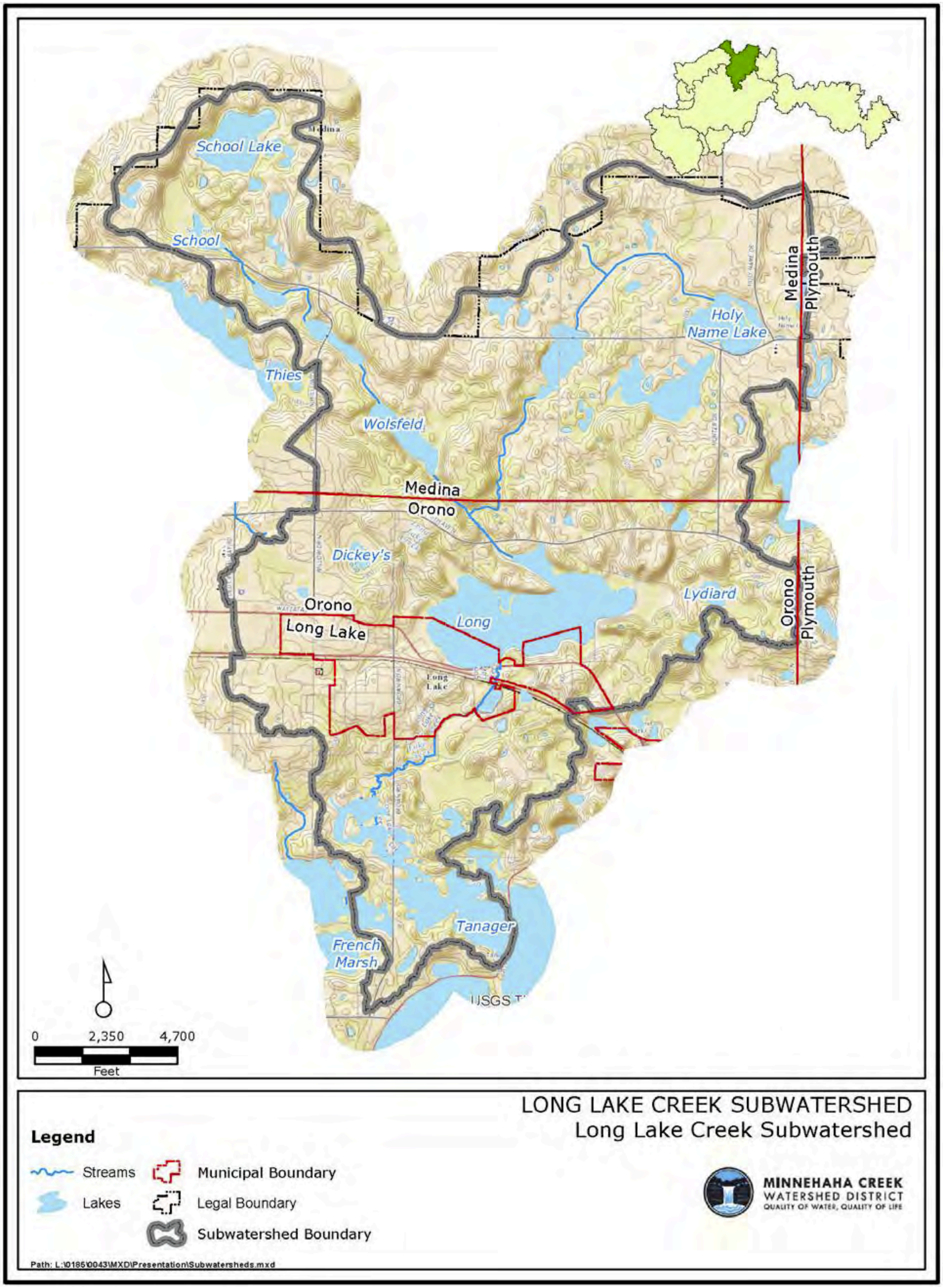

Figure 2. 60. The Long Lake Creek subwatershed.

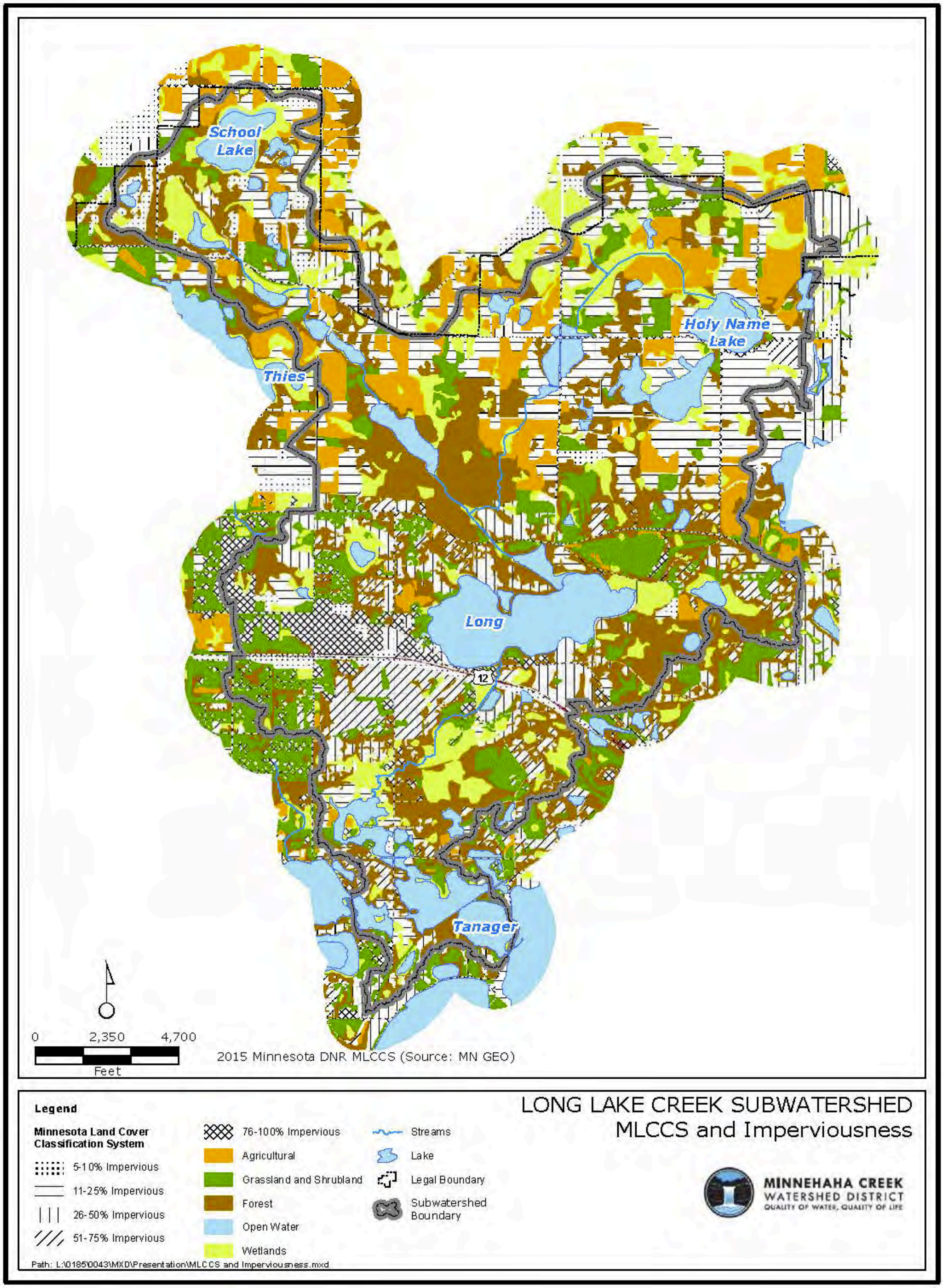

Figure 2. 61. Long Lake Creek subwatershed MLCCS and imperviousness.

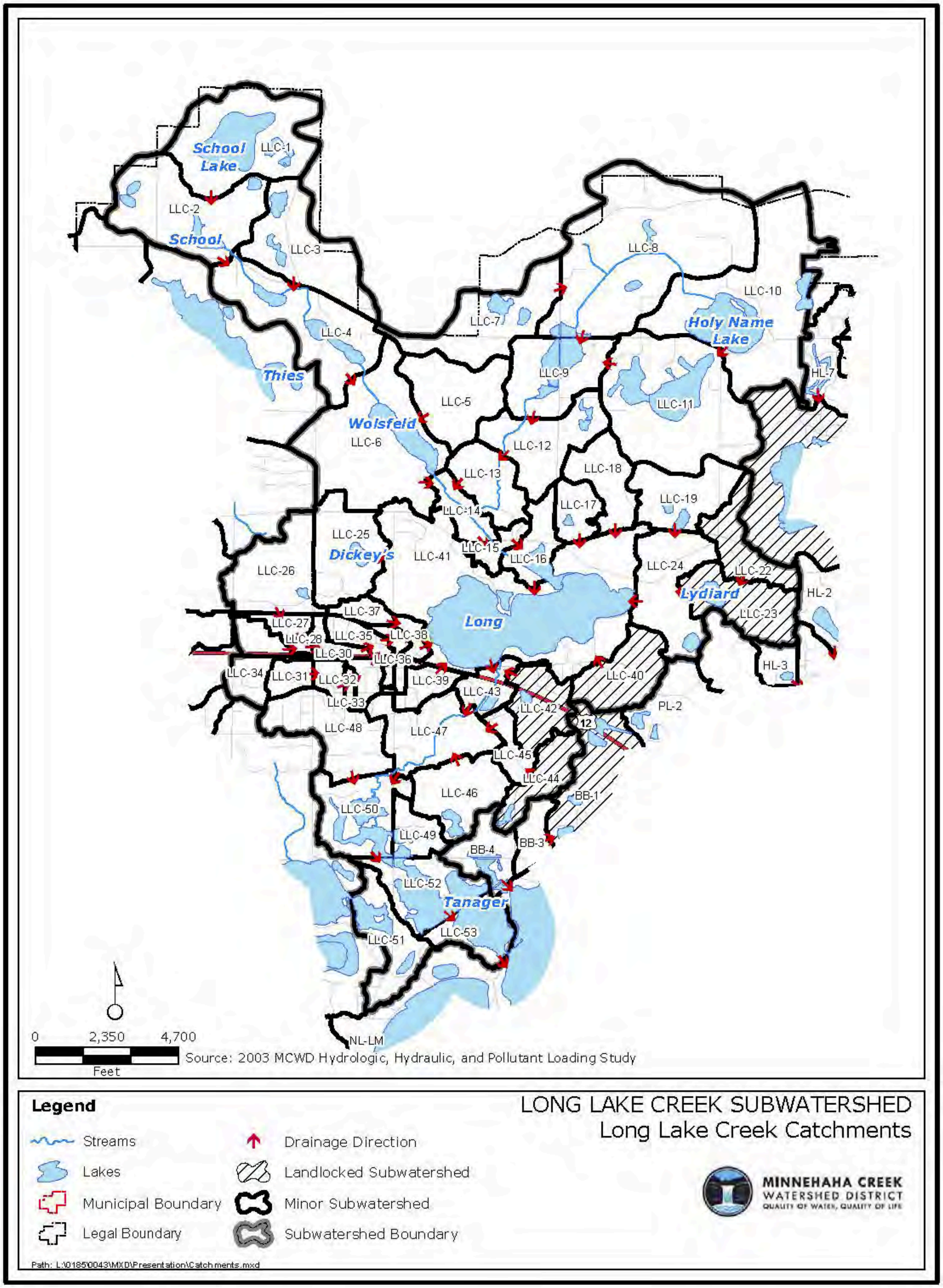

Figure 2. 62. Long Lake Creek subwatershed catchments.

Water Quality:

The following are summaries of the characteristics and classifications of lakes and streams within the subwatershed including water quality goals and trends.

Lakes:

Long Lake is the primary receiving water within the subwatershed, and is classified by the DNR for shoreland management purposes as a Recreational Development lake (Table 2.56). Six lakes in the subwatershed are listed on the State's Impaired Waters list: School, Wolsfeld, Holy Name, Long, and Tanager Lakes. Average summer nutrient concentrations are greater than the state standard with excessive nutrients being conveyed to them from the watershed for these six lakes.

To assess long-term change in lakes within the Long Lake Subwatershed, a Mann-Kendall statistical trend test was performed on total phosphorus (TP), chlorophyll-a (Chl-a), and Secchi depth from 2001-2015. There were statistically significant improvements in water clarity in Long Lake over this period, but the change is small. Tables 2.58 and 2.59 below detail the physical and water quality characteristics of Long Lake and other lakes within the subwatershed. For more information regarding water quality in the subwatershed, please refer to the District's Water Quality (Hydrodata) Reports and the Upper Minnehaha Creek Watershed Lakes TMDL.

Table 2. 58. Physical characteristics of lakes in the Long Lake Creek subwatershed.

Lake	Surface Area (acres)	Maximum Depth (ft)	Watershed to Lake Area Ratio	DNR Classification
Dickey's	12	26	13:1	Natural Environment
Holy Name	68	7	7:1	Recreational Development
Long	285	33	23:1	Recreational Development
Lydiard	33	52	26:1	Natural Environment
School	11	21	51:1	Natural Environment
Tanager	54	23	151:1	Recreational Development
Wolsfeld	34	26	47:1	Natural Environment

Source: Minnesota DNR, MCWD.

Table 2. 59. Selected water quality goals and current conditions of lakes in the Long Lake Creek subwatershed.

Lake	State TP Standard (µg/L)	2007 Plan Goal TP (µg/L)	Trend*	2001-2015 Summer Average		
				TP (µg/L)	Chl-a (µg/L)	Secchi (m)
Dickey's[1]	40	n/a	n/a	49	8.8	2.6
Holy Name[2]	60	n/a	n/a	94.82	54.2	0.9
Long	40	40-50	Imp Secchi	68	42	1.0
Lydiard[1]	40	n/a	n/a	19	4	3.0
School[3]	60	n/a	n/a	154	89	0.3
Tanager[4]	60	70	No trend	97	73	0.9
Wolsfeld[2]	40	n/a	n/a	90	59	0.7

*Statistically significant at ≤ 0.05, Imp = Improving

[1]Data are from 2009-2015. [2]Data are from 2006-2008, 2014-2015. [3]Data are from 2009-2010. [4]Data are from 2006-2015. [5]Data are from 2006-2008, 2011-2015.

Source: MCWD, Upper Minnehaha Creek Watershed Lakes TMDL, MPCA.

Streams:

There is one primary stream within the subwatershed: Long Lake Creek, which serves as the outlet of Long Lake and flows to Tanager Lake, when then discharges to Browns Bay of Lake Minnetonka. Part of the creek was channelized as County Ditch #27 in 1915. Flow to the creek is controlled by an outlet weir on Long Lake. Six storm sewer outfalls discharge into the creek. The creek flows through two large wetlands prior to discharging into Tanager Lake and then into Browns Bay (Figure 2.63).

Tables 2.60 and 2.61 below detail the physical and water quality characteristics of streams and tributaries within the subwatershed. No streams are listed as Impaired Waters, although Long Lake Creek TP is high relative to the state river eutrophication standards. However, those standards also look at other indicators such as chlorophyll-a, diel oxygen flux, and biological oxygen demand that haven't been assessed in Long Lake Creek.

Table 2.61 shows the average TSS concentrations at three sites on Long Lake Creek to be less than 10 mg/L, below the 30 mg/L state standard for this ecoregion. Maintaining sufficient dissolved oxygen (DO) is necessary to support aquatic life. The DO state standard requires the stream to never fall below 5 mg/L DO. Monitoring data show that the site above Long Lake and the site above Tanager Lake both fall below this standard at least several times per year.

To assess long-term change, a Mann-Kendall statistical trend test was performed on flow-corrected TP and TSS data from 2005-2015. There were no statistically significant changes in water quality in Long Lake Outlet over this period. For more information, please refer to the District's Water Quality (Hydrodata) reports.

Table 2. 60. Major streams in the Long Lake Creek subwatershed.

Stream	Length (mi)
Holy Name Tributary	2.24
School Lake Tributary	3.55
Long Lake Creek	1.25

Table 2. 61. Current conditions of streams in the Long Lake Creek subwatershed.
See Figure 2.63 for monitoring locations.

Stream	Trend*	2005-2015 Annual Average			
		TP (µg/L)	TN (mg/L)	TSS (mg/L)	Cl (mg/L)
Long Lake Cr –lake inlet (CLO05)	n/a	184	1.35	8	37
Long Lake Cr – lake outlet (CLO01)	n/a	85	1.40	8	49
Long Lake Cr – Tanager inlet (CLO03)	No trend	124	1.14	9	43

TP = total phosphorus, TN =total nitrogen, TSS = total suspended solids, Cl = chloride.
*Statistically significant at ≤ 0.05.
Source: MCWD.

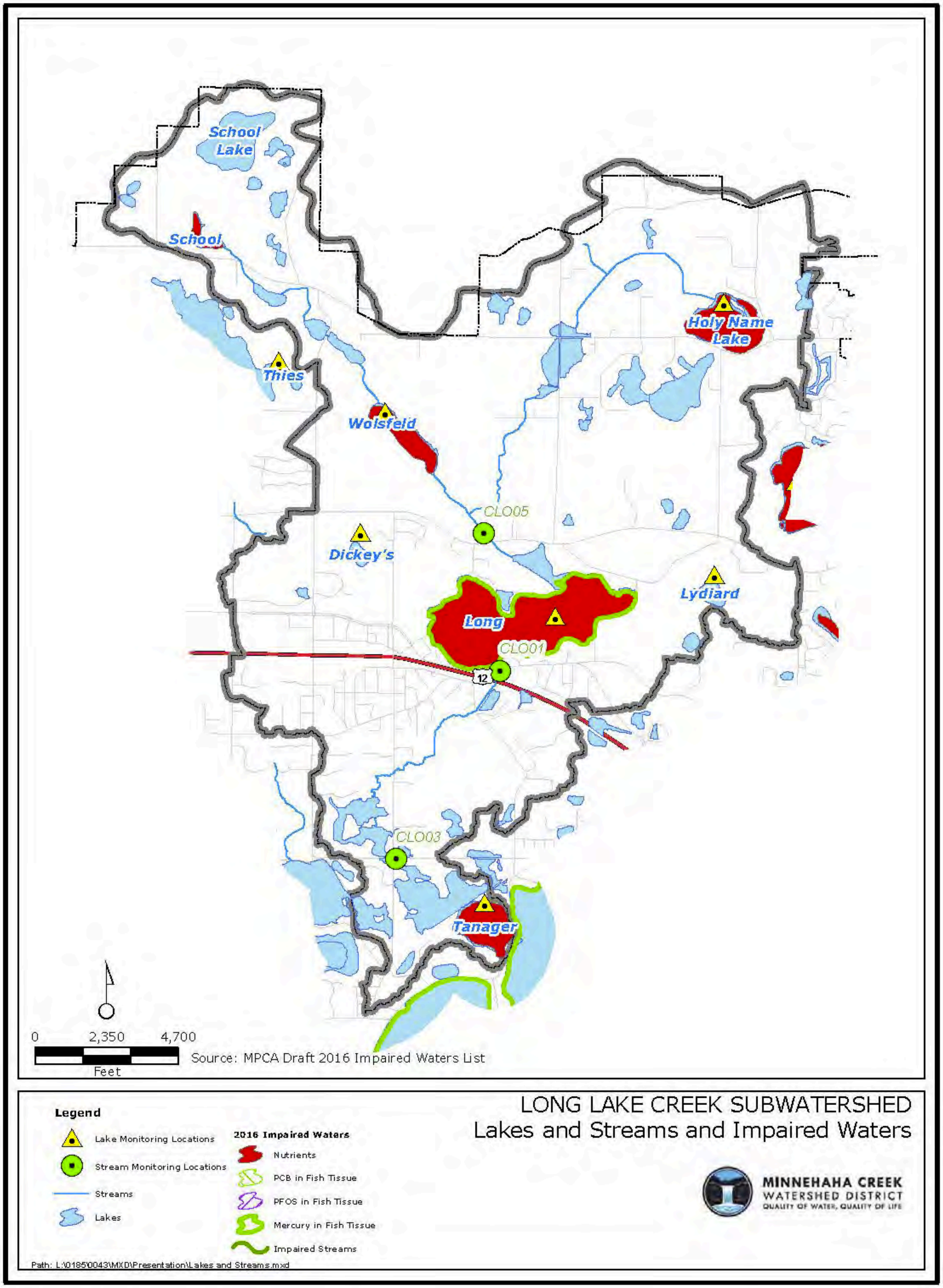

Figure 2. 63. Long Lake Creek subwatershed lakes and streams and Impaired Waters.

Wetlands:

According to the FAW, wetlands, including lakes, cover over 20 percent of the watershed's surface (Figure 2.64 and Table 2.62). A delineation of wetland boundaries is required to be completed any time development or other impacts may occur near or in a wetland. For more information regarding wetlands in the subwatershed, please refer to the *2007 MCWD Comprehensive Water Resources Management Plan*.

No data are available yet to evaluate the ability of the wetlands in the subwatershed to cycle nutrients to and from the subwatershed. E-Grade will assess wetland soil chemistry, overall vegetative conditions, presence or absence of algal blooms, and condition of the buffer and area within 500 feet of the wetlands.

Table 2. 62. Functional Assessment of Wetlands inventory of wetland types in the Long Lake Creek subwatershed.

FAW Circular 39 Wetland Type	Area (acres)	Percent
1 - Seasonal	63.5	0.80
2 - Wet Meadow	308.3	3.89
3 - Shallow Marsh	484.6	6.12
4 - Deep Marsh	28.3	0.36
5 - Open Water	205.8	2.60
6 - Scrub Shrub	388.6	4.91
7 - Forested	168.0	2.12
8 - Bog	-	-
Riverine	2.6	<0.1
Wetland Total	1,649.7	20.8
Upland	6,294.7	79.2
TOTAL	7,944.4	

Source: MCWD Functional Assessment of Wetlands.

Groundwater:

The District's roles in managing groundwater are to 1) promote surficial groundwater recharge to protect wetland hydrology and stream baseflow, and 2) assist in protecting deeper aquifers used for drinking water by limiting infiltration in sensitive recharge areas.

Areas of moderate to high or very high aquifer sensitivity roughly follow the two tributary/wetland corridors in the upper subwatershed and the Long Lake Creek corridor to Browns Bay. Elsewhere the *Hennepin County Geologic Atlas* classifies most of the upland areas as being of low to moderate sensitivity to pollution.

Portions of the Long Lake subwatershed have been designated by the Minnesota Department of Health as a Drinking Water Supply Management Area (DWSMA) and Wellhead Protection Area for City of Plymouth and City of Long Lake public wells. The MDH has designated much of this area to be of low risk and vulnerability to contamination of the drinking water supply, with a small area located in a till deposit being of moderate risk and vulnerability. Figure 2.65 shows areas in the subwatershed with groundwater sensitivity and that are designated Wellhead Protection Areas.

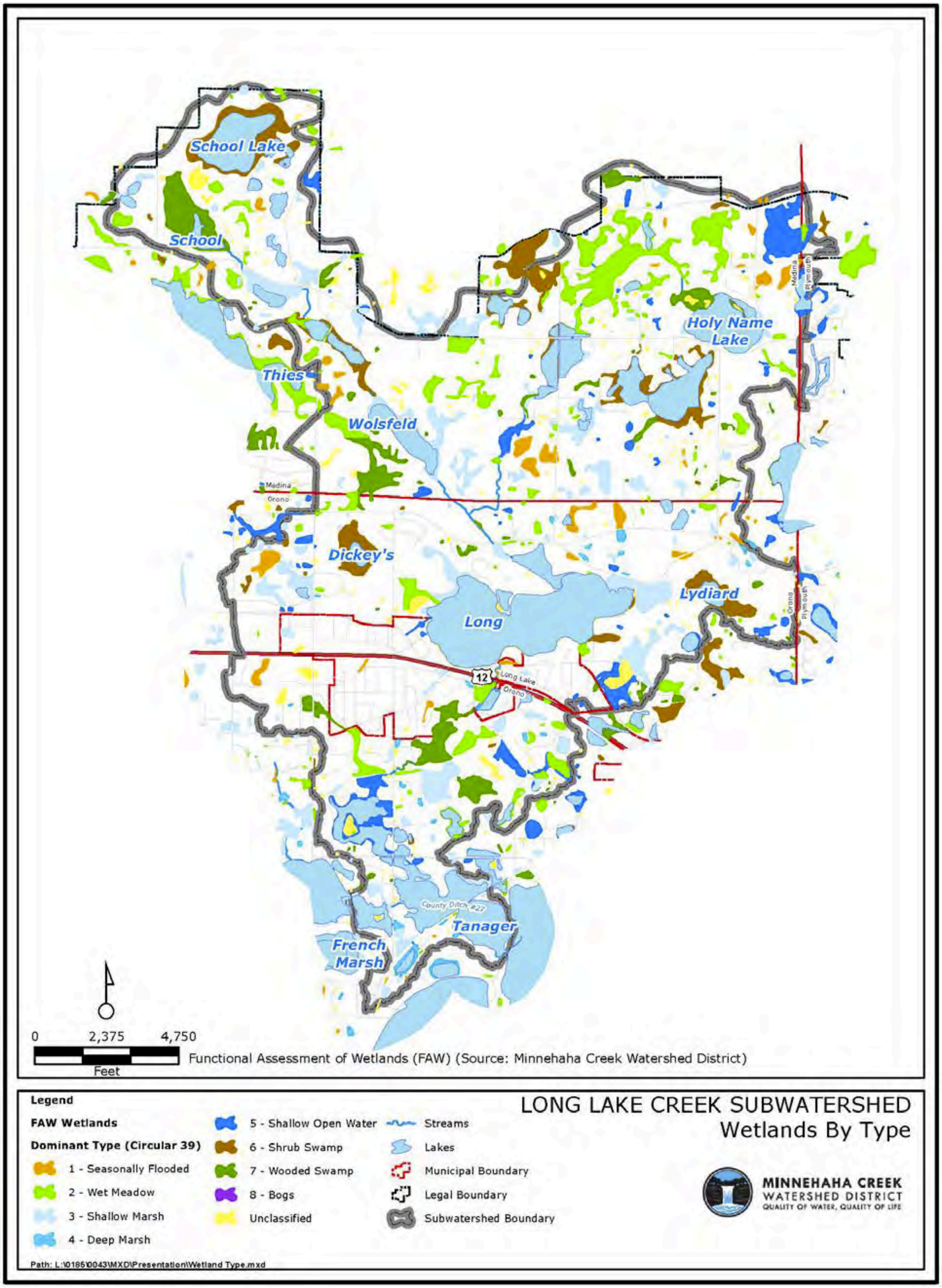

Figure 2. 64. Long Lake Creek subwatershed wetlands by type.

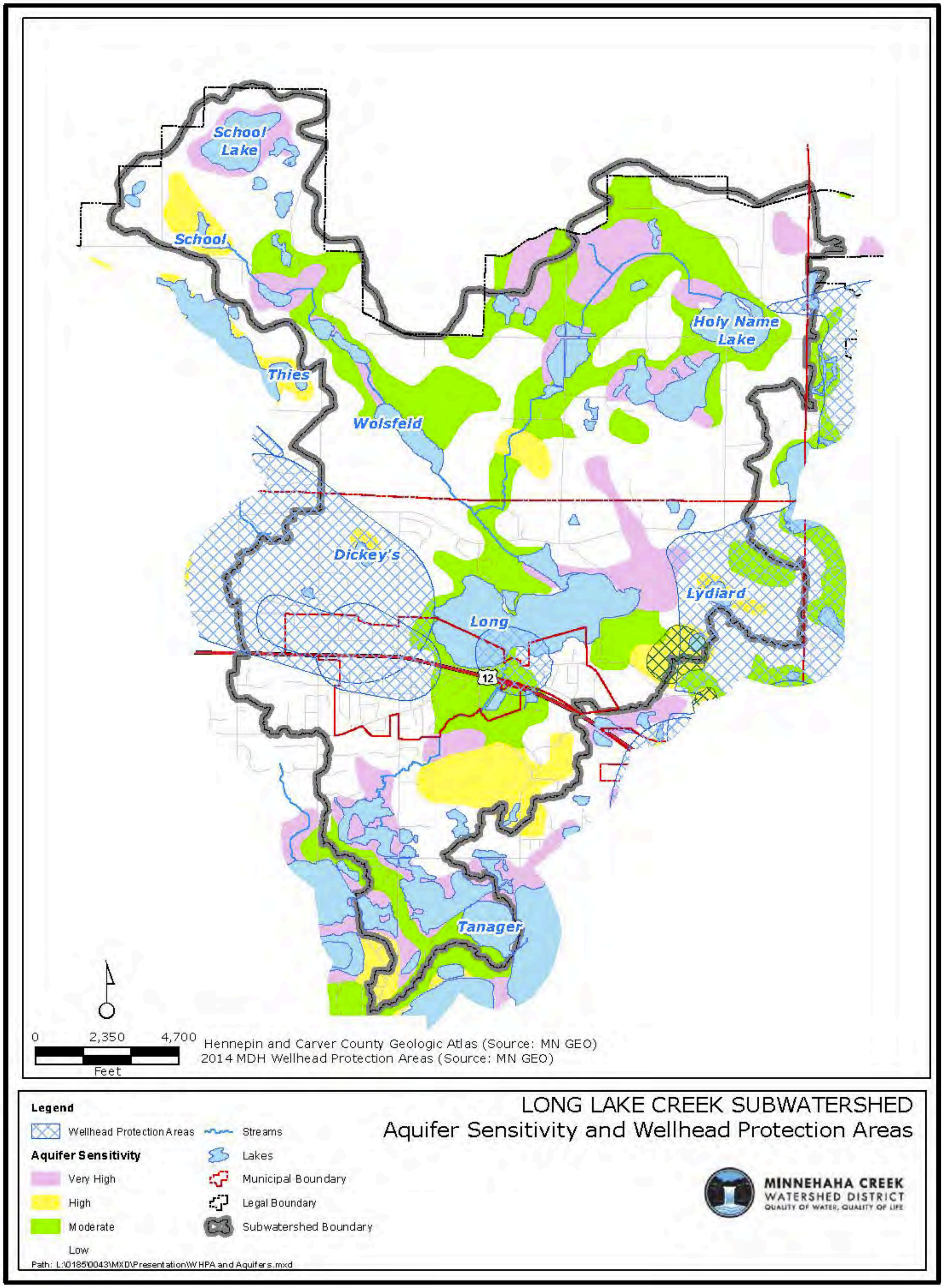

Figure 2. 65. Long Lake Creek subwatershed aquifer sensitivity and Wellhead Protection Areas.

Water Quantity:

Two significant areas within the subwatershed are landlocked. The first is units LLC-22, and 23, which include Lydiard Lake, and have no natural outlet. Units LLC-40, 42, and 43 contain wetlands that have no or limited outlet (Figure 2.62).

To assess change in water yield, a Mann-Kendall statistical trend test was performed on annual water yield data for the monitoring station upstream of Long Lake. Water yield for 2006-2015 did not exhibit any statistically significant trend upward or downward.

Ecological Integrity:

The E-Grade program defines watershed ecological integrity as the degree to which the watershed provides three key ecosystem services: biodiversity, habitat diversity, and nutrient cycling. Nutrient cycling is described in the Water Quality section. The Long Lake subwatershed has not yet been evaluated by the E-Grade program. This section summarizes ecological integrity using existing data, where available (Figure 2.66).

Lakes:

Biodiversity

Fish Community. No fish IBI data are available for the lakes in this subwatershed. Long Lake is stocked and maintained as a walleye fishery and was last surveyed by the DNR in 2013. That survey found that the walleye community was balanced, but the low dissolved oxygen and high summer temperatures were potentially limiting optimal growth and survival. The survey also found an abundant pike and panfish population. Limited fish survey data are available for the other lakes in the subwatershed.

Aquatic Vegetation Community. Biodiversity is determined by the number and variety of species, or richness. A survey was conducted on Long Lake in 2014, with 5 species observed. The Floristic Quality Index (FQI) score from the survey was 8.05 – Degraded indicating very low species diversity with non-native and/or intolerant species. The most disturbed communities present. Surveys have also been conducted on Dickey's, Lydiard and Wolsfeld. Dickey's and Wolsfeld have low biodiversity, less than 4 species observed, and an FQI score of less than 10, E-Grade = Degraded. Lydiard had 11 species observed, and a FQI score of 18.39, E-Grade = Poor, indicating obvious signs of anthropogenic disturbance. Lydiard has low species diversity often comprised of non-native and/or intolerant species.

Aquatic Invasive Species. Eurasian watermilfoil is present in Long Lake and Tanager Lake. Curlyleaf Pondweed is present in Holy Name Lake, Long Lake, and Tanager Lake. Zebra mussels are present in very low numbers in Tanager Lake. Common carp are believed to be an issue in this subwatershed, but no population data are available.

Habitat diversity

Aquatic Vegetation Community. Habitat diversity is determined by the percent occurrence of species, or the extent to which it may be dominated by a few species. This has not been assessed yet.

Shoreline Health. Shoreline health is assessed looking at shoreline vegetative cover and the relative human disturbance. The MnDNR is using the Score the Shore protocol to relate shoreline conditions to fish community structure using the fish IBI metric. No Score the Shore data are available; however, aerial photos show that many of the lakes in the subwatershed have significant woodland or wetland fringes, which are beneficial for controlling runoff and supporting emergent vegetation at the shoreline.

Streams:

Biodiversity

Fish Community. Limited fish data are available for Long Lake Creek. The DNR conducted a fish survey at one site in 2010. The fish IBI score for that survey was 40, which is on the border of Good and Poor. Fathead minnows were the most prevalent fish, a species that is tolerant of turbid, low oxygen conditions. A few lake species were also present.

Macroinvertebrate Community. Limited macroinvertebrate data are available for Long Lake Creek. The DNR conducted a survey in 2010; the IBI score for that survey was 41, which is just below the impairment threshold. The District conducted a survey at five locations on Long Lake Creek in 2013, and the IBI scores ranged from 9 to 12, well below the impairment threshold. Organisms found at these sites were very pollution-tolerant, and certain functional groups were not represented.

Aquatic Invasive Species. No AIS data are available for the any of the streams within this subwatershed.

Habitat diversity

Habitat Complexity. No Minnesota Stream Habitat Assessment data are available to assess habitat complexity, but notes taken for the 2003 *Upper Watershed Stream Assessment* were reviewed to better understand conditions in the in-stream zone and riparian zone, and to assess channel morphology. That survey found that the stream in some locations had moderately complex habitat and morphology, but there are reaches that are less complex and more altered.

Connectivity. Connectivity is defined by two metrics: presence or absence of barriers, and access to floodplain. Barriers such as dams, weirs, and culverts limit or prevent organisms from moving freely in the stream. There are several barriers on the streams in this subwatershed, most of them culverts at road or trail crossings. There are no stream cross-section data available, but notes taken for the *2003 Upper Watershed Stream Assessment* indicate the stream generally has low banks and ready access to the floodplain.

Water Quality. Water quality factors impacting stream habitat diversity include concentrations of TSS and DO. Higher TSS concentrations increase turbidity, which can interfere with aquatic predators seeking their prey and which can limit growth of aquatic vegetation. Refer to Water Quality section for data.

Hydrology Indicators. Stream hydrology is an important factor in habitat diversity. A stream that is very flashy, that is, one that rises and falls very quickly in response to rain events, can be stressful to organisms. In addition, streams that periodically are dry or have minimal flow are hostile to aquatic life. Continuous streamflow data are available at CLO01 station, and not available at CLO03 station. CLO01 station is the lake outlet, controlled by a weir, is often fast, but not flashy discharge. Instantaneous flow at CLO03 is not flashy and often has backflow, and since 2006, the CLO03 station has an average of discharge of 8.76 cfs. Note: Annual average flow for each year was computed first, and then all the years' averages were averaged together.

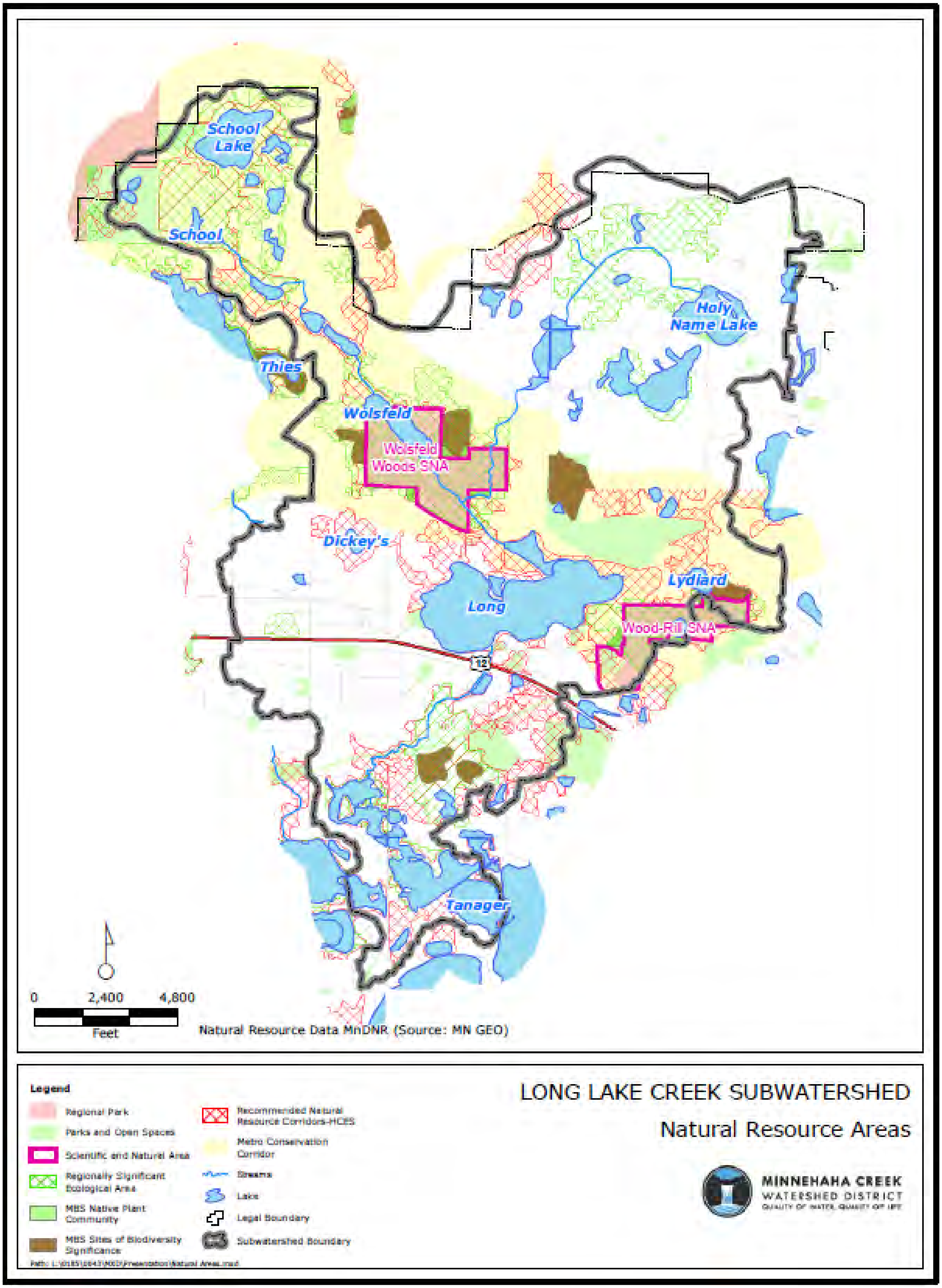

Figure 2. 66. Long Lake Creek subwatershed natural resource areas.

Wetlands:

Biodiversity

Vegetation Community. No Rapid Floristic Quality Assessment (RFQA) data are available for the wetlands in this subwatershed. However the *Functional Assessment of Wetlands* classified several large wetlands in the subwatershed as having exceptional vegetative diversity, including School Lake, wooded swamps in Wolsfeld Woods Scientific and Natural Area, and scrub shrub and wooded swamp wetlands in the Wood-Rill Scientific and Natural Area.

Macroinvertebrate Community. No macroinvertebrate data are available for the wetlands in this subwatershed.

Habitat diversity

Connectivity. There are several interconnected wetland corridors providing exceptional connectivity between wetlands of different type.

Size. Larger wetlands are more likely to support a notable on-site diversity and/or abundance of wildlife species. There are numerous large wetland complexes in the subwatershed, including wetlands along the two tributary corridors in the upper subwatershed and along Long Lake Creek.

Shoreline Protection. Riparian wetlands can provide significant shoreline protection and support emergent vegetation at the shoreline. The *Functional Assessment of Wetlands* evaluated riparian wetlands for their ability to protect lake or stream shoreline. About 22 percent of the Long Lake shoreline is protected by wetlands. About half the shoreline of Holy Name Lake and a third of Wolsfeld Lake is protected moderately well by fringing wetlands. School, Dickey's and Lydiard Lakes are ringed completely with wetlands and emergent vegetation.

Uplands:

Biodiversity

Two DNR Scientific and Natural Areas are present in the subwatershed: Wolsfeld Woods and Wood-Rill. Wolsfeld Woods is an example of the original "Big Woods" forest that once covered the south central part of the state. The large, mature stand of hardwoods covers gently rolling hills with a wide variety of tree species, including red oak, ironwood, butternut, maple, elm and basswood. Wolsfeld Lake is within this Scientific and Natural Area. Wood-Rill also preserves a remnant of the Big Woods, with land cover including maple-basswood forest, wetlands, ponds, and wet meadows. A moist lowland forest of red maple, black ash, hackberry, basswood, and green ash, grades into a small tamarack swamp at one end.

The Minnesota Biological Survey (MBS) has identified both terrestrial and aquatic locations in the watershed with intact native plant communities, and those with biodiversity significance (Figure 2.66). Native plant communities are a group of native plants that interact with each other and the surrounding environment in ways not greatly altered by humans or by introduced plant or animal species.

Habitat diversity

Regionally significant ecological areas are places where larger tracts of minimally disrupted land provide habitat complexity. These sites are numerous enough in the Long Lake Creek subwatershed that Hennepin County and the Metropolitan Council have identified several corridors within the subwatershed as important conservation corridors.

Thriving Communities:

Land use:

Table 2.63 shows the land uses within the area of the Long Lake Creek subwatershed in acres and as a percentage of the total subwatershed. The predominant land use in the subwatershed is vacant or undetermined use, mainly large wetland or woodland tracts (Figure 2.67). Single family residential dominates the central and eastern subwatershed. There is a commercial and industrial corridor along US Highway 12, in the City of Long Lake. Some large agricultural parcels remain in the upper subwatershed, mainly row crops and hobby farms.

Table 2. 63. 2016 land use in the Long Lake Creek subwatershed.

Land Use 2016	Acres	% of Subwatershed
Vacant or Undetermined	2,833.0	37.2
Single - Family Residential	2,148.3	28.2
Parks and Open Space	762.2	10.0
Agricultural	750.0	9.8
Water	672.7	8.8
Institutional	140.5	1.8
Commercial	93.6	1.2
Roads and Highways	85.2	1.1
Industrial	83.4	1.1
Multi - Family Residential	50.5	0.7

Source: Metropolitan Council.

Recreation:

The Luce Line Regional Trail passes through this subwatershed, as will the proposed Southwest Hennepin Regional Trail. The Minnesota Historic features database notes 22 historic features in this subwatershed, most are residences or farmhouses or agricultural buildings (Figure 2.68). The listing includes a school and a cemetery as well as three bridges, including a Luce Line bridge.

There is one public boat access, fishing pier and two public beaches on Long Lake. There is public boat (i.e., canoe) access to Holy Name Lake at Holy Name Park in Medina.

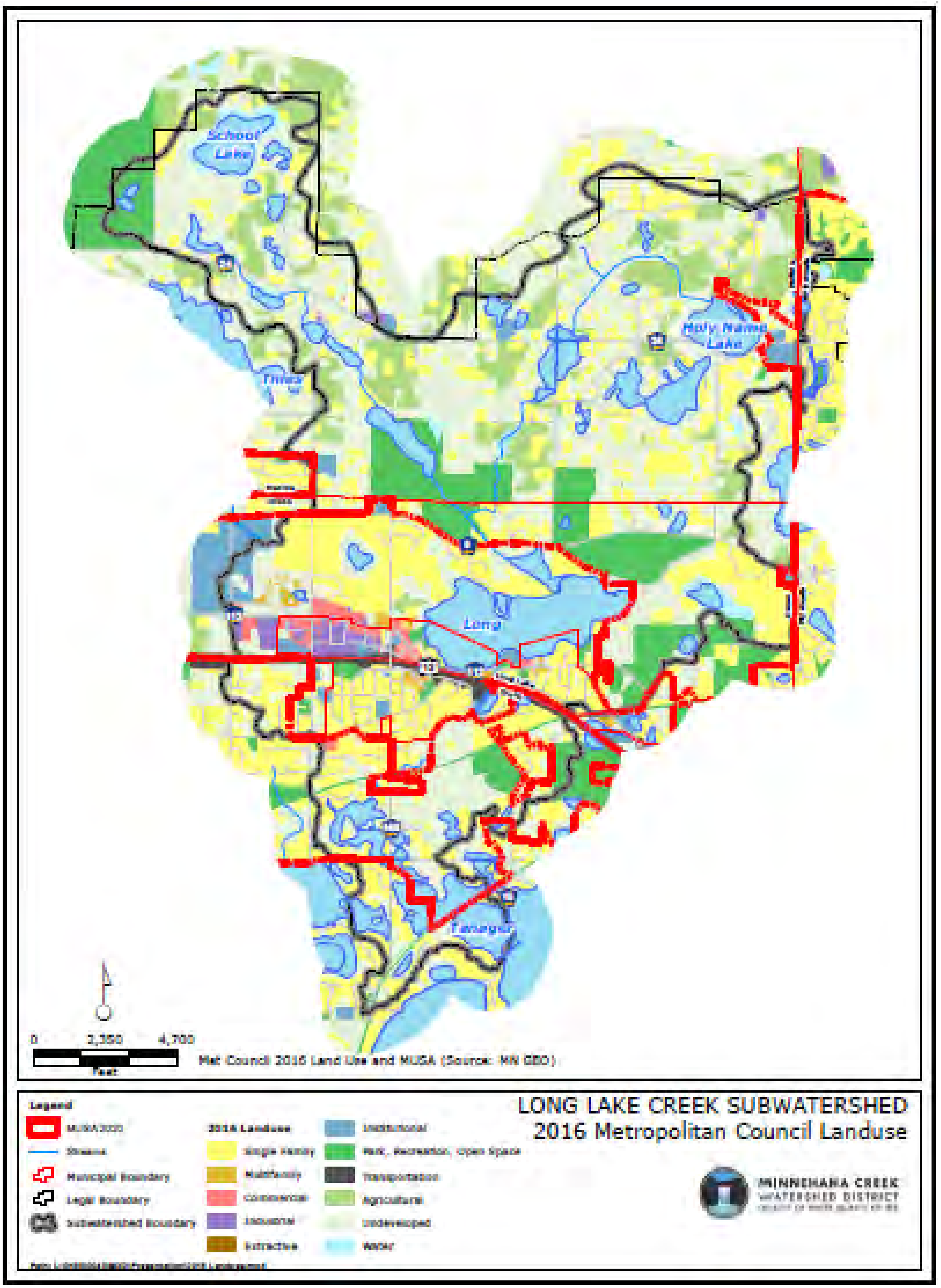

Figure 2. 67. Long Lake Creek subwatershed 2016 Metropolitan Council land use.

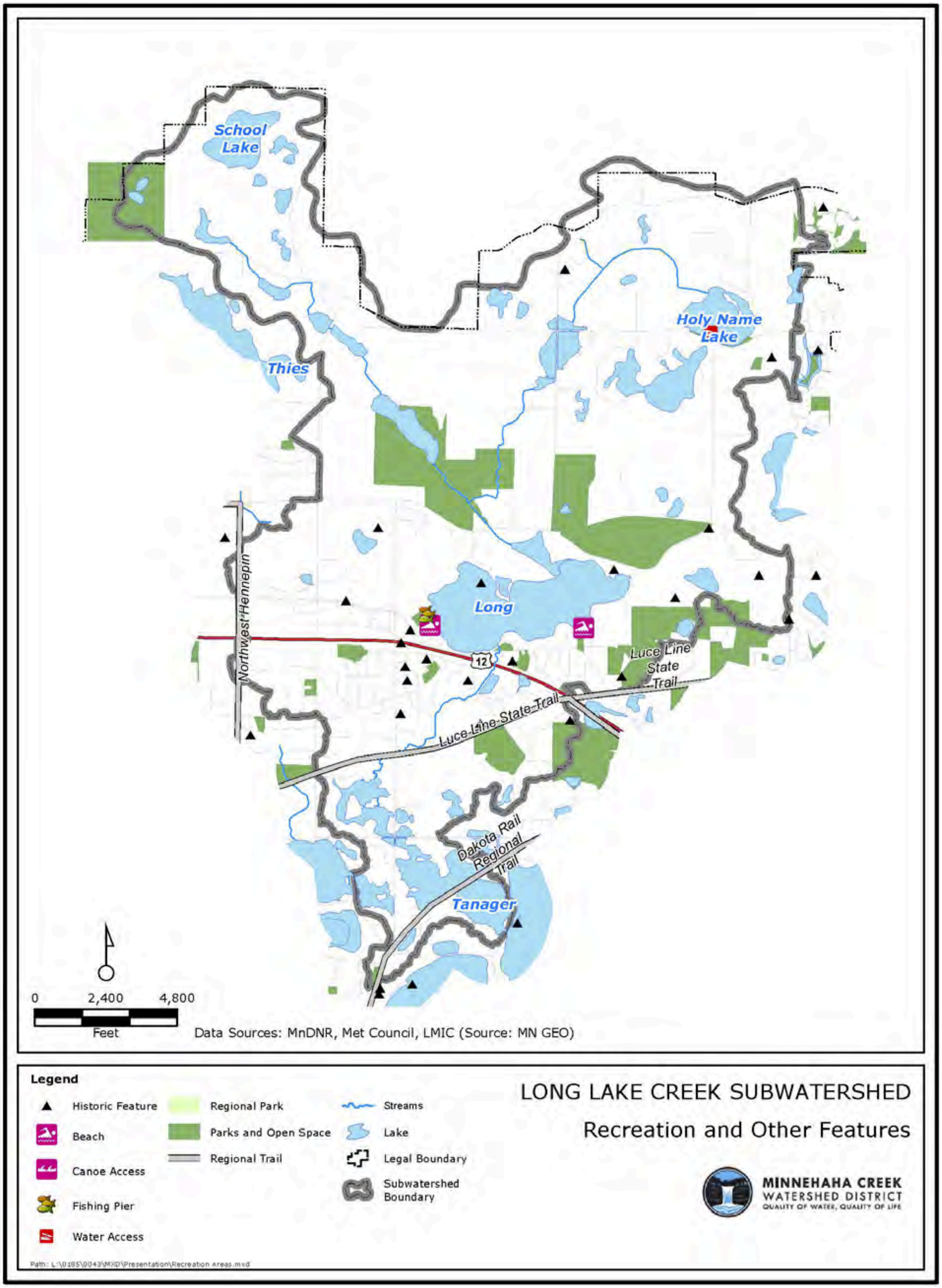

Figure 2. 68. Long Lake Creek subwatershed recreation and other features.

2.3.8 MINNEHAHA CREEK SUBWATERSHED

Minnehaha Creek Subwatershed is the only subwatershed east of the Lake Minnetonka. The land use is dominated by residential, business and industrial developments. The impervious cover on the land is higher in this subwatershed compared to the other ten subwatersheds. Land designated for parks and recreational areas are scattered throughout the subwatershed; many are adjacent to the lakes and the creek, as are the majority of the remaining wetlands and woodlands. Table 2.64 below shows the area of the Minnehaha Creek subwatershed in acres by individual city, in total and as a percentage of the total subwatershed. An additional 437.8 acres is included from Fort Snelling (Figure 2.69).

Table 2.64. Cities in the Minnehaha Creek subwatershed.

City	Area (Acres)	% of Subwatershed
Edina	2,634.3	8.7%
Fort Snelling	437.8	1.4%
Golden Valley	79.4	0.2%
Hopkins	1,193.7	3.9%
Minneapolis	11,096.3	36.6%
Minnetonka	7,068.0	23.3%
Plymouth	207.5	0.6%
Richfield	1321.1	4.3%
St. Louis Park	6,143.3	20.2%
Wayzata	119.3	0.3%
Total	30,301.1	

Source: MCWD.

Subwatershed Description and Hydrology:

The lower portion of this subwatershed generally east of the city of Hopkins is typified by gently rolling terraces and bottom lands punctuated by small lakes formed from melted blocks of glacial ice. The upper portion of this subwatershed is characterized by gently rolling to steep hilly landscapes with numerous lakes formed in deep irregular depressions called kettles. Soils within the watershed are predominantly urban disturbed soils that have not been classified. Where the soils have been classified, they are mainly Group B (loamy soils with moderate infiltration potential) and D (clayey soils with very low infiltration potential). For more information regarding geology and soils in the subwatershed, please refer to the *2007 MCWD Comprehensive Water Resources Management Plan.*

Land cover is classified by the Minnesota Land Cover Classification System (MLCCS) (Figure 2.70). Urban areas with moderate to high densities of impervious surface characterize the subwatershed which is entirely developed. There are some sizable areas of wetland and forest/woodland in the City of Minnetonka and in some locations along the creek corridor. An extensive, but narrow park system surrounds the Minneapolis lakes and Minnehaha Creek and along the Mississippi River.

The *2003 MCWD Hydrologic, Hydraulic, and Pollutant Loading Study (HHPLS)* subdivided the Minnehaha Creek subwatershed into 184 subwatershed units, designated MC-1 through MC-184 (Figure 2.71). Minnehaha Creek is formed at the outlet of Grays Bay and flows 22 miles to the Mississippi River. A significant area of the central portion of the subwatershed drains to the Chain of Lakes (Brownie, Cedar, Isles, Calhoun, and Harriet) in the City of Minneapolis, which outlets by a channel to Minnehaha Creek. Lake Nokomis is separated from Minnehaha Creek by a weir to reduce the influence of the creek on the lake's water quality and prevent the introduction of invasive species. Lake Hiawatha, however, is located in-line to Minnehaha Creek and is heavily influenced by it.

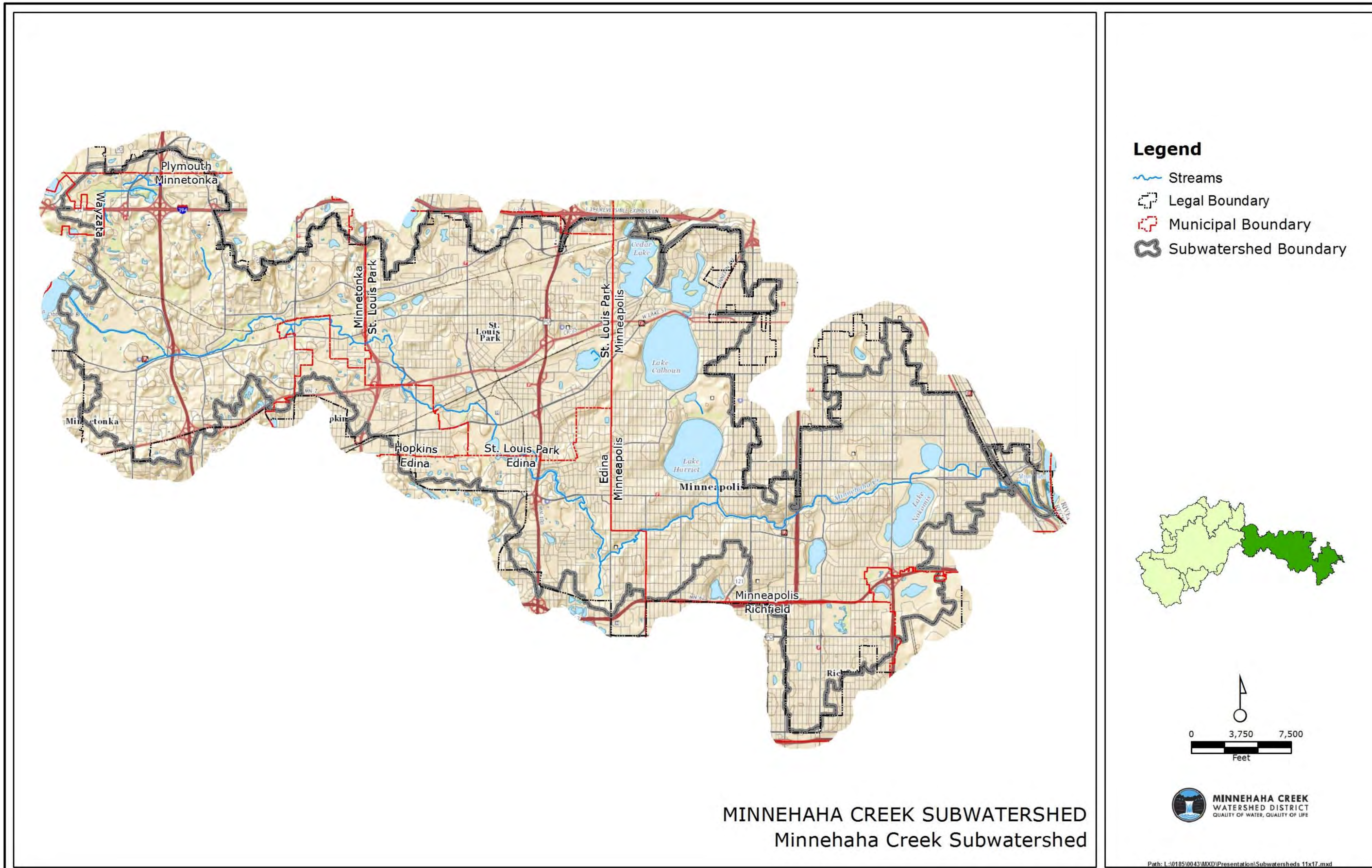

Figure 2.69. The Minnehaha Creek subwatershed.

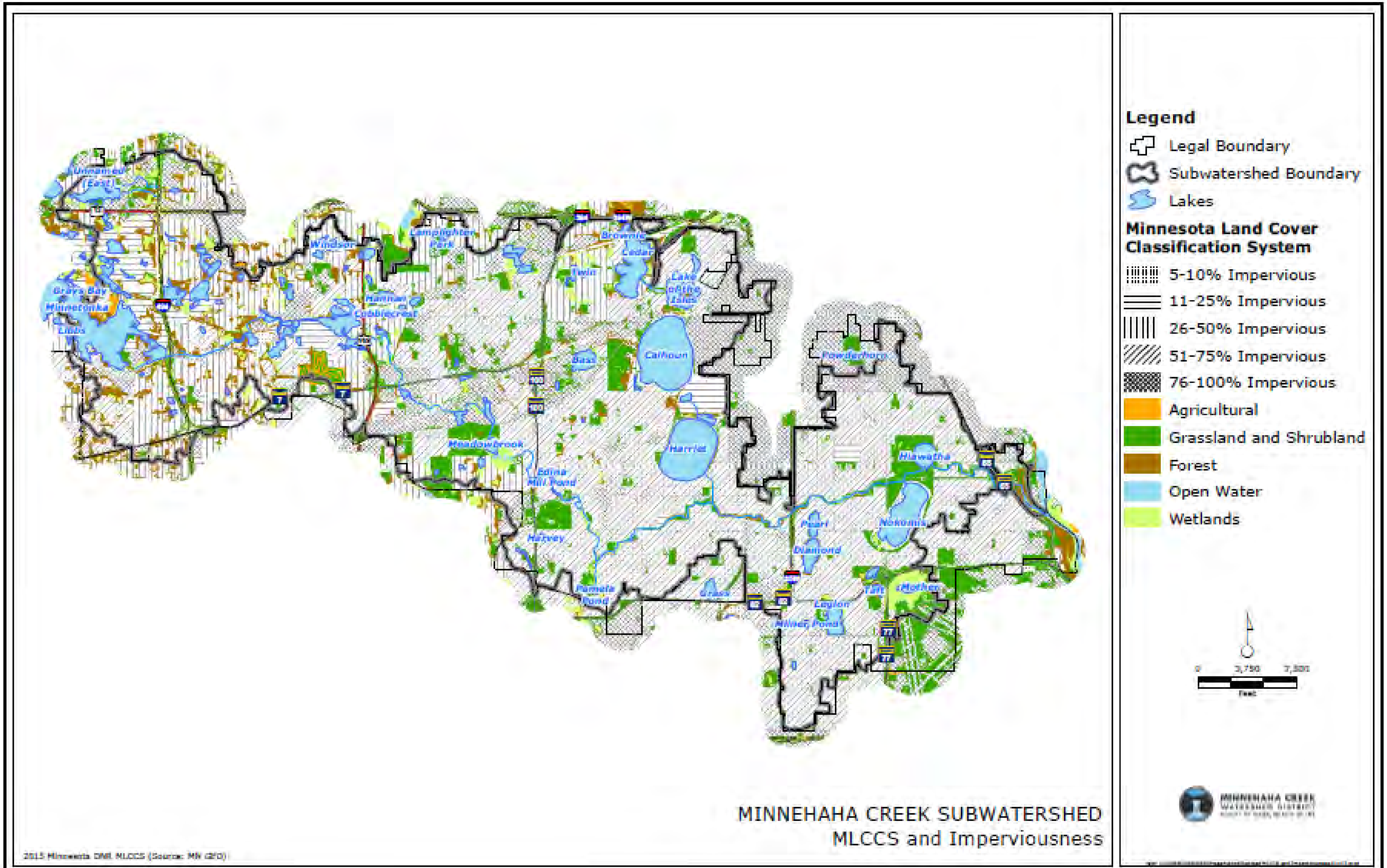

Figure 2.70. Minnehaha Creek subwatershed MLCCS and imperviousness.

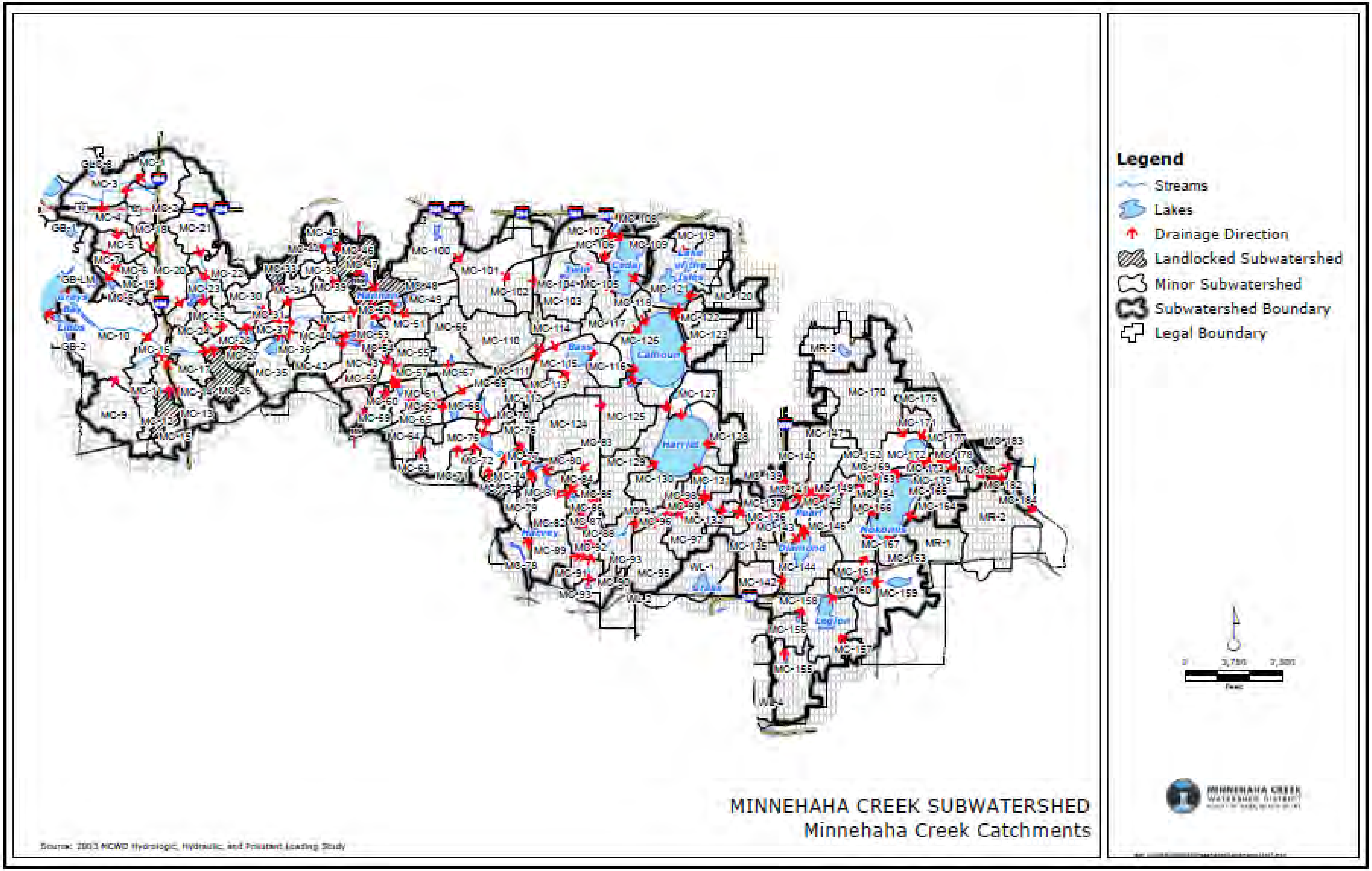

Figure 2.71. Minnehaha Creek subwatershed catchments.

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Water Quality:

The following are summaries of the characteristics and classifications of lakes and streams within the subwatershed including water quality goals and trends.

Lakes:

The Minnehaha Creek subwatershed includes the Chain of Lakes in Minneapolis and several other smaller lakes (Figure 2.72). Powderhorn Lake in Minneapolis does not drain to the creek, but rather is pumped to the Mississippi River. Tables 2.65 and 2.66 below detail the physical and water quality characteristics of the major lakes within the subwatershed and Table 2.65 includes the DNR shoreland management classification.

The District, the Minneapolis Park and Recreation Board (MPRB), and trained volunteers monitor many of the lakes in the subwatershed. Five lakes in the subwatershed are listed on the State's Impaired Waters list for exceeding the state standard for total phosphorus, with excessive nutrients being conveyed to them from the watershed. TMDLs have been completed for two of those lakes: Hiawatha and Nokomis. Powderhorn and Brownie had been listed previously, but meet standards and were delisted in 2012 and 2010, respectively. However, the water quality in Powderhorn Lake, from 2011-2016, is indicating that lake could once again be evaluated for re-listing.

Several lakes are also impaired for excess mercury and PFOS or PCBs in fish tissue. Two lakes – Powderhorn and Brownie - are impaired by excess chloride, likely from road salt. Diamond Lake and Grass Lake have been classified by the MPCA as a wetlands, so the lake eutrophication standards do not apply. Diamond Lake; however, is listed as impaired for chloride in the TCMA Chloride TMDL.

To assess long-term change, a Mann-Kendall statistical trend test was performed on total phosphorus (TP), chlorophyll-a (Chl-a), and Secchi depth data from 2001-2015. Statistically significant changes in water quality are listed in Table 2.66. For more information regarding water quality in the subwatershed, please refer to the District's Water Quality (Hydrodata) Reports.

Table 2.65. Physical characteristics of lakes in the Minnehaha Creek subwatershed.

Lake	Surface Area (acres)	Maximum Depth (ft)	Watershed to Lake Area Ratio	DNR Classification
Brownie	10	50	22:1	Natural Environment
Calhoun	419	82	13:1	Recreational Development
Cedar	164	51	16:1	Recreational Development
Hannan	14	6	14:1	Natural Environment
Harriet	341	87	26:1	Recreational Development
Hiawatha	53	33	546:1	Natural Environment
Isles	112	31	32:1	Recreational Development
Meadowbrook	28	7	406:1	Natural Environment
Nokomis	201	33	12:1	Natural Environment
Powderhorn	11	24	28:1	Natural Environment
Taft	14	45	131:1	Natural Environment
Twin	13	7	132:1	Natural Environment

Source: Minnesota DNR, MCWD.

Table 2. 66. Selected water quality goals and current conditions of waterbodies in the Minnehaha Creek subwatershed.

Waterbody	State TP Standard (µg/L)	2007 Plan Goal TP (µg/L)	Trend*	2001-2015 Summer Averages		
				TP (µg/L)	Chl-*a* (µg/L)	Secchi (m)
Brownie	60	35	n/a	44	12	1.3
Calhoun	40	25	No trend	17	4	3.7
Cedar	40	25	Deg Secchi	25	9	2.0
Cobblecrest[1]	n/a	n/a	n/a	119	83	0.44
Diamond	n/a	n/a	n/a	149	46	0.5
Grass	n/a	n/a	n/a	116	46	n/a
Hannan[2]	60	n/a	n/a	67	23	0.82
Harriet	40	20	Deg TP	21	5	3.0
Hiawatha	50**	50	No trend	70	18	1.4
Isles	40	40	No trend	44	28	1.3
Meadowbrook[3]	60	n/a	n/a	49	11	2.1
Nokomis	50**	50	Imp Chl-*a*, TP	52	22	1.2
Powderhorn	60	120	No trend	114	28	1.0
Taft[4]	40	n/a	n/a	75	40	1.1
Twin	60	n/a	Imp TP	165	65	0.6
Windsor[5]	n/a	n/a	n/a	143	43	0.47

*Statistically significant at ≤ 0.05., Imp = improving, Deg = degrading.
**Both Nokomis and Hiawatha were granted a site-specific standard by the MPCA due to unique conditions.
[1]Data are from 2002-2015. [2]Data are from 2010-2015. [3]Data are from 2013-2015. [4]Data are from 2010-2015. [5]Data are from 2011-2015.
Source: MCWD, MPCA.

Streams:

Minnehaha Creek is the primary stream within the subwatershed. It is formed at the outlet of Grays Bay in Lake Minnetonka and flows 22 miles to the Mississippi River. Lake Hiawatha is in-line to the creek and heavily influenced by it. As an outlet for Lake Minnetonka and the upper watershed, Minnehaha Creek must discharge large volumes of water during spring snowmelt runoff, summer and fall. During a typical year, 4-6 inches of runoff from the 122 square-mile upper watershed are discharged to Minnehaha Creek. The typical average flow in the creek due to this runoff is 60 to 90 cfs. Tables 2.67 and 2.68 below detail the physical and water quality characteristics of streams and tributaries within the subwatershed.

Total phosphorus concentrations on Minnehaha Creek are less than the state river eutrophication standards. The state river eutrophication standards also look at other indicators such as chlorophyll-a, diel oxygen flux, and biological oxygen demand, which have not been assessed on the Creek. The primary nutrient cycling concern for Minnehaha Creek is that it conveys phosphorus load to Lake Hiawatha. Minnehaha Creek is included in the State's Impaired Waters List due to excess chloride, fecal coliform concentrations, and low dissolved oxygen as well as impaired fish and macroinvertebrate communities. A small, unnamed channel (CGL04) that outlets the wetland on the southeast corner of Gleason Lake is also listed as impaired for chloride.

Table 2.67 shows the average TSS concentrations in Minnehaha Creek to be well below the 30 mg/L state standard for this ecoregion. Maintaining sufficient dissolved oxygen (DO) is necessary to support aquatic life. The DO state standard requires the stream to never fall below 5 mg/L DO. Monitoring data show that Minnehaha Creek upstream of the Browndale Dam can fall below this standard in summer, but the reaches below the dam have not been observed to do so. The upstream reaches are influenced by through-flow and riparian wetlands, which may increase sediment oxygen demand. To assess long-term change in water quality in Minnehaha Creek,

a Mann-Kendall statistical trend test was performed on flow-corrected TP and TSS data from 2005-2015. Statistically significant changes in water quality in Minnehaha Creek are listed in Table 2.67.
Minnehaha Creek was studied in-depth in 2003 and 2012 as part of the District's *Minnehaha Creek Stream Assessment*, which included a physical inventory, erosion survey, and a fluvial geomorphic assessment to determine channel stability. For more information regarding these parameters, please refer to the *Minnehaha Creek Stream Assessments*. For more information regarding water quality in the subwatershed, please refer to the District's Water Quality (Hydrodata) Reports and the Minnehaha Creek-Lake Hiawatha TMDL.

Table 2. 67. Current conditions of streams in the Minnehaha Creek subwatershed.
See Figure 2.72 for monitoring locations.

		2005-2015 Annual Average			
Stream	**Trend***	**TP (µg/L)**	**TN (mg/L)**	**TSS (mg/L)**	**Cl (mg/L)**
Unnamed Gleason Channel (CGL04)	n/a	156	0.97	6	312
Gray's Bay Dam (CMH07)	n/a	20	0.66	2	47
I-494 (CMH01)**	Imp TP	38	0.64	3	62
W. 34th Street (CMH02)	Imp TP	52	0.80	7	76
Excelsior Blvd (CMH11)	Imp TP	65	0.85	12	79
Browndale Dam (CMH03)	Imp TSS, TP	62	0.87	5	80
W. 56th Street (CMH04)	n/a	59	0.78	7	79
Xerxes Avenue (CMH15)	Imp TSS, TP	68	0.80	9	85
21st Avenue (CMH24)	n/a	71	0.86	17	88
28th Avenue (CMH18)	n/a	71	0.93	6	90
Hiawatha Avenue (CMH06)	Imp TP	75	1.0	9	97

TP = total phosphorus, TN =total nitrogen, TSS = total suspended solids, Cl = chloride, Imp = Improving
*Statistically significant at $\leq$ 0.05.
**Station used to be named CMH19, but due to historic data findings, the station was renamed CMH01.
Source: MCWD.

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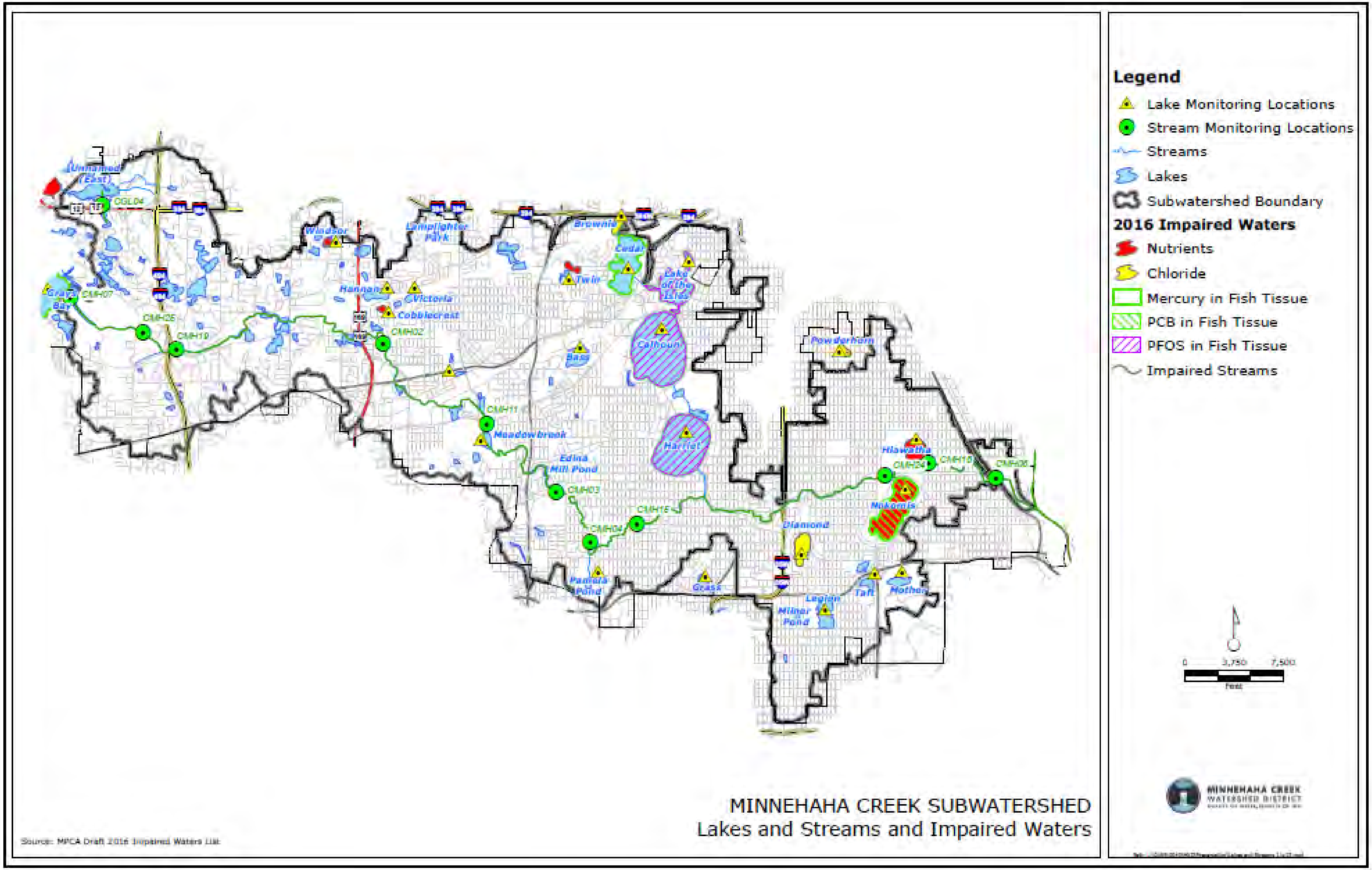

Figure 2.72. Minnehaha Creek subwatershed lakes and streams and Impaired Waters. *Note: CMH19 has been renamed as CMH01.

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Wetlands:

According to the FAW, wetlands, including lakes, cover just over 9 percent of the subwatershed's surface (Figure 2.73 and Table 2.68). A delineation of wetland boundaries is required to be completed any time development or other impacts may occur near or in a wetland. For more information regarding wetlands in the subwatershed, please refer to the *2007 MCWD Comprehensive Water Resources Management Plan*.

No data are available yet to evaluate the ability of the wetlands in the subwatershed to cycle nutrients to and from the subwatershed. E-Grade will assess wetland soil chemistry, overall vegetative conditions, presence or absence of algal blooms, and condition of the buffer and area within 500 feet of the wetlands.

Table 2.68. Functional Assessment of Wetlands inventory of wetland types in the Minnehaha Creek subwatershed.

FAW Circular 39 Wetland Type	Area (acres)	Percent
1 - Seasonal	105.9	0.36
2 - Wet Meadow	214.9	0.73
3 - Shallow Marsh	835.4	2.85
4 - Deep Marsh	33.0	0.11
5 - Open Water	591.7	2.02
6 - Scrub Shrub	435.6	1.48
7 - Forested	420.4	1.43
8 - Bog	3.0	0.01
Riverine	146.8	0.50
Wetland Total	2,786.7	9.5
Upland	26,585.1	90.5
TOTAL	29,371.8	

Source: MCWD Functional Assessment of Wetlands.

Groundwater:

The District's roles in managing groundwater are to 1) promote surficial groundwater recharge to protect wetland hydrology and stream baseflow, and 2) assist in protecting deeper aquifers used for drinking water by limiting infiltration in sensitive recharge areas.

The *HHPLS* identified the infiltration potential of the upland areas within the subwatershed as high to medium with some areas of variability where the soils are organic in nature. Most of the lower subwatershed is classified by the Hennepin County Geologic Atlas as being of high to very high aquifer sensitivity, reflecting the glacial outwash deposits that underlay the soils and the shallow depth to bedrock. The upper subwatershed, an area of loamy till, is classified as being generally of low to moderate sensitivity to pollution except along the Creek and in the large Grays Bay wetland complex.

There are a number of springs and seeps in the Mississippi River gorge area, including Camp Coldwater Spring, the largest limestone bedrock spring in the Metro area. The 2014 Baseflow Study by the University of Minnesota found that there is significant interaction between the creek and shallow groundwater, with some sections primarily gaining water from groundwater inputs while other sections primarily lose water through infiltration.

Much of the subwatershed has been designated by the Minnesota Department of Health as Drinking Water Supply Management Area (DWSMA) and Wellhead Protection Area (WHPA) for various municipal public wells. The MDH has designated areas within the DWSMAs as very high to moderate risk and vulnerability to contamination of the drinking water supply. Figure 2.74 shows areas in the subwatershed with groundwater sensitivity and that are designated as higher Drinking Water Sensitivity.

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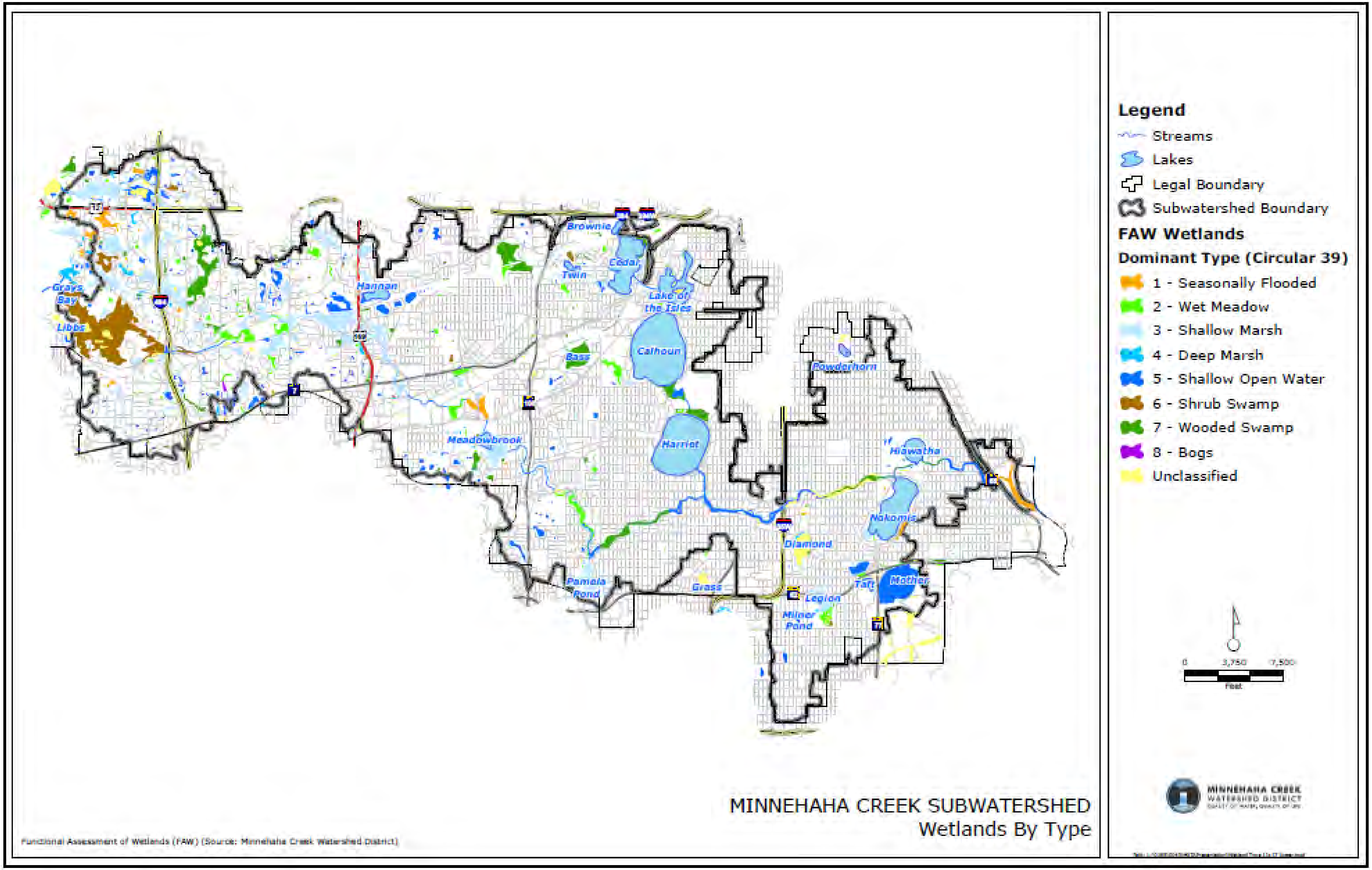

Figure 2. 73. Minnehaha Creek subwatershed wetlands by type.

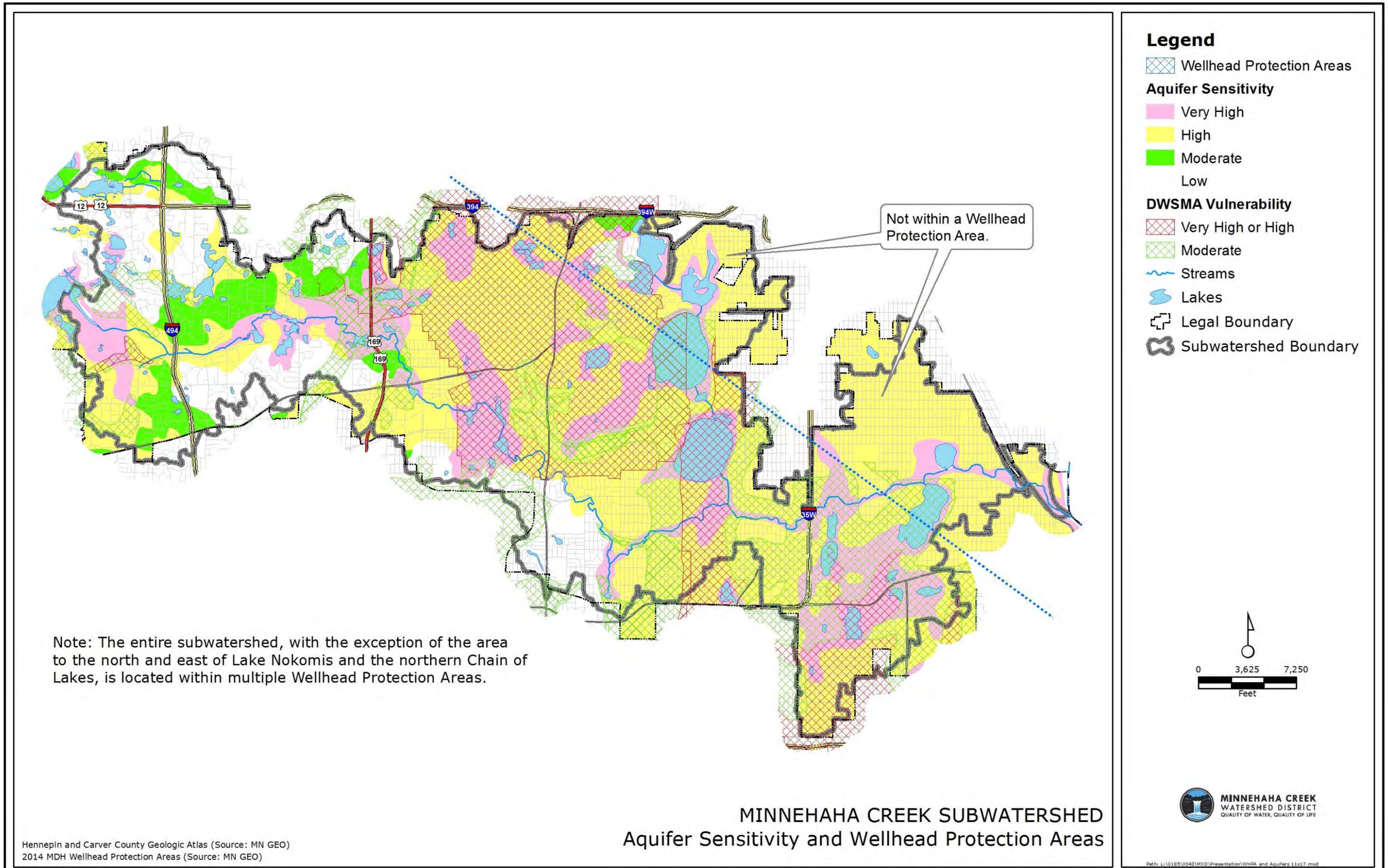

Figure 2.74. Minnehaha Creek subwatershed aquifer sensitivity and Wellhead Protection Areas.

Water Quantity:

An operating plan was established for Grays Bay dam headwaters control structure when it was put into service in 1980. The plan was intended to emulate the historical discharge hydrograph produced by previous controls and the natural outlet of Lake Minnetonka. In drier periods, Lake Minnetonka typically does not discharge water, and portions of the Creek may experience low or even no flow.

Several landlocked basins and many smaller landlocked pocket wetlands exist in the upper reaches of the Minnehaha Creek drainage area including large areas within the City of Minnetonka and portions of Hopkins, Edina and St. Louis Park (Figure 2.71). As noted in the previous section, the District partnered with the University of Minnesota and the Mississippi Watershed Management Organization (MWMO) to complete a baseflow and stormwater infiltration study of Minnehaha Creek in 2014 that found that there is significant interaction between the creek and shallow groundwater.

To assess change in water yield, a Mann-Kendall statistical trend test was performed on annual water yield data for the monitoring stations downstream of the Grays Bay dam. The water yields for 2006-2015 did not exhibit any statistically significant trend.

Ecological Integrity:

The E-Grade program defines watershed ecological integrity as the degree to which the watershed provides three key ecosystem services: biodiversity, habitat diversity, and nutrient cycling. Nutrient cycling is described in the Water Quality section. The Minnehaha Creek subwatershed has been evaluated by the E-Grade program in 2015-2017. At this time, only some of the E-Grade metrics have been assessed. The final E-Grade report for this subwatershed will not be available until 2018. This section summarizes ecological integrity using E-Grade and other existing data, where available (Figure 2.75).

Lakes:

Biodiversity

Fish Community. Biodiversity is measured using the Index of Biotic Integrity (IBI) for fish developed by the DNR. Fish IBI data are available for five of the lakes in the subwatershed. Cedar Lake and Lake of the Isles are classified as Good and meet state ecological integrity requirements. Lakes Calhoun, Harriet, and Nokomis are classified as Poor, meaning the biodiversity has been disturbed and the IBI is below the state threshold.
Aquatic Vegetation Community. Biodiversity is determined by the number and variety of species, or richness. Aquatic vegetation surveys are available on many of the lakes in the subwatershed and led to FQI scores for E-Grade. Brownie, Calhoun, and Cedar were classified as Good, meaning they had a good variety of species, including sensitive species. Lakes Harriet, Hiawatha, Nokomis, and Isles were classified as Degraded, due to low species diversity.

Aquatic Invasive Species. Biodiversity can be negatively impacted by the presence of aquatic invasive species (AIS). The most common AIS in the lakes in this subwatershed include Curlyleaf Pondweed and Eurasian watermilfoil. Common carp are known to be over abundant in Lake Nokomis. Population data in other lakes are limited. Zebra mussels have been found in Lake Hiawatha and Meadowbrook Lake, which are both connected to the zebra mussel infested Minnehaha Creek. Lake Nokomis is listed as infested for zebra mussels due to its connectivity to Minnehaha Creek via a weir, but zebra mussels have yet to be found in the lake. One lone zebra mussel was found in Lake Harriet in 2017, further searching has found no other zebra mussels at this time.

Habitat diversity

Aquatic Vegetation Community. Habitat diversity is determined by the percent occurrence of species, or the extent to which it may be dominated by a few species. The vegetation community has not been assessed for habitat diversity yet.

Shoreline Health. Shoreline health is assessed looking at shoreline vegetative cover and the relative human disturbance. The MnDNR is using the Score the Shore protocol to relate shoreline conditions to fish community structure using the fish IBI metric. The protocol subdivides the riparian area into three zones: aquatic, shoreline and shoreland and evaluates various metrics such as vegetative cover, land use, human disturbance, and emergent vegetation. Brownie Lake's shoreline health was classified as Exceptional. Cedar Lake and some of the smaller shallow lakes were classified as Good, while most the lakes in the lower subwatershed were classified as Poor. In lakes classified as Poor, suitable shoreland and shoreline vegetation is lacking and has disturbances such as seawalls or riprap shorelines.

Streams:

Biodiversity

Fish Community. The DNR periodically assesses the fish community in Minnehaha Creek. Fish IBI data are available at six locations along the Creek. Five of the sites were last surveyed in 2010, while the sixth has not been updated since 2000. The monitoring site just upstream of 34th Avenue in southeast Minneapolis was classified as Degraded, scoring well below the state's fish IBI standard. The site in Big Willow Park in Minnetonka was also classified as Degraded, although those data are from 2000. The other four sites on the Creek were classified as Poor, showing signs of disturbance and falling below the IBI threshold.

Macroinvertebrate Community. The District collected macroinvertebrate samples at 23 sites on Minnehaha Creek in 2013 and 2015. The DNR also collected macroinvertebrate samples at five sites as part of its fish sampling. Macroinvertebrates are more sensitive to the stream conditions in their immediate vicinity, so the IBI scores can vary from site to site, even those in close proximity. A majority of the sites were classified as Degraded, meaning they were highly disturbed, with low species diversity and dominated by pollution-tolerant species. However, other sites were classified as Poor, with slightly better diversity and supporting some pollution-intolerant species.

Aquatic Invasive Species. Zebra mussels, Curlyleaf Pondweed, Eurasian watermilfoil, Common Carp and Flowering Rush are present in Minnehaha Creek.

Habitat diversity

Habitat Complexity. Minnesota Stream Habitat Assessment data are available to assess habitat complexity, which is evaluated in three zones: instream, riparian, and channel shape. Complexity is highly variable along the length of the stream due to decades of human disturbance. However, the lower reaches of the stream are located within and protected by a parkway, which helps limit the impacts of urbanization. Generally, the reaches in the stream above the Browndale Dam have greater habitat complexity than the lower reaches and are classified as Good. The lower reaches, where the channel form or morphology is more likely to have been disturbed, are classified as either Good or Poor, with a few locations classified as Degraded in one or more of the three zones.

Minnehaha Creek was studied in-depth in 2003 and 2012 as part of the District's *Minnehaha Creek Stream Assessment*, which included a physical inventory, erosion survey, and a fluvial geomorphic assessment to determine channel stability. For more information regarding these parameters, please refer to the *Minnehaha Creek Stream Assessments*.

Connectivity. Connectivity is defined by two metrics: presence or absence of barriers, and access to floodplain. Barriers such as dams, weirs, and culverts limit or prevent organisms from moving freely in the stream. There are several barriers on Minnehaha Creek, the most significant being Minnehaha Falls, which disconnects the Creek from the Mississippi River. There are also three dams (Highway 55, 54th Street, and Browndale) and at least one significant culvert at McGinty Road. Access to floodplain is variable, and greatest in the upper subwatershed where there are riparian wetlands and low streambanks.

Water Quality. Water quality factors impacting stream habitat diversity include concentrations of TSS and DO. Higher TSS concentrations increase turbidity, which can interfere with aquatic predators seeking their prey and which can limit growth of aquatic vegetation. Refer to Water Quality section for data.

Hydrology Indicators. Stream hydrology is an important factor in habitat diversity. A stream that is very flashy, that is, one that rises and falls very quickly in response to rain events, can be stressful to organisms. In addition, streams that periodically are dry or have minimal flow are hostile to aquatic life. Continuous streamflow data are available, and will be assessed and included in the Minnehaha Creek E-Grade report (2018). However, by observation, Minnehaha Creek is an urban stream with numerous storm sewer outfalls, and it can rise quickly during rain events. Instantaneous flow is also available along the Creek. Annual average flow for each year was computed first, and then all the years' averages were averaged together. The low, average and high discharge for the major stations in Minnehaha Creek are listed in Table 2.67.

Table 2.69. Average discharge for stations in the Minnehaha Creek subwatershed.
See Figure 2.72 for monitoring locations.

Stream	2006-2015		
	Low Discharge (cfs)	Annual Average Discharge (cfs)	High Discharge (cfs)
Gray's Bay Dam (CMH07)	0	87	420
I-494 (CMH01)	0	53	421
W. 34th Street (CMH02)	0	54	441
Excelsior Blvd (CMS11)	0	49	368
Browndale Dam (CMH03)	0	69	495
W. 56th Street (CMH04)	0.2	64	441
Xerxes Avenue (CMH15)	0	66	518
21st Avenue (CMH24)	0	57	442
28th Avenue (CMH18)	0	68	511
Hiawatha Avenue (CMH06)	0	73	530

Source: MCWD.

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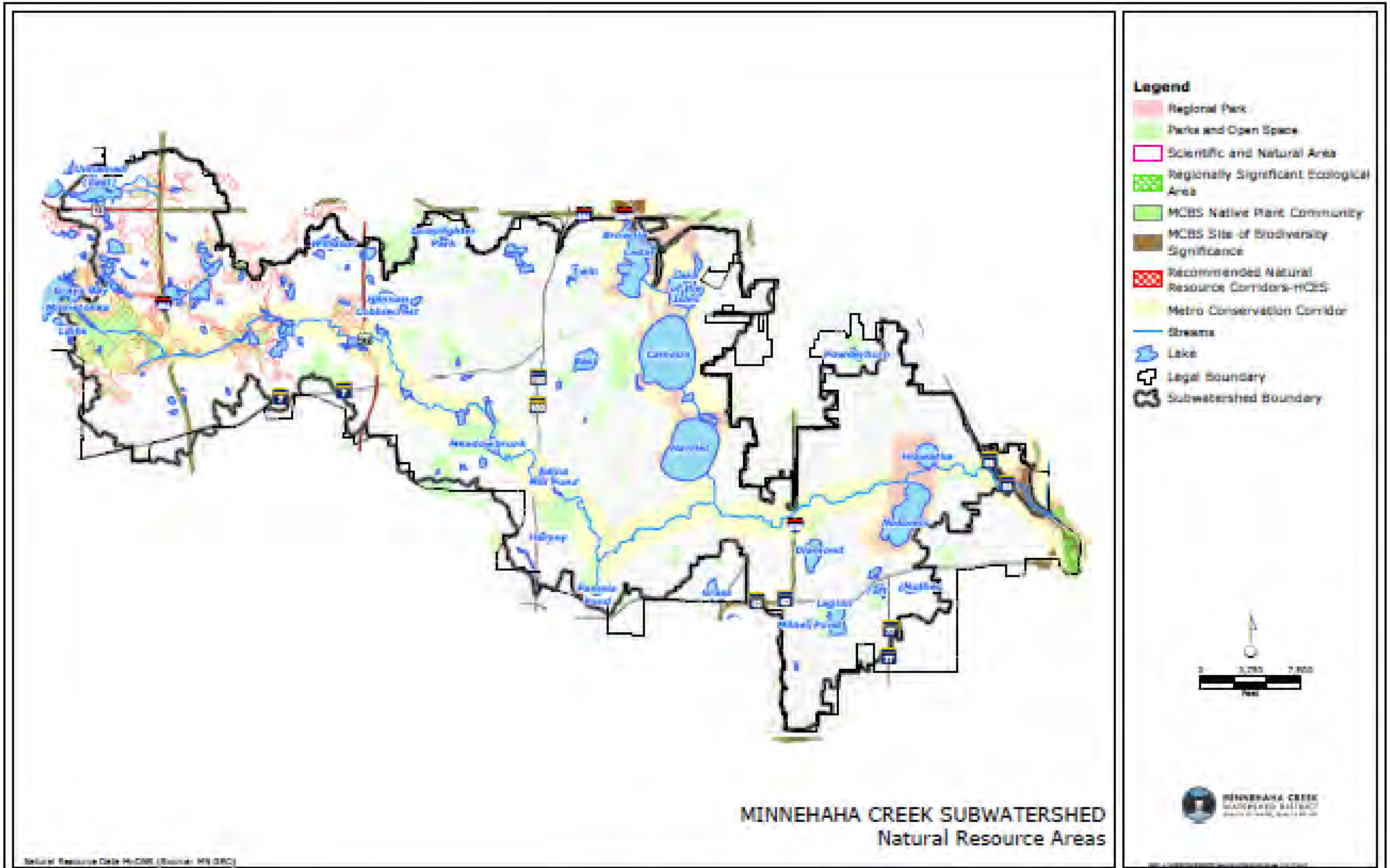

Figure 2.75. Minnehaha Creek subwatershed natural resource areas.

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Wetlands:

Biodiversity

Vegetation Community. The FQI developed by the DNR can be used to evaluate the biodiversity of vegetation in wetlands. A cross-section of 26 wetlands in the subwatershed were assessed for their vegetation condition, twelve in the upper subwatershed and fourteen in the lower subwatershed. Three of the twelve assessed in the upper subwatershed were classified as Degraded while nine were classified as Poor. Six of fourteen assessed in the lower subwatershed were classified as Degraded, and eight were classified as Poor. Wetlands ranked degraded tend to have fewer communities, primarily fresh meadow and/or floodplain forest. Buckthorn and reed canary grass tend to dominate in these communities. Some of the seasonally flooded basins are maintained as mowed turf.

Macroinvertebrate Community. These data are not currently being collected in E-Grade. For more information regarding macroinvertebrate community in the subwatershed, please refer to wetland health evaluation program (WHEP) program.

Habitat diversity

Connectivity. Hennepin County has identified the large wetland complex at the headwaters of Minnehaha Creek, and some wetlands and uplands connected to it, as Recommended Natural Resource Corridors. Minnehaha Creek itself and associated riverine and riparian wetlands is an important connected corridor, linking Lake Minnetonka, the Chain of Lakes, and the Mississippi River. Other smaller wetlands in the subwatershed are primarily isolated with limited opportunities for connectivity.

Size. Larger wetlands are more likely to support a notable on-site diversity and/or abundance of wildlife species. Most of the larger wetlands are in the upper subwatershed, to the west of TH 169. In the lower subwatershed, wetlands are smaller and isolated, and less likely to support a diversity of wildlife.

Shoreline Protection. Riparian wetlands can provide significant shoreline protection and support emergent vegetation at the shoreline. The *Functional Assessment of Wetlands* evaluated riparian wetlands for their ability to protect lake or stream shoreline. There are numerous riverine or riparian wetlands on Minnehaha Creek helping to stabilize the streambanks. However, there are few riparian wetlands protecting lakeshore. Cedar and Diamond Lakes have some moderate coverage, but most of the lakes do not.

Uplands:

Biodiversity

The Minnesota Biological Survey (MBS) did not identify any areas of biodiversity significance in the uplands of this subwatershed. (Figure 2.75).

Habitat diversity

The lower subwatershed – generally the area east of TH 169 – is developed with minimal areas of ecological significance. Regionally significant ecological areas are places where larger tracts of minimally disrupted land provide habitat complexity. The only such area in this subwatershed is the large wetland complex at the outflow from Gray's Bay, which is the headwaters of Minnehaha Creek, and some wetlands and uplands connecting that complex to other larger wetlands in the upper subwatershed.

Thriving Communities:

Land use:

Table 2.70 shows the land uses within the area of the Minnehaha Creek subwatershed in acres and as a percentage of the total subwatershed. The predominant land use in the subwatershed is single family residential, followed by parks and open space (Figure 2.76). The subwatershed is fully developed at typical urban and suburban densities and land uses. Redevelopment and infill development have increased since the last plan update, notably with an increase in multi-family residential. Most of the remaining vacant or undetermined land is large wetland or woodland tracts. The entire subwatershed is within the MUSA 2020 area.

Table 2.70. 2016 land use in the Minnehaha Creek subwatershed.

Land Use 2016	Acres	% of Subwatershed
Single - Family Residential	15,598.6	51.5
Parks and Open Space	4,409.5	14.6
Multi - Family Residential	2,338.5	7.7
Water	1,674.9	5.5
Commercial	1,483.1	4.9
Institutional	1,436.8	4.7
Roads and Highways	1,365.1	4.5
Vacant or Undetermined	1,227.7	4.1
Industrial	763.9	2.5
Agricultural	3.1	0.0

Source: Metropolitan Council.

Recreation:

The subwatershed contains numerous regional recreational facilities (Figure 2.77). The National Parks Service oversees the Mississippi River and Recreational Area, which includes the Mississippi River gorge area within the subwatershed, including Minnehaha Falls. The Falls area includes a number of structures constructed by the Works Progress Administration (WPA), including retaining walls along the creek. The Minneapolis Park and Recreation Board (MPRB) operates a popular park and trail system around the Chain of Lakes and along Minnehaha Creek east of Lake Harriet. The North and South branches of the Three Rivers Park District's Southwest LRT Regional Trail connects the Chain of Lakes with the western subwatershed.

Camp Coldwater Spring, a site with significance to Native American communities and the location of the first white settlement in Minnesota, is located in the extreme southeast part of the subwatershed. The Minnesota Historic Features database notes over 1300 historic features in this subwatershed, mostly residences or commercial buildings. Three Historic Districts are listed on the National Register of Historic Places: the Minnehaha District in the vicinity of Minnehaha Falls; the Nokomis Knolls District, a residential district at the southwest corner of Lake Nokomis; and the Country Club District in Edina, an area of over 500 historic residences, commercial buildings, and other properties, including the Minnehaha Grange. More detail regarding the Camp Coldwater Springs and other locations significant to the watershed's early history can be found in the *2007 MCWD Comprehensive Water Resources Management Plan*.

There are numerous boat accesses and beaches on the lakes in the subwatershed. There are seventeen canoe launches on Minnehaha Creek, and this popular urban canoe trail winds through numerous parks and open spaces. Most of these launches have parking available, and several have picnic areas and restrooms.

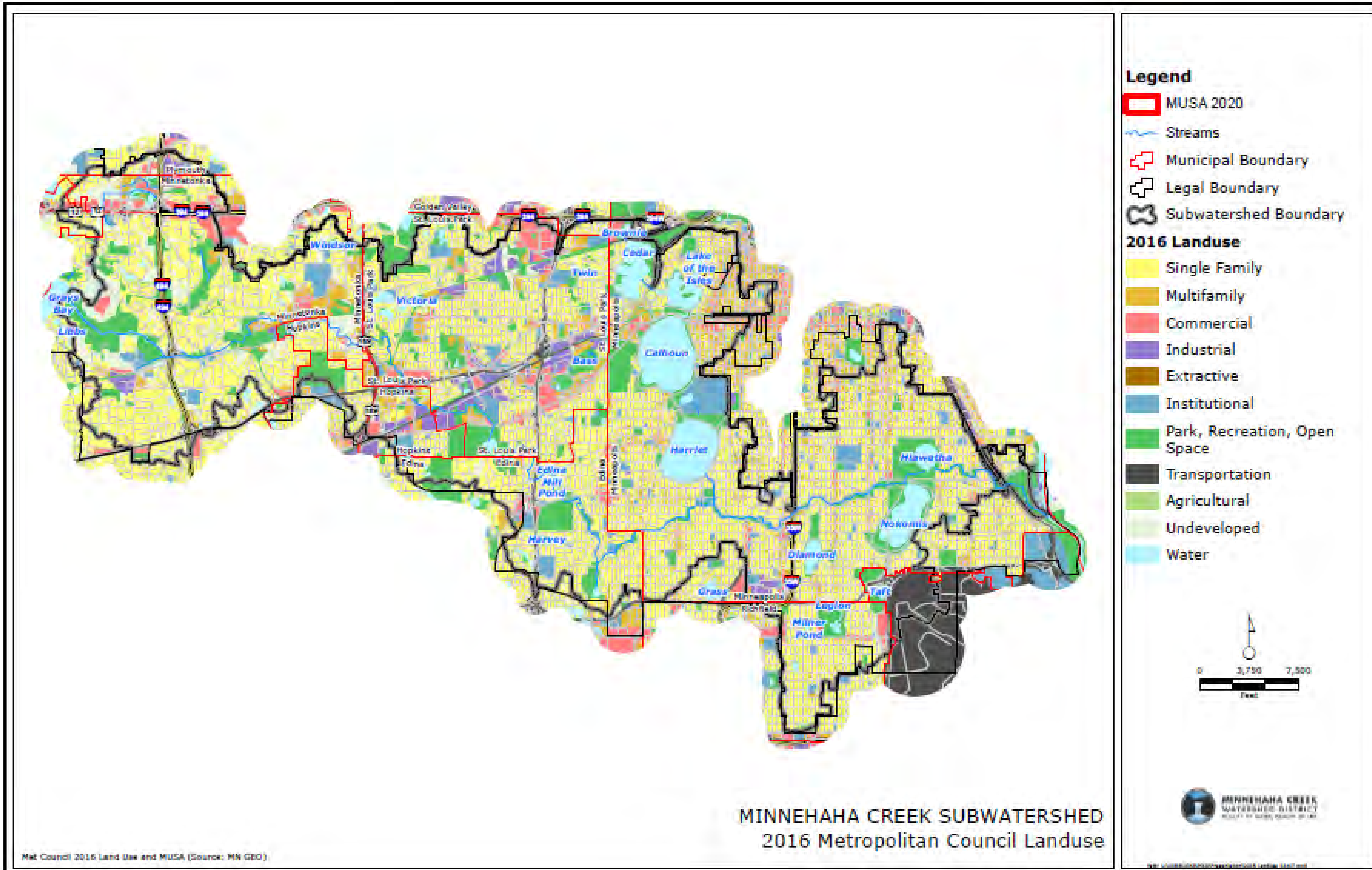

Figure 2.76. Minnehaha Creek subwatershed 2016 Metropolitan Council land use.

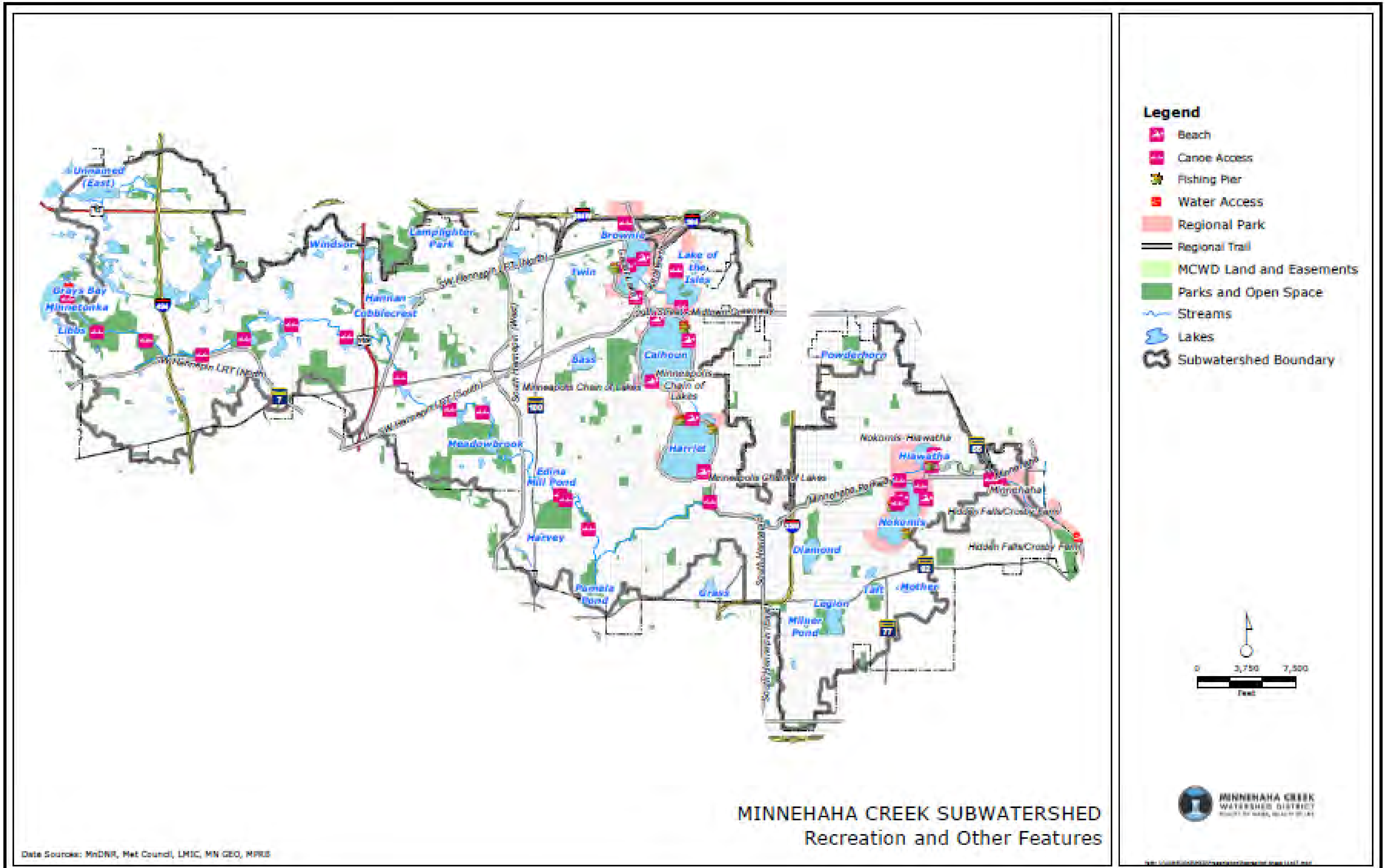

Figure 2.77. Minnehaha Creek subwatershed recreation and other features.

2.3.9 PAINTER CREEK SUBWATERSHED

Painter Creek Subwatershed drains the land and wetlands into Painter Creek, and eventually drains into Lake Minnetonka: Jennings Bay. The largest lake, Lake Katrina, was recently recommended by MPCA to be classified as a wetland. Wetlands make up over 25% of the land cover in the subwatershed, while the remaining 75% is a mix of agriculture, forests and woodlands, grasslands, and impervious cover. Painter Creek flows in and out of Katrina and flows through woodlands and through Painter Marsh before curving towards Lake Minnetonka. Most of Painter Creek is classified as ditched due to efforts to drain the landscape. Table 2.71 below shows the area of the Painter Creek subwatershed in acres by individual city, in total and as a percentage of the total subwatershed (Figure 2.78).

Table 2. 71. Cities in the Painter Creek subwatershed.

City	Area (Acres)	% of Subwatershed
Independence	3,069.1	35.4%
Maple Plain	202.8	2.3%
Medina	2,498.9	28.8%
Minnetrista	1,562.7	18.0%
Orono	1,336.0	15.4%
Total	8,669.7	

Source: MCWD.

Subwatershed Description and Hydrology:

Topography in the subwatershed is gently rolling, with circular, level-topped hills and numerous large wetlands. Soils within the watershed are predominantly classified as Natural Resources Conservation Service Hydrologic Soil Group B (loamy soils with moderate infiltration potential) and D (clay soils with very low infiltration potential). For more information regarding geology and soils in the subwatershed, please refer to the *2007 MCWD Comprehensive Water Resources Management Plan*.

Land cover is classified by the Minnesota Land Cover Classification System (MLCCS) (Figure 2.79). There is a wide variety of land cover types in the subwatershed. Wetland and forest/woodland cover dominate the central subwatershed along the Painter Creek corridor, while low-density development is dispersed throughout the subwatershed. There is a small area of higher density development in the City of Maple Plain. Large areas in agricultural use are present in the lower watershed.

The upper subwatershed drains through streams and channels to Lake Katrina in the Baker Park Reserve. Painter Creek is the outlet of Lake Katrina, flowing 6.2 miles south and east from the lake to Jennings Bay: Lake Minnetonka. Painter Creek was channelized as County Ditch #10 in 1905, connecting and outletting wetlands to support agriculture in the subwatershed.

The *2003 MCWD Hydrologic, Hydraulic, and Pollutant Loading Study (HHPLS)* subdivided the Painter Creek subwatershed into 26 subwatershed units, designated PC-1 through PC-26 (Figure 2.80).

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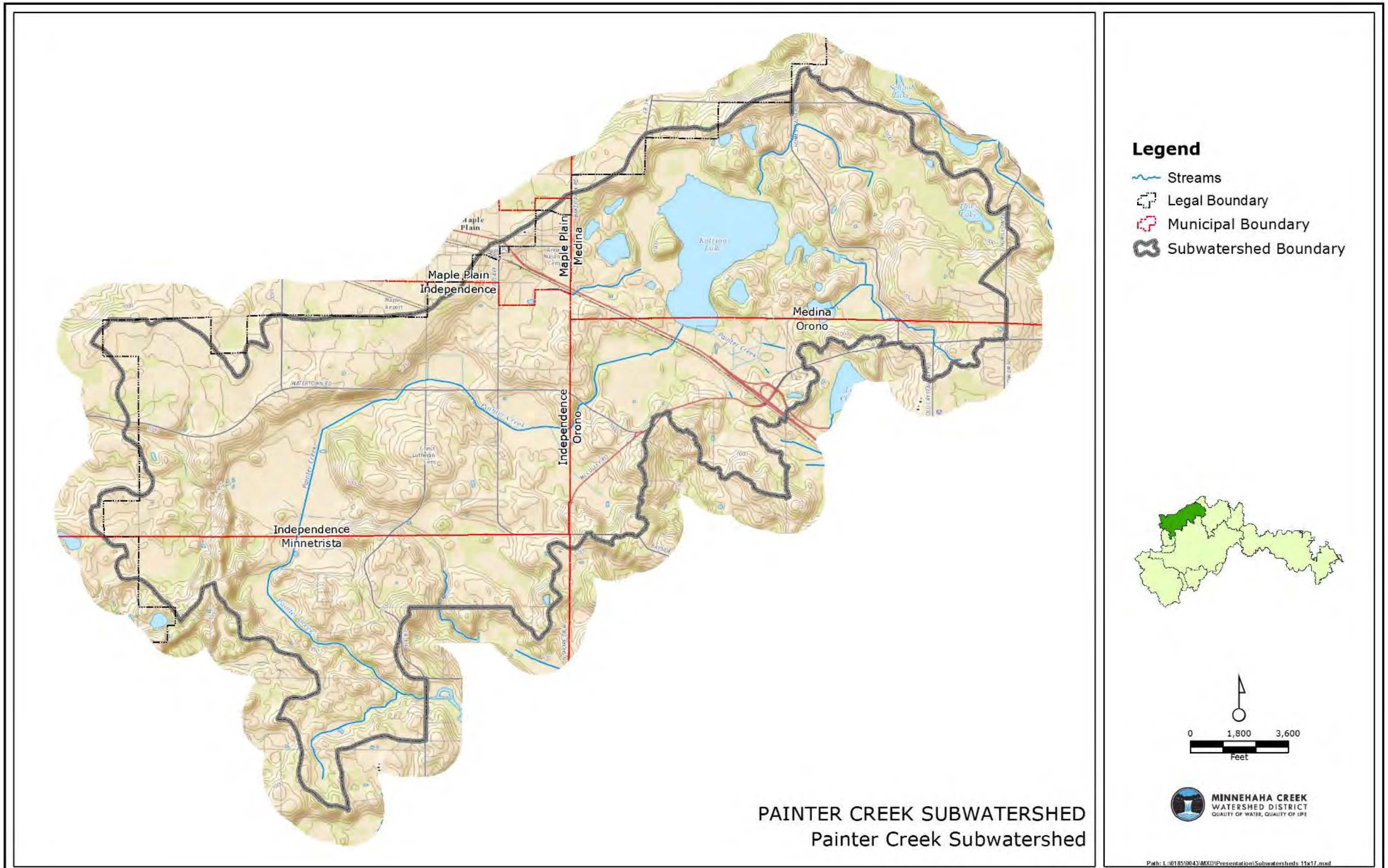

Figure 2. 78. The Painter Creek Subwatershed.

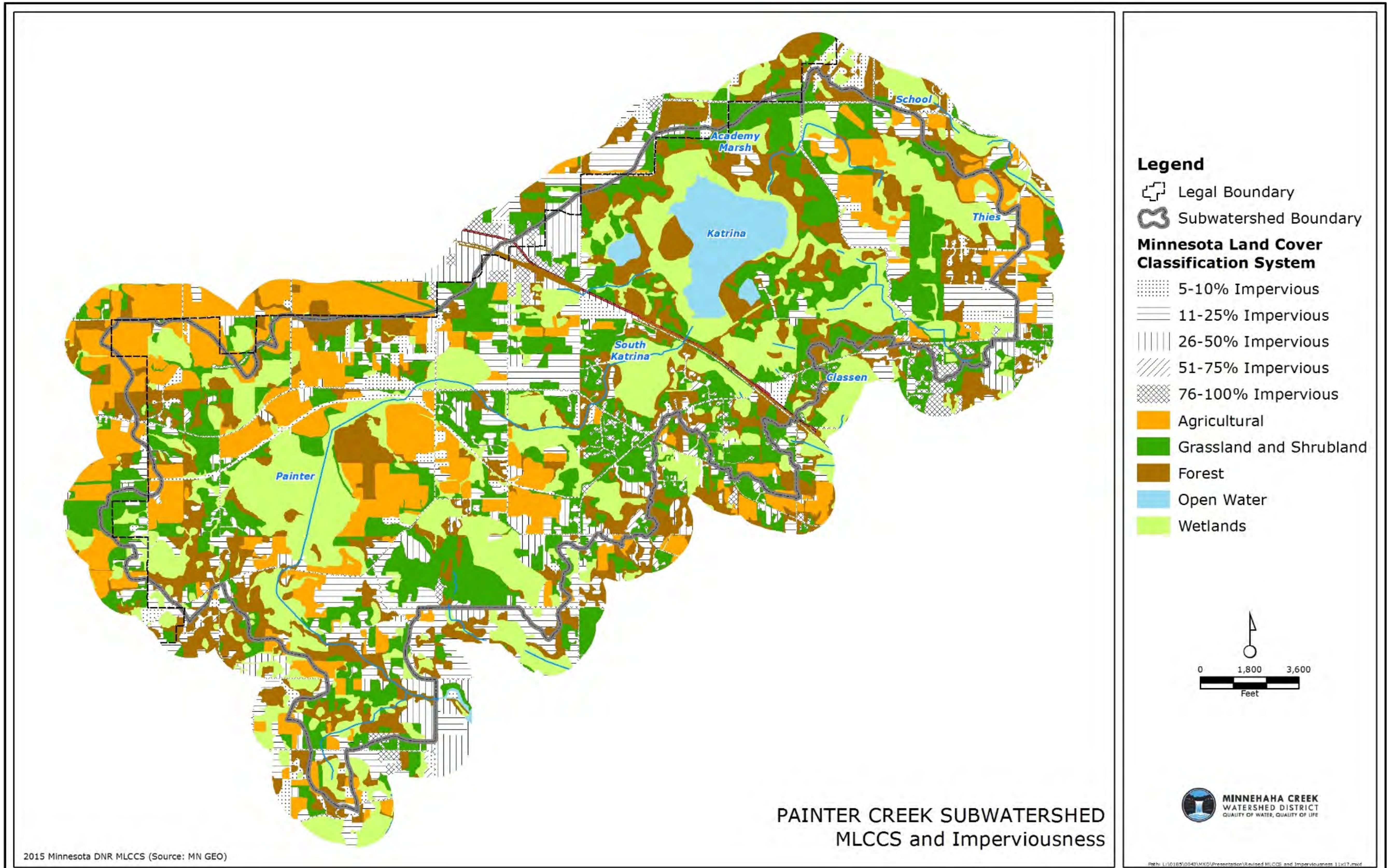

Figure 2. 79. Painter Creek subwatershed MLCCS and imperviousness.

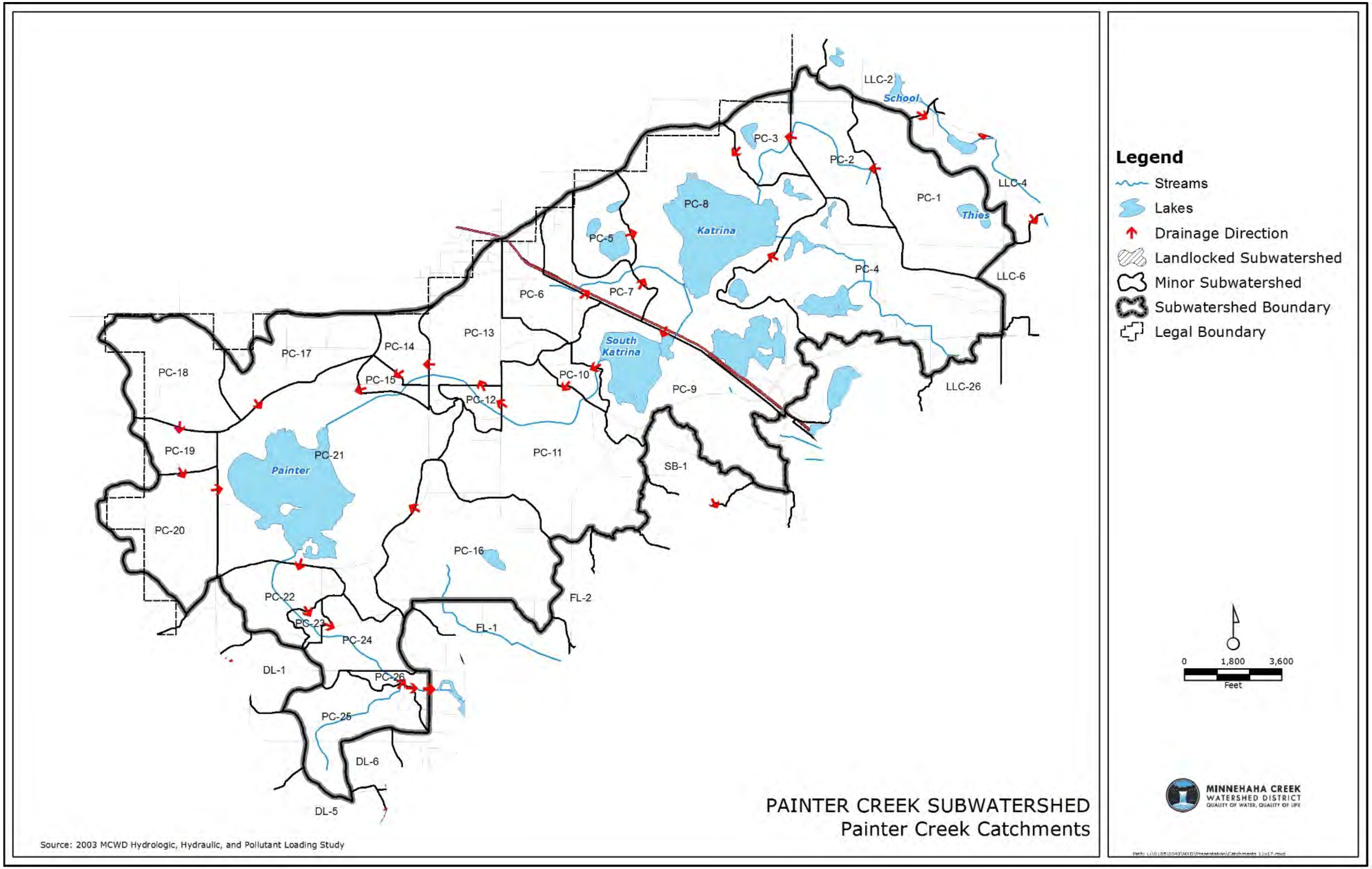

Figure 2. 80. Painter Creek subwatershed catchments.

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Water Quality:

The following are summaries of the characteristics and classifications of lakes, streams and wetlands within the subwatershed including water quality goals and trends.

Lakes:

Lake Katrina carries the informal designation of lake as the primary waterbody within the subwatershed, and is the headwaters for Painter Creek. Thies Lake is a small lake located in northeast portion of subwatershed (Figure 2.81). Lake Katrina is periodically monitored by the Three Rivers Park District and was monitored for three years by MCWD, while Thies Lake is monitored by trained volunteers. Tables 2.72 and 2.73 below detail the physical and water quality characteristics of the lakes within the Painter Creek subwatershed, and includes the DNR shoreland management classification.

Lake Katrina has been classified by the MPCA as a wetland; therefore, the lake eutrophication standard does not apply. Thies Lake exceeds the state standard for deep lakes (Table 2.73). For more information, refer to District's Water Quality (Hydrodata) Reports and the Upper Minnehaha Creek Watershed TMDL.

Table 2. 72. Physical characteristics of lakes in the Painter Creek subwatershed.

Lake	Surface Area (acres)	Maximum Depth (ft)	Watershed to Lake Area Ratio	DNR Classification
Thies	11	29	42:1	Natural Environment

Source: Minnesota DNR.

Table 2. 73. Selected water quality goals and current conditions of waterbodies in the Painter Creek subwatershed.

Waterbody	State TP Standard (μg/L)	2007 Plan Goal TP (μ/L)	Trend	2006-2015 Summer Average		
				TP (μg/L)	Chl-*a* (μg/L)	Secchi (m)
Katrina	n/a	n/a	n/a	158	72	0.7
Thies	40	n/a	n/a	54	24	1.3

TP = Total phosphorus concentration. *Katrina data are from 2006-2014; Thies data are from 2009-2015.
Source: MCWD, MPCA.

Streams:

Painter Creek outlets Lake Katrina, flowing 6.2 miles to Jennings Bay. It is comprised mainly of ditches through large wetlands connected by relatively short reaches of channel. Flow is controlled by weirs at the outlets of Katrina Lake, South Katrina Marsh, Painter Marsh and Pond 937. The creek was channelized as County Ditch #10 in 1905. Several small streams and channels provide local conveyance (Figure 2.81). It was also studied in-depth in 2003 as part of the District's *Upper Watershed Stream Assessment* and the *Painter Creek Feasibility Study.*

Table 2.74 below details Painter Creek's water quality characteristics. Monitoring sites along the Painter Creek find TP concentrations high relative to the state river eutrophication standards. However, those standards also look at other indicators such as chlorophyll-a, diel oxygen flux, and biological oxygen demand that have not been assessed in the Creek.

Painter Creek has low TSS concentrations, as shown on Table 2.74. Maintaining sufficient DO is necessary to support aquatic life. The DO state standard requires the stream to never fall below 5 mg/L DO. District monitoring data show that all the monitoring sites on the creek fall below the standard multiple times per year.

Painter Creek downstream of Painter Marsh is designated an Impaired Water due to elevated levels of *E. coli* bacteria and has an approved TMDL. The state standard requires that the geometric mean of the aggregated monthly *E. coli* concentrations for one or more months must not exceed 126 organisms per 100 mL. A waterbody is also considered impaired if more than 10% of the individual samples within a month exceed 1,260 organisms per 100 mL. Data from 2001 to 2011 show that *E. coli* concentrations in Painter Creek exceed the monthly standard July to October, and the acute, individual standard 25% of the time in September and October.

To assess long-term change in Painter Creek, a Mann-Kendall statistical trend test was performed on flow-corrected TP and TSS data from 2005-2015. There was a statistically significant change in TP concentrations at W. Branch Rd stream station in Painter Creek with TP concentrations increasing over time (Table 2.74). For more information, refer to District's Water Quality (Hydrodata) Reports.

Table 2. 74. Current Painter Creek conditions.
See Figure 2.81 for monitoring locations.

Stream	Trend*	2005-2015 Annual Average			
		TP (µg/L)	TN (mg/L)	TSS (mg/L)	Cl (mg/L)
Jennings Bay Inlet (CPA05)	n/a	281	1.45	15	40
W Branch Road (CPA01)	Deg TP	280	1.50	11	47
Painter Creek Drive (CPA06)	n/a	277	1.38	5	46
Painter Marsh Outlet (CPA04)	n/a	272	1.21	3	43
Katrina Wetland Outlet (CPA03)	n/a	201	1.31	4	52

TP = total phosphorus, TN =total nitrogen, TSS = total suspended solids, Cl = chloride, Deg = degrading.
*Statistically significant at ≤ 0.05.
Source: MCWD.

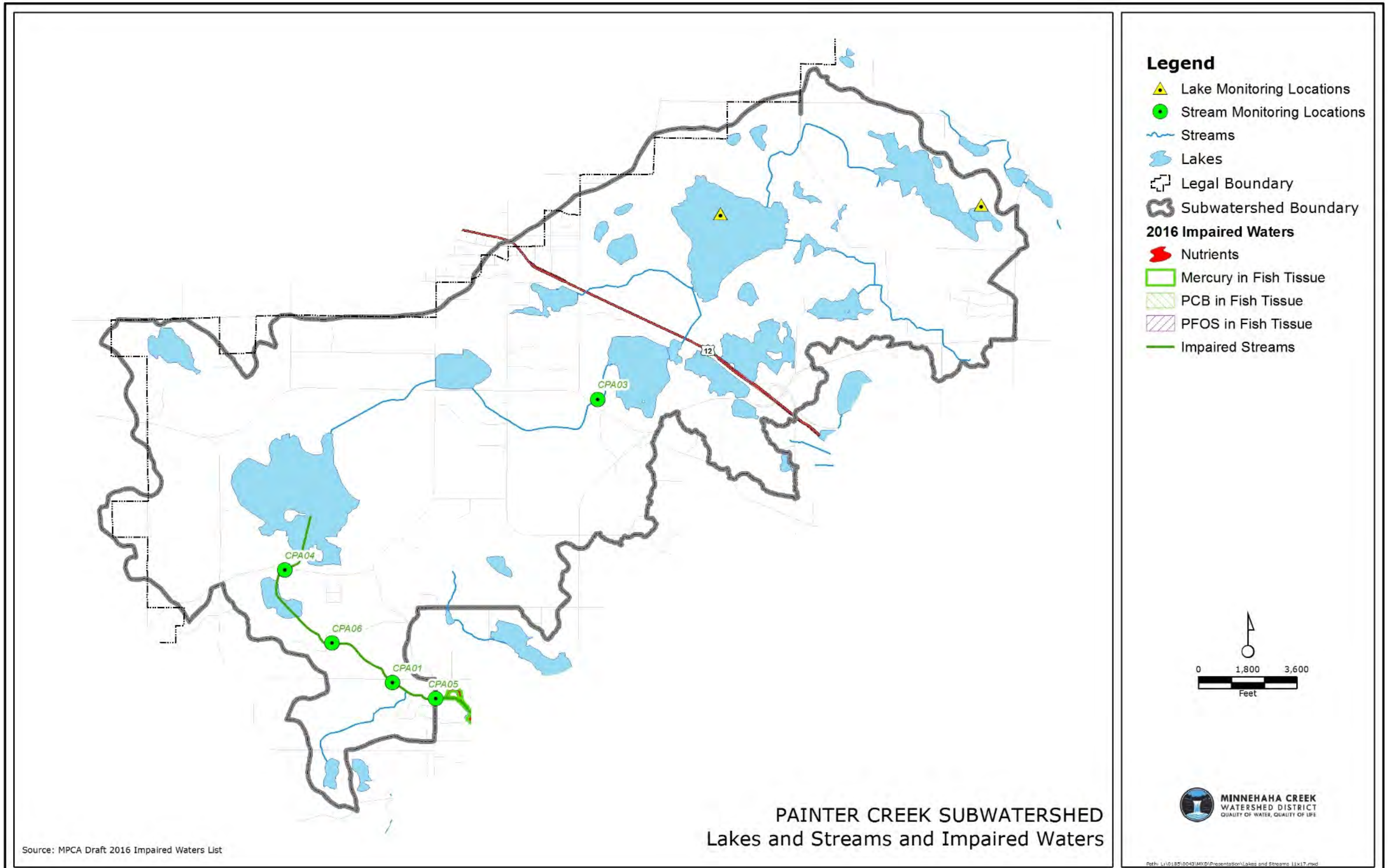

Figure 2. 81. Painter Creek subwatershed lakes and streams and Impaired Waters.

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Wetlands:

According to the FAW, wetlands, including lakes, cover almost 29 percent of the watershed's surface (Figure 2.82 and Table 2.75).

No data are available yet to evaluate the ability of the wetlands in the subwatershed to cycle nutrients to and from the subwatershed. E-Grade will assess wetland soil chemistry, overall vegetative conditions, presence or absence of algal blooms, and condition of the buffer and area within 500 feet of the wetlands.

A delineation of wetland boundaries is required to be completed any time development or other impacts may occur near or in a wetland. For more information regarding wetlands in the subwatershed, please refer to the *2007 MCWD Comprehensive Water Resources Management Plan*.

Table 2. 75. Functional Assessment of Wetlands inventory of wetland types in the Painter Creek subwatershed.

FAW Circular 39 Wetland Type	Area (acres)	Percent
1 - Seasonal	337.4	3.99
2 - Wet Meadow	538.6	6.38
3 - Shallow Marsh	1,155.7	13.68
4 - Deep Marsh	30.5	0.36
5 - Open Water	43.2	0.51
6 - Scrub Shrub	97.9	1.16
7 - Forested	48.6	0.58
8 - Bog	-	-
Riverine	12.1	0.14
Wetland Total	2,264.0	26.8
Upland	6,172.7	73.2
TOTAL	8,436.7	

Source: MCWD Functional Assessment of Wetlands.

Groundwater:

The District's roles in managing groundwater are to 1) promote surficial groundwater recharge to protect wetland hydrology and stream baseflow, and 2) assist in protecting deeper aquifers used for drinking water by limiting infiltration in sensitive recharge areas.

The HHPLS identified the infiltration potential of the upland areas within the subwatershed as medium to low with some areas of variability where the soils are organic in nature. Areas of moderate to high or very high aquifer sensitivity roughly follow the Painter Creek corridor to Jennings Bay. Elsewhere the Hennepin County Geologic Atlas classifies most of the upland areas as being of low to moderate sensitivity to pollution.

Two small areas of the Painter Creek subwatershed have been designated by the Minnesota Department of Health as Drinking Water Supply Management Areas (DWSMA) for a City of Orono well and a City of Medina well. The MDH has designated these areas to be of low risk and vulnerability to contamination of the drinking water supply. Figure 2.83 shows areas in the subwatershed with groundwater sensitivity and that are designated Wellhead Protection Areas.

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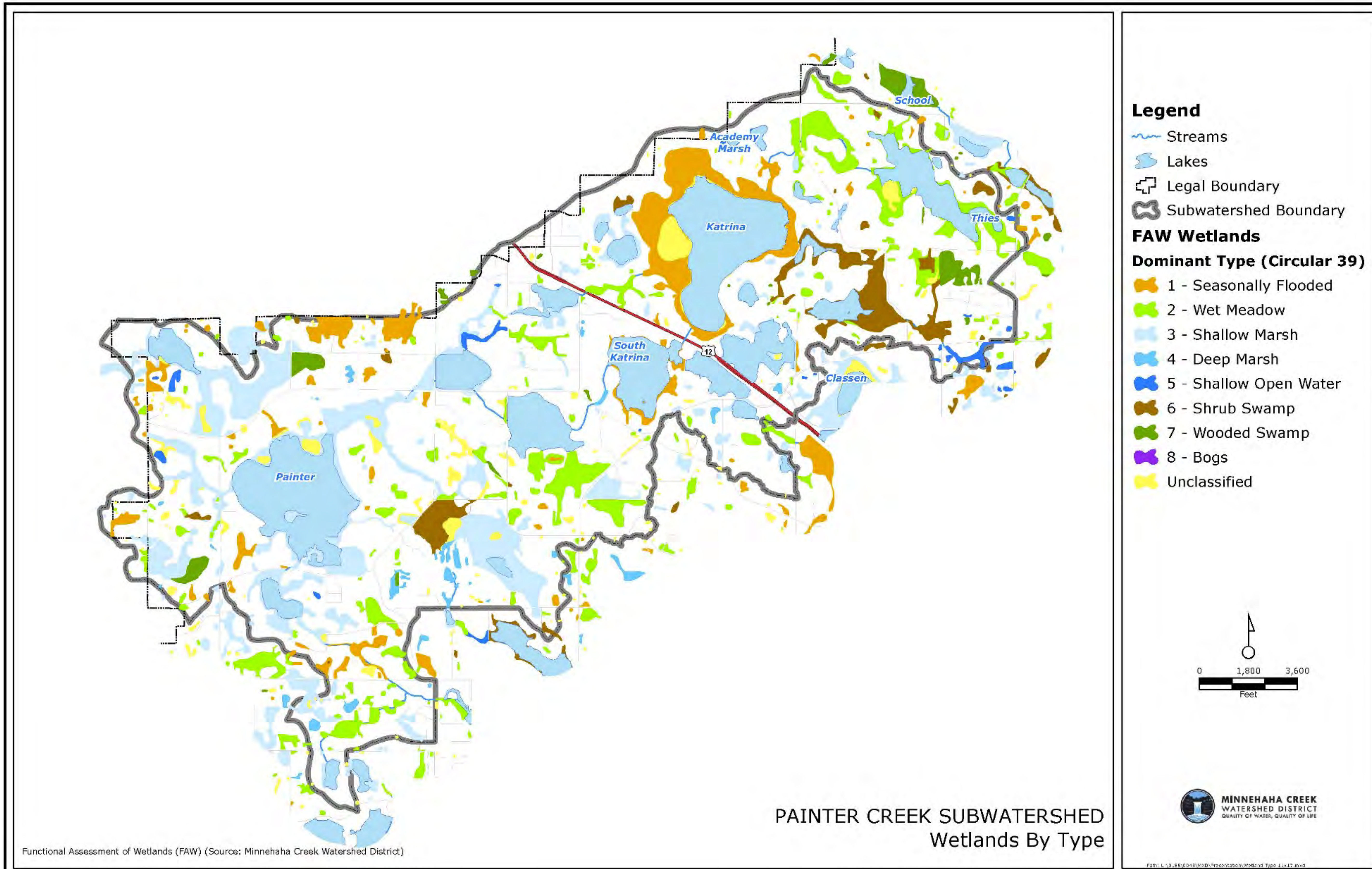

Figure 2. 82. Painter Creek subwatershed wetlands by type.

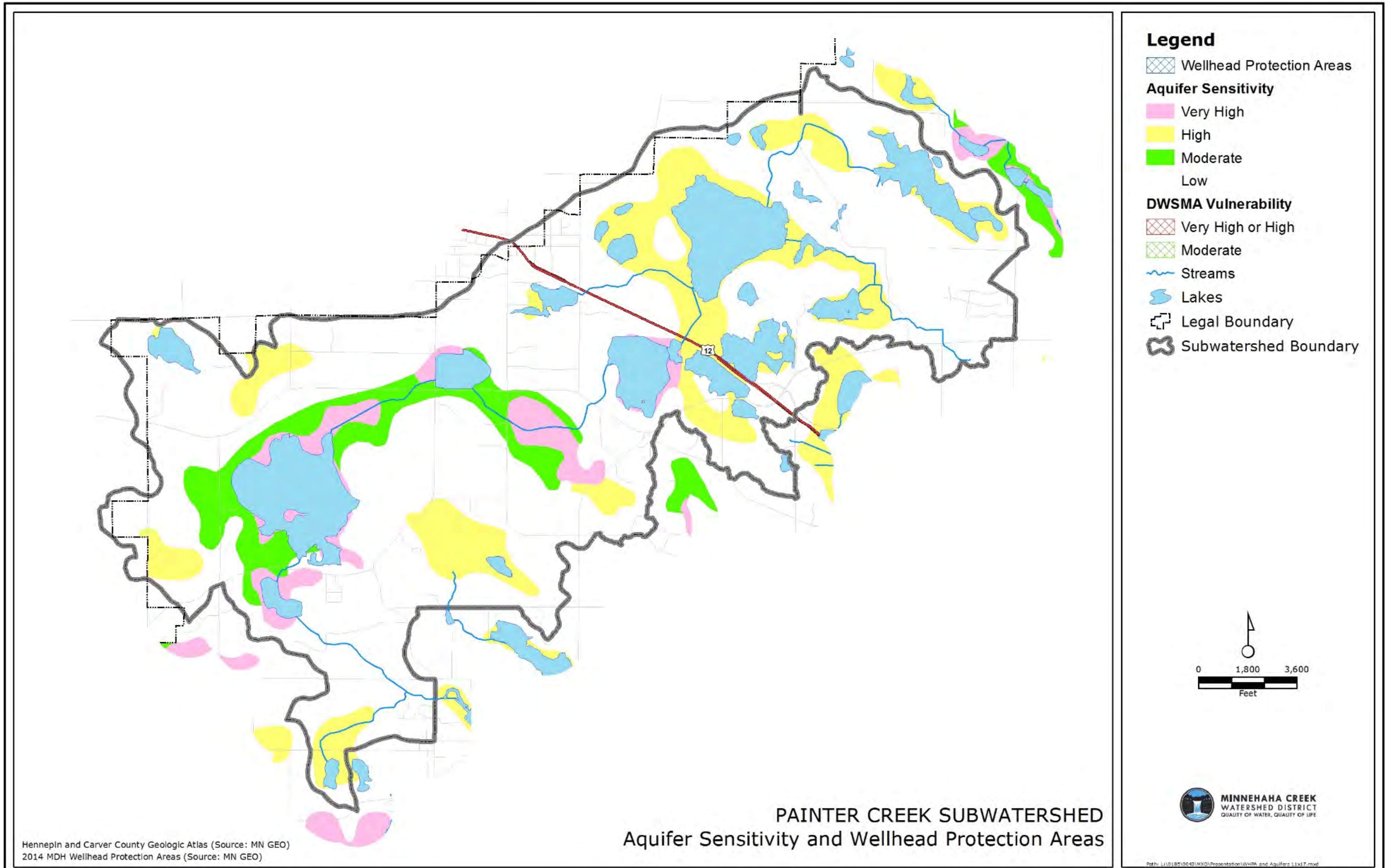

Figure 2. 83. Painter Creek subwatershed aquifer sensitivity and Wellhead Protection Areas.

Water Quantity:

There are no landlocked basins in this subwatershed (Figure 2.80). To assess change in water yield, a Mann-Kendall statistical trend test was performed on annual water yield data for the monitoring station at West Branch Rd. The period of record for the station was 2006-2015. Water yield did not exhibit any statistically significant trend.

Ecological Integrity:

The E-Grade program defines watershed ecological integrity as the degree to which the watershed provides three key ecosystem services: biodiversity, habitat diversity, and nutrient cycling. Nutrient cycling is described in the Water Quality section. The Painter Creek subwatershed has not yet been evaluated by the E-Grade program. This section summarizes ecological integrity using existing data, where available (Figure 2.84).

Lakes:

Biodiversity

Fish Community. No fish IBI or survey data are available for the lakes in this subwatershed.

Aquatic Vegetation Community. Biodiversity is determined by the number and variety of species, or richness. No aquatic vegetation survey or Floristic Quality Index (FQI) data are available for the lakes in this subwatershed.

Aquatic Invasive Species. No AIS data are available for the lakes in this subwatershed.

Habitat diversity

Aquatic Vegetation Community. No Floristic Quality Index (FQI) data are available for the lakes in the subwatershed.

Shoreline Health. Shoreline health is assessed looking at shoreline vegetative cover and the relative human disturbance. The MnDNR is using the Score the Shore protocol to relate shoreline conditions to fish community structure using the fish IBI metric. No Score the Shore data are available; however, aerial photos show that the lakes and larger wetlands with open water are bordered with riparian wetland or woodland.

Streams:

Biodiversity

Fish Community. The DNR conducted a fish survey on Painter Creek in 2010. The fish IBI score was 67, above the state's threshold. The survey found a variety of species and a good abundance of fish, including blackchin shiners and Iowa darters, both of which are intolerant species. The fish community in Painter Creek downstream of Painter Marsh, where this survey was completed, is likely colonized from Jennings Bay: Lake Minnetonka. Largemouth bass, bluegill, several sunfish species, and common carp were also present.

Macroinvertebrate Community. The DNR conducted a macroinvertebrate survey twice in 2010, and the District surveyed several sites along the creek in 2013. The DNR's M-IBI scores were 5 and 8 out of 100, well below the state's threshold. Scores from the District's surveys ranged from 3 to 20. Species were very pollution-tolerant, and there was low species diversity.

Aquatic Invasive Species. No AIS data are available for the stream stations in this subwatershed.

Habitat diversity

Habitat Complexity. No Minnesota Stream Habitat Assessment data are available to assess habitat complexity, but notes taken for the 2004 *Upper Watershed Stream Assessment* were reviewed to better understand conditions in the in-stream zone and riparian zone, and to assess channel morphology. That survey found that the stream has been channelized and straightened, with altered and limited habitat and morphology.

Connectivity. Connectivity is defined by two metrics: presence or absence of barriers, and access to floodplain. Barriers such as dams, weirs, and culverts limit or prevent organisms from moving freely in the stream. There are several barriers on the streams in this subwatershed, most of them culverts at road crossings, or outlet structures on the larger of the flow-through wetlands.

Water Quality. Water quality factors impacting stream habitat diversity include concentrations of TSS and DO. Higher TSS concentrations increase turbidity, which can interfere with aquatic predators seeking their prey and which can limit growth of aquatic vegetation. Refer to Water Quality section for data.

Hydrology Indicators. Stream hydrology is an important factor in habitat diversity. A stream that is very flashy, that is, one that rises and falls very quickly in response to rain events, can be stressful to organisms. In addition, streams that periodically are dry or have minimal flow are hostile to aquatic life. Continuous streamflow data are available for CPA01 and CPA03. Instantaneous flow at CPA01 can be flashy following storm events, and since 2006, the CPA01 station has an average of discharge of 8.35 cfs. Note: Annual average flow for each year was computed first, and then all the years' averages were averaged together.

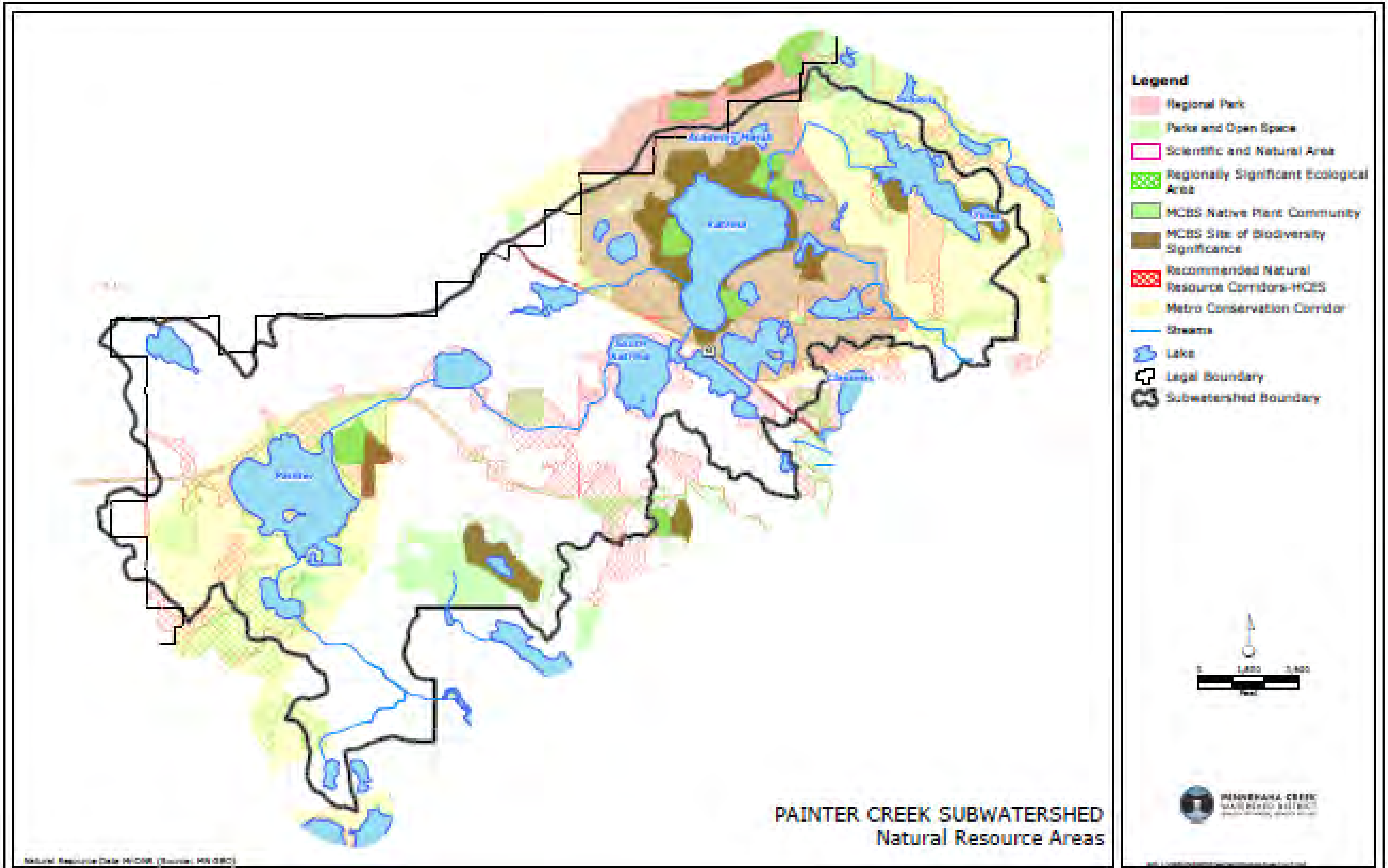

Figure 2. 84. Painter Creek subwatershed natural resource areas.

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Wetlands:

Biodiversity

Vegetation Community. No Rapid Floristic Quality Assessment (RFQA) data are available for the wetlands in this subwatershed. However, the *Functional Assessment of Wetlands* assessed two large riparian wetlands – around Lake Katrina and Thies Lake, which scored highly on vegetative diversity, fish and wildlife habitat, or aesthetics. Most of these high function and value wetlands are located within Baker Park Reserve.

Macroinvertebrate Community. No macroinvertebrate data are available for the wetlands in this subwatershed.

Uplands:

Biodiversity

Regionally Significant Ecological Areas are places where larger tracts of minimally disrupted land provide habitat complexity. Large areas of undisturbed or minimally disturbed forest and wetland in the subwatershed, including the Baker Park Reserve and Painter Marsh, have been designated Regionally Significant Ecological Areas by the DNR. The Minnesota Biological Survey (MBS) determined that several areas in the subwatershed were of moderate or high biodiversity significance, including a tamarack swamp complex; the wetland and upland areas surrounding Lake Katrina; and patches of maple-basswood and oak forest that are ranked as imperiled and vulnerable to extirpation (Figure 2.84).

Habitat diversity

The Baker Park Reserve and a large area in the lower subwatershed surrounding and including Painter Marsh are part of a DNR-designated Metro Conservation Corridor. The lower subwatershed conservation corridor area is part of a much larger corridor that extends south into the Dutch Lake and Langdon Lake subwatersheds, eventually connecting with the Gale Woods Regional Park in Minnetrista.

Thriving Communities:

Land use:

Table 2.76 shows the land uses within the area of the Painter Creek subwatershed in acres and as a percentage of the total subwatershed. The predominant land use in the subwatershed is vacant or undetermined use, followed by parks and open space and agriculture (Figure 2.85). The percentage of single-family residential has increased since the last plan update. Some large tracts of agricultural uses remain in the lower subwatershed, while the upper watershed is dominated by Baker Park Reserve. Much of the watershed is outside of the MUSA 2020 boundary, and is not served by regional wastewater facilities.

Table 2. 76. 2016 land use in the Painter Creek subwatershed.

Land Use 2016	Acres	% of Subwatershed
Vacant or Undetermined	3,163.8	36.5
Agricultural	1,643.0	19.0
Parks and Open Space	1,633.9	18.8
Single - Family Residential	1,600.9	18.5
Water	395.7	4.6
Roads and Highways	71.6	0.8
Institutional	69.0	0.8
Industrial	40.6	0.5
Commercial	34.5	0.4
Multi - Family Residential	16.9	0.2

Source: Metropolitan Council.

Recreation:

The Three Rivers Park District's Baker Park Reserve covers much of the upper subwatershed. The park includes numerous wetlands and Lake Katrina, and bicycle/hiking trails provide access to many natural features. The Luce Line Regional Trail passes across this subwatershed. There are no boat accesses or beaches on the lakes in the subwatershed, nor on Painter Creek.

The Minnesota Historic Features database notes 14 historic features in the subwatershed, most being residences, farmhouses or agricultural buildings. The listing includes a church, a post office as well as two commercial buildings in Maple Plain (Figure 2.86).

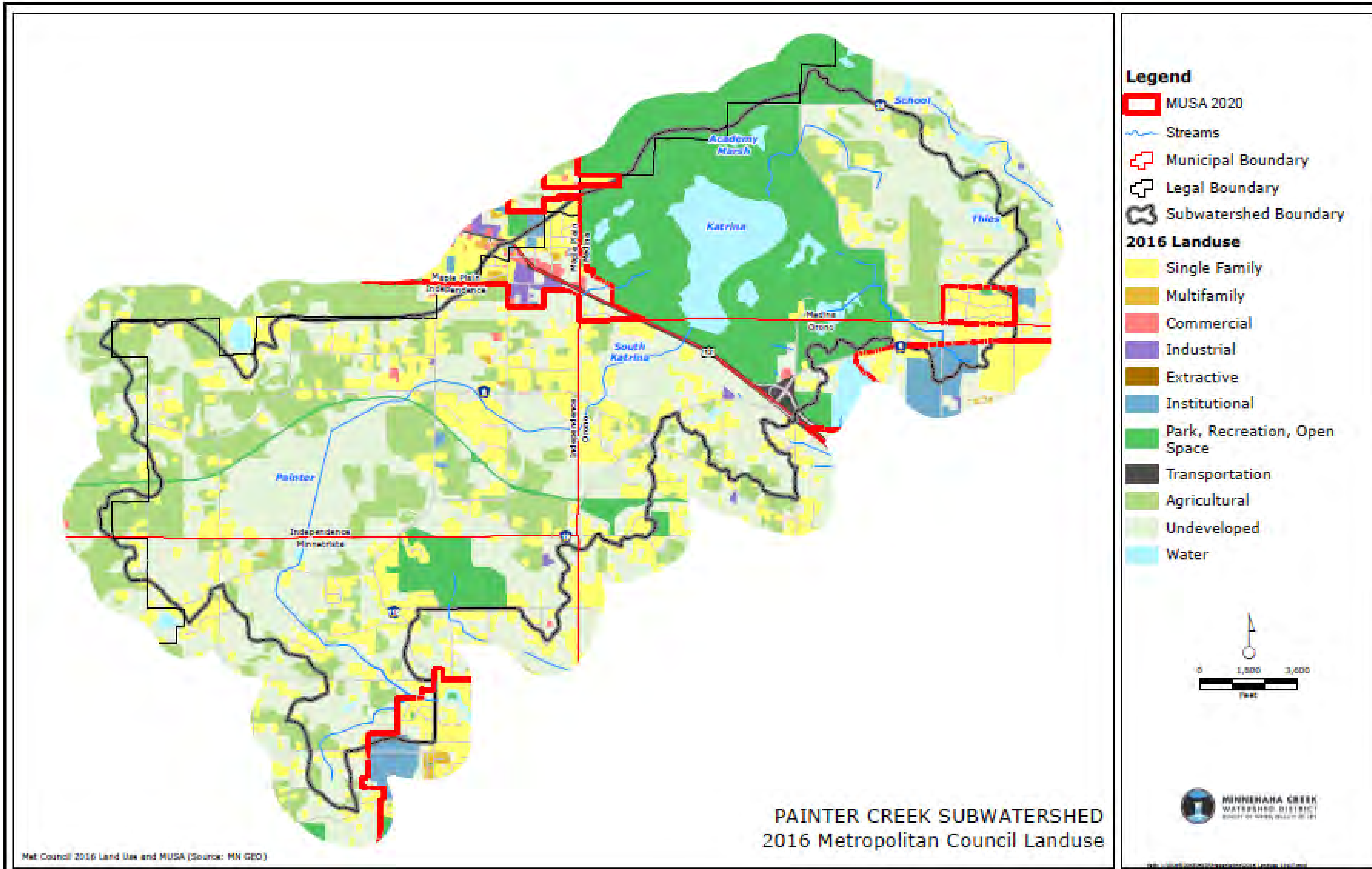


Figure 2. 85. Painter Creek subwatershed 2016 Metropolitan Council land use.

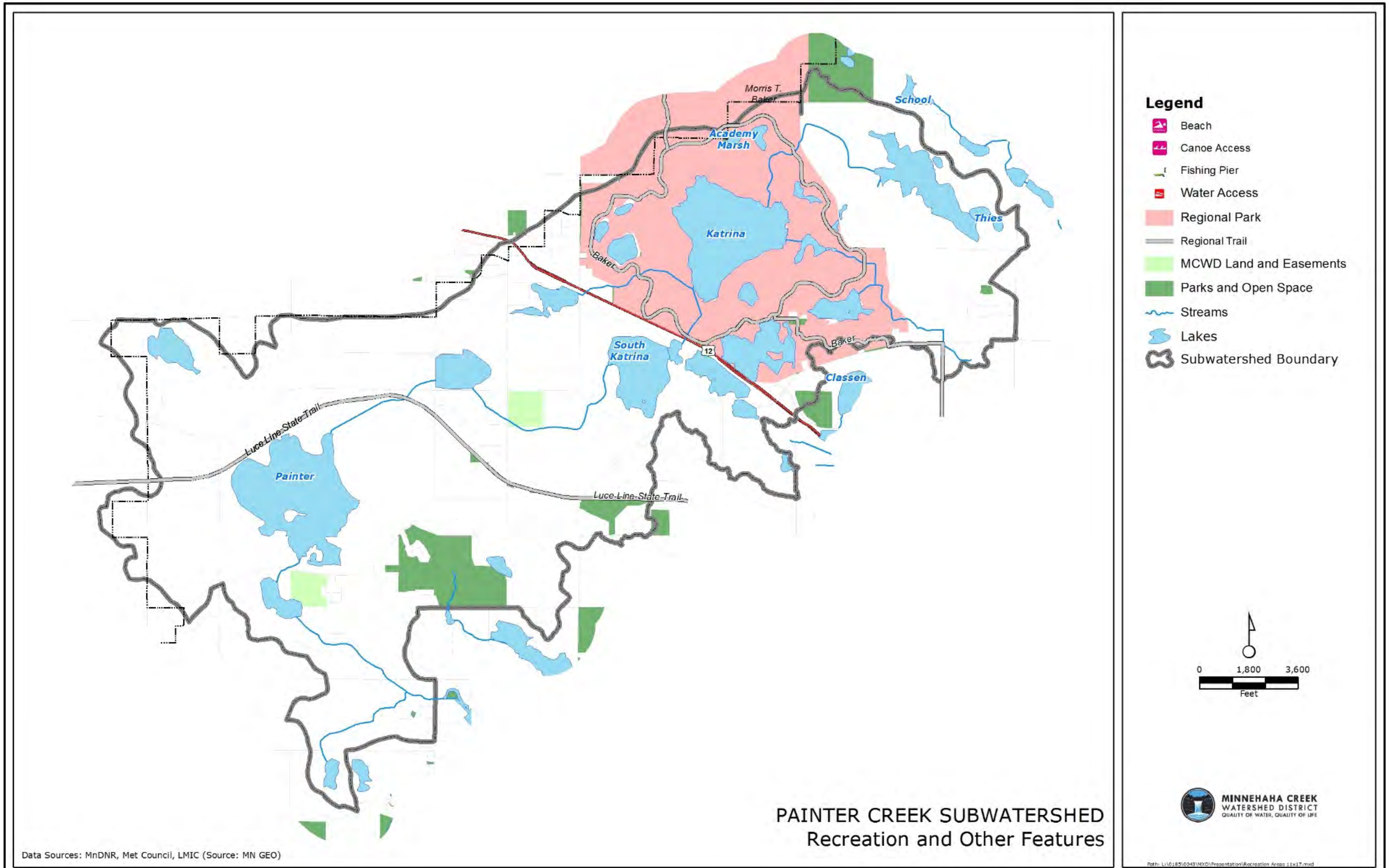


Figure 2. 86. Painter Creek subwatershed recreation and other features.

2.3.10 SCHUTZ LAKE SUBWATERSHED

Schutz Lake Subwatershed is one of the smaller subwatersheds throughout MCWD. It has a mixed land use - open space in Carver Park Reserve in the north, residential use in the east and agricultural use in the south. Wetlands, forests and woodlands are patchy throughout the subwatershed, but mostly concentrated around Schutz Lake. The subwatershed drains into Schutz Lake and then the lake drains into Lake Minnetonka: Smithtown Bay. The nutrient contribution to Lake Minnetonka from the Schutz Lake Subwatershed is not well understood. Table 2.77 below shows the area of the Schutz Lake subwatershed in acres by individual city, in total and as a percentage of the total subwatershed (Figure 2.87).

Table 2. 77. Cities in the Schutz Lake subwatershed.

City	Area (Acres)	% of Subwatershed
Victoria	969.2	100%
Total	969.2	100%

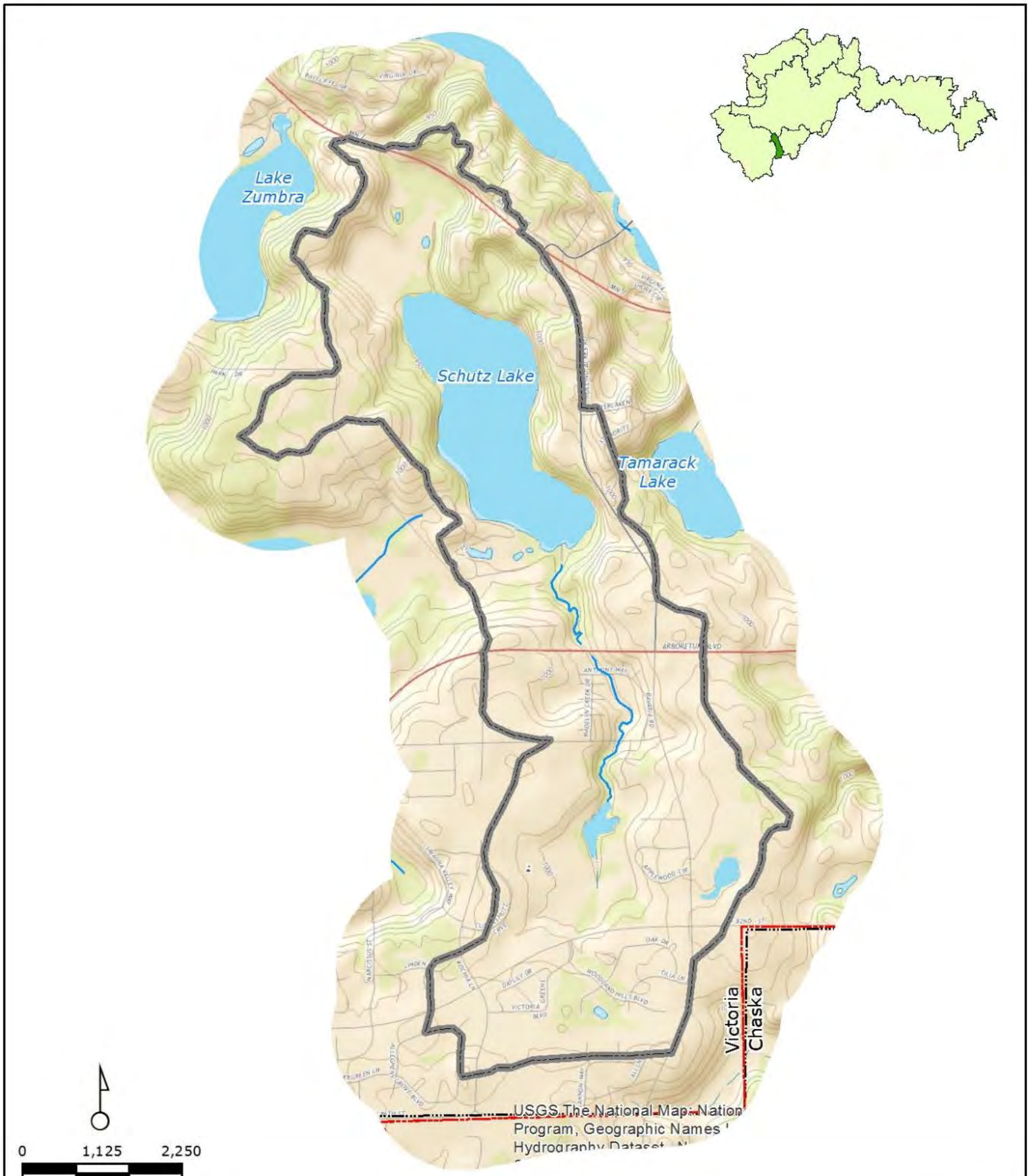
Source: MCWD

Subwatershed Description and Hydrology:

The Schutz Lake subwatershed is rolling and hilly with steep slopes abutting Schutz Lake and the wetlands to the north. A portion of the northwestern subwatershed is located within the Carver Regional Park Reserve, while the southern subwatershed contains lands that are part of the University of Minnesota Horticultural Research Center and Landscape Arboretum. The southern subwatershed contains agriculture and scattered residential development and drains through Schutz Creek north under Highway 5 to Schutz Lake. The lake dominates the northern subwatershed, with some residential development on its east side. Schutz Lake outlets into a large wetland that discharges to an outlet under Highway 7 into Smithtown Bay: Lake Minnetonka. For information regarding geology and soils in the subwatershed, please refer to the *2007 MCWD Comprehensive Water Resources Management Plan*.

Land cover is classified by the Minnesota Land Cover Classification System (MLCCS) (Figure 2.88). The subwatershed is bisected by Highway 5. The lake dominates the north, with the forest, woodland and grasslands of the Carver Park Reserve to the west and residential areas with low to medium impervious surface to the east. The southern half of the subwatershed is maintained or natural grassland and agriculture with scattered residential development.

The *2003 MCWD Hydrologic, Hydraulic, and Pollutant Loading Study (HHPLS)* subdivided the Schutz Lake subwatershed into four units, designated SL-1 through SL-4 (Figure 2.89).



SCHUTZ LAKE SUBWATERSHED
Schutz Lake Subwatershed

Legend

Streams
Lakes
Municipal Boundary
Legal Boundary
Subwatershed Boundary

MINNEHAHA CREEK WATERSHED DISTRICT
QUALITY OF WATER, QUALITY OF LIFE

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Figure 2. 87. The Schutz Lake subwatershed.

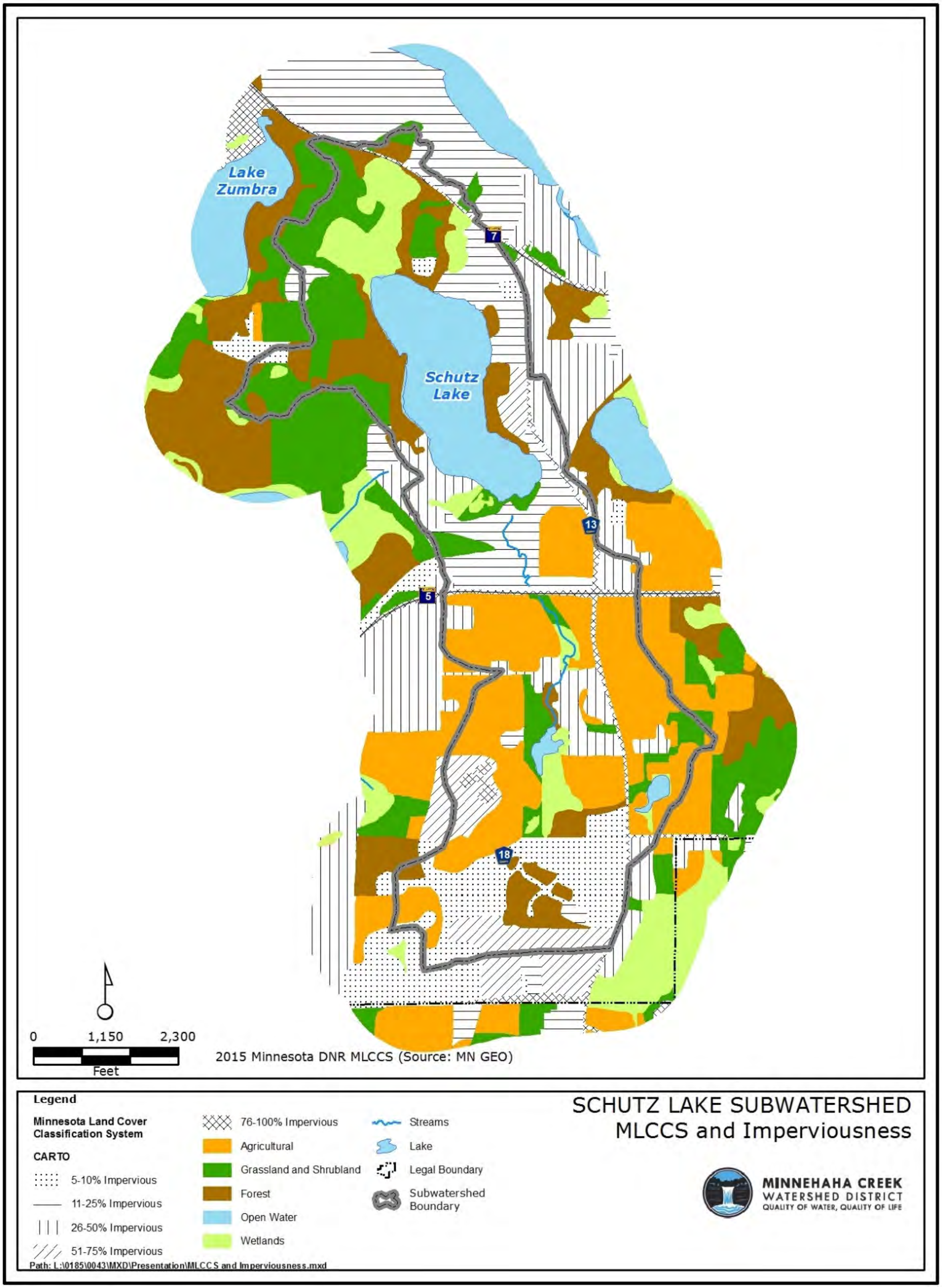

Figure 2. 88. Schutz Lake subwatershed MLCCS and imperviousness.

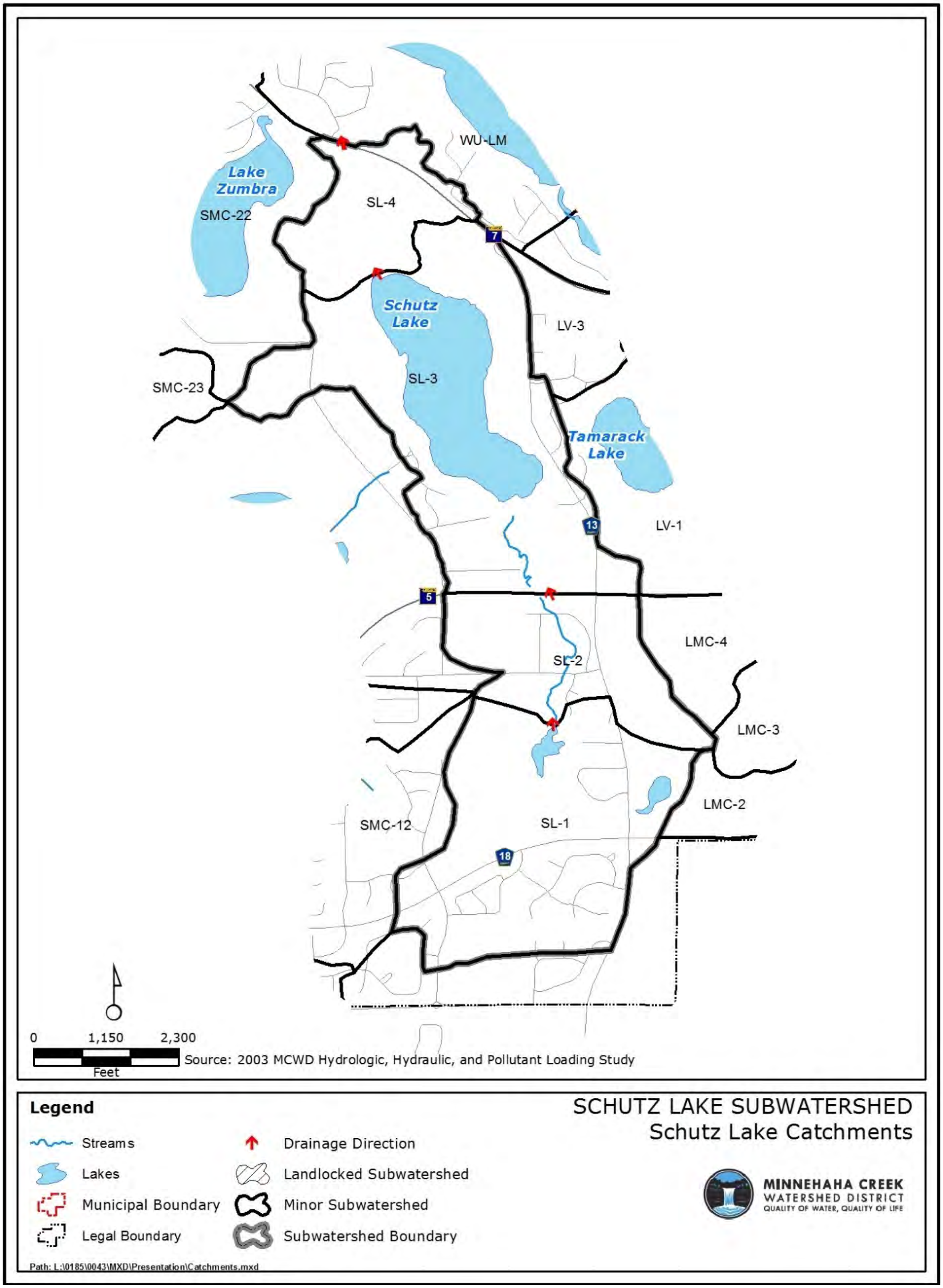

Figure 2. 89. Schutz Lake catchments.

Water Quality:

The following are summaries of the characteristics and classifications of lakes and streams within the subwatershed including water quality goals and trends.

Lakes:

Schutz Lake is the primary receiving water within the subwatershed, and is classified by the DNR for shoreland management purposes as a Recreational Development lake (Table 2.78). Schutz Lake is not on the State's Impaired Waters list. However, the lake is eutrophic, with observations of greenish-brown water (an indication of algae). Tables 2.78 and 2.79 below detail the physical and water quality characteristics of Schutz Lake.

To assess long-term change in Schutz Lake, a Mann-Kendall trend analysis was performed on total phosphorus (TP), chlorophyll-a (Chl-a), and Secchi depth data for the period 2002-2015. This analysis showed no trend in TP concentration or Secchi depth, but showed a statistically significant ($p<0.05$) degrading trend in chlorophyll-a, which is a measure of algal growth. For more information please refer to the District's Water Quality (Hydrodata) reports.

Table 2. 78. Physical characteristics of lakes in the Schutz Lake subwatershed.

Lake	Surface Area (acres)	Maximum Depth (ft)	Watershed to Lake Area Ratio	DNR Classification
Schutz	106	49	8:1	Recreational Development

Source: Minnesota DNR.

Table 2. 79. Selected water quality goals and current conditions of lakes in the Schutz Lake subwatershed.

Lake	State TP Standard (µg/L)	2007 Plan Goal TP (µg/)	Trend*	2002-2015 Summer Average		
				TP (µg/L)	Chl-*a* (µg/L)	Secchi (m)
Schutz	40	40	Deg Chl-*a*	39	22	1.6

*Statistically significant at ≤ 0.05, Deg = degrading.
Source: MCWD.

Streams:

Schutz Creek conveys discharge through the upper subwatershed north under Highway 5 and empties into Schutz Lake (Figure 2.90). It is not listed as an Impaired Water; however, summer average total phosphorus concentration is greater than the nutrient component of the state's river eutrophication standard. Elevated levels of total phosphorus suggest that: 1) excess nutrients may be conveyed from the watershed to Schutz Lake through Schutz Creek, and/or 2) riparian wetlands in the watershed may be discharging phosphorus to the stream, indicating wetland disturbance.

Tables 2.80 and 2.81 below detail the physical and water quality characteristics of streams and tributaries within the subwatershed. To assess long-term change in Schutz Lake Inlet, a Mann-Kendall statistical trend test was performed on flow-corrected TP and TSS data from 2006-2015. There were no statistically significant changes in water quality during this period.

Table 2.81 shows the average concentrations at the monitoring site of the Schutz Lake Creek outlet. The stream has an average TSS concentration of 12 mg/L, which is well below the 30 mg/L state standard. Maintaining sufficient dissolved oxygen (DO) is necessary to support aquatic life. The DO state standard requires the stream to never fall below 5 mg/L DO. The most recent DO readings available by the District were above the standard. For more information, refer to District's Water Quality (Hydrodata) reports.

Table 2. 80. Major streams in the Schutz Lake subwatershed.

Stream	Length (mi)
Schutz Lake Creek Inlet (CSC01)	1.14

Table 2. 81. Current conditions of streams in the Schutz Lake subwatershed.
See Figure 2.90 for monitoring locations.

Stream	Trend*	2006-2015 Annual Average			
		TP (µg/L)	TN (mg/L)	TSS (mg/L)	Cl (mg/L)
Schutz Lake Creek Inlet (CSC01)	No trend	182	1.23	12	54**

TP = total phosphorus, TN =total nitrogen, TSS = total suspended solids, Cl = chloride.
*Statistically significant at ≤ 0.05, **Cl data 2008-2015
Source: MCWD.

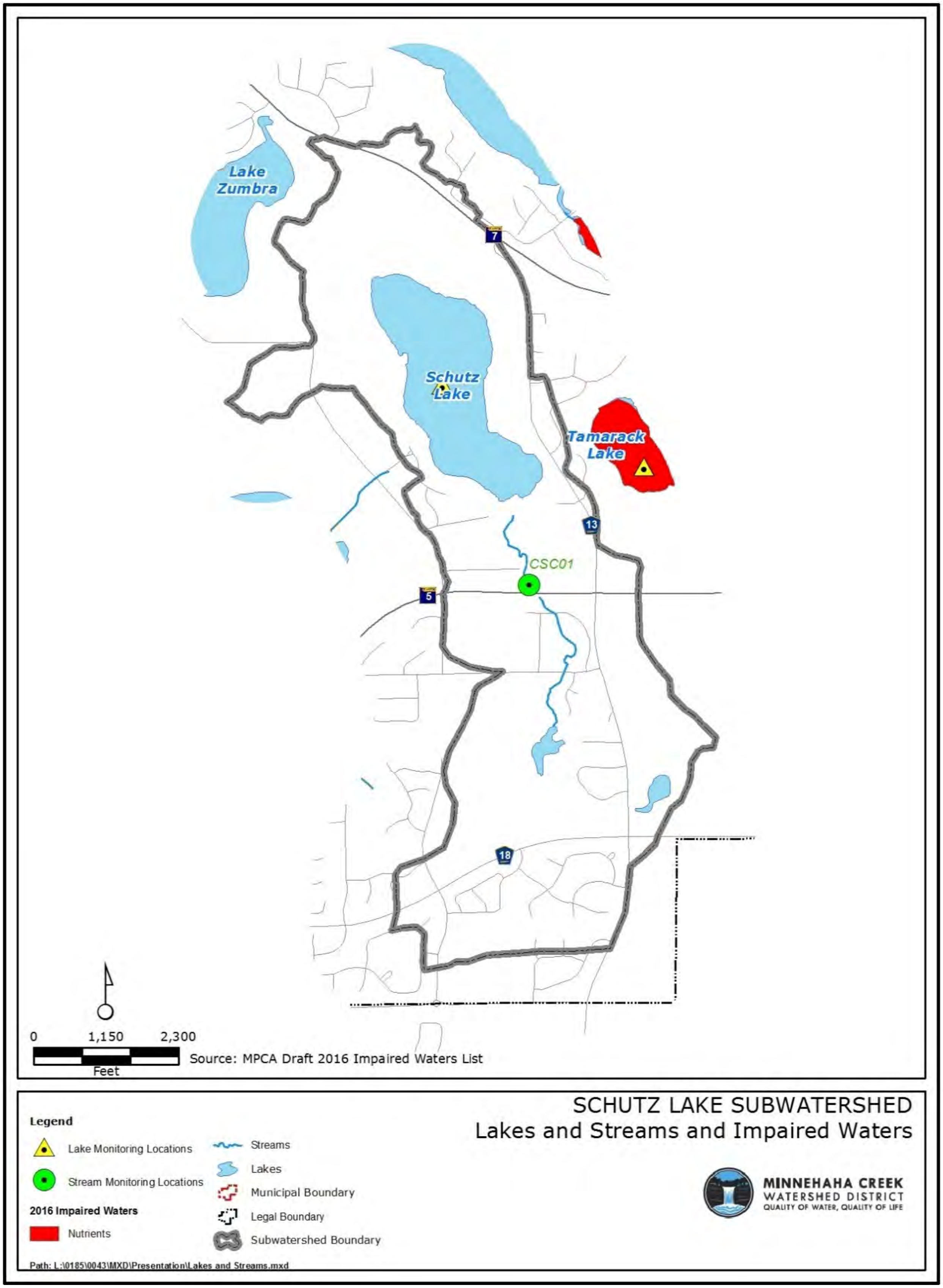

Figure 2. 90. Schutz Lake subwatershed lakes and streams and Impaired Waters.

Wetlands:

According to the FAW, wetlands, including lakes, cover over 20 percent of the watershed's surface (Figure 2.91 and Table 2.82). A delineation of wetland boundaries is required to be completed any time development or other impacts may occur near or in a wetland. For more information regarding wetlands in the subwatershed, please refer to the *2007 MCWD Comprehensive Water Resources Management Plan*.

No data are available yet to evaluate the ability of the wetlands in the subwatershed to cycle nutrients to and from the subwatershed. E-Grade will assess wetland soil chemistry, overall vegetative conditions, presence or absence of algal blooms, and condition of the buffer and area within 500 feet of the wetlands.

Table 2. 82. Functional Assessment of Wetlands inventory of wetland types in the Schutz Lake subwatershed.

FAW Circular 39 Wetland Type	Area (acres)	Percent
1 - Seasonal	6.5	0.71
2 - Wet Meadow	66.5	7.29
3 - Shallow Marsh	14.4	1.58
4 - Deep Marsh	36.6	4.01
5 - Open Water	3.2	0.35
6 - Scrub Shrub	0.3	0.03
7 - Forested	13.9	1.52
8 - Bog	-	-
Riverine	-	-
Wetland Total	141.4	15.5
Upland	770.2	84.5
TOTAL	911.6	

Source: MCWD Functional Assessment of Wetlands.

Groundwater:

The District's roles in managing groundwater are to 1) promote surficial groundwater recharge to protect wetland hydrology and stream base flow, and 2) assist in protecting deeper aquifers used for drinking water by limiting infiltration in sensitive recharge areas.

Infiltration potential of the upland areas within the subwatershed is generally medium, with the areas of loamy clay soils classified as low potential. Because of the organic nature of the soils in the wetland areas, generally, the infiltration potential there is variable. The *Carver County Water Resource Management Plan* classifies the groundwater resources of most of the western subwatershed area as being of medium to low sensitivity to pollution, and the major wetland areas on the north and in the south as being highly sensitive.

The western edge of the subwatershed has been designated by the Minnesota Department of Health as a Drinking Water Supply Management Area (DWSMA) and Wellhead Protection Area for the City of Victoria. Figure 2.92 shows areas in the subwatershed with groundwater sensitivity and that are designated Wellhead Protection Areas.

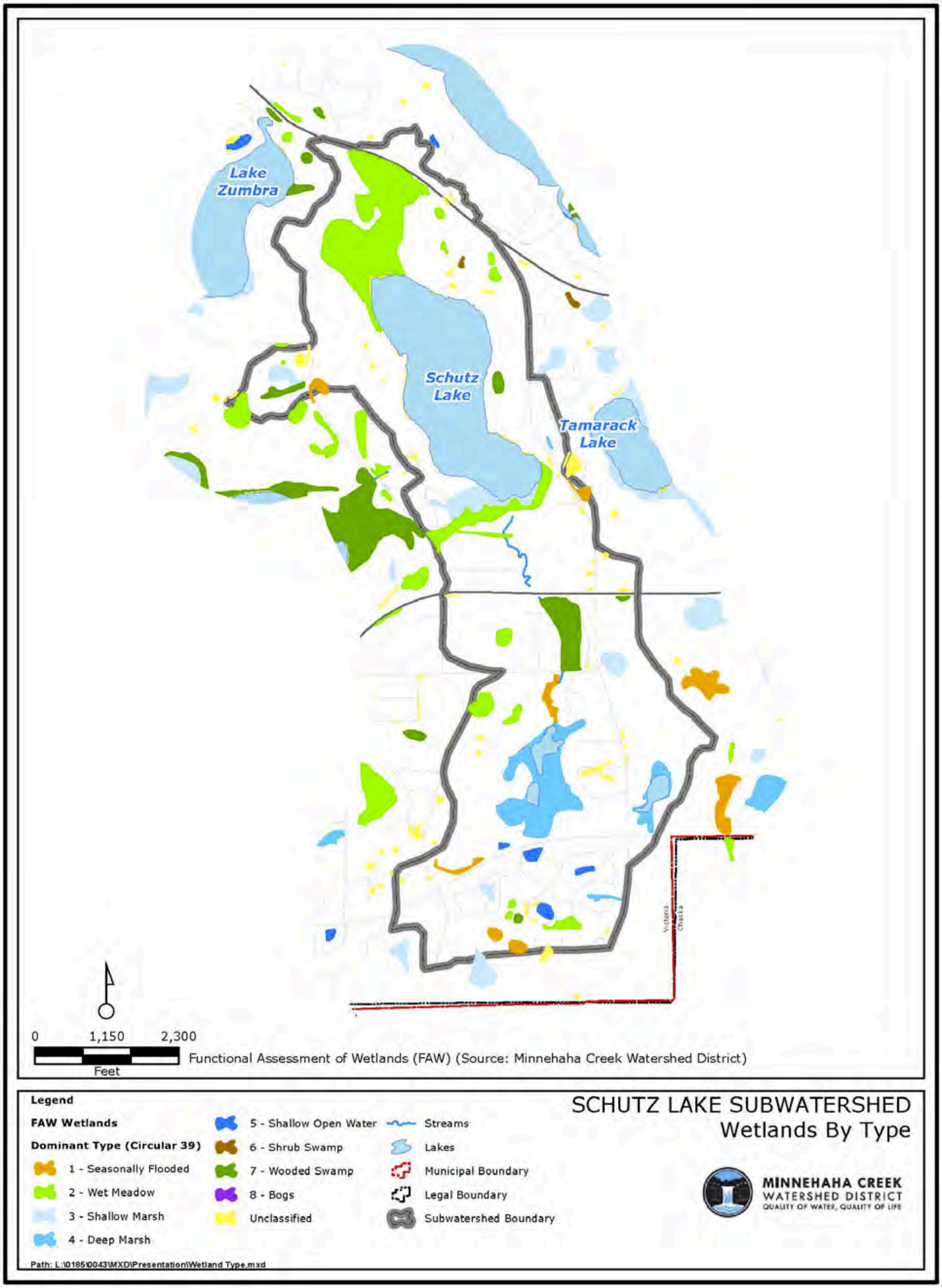

Figure 2. 91. Schutz Lake subwatershed wetlands by type.

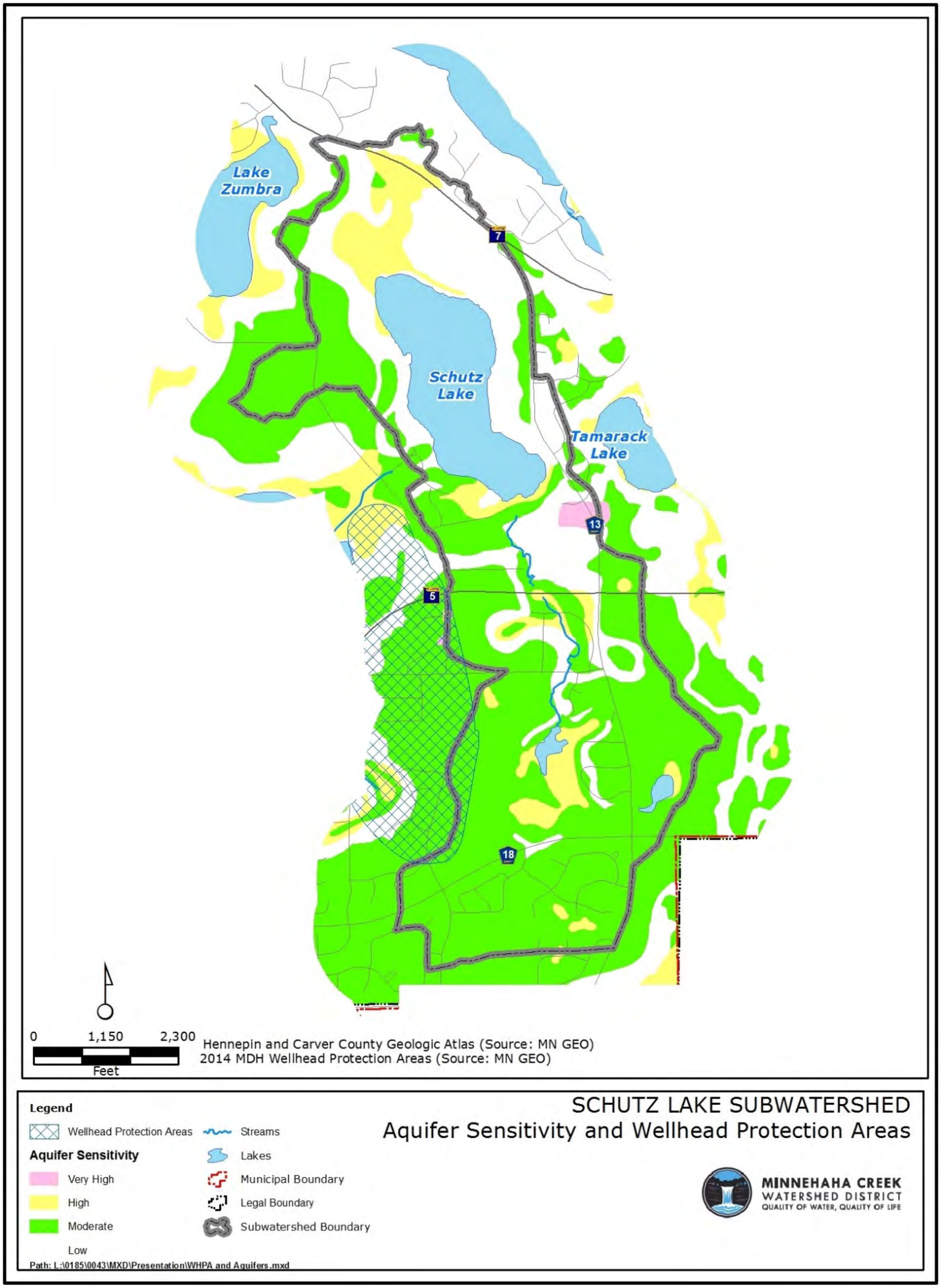

Figure 2. 92. Schutz Lake subwatershed aquifer sensitivity and Wellhead Protection Areas.

Water Quantity:

There are no landlocked basins in this subwatershed. To assess change in water yield, a Mann-Kendall statistical trend test was performed on annual water yield data for the monitoring station downstream of Highway 5. Water yield from 2006-2015 showed a statistically significant ($p=0.04$) increasing trend. There has been some development in the upper subwatershed during that period.

Ecological Integrity:

The E-Grade program defines watershed ecological integrity as the degree to which the watershed provides three key ecosystem services: biodiversity, habitat diversity, and nutrient cycling. Nutrient cycling is described in the Water Quality section. The Schutz Lake subwatershed is being evaluated by the E-Grade program in 2015-2017. At this time, only some of the E-Grade metrics have been assessed. The final E-Grade report for this subwatershed will not be available until 2018. This section summarizes ecological integrity using E-Grade and other data, where available (Figure 2.93).

Lakes:

Biodiversity

Fish Community. Biodiversity is measured using the Index of Biotic Integrity (IBI) for fish developed by the DNR. MCWD surveyed Schutz Lake in 2015 for E-Grade. Schutz Lake's Fish IBI score is 22.8, which is classified as Poor, with the community showing obvious signs of anthropogenic disturbance compared to other similar lakes. Schutz Lake was last surveyed by the DNR in 1991. At that time the fish population was dominated by bluegill, black crappie, and largemouth bass in above average numbers.

Aquatic Vegetation Community. Biodiversity is determined by the number and variety of species, or richness. A Floristic Quality Index (FQI) assessment was completed for the Schutz Lake aquatic vegetation community. The FQI score was 9.4, which is classified as Degraded, with very low species richness and with a community comprised of non-native and/or intolerant species.

Aquatic Invasive Species. Schutz Lake is infested by Eurasian watermilfoil and Curlyleaf Pondweed.

Habitat diversity

Aquatic Vegetation Community. Habitat diversity is determined by the percent occurrence of species, or the extent to which it may be dominated by a few species. The habitat diversity of the vegetation community has not been assessed yet.

Shoreline Health. Shoreline health is assessed looking at shoreline vegetative cover and the relative human disturbance. The MnDNR is using the Score the Shore protocol to relate shoreline conditions to fish community structure using the fish IBI metric. Score the Shore data are available, but has not been assessed yet through E-Grade. Aerial photos, however, show that much of Schutz Lake has significant woodland or wetland fringes, which are beneficial for controlling runoff and supporting emergent vegetation at the shoreline.

Streams:

Biodiversity

Fish Community. No fish IBI data are available for the streams in this subwatershed.

Macroinvertebrate Community. Macroinvertebrate samples were collected in 2013 and 2015 in Schutz Creek. The M-IBI scores were 19 and 28, below the M-IBI threshold of 37 for a Southern Streams riffle/run stream. The community lacked species richness and was missing certain classes of organisms, which is indicative of poor water quality or habitat alteration.

Aquatic Invasive Species. No AIS data are available for the streams in this subwatershed.

Habitat diversity

Habitat Complexity. E-Grade uses the Minnesota Stream Habitat Assessment tool to assess habitat complexity in Schutz Creek. Habitat Complexity is determined by evaluating three zones: in-stream, riparian or near-stream, and channel morphology, or channel form. Schutz Creek scored 27 of 46 points for conditions in-stream, which is classified as Good. The stream bed was a good mix of cobble, gravel and sand, there were riffles and pools present, and multiple types of cover, although in low quantities. The riparian zone was scored 10 of 14, also Good. The riparian zone is moderately wide, the banks exhibit little erosion, and riparian tree cover provides adequate shading. Channel morphology was scored 28 out of 35, classified Exceptional. The channel was very sinuous, was well developed with variable depths, pools, and riffles, and minimal modifications.

Connectivity. Connectivity is defined by two metrics: presence or absence of barriers, and access to floodplain. Barriers such as dams, weirs, and culverts limit or prevent organisms from moving freely in the stream. Schutz Creek is classified as Poor by the presence of culverts at Highway 5 and at the trail crossing.

Water Quality. Water quality factors impacting stream habitat diversity include concentrations of TSS and DO. Higher TSS concentrations increase turbidity, which can interfere with aquatic predators seeking their prey and which can limit growth of aquatic vegetation. Refer to Water Quality section for data.

Hydrology Indicators. Stream hydrology is an important factor in habitat diversity. A stream that is very flashy, that is, one that rises and falls very quickly in response to rain events, can be stressful to organisms. In addition, streams that periodically are dry or have minimal flow are hostile to aquatic life. Continuous streamflow data are not available, but instantaneous flow has been measured since 2006. Annual average flow for each year was computed first, and then all the years' averages were averaged together. Annual average flow at CSC01 was 1.44 cfs indicating generally low flow conditions at time of data collection.

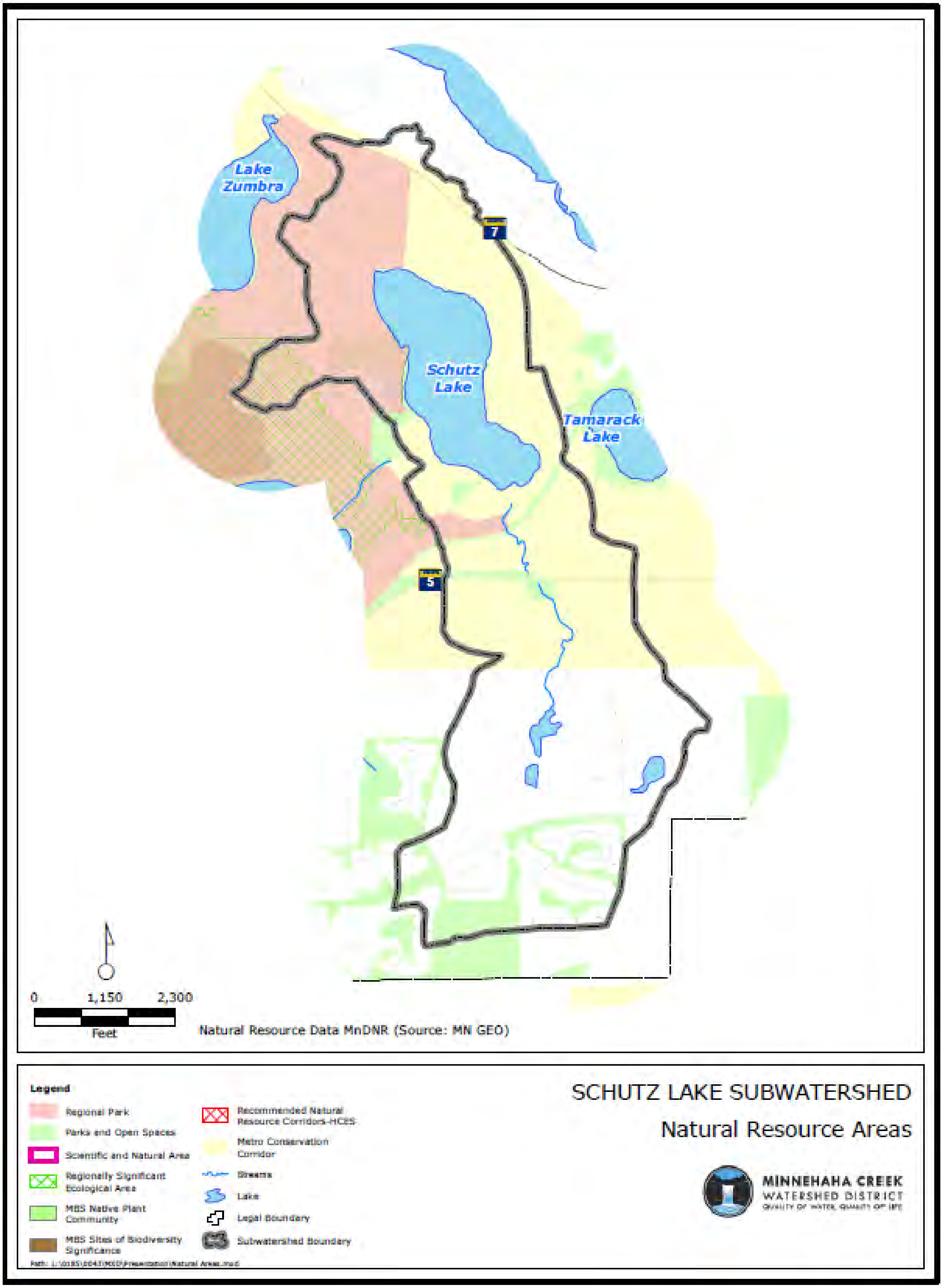

Figure 2. 93. Schutz Lake subwatershed natural resource areas.

Wetlands:

Biodiversity

Vegetation Community. Floristic Quality Index (FQI) data are available for seven wetlands in this subwatershed. One small wetland to the west of Mt. Olivet Church on Rolling Acres Road was classified as Good floristic quality. Four wetlands, including the large wetland at the headwaters of Schutz Creek to the northeast of Holy Family Catholic High School, were classified as Poor. Two small wetlands in the residential area to the north of Schutz Lake were classified as Degraded. Both were heavily infested with buckthorn, reed canary grass, and Canadian wood-nettle.

Habitat diversity

Connectivity. Few wetlands are present in the subwatershed, therefore there is limited opportunity to provide connectivity.

Size. Larger wetlands are more likely to support a notable on-site diversity and/or abundance of wildlife species. There are several large wetlands present in the west of the watershed, along the headwaters of Schutz Creek to Schutz Lake as well as on the north side of Schutz Lake.

Shoreline Protection. Riparian wetlands can provide significant shoreline protection and support emergent vegetation at the shoreline. The *Functional Assessment of Wetlands* evaluated riparian wetlands for their ability to protect lake or stream shoreline. About 30 percent of the Schutz Lake shoreline is protected by wetland.

Uplands:

Biodiversity

Within the Carver Park Reserve on the west side of the lake is a large patch of maple-basswood forest that has been designated on the Minnesota Biological Survey (MBS) as being a high-value native plant community. The larger area within Carver Park Reserve has been designated by the DNR as a regionally significant ecological area within the Metro area. (Figure 2.93).

Habitat diversity

Regionally significant ecological areas are places where larger tracts of minimally disrupted land provide habitat complexity. A portion of the northwestern subwatershed is located within the Carver Regional Park Reserve, while the southern subwatershed contains lands that are part of the University of Minnesota Horticultural Research Center and Landscape Arboretum.

Thriving Communities:

Land use:

Table 2.83 below shows the land uses within the area of the Schutz Lake subwatershed in acres and as a percentage of the total subwatershed. The principal land uses in the northern part of the subwatershed are single-family residential and parks and open space (Figure 2.94).

Table 2. 83. 2016 land use in the Schutz Lake subwatershed.

Land Use 2016	Acres	% of Subwatershed
Parks and Open Space	240.7	24.8
Single - Family Residential	228.4	23.6
Agricultural	140.9	14.5
Institutional	117.4	12.1
Water	109.8	11.3
Vacant or Undetermined	71.9	7.4
Multi - Family Residential	35.5	3.7
Roads and Highways	11.6	1.2
Commercial	8.1	0.8
Industrial	5.0	0.5

Source: Metropolitan Council.

Recreation:

There are no public beaches or accesses to the lake; however, there is a private access that the property owner has granted permission for a fee to anglers and monitoring agencies. The Carver Park Reserve abuts the northwesterly portion of the lake. A park trail loops through the area but does not access the lake. The Southwest Hennepin LRT Regional Trail crosses the subwatershed and portions of the southern subwatershed are part of the University of Minnesota Horticultural Research Center and Landscape Arboretum (Figure 2.95).

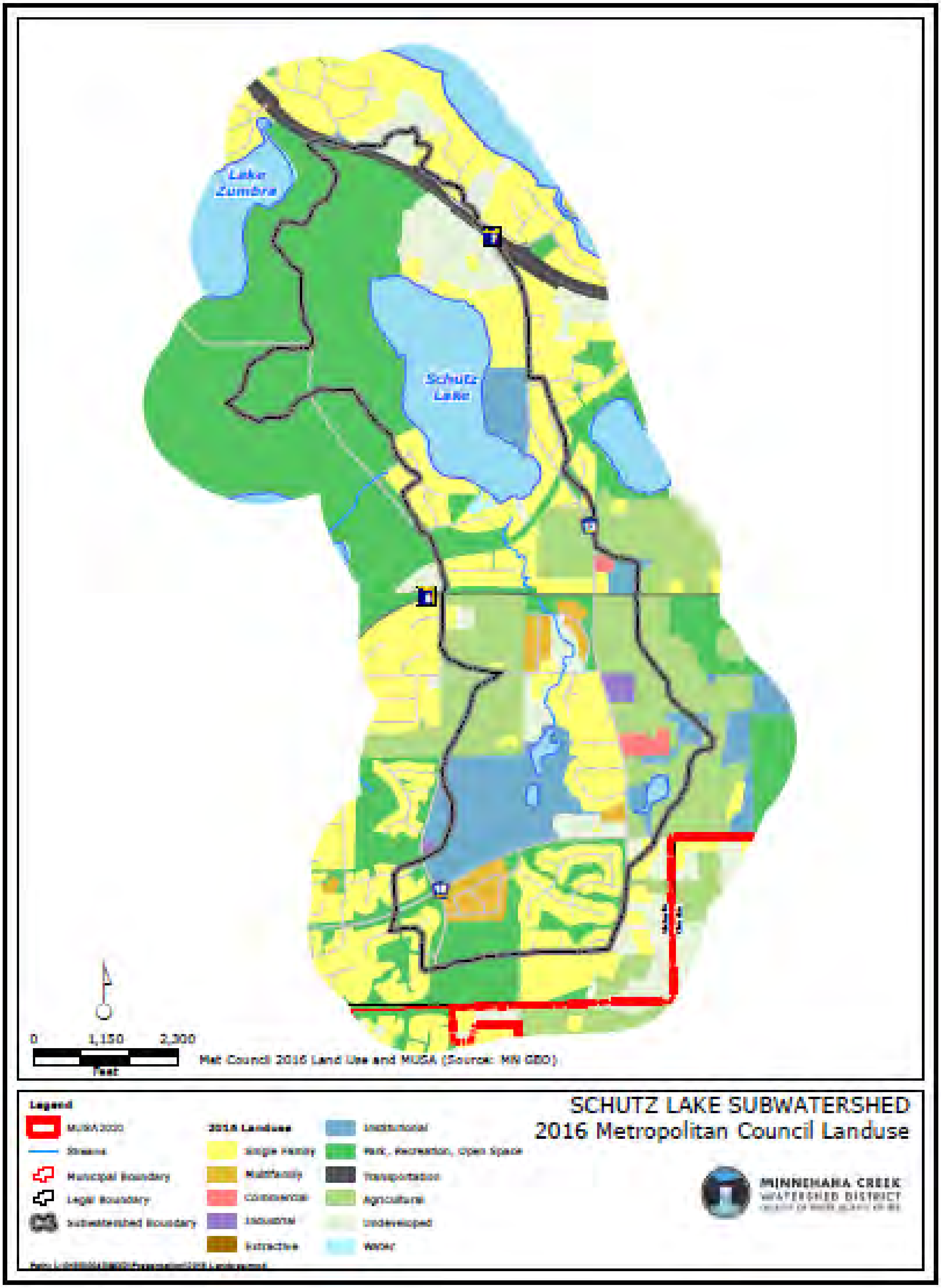

Figure 2. 94. Schutz Lake subwatershed 2016 Metropolitan Council land use.

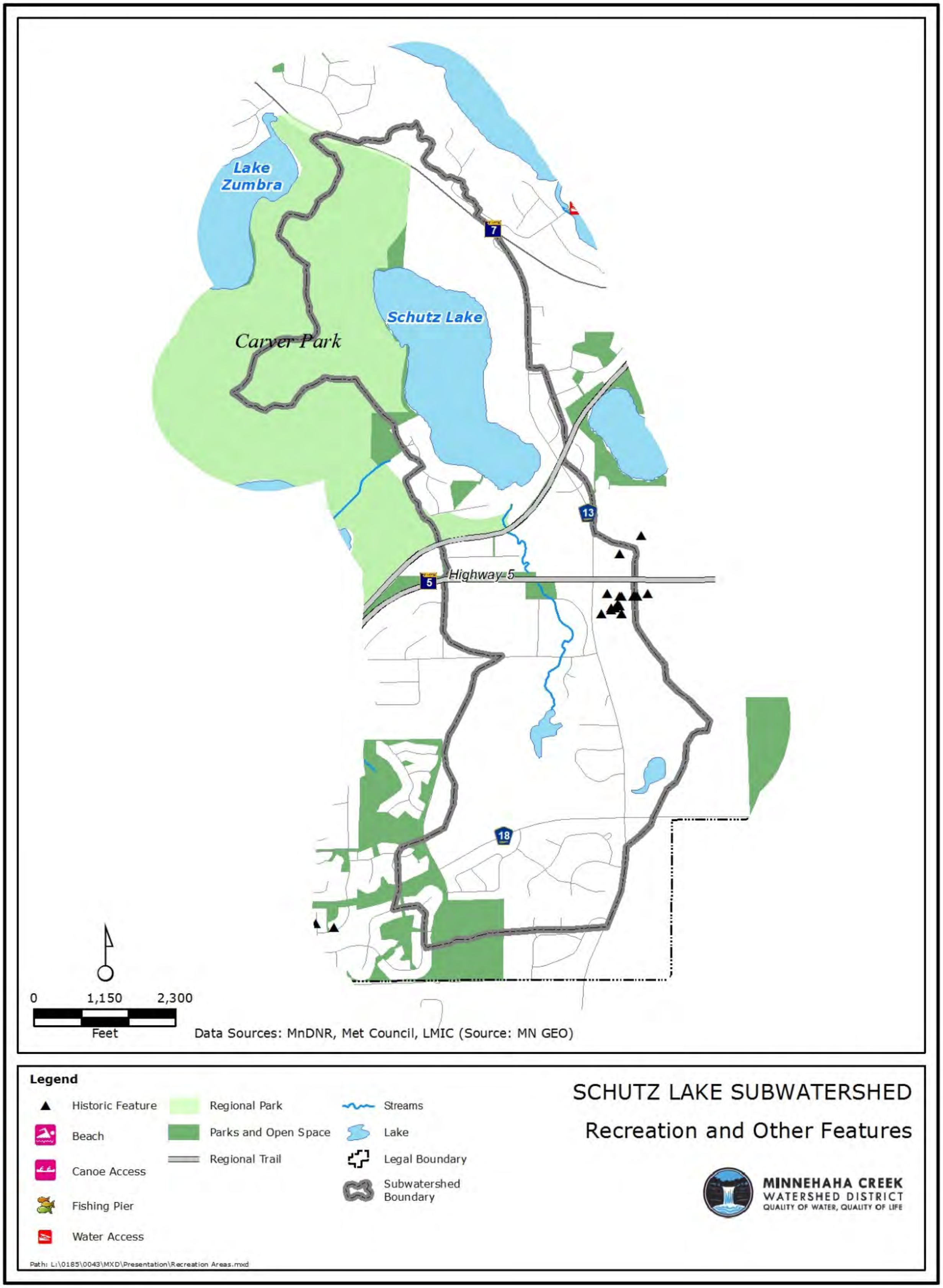

Figure 2. 95. Schutz Lake subwatershed recreation and other features.

2.3.11 SIX MILE CREEK SUBWATERSHED

Six Mile Creek Subwatershed is the third largest subwatershed within Minnehaha Creek Watershed. The land use is primarily agricultural, but residential and commercial development is on the rise as cities and townships within the subwatershed grow. Natural, open areas reside within the Carver Park Reserve, which is managed by Three Rivers Park District. The land cover within Carver Park Reserve is grassland, woodlands, forest and wetlands that surrounds the following lakes: Steiger, Lundsten, Auburn and portions of Zumbra. These lakes are part of a larger series of lakes within the subwatershed nicknamed the "western chain of lakes." Six Mile Creek, which is actually 11 miles long, flows through the "western chain of lakes," beginning with Piersons Lake and passes through Mud Lake wetland before discharging into Lake Minnetonka: Halsted Bay. Table 2.84 below shows the area of the Six Mile Creek subwatershed in acres by individual city, in total and as a percentage of the total subwatershed (Figure 2.96).

Table 2. 84. Cities and Townships in the Six Mile Creek subwatershed.

City	Area (Acres)	% of Subwatershed
Minnetrista	3,572.2	20.9%
St. Bonifacius	662.2	3.8
Victoria	4,476.2	26.2
Laketown Township	8,154.0	47.8
Watertown Township	167.9	0.9
Total	17,032.8	100%

Source: MCWD

Subwatershed Description and Hydrology:

The Six Mile Creek subwatershed has a rolling landscape with low slopes, small streams, numerous lakes and peat bogs. The subwatershed is drained by Six Mile Creek, which flows 11 miles from Piersons Lake to Halsted Bay: Lake Minnetonka. Many of the subwatershed's lakes are located in the Carver Regional Park Reserve.

Land cover is classified by the Minnesota Land Cover Classification System (MLCCS) (Figure 2.97). The subwatershed is dominated by agriculture in the southwest and northwest, while forest and woodland along with grass and shrubland is predominant through the central section. Smaller areas of lower density development are present in the southeast corner of the subwatershed. Wetlands are scattered throughout the subwatershed.

For more information regarding geology and soils in the subwatershed, please refer to the *2007 MCWD Comprehensive Water Resources Management Plan*.

The *2003 MCWD Hydrologic, Hydraulic, and Pollutant Loading Study (HHPLS)* subdivided the Six Mile Creek subwatershed into 66 subwatershed units, designated SMC-1 through SMC-66 (Figure 2.98). More detailed information about the hydrology of the subwatershed can be found in the *Six Mile Creek Diagnostic Study* (Wenck 2013). That study divided the subwatershed into five Watershed Management Units (MUs): including Piersons-Marsh-Wassermann, Carver Park Reserve, Turbid-South Lundsten, Auburn-North Lundsten, and Parley-Mud.

Figure 2. 96. The Six Mile Creek subwatershed.

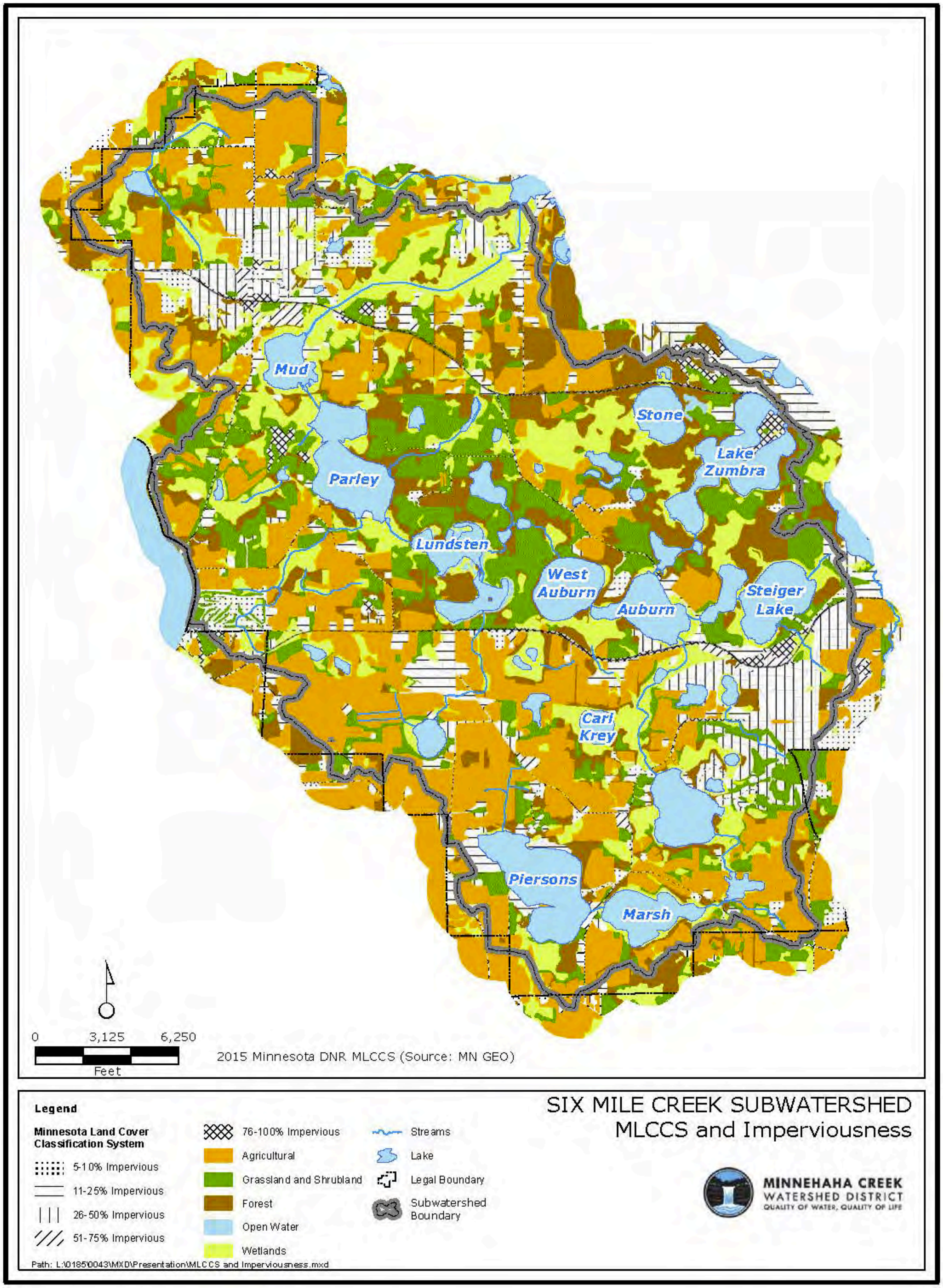

Figure 2. 97. Six Mile Creek subwatershed MLCCS and imperviousness.

Figure 2. 98. Six Mile Creek subwatershed catchments.

Water Quality

The following are summaries of the characteristics and classifications of lakes and streams within the subwatershed including water quality goals and trends.

Lakes:

The subwatershed includes several lakes through which Six Mile Creek flows, as well as other lakes not associated with that stream. Many of the lakes are located within the Carver Park Reserve (Figure 2.99). Most of the lakes are monitored either as part of the District's monitoring program or by Three Rivers Park District. Little or no water quality data are available for smaller lakes scattered throughout the subwatershed. Tables 2.85 and 2.86 below detail the physical and water quality characteristics of the lakes and DNR shoreland classification within the subwatershed.

The following lakes in the Six Mile Creek subwatershed are on the State's Impaired Waters List for excessive phosphorus: West Auburn, Parley, Stone, and Wassermann. Mud Lake has been classified by the MPCA as a wetland rather than a lake, so the lake standard does not apply. *Six Mile Creek Diagnosis Study* and the *Upper Minnehaha Creek Watershed Lakes TMDL* highlight whether external, internal or both are the sources contributing excessive nutrients to these lakes. Lakes Zumbra-Sunny, Steiger, and Wassermann are on the State's Impaired Waters List for Mercury in Fish Tissue, and is included in the statewide mercury TMDL.

To assess long-term change, a Mann-Kendall statistical trend test was performed on total phosphorus (TP), chlorophyll-a (Chl-a), and Secchi depth data from 2001-2015. Statistically significant changes in water quality in the lakes in the Six Mile Creek Subwatershed are listed in Table 2.86. For more information regarding water quality in the subwatershed, please refer to the District's Water Quality (Hydrodata) Reports and the *Six Mile Creek Diagnostic Study*.

Table 2. 85. Physical characteristics of lakes in the Six Mile Creek subwatershed.

Lake	Surface Area (acres)	Maximum Depth (ft)	Watershed to Lake Area Ratio	DNR Classification
Auburn East	148	40	52:1	Recreational Development
Auburn West	145	80	54:1	Recreational Development
Carl Krey	44	15	8:1	Natural Environment
Church	12	54	28:1	Recreational Development
Lundsten N	114	7	53:1	Natural Environment
Lundsten S	77	10	7:1	Natural Environment
Marsh	143	4	10:1	Natural Environment
Parley	257	19	48:1	Recreational Development
Piersons	267	119	5:1	Recreational Development
Stone	96	30	9:1	Natural Environment
Steiger	166	37	5:1	Recreational Development
Sunny (Zumbra-Sunny)	78	18	38:1	Natural Environment
Turbid	39	37	14:1	Natural Environment
Wassermann	170	41	17:1	Recreational Development
Zumbra (Zumbra-Sunny)	271	58	2:1	Recreational Development

Source: Minnesota DNR.

Table 2. 86. Selected water quality goals and current conditions of waterbodies in the Six Mile Creek subwatershed.

Waterbody	State TP Standard (µg/L)	2007 Plan Goal TP (µ/L)	Trend*	2001-2015 Summer Average			Years Monitored
				TP (µg/L)	Chl-a (µg/L)	Secchi (m)	
Auburn East	40	50	No trend	47	31	1.3	2006-2015
Auburn West	40	27	No trend	31	12	2.4	2002-2015
Carl Krey	60	n/a	No trend	28	7	2.2	2006-2015
Church	40	n/a	Deg Secchi	101	27	2.1	2006-2015
Lundsten N	60	70	n/a	61	17	1.4	2006-2015
Lundsten S	60	70	n/a	273	118	0.8	2012-2015
Marsh	60	n/a	n/a	29	7	0.9	2010-2015
Mud	n/a	n/a	n/a	227	126	0.4	2006-2015
Parley	60	50	No trend	95	69	0.7	1999-2015
Piersons	40	27	No trend	26	9	2.4	1997-2015
Stone	40	36	Imp Chl-a	40	13	2.4	2007-2015
Steiger	40	30	Imp Secchi, TP	35	14	2.2	2002-2015
Sunny	60	n/a	n/a	57	15	1.8	2013-2015
Turbid	40	n/a	n/a	68	28	1.4	2006-2016
Wassermann	40	50	No trend	78	51	0.9	1997-2015
Zumbra	40	25	All Imp	25	8	3	1994-2015

*Statistically significant at $\leq$ 0.05, Imp = improving, Deg = degrading.
Source: MCWD, MPCA.

Streams:

There is one primary stream within the subwatershed: Six Mile Creek, which flows to Halsted Bay. Several other small streams and channels provide drainage and local conveyance within the subwatershed. The creek was channelized as Judicial Ditch #2 in 1903 and is comprised of a series of small channels connecting flow-through lakes and wetlands. There are no known storm sewer outfalls to the creek, mainly due to minimal near-stream development. There are 5 bridge crossings, and some culvert crossings, which are mainly park trail, and path crossings. Table 2.85 below details the water quality characteristics of Six Mile Creek. Due to its nature as short channels connecting lakes, water quality in the stream is highly influenced by outflow from those lakes.

A majority of the Six Mile Creek stations are less than the State's river eutrophication standards for total phosphorus, except for Highland Rd (Mud Lake outlet (CSI02)). The state river eutrophication standards also look at other indicators such as chlorophyll-a, diel oxygen flux, and biological oxygen demand, for which chlorophyll-*a* has been assessed at the Highland Rd (CSI02) station. Chlorophyll-a concentrations are above the State's river eutrophication standards for the response (stressor) variable. The primary nutrient cycling concern for Six Mile Creek is that it conveys phosphorus load to Halsted Bay: Lake Minnetonka.
Table 2.87 shows the average TSS concentrations in Six Mile Creek to be below the 30 mg/L state standard for this ecoregion. Maintaining sufficient dissolved oxygen (DO) is necessary to support aquatic life. The DO state standard requires the stream to never fall below 5 mg/L DO. Monitoring data show that stations along Six Mile Creek often fall below this standard in summer. Stations (i.e., CSI14, and CSI10) that have DO above 5 mg/L earlier in the season, can run dry by mid-late summer. Six Mile Creek flows between lakes and wetlands. Stretches of the creek that are influenced by riparian wetlands may have increased sediment oxygen demand.

To assess long-term change in Six Mile Creek, a Mann-Kendall statistical trend test was performed on flow-corrected TP and TSS concentrations for the Highland Rd (CSI02) station from 2005-2015. There was a statistically significant improvement in TSS concentrations during this period (Table 2.87). For more information on Six Mile Creek and tributaries, please refer the District's Water Quality (Hydrodata) Reports, District's 2003 *Upper Watershed Stream Assessment*, and *Six Mile Creek Diagnostic Study.*

Table 2. 87. Current conditions of streams in the Six Mile Creek subwatershed.
See Figure 2.99 for monitoring locations.

Stream	Trend*	2005-2015 Annual Average				
		TP (µg/L)	TN (mg/L)	TSS (mg/L)	Cl (mg/L)[1]	Chl-a (µg/L)[2]
Highland Rd (CSI02)	Imp TSS	152	1.86	21	30	50
Lundsten Lake Outlet (CSI01)	n/a	73	1.07	8	21	n/a
Auburn Lake Outlet (CSI09)	n/a	38	0.99	3	30	n/a
Auburn Lake Inlet (CSI05)	n/a	106	0.94	4	23	n/a
Wassermann Outlet (CSI12)	n/a	87	1.36	9	22	n/a
Marsh Lake Outlet (CSI11)	n/a	63	0.79	11	22	n/a
Piersons Lake Outlet (CSI14)[3]	n/a	27	0.81	9	24	n/a

TP = total phosphorus, TN =total nitrogen, TSS = total suspended solids, Cl = chloride,
*Statistically significant at ≤ 0.05, Imp = Improving
[1]Cl data 2008-2015; [2]Chl-a data June-Sept 2013-2015; [3]All data 2010-2015
Source: MCWD.

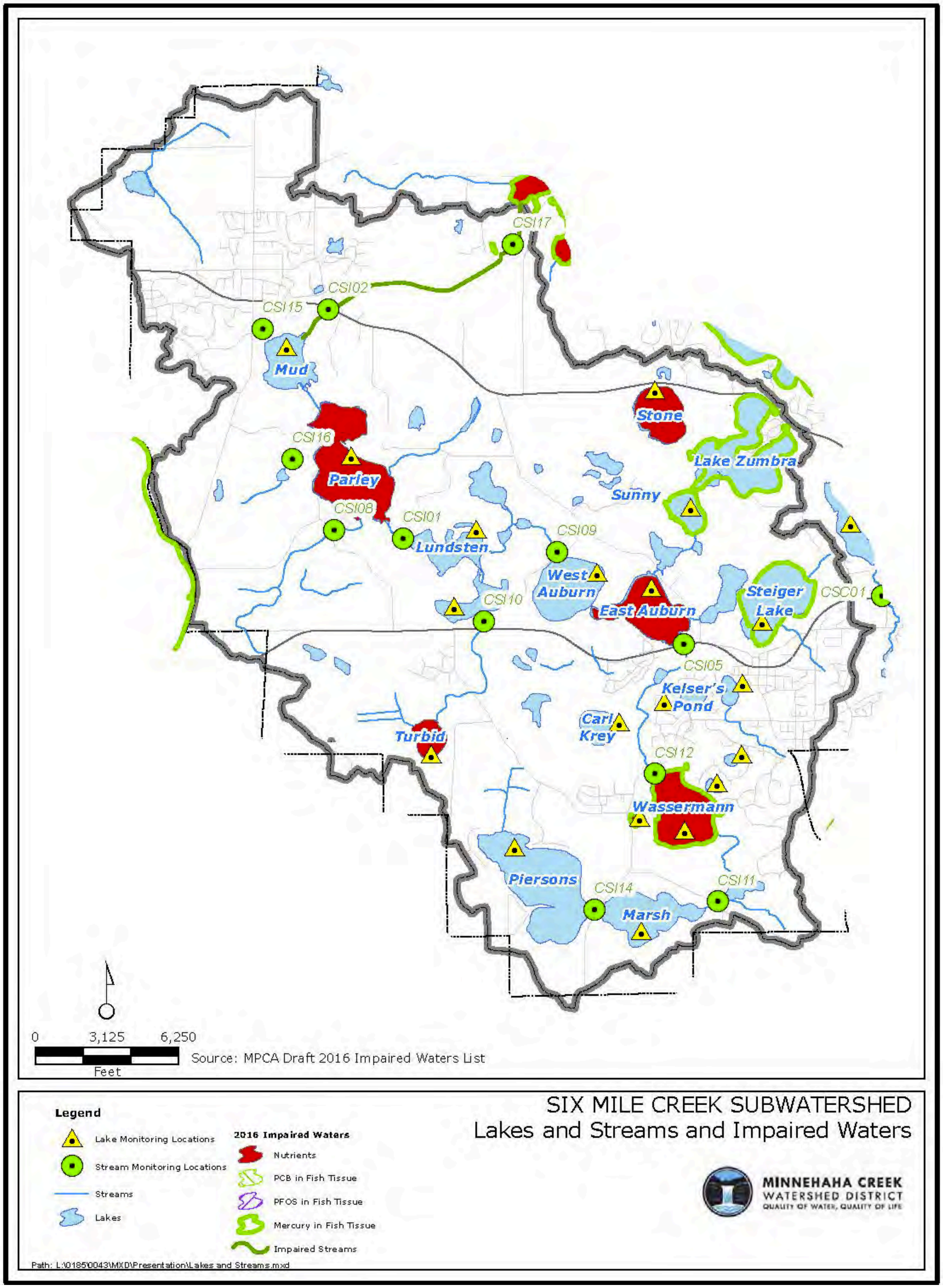

Figure 2. 99. Six Mile Creek subwatershed lakes and streams and Impaired Waters.

Wetlands:

According to the FAW, wetlands, including lakes, cover over 30 percent of the subwatershed's surface (Figure 2.100 and Table 2.88). A delineation of wetland boundaries is required to be completed any time development or other impacts may occur near or in a wetland. For more information regarding wetlands in the subwatershed, please refer to the *2007 MCWD Comprehensive Water Resources Management Plan*.

Table 2. 88. Functional Assessment of Wetlands inventory of wetland types in the Six Mile Creek subwatershed.

FAW Circular 39 Wetland Type	Area (acres)	Percent
1 - Seasonal	404.4	2.51
2 - Wet Meadow	480.3	2.98
3 - Shallow Marsh	1,678.1	10.42
4 - Deep Marsh	279.4	1.74
5 - Open Water	776.3	4.82
6 - Scrub Shrub	94.5	0.59
7 - Forested	279.4	1.74
8 - Bog	207.0	1.29
Riverine	19.4	0.12
Wetland Total	4,219.0	26.2
Upland	11,905.4	73.8
TOTAL	16,124.4	

Source: MCWD Functional Assessment of Wetlands.

Groundwater:

The District's roles in managing groundwater are to 1) promote surficial groundwater recharge to protect wetland hydrology and stream base flow, and 2) assist in protecting deeper aquifers used for drinking water by limiting infiltration in sensitive recharge areas.

Infiltration potential of the upland areas within the subwatershed is generally medium. Because of the organic nature of the soils in the wetland areas, in general infiltration potential there is variable. Groundwater sensitivity is low to medium in the uplands and high to very high in the wetlands.

Parts of the subwatershed have been designated by the Minnesota Department of Health as Drinking Water Supply Management Areas (DWSMAs) and Wellhead Protection Areas for the Cities of Victoria, Minnetrista, and St. Bonifacius. Figure 2.101 shows areas in the subwatershed with groundwater sensitivity and that are designated Wellhead Protection Areas.

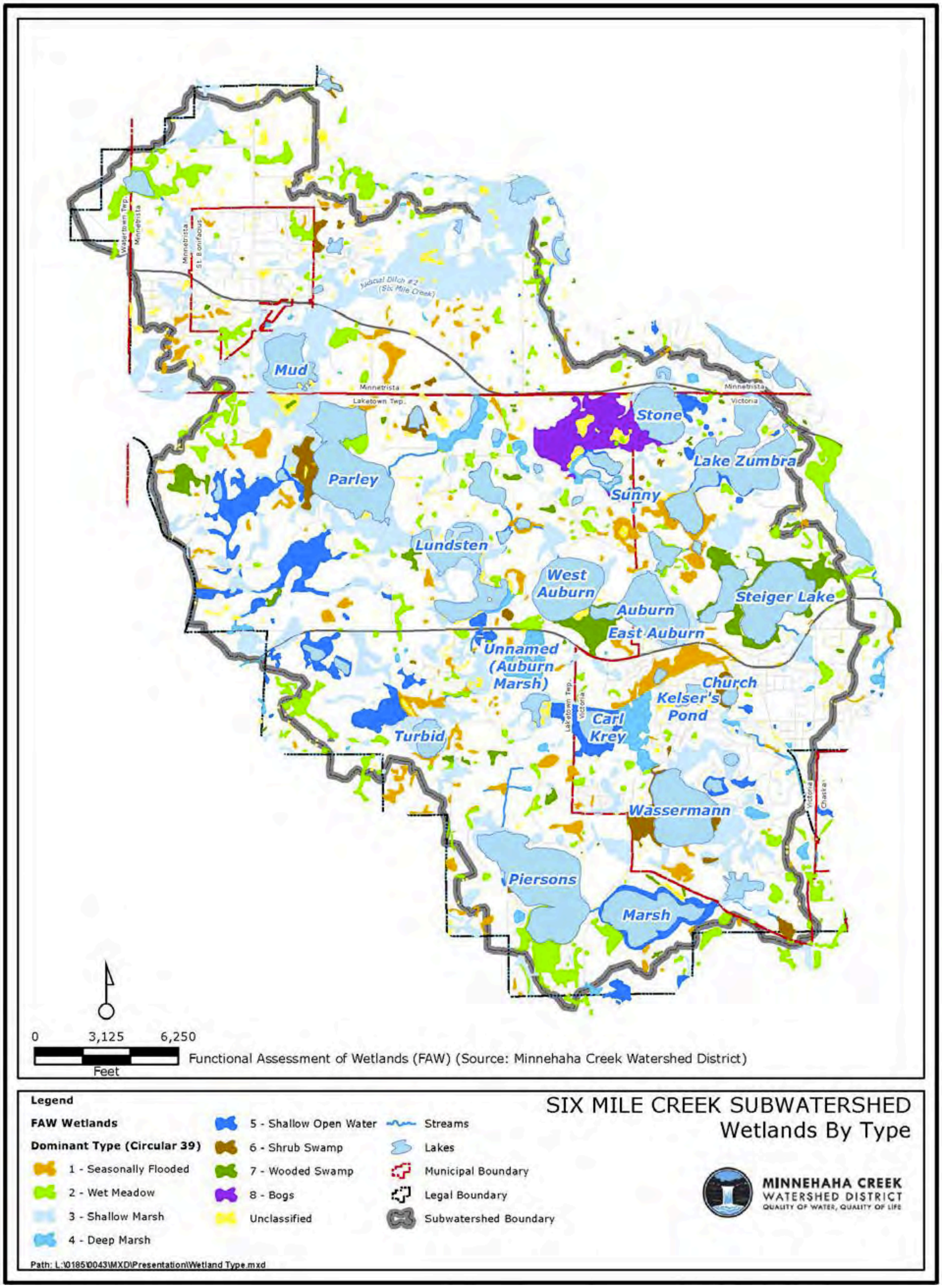

Figure 2. 100. Six Mile Creek subwatershed wetlands by type.

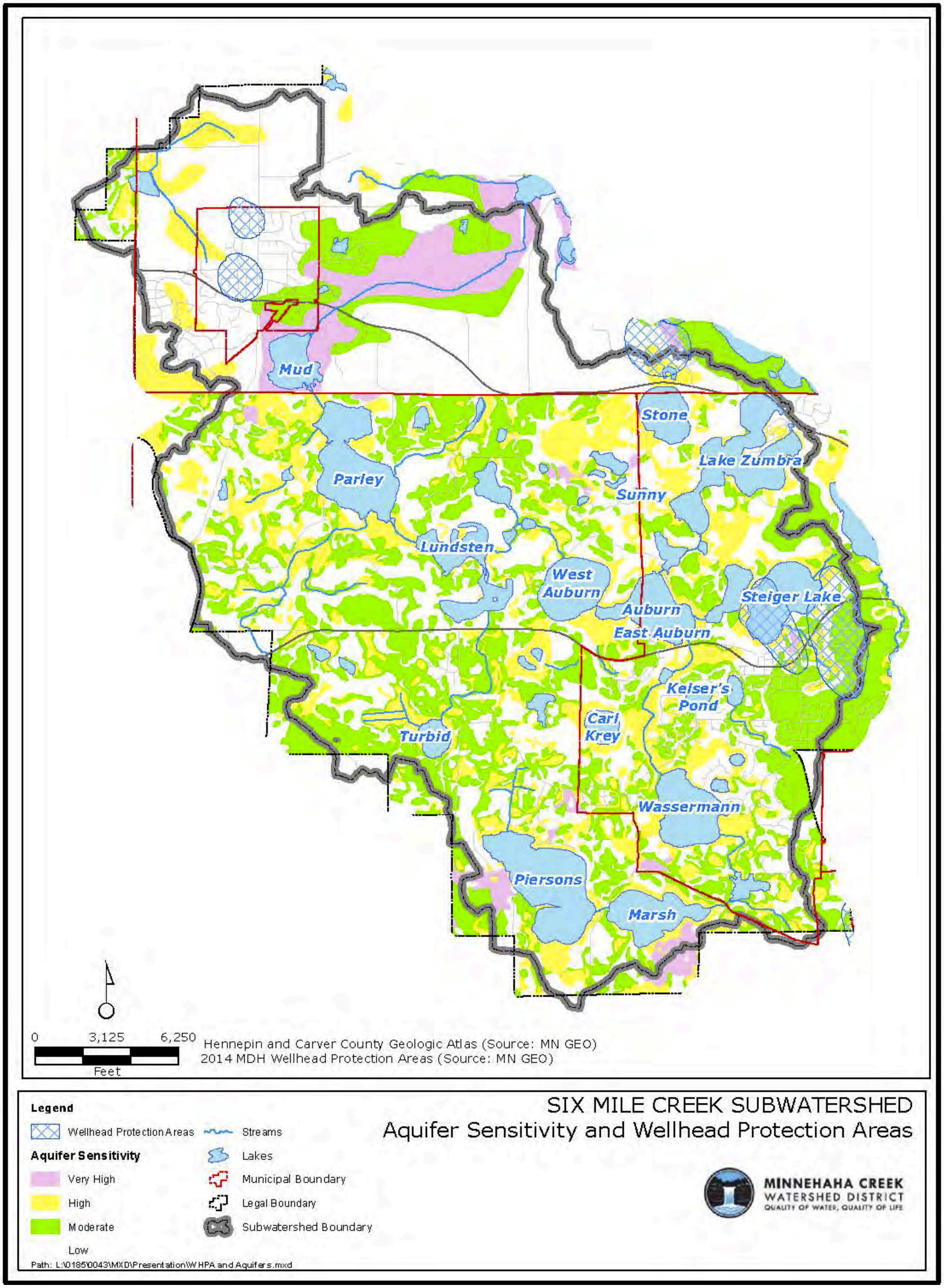

Figure 2. 101. Six Mile Creek aquifer sensitivity and wellhead Protection Areas.

Water Quantity:

There are four landlocked basins in the Six Mile Creek subwatershed (Figure 2.98). To assess change in water yield, a Mann-Kendall statistical trend test was performed on annual water yield data from 2006-2015 for the three monitoring stations along Six Mile Creek – East Auburn inlet, Lundsten Lake outlet, and Highland Rd. Water yield did not exhibit any statistically significant trend upward or downward.

Ecological Integrity:

The E-Grade program defines watershed ecological integrity as the degree to which the watershed provides three key ecosystem services: biodiversity, habitat diversity, and nutrient cycling. Nutrient cycling is described in the Water Quality section. The Six Mile Creek subwatershed is being evaluated by the E-Grade program in 2015-2017. At this time, not all of the E-Grade metrics have been assessed. The final E-Grade report for this subwatershed will not be available until 2018. This section summarizes ecological integrity using E-Grade and other data, where available (Figure 2.102).

Lakes:

<u>Biodiversity</u>

Fish Community.

<u>Piersons-Marsh-Wassermann MU</u>: E-Grade data that are available indicate F-IBI scores for Piersons and Wassermann lakes and Kelser's Pond are classified as Poor. This score means the biodiversity has been disturbed and the IBI is below the state threshold. For more information, refer to *Six Mile Creek Diagnostic Study* and *Six Mile Carp Assessment*.

<u>Carver Park Reserve MU</u>: E-Grade data that are available indicate F-IBI scores for Stieger and Zumbra lakes are classified as Poor. This score means the biodiversity has been disturbed and the IBI is below the state threshold. For more information, refer to *Six Mile Creek Diagnostic Study* and *Six Mile Carp Assessment*.

<u>Auburn-North Lundsten MU</u>: E-Grade data that are available indicate F-IBI scores for East and West Auburn lakes are classified as Degraded. This score means there is very low species diversity, there has been great disturbance to the fish community. The F-IBI is very below the state threshold. For more information, refer to *Six Mile Creek Diagnostic Study* and *Six Mile Carp Assessment*.

<u>Turbid-South Lundsten MU</u>: There is no F-IBI scoring available for Turbid and South Lundsten due to the small acreage of the lakes. The most recent fish survey for Turbid Lake is from 1992, more than 20 years ago. At that time, the fish population was dominated by rough fish, mostly black bullheads. No carp were captured during this sampling event. Overall, the lake had a very poor fish community. For more information, refer to *Six Mile Creek Diagnostic Study* and *Six Mile Carp Assessment*.

<u>Parley-Mud MU</u>: E-Grade data that are available indicate the F-IBI score for Parley Lake is classified as Good, meaning it has a good variety of species, including sensitive species. For more information, refer to *Six Mile Creek Diagnostic Study* and *Six Mile Carp Assessment.*

Aquatic Vegetation Community.

<u>Piersons-Marsh-Wassermann MU</u>: Floristic quality index (FQI) score was available for the following lakes in the Management Unit including Piersons, Marsh, Wassermann, Church, Kelser's Pond, and Carl Krey Lake. Piersons Lake is classified as Good, meaning moderate species diversity with mixed assemblage of tolerant and intolerant species. Kelser's Pond and Carl Krey are classified as Poor. Obvious signs of anthropogenic disturbance are present and low species diversity as non-native and/or intolerant species are present in these lakes. Wassermann

and Church lakes are classified as Degraded. This score means there is very low species diversity, and there has been great disturbance to the vegetation community. For more information, refer to *Six Mile Creek Diagnostic Study.*

Carver Park Reserve MU: Steiger, Zumbra and Stone have FQI data for deep lakes, and Sunny has FQI data available for shallow lakes. Zumbra Lake is classified as Good, meaning the vegetation community is beginning to show signs of anthropogenic disturbance and there is moderate species diversity. Sunny, the adjacent bay to Zumbra, and Steiger are classified as Poor. Obvious signs of anthropogenic disturbance are present and low species diversity as non-native and/or intolerant species are present in these lakes. Stone is classified as Degraded. This score means there is very low species diversity, and there has been great disturbance to the vegetation community. For more information, refer to *Six Mile Creek Diagnostic Study.*

Auburn-North Lundsten MU: East and West Auburn lakes and North Lundsten lake have FQI scores that classifies the vegetation community as Poor. Obvious signs of anthropogenic disturbance are present and low species diversity as non-native and/or intolerant species are present in these lakes. For more information, refer to *Six Mile Creek Diagnostic Study.*

Turbid-South Lundsten MU: South Lundsten has a FQI score that classifies the vegetation community as Poor. Obvious signs of anthropogenic disturbance are present and low species diversity as non-native and/or intolerant species are present. The FQI score for Turbid Lake classifies the vegetation community as Degraded, meaning there is very low species diversity, and there has been great disturbance to the vegetation community. For more information, refer to *Six Mile Creek Diagnostic Study.*

Parley-Mud MU: Both Parley and Mud lakes have FQI scores that classifies the vegetation communities as Degraded. This score means that there is very low species diversity with non-native and/or intolerant species. There has been great disturbance to the vegetation community in both of these lakes. For more information, refer to *Six Mile Creek Diagnostic Study.*

Aquatic Invasive Species:

Piersons-Marsh-Wassermann MU: Pierson, Marsh, and Wassermann lakes have Eurasian watermilfoil and Curlyleaf Pondweed present with Pierson Lake demonstrating the densest populations. Church Lake only has Curlylead Pondweed. Common carp are known to be overabundant in Wassermann Lake, as described in the *Six Mile Creek Carp Assessment Report.*

Carver Park Reserve MU: Zumbra. Steiger and Stone lakes have Eurasian watermilfoil and curly-leaf pondweed with Steiger being heavily infested with Eurasian watermilfoil. Sunny Lake just has Eurasian watermilfoil. Common carp are overabundant in Zumbra, Steiger and Sunny, as described in the *Six Mile Creek Carp Assessment Report.*

Auburn-North Lundsten MU: East and West Auburn lakes are dominated by Eurasian watermilfoil and Curlyleaf Pondweed, while North Lundsten just has Curlyleaf Pondweed. Common carp are overabundant in both waterbodies, as described in the *Six Mile Creek Carp Assessment Report.*

Turbid-South Lundsten MU: South Lundsten and Turbid lakes have Curlyleaf Pondweed. Common carp are overabundant in both waterbodies, as described in the *Six Mile Creek Carp Assessment Report.*

Parley-Mud MU: Big SOB Lake, Mud Lake, and Parley Lake have Curlyleaf Pondweed. Parley Lake also has Eurasian watermilfoil. Common carp are overabundant in both waterbodies, as described in the *Six Mile Creek Carp Assessment Report.*

Habitat diversity

Aquatic Vegetation community. Habitat diversity is determined by the percent occurrence of species, or the extent to which it may be dominated by a few species. The vegetation community has not been assessed yet habitat diversity.

Shoreline Health. Shoreline health is assessed looking at shoreline vegetative cover and the relative human disturbance. The MnDNR is using the Score the Shore protocol to relate shoreline conditions to fish community structure using the fish IBI metric. Score the Shore data are available, but have not been assessed yet through E-Grade.

Streams:

Biodiversity

Fish Community. No fish IBI data are available for the streams in this subwatershed.

Macroinvertebrate Community. Macroinvertebrate samples were collected in 2003, 2013 and 2015 in Six Mile Creek For the 2013 assessment, Six Mile Creek showed the best biological community of the Upper Watershed streams, but it is still impacted by urbanization. The M-IBI scores were 22-47. The station with M-IBI score of 47 was above the threshold for glide/pool streams. The rest of the stations were below the M-IBI threshold. Two stations that were classified as riffle/run habitat were at the M-IBI threshold for modified use. Species richness ranged from 17 to 34 taxa. Five of the six stations sampled showed good overall diversity and good POET diversity.

The 2003 assessment had M-IBI scores for most of the sites below the M-IBI threshold. However, the M-IBI does not allow discrimination between low scores due to poor water quality or low scores due to lack of habitat. Six Mile Creek showed the most diversity of the upper watershed streams, with thirteen aquatic invertebrate taxa representing thirteen families. Most of the taxa found were those that are tolerant of poor water quality, although some taxa that are less tolerant were identified in some reaches. Six Mile Creek is mainly a wetland stream, and lacks the habitat complexity necessary to sustain a varied macroinvertebrate community.

Aquatic Invasive Species. No AIS data are available for the streams in this subwatershed.

Habitat diversity

Habitat Complexity. E-Grade uses the Minnesota Stream Habitat Assessment tool to assess habitat complexity in Six Mile Creek. Habitat complexity is determined by evaluating three zones: in-stream, riparian or near-stream, and channel morphology, or channel form.

Connectivity. Connectivity is defined by two metrics: presence or absence of barriers, and access to floodplain. Barriers such as dams, weirs, and culverts limit or prevent organisms from moving freely in the stream. Six Mile Creek has many culverts and water control structure at Lundsten Lake outlet.

Water Quality. Water quality factors impacting stream habitat diversity include concentrations of TSS and DO. Higher TSS concentrations increase turbidity, which can interfere with aquatic predators seeking their prey and which can limit growth of aquatic vegetation. Refer to Water Quality section for data.

Hydrology Indicators. Stream hydrology is an important factor in habitat diversity. A stream that is very flashy, that is, one that rises and falls very quickly in response to rain events, can be stressful to organisms. In addition, streams that periodically are dry or have minimal flow are hostile to aquatic life. Continuous streamflow data are available at Highland Rd (CSI02), Parley Lake inlet (CSI08), Lundsten Lake North outlet (CSI01), and instantaneous flow has been measured at all other stations since 2006. Instantaneous flow at CSI01 can be flashy following a clean out of the water control structure that is often obstructed by beavers, but the stream is buffered by wetlands downstream. Instantaneous flow at CSI02 is often slow with backflow conditions in the summer. Following storm events, CSI02 does receive higher flows, but the rise is gradual, not flashy. Annual average flow for each year was computed first, and then all the years' averages were averaged together. The annual average discharge at CSI02 is 16.52 cfs.

Wetlands:

Biodiversity

Vegetation Community. A high density of wetlands is present in the subwatershed. A number of them were identified in the 2003 MCWD *Functional Assessment of Wetlands* (FAW) as having exceptional to high vegetative diversity and wildlife habitat potential as well as having high aesthetic values. Tamarack swamp is present in the Carver Park Reserve and contains mostly invasive or non-native vegetation. The riparian wetlands adjacent to much of Six Mile Creek include cattails and some reed canary grasses.

Habitat diversity

Connectivity. There are numerous wetlands in this subwatershed; therefore, opportunities for connectivity is possible.

Size. Larger wetlands are more likely to support a notable on-site diversity and/or abundance of wildlife species.

Shoreland Protection. Riparian wetlands can provide significant shoreline protection and support emergent vegetation at the shoreline. The *Functional Assessment of Wetlands* evaluated riparian wetlands for their ability to protect lake or stream shoreline. Much of the riparian area along Six Mile Creek is wetland.

Uplands:

Biodiversity

The Minnesota County Biological Survey (MCBS) identified several areas of moderate or high biodiversity significance both within and outside of the regional park, including a large area of maple-basswood forest and tamarack swamp surrounding and west of Stone, Steiger and Zumbra Lakes. Areas of (Figure 2.102).

The Minnesota Natural Heritage Information System lists several rare natural features in this subwatershed. These include bald eagle, a federally-listed threatened species; trumpeter swans, a state-listed threatened species; and cerulean warbler, a bird of state species special concern; and the least darter, a fish of state species of special concern.

Habitat diversity

There are small patches of forest and woodland as well as larger, more extensive grasslands in the upland areas of the Carver Park Reserve. The forest and wetland in the subwatershed have been designated Regionally Significant Ecological Areas by the DNR, including nearly all of the Carver Park Reserve.

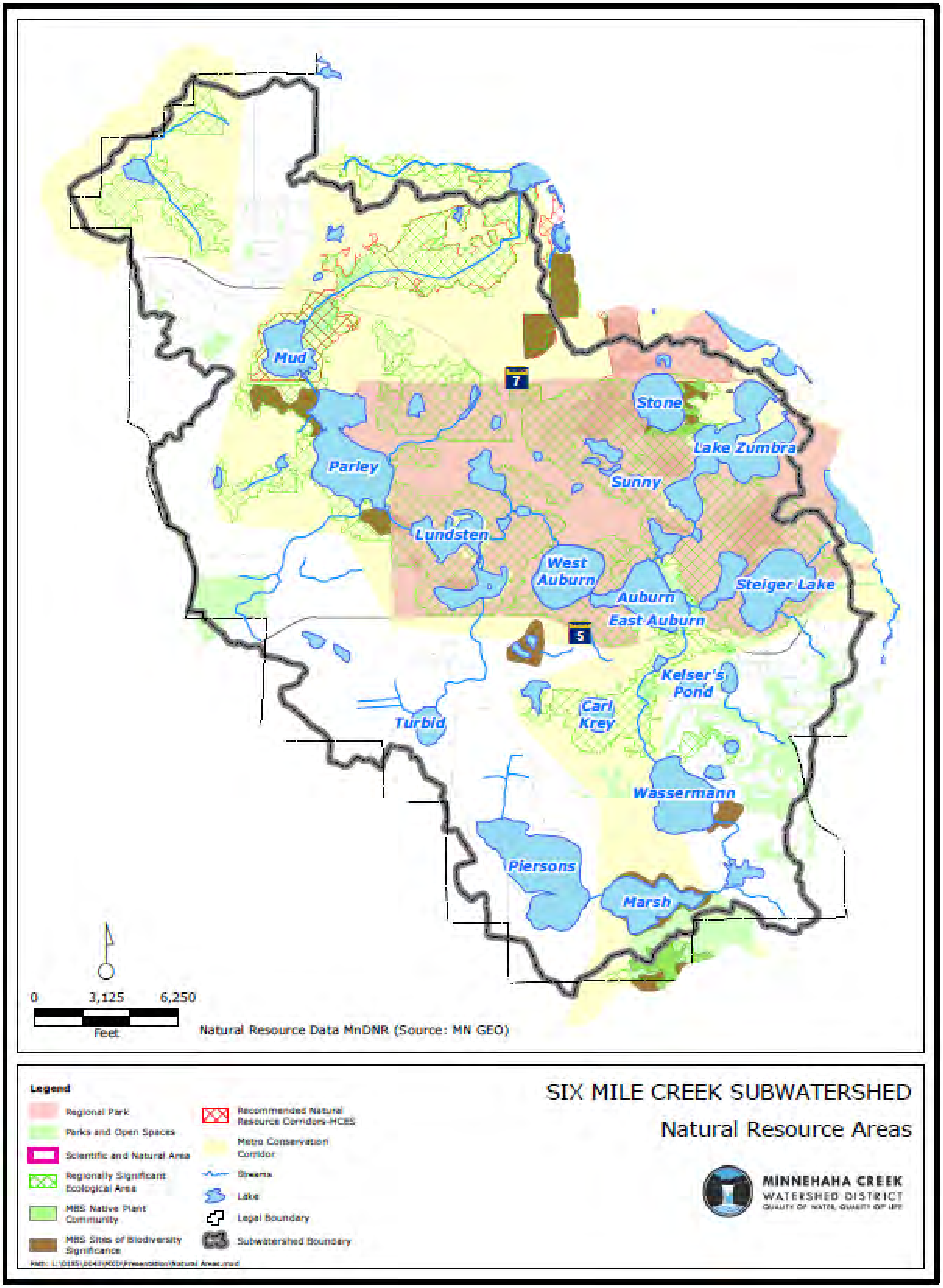

Figure 2. 102. Six Mile Creek subwatershed natural resource areas.

Thriving Communities:

Land use:

Table 2.89 below shows the land uses within the area of the Six Mile Creek subwatershed in acres and as a percentage of the total subwatershed. The predominant land use in the subwatershed is parks and open space , followed by agricultural and vacant or undetermined (Figure 2.103). Much of the vacant land is either large wetland or woodland tracts or grass and shrubland. Some large agricultural uses are present in Laketown Township, Victoria and St. Bonifacius. There are also other areas scattered throughout the west central and north central and northwest parts of the subwatershed.

Table 2. 89. 2016 land use in the Six Mile Creek subwatershed.

Land Use 2016	Acres	% of Subwatershed
Parks and Open Space	4,188.7	24.6
Agricultural	4,008.2	23.5
Vacant or Undetermined	3,687.6	21.7
Water	2,400.9	14.1
Single - Family Residential	2,091.0	12.3
Institutional	312.6	1.8
Roads and Highways	112.4	0.7
Multi - Family Residential	91.4	0.5
Commercial	84.9	0.5
Industrial	55.1	0.3

Source: Metropolitan Council.

Recreation:

The Three Rivers Park District's Carver Park Reserve covers much of the central subwatershed. The park includes numerous wetland and several lakes, and bicycling/hiking trails provide access to many natural features. The Minnesota Historic Features database notes about 50 historic features in this subwatershed, mostly residences or farmhouses or agricultural buildings. The listing also includes 5 churches and several commercial buildings in Victoria and St. Bonifacius. Part of the Three Rivers Park District's Lake Minnetonka Regional Park is located in the subwatershed.

The Carver County Park Reserve offers numerous opportunities for aquatic recreation in the Six Mile Creek subwatershed (Figure 2.104). Three fishing piers are available, with one located on the east southeast side of Steiger Lake and two on West Lake Auburn. Public water access can be found at Parley Lake, Piersons Lake, Wassermann Lake, Steiger Lake, Lake Auburn and Lake Zumbra. There are no access points directly to Six Mile Creek.

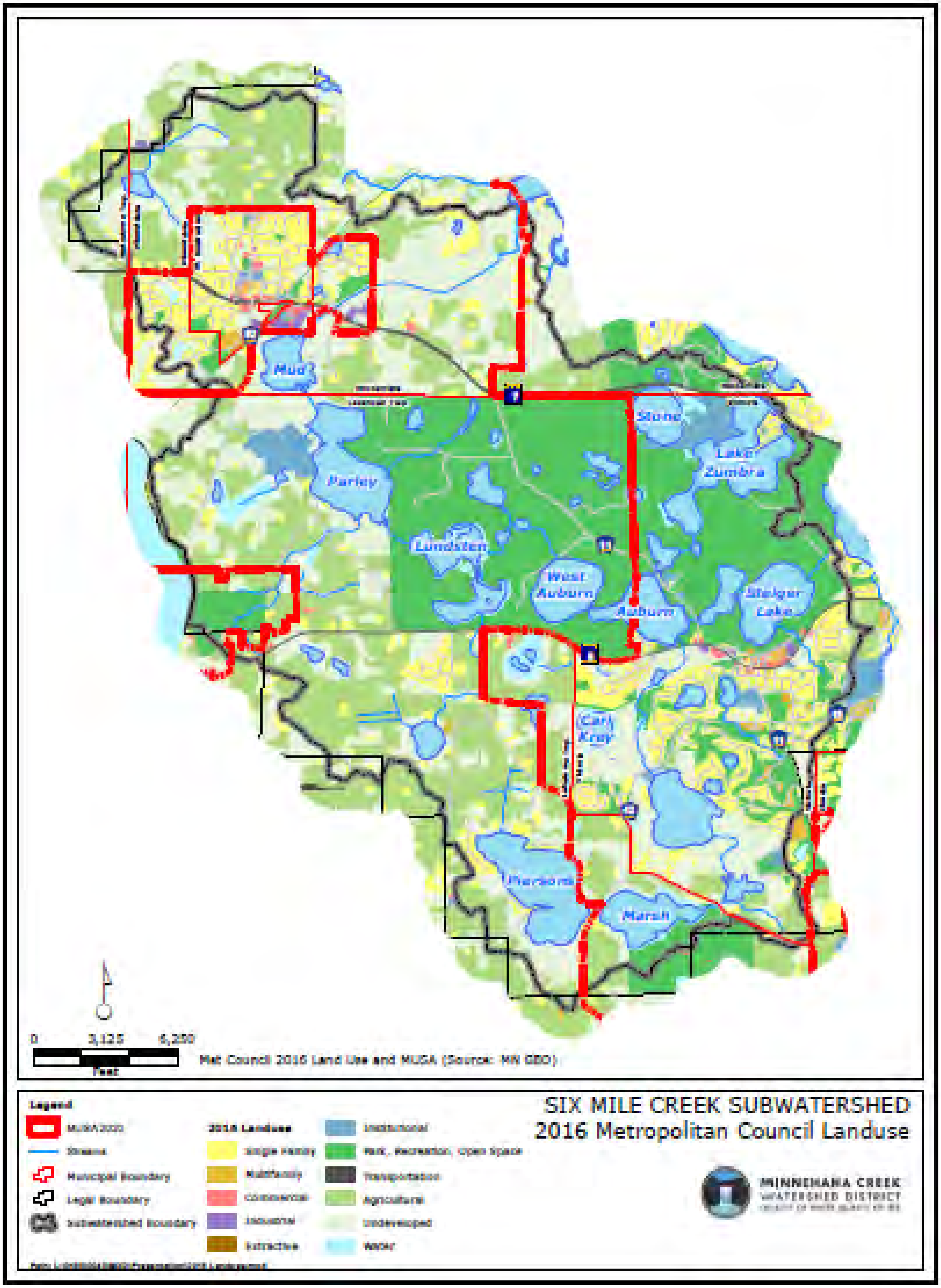

Figure 2. 103. Six Mile Creek subwatershed 2016 land use.

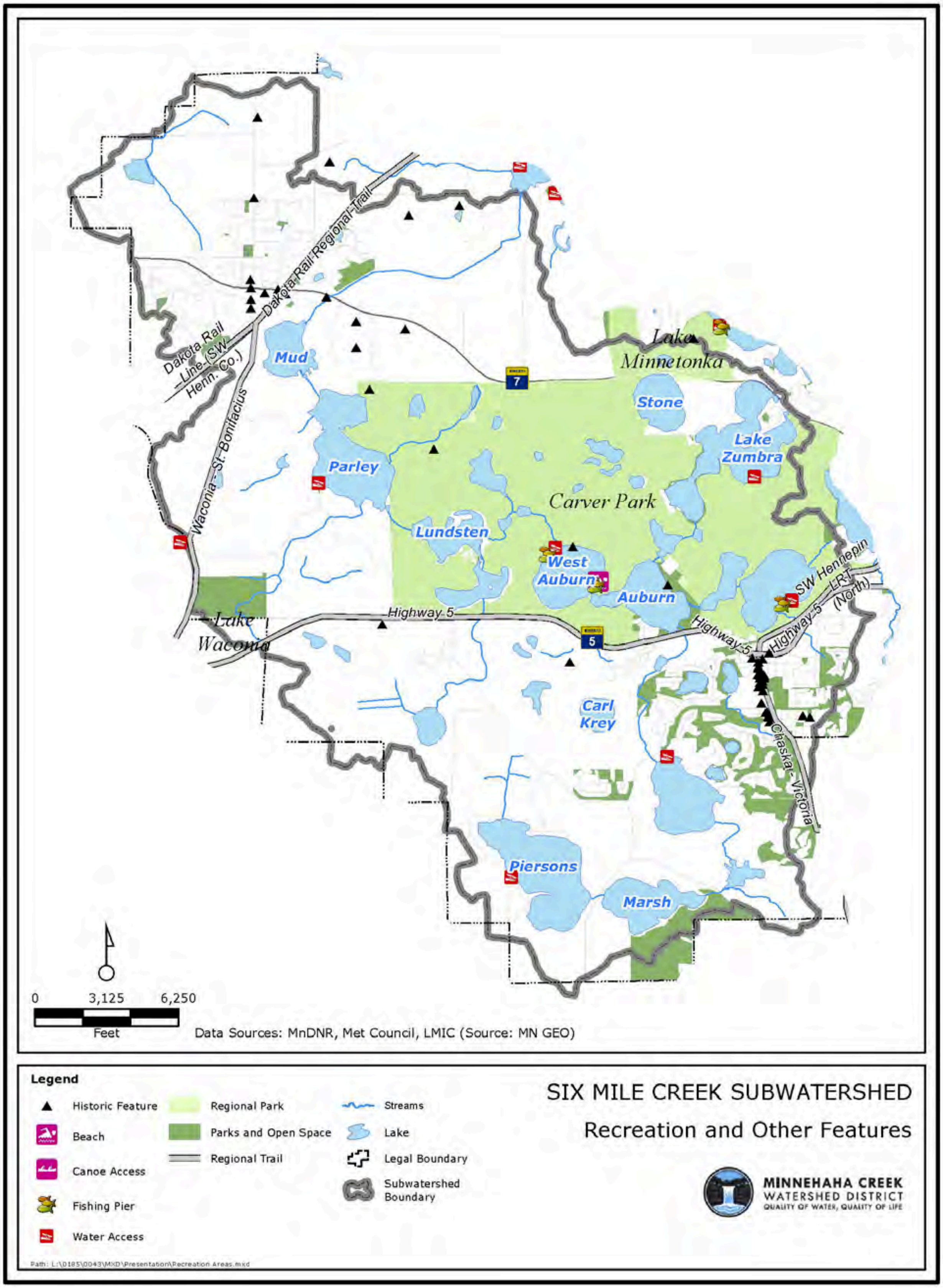

Figure 2. 104. Six Mile Creek subwatershed recreation and other features.

2.4 Inventory of Studies

District-Wide

- 1997-1998 Water Quality, Physical Habitat, and Fish Community Composition in Streams in the Twin Cities Metropolitan Area, USGS 1999
- Assessment of Effects of Whole Lake Treatments to Control Nuisance Aquatic Plants, University of Minnesota 2007
- Benefits of Wetland Buffers: A Study of Functions, Values and Size, EOR 2001
- Contamination of Stormwater Pond Sediments by PAHs in Minnesota, MPCA 2010
- Diatom Inferred TP in MCWD Lakes Report, Science Museum of MN & St. Croix Watershed Research Station 2006
- Diatom Inferred TP in MCWD Lakes Report Phase II, Science Museum of MN & St. Croix Watershed Research Station 2009
- Economic Aspects of Aquatic Invasive Species, University of Minnesota 2014
- Environmental Quality Report, Hennepin County 2007
- Extending Satellite Remote Sensing to Local Scales, University of Minnesota 2003
- Evaluating and Monitoring BMPs with Networked Wireless Sensors, University of Minnesota 2012
- Historical Water Clarity Assessment of Lakes in MCWD using Landsat Satellite Imagery, University of Minnesota 2006
- MCWD 1st Order Drainage Assessment, Fluvial Geomorphic Assessment Update Report, Inter-Fluve Inc. 2013
- MCWD 2003 Stream Stability and Habitat Assessment Report, Wenck 2004
- MCWD 2013 Macroinvertebrate Assessment, RMB 2014
- MCWD 2014 Flood Report, Wenck 2015
- MCWD 2015 Macroinvertebrate Assessment, RMB 2016
- MCWD: 30 Years of Water Resources Management 1967-1997, MCWD 1998
- MCWD Comprehensive Water Resources Management Plan, Wenck 2007
- MCWD Ditch Records and Policy Considerations Report, Wenck 2003
- MCWD Functional Assessment of Wetlands, Wenck 2003
- MCWD Hydrologic, Hydraulic, and Pollutant Loading Study (HHPLS), EOR 2003
- MCWD Lake Data Statistical Analysis I Report, HDR 2013
- MCWD Lake Data Statistical Analysis II Report, HDR 2014
- MCWD Period of Record Hydrographs, EOR 2005
- MCWD Stream Assessment Data Report, Wenck 2004
- MCWD Stream Data Statistical Analysis Report, HDR 2015
- MCWD Water Quality (Hydrodata) Reports, 1968-1988, 1992-2015
- Measuring Water Clarity and Quality in MN Lakes and Rivers: A Census-Based Approach Using Remote-Sensing Techniques, University of Minnesota 2007
- Minnehaha Creek *E. Coli* Bacteria / Lake Hiawatha Nutrients Total Maximum Daily Load, Tetra Tech. 2013
- Minnehaha Creek Watershed SWMM5 Model Data Analysis and Future Recommendations, US Army Corps of Engineers 2013
- Minnesota Statewide Mercury TMDL, MPCA, 2007
- Predicting Water Clarity of Lakes via Remote Sensing, University of Minnesota 2006
- Study of the Water Quality of Metropolitan Area Lakes, Metropolitan Council 1989, 1994, 1998, 2010, 2015
- Summary of MCWD Plans, Studies and Reports, US Army Corps of Engineers 2004

- Twin Cities Metropolitan Area Chloride Total Maximum Daily Load Study and Chloride Management Plan, MPCA and LimnoTech 2016
- Water Quality Reconstruction from Fossil Diatoms, MPCA and University of Minnesota 2002
- Weather: Extreme Trends, NOAA and Syntectic International, LLC 2014
- Upper Minnehaha Creek Watershed Lakes and Bacteria TMDL Project, MPCA and Wenck 2014

Christmas Lake Subwatershed

- Assessment of milfoil weevil populations for potential for control of Eurasian watermilfoil in selected lakes of the MCWD, University of Minnesota 2014
- Occurrence and Distribution of Eurasian, Northern and Hybrid Watermilfoil in Lake Minnetonka and Christmas Lake: Genetic Analysis, Montana State University, University of Minnesota and MCWD 2016
- Occurrence and Distribution of Eurasian, Northern and Hybrid Watermilfoil in Lake Minnetonka and Christmas Lake: Genetic Analysis Phase II, Montana State University, University of Minnesota and MCWD 2017

Dutch Lake Subwatershed

- Dutch Lake Infiltration (DL-5) Feasibility Study, Wenck 2010
- Dutch Lake Wetland Restoration Feasibility Study, HR Green and Applied Ecological Services 2009
- Technical Memo: Dutch Lake Outlet (DL-7) – SRP Loading to Jennings Bay, Wenck 2012

Gleason Lake Subwatershed

- Effects of Curly leaf Pondweed Control on Gleason Lake, Blue Water Science and MCWD 2015
- Gleason Lake/ CR 6 Pond Project Feasibility Study, Houston Engineering 2009
- Gleason Lake Fish Survey, Blue Water Science 2011
- Gleason Lake Regional Infiltration (GL-4) Feasibility Study, Mead & Hunt 2008
- Mooney Lake Aquatic Plant Survey, Blue Water Science 2011
- Mooney Lake Fish Survey, Blue Water Science 2011
- Mooney Lake Fish Survey, Blue Water Science 2016
- Mooney Lake Outlet Structure (Wetland Restoration#1) Feasibility Study, 2007
- Upper Minnehaha Creek Watershed Lakes TMDL, Wenck 2014

Lake Minnetonka Subwatershed

- 1995-1999 Water Quality of Lake Minnetonka, TRPD 1995-2000
- 1995-1999 Water Quality of Lake Minnetonka, TRPD 1995-2000
- 2014 Pilot Study: Spring Phenology of Submersed Aquatic Plants, Freshwater Scientific Services, LLC 2015
- A Preliminary Geotechnical Evaluation Report: Street and Utility Reconstruction Projects in Excelsior, MN, WSB 2011
- A Program for Preserving the Quality of Lake Minnetonka, MPCA 1971
- Assessment of 2008-2011 Coordinated Herbicide Treatments on Carmans, Grays, and Phelps Bay Summary Report, LMCD 2012
- Bathymetric Analysis of Lake Minnetonka, MCWD 2008
- Benthic Monitoring Study of Lake Minnetonka, MCWD 2000
- Big Island Wetland Restoration Feasibility Study, EOR 2008
- Boating Trends on Lake Minnetonka (1984-2004), MnDNR 2005
- Common Carp Assessment in Six Mile Creek, University of Minnesota 2016
- Distribution and Abundance of Milfoil Weevils in Lake Minnetonka, Inglis 2004
- Effects of Harvesting on Plant Communities Dominated By Eurasian Watermilfoil in Lake Minnetonka, University of Minnesota and MnDNR 1994
- Efficacy of Spray-Dried Zequanox for Controlling ZMs within Lake Minnetonka Enclosures, USGS 2016

- Evaluation and Application of a 3D Water Quality Model in a Shallow Lake with Complex Morphometry, University of Minnesota 2010
- Evaluation of the June 2009 Aquatic Herbicide Treatments on Grays Bay and Phelps Bay, Lake Minnetonka, US Army Corps of Engineers 2010
- Field evaluation of toxicity of low-dose molluscicide treatments for zebra mussel veliger larvae – potential applications in lake management, Minnesota AIS Research Center 2016
- Filling and Dredging in the Lake Minnetonka Area: Effects on Aquatic Habitats and Impacts on Fish and Wildlife, Kucera 1978
- Flowering Rush Hand Removal Study on Lake Minnetonka, MCWD & Blue Water Science & Waterfront Restoration 2011-2015
- Grays Bay Headwaters Projects Feasibility Study, 2003
- Technical Memos: Bushaway Road-Jennings Bay Wetland & Floodplain Restoration Project, Wenck 2014
- Halsted Bay Internal Load Management Feasibility Study, 2013
- Halsted Bay Wetland Restoration Project, HR Green 2008
- Lake Minnetonka Area Cities Land Cover Classification and Natural Resource Inventory, Bonestroo 2005
- Lake Minnetonka Boat Use Study, LMCD 2001
- Lake Minnetonka Comprehensive Study: Interim Report, MPCA 1970
- Lake Minnetonka Coordinated Herbicide Treatment Study on Carmans, Grays & Phelps, LMCD 2008-2011
- Lake Minnetonka Direct Infiltration (GB-LM) Feasibility Study, 2011
- Lake Minnetonka Direct Infiltration (CLC-2) Feasibility Study, 2012
- Lake Minnetonka Fisheries Special Assessment, MnDNR 2010
- Lake Minnetonka Habitat Suitability Assessment for Invasive Zebra Mussels, Blue Water Science 2010
- Lake Minnetonka Investigation, Hickok & Associates 1969-1970
- Lake Minnetonka Shoreline Restoration Feasibility Study, 2008
- Nutrient Removal System Feasibility Study, WSB 2013
- Occurrence and Distribution of Eurasian, Northern and Hybrid Watermilfoil in Lake Minnetonka and Christmas Lake – Genetic Analysis, MCWD & University of Minnesota & Montana State University 2015-2016
- Phytoplankton, Photosynthesis, and Phosphorus in Lake Minnetonka, University of Minnesota 1972
- Soil Bioengineering Technology for the Causeway and Headwaters Area in Grays Bay on Lake Minnetonka Feasibility Study, Robbin B. Sotir & Associates 2001
- Stubbs Bay- Lake Minnetonka Diagnostic Study, Wenck 2003
- Stubbs Bay Feasibility Study, BARR 2004
- Summary of Biological Survey of Lake Minnetonka, Hickok & Associates 1971
- Supplementing Mound Downtown Redevelopment with Innovative Stormwater Management, EOR 2004
- Technical Memo: MCWD Managers Request to Inventory Rip Rap Shoreline, Wenck 2010Technical Report: Stubbs Bay Feasibility Study, Wenck 2006

Lake Virginia Subwatershed

- Lake Virginia Regional Infiltration (LV-5) Feasibility Study, 2012
- MCWD Lakes TMDL – Lake Nokomis, Parley Lake, Lake Virginia, and Wassermann Lake, EOR & MPCA 2011
- Memo: Report from Curlyleaf Pondweed Harvesting Case Study, MCWD 2014
- Rapid Response to Zebra Mussels Infestation in Lake Minnewashta, MCWD 2016

Langdon Lake Subwatershed

- Environmental Testing Report MCES L38 Lagoon Sampling, MCES 2008
- Internal Phosphorus Loading and Sediment Phosphorus Fractionation Analysis for Langdon Lake, ERDC Eau Galle Aquatic Ecology Laboratory 2010

- Langdon Lake Infiltration (LL-2) Feasibility Study, 2008
- Langdon Lake Infiltration (LL-3) Feasibility Study, 2010
- Technical Memo: Langdon Lake Feasibility Study, Lake Sediment Analysis: Total Phosphorus Release Rates, Wenck 2010

Long Lake Creek Subwatershed

- Comprehensive Long Lake Creek Feasibility Study, EOR 2011
- Environmental Assessment Worksheet: Long Lake Creek Improvement Project, MCWD 2013
- Long Lake Improvement Projects: Deer Hill Road Pond 1997 Monitoring Report, Wenck 1998
- Long Lake Improvement Projects: Deer Hill Road Pond and CR 6 Pond 1998 Performance Monitoring Report, Wenck 1999
- Long Lake Regional Infiltration: LLC-8 Feasibility Study, HR Green 2012
- Long Lake Water Quality Improvement Project: Conceptual Downtown Redevelopment Stormwater Design, HR Green 2006
- Long Lake Wetland Restoration Project#2 Feasibility Study, BARR 2009
- Technical Memo: Effectiveness of Alum on Long Lake Water Quality, Wenck 2004

Minnehaha Creek Subwatershed

- Baseflow Restoration in Minnehaha Creek Watershed with Stormwater Infiltration, University of Minnesota and MWMO 2014
- Blue Water Commission Report, Metro Area Agencies 1998
- Comprehensive Water Quality Assessment of Select Metropolitan Area Streams: Minnehaha Creek, Metropolitan Council 2014
- Contribution of PAHs from Coal-Tar Pavement Sealcoat and Other Sources to 40 US Lakes, USGS 2010
- Cottageville Park Feasibility Study, Cuningham Group Architecture Inc. and WSB & Associates 2013
- Diamond Lake Watershed Monitoring and Modeling Report, MnDOT 2009
- Effects of Barley Straw on Water Clarity in Powderhorn Lake, MPRB and Blue Water Science 2008
- Evaluating and Monitoring BMPs with Network Wireless Sensors, University of Minnesota and MWMO 2012
- City Lakes Improvement Project Feasibility Report, Wenck 1994
- Fish Survey for 3 Pools in Minnehaha Creek and Lake Hiawatha, Blue Water Science 2010
- Grass Lake Hydrologic Study, Wenck 1996
- Knollwood Mall Stormwater Management, Wenck 2013
- Lake Hiawatha Stormwater Management Feasibility Study, City of Minneapolis and Houston Engineering 2014
- Technical Memo: Lake Nokomis Alum Dosing Study, HDR 2004
- Lake Nokomis Water Quality Improvements: Lake Nokomis Biomanipulation Study, Blue Water Science 2017
- Lakes Nokomis and Hiawatha Diagnostic-Feasibility Study, Wenck 1998
- MCWD Lakes TMDL – Lakes Nokomis, Parley, Virginia, and Wassermann, EOR 2011
- Minneapolis Chain of Lakes Clean Water Partnership Project: Stormwater Monitoring Study, BARR 1992
- Minnehaha Creek *E. coli* Bacteria/ Lake Hiawatha Nutrients, MPCA and Tetra Tech Inc. 2013
- Minnehaha Creek Fish and Habitat Assessment, MnDNR 2003
- Minnehaha Creek Meander Study, Inter-Fluve Inc 2012
- Minnehaha Creek Restoration Project: Methodist Hospital Campus Site Design Report, Inter-Fluve Inc. and HR Green 2008
- Minnehaha Glen Feasibility Study, Wenck and Kestrel Design Group 2007
- Minnehaha Creek Reach 7-Channel Restoration and Reconstruction Feasibility Study, Inter-Fluve Inc. 2010

- Minnehaha Creek Reach 14-Channel Restoration and Reconstruction Feasibility Study, Inter-Fluve Inc. 2011
- Minnehaha Creek Reach 20-= Restoration Project Feasibility Study, Inter-Fluve Inc. and HR Green 2011
- PAHs Underfoot: Contaminated Dust from Coal-Tar Sealcoated Pavement is Widespread in the USA, USGS 2008
- Pamela Park Wetland Restoration, 1999
- Stormwater Harvesting and Reuse Report, University of Minnesota and MWMO 2013
- Surface Water Pathogen Study, Wenck 2003
- Taft-Legion Lakes Watershed Water Quality Improvement Project Feasibility Study, WSB & Associates 2010
- Technical Memo: Habitat Improvements alternatives from 54th St to Browndale Dam, Inter-Fluve Inc 2014
- Technical Memo: Comparison of 1997-1998 Results for Minnehaha Creek, Wenck 1999
- Technical Memo: 1997 Minnehaha Creek Phosphorus Loads, Wenck 1999
- Technical Memo: Calculation of In-Lake Phosphorus Reductions in Calhoun and Lake of Isles Following Alum Dosing, MPRB 1996
- Technical Memo: Lake Calhoun Alum Treatment, Wenck 2000
- Technical Memo: Reach 8-Channel Restoration and Reconstruction Concept Design Report, 2007
- Trends in Hydrophobic Organic Contaminants in Urban and Reference Lake Sediments Across the US, USGS 2005
- Twin Lakes Improvement Study, City of St. Louis Park and Hickok and Associates 1984

Painter Creek Subwatershed

- An Assessment of the Phosphorus Retention Capacity of Wetlands in the Painter Creek Watershed, Bruland & Richardson 2005
- Painter Creek (PC-2, 6 and 7) Volume and Load Reduction Feasibility Study, Wenck 2012
- Painter Creek Feasibility Study, HDR and EOR 2004
- Painter Creek Section 206 Feasibility Study, US Army Corps of Engineers, 2010

Schutz Lake Subwatershed

- No subwatershed-specific studies

Six Mile Creek Subwatershed

- Common Carp Assessment in Six Mile Creek Report, University of Minnesota 2016
- Evaluation and Application of a 3D Water Quality Model in a Shallow Lake with Complex Morphometry, University of Minnesota 2010
- Halsted Bay Wetland Restoration Project, HR Green 2008
- MCWD Lakes TMDL – Lakes Nokomis, Parley, Virginia, and Wassermann, MPCA and EOR 2011
- Marsh-Wassermann Corridor Plan, Cross River Consulting 2009
- Nutrient Removal System Feasibility Study, WSB 2013
- Parley Lake Internal Nutrient Load Diagnostic Study, Wenck 2011
- Parley Lake Wetland Restoration Feasibility Study, EOR 2007
- Six Mile Creek Diagnostic Study, Wenck 2013
- Steiger Lake Wet Detention Pond Feasibility Study, SRF Consulting Group, Inc. 2010Turbid-Lundsten Corridor Restoration Phase II, MCWD 2011
- Technical Memo: Lake Zumbra High Water Level Investigation, Wenck 2015
- Technical Memo: Pierson Lake Delta Sediment Investigation, Wenck 2014
- Turbid-Lundsten Wetland Restoration Feasibility Study, Wenck 2010
- Wassermann Lake Wetland Restoration Project, HR Green and Inter-Fluve 2007
- Wassermann Lake Wetland Restoration Project Phase II, Barr 2010

VOLUME 3
IMPLEMENTATION PLAN

3 IMPLEMENTATION PLAN

3 FIGURES

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3.1 INTRODUCTION

This volume of the Plan constitutes the MCWD Implementation Plan. It serves as an actionable roadmap, outlining natural resource issues within the Minnehaha Creek Watershed, the system drivers that cause those issues, and the management strategies that the District and its partners can employ to achieve measurable change in identified goals.

Also included is a description of the MCWD's Balanced Urban Ecology philosophy of water resource planning and implementation, which emphasizes the social and economic value created when built and natural systems work in harmony. Following is an outline of MCWD's methodology to prioritize water resource issues, how it plans and implements its management strategies, how programs are aligned to accomplish the MCWD mission, and the administrative procedures that govern MCWD efforts.

Nested within this volume, the District's overarching Implementation Plan has been further subdivided geographically into eleven (11) subwatershed implementation plans. Each of these plans lays out a framework for actions that can be taken by the District and its partners to address the combination of issues and drivers, unique to each area of the watershed.

These subwatershed plans are not intended to serve as a prescriptive formula for action. Watershed issues and the stressors driving the system may be relatively static, but the successful implementation of solutions requires partners to be able to respond fluidly to opportunities emerging across the landscape. Accordingly, each subwatershed plan is designed to provide a foundation to guide future collaborative implementation efforts.

3.2 DISTRICT PHILOSOPHY

The MCWD sees natural resources as an integral component of vibrant communities, serving to create a sense of place, providing vital connections, and enhancing social and economic value. It aspires to a vision of a landscape of vibrant communities where the natural and built environments in balance create value and enjoyment.

This vision stems from the District's 2014 adoption of the Balanced Urban Ecology policy, which now serves as the MCWD's underlying organizational strategy. This strategy prioritizes partnership with the land use community to integrate policy, planning and implementation and to leverage the value created when built and natural systems are in harmony.

This policy guided the creation of the Minnehaha Greenway, and was developed in direct response to a series of policy analyses that identified

Frozen Minnehaha Falls, Nathan Lodermeier

Big Island on Lake Minnetonka, Peter Stratmoen

Six Mile Creek

the governance gap between land use and water planning and called for increased water and land use planning integration to improve the watershed management model in Minnesota.

For example, the 2007 Evaluation Report on Watershed Management, drafted by the Office of the Legislative Auditor, concluded that efforts to manage water quality are most effective when coordinated with land use decisions.

Reinforcing these findings, in 2009 the Minnesota Environmental Initiative found that water and land planning in Minnesota is compartmentalized at all levels, under separate bodies of regulation and various agency jurisdictions. This evaluation noted that "a coordinated planning cycle will result in more informed land use decisions and a better balance between planning and implementation activities for land and water resources."

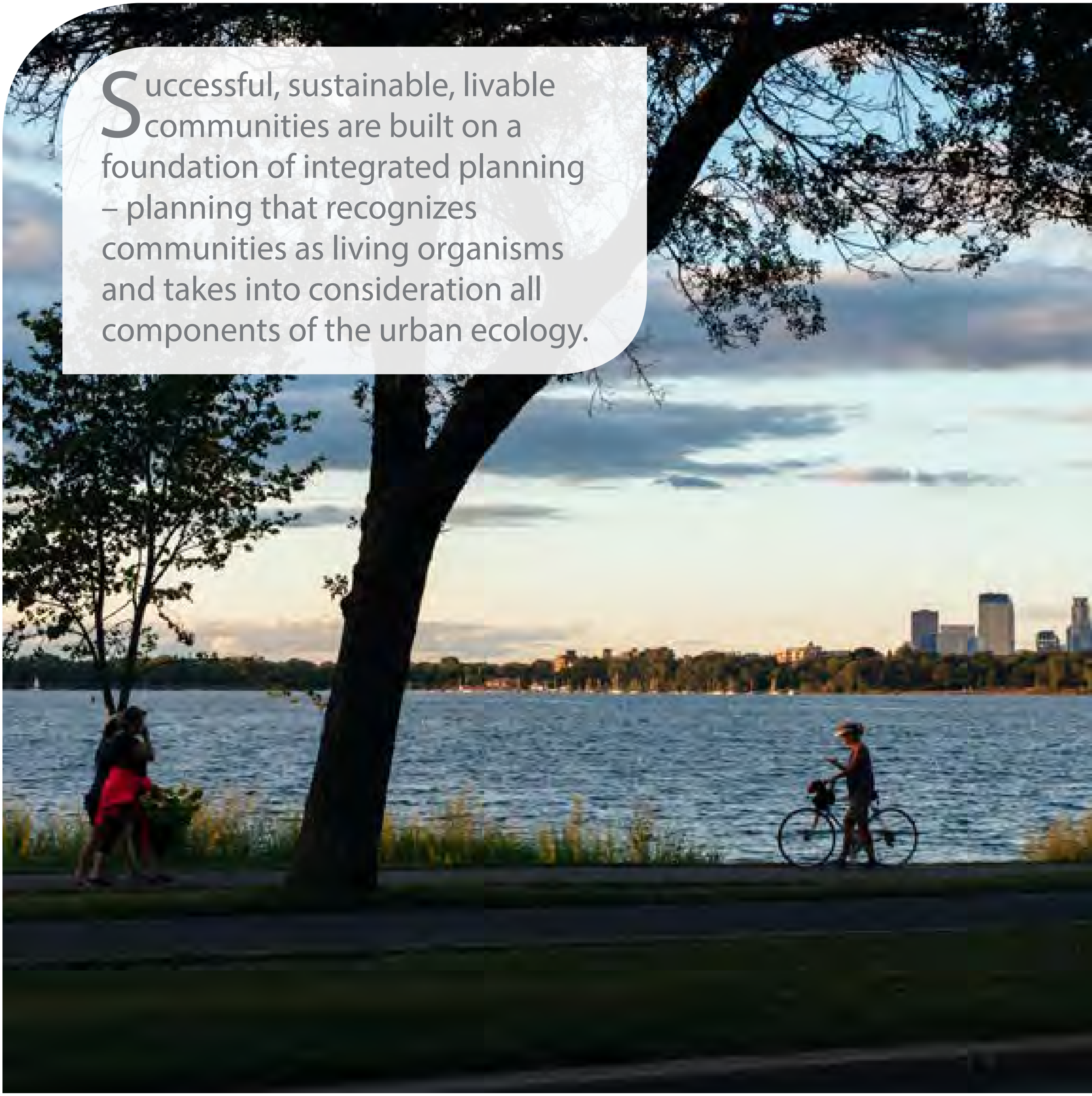
Similarly, a 2011 Hennepin County Water Governance Project noted a complicated relationship between politically managed built systems and watershed based management that requires significant effort to coordinate. This study recognized "the potential for implementing good water management practices through better integration of water management plans and comprehensive land use plans of all kinds. Effective collaboration in the planning stage before spending funds on intensive capital improvement projects can save valuable resources."

The 2013 Water Regulation and Governance Evaluation, drafted by the Minnesota Pollution Control Agency (MPCA), found that opportunities to address land use and water connections have waned in recent decades, that state land use statutes lack an explicit connection to water plans, and that the major water management goals of the state can be achieved only by strong integration with land use management.

One reason for the persistent disconnect between watershed management and land use planning has been the difficulty in synchronizing planning between watershed districts and land use authorities. Land use decisions are made relatively quickly compared with the historically static ten-year plans developed by watershed districts. Land may be bought and sold, platted, and moved into construction within months. For watershed planners working under fixed ten-year plans and state rules, this can make it difficult to integrate watershed capital improvements or design enhancements into the development plans of a private or institutional developer.

A secondary issue has been the prevailing perception of watershed organizations acting principally as regulatory agencies. Historically, watershed districts have used regulation as a foundational tool to connect with local land use planning and infrastructure investment. Such programs

Successful, sustainable, livable communities are built on a foundation of integrated planning – planning that recognizes communities as living organisms and takes into consideration all components of the urban ecology.



Lake Bde Maka Ska / Calhoun

guarantee a certain level of integration of water resource planning into the built environment. However, this view often results in watershed districts receiving development or infrastructure plans later in the approval process, during permit review, rather than in the due diligence or feasibility period of development or infrastructure planning.

Recognizing these challenges within the realm of water management, and the opportunity for MCWD to meaningfully integrate its work into the planning of vibrant communities, the District has strategically realigned its planning and implementation model emphasizing water's complementary, rather than competing, role in the urban landscape.

A source of inspiration for the District's Balanced Urban Ecology policy was the 1994 Hennepin Community Works model. This well-respected urban planning model acknowledged the power of natural systems to be developed as the underlying structure of place, underpinning local community identity. Community Works found that well designed and carefully integrated natural systems and infrastructure projects are able to maintain and enhance the long-term tax base of neighborhoods while improving the quality of life.

Since its adoption in 2014, the District now views its mission of water resource protection and improvement through the lens of its Balanced Urban Ecology policy:

> *Rather than viewing the natural and built environments as a clash of opposing forces, we recognize the interrelated and interdependent character of modern life; communities cannot thrive without healthy natural areas, and healthy natural areas become irrelevant without the interplay of human activity. This is the integrated setting in which we live. Indeed, our quality of life and our economic wellbeing are inextricably linked. Any notion that land development and environmental protection are locked in a winner-take-all battle is sadly outdated.*
>
> *Successful, sustainable, livable communities are built on a foundation of integrated planning – planning that recognizes communities as living organisms and takes into consideration all components of the urban ecology.*
>
> *Our work will be strengthened through these collaborative efforts. Not only will they offer greater community impact, they will produce creative public-private funding opportunities that will leverage scare resources and maximize benefits. Going it alone is no longer the best path forward.*

The Balanced Urban Ecology policy represents the MCWD's fundamental philosophy and way of doing business and is guided by the following three principles:

» Intensifying and maintaining focus on high-priority projects

» Partnering with others to pursue watershed management goals

» Being flexible and creative in adapting to the needs of partners

3.3 DISTRICT GOALS

The District has established four strategic goals. All specific issues within the watershed nest under these goals.

» **Water Quality** - To preserve and improve the quality of surface and groundwater.

» **Water Quantity** - To manage the volume and flow of stormwater runoff to minimize the impacts of land use change on surface and groundwater.

» **Ecological Integrity** - To restore, maintain, and improve the health of ecological systems.

» **Thriving Communities** - To promote and enhance the value of water resources in creating successful, sustainable communities.

While the Plan is organized around these four simple strategic goals, the MCWD recognizes that watershed management requires a holistic approach of ecosystem management. Accordingly, it approaches planning and implementation in a manner that integrates hydrologic, chemical, physical, biological and built components of the subwatershed system. Further discussion of the District's goal-setting and evaluation framework is provided in Section 3.7.

3.4 IMPLEMENTATION MODEL

The District's approach under this Plan is guided by the Balanced Urban Ecology policy and its principles of focus, partnership, and flexibility. The implementation model to support this approach is ongoing and iterative, but can be simplified into four basic steps:

1. Understanding resource needs
2. Understanding land use plans and opportunities
3. Integrating and prioritizing
4. Program implementation

Minnehaha Creek, Nathan Lodermeier

The following sections provide further detail on each of these elements. Each of the District's eleven (11) subwatershed plans in Section 3.9 follows this sequence.

3.4.1 UNDERSTANDING RESOURCE NEEDS

The first element of the District's implementation model is to understand water resource needs on a subwatershed basis. The MCWD maintains multiple technical data sets, summarized in Volume 2, that provide the District and its partners with the information needed to guide implementation planning. Analysis of these data enables the District to identify areas of highest need, based on sound science. This represents the first step in the iterative process of establishing implementation priorities.

Each subwatershed plan within Section 3.9 follows an issues, drivers, and strategies sequence as described below.

Issues

For purposes of Plan organization, all natural resource issues within the District are nested within the three strategic goal areas of Water Quality, Water Quantity, and Ecological Integrity. Each of these three goal areas are described in more detail below.

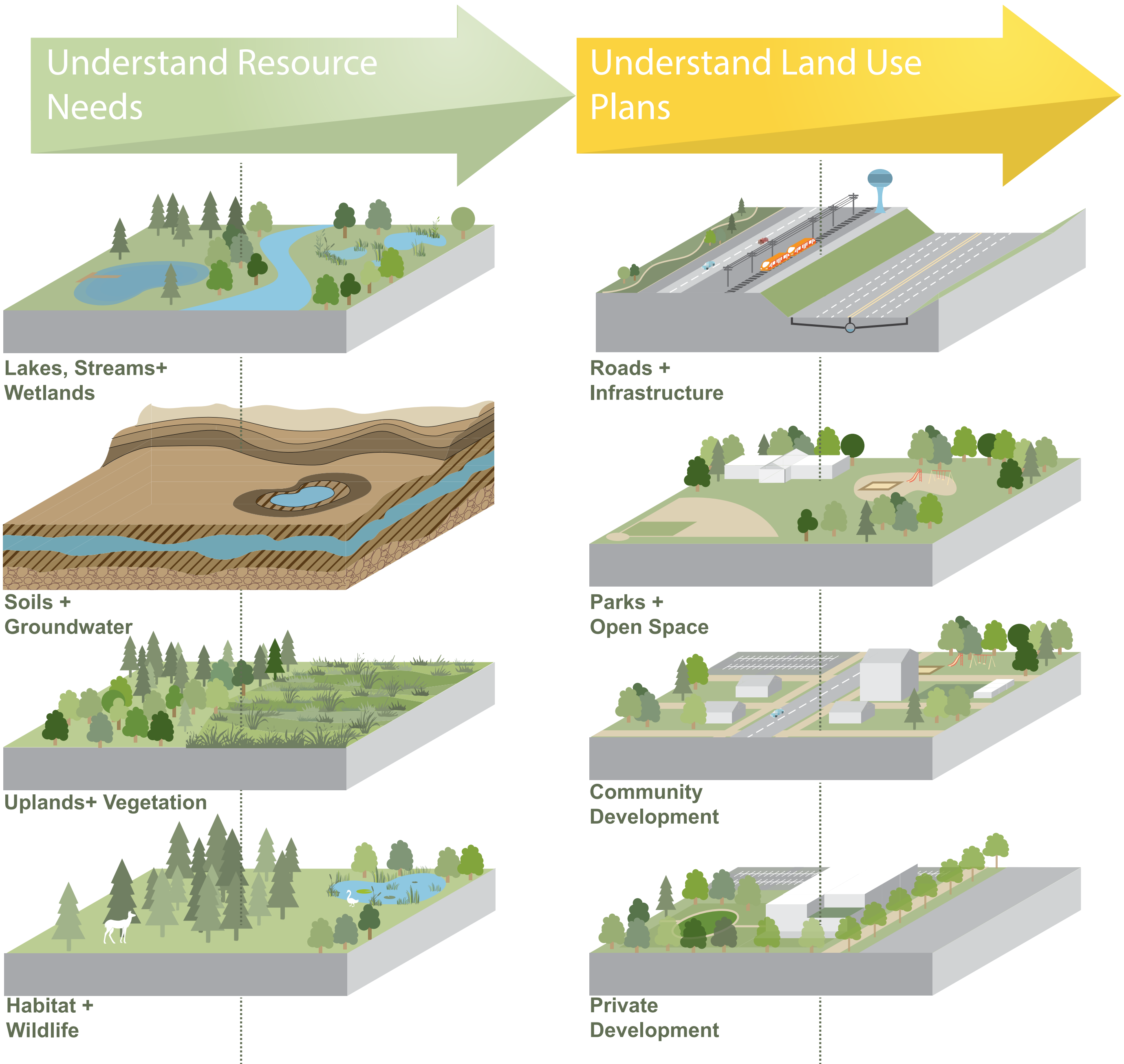
No issues are outlined within the goal area of Thriving Communities. Thriving Communities serves as an overarching organizing element to guide the District in implementing its natural resource mission. The District strives to implement its clean water objectives in ways that meaningfully contribute to the development of thriving communities. As such, this goal area is informed by the goals of individual communities and no specific issues are identified within this plan under Thriving Communities.

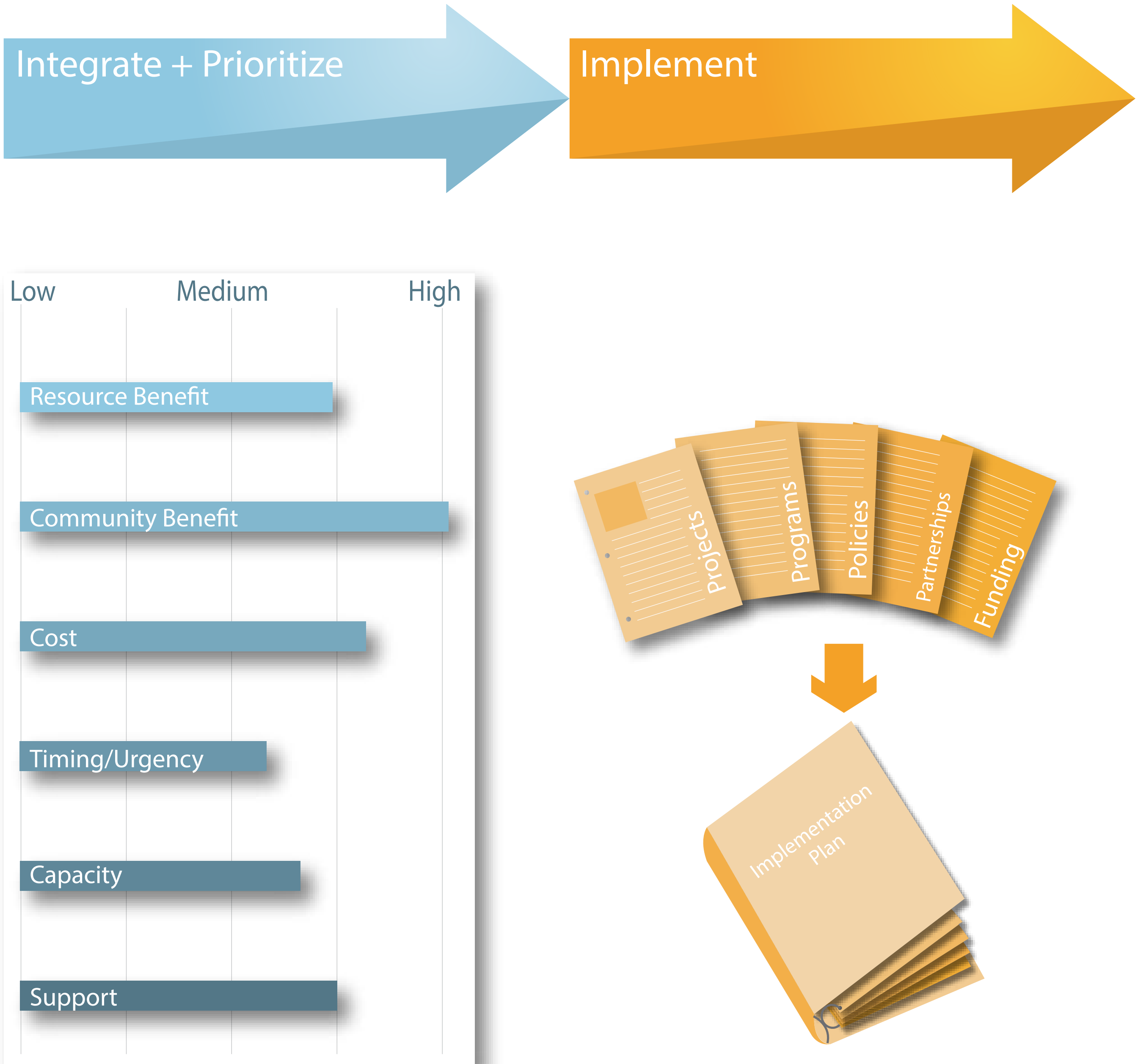
Water Quality Issues

The Environmental Protection Agency (EPA) and the Minnesota Pollution Control Agency (MPCA) define acceptable water quality as that which supports the designated use of the waterbody (e.g. fishable, swimmable, drinkable).

Pollution discharged to waterbodies impacts water quality. Pollutant discharge within the Minnehaha Creek watershed is primarily from non-point sources, carried to lakes, streams and wetlands by snowmelt or rainfall that runs across the landscape. Land use within the landscape influences both the quality and quantity of the runoff. Runoff contains sediment, nutrients and other contaminants that exceed what lakes, streams and wetlands would receive in an undeveloped watershed.

IMPLEMENTATION MODEL




Integrate + Prioritize
Implement
Low
Medium
High
Resource Benefit
Community Benefit
Cost
Timing/Urgency
Capacity
Support
Projects
Programs
Policies
Partnerships
Funding
Implementation Plan

Within freshwater systems, an excess of nutrients like phosphorus (eutrophication) is the most common problem impacting the use of lakes and streams. Phosphorus impacts algal and plant productivity, water clarity, fish habitat and aesthetics. While other pollutants do stress freshwater systems, phosphorus is used as standard indicator of the health of a system.

This Plan considers good water quality to be achieved when the physical, chemical, biological and aesthetic characteristics of a waterbody support designated use. Because the principal standard by which water quality is judged is total phosphorus concentration, the water quality emphasis of this Plan is on reducing phosphorus loads to lakes to achieve standards set by the state.

Water Quantity Issues

As watersheds are altered and developed by humans, the flow of water across the landscape changes. In undeveloped watersheds rainfall largely infiltrates into the ground. However, historically, as watersheds were built out, drainage systems were installed both to remove surface water and lower groundwater for agricultural production, and to channelize and accelerate removal of surface runoff for urban development and infrastructure.

As watersheds began to include built components, channels were straightened, wetlands were filled, drainage ways were placed into pipes, natural vegetation was removed, and hard surfaces (parking lots, roofs, roads, etc.) were built.

Combined, these modifications reduce the infiltration and storage of water. The result is larger volumes of water draining through the system faster. The volume of water and the rate at which it moves through the watershed are defined as water quantity issues.

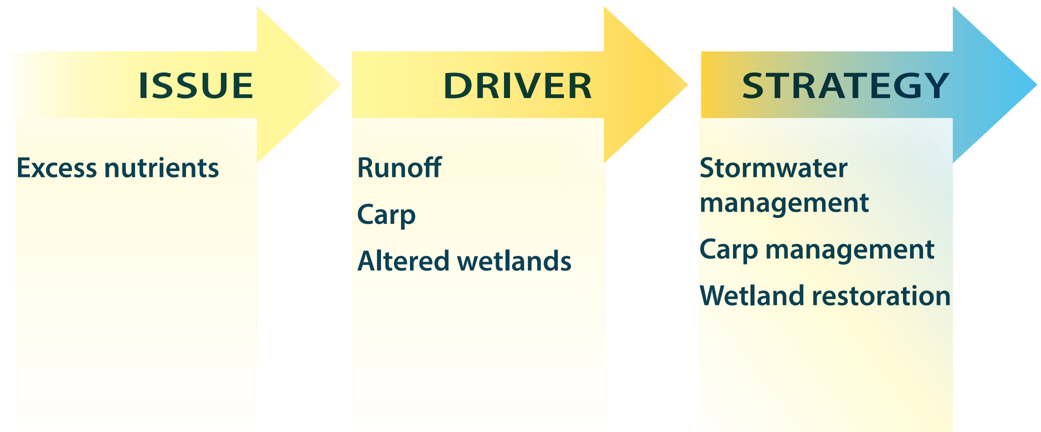
Water quantity is most often recognized as flooding. Flooding occurs when a watershed is overwhelmed with rainfall that cannot infiltrate into the ground, or be appropriately stored on the landscape. Flooding can occur at a system level, across the watershed on major lakes and streams, or more locally in ponds and in street systems that cannot adequately store or convey the water being received during and after storm events.

However, water quantity is also an issue when there is not enough water. Water is essential for aquatic life and the health of aquatic systems. Streams with highly modified watersheds, like Minnehaha Creek, have a high proportion of hard surface that pipes water directly to the stream. In an undeveloped condition water would be stored in wetlands or infiltrated into the ground. This water then would be slowly released into the stream channel, promoting long periods of stable water flow. In modified watersheds stream flow can be “flashy,” with water moving through the system quickly after rainfall events.

Stream monitoring equipment

Lake Hiawatha during the 2014 flood, Erdahl Aerial Photos

Mallard ducks at Lake Calhoun, credit: Svetlana Schulte



In streams like Minnehaha Creek, this can result in intermittent flow and periods where the channel is dry. This water quantity issue directly impacts the ecological health of the stream, stressing fish, macroinvertebrates, plants, and other aquatic life.

Within this Plan, the District is focused on water quantity issues that stress the regional system. In general, the District considers LGUs to have the primary role with respect to flood prevention and management by virtue of their roles in land use planning and development regulation, as owner and operator of stormwater conveyance infrastructure, and as the implementing authority for the National Flood Insurance Program and the state floodplain management program (Minn Rules 6120). The District's primary roles related to flood management are: (1) management of the Lake Minnetonka/Minnehaha Creek regional conveyance system through the operation of Grays Bay Dam; (2) providing cities and the public with flood prediction data using the District's Hydraulic and Hydrologic model; (3) preserving local flood storage volume by regulating floodplain fill during development permitting; and (4) implementing and promoting stormwater management practices to address pollutant loading, prevent local peak flow increase and provide for volume reduction. The District serves as a technical resource and will work with its partners to plan and implement solutions that create a more resilient system that is capable of handling both ends of the water quantity spectrum.

Ecological Integrity Issues

Ecological integrity encompasses issues of water quality and water quantity, but is broken out for simplicity in Plan organization. The three primary elements of an ecosystem are its structure, composition and function. Structure refers to all of the living and non-living physical components that make up an ecosystems. Composition refers to the variety of living things within an ecosystems. Function refers to all of the natural processes that occur within an ecosystem.

Ecological integrity exists when the composition and function of the ecosystem are unimpaired by stresses from human activity. It exists when natural ecological processes are intact and self-sustaining, where the system evolves naturally and with a capacity for self-renewal.

Within this plan, ecological integrity focuses on achieving balance between the built and natural environments, with ecosystems providing the highest possible measures of structure, composition and function. Within the implementation plan, emphasis is placed not only on improving structure, composition and function at an individual resource level, but on connectivity between aquatic and terrestrial ecosystems, and connectivity at a regional landscape scale.

Drivers

Within each subwatershed plan, issue drivers are identified. A driver of a water quality, water quantity, or ecological integrity issue is a driving force or stressor that causes a biological community or physical structure to change. For example, in regards to water quality issues, stormwater runoff and altered wetlands can drive excess nutrient loading, increase the quantity of water flowing downstream, and degrade habitat and ecological integrity.

Management Strategies

To guide planning and implementation efforts, the District has established a simple framework of general strategies that will address the identified issues. Management Strategies correlate directly to the drivers of the subwatershed system. If, for example, stormwater runoff is driving an increase in water quantity and degrading water quality, the appropriate management strategy will be managing stormwater runoff through the use of best management practices tailored to the individual circumstance. If degraded water quality within a lake is driven by the presence of common carp and internal loading, management strategies may include rough fish management, and alum dosing. These strategies cover both the short and

> To better integrate our efforts with those acting on the landscape and address the dynamic environment in which water resource management efforts are implemented, the District has adopted a partnership framework to create alignment between our goals and the goals of others.

Monarch caterpillar

long-term, and serve to guide the identification and prioritization of individual implementation efforts.

3.4.2 UNDERSTANDING LAND USE PLANS

The second element of the District's implementation model is to understand the land use setting. Guiding all of District's implementation efforts to protect and improve the landscape is the principle of integrated planning, through collaboration with public and private partners. To better combine our efforts with those acting on the landscape, and to operate effectively within the dynamic environment in which water resource management efforts are implemented, the District has adopted a partnership framework to create alignment between our goals and the goals of others.

The District uses several mechanisms to understand the land use environment within its boundaries and align its water resource planning with land use planning. These include, but are not limited to:

- Review and coordination of local water management plans
- Annual meetings with cities
- Exchange of land use, infrastructure, park, and capital improvement plans with cities, counties, and agencies
- Early regulatory coordination on pending development activity
- Coordination agreements with public and private partners

This effort to improve communication and collaboration between the District and its communities is further described in Section 3.6.

3.4.3 INTEGRATING AND PRIORITIZING

The subwatershed plans in Section 3.9 describe the resource needs and corresponding management strategies across the District's eleven (11) subwatersheds. The District recognizes that it is not feasible to address all of the resource issues throughout the watershed within a 10-year plan cycle. For this reason, the District prioritizes using both its knowledge of water resource needs and its understanding of land use plans and opportunities.

When setting implementation priorities, the MCWD considers factors such as these:

- Water resource issues/impairments
- Public value of resources

» Probability of achieving measurable resource improvement

» Local partnerships and support

» Known project opportunities

» Funding opportunities

The MCWD first uses its water resource data to identify issues and set implementation priorities across the District. For example, based on long term monitoring data, the District can prioritize water quality issues based on the degree of water quality impairment. This information enables the District to identify regionally significant waterbodies that are the most degraded, as well as waterbodies that currently meet standards but are at a "tipping point" – poised to become impaired.

In addition to prioritizing based on water resource data, the District also considers what is happening on the landscape. For instance, if an area is projected to undergo significant redevelopment, or there is a major infrastructure project planned by another entity, these changes may present opportunities to address water resource issues in ways that are well-integrated with land use plans and more cost-effective.

The District prioritizes at multiple scales. At a subwatershed scale, the District identifies priorities for implementation based on the resource needs of that system. Then as opportunities for implementation arise, the District can weigh them against the resource needs and priorities it has identified.

Prioritization is also done at a watershed-wide scale. The District has found that it can most effectively achieve its mission to manage and improve water resources, not when it seeks to apply its resources evenly across the watershed at all times, but rather when it coordinates its programs and capital investments so as to focus on specific areas of high need and opportunity. For this reason, the District identifies priority subwatersheds on which to focus on system-level planning and implementation.

Through sustained focus in a subwatershed, the District is able to develop a thorough understanding of a system's issues and drivers, build relationships, identify opportunities, and coordinate plans and investments with its partners for maximum natural resource and community benefit. This focused approach is best suited in areas where there are significant resource needs and a level of complexity that require sustained effort and coordination across multiple public and private partners. This process is described further in the next section.

Boardwalks trace a restored stream at the Minnehaha Creek Preserve.

Establishing implementation priorities is an iterative process. The priorities identified in this Plan are based on information available at the time the Plan was drafted; however, the District recognizes the need to continually scan for threats and opportunities and adjust its priorities accordingly. In cases where new priorities are identified that are beyond the scope of this Plan, the District will pursue a plan amendment as described in Section 3.8.

3.4.4 PROGRAM IMPLEMENTATION

The last element is implementation. The District has a wide range of programs and services that work together to make progress toward the District's goals and provide value to its communities. These services include:

» Monitoring – collecting and analyzing data to identify issues and inform implementation

» Technical Assistance – providing guidance to landowners, cities, and others on the planning, funding, and implementation of best management practices

» Permitting Assistance – assisting applicants by coordinating with other regulatory agencies and identifying alternatives that meet the applicants' goals and meet or exceed natural resource protection requirements

» Education and Outreach – providing education and capacity building for communities and residents

» Capital Improvement Projects – constructing physical improvements on the landscape

» Land Conservation – preserving and restoring high-value green infrastructure

» Ecosystem Management – managing invasive species, such as carp, for water quality and ecological integrity benefit

» Grants – identifying funding sources through the District's own competitive grants or other federal, state, and regional sources

Focal Subwatershed Planning

The previous section describes the rationale behind the District's selection of priority subwatersheds. The District has identified three priority subwatersheds in which to focus its implementation efforts for the 2018-2027 plan cycle – Minnehaha Creek, Six Mile Creek-Halsted Bay, and Painter Creek. These three subwatersheds have been prioritized based on a combination of resource needs and opportunities, as described briefly below and in more detail in the respective subwatershed plans in Section 3.9.

As the regional water resource authority, the District is responsible to understand hydrologic systems on a watershed basis and what is needed for their health and sustainability. Through its review of local water plans, the District seeks to engage its LGUs as partners in incorporating this basis of knowledge and understanding into the exercise of land use planning, regulatory, capital, infrastructure maintenance and related local authorities.

Sunset at the Burwell House on Minnehaha Creek, Aldo Abelleira

Six Mile Marsh

Rolling hills restoration in Painter Creek subwatershed

Within these focal subwatersheds, the District acts as a convener to bring together cities, counties, park districts, and others involved in land use change to develop a coordinated implementation and investment plan. Through this planning process, the parties align goals and plans to create a roadmap for implementation including both short-term actions and long-term efforts that can be executed as land use change takes place. This scale of coordinated implementation planning also positions the District and its partners well to pursue federal, state, and regional funding sources.

Minnehaha Creek

The Board has identified the section of Minnehaha Creek through Hopkins and St. Louis Park as a priority focus area because of its resource needs – Minnehaha Creek and downstream Lake Hiawatha are impaired and this stretch of creek was identified as contributing the highest pollutant loads; and its opportunities – the area is undergoing significant land use planning and redevelopment for reasons including the planned light rail transit system. The District has also identified opportunities to extend stream restoration and stormwater management efforts downstream through partnerships with the cities of Edina and Minneapolis and the Minneapolis Park and Recreation Board and through grant funding received from the Federal Emergency Management Agency (FEMA) to repair stream damage that occurred during the 2014 flood event.

Six Mile Creek-Halsted Bay

The Six Mile Creek-Halsted Bay focal geography is a complex system that spans four communities, two counties, and a significant portion of Three Rivers Park District land. It is resource-rich with 17 lakes Halsted Bay of Lake Minnetonka, and over 6,000 acres of wetlands. Six of these lakes are classified as impaired under Minnesota Pollution Control Agency standards with Halsted Bay requiring the largest load reduction of any waterbody in the District. The subwatershed is experiencing significant growth and development activity that creates opportunities, and an urgency, for integrated land use and water resource planning.

Painter Creek

The Painter Creek Subwatershed contains a number of large wetlands, many of which have been ditched or otherwise altered, that are connected by Painter Creek. The system delivers high phosphorus loads to Jennings Bay on Lake Minnetonka, which is listed as impaired and requires the second largest load reduction in the District. Painter Creek is also impaired by excess E. coli bacteria. The subwatershed includes areas of high quality wetland and upland, including several regionally significant ecological areas. The MCWD has previously established a partnership with the United States Army Corps of Engineers (USACE), which identified the potential restoration of four of the major wetland marsh systems that would be eligible for funding under the Federal Section 206 Program.

Opportunity-Driven Implementation

In addition to these focused planning and implementation efforts, the District's approach watershed-wide is to remain responsive to opportunities created by land use change or partner initiatives. Development of local water plans will produce a coordination framework through which the District will maintain current knowledge of land use and capital planning by its LGUs, and of potential land use development and redevelopment activity.

As opportunities arise, the District will evaluate them against the resource needs and priorities defined in the subwatershed plans in Section 3.9 and determine the appropriate response. As noted above, the District has a range of services it can mobilize to address resource needs and support partner efforts. As the District evaluates opportunities for implementation, it custom-tailors its response based on the community and resource need. The level of response will also depend on the urgency of the opportunity and the District's capacity. For instance, in some cases, the District may play more of a supporting role by providing data and technical assistance or helping to pursue grant funds. In other cases, the District may take a lead role by developing a management plan or implementing a capital project.

NEMO boat tour

Subwatershed planning meeting

Tour at the Minnehaha Creek Preserve Program

Implementation Funding

A key to any successful implementation effort is developing a funding strategy. In recent years, the District's planning and implementation model has evolved, as described in previous sections. This shift in approach prioritizes resources and actions on a watershed and subwatershed basis, to achieve a larger scale of measurable natural resource benefit. This, of course, is complemented by remaining responsive to opportunities that emerge from the public and private partners of the District.

While this mode and scale of implementation has demonstrated substantial results already, it has also been limited by the District's ad valorem tax levy – requiring a complementary focus on developing funding strategies that leverage outside monies from grants, partnerships, and innovative financing to supplement the District's tax levy.

Consequently, a critical component of all implementation plans will be the development of a funding strategy that identifies the sources, uses, and timing of funds needed to successfully achieve identified goals. These plans will be developed in conjunction with the District's public and private partners as capital projects or programs are advanced. Therefore, any costs identified within this Plan are projections. Intended expenditures will be refined during project development and budgeting, and among other things will reflect the District's intent to complement its ad valorem funds with other funding sources.

3.5 MCWD PROGRAMS

The MCWD exists to protect and improve land and water for current and future generations. It does this work through public and private partnerships guided by the Balanced Urban Ecology policy, which emphasizes the social and economic value created when built and natural systems are planned to work in harmony.

The two overarching organizational strategies with which the District will achieve its mission are:

- » Developing high impact capital improvement projects that are integrated with non-water initiatives through multi-jurisdictional partnerships; and
- » Improving the integration of land-use and water resource planning and policies to produce value-added partnerships with private development and public infrastructure investments.

All District programs work in support of these efforts. Descriptions of the major District program areas are provided below. These programs include:

- » Planning
- » Research and Monitoring
- » Permitting
- » Education and Communications
- » Capital Improvement Projects
- » Land Conservation
- » Project Maintenance and Land Management
- » Incentive Programs

3.5.1 PLANNING

Program Purpose

District planning is focused in three main areas:

- » Developing high impact capital improvements
- » Developing policies to improve the integration of land-use and water planning and implementation
- » Aligning and deploying District programs and resources to address identified opportunities

Capital Project Planning

Over recent years, the District has invested significant organizational effort to develop new policy models for planning and partnerships, with the goal of improving the success of capital project implementation in partnership with the local land-use community. The District's capital improvement planning model is described in more detail in Section 3.5.5.

Policy Development

Following the Balanced Urban Ecology policy, the Planning program seeks to develop shifts in policy that increase the synergy of land-use and water planning. Specifically, the District wishes to improve collaboration with public and private partners in the following areas:

- » Private development
- » Public infrastructure planning and investment (e.g. parks, roads, utilities)
- » Land use and water planning and policy

Section 3.6 outlines how the District will collaborate with local municipalities through the development and coordination of Local Surface Water Management Plans, to continue strengthening partnership connections in these areas.

The District will also rely heavily on its Permitting Program and Education and Communications Program, to improve integration in these areas and increase awareness of partnership opportunities by:

- » Engaging the private development community and
- » Working with land use planning staff and officials

Aligning and Deploying Program Resources

The District's Planning Program also works pro-actively with the MCWD Board of Managers to scan the environment for opportunities to achieve the District's mission, and recommends the alignment and deployment of policy, project, and program resources. This work includes periodically conducting strategic assessments of existing and proposed District programming, recommending and maintaining organizational alignment, and evaluating and reporting on District effectiveness.

3.5.2 RESEARCH AND MONITORING

Program Purpose

The Research and Monitoring program serves as the scientific base to implement the District's mission, by collecting and analyzing data across the watershed's natural resources. This information is used primarily to inform

Staff gathering a sample

Winter chloride sampling

Zebra mussels on Lake Minnetonka

District planning and implementation, and secondarily to inform and educate members of the public. The program has the four following areas of focus:

» Diagnosing drivers of water resource issues

» Collaborating to identify management strategies

» Broadly characterizing ecological health

» Communicating analyses of data and recommendations

It accomplishes these goals through the following programmatic activities:

» Diagnostic monitoring – smaller scale, higher resolution monitoring that identifies the cause of water resource impairment, to inform planning and implementation.

» Anchor monitoring – maintaining long-term data sets across the watershed, at select representative sites, to monitor watershed-scale trends over time.

» Performance monitoring – pre- and post-project monitoring at priority project sites to demonstrate efficacy.

» E-Grade – broadly characterizing ecosystem health at a subwatershed or system scale to support planning and public communications.

Section 2.1.2 of the Plan provides an overview of monitoring locations, frequency, and parameters. These are evaluated annually and may be adjusted to serve program purposes.

The Research and Monitoring program also includes aquatic biology expertise focused on assessing and managing the impact of aquatic invasive species (AIS) within the watershed. District AIS monitoring and management efforts help to inform a more holistic interpretation of the watershed's ecological health. Programming focused on AIS includes the following activities:

» Managing species with high ecological impact (i.e. common carp), in coordination with capital project planning, to improve water quality and ecological integrity.

» Early detection monitoring and rapid response – conduct monitoring to identify recent introductions and respond with management and control, where appropriate, to address ecological impact and prevent new infestations.

» Promoting research – encourage strategic partnerships that advance the use of the watershed as a living laboratory to advance AIS science while informing District planning and implementation.

» Supporting the prevention efforts led by District partners – develop financial and technical partnerships to influence, engage and support partners in AIS prevention activities.

3.5.3 PERMITTING

Program Purpose

The primary purpose of the Permitting program is to review and oversee construction activity to protect the District's natural resources from degradation that can occur as a result of land use change.

The program also uses early engagement to identify and foster partnerships with property owners, developers and local land use authorities, to achieve project outcomes that exceed regulatory requirements and create mutual benefit.

Given that Permitting program staff interact with the public on a daily basis, the program also serves as a public face of the District. This enables the Permitting program to operate in an educational capacity with respect to property owners, the development community and the District's municipalities.

The Permitting program performs the following five functions:

» Permit Administration – development plan review and permit issuance

» Oversight and Compliance – field inspections and compliance enforcement

» Partnerships – identifying and developing public-private partnerships to achieve outcomes that exceed requirements

» Communication and Education – increasing public awareness of water resource management needs and the MCWD's vision and mission

» District Obligations - fulfilling the District's own legal obligations including administering the Minnesota Wetland Conservation Act (WCA) and complying with its stormwater permit under the federal National Pollutant Discharge Elimination System (NPDES) program

Permit Administration and Compliance

Future development and redevelopment in the watershed is expected to have an impact on water and other natural resources. The District administers a permitting program so that construction projects that change land use comply with standards that limit these impacts. These standards are contained in the District Rules, which presently include regulations for:

Staff inspecting a retaining wall

Staff doing a stormwater pond inspection

Staff inspecting a construction site

» Erosion and Sediment Control
» Floodplain Alteration
» Wetland Protection
» Dredging
» Shoreline and Streambank Stabilization
» Waterbody Crossings and Structures
» Stormwater Management
» Appropriations
» Illicit Discharge Detection and Elimination

The dredging, shoreline and streambank, and waterbody crossing rules also allow the Minnesota Department of Natural Resources (DNR) to maintain a General Permit for work within District boundaries that meets District rule requirements, thus relieving landowners of the need to obtain a DNR individual permit as well. The last substantial review and revision of the District Rules was in 2014. The District monitors developments in approaches toward regulatory protection and assesses its own permitting experience on an ongoing basis for the purpose of periodic rule-making to improve its Rules.

The District works with permit applicants, and coordinates with other permitting agencies, to ensure that plans, designs, and specifications for proposed construction projects meet requirements that minimize the impact a project will have on the watershed's natural resources. Once a project has been approved and moves into construction, the District monitors construction for compliance with the approved design. District permits require the landowner to assume responsibility for ongoing maintenance of stormwater management facilities and preservation of wetland buffers. Ordinarily, a private landowner must record this obligation on the property title, while maintenance obligations assumed by units of government are established by means of written agreement. The District's Permitting program also includes tracking facility maintenance and buffer preservation over time. Because of its legacy nature and resource limitations, there is a substantial deferred maintenance concern as to both public and private stormwater basins throughout the watershed. As noted in Appendix A, the District has begun discussions with its LGUs about approaches to addressing this concern.

The District's enforcement process typically occurs in steps. When a potential violation is observed, the District seeks to confirm the violation and obtain voluntary compliance with the permittee and responsible construction firm. If compliance is not achieved, District staff may issue a temporary field compliance order and/or provide notice for a compliance hearing before the Board of Managers, which then may issue an order. During this process, District staff will coordinate with the local land use authority and any other agency that may have jurisdiction over the violation so that enforcement is efficient and consistent. If compliance does not result, the District, under Minnesota Statutes §§103D.545 and 103D.551, may seek enforcement of its order or other remedies in Minnesota District Court, though this step rarely has been required. If a violation presents an occurring or threatened risk of harm to water resources, the District may not follow this enforcement sequence but may move to stop work or issue a compliance order immediately.

Coordination with Local Government Units

The framework for District coordination of its regulatory program with the land use and water resource regulatory programs of its local government units (LGUs) is established through the local water planning process under Minnesota Statutes §§103B.211 and 103B.235. This framework is described extensively in Section 3.6, below.

Under those statutes, an LGU may choose to exercise sole regulatory authority over erosion control, stormwater management, floodplain alteration, wetland protection and/or waterbody crossings and structures. It also may elect to serve as the WCA implementing agency. If it chooses for the District to withdraw its own regulatory authority in any of these areas, it first must establish, for District approval, that it has adequate regulatory standards, as well as procedures and capacity to implement its program. The local plan also must provide for periodic mutual review of LGU program implementation.

Conversely, if the District will continue to exercise its authority within an LGU's boundaries, it will not assert the right to review or mandate changes in the LGU's standards or procedures. In this case, the LGU will remain subject to separate federal and state mandates (e.g., NPDES, Minnesota shoreland and floodplain programs, WCA, Safe Drinking Water Act) with respect to its regulatory program.

Appendix A describes how, through the local plan process, the District and its LGUs will establish a framework to coordinate where both agencies are implementing regulatory programs. The purposes of this coordination are to ensure early mutual awareness of proposed development activity, afford certainty and consistency to applicants and permittees, and provide for efficient and cost-effective compliance oversight.

Early Coordination and Value-Added Partnership

The broader District intention with respect to its Permitting program, and a


Cottageville Park ribbon cutting


Master Water Stewards project


Storm drain stenciling

substantial policy orientation underlying this WMP, is its effort to more closely integrate land use planning and water resource management. Principally, this will occur through closer coordination with LGUs at a planning level and in early development review. Appendix A outlines the coordination framework that the District hopes to achieve with interested LGUs.

The goals of this approach include the following:

» Incorporate regional water resource considerations into development regulation before broader patterns of land development are fixed or regional infrastructure investments programmed.

» Foster closer integration of water resource management standards into land development codes.

» Identify opportunities to add public value to public or private development by enhancing development design to integrate water resource elements, or by cooperation between development or public infrastructure activity and independent District capital work.

It should be emphasized that the District will not impose any mandate on private development to participate in this sort of partnership exploration. A property owner or developer that simply wishes to obtain its permit and proceed with its work may apply and have its project reviewed and approved in accordance with District Rules. Similarly, if an owner or developer begins a mutual exploration but later determines simply to proceed with its project, it always will retain the right and ability to do so.

3.5.4 EDUCATION AND COMMUNICATIONS

Program Purpose

The District's Education and Communications program supports the District's mission by:

» Promoting and supporting the policy objectives of Balanced Urban Ecology to integrate land-use and water planning

» Supporting District programs by building awareness and support for the District and cultivating partnerships

» Affecting change on the landscape by providing target audiences with the knowledge and skills needed to take action

The program also fulfills the District's obligations for public education and outreach under its Municipal Separate Stormsewer System (MS4) Permit. The program provides this support through a variety of program initiatives, including but not limited to:

» Developing a Balanced Urban Ecology education program for policy makers, business leaders, and the land-use planning community that promotes and develops knowledge about the added value created when development, public infrastructure, planning, and policy are coordinated early with the District.

» Engaging communities in the planning, design, and place-based programming of District capital projects.

» Maintaining a network of public agencies and non-profit partners that align with and support the District's mission and implementation priorities.

» Creating broad and targeted awareness of District initiatives and through newsletters, fact sheets, media, website, events, and other means.

» Managing a Citizen Advisory Committee to engage a broad and representative cross-section of watershed residents in the District's planning, policy development, and implementation.

» Providing target audiences with the skills they need to adopt clean water practices through trainings and workshops, including: Non-point Education for Municipal Officials (NEMO), Clean Water Summit, winter maintenance, turf maintenance, raingardens, and shoreline restoration.

» Providing engaged citizens with skills to implement clean water practices and to influence others on clean water issues through programs such as Master Water Stewards and the Watershed Association Initiative.

3.5.5 CAPITAL IMPROVEMENT PROJECTS

Program Purpose

The District's implementation plan includes a capital improvement plan (CIP). In accordance with Minnesota Rules 8410.0105, subpart 2, the CIP describes structural solutions to attain the District's Water Quality, Water Quantity, Ecological Integrity and Thriving Communities strategic goals.

The CIP table in Section 3.10 groups capital projects by subwatershed. The organizing principle of the Plan is to make these four strategic goals concrete on a subwatershed basis. This is done by analyzing the water resource issues, causes of those issues, stakeholder capacities, and opportunities within each subwatershed. Like the other elements of the District's implementation plan, the CIP is derived through this analysis. The identification of potential funding sources in the CIP table is not intended to be exclusive of other sources of funding that may become available or appropriate during the planning period.

Lake Minnetonka shoreline restoration

Cottageville Park, Erdahl Aerial Photos

Long Lake wetland restoration

The CIP reflects the Balanced Urban Ecology approach described in Section 3.2 of the Plan. Subwatershed assessment has identified certain capital projects that are specific as to project location and as to the land alteration, technique, or technology to be implemented. However, other projects have less specificity. The CIP defines them by a set of prioritized water quality, water quantity, and ecological integrity needs within an identified part of the subwatershed; a set of approaches suited to address those needs; and a programmed spending cap for such work over the planning period. The District will maintain a posture of ongoing monitoring of land use developments and landowner interests, communication with public and private interest holders and feasibility review. In that posture, the District will be prepared to recognize opportunities and initiate specific projects that address the defined subwatershed water resource issues cost-effectively and also support other public and private goals.

The CIP is a planning tool. It also is a means to inform partners, District residents and other interested parties as to the District's scope and priorities for its capital work over the planning period. A project's inclusion in the CIP does not mean that the project will be constructed, only that the District has identified it as an action that may be a cost-effective way for the District to achieve identified water resource goals. A project identified in the CIP always will need further review as to technical feasibility, cost and financing, consistency with local needs and other policy considerations before a formal decision to proceed to construction is made. The "Procedures" section below describes the development and evaluation steps that will occur before the District will commit resources to a project.

That section also describes how the District will review the CIP on an ongoing basis throughout the planning period. This review will allow the District to reassess described projects from a technical perspective, but also will involve broader policy considerations such as shifts in District priorities, decisions as to annual budget and levy levels, and the prospect of state and federal grant funds or financing. For this reason, projects may be added to and deleted from the CIP from year to year, in accordance with the procedures described below.

A capital improvement is "a physical improvement that has an extended useful life" (Minn. Rules 8410.0020, subpart 3). The District undertakes a variety of such improvements to achieve its water resource goals. The District's capital work includes both the construction or installation of structural improvements (e.g., lake outlet or water elevation management structures, water quality treatment devices, structural shoreline stabilization) and improvements in the form of permanent land alterations (e.g., stormwater basins, wetland restorations). The capital work that the District has identified for potential implementation over the planning period is listed in the CIP. Implementation of this work will follow the "Procedures" section below.

Certain District improvements with capital improvement aspects are not considered capital improvements, and for that reason are not in the CIP or subject to capital improvement procedures. For example:

» Some actions are larger scale improvements to the natural environment but are not considered a "physical improvement with an extended life." These may include, for example, vegetation restoration and management in wetlands or on upland, lake treatments for water quality, and rough fish management.

» Some District activities may include work of a capital nature, but as a subordinate element of a non-capital program. Examples here include smaller-scale water quality or shoreline stabilization work funded principally for education or demonstration purposes; boardwalks and educational signage for recreational sites; and temporary barrier installations for fish management.

» The District is programming, and intends to budget for, grant programs that fund work by partners to advance the District's water quality, water quantity and ecological integrity goals. Funded work may be capital in nature, but BWSR rules stipulate that these incentive programs may be administered separately from the CIP. A description of these programs is found at Section 3.5.5 of this Plan.

» Maintenance and capital replacement for existing District projects will be administered under the District's Project Maintenance and Land Management Program. A description of this program is found at Section 3.5.7 of this Plan.

Procedures

Before implementing a capital project or committing levied funds to its design or construction, the District will perform feasibility work to identify an effective design concept; develop confidence that the property agreements, permits and approvals to build and maintain it can be obtained; and establish a project cost estimate. Pursuant to Minnesota Statutes §103B.251, the District then will provide notice of a public hearing before the Board of Managers. The Board will consider the presentation of District staff and engineer, as well as input offered by partners and interested parties. On the basis of that information, the Board will decide whether the project should be established. In addition to statutory notice, the District will provide written notice to all properties within 600 feet of the project location.

In the course of feasibility work for a project, the District expects to maintain close coordination with the host LGU. LGU support for a project will be an important consideration in the District decision to advance a project and

Cottageville Park

the District expects that, in all but the unusual case, this support will be an element of the feasibility work. Nevertheless, in addition to the above statutory process, before the Board establishes a capital improvement project for which District-levied funds are estimated to exceed $300,000, the District will seek a resolution of support or equivalent project concurrence from the LGU(s) where the project is located.

In addition, before the Board approves final design of such a project, the District will hold at least one public information meeting at a location near the project site, with notice to properties within 600 feet of the project location as well as published notice in an appropriate local newspaper.

The District also will review its CIP each year, as a part of its budgeting process. The District will review the status of all capital projects and their priority for budget and levy purposes, and will allocate funds for the following year accordingly. On a two-year basis, the District will review its capital improvement program and its capital project priorities more comprehensively, on a District-wide and a subwatershed basis, to meet the requirements of Minnesota Rules 8410.0150, subpart 3.E.

As a part of annual budgeting, by late June each year, the District will transmit revised copies of it 10-year CIP to Hennepin and Carver Counties and all of the cities within the District for a 30-day review and comment opportunity. No later than late August each year, the District will mail Hennepin and Carver Counties copies of any comments from cities, and District responses. At the pleasure of either County, but by the first Friday in November, the District will meet with the County Board to discuss the District's CIP and annual budget and levy. Any comments received from the County Board will be considered by the District Board of Managers, and any resulting levy decrease or, if permitted, increase will be certified to the County Auditor before the date it certifies the County levy to the State.

Minnesota Rules 8410.0140 and Section 3.8 of this Plan describe the procedures to amend the Plan. An amendment will be required when the District elects to proceed beyond feasibility or conceptual design to advance a capital improvement that is not in the CIP. An amendment for this purpose may concern a single project, or may be programmatic. When the District undertakes a collaborative planning process for a subwatershed or other defined hydrologic area, as generally defined in Section 3.4 of this Plan, the outcome of that process normally will be an implementation plan for the planning area that includes capital projects. Here, the entire slate of potential capital projects would be incorporated into the CIP by a plan amendment.

Project Maintenance

When District staff presents a capital improvement to the Board for the purpose of a decision to establish the improvement under Minnesota Statutes §103B.251, the record before the Board will include a general description of maintenance requirements and a general estimate of maintenance costs. Maintenance of existing District capital improvements will be programmed and carried out under the District's Project Maintenance and Land Management Program and funding determined through annual budgeting. Pursuant to a project agreement, maintenance responsibility for a District capital improvement may be allocated to a partner such as a property owner or an LGU. As a general policy, the District will prefer to maintain its own projects, including both structural elements and vegetation. However, in any event it will seek a fair allocation of maintenance costs and in appropriate cases may agree to allocate the maintenance responsibility, or a part of it, to a partner.

3.5.6 LAND CONSERVATION

Program Purpose

The District operates a Land Conservation Program to conserve natural resource areas for the purpose of protecting and enhancing water resources and ecological integrity. Under the Land Conservation Program, the District may acquire land in fee title or may acquire an easement or lesser interest.

The District acquires land interests for several purposes. The land may be a desired site for a District capital project or other improvement identified in its implementation plan. In this circumstance, the acquisition typically would be considered an element of the project in question and would not be funded or carried out under the Land Conservation Program.

Differently, a tract of land may be a site suited for improvements not yet programmed, but may be available under favorable conditions. Preserving the land in its unimproved state, or actively restoring and managing its ecological condition, may serve water resource goals identified in the subwatershed plan. A primary purpose of the Land Conservation Program is to conserve, restore and enhance green infrastructure for regional stormwater management, regional management of sediment and phosphorus flows resulting from land alteration, corridor protection, habitat, and other water resources benefits.

Background

In the District's 2007 watershed management plan, targets for land rights acquisition were mapped by identifying strategic locations at a landscape scale. Qualifying lands were those with resources protecting surface water and groundwater quality and quantity; those demonstrating high-value habitat characteristics; those protecting aquatic habitat; or those offering habitat supporting aquatic-based species abundance. More specifically, the District sought to:

Staff seeding wild rice

- Create corridors along streams and channels to provide buffers for water quality and stream stability and create wildlife corridors.
- Include wetlands previously identified with exceptional or high vegetative diversity or wildlife habitat, or moderate-to-high restoration potential.
- Include high-value upland areas, such as forested areas with connected habitat and high potential infiltration or evapotranspiration.
- Incorporate land cover types identified in the Minnesota Land Cover Classification System (MLCCS) survey conducted by Hennepin County as minimally disturbed with potential high-value habitat.
- Contain areas with multiple natural resource values, such as Minnesota County Biological Survey (MCBS) sites of biodiversity significance; Metro regionally significant ecological areas; or areas where the DNR had documented rare or threatened species.
- Incorporate green and natural resource corridors as designated by the DNR, Metropolitan Council, Hennepin County and local communities.

Section 2.3 includes a map for each subwatershed (titled Recreation and Other Features) showing lands where the District owns fee title or a conservation easement as a result of implementing the Land Conservation Program over the prior planning period. As the result of applying the above criteria, the District has acquired rights in ecologically connected tracts that together afford the District a land platform for regionally significant work in locations such as the Painter Creek and Six Mile Creek subwatersheds. However, acquisition strategy was not explicitly driven by aggregating holdings for such purposes or by the intent to serve specifically prioritized subwatershed goals.

Program Description

The Plan is oriented on achieving District strategic water quality, water quantity and ecological integrity goals. Each subwatershed plan will particularize these goals at a subwatershed level and identify implementation actions to achieve them. Land Conservation Program activity will be driven more specifically to achieve these subwatershed goals and to facilitate these implementation actions. The District will seek to implement the Program through the partnership framework of the Plan, so that District land and easement acquisitions and other Program activity defining land use and protection will align with land use priorities of local units of government, park agencies and other local partners.

In addition to its own acquisition of lands and land rights, under the Land Conservation Program the District may direct funds and staff resources toward

Six Mile Marsh prairie restoration

Prairie seed collection

Katrina Marsh, Erdahl Aerial Photos

the following, when they serve District strategic goals:

- » Assisting landowners and local units of government to explore conservation options.
- » Encouraging natural-resource oriented land management and ecological restoration.
- » Facilitating conservation development by participating in local land use planning and ordinance development, assisting technical evaluation and serving as a conservation easement holder.
- » Supporting cost-share, partnership, and tax incentive opportunities for landowners and other partners.

This Plan specifically supports District land rights acquisition through a watershed-wide implementation program. This program specifies a 10-year budget for the Land Conservation Program, further broken down into Program activities ranging from land rights acquisitions and management of District landholdings, to technical assistance. Acquisitions under the implementation program budget will link to land rights acquisition needs, as well as land management, technical assistance and similar support activities, identified through subwatershed planning. As Table 3.17 indicates, the District estimates expending $25 million over the 10-year planning period for land rights acquisitions, with a portion of that amount to support related program elements listed above. This budget amount is net of funds received into the program by grants, property reconveyance and any other external source. The acquisition expenditure of $25 million, or an average of $2.5 million/year, encompasses both direct spending and debt service for financed acquisitions. The District will rely principally on its ad valorem levy to meet this spending level, though also will consider other sources as may be available.

The implementation program description does not identify specific acquisitions. Instead, it references land-based implementation actions that will achieve subwatershed goals. Land rights availability is highly opportunity-based and, further, identifying specific properties in a plan format would put public funds at a disadvantage in negotiating with landowners. In addition, the timing of land rights purchases typically is driven by external (landowner) requirements that would not easily accommodate additional procedures to formally incorporate specific acquisitions into the Plan. The above implementation program description, with its linkage to identified subwatershed goals, and in conjunction with the procedures stated here, is intended to meet Plan requirements for capital expenditures.

In addition, individual land acquisition opportunities not specifically rooted in subwatershed implementation programs may arise. The District may have an opportunity to acquire a fee or easement interest for a favorable price. It may be property owned by the state for nonpayment of taxes and available to local units of government, or private land placed on the market on favorable terms, or offered to the District at a below-market price for tax benefits or other reasons. It may be undevelopable land that has a low market value but value for water resource purposes.

The Land Conservation Program allows the District to acquire such lands or easements. Before committing funds to acquire a fee or easement interest under this circumstance, the Board of Managers will consider and make findings as to the following:

» The potential suitability of the property for a capital project or other project identified in the Plan.

» The potential for the land rights to facilitate the District's pursuit of its strategic water quality, water quantity and ecological integrity goals with respect to the specific subwatershed.

» The market value of the rights to be acquired, by means of appraisal or other valuation as the Board of Managers determines appropriate for the transaction.

» The extent to which the water resource purposes of the acquisition may be achieved without the District's spending public funds, due to physical, regulatory or similar constraints on use of the property.

» Ongoing property management costs.

» The District's ability to dispose of its property interests if the potential use on which the decision to acquire is based fails to materialize.

Acquisition Procedures

For any land rights acquisition under the Land Conservation Program, the District will follow these procedures:

1. The District will solicit review by a technical advisory team that includes staff from several natural resource agencies. The advisory team's recommendations will be a part of the record forwarded to the Board of Managers as it decides on a potential acquisition.

2. The District will consult with the local unit of government in which the land is located regarding alignment of the District's proposed acquisition with local land use, park and related plans. The precise means of consultation will vary depending on circumstances such as the extent of ongoing coordination, timing urgency, the sensitivity of negotiations, the scale of the acquisition, and what District staff deter-

Grays Bay dam, Dale Antonson

Low impact development practices in St. Louis Park

Underground stormwater treatment in Minneapolis mines to be warranted in order to understand the LGU's position with confidence. The result of the consultation also will be forwarded to the Board of Managers.

3. The acquisition will be valued by appraisal or other means pursuant to a written appraisal policy adopted by the Board of Managers.

4. The District's legal counsel will be retained to advise as to the structure and terms of, and prepare the necessary documents for, the transaction.

5. In accordance with Minnesota Statutes §103B.251 governing capital expenditures, the Board of Managers will notice and hold a public hearing to receive public comment on the proposed acquisition.

6. The Board of Managers will approve any acquisition in open meeting.

These steps may be updated from time to time by the Board of Managers without a formal amendment to this plan, provided that they continue to advance a detailed and thorough case-by-case review of each potential transaction, have an appropriate level of legal review, and continue to require approval of all transactions by the Board of Managers.

Land Management and Restoration

When an acquisition occurs, the District will prepare a management plan for the property that will present a recommended management status and, as relevant, evaluate restoration opportunities and costs in more detail. Site management and restoration activities on District land or pursuant to a District easement may be funded under the Land Conservation Program or under another identified land restoration program. The types of activities that the District may include in parcel restoration work include activities such as the following:

1. Regrading for natural system restoration.

2. Excavating to enlarge wetland or improve wetland functions and values.

3. Re-meandering of a small section of creek, ditch or other watercourse.

4. Removing drainage tiles, placing ditch plugs and other steps to restore natural hydrology.

5. Installing erosion control and stabilizing banks with engineered and bioengineered features.

6. Installing local stormwater conveyance/control structures such as culverts and weirs.

7. Installing stormwater treatment best management practices.

8. Planting native vegetation.

9. Managing existing vegetation and invasive species via cutting, herbicides, prescribed burning and other techniques.

When the proposed work constitutes a capital improvement, it will be considered and authorized pursuant to the formal process specified at Minnesota Statutes §103B.251. If the proposed work is a capital improvement beyond the scope of restoring the natural features and function of the acquired property, it will not fall within the Land Conservation Program and must be established independently through applicable plan amendment and ordering procedures.

Partners

There are a number of other units of government with which the District may collaborate under this Program. Table 3.1 lists some of the agencies active in the District and roles in the Land Conservation Program these agencies may assume:

Table 3.1 MCWD Land Conservation Program potential partners

Organization/Agency	Role
MCWD	Acquisition of conservation easements and fee title; restoration of conserved lands; cost-share on private land restoration
Cities	Varies by city. Some have active land and easement acquisition programs. Others use park dedication through the development process to help secure greenway areas. Also see LGU requirements below.
Minneapolis Park and Recreation Board	Park and trail acquisition and management
Hennepin County Dept. of Environmental Services	Acquisition of donated conservation easements; cost-share and technical assistance for restoration and best management practices
Hennepin County Regional Rail Authority	Trail acquisition and maintenance
Carver County Parks	Park and trail acquisition and management
Three Rivers Park District	Park and trail acquisition and management
Metropolitan Council	Partial funding for regional parks and trails
State of Minnesota	DNR owns and manages Wolsfeld Woods and Woodrill Scientific and Natural Areas. DNR provides grants to cities for acquisition. Funding for state and regional parks and trails.

Organization/Agency	Role
US Department of Agriculture/Natural Resources Conservation Service and Farm Services Agency	Cost-share and technical assistance for restoration and best management practices
US Fish and Wildlife Service	Cost-share and technical assistance for restoration
The Trust for Public Land	Assists government agencies and non-profit organizations with acquisitions, financing for acquisitions, and prioritizing lands to conserve in urban and developing areas.
MN Land Trust	Acquires and monitors conservation easements, primarily through donation or as part of conservation development projects. Works with individual landowners and developers.
The Nature Conservancy	Owns and manages two nature reserves in the District – Hardscrabble Woods (Minnetrista), Ferndale Marsh (Wayzata)
Embrace Open Space	Education, technical assistance, and communications on open space issues for local communities.
Wildlife Organizations (e.g. MN Waterfowl Association)	Cost-share and technical assistance for restoration

3.5.7 PROJECT MAINTENANCE AND LAND MANAGEMENT (PMLM)

Program Purpose

Actions detailed in the subwatershed plans will require ongoing maintenance and management activities. The PMLM program's role is to maintain the District's capital investments, manage District lands, operate functional District infrastructure, and coordinate the District's response for flood events. The PMLM program has compiled an Operations and Maintenance (O&M) Manual which outlines the inspection, operation, and maintenance requirements and responsibilities for each of the District's past capital improvement projects. The O&M Manual will be updated regularly to include new capital improvement projects as they are implemented.

The PMLM program has also assembled an Infrastructure Maintenance Plan, which identifies annual repairs and their associated costs needed to repair and replace District infrastructure as it ages. Implementation of the District's Infrastructure Maintenance Plan will pro-actively address issues with aging infrastructure and limit liability associated with infrastructure failure. The Capital Improvement Program includes a cost estimate for the ongoing project maintenance and land management activities.

The District is the drainage authority for County Ditches 10, 14, 15, 17, 27, 29, and 32 and Judicial Ditch 2, as described in Section 2.2.4 and shown on Figure 2.5. The PMLM program includes inspecting and maintaining public drainage systems within the District as required under the drainage code, Minnesota Statute Chapter 103E. County Ditches 14, 17, and 29, within urban areas of the District, have been replaced by storm sewers or a combination of storm sewers and open channel. County Ditches 15 and 32 continue to serve drainage purposes, but principally as municipal stormwater conveyance. The drainage code allows for a drainage system to be abandoned, in whole or part, if it no longer provides a drainage benefit to assessed lands. It also provides for a system to be transferred to a municipality or other body when the system is better managed as stormwater conveyance infrastructure rather than under the drainage code. The District, in cooperation with the relevant local government units, may consider whether one or more of its urban systems is appropriately subject to a shift in management pursuant to these drainage code provisions. County Ditches 10 and 27, and Judicial Ditch 2, are altered natural watercourses that continue to provide valuable drainage conveyance for agricultural and other purposes. The District intends to continue to manage these systems under the drainage code.

3.5.8 INCENTIVE PROGRAMS

Program Purpose

To facilitate actions to improve stormwater management, enhance water resources, and implement green infrastructure, the District will administer cost-share grant programs to provide financial assistance to landowners, the development community, and public agencies. Two specific programs, Opportunity Grants and Stewardship Grants, are described below.

Opportunity Grants:

The Opportunity Grant will provide financial incentives for value added collaboration with public agencies, private developers and land owners.

The District will provide financial incentive for actions that advance its strategic goals, address drivers of watershed impacts in a subwatershed plan, and align with the management strategies identified and prioritized within the plan. The District anticipates grant opportunities arising via three routes:

- Public agency coordination
- MCWD permitting program
- Landowner and developer requests

Based on the coordination framework that the District will establish with engaged local government units through this Plan and the local water plans,

Residential raingarden

the District intends to formulate a periodically updated Project Priority List. Grant opportunities will be evaluated for proof of concept, cost, and benefit, and measured against subwatershed priority issues, drivers, and management strategies.

The District will use this Project Priority List to formulate a planned approach to potential financial incentive opportunities, allowing the District's Opportunity Grant to become increasingly synchronized with two- to three-year public agency infrastructure investment plans and planned development.

In addition to its effort to become integrated earlier in public infrastructure and development planning, the District also will remain responsive to opportunities for green infrastructure improvements identified through the District's Permitting Program or brought forward by individual landowners. District funding and applicant cost-share would apply not to defray applicant compliance costs, but to secure benefits beyond or independent of compliance. In this setting, the District would evaluate an opportunity only with landowner or developer interest and with a clear understanding as to any effect on the timing of the permit review process. A landowner or developer who seeks a required District permit and does not wish to explore District funding for added value will be entitled to standard permit review procedures and timing.

These opportunities similarly will be evaluated for proof of concept, cost, and benefit, and measured against subwatershed priority issues, drivers and management strategies and, on that basis, added to the existing Project Priority List.

Stewardship Grants:

The Stewardship Grant will incentivize the installation of best management practices by public agencies, private organizations, non-profit groups, and neighborhoods who will promote those practices to others through robust education and outreach plans.

The District will provide financial incentives for projects that have meaningful, measurable natural resource benefits, and that serve as effective, valuable education tools in their communities. The District believes that by seeing tangible, effective improvements on the landscape and learning about their importance from their neighbors and other community leaders, people are more likely to make similar improvements on their property. This enhances not only the impact of the District's education activities, but also, the water quality benefit of the District's work.

The District anticipates identifying opportunities for grant funding through the following routes:

Kayakers on Minnehaha Creek

- WAI and Master Water Stewards Program
- Proactive recruitment in focal geographies and near MCWD project sites
- Soliciting proposals for projects that align with District mission and priorities
- MCWD's Planning and Permitting Programs

Program Administration:

Annual funding for the District grant program will be set through the budget process. The District will administer the program by means of program guidance documents adopted by the Board of Managers. Guidance will describe how the District will generate and maintain Project Priority Lists and will specify procedures by which the District will solicit, accept, and review cost-share proposals. The guidance also will refine terms of grant programs including who may apply, project funding limits, cost-share obligations, and how the above funding criteria will be refined and applied to evaluate proposals.

Minnesota Rules 8410.0105 establishes cost-share and grant programs as a separate category of implementation action. Although District-supported projects necessarily will not proceed through the District's own capital improvement program, they may include elements of capital construction. At the same time, a project may be principally for experimental, demonstration, or education purposes.

These purposes may include supporting research to advance water resource protection knowledge, demonstrating innovative methods, developing local capacity for water resource protection, or fostering community service and public education. As appropriate, demonstration and education benefits will be secured through program requirements for educational signage and reasonable access for public viewing.

Because an action supported by District cost-sharing may involve a substantial District funding contribution and a significant alteration of the environment of a capital or non-capital nature, it is important that the District afford some measure of public process. Largely this will be achieved through the very nature of the District's collaborative approach from which the Project Priority List will develop, but as described above, opportunities may arise independently of that process.

The formal structure by which the District will manage its cost-share expenditures is as follows:

First, the overall program funding level will be set annually through the District's budgeting process. This is an open process that occurs in August and early September each year, and includes a public hearing required by statute at which all parties can review and address the Board of Managers on the District's proposed program budget.

Second, grant funding proposals will be processed and evaluated according to adopted written guidance as described above, to: (a) provide for consistency in District review and selection of proposals for funding; and (b) direct District funds to projects and locations that will further Plan goals and priorities effectively. The District will enter into formal grant agreements with awardees to guarantee project completion and maintenance.

Third, the Citizens' Advisory Committee will have a formalized role in reviewing both program guidance and submitted proposals. The Board and, where delegated grant approval authority, the Administrator carefully will consider the committee's recommendations.

The District invites a partnership framework that fosters increased and early flow of information, to provide for a stronger coordination of land use and water resource management, and to achieve water quality and flood management goals.

Bikers enjoy one of the many trail systems woven throughout the watershed

Wildflowers

Canoe on lake, Garrett Graves

Lake Hiawatha into Minnehaha Creek, Brianna Prahl

3.6 REVIEW OF LOCAL WATER PLANS AND MUNICIPAL COORDINATION

3.6.1 STATUTORY REQUIREMENTS FOR LOCAL WATER PLANS

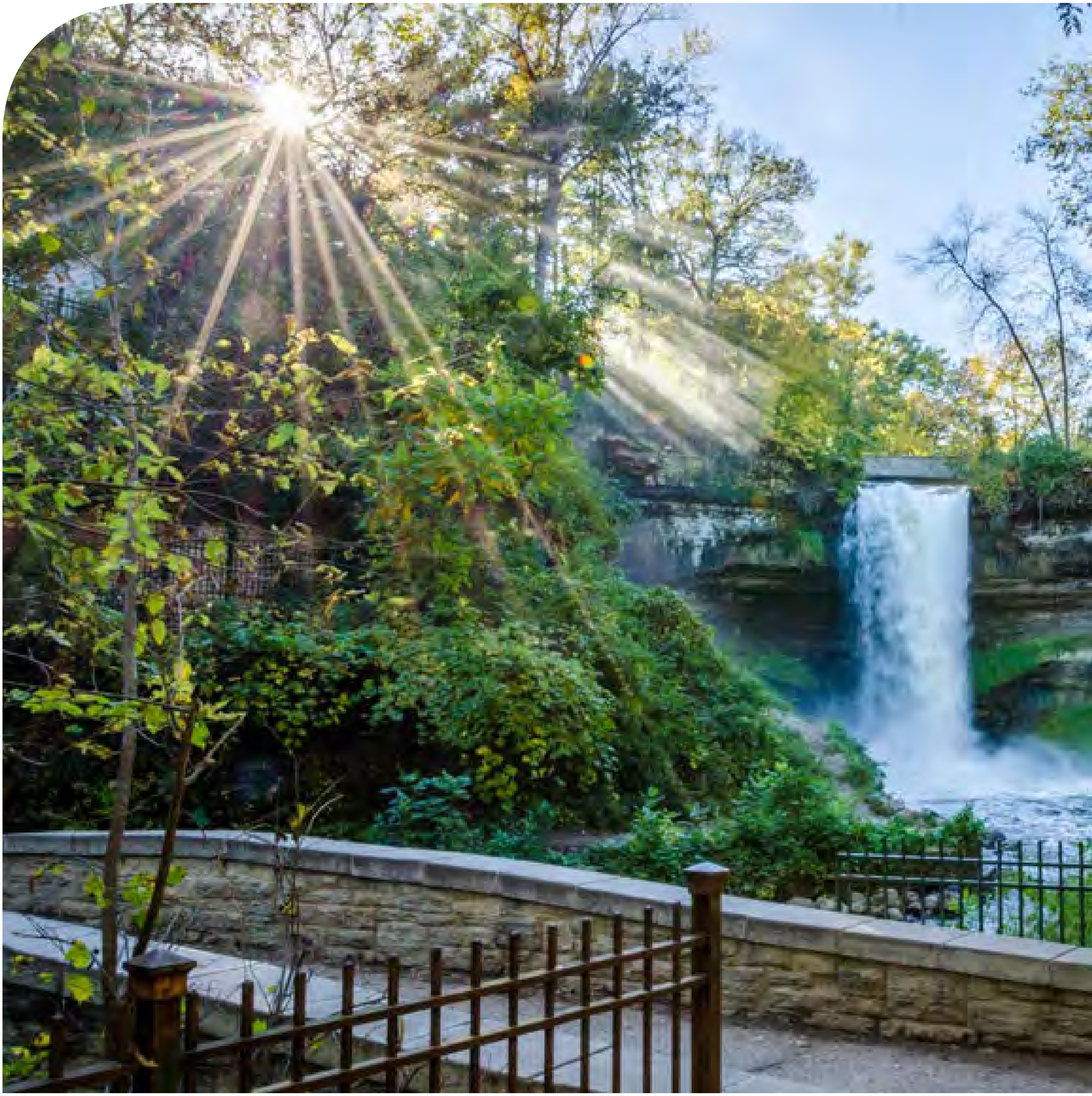
Minnesota Statutes §103B.235 prescribes that after the District watershed management plan (WMP) is approved or amended, each local government unit (LGU) having land use planning and regulatory responsibility for territory within the District must prepare a local water management plan, capital improvement program, and official controls as necessary so that local water management conforms with the WMP within the time period prescribed in the WMP implementation program. The local water plan, in turn, is a required element of the LGU comprehensive land use management plan that it must prepare and maintain in accordance with Minnesota Statutes §§473.858-473.864.

This planning framework shows the link that the legislature has recognized between land use and water resource planning. More precisely, it reflects the legislature's intent that regional development patterns and infrastructure, as well as site-level development, both the province of the LGU as the local land use authority, be well integrated with the hydrologic systems within which they are set. As the regional water resource authority, the District is responsible to understand hydrologic systems on a watershed basis and what is needed for their health and sustainability. Through its review of local water plans, the District seeks to engage its LGUs as partners in incorporating this basis of knowledge and understanding into the exercise of land use planning, regulatory, capital, infrastructure maintenance, and related local authorities.

Local water management plans must conform to Minnesota Statutes §103B.235, Minnesota Rules 8410.0160 and this Plan. The District approach to local plan requirements reflects a change from the approach under the District's 2007 WMP, as described below. The specific requirements for local water management plans under this Plan are detailed in Appendix A.

3.6.2 DISTRICT APPROACH TO LOCAL WATER PLANNING

The District's 2007 WMP was organized around the District's eleven subwatersheds and phosphorus load reduction goals for the principal receiving waters within each subwatershed. Necessary load reductions then were allocated among local government units. Local plans were required to commit to reductions identified in the 2007 WMP by identifying and programming capital projects and other implementation actions that would produce the required reductions. This approach was similar in form to the



Minnehaha Falls, Tom Dixon

federal Total Maximum Daily Load (TMDL) process. In part, it defined needed phosphorus load reductions for non-impaired waters within the District and other waters for which federal TMDLs have not been adopted.

This framework has produced some very useful collaborative efforts, but more so had the tendency to send District projects off on a separate trail from local projects and to consider land use regulation as a role carried out in a reactive fashion and separate from District- or LGU-initiated project work. The District's identification of the LGU share of pollutant load reduction appeared more as a mandate and less as something that the District could facilitate through coordination.

This Plan departs from the prior centering on phosphorus load reductions, and the prior mandate imposed on LGUs to specify and implement actions to achieve those reductions. There are two chief reasons for this:

» The past 10-year planning period has witnessed a continuing evolution in LGU capacity, the relationship of the District and LGUs, and the District's approach to partnership. LGUs within the watershed have water resource capacity and knowledge needed to recognize water resource needs and incorporate them into development controls, capital programs and planning. LGUs have been operating under federal municipal stormwater (MS4) permits and, in some cases, federal antidegradation (formerly "non-degradation") requirements, for nearly 15 years and have institutionalized baseline stormwater management programs to meet MS4 permit requirements. Under the District's partnership approach, the District is not seeking to mandate LGU actions toward goals identified in the Plan, but instead to invite those LGUs that see alignment between their goals and District goals to use their local water plan to, in effect, present their vision for collaboration.

» This Plan reflects the District's movement from a water quality criterion based predominantly on phosphorus concentration to a broader approach to ecosystem evaluation. This broader approach is reflected in the District's Ecosystem Evaluation Program ("E-Grade"), a method that evaluates subwatershed health from the standpoint of flood control, biodiversity, habitat diversity, recreation, drinking water supply and nutrient cycling.

» The E-grade recognizes a broader concept of hydrologic function and beneficial public use. This increases both the need to work, and the benefit from working, in concert with LGUs and other local partners so that outcomes of potential resource investments can be assessed from all relevant standpoints and investments are leveraged to achieve multiple public and private goals.

3.6.3 THE ROLE OF THE LOCAL WATER PLAN IN ACHIEVING REGIONAL LAND AND WATER GOALS

An important component of the local water plan is defining a set of protocols that supports ongoing communication and promotes value-added collaboration between the District and LGU. Through these communications, the District and LGU will coordinate programs and be best situated to anticipate and identify opportunities for collaboration.

The District invites a partnership framework that fosters increased and early flow of information, to provide for a stronger coordination of land use and water resource management, and to achieve water quality and flood management goals. Targeted areas of collaboration include:

» Land use policy development and its implementation through planning activities including long-range land use and infrastructure plans and area-wide plans

» Capital improvement feasibility planning for public infrastructure including roads, sewer, and drinking water supply

» Land use and development regulation, from initial development feasibility through ongoing inspection and facility maintenance functions

» LGU operations and facility maintenance

The District asks that the LGU plan complete the assessment of water resource needs by identifying local water resource issues and provide finer-grained data concerning those issues. Then, it will look to the LGU to describe how it intends to align planning, regulatory and investment decisions to address both District- and LGU-identified water resource goals. The framework for communication and collaboration will be the key to creating opportunities for partnership at the intersection of municipal, private and District interests.

As it implements the WMP over the ten-year planning period, the District will be engaged in a continuing process of reviewing priorities and programming the commitment of technical resources and funds. The District is inviting each LGU to use its local plan to communicate its interest in the collaborative relationship described in this section and to help erect the framework that the District and LGU will use over the planning period to promote opportunities to achieve mutual goals. The LGU is invited to use its local water plan to articulate its water resource goals; how it will pursue these in conjunction with its development, transportation, parks and recreation and other public goals; and how it proposes to integrate its vision, investments, expenditures and regulatory programs with those of the District. The District is prepared to program staff capacity to track planning, development, public infrastructure

The watershed features numerous canoeing and boating opportunities

A young fisherman casts his line on Lake Minnewashta

The Minneapolis skyline overlooks Lake of the Isles, Noah Kleinschmidt

Red Osier Dogwood

The most substantial policy shift from the previous WMP to this one is the District's effort to more closely integrate land use planning and water resource management.

and program activity within interested LGUs, so as to position the District to work with public and private interests within those LGUs in pursuit of the shared and compatible goals of each.

In addition to capital projects and other work undertaken collaboratively, the District will continue to implement projects and programs independently as well. As the District programs resources for this work, local water plans, and LGU implementation of those plans, will be relevant in that District efforts will tend to leverage greatest benefit within a local setting where the LGU is working toward complementary goals and the stakeholder environment otherwise is supportive. The following are examples where decisions as to District spending and use of resources are likely to depend in part on local water plan focus and LGU commitment as shown in the local plan and the LGU's implementation of it:

- » Joint grant applications: Coordination to seek funding for work that serves aligned interests of the District and LGU
- » District incentive programs: Grant or cost-share funds awarded at the discretion of the Board of Managers to an LGU, or to institutional or individual property owners within an LGU
- » Technical assistance: Services of the District staff or engineer to assist LGUs and their residents in resolving water resource issues or pursuing opportunities in areas such as flood management, wetland banking and others

» Education initiatives and coordination of education activities for MS4 compliance and other purposes

» Conservation third party: Helping LGU and its property owners achieve mutual conservation goals by serving as easement holder for conservation development, assuming wetland bank maintenance obligations, and similar roles

» Watershed management district: Using watershed district authority to establish localized taxing district to allow lake associations or other groups with common, geographically defined interests to raise funds in order to pursue community goals

3.6.4 DISTRICT REVIEW AND APPROVAL OF LOCAL WATER PLANS

Review and Implementation Procedure

Minnesota Statutes §103B.235 states that each LGU must adopt a local water plan not more than two years before its local comprehensive land use plan is due. Before an LGU adopts its local water plan, it must submit its plan to the District for review and approval. Approval rests on the District's finding that the local plan is consistent with the WMP.

The District must complete its review within 60 days of receipt. If it finds that the local water plan is not yet complete or not consistent with the WMP, it will advise the LGU and will provide guidance as will be helpful to the LGU in preparing a final plan for District approval. Within this review period, the District may receive comments from the Metropolitan Council addressing the question of consistency with the Council's comprehensive development guide for the metropolitan area. The District must take these comments into account in its review.

After District approval, the LGU must adopt and implement its plan within 120 days, must notify the District and Metropolitan Council within 30 days thereafter, and must complete any required amendments to its official controls within 180 days.

Water Resource Official Controls

The LGU, under its police powers, and the District, under Minnesota Statutes §103D.341, each have the authority to adopt and apply rules and permitting requirements for activities that may create impacts on water resources. These are parallel authorities and, ordinarily, a landowner or other responsible party must obtain permits from both the LGU and the District, and therefore meet both sets of regulatory requirements.

A Monarch butterfly on a Blazing Star

An LGU may elect to simplify this duplication by requesting that the District cease to apply its rules within the LGU's boundaries on District approval of the LGU local water plan. Specifically, Minnesota Statutes §103B.211, subdivision 1(a)(3), authorizes the District to regulate the use and development of land within its boundaries when one or more of the following conditions exist:

» The LGU does not have a District-approved local water plan, or has not adopted the implementation program described in the plan;

» An application to the LGU for a permit for the use and development of land requires an amendment to or variance from the adopted local water plan or its implementation program; or

» The LGU has authorized the organization to require permits for the use and development of land.

Pursuant to the third condition, an LGU may specify in its local plan that it does not wish the District to cease exercising regulatory authority within its boundaries. However, if it does wish the District to cease exercising such authority, it must meet the standards set forth in this section. These standards are intended to assure the District that LGU official controls are at least as protective of water resources as the District rules, that the LGU has made a conscious decision to allocate sufficient resources to the regulatory program, that it has procedures in place to provide for proper monitoring and compliance oversight after permit issuance, and that the District can remain informed as to the operation of the LGU regulatory program.

An LGU may elect to exercise sole regulatory authority in the following specific areas of District regulation: erosion control, floodplain alteration, wetland protection, waterbody crossings and structures, and stormwater management rules. The District in all cases will continue to apply its dredging and shoreline and streambank stabilization rules within the LGU, as they concern inter-jurisdictional resources that LGUs have limited authority to regulate. Also, it will continue to apply its appropriations and illicit discharge rules, as it is under an independent statutory mandate to implement these rules. The LGU may choose to assume sole authority for all five listed rules, or fewer. The local plan must identify those District rules for which it wishes to assume sole regulatory authority.

The following are the standards the District will apply when an LGU has requested that the District cease exercising authority with respect to one or more of its rules:

» For the relevant District rule, the local plan must include existing or proposed ordinances for a District determination that they are at least as protective of water resources as the associated District rules. District staff may provide checklists of substantive requirements and other guidance to LGUs for their use in understanding the standards that must be met. A proposed ordinance need not be submitted in final form, provided there is adequate detail for a District determination. If the ordinance has not yet been adopted, the District plan approval resolution may be contingent on confirming that the adopted ordinance conforms to the proposed ordinance as approved.

» Procedural details of local ordinances (relating to, for example, permit processing, hearings or public notice) may differ from District rules provided they do not compromise water resource protection.

» The LGU must describe the technical expertise it has or will acquire to implement its ordinances, and provide an estimate of its annual cost to implement its program.

» The local plan must establish written protocols for: (i) LGU procedures to administer and enforce its water resource ordinances, including maintenance of those stormwater practices constructed or installed for compliance with LGU ordinances and that the LGU owns or has assumed the obligation to maintain; and (ii) procedures for District review of LGU regulatory program implementation. Administration and enforcement procedures must address work without a permit; active work under permit; maintenance of vegetated buffers; and maintenance of stormwater management practices.

» The following will apply to LGU administration of its rules:

  - With respect to proposed activities of state agencies or any other entity over whom the LGU does not have regulatory jurisdiction, the LGU authorizes the District to exercise jurisdiction.
  - The LGU need not formally issue itself a permit for its own activities, but for each activity that would be subject to permitting if performed by another party, the LGU will prepare a memorandum documenting its review and determination that its ordinance standards are met. These memoranda will be available to the District in any review of LGU permitting activity.
  - If a permit application requires an amendment to or variance from an LGU ordinance approved by the District under this section, the District will have permitting jurisdiction.
  - The District will retain permitting jurisdiction as required by a legal obligation under its NPDES MS4 permit or any other independent law.

Dutch Lake

- As a general matter or on a case-by-case basis, the LGU may request that the District exercise its regulatory jurisdiction, and the District may accede to that request.

» If the District revises a rule in a manner that it considers significant, and thereafter advises the LGU in writing, the LGU will revise its own ordinance to maintain equivalent water resource protection. If the District has not approved the LGU's revision within six months or such other time as mutually agreed, the District may reassert regulatory jurisdiction with respect to the affected rule. If an LGU chooses not to make the revision, it may authorize the District to reassert its regulatory authority for that rule within LGU boundaries.

» The District may reassert regulatory jurisdiction if the District Board of Managers finds that the LGU is not implementing its local water plan or the regulatory program. Before the Board reasserts jurisdiction, the District will engage the LGU to review concerns and work with the LGU to mutually address those concerns.

» The District's withdrawal of regulatory authority will expire two years after it adopts the ten-year WMP that succeeds this one, or at another time by agreement of the District and LGU.

Minnesota Wetland Conservation Act

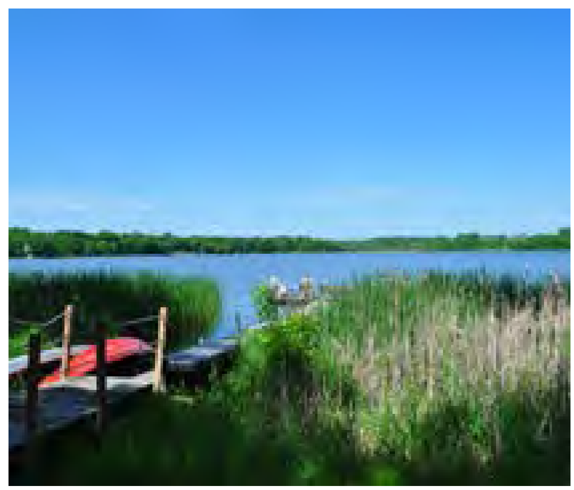
The local plan must state whether the LGU intends to assume the role of "local government unit" responsible to implement the Minnesota Wetlands Conservation Act (WCA) within that part of the LGU that lies within the watershed or, conversely, whether it chooses for the District to assume that role. If the former, it must describe the technical expertise it has or will acquire to implement WCA, describe how it will monitor and enforce WCA compliance, and present an estimate of its annual cost to implement and enforce WCA. If the LGU elects to assume the role of WCA LGU, the District asks that it include in its local plan a commitment to reasonable coordination and consultation between the LGU member of the Technical Evaluation Panel and District regulatory staff.

3.7 EVALUATION AND REPORTING

3.7.1 GOAL-SETTING FRAMEWORK

Section 3.3 describes the District's four strategic goals of Water Quality, Water Quantity, Ecological Integrity, and Thriving Communities. As noted in previous sections, the strategic goal of Thriving Communities serves to guide the District in implementing its natural resource mission in ways that meaningfully contribute to the development of thriving communities. Progress toward this strategic goal is not subject to measurement through the water resource

Fisherman on Lake Harriet, Stan Waldhauser



Langdon Lake

A stream in the Schutz Lake subwatershed metrics of Minnesota Rules 8410, but will be tracked by means developed in conjunction with the District's individual communities. Progress toward the remaining three strategic goals will be assessed as discussed in this section.

Each of the District's strategic goals encompasses a range of goals specific to concerns at a subwatershed or other more local level. In addition, to evaluate the performance of individual capital projects or other initiatives, in order to address project function, refine subwatershed implementation plans or provide for meaningful technology transfer, requires performance monitoring that is project and location specific. To assess progress toward the strategic goals, then, the District must develop and track more specific, quantifiable goals and metrics.

In addition, the District's implementation approach, based on collaborative planning with its stakeholders and largely opportunity-driven, means that it is not practical to prescribe specific local goals at the beginning of the ten-year planning cycle.

For these reasons, the District intends to set goals, establish performance monitoring plans and evaluate performance through a sequential process that begins with strategic goals and long-range targets and leads to subwatershed and then project-specific targets, performance measurement and evaluation.

Table 3.2 describes the District's strategic goals and the long-range targets associated with each. For the goal areas of water quality and ecological integrity, the measurable target is to achieve state standards for the impaired waters in the District. These impairments and the associated Total Maximum Daily Load (TMDL) studies are discussed further in Section 3.7.3. The measurable target for the water quantity is to, at a minimum, prevent an increase in peak stormwater flow or stormwater flow volume at critical locations. In addition, the District has identified a target of preserving existing wetland acreage as a means to serve all three of these strategic goals. Apart from the District's own wetland restoration work, it tracks gain and loss of wetland acreage through its implementation of WCA and its own wetland rule.

As discussed in Section 3.4, over the planning period the District will pursue a priority subwatershed approach, in which the District will implement coordinated projects and initiatives within a defined subwatershed identified through a planning process that integrates local interests. The result of this planning process will be an implementation program that addresses subwatershed-specific issues and priorities articulated in the Plan. The implementation program will include implementation goals and targets, and a plan of monitoring or other performance measurement that will allow performance toward these goals and targets to be assessed. When an individual project or initiative is pursued independent of the priority subwatershed process, a component of the design will include a statement of project targets and a performance assessment plan specifically oriented toward the project goals and targets.

The Plan, at Section 3.9, also includes certain already-defined capital projects that are intended to reduce phosphorus loading. For these, each project description includes an estimated load reduction. These estimates will be refined through project feasibility and design.

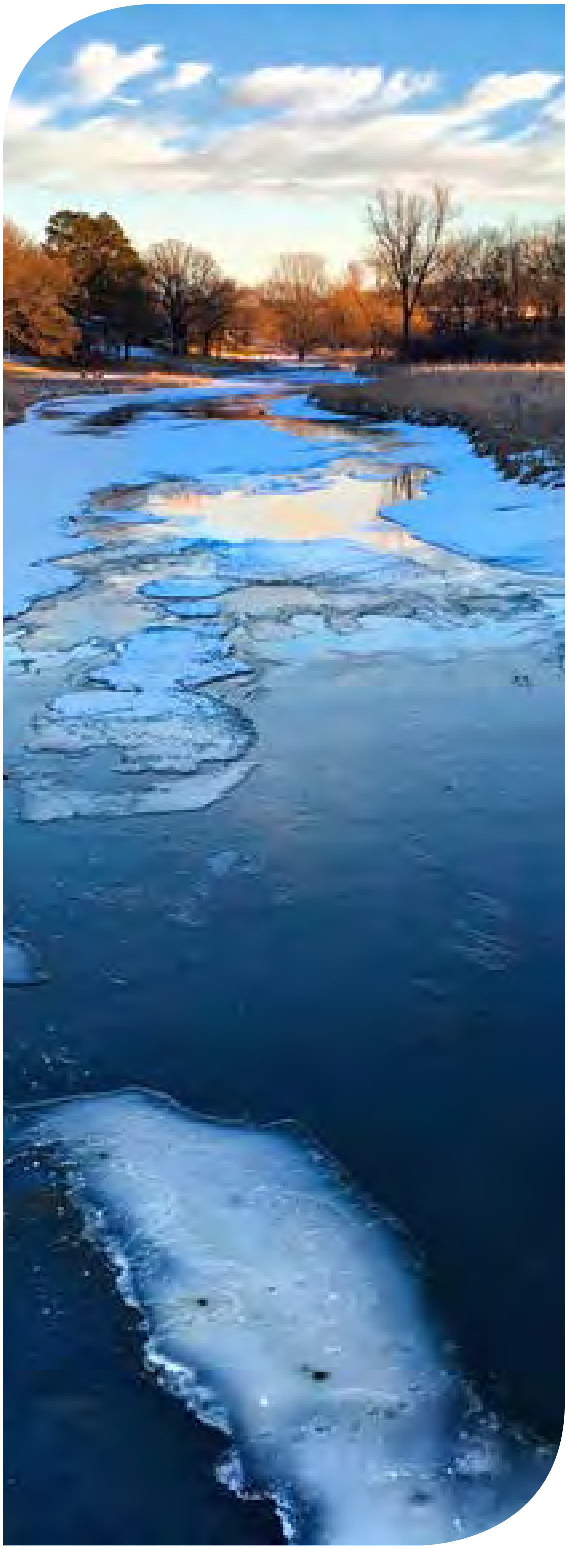
Table 3.2 District goals and targets

Strategic Goal	Description	Long-Range Targets
Water Quality	Conserve, maintain, and improve the aesthetic, physical, chemical, and biological composition of surface and groundwater within the District.	Achieve state standards for nutrient, chloride, *E. coli*, and dissolved oxygen impairments in the District.
Water Quantity	Maintain or reduce existing flows from drainage within the watershed to decrease the negative effects of stormwater runoff and bounce from existing and proposed development as well as provide low flow augmentation to surface waters. Protect and maintain existing groundwater flow and promote groundwater recharge.	No net increase in volume or rate of stormwater runoff.
Ecological Integrity	Maintain and enhance floral and faunal quantity and ecological integrity of upland and aquatic resources throughout the watershed.	Achieve state standards for fish and macroinvertebrate bioassessment impairments in the District.
All of the above	Maintain or increase existing acreage of wetlands in the watershed and achieve no net loss in their size, quality, type, and biological diversity.	No net loss of wetland acreage.

3.7.2 TYPES OF EVALUATION AND REPORTING

The District uses a variety of methods to evaluate performance and measure progress toward District goals, as described below. These evaluation and reporting processes are designed to meet the requirements of MN Rules 8410 and the District's Municipal Separate Storm Sewer System (MS4) Permit.

Table 3.3 provides a summary of key metrics that are tracked by the District, the programs responsible for tracking them, and the frequency with which they will be reported. These metrics will be tracked by subwatershed and summarized as part of the District's reports to the MN Pollution Control Agency and MN Board of Water and Soil Resources and in accordance with the biannual evaluation required by Minnesota Rules 8410. The reporting function will serve as a vehicle to engage with these agencies on matters of performance and accountability.



Frozen Minnehaha Creek, Aldo Abelleira

Observed Outcomes

The District has a robust monitoring program that measures progress toward the District's water quality, water quantity, and ecological integrity goals using a variety of metrics. This includes regular baseline monitoring to identify impairments and track trends over time; expanded monitoring through the District's E-grade program to broadly characterize ecosystem health on a 10-year rotating basis; and effectiveness monitoring to more directly measure the effectiveness of select District capital projects. The District's monitoring program is described in more detail in Section 2.1, including a summary of monitoring locations, parameters measured, and frequencies.

Projected Outcomes

Given the length of time it can take to observe changes in water quality, water quantity, and ecological integrity on the landscape, and the complexity of linking those changes causally to the District's work, the District also relies on projections or estimates to measure progress toward its goals. This includes the use of models to estimate metrics like phosphorus load reduction or volume reduction resulting from District capital projects, permit compliance, and grants. The District tracks as well a number of discrete metrics that serve as surrogates for water quality, water quantity, and ecological integrity benefit, such as acres of wetland restored and lineal feet of shoreline restored.

The District also tracks a number of metrics related to citizen engagement and awareness based on the assumption that increased awareness leads to action. Through various methods of data collection, the District is able to assess how many people are being reached, what they are learning, and the actions they are taking to protect and improve water quality. Approximately every five years the District conducts a public opinion survey of its residents to assess their level of awareness of the District and water quality issues, their perception of the condition of local lakes and streams, the personal actions they take to protect clean water and other metrics. The District also tracks and evaluates participation in its events, workshops, and programs such as Master Water Stewards and Watershed Association Initiative. Analytics from the District's online presence provide information on how many people are following the District's social media accounts (Facebook, Twitter, Instagram and YouTube), subscribe to the District's on-line newsletter, and visit the District's website.

While the District does not define specific issues or targets related to its strategic goal of Thriving Communities, the District is interested in quantifying and tracking outcomes related to broader community value. Examples include increased green space, access to water resources, and recreational opportunities.

District Effectiveness

As part of the development of this Plan, the District undertook an internal strategic planning process to establish clear and focused mission, vision, goals, and guiding principles; and to evaluate District programs to ensure alignment with the mission and improve effectiveness. The process resulted in a Strategic Alignment Plan that established clear and focused priorities for each program and the District as a whole. The District intends to use this Strategic Alignment Plan as a foundation to evaluate new initiatives and revisit existing work to ensure that the District maintains its focus and alignment moving forward.

3.7.3 TOTAL MAXIMUM DAILY LOAD (TMDL) REQUIREMENTS

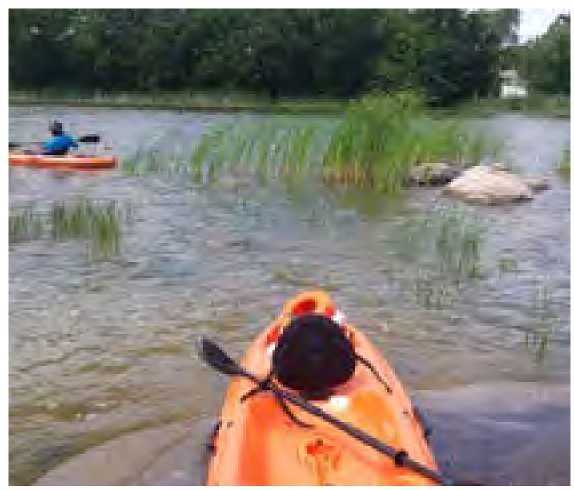
As noted previously, there are a number of impaired waters in the District for which TMDL studies have been completed (see Table 3.4). Through these TMDLs, the MPCA allocates pollutant load reduction obligations among entities determined to be responsible for pollutant loads to the impaired water, which includes the municipalities, road authorities and other MS4s such as the District whose stormwater conveyance systems outlet to the impaired water. These obligations become conditions of MS4 National Pollutant Discharge Elimination System (NPDES) stormwater permits administered by the MPCA. MS4s are then required to report annually to the MPCA on their progress toward achieving the necessary reductions.

The District's capital projects and other initiatives often are accomplished in partnership with its local government units (LGUs) and with a contribution of funds or other elements of value from those partners. Although the District is a regulated MS4, its jurisdiction is limited to areas served by storm water conveyances that are owned or operated by the District, so there have been few load reduction obligations assigned directly to the District through these TMDLs. For both of these reasons, the District adopted and implements a policy (Resolution 13-062) that describes how load reduction credits for District water quality improvement projects are allocated among itself and other LGUs for the purpose of TMDL reporting.

Under this policy, load reduction first is allocated to MS4 project partners in proportion to those partners' share of project funding, typically as the allocation is defined in the project agreement. Then, reduction is allocated to meet any WLA assigned directly to the District. Remaining credit then is allocated among LGUs within the drainage area of the impaired water, in proportion to their TMDL-assigned WLAs. The District adopted this policy with support from MPCA staff, and it was incorporated into both the Minnehaha Creek-Lake Hiawatha TMDL and the MCWD Upper Watershed TMDL.

The main purpose behind the policy is to ensure that credit for pollutant reductions achieved through District projects is distributed equitably and in a way that limits obstacles to collaboration among its member communities.

White water lilies



Kayakers on Long Lake

Lake Harriet, Margi MacMurdo

Table 3.3 Metrics tracked by MCWD

Strategic Goal	Metric	Programs	Reporting Frequency
Water Quality	Lake and stream concentrations for: Total and dissolved phosphorus Total suspended solids Chlorophyll-a Secchi disc depth Dissolved oxygen Chlorides E. coli bacteria (streams only)	Research and Monitoring	Annually
	Lake and stream trends for: Total phosphorus Total suspended solids Chlorophyll-a Secchi disc depth	Research and Monitoring	Annually
	Phosphorus load reduction (modeled)	Projects, Grants, Permitting	At least every 2 years
Water Quantity	Stream discharge and trends	Research and Monitoring	At least every 2 years
	Volume of runoff (modeled)	Projects, Grants, Permitting	At least every 2 years
Ecological Integrity	Index of Biotic Integrity for fish and macroinvertebrates	Research and Monitoring	Every 10 years
	MPCA Stream Habitat Assessment	Research and Monitoring	Every 10 years
	Shoreline/streambank restored	Projects	At least every 2 years
All of the above	Wetland restoration/loss	Projects, Permitting	At least every 2 years
	Community engagement: Participants in events, workshops, and programs Analytics on District website, social media, and newsletter	Education and Communications	At least every 2 years
	Public opinion survey responses		Every 10 years

The policy recognizes that the portion of load reduction not resulting from the specific financial or other value contribution from a project partner MS4 ordinarily derives from the District's watershed-wide *ad valorem* tax levy. Importantly, this policy encourages LGUs to collaborate with the District to put projects where they will be most effective for improving the resource and where opportunities exist, without concern for political boundaries.

As explained in MPCA guidance documents, the method that the MPCA presently requires for MS4s to report on TMDL load reduction progress gives reporting primacy to the MS4 in whose boundaries a best management practice or activity is located. This MS4 reports the entirety of the estimated reduction. Other MS4s that have contributed to the BMP/activity may report it without a quantified reduction. Those MS4s that discharge to the impaired water but that have not contributed to the cost of the BMP/activity do not report it. This is different from the District policy; the District is concerned that it may serve to introduce local interests concerning project location, and otherwise may have the effect of discouraging collaboration among the District and its LGUs. The District will work with the MPCA and its LGUs to explore and address this policy concern.

In addition to its own evaluation and reporting efforts, the District intends to serve in a coordinating role to track collective progress toward TMDL goals among MS4s within its boundaries.

Table 3.4 Impaired Waters with Approved TMDLs

Waterbody	Pollutant	Target	Reduction Needed
Brownie Lake	Chloride	See TCMA Chloride TMDL	
Diamond Lake	Chloride	See TCMA Chloride TMDL	
Dutch Lake	Total Phosphorus	40 µg/L	262 lbs
East Auburn Lake	Total Phosphorus	40 µg/L	626 lbs
Forest Lake	Total Phosphorus	40 µg/L	147 lbs
Gleason Lake	Total Phosphorus	60 µg/L	447 lbs
Hadley Lake	Total Phosphorus	40 µg/L	72 lbs
Halsted Bay	Total Phosphorus	40 µg/L	4210 lbs
Holy Name Lake	Total Phosphorus	60 µg/L	350 lbs
Jennings Bay	Total Phosphorus	40 µg/L	2518 lbs
Lake Hiawatha	Total Phosphorus	50 µg/L	1907 lbs
Lake Nokomis	Total Phosphorus	50 µg/L	399 lbs
Lake Virginia	Total Phosphorus	40 µg/L	77 lbs
Langdon Lake	Total Phosphorus	60 µg/L	84 lbs
Long Lake	Total Phosphorus	40 µg/L	742 lbs
Minnehaha Creek	E. coli	See Minnehaha Creek TMDL	
Minnehaha Creek	Chloride	See TCMA Chloride TMDL	
Mooney Lake	Total Phosphorus	60 µg/L	81 lbs
Painter Creek	E. coli	See Upper Watershed TMDL	
Parley Lake	Total Phosphorus	60 µg/L	998 lbs
Peavey Lake	Chloride	See TCMA Chloride TMDL	
Powderhorn Lake	Chloride	See TCMA Chloride TMDL	
School Lake	Total Phosphorus	60 µg/L	176 lbs
Snyder Lake	Total Phosphorus	60 µg/L	22 lbs
Stone Lake	Total Phosphorus	40 µg/L	29 lbs
Stubbs Bay	Total Phosphorus	40 µg/L	199 lbs
Tamarack Lake	Total Phosphorus	40 µg/L	0 lbs
Tanager Bay	Total Phosphorus	40 µg/L	753 lbs
Turbid Lake	Total Phosphorus	40 µg/L	138 lbs
Unnamed Creek (07010206-718)	Chloride	See TCMA Chloride TMDL	
Wassermann Lake	Total Phosphorus	40 µg/L	470 lbs
West Arm	Total Phosphorus	40 µg/L	1602 lbs
Wolsfeld Lake	Total Phosphorus	40 µg/L	232 lbs

3.8 PLAN AMENDMENTS

The Plan will extend through the year 2027. The Plan will remain in effect as revised and amended, until superseded by a subsequent plan approved by the Board of Water and Soil Resources (BWSR) and adopted by the District.

Only the District Board of Managers can initiate a formal plan amendment. Other individuals or entities may petition the Board to initiate an amendment, but the decision to do so will remain a matter for the Board's discretion. All plan amendments must follow the process provided in Minnesota Statutes, 103B.231, subdivision 11, except in the following two instances:

- » Plan changes that do not constitute plan amendments. When such changes are made, they will be distributed to those on the distribution list indicated below in a form that communicates deleted and new text. These changes include the following:
    - Plan reformatting or reorganization;
    - Revision of a procedure meant to streamline plan administration;
    - Clarification of existing plan goals or policies;
    - Inclusion of additional data that don't require interpretation;
    - Expansion of public process;
    - Adjustments in implementing program activities within the District's discretion.
- » With respect to changes to the District's implementation action table that fall within this subsection, this subsection will be implemented through a revised table distributed annually. Such changes may include a change in the timing of one or more actions, or a substantial change in the estimated cost of a program or project.
    - Minor plan amendments. The District will send the proposed amendment to each of the plan review authorities, as defined in Minnesota Rules 8410, for a review and comment period of at least 30 days. The notice will state that the minor amendment procedure is being followed, and will direct that comments be sent to the District and to BWSR. The amendment will be considered a minor amendment if:
        - BWSR has agreed that the amendment is minor or has failed to act within five working days of the end of the comment period, or such other period to which BWSR and the District have agreed;
        - Neither the Hennepin nor the Carver County Board of Commissioners has filed an objection to the amendment

with the District and BWSR within the comment period, or such other period to which the County and the District have agreed; and

- The amendment is not needed to make the Plan consistent with an approved and adopted county groundwater plan.

» Before adopting a proposed minor amendment, the District will hold a public meeting to explain and receive comment on the amendment. This will occur after legal notice of the meeting has been published twice, at least seven and at least 14 days before the meeting date.

The District maintains and annually solicits applications for a Citizens Advisory Committee to provide advice and recommendations on watershed issues, including amendments to its Plan. For ten-year plan amendments, the District will also establish technical and policy advisory committees, consistent with the process used for development of this Plan as described in Appendix B.

The District will transmit draft and final amendments to the distribution list electronically, and in paper format to any entity that has requested to receive amendments in that form. Draft amendments will show deleted text as stricken and new text as underlined. A final amendment adopted by the District will be in the form of replacement pages for the Plan, with each page renumbered as appropriate and stating the effective date of the amendment.

The District will maintain a distribution list of agencies and individuals who have received a copy of the Plan, which includes "plan review authorities" as defined in Minnesota Rules 8410. The District will distribute copies of an adopted amendment to all on the distribution list and post the amendment on its website within 30 days of adoption.

It is the intent of this section to conform to procedures stated in Minnesota Rules 8410. If BWSR should amend those rules in any manner that makes them inconsistent with this section, the District will adjust its amendment practice to maintain conformity with Minnesota Rules 8410 pending any formal amendment of this section.

3.9 SUBWATERSHED PLANS

This section contains information specific to each of the District's eleven subwatersheds. Each subwatershed plan follows the same sequence: existing conditions and issues; causes; management strategies; and implementation priorities. The implementation plan for each subwatershed identifies specific, known projects and initiatives but also provides for projects and initiatives to develop specificity through planning, collaborative processes, and opportunities.

3.9.1 CHRISTMAS LAKE SUBWATERSHED PLAN

INTRODUCTION

This subwatershed plan contains information specific to the Christmas Lake Subwatershed, including existing conditions and issues, drivers, management strategies, land use information, and an implementation plan. Information regarding the District's philosophy, goals, and implementation approach can be found in Sections 3.2-3.4 and should be reviewed first to provide context for the following subwatershed plan.

EXECUTIVE SUMMARY

Christmas Lake is a 1.2 square mile (742 acre) subwatershed located along the southwestern boundary of the MCWD and includes portions of the cities of Chanhassen and Shorewood, with a small area in Excelsior.

The subwatershed is dominated by single family residential uses (47%) and the 276 acre Christmas Lake (37%), with the remaining balance being primarily wetland or woodland (13%). There are a few isolated wetlands in the watershed and some that are riparian to the lake.

A small stream drains the upper part of the subwatershed and outlets into the southwest side of Christmas Lake. Some of the small basins in the subwatershed are landlocked and have no natural outlet. The subwatershed discharges into St. Albans Bay of Lake Minnetonka.

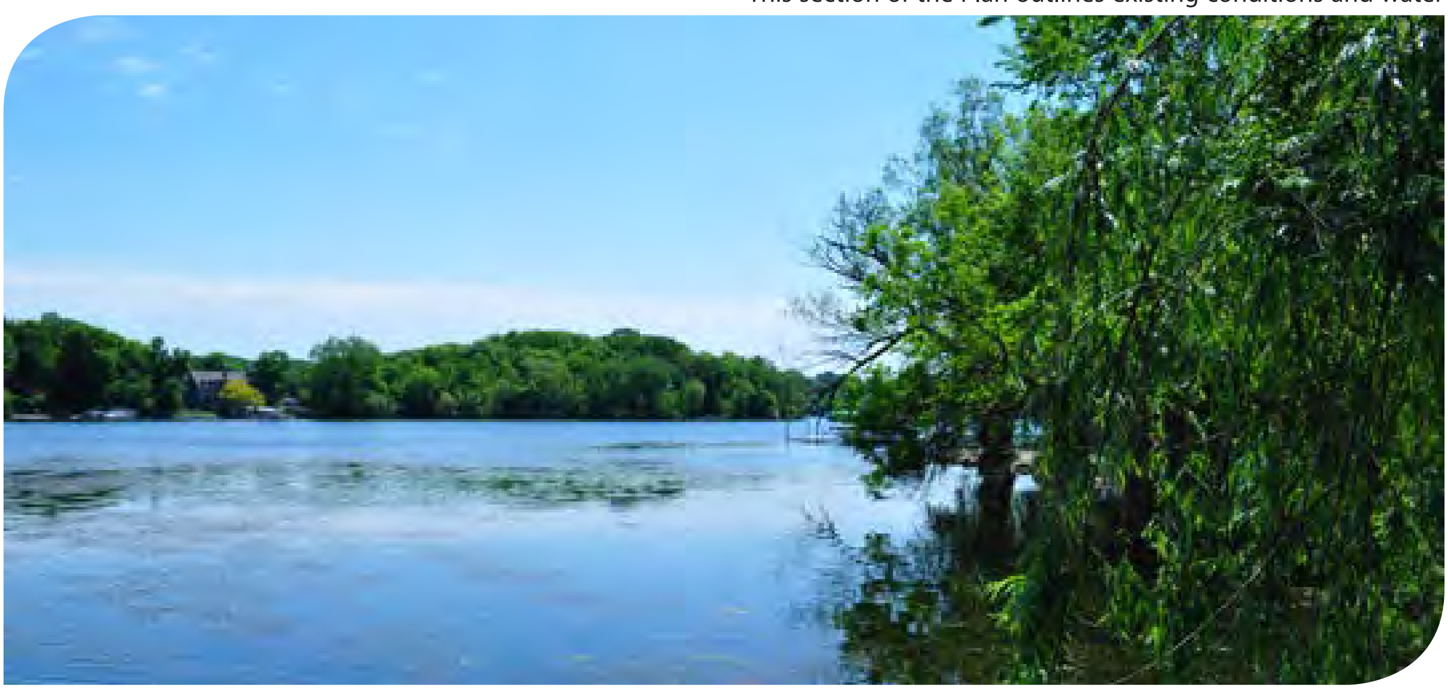
Water quality in Christmas Lake is better than state standards and is typically among the best in the District. Zebra mussels infested Christmas Lake in 2014 and are now established lake wide. The channel that conveys drainage from the southern subwatershed unit to the lake is experiencing some erosion, possibly conveying sediment to the lake, and phosphorus concentrations in the stream are elevated compared to state standards.

Management strategies within the Christmas Lake subwatershed will focus on protecting water quality in the lake by limiting nutrients and sediment in stormwater runoff. The District will collaborate on these management strategies with local and state government, developers, lake associations, citizens' groups and other parties to implement. This is summarized in the Implementation Plan.

RESOURCE NEEDS

EXISTING CONDITIONS AND ISSUES

This section of the Plan outlines existing conditions and water



Christmas Lake

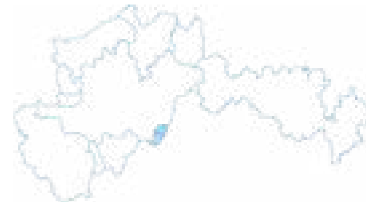


Figure 3.1 Christmas Lake Base map

resource issues categorized by water quality, water quantity, and ecologic integrity. Condition information was compiled from community input, monitoring data, special studies, the Hydrologic and Hydraulic Pollutant Loading Study (HHPLS), Minnehaha Creek and Upper Watershed Stream Assessments, the Functional Assessment of Wetlands (FAW), Total Maximum Daily Load (TMDL) studies, and state and regional land use and land cover data. A review of these conditions and data revealed several issues and concerns that may require action on the part of the District or its partners. More detailed information about the Christmas Lake subwatershed may be found in Volume 2: Land and Natural Resources Inventory.

Water Quality

Lakes and Streams

The Christmas Lake subwatershed is dominated by Christmas Lake itself. Water quality in Christmas Lake is better than state standards and is typically among the best in the District.

There is a small stream that conveys drainage from the upper subwatershed to Christmas Lake. While it is not listed as an Impaired Water for nutrients, the stream exhibits significantly high total phosphorus concentrations, and exceeds state river eutrophication standards.

Zebra mussels are established in the lake, and when abundant, can drive water quality changes through their filtering ability and can have the potential to mask other nutrient loading issues.

Wetlands

There are few wetlands in the Christmas Lake subwatershed, totaling about 33.7 acres. Most are small and isolated, but there are some riparian to the lake that provide fish and wildlife habitat.

Groundwater

While most of the subwatershed has only low to moderate sensitivity to pollution, some scattered areas are classified as highly sensitive. The entire subwatershed is designated as a Wellhead Protection Area. As development occurs and infiltration is proposed to meet water quality and volume control standards, special attention should be paid in areas of aquifer sensitivity and wellhead protection areas.

Water Quantity

Surface flows in the Christmas Lake subwatershed are routed primarily through a system of culverts connecting small depressions. A small channel drains the upper subwatershed into the southeast corner of Christmas Lake. A few locations

Barrier in Christmas Lake

Figure 3.2 Christmas Lake Water Resources map

N
0 600' 1200' 2400'

have been identified through observation or the District's modeling as being vulnerable to localized flooding.

Most of the wetlands in the subwatershed are combination discharge-recharge, but some of the wetlands with the highest functions and values in the watershed are discharge wetlands. Changes in the surficial groundwater table or flow can negatively impact discharge wetlands' vegetation and biota, making it important to protect and increase groundwater recharge.

Ecological Integrity

Lakes and Streams

Christmas Lake is one of a few lakes in the Metro Region that can support a two-story fishery, supporting both cold-water species in the cooler, deeper portions of the lake and warm-water species in the warmer water above the thermocline.

Zebra mussels infested Christmas Lake in 2014 and while initial treatments controlled the population within the treatment area, they were found established lake wide by fall of 2015. The zebra mussel population in Christmas Lake is expected to be limited due to low algal concentrations in the lake; however, even a small population could impact the healthy native mussel population in the lake.

There is an abundant and diverse aquatic plant community in the lake that benefits biodiversity and habitat diversity. The invasive Eurasian watermilfoil and curly leaf pondweed are both present in the lake, but thus far have not had a great impact on the overall aquatic plant community.

Wetlands

Wetland assessments have classified one small wetland as having exceptional vegetative diversity and another has high diversity. Three wetlands were classified as having exceptional aesthetic and fish habitat values. Their conservation is integral to achieving ecological integrity, water quality, stormwater management and floodplain management goals.

Uplands and Natural Corridors

The subwatershed is almost fully developed, and there are only a few remaining patches of undeveloped landscape. Most of these areas are wetlands or wooded portions of large residential lots. No areas within the subwatershed have been identified by the DNR or the Minnesota County Biological Survey (MCBS) as being high-value or ecological areas.

DRIVERS

A driver of water quality, water quantity, or ecological integrity is a driving force or stressor that causes a biological community or

Carp in Christmas Lake

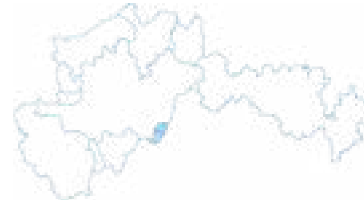
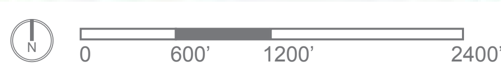


Figure 3.3 Christmas Lake Parks, Trails, and Open Space map



physical structure to change. Example drivers include increased phosphorus loading, increased impervious areas, straightened channels, and drained wetlands. Some drivers are natural, such as storm events. Most are human-caused, either directly or as a side effect of some other change such as a land use change or removal of natural land cover. This section of the Plan outlines the main drivers of water quality, water quantity, and ecological integrity issues within the Christmas Lake subwatershed.

The principal issues within the Christmas Lake subwatershed are:

Water Quality

» Excessive nutrients from stream input

Water Quantity

» Localized flooding

These issues are primarily the result of the following drivers:

» Altered wetlands

» Stormwater runoff

» Altered channels

Altered Wetlands

On a watershed scale, wetlands can act as sinks, sources, or transformers (particulate to dissolved fraction) for nutrients like phosphorus. Historically, wetlands acted as nutrient sinks within a watershed, capturing and retaining nutrients, even as nutrient loads to the wetland were increased as land use intensified. However, as wetlands were ditched and drained to facilitate watershed drainage and land use change, they often converted from a sink for nutrients to sources by increasing the breakdown of wetland soil and the conveyance of stormwater. These processes within altered wetlands can release large pools of stored nutrients causing nutrient impairments in downstream surface waters.

There are few remaining wetlands in the Christmas Lake subwatershed aside from those riparian to the lake. There is a series of flow-through, riparian small ponds and altered wetlands along the small channel that drains the upper subwatershed into the southwest corner of Christmas Lake. That channel has elevated concentrations of total phosphorus, one of the sources of which could be wetland export.

Stormwater Runoff

Watershed runoff from rainfall events or stormwater can carry nutrients and other pollutants to surface waters leading to negative impacts in lakes, streams and wetlands. In urban and suburban areas, high proportions of impervious surfaces such as parking lots and driveways increase the volume and rate of stormwater runoff, which can cause flooding and change stream flow that negatively impact habitat for critical parts of the food-web like fish and macroinvertebrates. In rural areas drained for agriculture, the increased volume and peak flow of stormwater runoff causes similar negative impacts.

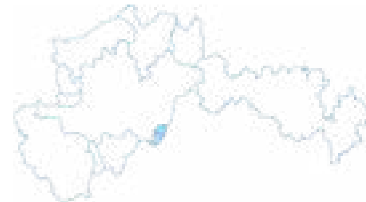
While the increased volume and rate of stormwater runoff can negatively impact physical conditions in receiving waters, the runoff also carries with it increased loads of pollution that negatively impact the quality of lakes, streams and wetlands. In urban and suburban areas, stormwater picks up pollutants such as excess nutrients, bacteria (e.g., *E. coli*), chloride from road salt, and toxic pollutants. In more rural areas, stormwater mobilizes pollutants from manure and fertilizer including excess nutrients, bacteria, herbicides and pesticides.

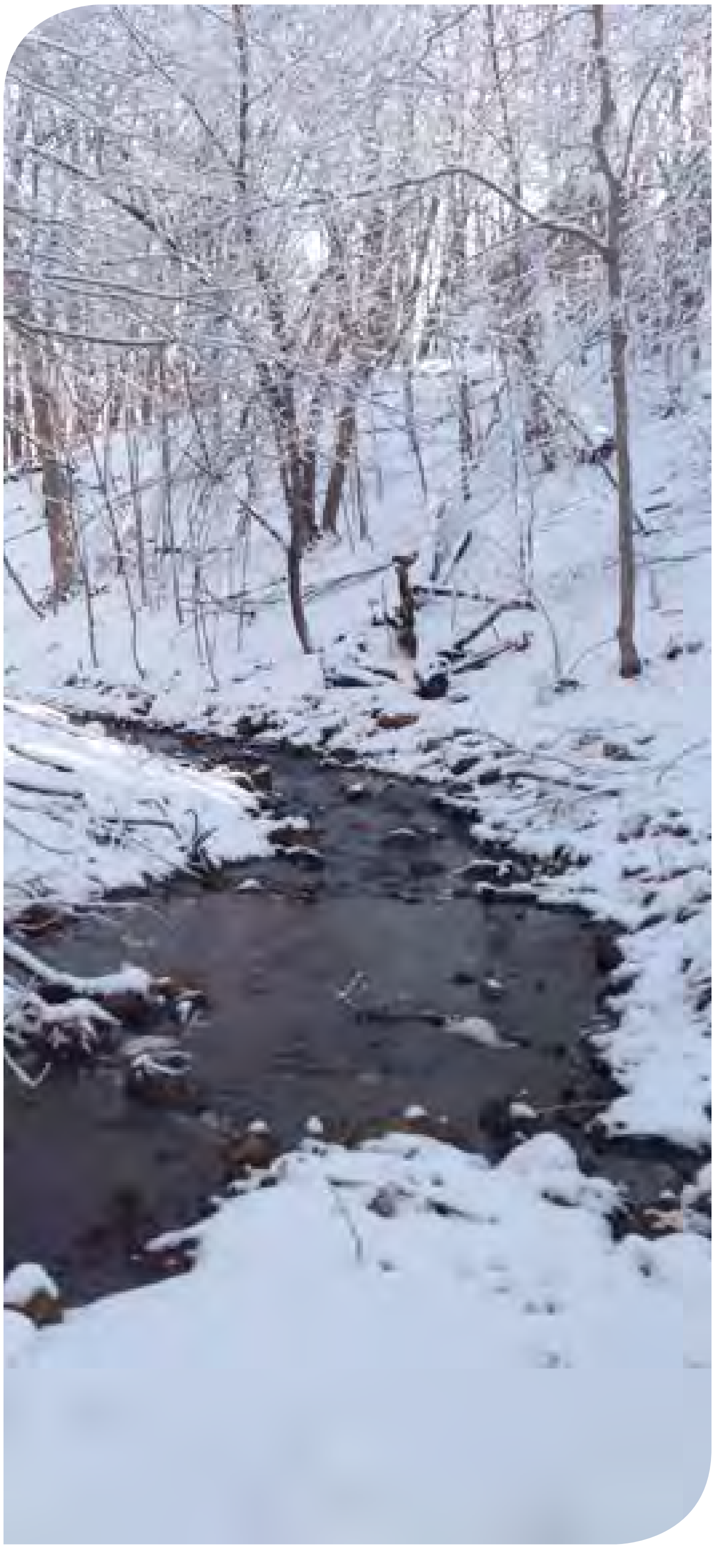
These impacts heavily influence the conditions of surface waters, because a healthy hydrologic condition is critical to supporting a healthy lake, stream or wetland. Generally as impervious cover, altered drainage, and stormwater runoff within a watershed increases, the quality of lakes, streams and wetlands decreases.

The Christmas Lake subwatershed is almost fully developed with single family residential uses. Storm water runoff is conveyed to either the drainage channel in the upper subwatershed or directly to the lake. There is some water quality treatment of this runoff. The channel has elevated concentrations of total phosphorus, the source of which could be untreated stormwater runoff, wetland export, sedimentation from an eroding channel, or a combination of these sources.

Altered Channels

Historically, natural channels were straightened, widened and relocated to accommodate land use change. Channel





Christmas Creek in winter

alteration to improve watershed drainage can lead to a loss of physical habitat, increased peak flow velocities and downstream flooding, decreases in dissolved oxygen, and increased sediment transport which can negatively impact fish and macroinvertebrate communities.

The channel that drains the upper subwatershed is likely to be a historically ephemeral stream that was an outlet for wetlands and which conveyed large events and snowmelt, but has been altered and straightened to convey urbanized stormwater runoff. Portions of the channel are confined to storm sewer. Below Powers Boulevard, the stream is experiencing some erosion, which may be conveying excess sediment and nutrients to the lake and stressing the local biotic community.

MANAGEMENT STRATEGIES

Informed by the identification and prioritization of conditions and issues in the subwatershed and an understanding of the drivers impacting its water resources, the District has developed general strategies to guide actions in the Christmas Lake subwatershed. These strategies are both short- and long-term, and establish a framework for the Christmas Lake subwatershed Implementation Plan programs and projects.

Wetland Restoration

Traditional approaches to wetland restoration focus on restoring wetland channels and hydrology to support a more diverse native plant population. While this strategy addresses ecological integrity within the wetland, it often overlooks the need to alter the cycles of wetland chemistry created by historic wetland alteration, which transform and release phosphorus to downstream waterbodies.

To address both ecological integrity and the release of phosphorus, wetland restoration must focus on modifying hydrology to support the native plant community while minimizing phosphorus export. This may include, but is not limited to, bypassing flow around the wetland, the addition of nutrient filters, soil engineering or augmentation to permanently sequester phosphorus, or the development of wetland treatment cells. Selected restoration options will depend on site specific wetland conditions and hydrology, and overall needs of the subwatershed system.

The series of wetlands west of, and in, Curry Farms Park in Chanhassen, through which the upper subwatershed channel flows, was classified with moderate restoration potential. Each of these wetlands was assessed as being currently of moderate vegetative quality. Wetland restoration may improve habitat and aesthetics as well as reduce the export of nutrients into the channel downstream to Christmas Lake.

Stormwater Management

Stormwater management will focus on reducing runoff volumes and rates, as well as reducing pollutant loading from runoff producing rain events. Stormwater management in the developed or developing urban and suburban areas will focus on retrofitting low impact development techniques such as ponds, filters, infiltration techniques, and other technologies where they are applicable. In the rural and agricultural areas, stormwater management will focus on buffers, improved agricultural practices such as conservation tillage, manure management for animal agriculture and hobby farms, wetland restoration and fertilizer management.

The overall strategy for protecting water quality in Christmas Lake is to reduce pollutant loading and stormwater runoff volume from the subwatershed by retrofitting developed areas with Best Management Practices (BMPs) as infrastructure and development/redevelopment opportunities arise, and to encourage property owners to incorporate BMPs on their own properties.

Stream Channel Restoration

Stream restoration focuses on balancing stormwater conveyance to prevent flooding and channel erosion while providing high quality habitat for fish and macroinvertebrates. Restoration includes, where applicable, improving channel sinuosity, stabilizing streambanks, controlling peak flow velocities, increasing channel roughness for habitat and re-aeration, narrowing stream channels to improve wetted width and ecological baseflow, and increasing stream structure.

Below Powers Boulevard, the stream is experiencing some erosion, which may be conveying excess sediment and nutrients to the lake and stressing the local biotic community. Stream restoration would stabilize the streambanks, filter overland runoff, enhance habitat, and reduce nutrient and sediment load downstream.

Watershed Protection

Several areas of the watershed are rapidly converting from undeveloped or rural land uses to developments which can increase impervious areas, reduce flood storage, increase pollutant loads, and eliminate or reduce biologically significant land cover. A critical strategy to maintain existing resources and critical functions is to protect these areas by minimizing the impacts of the development. This is accomplished by conserving biologically significant upland areas, protecting high value wetlands, mimicking natural watershed hydrology, maintaining stream geomorphology, protecting stream buffers and riparian areas, and protecting critical fish and wildlife corridors.

The highest value resource in the subwatershed is Christmas Lake with its excellent water quality and unique two-story fishery, supporting both cold and warm water species. Protecting the lake from future degradation is a high priority. As infill development and redevelopment occurs, opportunities should be evaluated to achieve net reductions over current stormwater runoff volume and pollutant loads.

LAND USE

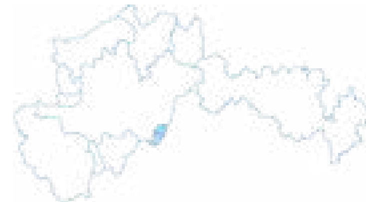
EXISTING CONDITIONS

The subwatershed includes portions of the cities of Shorewood and Chanhassen, with a small area in Excelsior. The subwatershed is fully developed with single family residential (47%) dominating the land use, followed by open water (37%), and undeveloped land (13%) which is primarily undevelopable wetland.

LOCAL PLANS AND PRIORITIES

As described in the District's goals (Sections 3.3), the District strives to implement its clean water objectives in ways that meaningfully contribute to the development of thriving communities. This is achieved through collaboration and integrated planning with public and private partners.

As part of the development of this plan, the District reached out to its communities to gather information on local goals, plans, and priorities for 2018-2027 (see Appendix B for details on the public input process). This information was used to broadly characterize opportunities, and to inform the development of the District's implementation plans. The information received



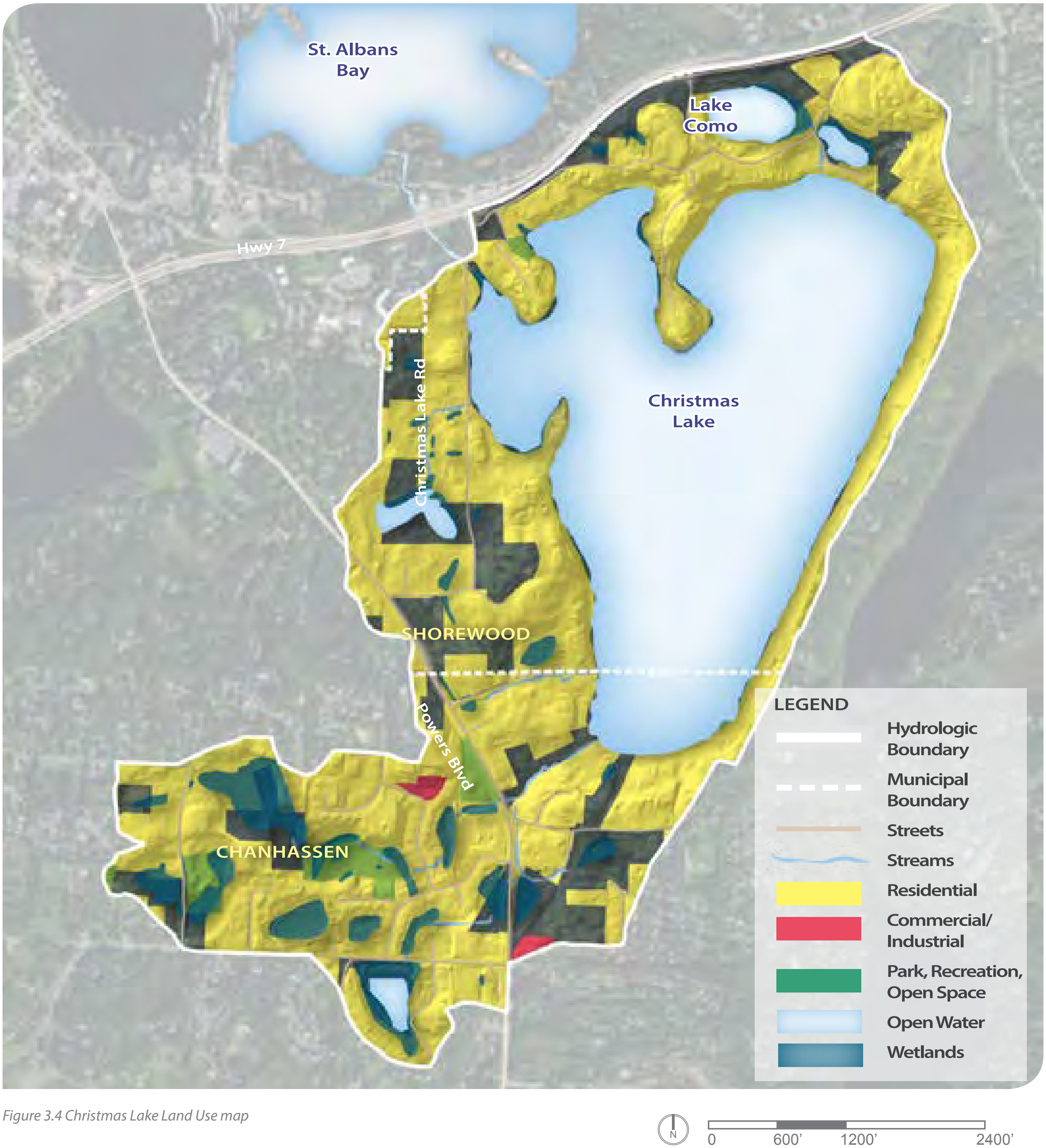


Figure 3.4 Christmas Lake Land Use map

was used only as a guide during the development of this Plan to inform the District of opportunities for partnership on the near term horizon, and was not intended to be exhaustive or restrict future collaborative efforts.

As discussed in Section 3.6, the District intends to cultivate a framework for two-directional coordination with communities on an ongoing basis, to stay apprised of emerging needs at a local level, and to identify and evaluate opportunities to implement management strategies outlined in this Plan over the next ten years. The District recognizes that local needs, opportunities and priorities may shift over time. Therefore, this Plan does not intend to capture or prescribe opportunities for partnership over a ten-year term.

Long term goals, growth and private development, and public investment in infrastructure differ across each community – and therefore, frameworks for ongoing coordination will be custom tailored based on the individual needs of each community. Coordination may occur at varying levels, through various means, with communities across the following areas:

» Regulation of, and partnership with, private development

» Collaboration on public planning and investment (e.g. parks , roads, utilities)

» MS4 compliance

» Development and implementation of TMDLs

Through the information gathering processes of this Plan, the District was informed that the subwatershed is largely residential with potential future redevelopment identified on the lake and along Christmas Lake Road. Within the subwatershed, there are some localized flooding issues which the cities will seek to address as part of future road improvements.

There is an active lake association for Christmas Lake, and priority issues identified by the group include aquatic invasive species (AIS) prevention and management, regulation of single family home redevelopment, and shoreline erosion from boat wakes.

Both the municipalities and Christmas Lake Association are actively engaged in protecting Christmas Lake. By City of Shorewood ordinance, watercraft must be inspected for AIS before entering Christmas Lake. Such inspections are provided at the boat launch for no charge.

IMPLEMENTATION PLAN

The goals set forth in this subwatershed plan will require an integrated set of programs and projects oriented toward the conservation and improvement of water resources within the watershed. The Implementation Priorities section generally describes the actions that the District and its partners will look to take in order to address the issues present in the subwatershed and achieve the goals as set forth in the plan. The Capital Improvement Plan (CIP) provides cost estimates and schedules for any proposed capital investments.

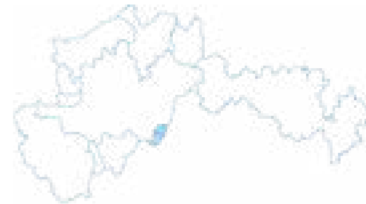
IMPLEMENTATION PRIORITIES

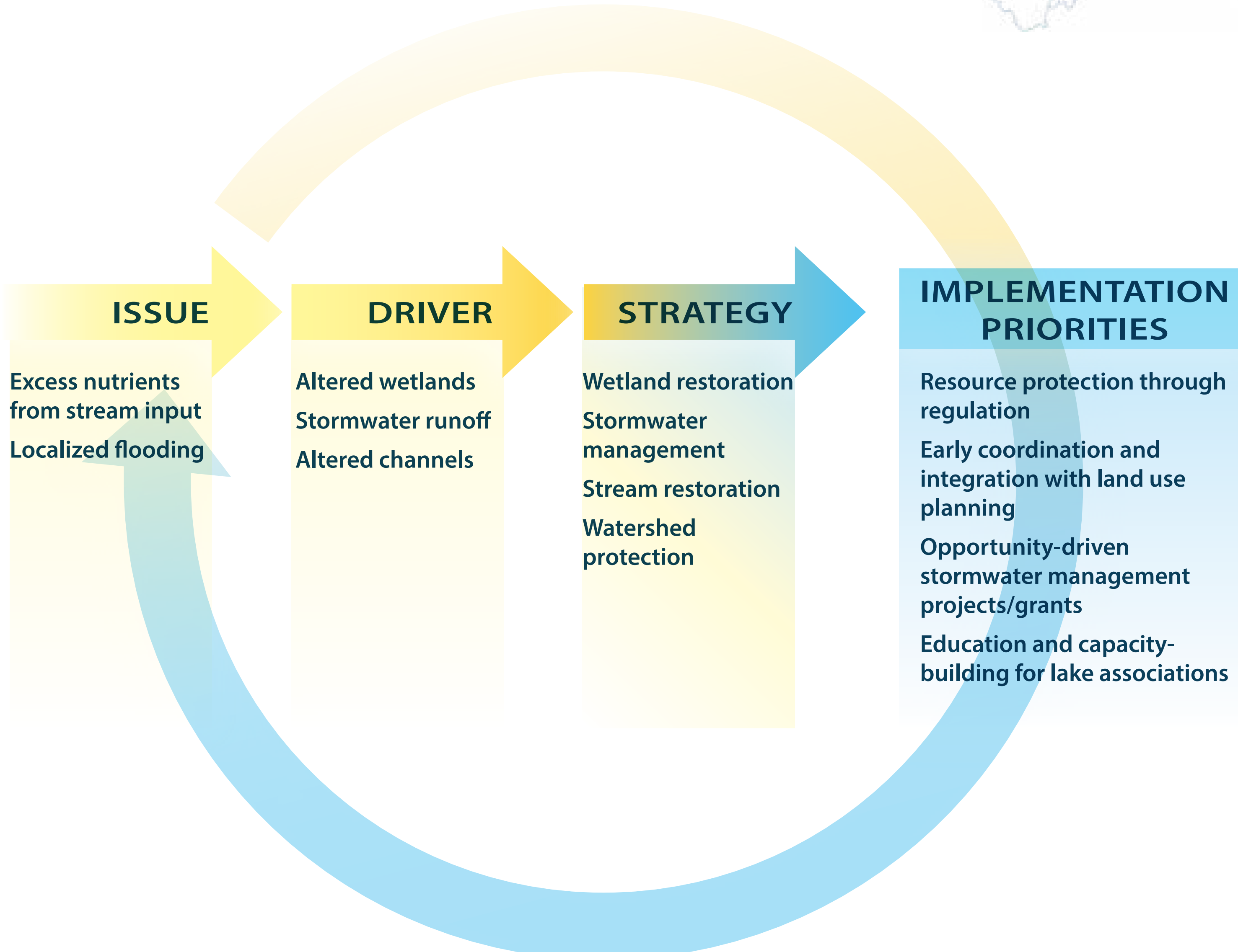
As described in previous sections, water quality in Christmas Lake is better than state standards and is typically among the best in the District. The channel that conveys drainage from the southern subwatershed unit to the lake is experiencing some erosion, possibly conveying sediment to the lake, and phosphorus concentrations in the stream are elevated compared to state standards.

Based on these conditions, management strategies within the subwatershed will focus on protecting water quality in the lake by limiting nutrients and sediment in stormwater runoff. This will be achieved primarily through the District's rules which require no net increase in runoff and pollutant loading for new developments. For redevelopment, the rules require a reduction in runoff and pollutant loading depending on the development size and current conditions.

The Christmas Lake subwatershed is relatively small and mostly built out, so the District expects implementation opportunities from land use change to be limited. The Plan establishes a coordination framework through which the District will seek to maintain current knowledge of land use and capital planning by its LGUs, and of potential land use development and redevelopment activity.

As opportunities arise, the District will evaluate them against the resource needs and priorities defined throughout the Plan and determine the appropriate response. The District has a





wide range of services it can mobilize to address resource needs and support partner efforts, including data collection and diagnostics, technical and planning assistance, permitting assistance, education and capacity building, grants, and capital projects.

As noted in the previous section, there is an active lake association for Christmas Lake. The District will continue to work with its lake associations to provide education and technical assistance to build their capacity and target implementation efforts.

Zebra mussels infested Christmas Lake in 2014 and are now established lake wide. The zebra mussel population in Christmas Lake is expected to be limited due to low algal concentrations in the lake. The District will continue to monitor any impacts or trends.

To allow the District the flexibility to respond to opportunities identified by the cities or other partners, or that may arise through land-use change, the capital improvement plan for this subwatershed includes a project for stormwater management. In the future, should the District or a partner determine that a larger or more concentrated scale of capital and program implementation may be needed, a discrete subwatershed planning process may be initiated to:

» Provide high resolution diagnostic of watershed issues and drivers

» Map current projected land use and infrastructure changes

» Define a detailed and integrated capital and program implementation plan

» Outline a funding strategy including program costs and sources

The details of such a plan would provide the information needed for the District to pursue a plan amendment under MN Rules 8410, thereby updating specific subwatershed components of this Plan.

CAPITAL IMPROVEMENT PLAN

The CIP is a planning tool. It also is a means to inform partners, District residents, and other interested parties as to the District's scope and priorities for its capital work over the planning period. A project's inclusion in the CIP does not mean that the project will be constructed, only that the District has identified it as an action that may be a cost-effective way for the District to achieve identified water resource goals. A project identified in the CIP always will need further review as to technical feasibility, cost and financing, consistency with local needs, and other policy considerations before a formal decision to proceed to construction is made. Section 3.5.5 describes the development and evaluation steps that will occur before the District will commit resources to a project.

Section 3.5.5 also describes how the District will review the CIP on an ongoing basis throughout the planning period. This review will allow the District to reassess described projects from a technical perspective, but also will involve broader policy considerations such as shifts in District priorities, decisions as to annual budget and levy levels, and the prospect of state and federal grant funds or financing. For this reason, projects may be added to and deleted from the CIP from year to year, in accordance with those procedures.

A critical component of any project will be the development of a funding strategy that identifies the sources, uses, and timing of funds needed to successfully achieve identified goals. These plans will be developed in conjunction with the District's public and private partners as capital projects are advanced. Therefore, any costs identified within this Plan are projections. Intended expenditures will be refined during project development and budgeting, and among other things will reflect the District's intent to complement its ad valorem funds with other funding sources.

Table 3.5 Christmas Lake Subwatershed CIP

Project	Stormwater Volume and Pollutant Load Reduction
Description	Implementation of opportunities to reduce stormwater volumes and nutrient loading to Christmas Lake, including but not limited to infiltration or filtration basins and devices, reforestation, revegetation, and stormwater detention or redirection.
Need	Christmas Lake displays excellent water quality but is sensitive to potential future loading increases. The channel that conveys drainage from the southern subwatershed unit to the lake exhibits phosphorus concentrations that are elevated compared to state standards.
Outcome	Reduction of pollutant loading to Christmas Lake; reduction of stormwater runoff volume and rate and associated impacts; protection and enhancement of groundwater recharge, stream base flow, and wetland hydrology.
Estimated Cost	Capital costs: $200,000, excluding land, in 2017 dollars.
Potential Funding Sources	MCWD levy, partner contributions, grants
Schedule	2018-2027

3.9.2 DUTCH LAKE SUBWATERSHED PLAN

INTRODUCTION

This subwatershed plan contains information specific to the Dutch Lake Subwatershed, including existing conditions and issues, drivers, management strategies, land use information, and an implementation plan. Information regarding the District's philosophy, goals, and implementation approach can be found in Sections 3.2-3.4 and should be reviewed first to provide context for the following subwatershed plan.

EXECUTIVE SUMMARY

Dutch Lake is a 3.0 square mile (1,888 acre) subwatershed located along the northwestern boundary of the MCWD and includes portions of the cities of Mound and Minnetrista. The subwatershed is generally characterized by undeveloped land (50%), including numerous large wetland systems and wooded areas, low-density development (20%), agricultural uses (10%), parks and open spaces (6%), and water (10%). Mound Westonka High School is a large, institutional use in the eastern subwatershed.

The subwatershed includes large areas of undisturbed or minimally disturbed wetland and woodland. Much of the subwatershed has been identified by the DNR as a Metropolitan Conservation Corridor and by the City of Minnetrista as a natural resources corridor due to the predominance and contiguity of wetlands.

The Dutch Lake subwatershed has two large wetland systems, which through a series of ditches and culverts both drain to Dutch Lake, the primary receiving water within the subwatershed. The small stream that drains wetlands on the west side of Dutch Lake flows intermittently. There is one primary stream, Dutch Creek, which serves as the outlet of Dutch Lake and flows to Lake Minnetonka: Jennings Bay.

The Dutch Lake subwatershed has several issues relating to water quality, water quantity, and ecological integrity. Dutch Lake is impaired by excess nutrients and the inlet and outlet of Dutch Lake have elevated levels of total phosphorus. The outlet of Dutch Lake is also at high risk of chloride impairment. The fish and vegetation communities in Dutch Lake and its inlet and outlet may be negatively impacted by nutrient enrichment, low dissolved oxygen, and reduced water clarity. The subwatershed also contains areas of high quality, extensively connected wetland and upland, including several regionally significant ecological areas. Overall, the system has moderate to high ecological integrity.

Management strategies within the Dutch Lake subwatershed will focus on promoting infiltration, reducing pollutant loading, managing carp, improving biodiversity and protecting existing resources. The District will collaborate on these management strategies with local and state government, developers, lake associations, citizens' groups and other parties to implement. This is summarized in the Implementation Plan.

RESOURCE NEEDS

EXISTING CONDITIONS AND ISSUES

This section of the Plan outlines existing conditions and water resource issues, categorized by water quality, water quantity, and ecologic integrity. Condition information was compiled from community input, monitoring data, special studies, the Hydrologic and Hydraulic Pollutant Loading Study (HHPLS), Minnehaha Creek and Upper Watershed Stream Assessments, the Functional Assessment of Wetlands (FAW), Total Maximum Daily Load (TMDL) studies, and state and regional land use and land cover data. A review of these conditions and data revealed several issues and concerns that may require action on the part of the District or its partners. More detailed information about the Dutch Lake subwatershed may be found in Volume 2: Land and Natural Resources Inventory.

Water Quality

Lakes and Streams

Dutch Lake is listed on the State's Impaired Waters list for nutrient/eutrophication biologic indicators, and a TMDL identifying nutrient load reduction goals and suggested actions has been completed.

No streams are listed as Impaired Waters; however, both Dutch Creek and a small stream draining wetlands on the west side of Dutch Lake have elevated total phosphorus concentrations. In addition, Dutch Creek has elevated chloride concentrations and is at high risk of chloride impairment.

Wetlands

The Dutch Lake subwatershed has two large riparian wetlands –

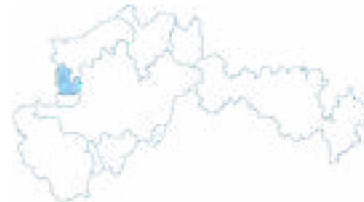


Figure 3.5 Dutch Lake Base map

one on the north side and one on the west side of Dutch Lake - that have scored highly on vegetative diversity, fish and wildlife habitat, or aesthetics. The subwatershed also has numerous small wetlands. These wetlands are sensitive to the quality of stormwater inputs and should be protected.

Groundwater

There are wide areas of aquifer sensitivity in the Dutch Lake Subwatershed, particularly those within wellhead protection areas. As development occurs and infiltration is proposed to meet water quality and volume control standards, special attention should be paid in areas of aquifer sensitivity and wellhead protection areas.

Water Quantity

There are no known flooding issues, but modeling suggests that the Dutch Lake culvert may provide less freeboard than required. This culvert is also unstable and needs maintenance.

There are wetlands and streams in the subwatershed that rely on steady inflow from surficial groundwater. A small area of the subwatershed is within a Wellhead Protection Area and there may be restrictions on the use of infiltration as a water quality practice within that area.

Ecological Integrity

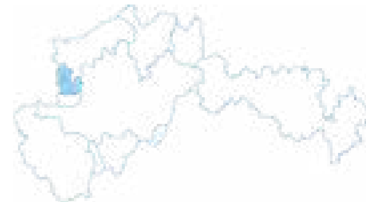
Lakes and Streams

Dutch Lake maintains a moderately healthy fishery, according to limited fish data. Although excess nutrients, reduced water clarity, and low dissolved oxygen may negatively impact the lake's fish community. Dutch Lake is infested with Eurasian watermilfoil, and overall the aquatic vegetation community is degraded due to excess nutrients and low water clarity. Dutch Lake has significant woodland or wetland fringes, which are ecologically beneficial.

Streams in the subwatershed include a small stream that drains wetlands on the west side of Dutch Lake and Dutch Creek, which serves as an outlet to Dutch Lake and flows into Lake Minnetonka: Jennings Bay. In the small unnamed stream on the west side of Dutch Lake, total phosphorus concentrations are elevated relative to the state river eutrophication standards. Dutch Creek shows elevated concentrations of total phosphorus and dissolved oxygen levels that fall below the state standard several times per year. Chloride concentrations are also elevated and the stream is at high risk of surpassing the state chloride standard. Stream connectivity is also low, as there are several culverts and road crossings that may impede passage for fish and other aquatic organisms.

Dutch Lake

DUTCH LAKE SUBWATERSHED



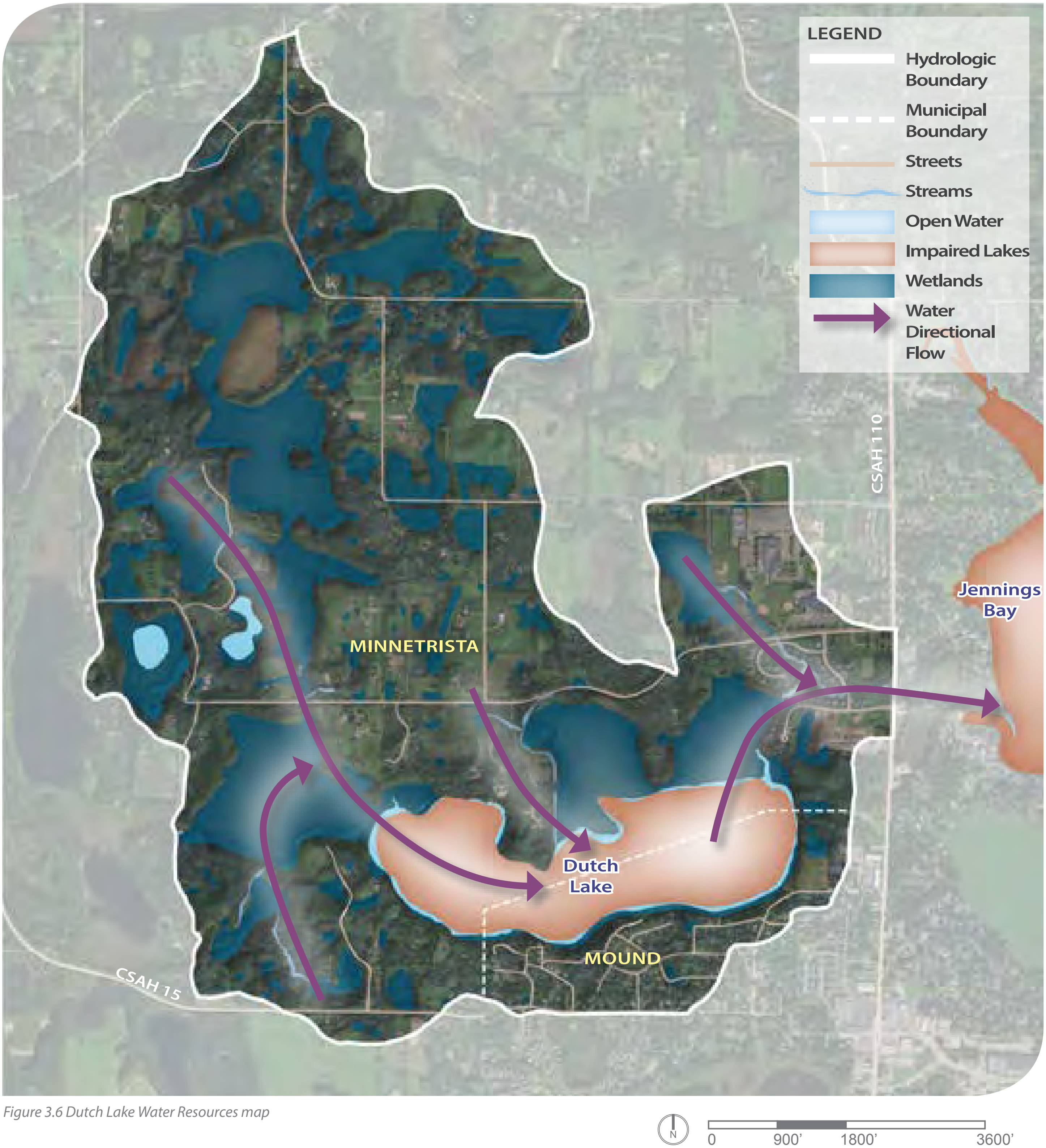


Figure 3.6 Dutch Lake Water Resources map

Wetlands

There are extensive high quality wetlands in the subwatershed. Due to the predominance and contiguity of wetlands, much of the subwatershed has been identified by the DNR as a Metropolitan Conservation Corridor and by the City of Minnetrista as a natural resources corridor. Wetland assessments have classified two wetlands in the subwatershed (one north and one west of Dutch Lake) as having excellent vegetative diversity, fish and wildlife habitat, or aesthetics. Further, these wetlands are large and have high connectivity, which makes them more likely to support notable diversity and/or abundance of wildlife. Wetlands in the subwatershed should be protected and considered for preservation to maximize habitat and biodiversity.

Uplands and Natural Corridors

Within the subwatershed, there are extensive corridors of upland habitat that should be protected. On the west side of Dutch Lake there are two native plant communities classified as Imperiled or Imperiled/Vulnerable: a 25-acre Tamarack Swamp and a 32-acre Sugar Maple-Basswood-Bitternut Hickory Forest, which are part of a native plant corridor between Dutch Lake and Long Lake/Little Long Lake.

DRIVERS

A driver of water quality, water quantity, or ecological integrity is a driving force or stressor that causes a biological community or physical structure to change. Some example drivers include increased phosphorus loading, increased impervious areas, straightened channels, and drained wetlands. Some drivers are natural, such as storm events. Most are human-caused, either directly or as a side effect of some other change such as a land use change or removal of natural land cover. This section of the Plan outlines the main drivers of water quality, water quantity, and ecological integrity issues within the Dutch Lake subwatershed.

The principal water quality, water quantity, and ecological integrity issues within the Dutch Lake subwatershed are:

Water Quality

» Excess nutrients

» Low dissolved oxygen (DO)

» Elevated chloride concentrations

Water Quantity

» Culverts may need repair or replacement

Ecological Integrity

» Fish community in Dutch Lake may be negatively impacted by reduced clarity and low DO

» Degraded aquatic plant community

» Nutrient enrichment and low DO in Dutch Creek Inlet and Outlet could negatively impact biota

These issues are primarily the result of the following drivers:

» Altered wetlands

» Carp

» Stormwater runoff

» Altered channels

» Internal sediment phosphorus loading

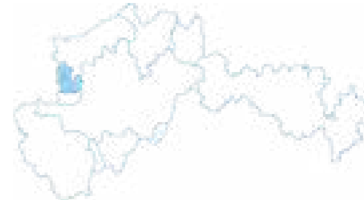
Altered Wetlands

On a watershed scale, wetlands can act as sinks, sources, or transformers (particulate to dissolved) for nutrients like phosphorus. Historically, wetlands acted as nutrient sinks within a watershed, capturing and retaining nutrients, even as nutrient loads to the wetland were increased as land use intensified. However, as wetlands were ditched and drained to facilitate watershed drainage and land use change, they often converted from a sink for nutrients to sources, by increasing the breakdown of wetland soil and the conveyance of stormwater. These processes within altered wetlands can release large pools of stored nutrients, causing nutrient impairments in downstream surface waters.

Many wetlands in the subwatershed are of high or exceptional quality, but some have been ditched or altered in the area's agricultural past. As a result of alteration, the natural hydrology of wetlands is disrupted. Water quality monitoring shows excess nutrients in Dutch Lake and Dutch Creek. Wetland alteration may have caused export of nutrients from upstream wetlands to these water bodies, contributing to water quality issues.

Carp

Invasive common carp negatively impact water quality and



Stream in Dutch Lake Subwatershed

ecological conditions in surface waters when carp dominate fish communities. Carp impact aquatic systems by their bottom feeding behavior which uproots aquatic plants, re-suspends bottom sediments, and releases nutrients into the water column. This leads to decreased water clarity and a switch to a water state dominated by algae in shallow lakes and wetlands. This turbid water condition is the least ecologically diverse state, and is often characterized by a significant loss of natural vegetation, harmful algal blooms, and the release of phosphorus from re-suspended sediments, all of which contribute to water quality impairments and the loss of fish and wildlife habitat.

Common carp were noted in the TMDL for Dutch Lake as being present and a potential source of water quality and ecological issues, but at an unknown level. Dutch Lake outlets to Jennings Bay of Lake Minnetonka, which has been confirmed to have a high abundance of common carp. A carp assessment would need to be completed in the Dutch Lake subwatershed to determine the impact carp are having in the system, and to develop management strategies.

Stormwater Runoff

Watershed runoff from rainfall events or stormwater can carry nutrients and other pollutants to surface waters leading to negative impacts in lakes, streams and wetlands. In urban and suburban areas, high proportions of impervious surfaces such as parking lots and driveways increase the volume and rate of stormwater runoff, which can cause flooding, and change stream flow in ways that negatively impact habitat for critical parts of the food-web like fish and macroinvertebrates. In rural areas drained for agriculture, the increased volume and peak flow of stormwater runoff causes similar negative impacts.

While the increased volume and rate of stormwater runoff can negatively impact physical conditions in receiving waters, the runoff also carries with it increased loads of pollution that negatively impact the quality of lakes, streams and wetlands. In urban and suburban areas, stormwater picks up excess nutrients, bacteria such as *E. coli*, chloride from road salt, and other pollutants causing toxicity to organisms or issues with excess nutrients (eutrophication). In more rural areas, stormwater mobilizes pollutants from manure and fertilizer including excess nutrients, bacteria, herbicides and pesticides.

These impacts heavily influence the conditions of surface waters because a healthy hydrologic condition is critical to supporting a healthy lake, stream or wetland. Generally as impervious cover, altered drainage, and stormwater runoff within a watershed increases, the quality of lakes, streams and wetlands decreases.

Dutch Lake is impaired for excess nutrients, and Dutch Creek has elevated total phosphorus concentrations relative to state river eutrophication standards. Runoff from lawns, streets, and agriculture in the subwatershed could be a source of nutrients and sediment to these water bodies. The Dutch Lake TMDL requires a sixty percent reduction in nutrients from stormwater runoff to meet state lake water quality standards.

Altered Channels

Historically, natural channels were straightened, widened and relocated to accommodate land use change. Channel alteration to improve watershed drainage can lead to a loss of physical habitat, increased peak flow velocities and downstream flooding, decreases in dissolved oxygen, and increased sediment transport which can negatively impact fish and macroinvertebrate communities.

There are only a few channels in the subwatershed upstream of Dutch Lake, and they have not been evaluated. Dutch Creek is relatively unaltered, but there are areas with little bank vegetation to buffer runoff and stabilize banks.

Internal Sediment Phosphorus Loading

Long-term excessive loading of phosphorus to lakes can lead to phosphorus buildup in the sediments of the lake bed. Ultimately, this phosphorus can be released from the sediment back into the water. Further exacerbating the problem, released phosphorus is typically dissolved which is readily available for plant uptake and contributes directly to algae blooms. Sediment phosphorus release can lead to summer algae blooms, poor water clarity and, in severe cases, summer fish kills and harmful algal blooms. Restoration of water quality in lakes often requires significantly reducing phosphorus release from sediments.

The Dutch Lake TMDL found that internal sediment load contributes an estimated 30 percent of the annual phosphorus load to the lake, and requires a ten percent reduction in that internal sediment load to meet state lake water quality standards.

MANAGEMENT STRATEGIES

Informed by the identification and prioritization of conditions and issues in the subwatershed and an understanding of the drivers impacting its water resources, the District has developed general strategies to guide actions in the Dutch Lake subwatershed. These strategies are both short- and long-term, and establish a framework for the Dutch Lake subwatershed Implementation Plan programs and projects.

Wetland Restoration

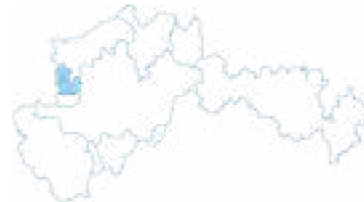
Traditional approaches to wetland restoration focus on restoring wetland channels and hydrology to support a more diverse native plant population. While this strategy addresses ecological integrity within the wetland, it often overlooks the need to alter the cycles of wetland chemistry created by historic wetland alteration, which transform and release phosphorus to downstream waterbodies.

To address both ecological integrity and the release of phosphorus, wetland restoration must focus on modifying hydrology to support the native plant community while minimizing phosphorus export. This may include, but is not limited to, bypassing flow around the wetland, the addition of nutrient filters, soil engineering or augmentation to permanently sequester phosphorus, or the development of wetland treatment cells. Selected restoration options will depend on site specific wetland conditions and hydrology, and overall needs of the subwatershed system.

Although there are large, high quality wetlands in the subwatershed, there are several wetlands that have high or moderate restoration potential. Numerous other small wetlands of moderate restoration potential are located throughout the subwatershed. If restored, these wetlands could improve vegetative diversity and provide connected habitat within the watershed in addition to improving the water quality of Dutch Lake and Dutch Creek.

Carp Management

Historically, carp management focused on removal of carp



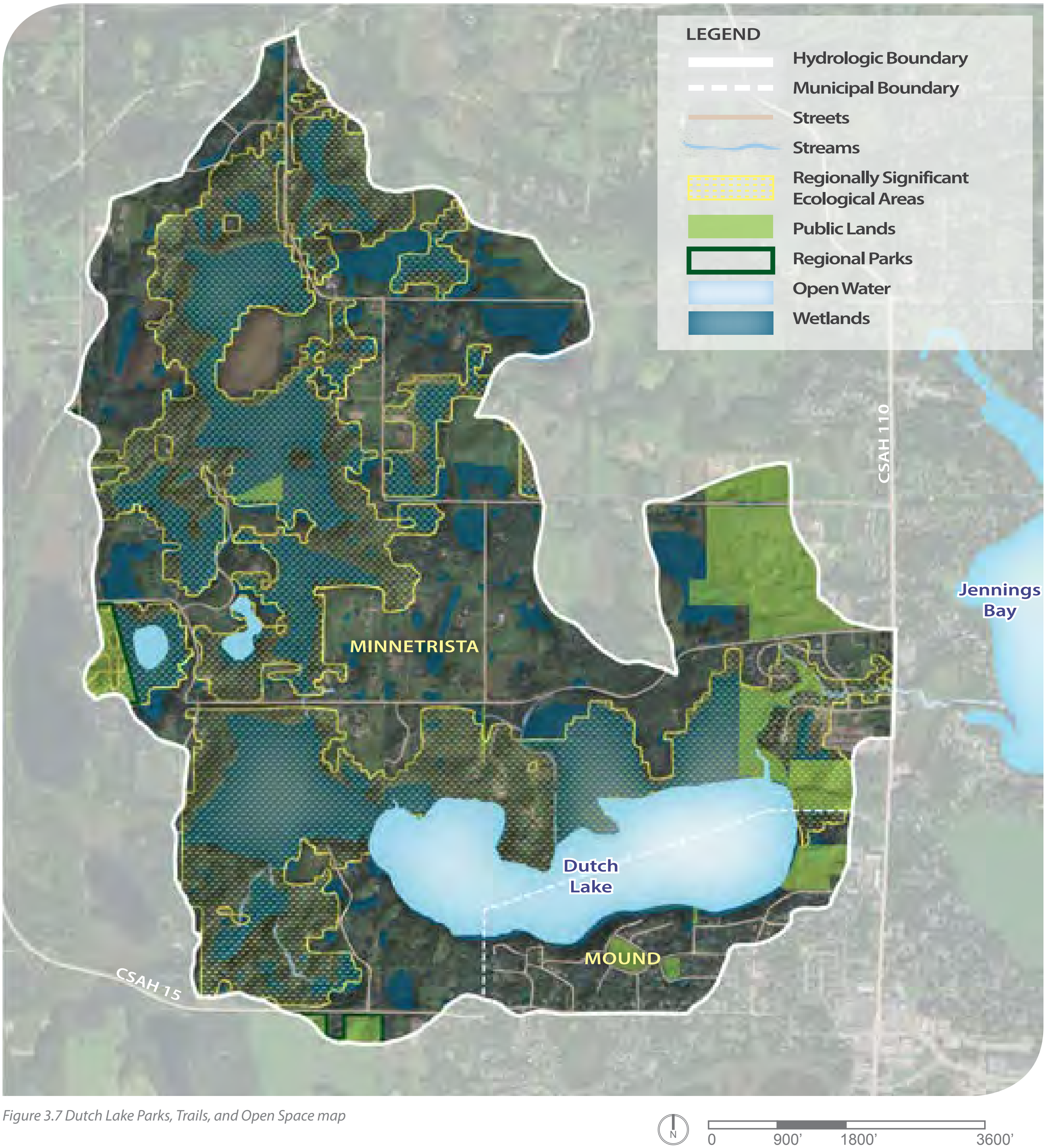


Figure 3.7 Dutch Lake Parks, Trails, and Open Space map

populations from impacted water bodies without any consideration of population dynamics such as reproduction, immigration, and emigration. More recent carp management techniques focus on integrated pest management where activities focus not only on removal, but also on the long-term prevention of carp reproduction and immigration into sensitive water bodies. These new techniques allow for sustainable control of carp populations to measurably improve shallow lake and wetland water quality, plant communities and overall ecological health.

Surveys should be conducted to determine the abundance of common carp in Dutch Lake and could warrant a subwatershed-wide assessment to inform management strategies. Carp management may need to occur prior to implementing other strategies to reduce internal loading.

Stormwater Management

Stormwater management will focus on reducing runoff volumes and rates, as well as reducing pollutant loading from runoff producing rain events. Stormwater management in the developed or developing urban and suburban areas will focus on retrofitting low impact development techniques such as ponds, filters, infiltration techniques, and other technologies where they are applicable. In the rural and agricultural areas, stormwater management will focus on buffers, improved agricultural practices such as conservation tillage, manure management for animal agriculture and hobby farms, wetland restoration and fertilizer management.

In the Dutch Lake subwatershed, the focus will be on installing infiltration and load reduction BMPs, requiring stormwater pretreatment before discharge into any wetland, and enhancing buffers along Dutch Creek. The Dutch Lake TMDL also recommended enhancing shoreline buffers to filter runoff from lakeshore turf grass lawns. The District is also considering other strategies to reduce nutrient loads from the subwatershed. These include promoting repair or replacement of failing septic systems, assessing phosphorus loading from Camp Christmas Tree, and implementing BMPs on the Camp Christmas Tree property if necessary.

Stream Channel Restoration

Stream restoration focuses on balancing stormwater conveyance to prevent flooding and channel erosion while providing high quality habitat for fish and macroinvertebrates. Restoration includes, where applicable, improving channel sinuosity, stabilizing streambanks, controlling peak flow velocities, increasing channel roughness for habitat and re-aeration, narrowing stream channels to improve wetted width and ecological baseflow, and increasing stream structure.

Dutch Creek and other channels in the watershed should be investigated for restoration potential. While there is no biologic monitoring data available to document whether current conditions are stressful to aquatic life, Dutch Creek could benefit from streambank stabilization, buffer enhancement, improvements to stream aeration, and habitat enhancement.

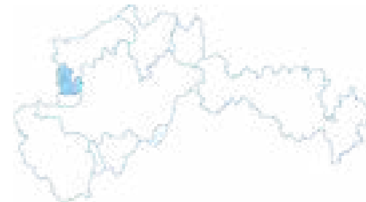
Internal Sediment Phosphorus Control

Reducing or eliminating phosphorus release from sediments is often essential to meet water quality standards in lakes. There are several techniques available for controlling sediment phosphorus release including sediment phosphorus inactivation using a chemical such as aluminum, oxygenation to prevent sediment anoxia, hypolimnetic aeration and iron addition to prevent phosphorus release, or hypolimnetic withdrawal. While all the techniques can be effective, the application of aluminum to sediments using aluminum sulfate (alum) or a mixture of sodium aluminate and alum is typically the most cost effective approach for reducing sediment phosphorus release.

Once nutrient loads from the subwatershed have been reduced and common carp managed to low densities, an internal load reduction strategy, such as alum treatment or a flocculation system, should be considered for Dutch Lake. Additional data will need to be collected to determine appropriate treatment options.

Watershed Protection

Several subwatersheds, especially in the western part of the watershed, are rapidly converting from undeveloped or rural land uses to developments which can increase impervious areas, reduce flood storage, increase pollutant loads, and eliminate or reduce biologically significant land cover. A critical strategy to maintain existing resources and critical functions is to protect these areas by minimizing the impacts of development. This is accomplished by conserving biologically significant upland



Tamarack trees in Turner Wetland

areas, protecting high value wetlands, mimicking natural watershed hydrology, maintaining stream geomorphology, protecting stream buffers and riparian areas, and protecting critical fish and wildlife corridors.

There are extensive high quality wetlands and uplands in the subwatershed. Much of the subwatershed has been identified by the DNR as a Metropolitan Conservation Corridor and by the City of Minnetrista as a natural resources corridor. These natural areas are large and have high connectivity, creating corridors of habitat between Dutch Lake and Long Lake/Little Long Lake. The focus in this subwatershed will be to preserve these high-value resources through Land Conservation, where appropriate, and by working with cities and developers to minimize disturbance during development and construction.

LAND USE

EXISTING CONDITIONS

The subwatershed includes portions of the cities of Mound and Minnetrista. Land use in the subwatershed is generally characterized by undeveloped land (50%), including numerous large wetland systems and wooded areas, low-density development (20%), agricultural uses (10%), parks and open spaces (6%), and water (10%). The subwatershed includes large areas of undisturbed or minimally disturbed wetland and wooded areas. Much of the subwatershed has been identified by the DNR as a Metropolitan Conservation Corridor and by the City of Minnetrista as a natural resources corridor due to the predominance and contiguity of wetlands.

LOCAL PLANS AND PRIORITIES

As described in the District's goals (Section 3.3), the District strives to implement its clean water objectives in ways that meaningfully contribute to the development of thriving communities. This is achieved through collaboration and integrated planning with public and private partners.

As part of the development of this plan, the District reached out to its communities to gather information on local goals, plans, and priorities for 2018-2027 (see Appendix B for details on the public input process). This information was used to broadly characterize opportunities, and to inform the development of the District's implementation plans. The information received

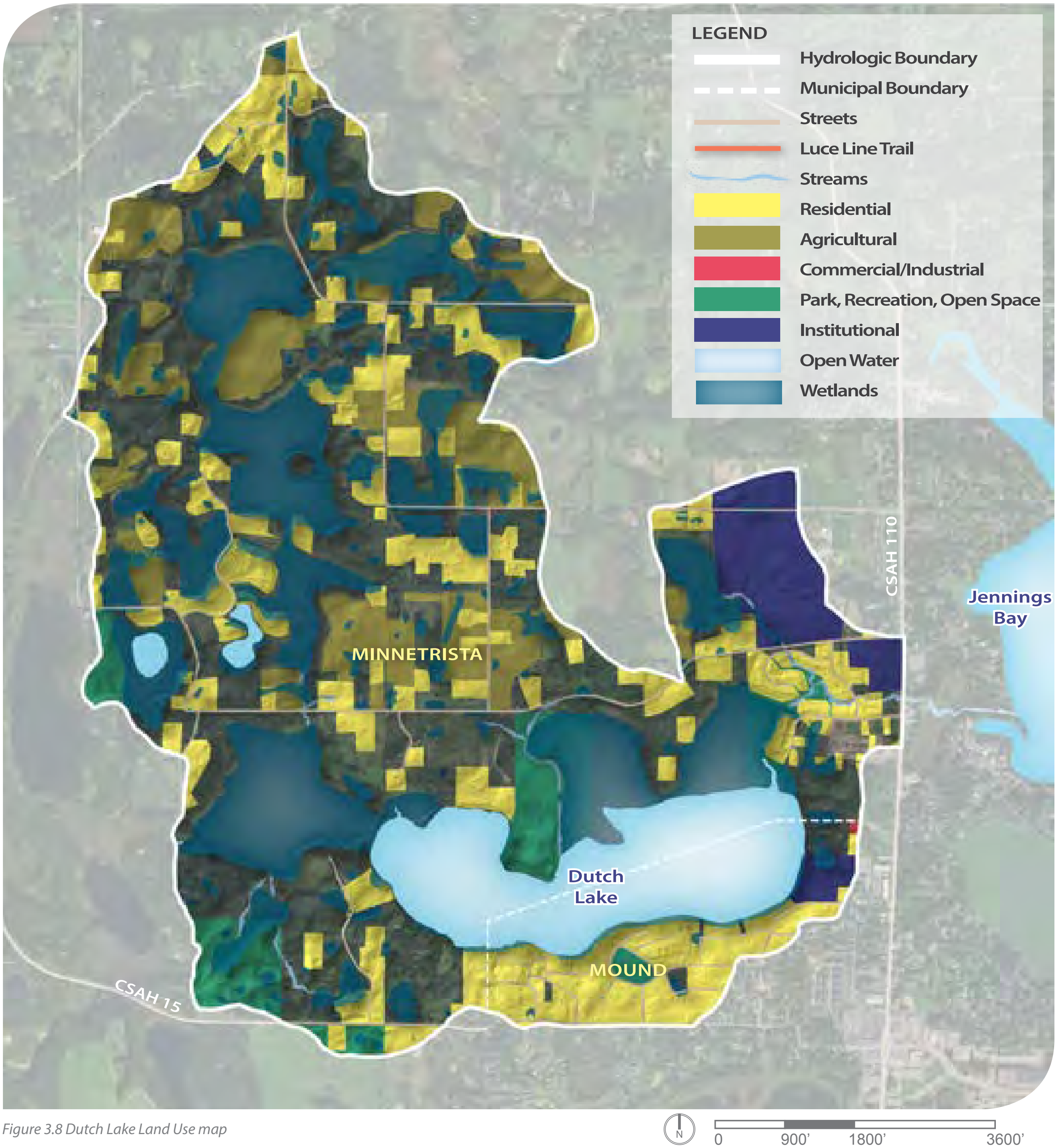
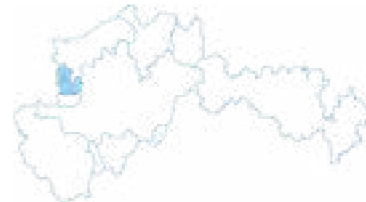


Figure 3.8 Dutch Lake Land Use map



was used only as a guide during the development of this Plan to inform the District of opportunities for partnership on the near term horizon, and was not intended to be exhaustive or restrict future collaborative efforts.

As discussed in Section 3.6, the District intends to cultivate a framework for two-directional coordination with communities on an ongoing basis, to stay apprised of emerging needs at a local level, and to identify and evaluate opportunities to implement management strategies outlined in this Plan over the next ten years. The District recognizes that local needs, opportunities and priorities may shift over time. Therefore, this Plan does not intend to capture or prescribe opportunities for partnership over a ten-year term.

Long term goals, growth and private development, and public investment in infrastructure differ across each community – and therefore, frameworks for ongoing coordination will be custom tailored based on the individual needs of each community. Coordination may occur at varying levels, through various means, with communities across the following areas:

- Regulation of, and partnership with, private development
- Collaboration on public planning and investment (e.g. parks , roads, utilities)
- MS4 compliance
- Development and implementation of TMDLs

During the information gathering processes of this Plan, one of the priorities identified by cities in the Dutch Lake Subwatershed was maintaining the area's rural character and access to natural resources. There was little anticipated for development or infrastructure investment within this subwatershed in the near-term, though some single family home rebuilds on Dutch Lake are expected.

There is an active lake association for Dutch Lake that is working to expand its membership. The Association plans to conduct outreach efforts to promote native shoreline plantings and residential stormwater management through raingardens or other BMPs.

IMPLEMENTATION PLAN

The goals set forth in this subwatershed plan will require an integrated set of programs and projects oriented toward the conservation and improvement of water resources within the watershed. The Implementation Priorities section generally describes the actions that the District and its partners will look to take in order to address the issues present in the subwatershed and achieve the goals as set forth in the plan. The Capital Improvement Plan (CIP) provides cost estimates and schedules for any proposed capital investments.

IMPLEMENTATION PRIORITIES

As described in previous sections, Dutch Lake is impaired by excess nutrients, and the inlet and outlet of Dutch Lake have elevated levels of total phosphorus. The outlet of Dutch Lake is also at high risk of chloride impairment. The fish and vegetation communities in Dutch Lake and its inlet and outlet may be negatively impacted by nutrient enrichment, low dissolved oxygen, and reduced water clarity. The subwatershed also contains areas of high quality, extensively connected wetland and upland, including several regionally significant ecological areas.

Based on these conditions, management strategies within the subwatershed will focus on promoting infiltration, reducing pollutant loading, managing carp, improving biodiversity and protecting existing resources.

The Dutch Lake subwatershed is relatively small and there is little anticipated for development or infrastructure investment within this subwatershed in the near-term, so the District expects limited opportunities to arise from land use change. However, the Plan establishes a coordination framework through which the District will seek to maintain current knowledge of land use and capital planning by its LGUs, and of potential land use development and redevelopment activity.

As opportunities arise, the District will evaluate them against the resource needs and priorities defined throughout this plan and determine the appropriate response. The District has a wide range of services it can mobilize to address resource needs and support partner efforts, including data collection and diagnostics, technical and planning assistance, permitting assistance, education and capacity building, grants, and capital projects.

In 2012, the District installed a sand-iron filter on the creek that flows into the northwest side of Dutch Lake in order to remove dissolved phosphorus. The project showed a significant reduction in phosphorus levels initially, but its performance has declined. The District is investigating why performance has declined and will seek to restore and maintain project function.

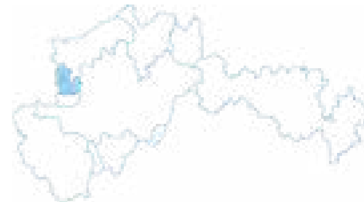
High quality wetlands and uplands in the subwatershed are extensive. The focus in this subwatershed will be to preserve these high-value resources through Land Conservation, where appropriate, and by working with cities and developers to minimize disturbance during development and construction.

The District may pursue a carp assessment for the Dutch Lake subwatershed as part of a larger assessment for the northwestern bays of Lake Minnetonka and their tributary subwatersheds. The goal of the assessment would be to understand the movement and recruitment patterns of carp in the system to inform management efforts. This work will be dependent on the District's ability to secure partner support and funding.

Dutch Creek was identified as being at high risk for chloride impairment. The District will continue to monitor chloride levels and provide education and training for public and private applicators and residents on best practices for chloride use.

As noted in the previous section, there is an active lake association for Dutch Lake. The District will continue to work with its lake associations to provide education and technical assistance to build their capacity and target implementation efforts.

To allow the District the flexibility to respond to opportunities identified by the cities or other partners, or that may arise through land-use change, the capital improvement plan for this subwatershed includes a project for stormwater management. In the future, should the District or a partner determine that a larger or more concentrated scale of capital and program implementation may be needed, a discrete subwatershed planning process may be initiated to:



ISSUE

- Excess nutrients from stream input
- Low dissolved oxygen
- Elevated chloride concentrations
- Culverts may need repair or replacement
- Biota may be impacted by poor quality
- Degraded aquatic plant community

DRIVER

- Altered wetlands
- Carp
- Stormwater runoff
- Altered channels
- Internal sediment phosphorous loading

STRATEGY

- Wetland restoration
- Carp management
- Stormwater management
- Stream channel restoration
- Internal sediment phosphorous control
- Watershed protection

IMPLEMENTATION PRIORITIES

- Resource protection through regulation
- Early coordination and integration with land use planning
- Opportunity-driven stormwater management projects/grants
- Carp assessment
- Maintenance of sand-iron filter on inlet to dutch lake
- Land conservation/corridor connection
- Education and training on best practices for chloride use
- Education and capacity-building for lake associations

» Provide high resolution diagnostic of watershed issues and drivers

» Map current projected land use and infrastructure changes

» Define a detailed and integrated capital and program implementation plan

» Outline a funding strategy including program costs and sources

The details of such a plan would provide the information needed for the District to pursue a plan amendment under MN Rules 8410, thereby updating specific subwatershed components of this Plan.

CAPITAL IMPROVEMENT PLAN

The CIP is a planning tool. It also is a means to inform partners, District residents, and other interested parties as to the District's scope and priorities for its capital work over the planning period. A project's inclusion in the CIP does not mean that the project will be constructed, only that the District has identified it as an action that may be a cost-effective way for the District to achieve identified water resource goals. A project identified in the CIP always will need further review as to technical feasibility, cost and financing, consistency with local needs, and other policy considerations before a formal decision to proceed to construction is made. Section 3.5.5 describes the development and evaluation steps that will occur before the District will commit resources to a project.

Section 3.5.5 also describes how the District will review the CIP on an ongoing basis throughout the planning period. This review will allow the District to reassess described projects from a technical perspective, but also will involve broader policy considerations such as shifts in District priorities, decisions as to annual budget and levy levels, and the prospect of state and federal grant funds or financing. For this reason, projects may be added to and deleted from the CIP from year to year, in accordance with those procedures.

A critical component of any project will be the development of a funding strategy that identifies the sources, uses, and timing of funds needed to successfully achieve identified goals. These plans will be developed in conjunction with the District's public and private partners as capital projects are advanced. Therefore, any costs identified within this Plan are projections. Intended expenditures will be refined during project development and budgeting, and among other things will reflect the District's intent to complement its ad valorem funds with other funding sources.

Table 3.6 Dutch Lake Subwatershed CIP

Project	**Stormwater Volume and Pollutant Load Reduction**
Description	Implementation of opportunities to reduce stormwater volumes and nutrient loading to Dutch Lake and downstream Jennings Bay, including but not limited to infiltration or filtration basins and devices, reforestation, revegetation, and stormwater detention or redirection.
Need	Dutch Lake exceeds state excess nutrient standards. A TMDL identified a need to reduce external phosphorus loading by 60% (193 pounds) to Dutch Lake.
Outcome	Reduction of pollutant loading to Dutch Lake and downstream Jennings Bay; reduction of stormwater runoff volume and rate and associated impacts; protection and enhancement of groundwater recharge, stream base flow, and wetland hydrology.
Estimated Cost	Capital costs: $780,000, excluding land, in 2017 dollars.
Potential Funding Sources	District levy, partner contributions, grants
Schedule	2018-2027

3.9.3 GLEASON LAKE SUBWATERSHED PLAN

INTRODUCTION

This subwatershed plan contains information specific to the Gleason Lake Subwatershed, including existing conditions and issues, drivers, management strategies, land use information, and an implementation plan. Information regarding the District's philosophy, goals, and implementation approach can be found in Sections 3.2-3.4 and should be reviewed first to provide context for the following subwatershed plan.

EXECUTIVE SUMMARY

Gleason Lake is a 6.8 square mile (4,365 acre) subwatershed located along the northern boundary of the MCWD and includes portions of the cities of Minnetonka, Orono, Plymouth and Wayzata. The subwatershed is generally characterized by low density development, including many single-family homes (58%), water (9%), parks and open spaces (8%), and undeveloped land (7%). The subwatershed contains several lakes, including Gleason, Hadley, Mooney, Kreatz and Snyder. Some scattered wetlands are identified as having high vegetative diversity and wildlife habitat.

The eastern portion of the subwatershed drains through several wetlands including Kreatz and Snyder Lakes and then to County Ditch #15, which discharges into Gleason Lake. The western watershed drains through Hadley Lake and then south to Gleason Lake Creek, which outlets the south end of Gleason Lake and flows by channel and culvert to Glenbrook Pond. The Pond outlets to a storm sewer that discharges downstream to Wayzata Bay. Mooney Lake is naturally land-locked, but the City of Plymouth, in coordination with the District, maintains the capacity to reduce high water by pumping from the lake toward Hadley Lake.

Gleason Lake subwatershed has several issues relating to water quality, water quantity and ecological integrity. Four lakes in the subwatershed, Mooney, Kreatz, Gleason and Hadley are listed on the State's Impaired Waters list for excessive nutrients. One county ditch also has elevated levels of total phosphorus and chloride. Modeling predicts that the subwatershed will experience localized flooding during large rain or snowmelt events due to overtopping of infrastructure. Overall, the system has moderate ecological integrity. There are areas of high quality wetland, which must be protected, but the lower watershed lacks high-quality wetland and habitat connectivity. There are also impaired macroinvertebrate and fish communities within the subwatershed, as well as invasive vegetation and low dissolved oxygen.

Management strategies within Gleason Lake subwatershed will focus on promoting infiltration, reducing pollutant loading, improving biodiversity and protecting existing resources. The District will collaborate on these management strategies with local and state government, developers, lake associations, citizens' groups and other parties to implement. This is summarized in the Implementation Plan.

RESOURCE NEEDS

EXISTING CONDITIONS AND ISSUES

This section of the Plan outlines existing conditions and water resource issues, categorized by water quality, water quantity, and ecologic integrity. Condition information was compiled from community input, monitoring data, special studies, the Hydrologic and Hydraulic Pollutant Loading Study (HHPLS), Minnehaha Creek and Upper Watershed Stream Assessments, the Functional Assessment of Wetlands (FAW), Total Maximum Daily Load (TMDL) studies, and state and regional land use and land cover data. A review of these conditions and data revealed several issues and concerns that may require action on the part of the District or its partners. More detailed information about the Gleason Lake subwatershed may be found in Volume 2: Land and Natural Resources Inventory.

Water Quality

Lakes and Streams

Four lakes in the subwatershed are listed on the State's Impaired Waters list, with average summer nutrient concentrations greater than the state standard: Gleason, Hadley, Mooney and Kreatz Lakes. In addition, Snyder Lake exceeds the state water quality standards, but does not meet the state's size threshold for impairment. A TMDL identifying nutrient load reduction goals and suggested actions has been completed for those lakes. Water quality data are limited for the other lakes in the subwatershed.

The inlet to Gleason Lake has elevated levels of total phosphorus and chloride. Gleason Creek, the outlet to Gleason Lake, also has elevated levels of chloride.

GLEASON LAKE SUBWATERSHED

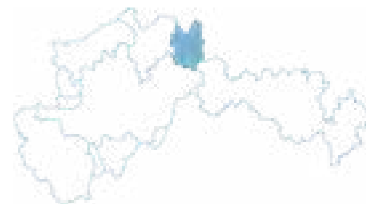


Figure 3.9 Gleason Lake Base map

Wetlands
Most of the wetlands in the subwatershed have been impacted by development and stormwater inflow, and serve mainly to protect downstream water quality.

Groundwater
There are areas of aquifer sensitivity in the subwatershed. The entire Gleason Lake subwatershed has been designated by the Minnesota Department of Health as a Drinking Water Supply Management Area and as a Wellhead Protection Area for City of Plymouth public wells. As development occurs and infiltration is proposed to meet water quality and volume control standards, special attention should be paid in areas of aquifer sensitivity and wellhead protection areas.

Water Quantity
Locations throughout the system have been identified through observation and the District's modeling as vulnerable to localized flooding.

Many of the wetlands in this subwatershed are groundwater-fed discharge or recharge-discharge wetlands. Groundwater recharge is important within the subwatershed to maintain wetland hydrology and stream baseflow, as well as to recharge aquifers that supply public and private drinking water wells.

Nearly the entire subwatershed is within a Wellhead Protection Area and there may be restrictions on the use of infiltration as a water quality practice.

Mooney Lake has no natural outlet. In 2007, the City of Plymouth and the District undertook a cooperative project to install infrastructure to support future emergency pumping, including an outlet pipe, lift station, and connection to the Plymouth storm sewer system. Plymouth is responsible for operating the system, and the District is responsible for monitoring downstream areas and potential adverse impacts.

Ecological Integrity
Lakes and Streams
Data suggest that Gleason Lake maintains a moderately healthy fishery and vegetation community, although the vegetation community lacks biodiversity. Curly leaf pondweed is present and has been managed in the lake.

Gleason Creek also has a highly degraded macroinvertebrate community dominated by pollution-tolerant species. The Creek experiences periods of low dissolved oxygen. No fish data are available for any streams within the subwatershed.

Gleason Lake

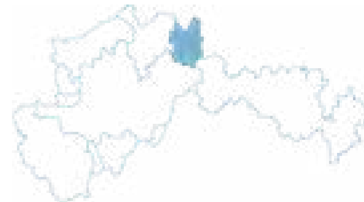
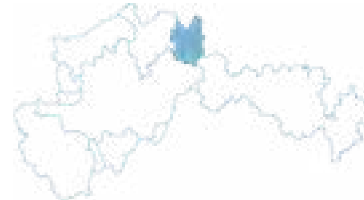


Figure 3.10 Gleason Lake Water Resources map

Figure 3.11 Gleason Lake Pakrs, Trails, and Open Space map



Wetlands

Scattered wetlands have been identified as having high vegetative diversity and wildlife habitat, as well as high aesthetic values. Two large wetlands scored highly on vegetative diversity, fish and wildlife habitat or aesthetics. Wetlands with these qualities are in need of protection. Their conservation is integral to achieving ecological integrity, water quality, stormwater management and floodplain management goals.

One small wetland within in the watershed has high restoration potential and a few small wetlands have moderate restoration potential.

Uplands and Natural Corridors

Uplands in the subwatershed are mostly developed, with few intact areas of minimal disturbance. The Minnesota Biological Survey (MBS) did not identify any landscape areas of biological significance in this subwatershed. Some wooded and wetland areas around Hadley Lake and a few pocket wetlands and wooded areas elsewhere in the subwatershed provide the most significant areas of habitat and biological integrity.

DRIVERS

A driver of water quality, water quantity, or ecological integrity is a driving force or stressor that causes a biological community or physical structure to change. Some example drivers include increased phosphorus loading, increased impervious areas, straightened channels, and drained wetlands. Some drivers are natural, such as storm events. Most are human-caused, either directly or as a side effect of some other change such as a land use change or removal of natural land cover. This section of the Plan outlines the main drivers of water quality, water quantity, and ecological integrity issues within the Gleason Lake subwatershed.

The principal water quality, water quantity, and ecological integrity issues within the Gleason Lake subwatershed are:

Water Quality

- Excess nutrients in lakes and streams
- Low dissolved oxygen
- Elevated chloride concentrations in streams

Water Quantity

- Localized flooding
- Emergency pumping from Mooney Lake

Ecological Integrity

- Degraded macroinvertebrate community
- Degraded and disconnected wetland and terrestrial corridors

These issues are primarily the result of the following drivers:

- Altered wetlands
- Stormwater runoff
- Altered channels
- Internal sediment phosphorus loading
- Water quality from upstream waterbodies

Altered Wetlands

On a watershed scale, wetlands can act as sinks, sources, or transformers (particulate to dissolved fraction) for nutrients like phosphorus. Historically, wetlands acted as nutrient sinks within a watershed, capturing and retaining nutrients, even as nutrient loads to the wetland were increased as land use intensified. However, as wetlands were ditched and drained to facilitate watershed drainage and land use change, they often converted from a sink for nutrients to sources, by increasing the breakdown of wetland soil and the conveyance of stormwater. These processes within altered wetlands can release large pools of stored nutrients, causing nutrient impairments in downstream surface waters.

There are scattered wetlands in the Gleason Lake subwatershed. County Ditch #15, which flows south through open channel and storm sewer along Dunkirk Lane, flows though some ponds and small remnant wetlands. South of County Road 6 it flows through a pond/wetland system before discharging into Gleason Lake. Nutrient concentrations in the channel at the lake's inlet are elevated, which is likely a combination of nutrient load from the urbanized subwatershed and load from sediment release in the altered wetlands.

Stormwater Runoff

Watershed runoff from rainfall events, or stormwater, can carry nutrients and other pollutants to surface waters leading to negative impacts in lakes, streams and wetlands. In urban and suburban areas, high proportions of impervious surfaces such as parking lots and driveways increase the volume and rate of stormwater runoff, which can cause flooding, and change stream flow in ways that negatively impact habitat for critical parts of the food-web like fish and macroinvertebrates. In rural areas drained for agriculture, the increased volume and peak flow of stormwater runoff causes similar negative impacts.

While the increased volume and rate of stormwater runoff can negatively impact physical conditions in receiving waters, the runoff also carries with it increased loads of pollution that negatively impact the quality of lakes, streams and wetlands. In urban and suburban areas, stormwater picks up pollutants such as excess nutrients, bacteria (e.g., *E. coli*), chloride from road salt, and toxic pollutants. In more rural areas, stormwater mobilizes pollutants from manure and fertilizer including excess nutrients, bacteria, herbicides and pesticides.

These impacts heavily influence the conditions of surface waters, because a healthy hydrologic condition is critical to supporting a healthy lake, stream or wetland. Generally, as impervious cover, altered drainage, and stormwater runoff within a watershed increase, the quality of lakes, streams and wetlands decreases.

Gleason, Hadley, Mooney and Kreatz Lakes exceed the state standard for total phosphorus, and Gleason Creek has elevated levels of phosphorus and chloride. Runoff from lawns and streets in the subwatershed could be a source of phosphorus and chloride to these water bodies. The Upper Watershed Lakes TMDL requires reductions in nutrients from stormwater runoff to meet state lake water quality standards in each lake by 64, 41, 89, and 33 percent respectively.

Altered Channels

Historically, natural channels were straightened, widened and relocated to accommodate land use change. Channel alteration to improve watershed drainage can lead to a loss of physical habitat, increased peak flow velocities and downstream flooding, decreases in dissolved oxygen, and increased sediment transport which can negatively impact fish and macroinvertebrate communities.

At least two altered channels exist within the Gleason Lake subwatershed. County Ditch #15 drains the upper watershed to Gleason Lake. County Ditch #32 is the channelized portion of Gleason Creek, the outlet of Gleason Lake. Gleason Creek has a highly degraded macroinvertebrate community, which is likely due in part to habitat degradation that occurred when the stream was channelized. No data exist for macroinvertebrate communities in County Ditch #15.

Internal Sediment Phosphorus Loading

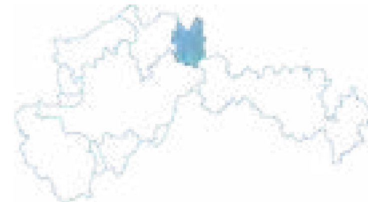
Long term excessive loading of phosphorus to lakes can lead to phosphorus buildup in the sediments of the lake bed. Ultimately, this phosphorus can be released from the sediment back into the water. Further exacerbating the problem, released phosphorus is typically dissolved which is readily available for plant uptake and contributes directly to algae blooms. Sediment phosphorus release can lead to summer algae blooms, poor water clarity and, in severe cases, summer fish kills and harmful algal blooms. Restoration of water quality in lakes often requires significantly reducing phosphorus release from sediments.

Internal loading does not appear to be a significant issue for Mooney and Kreatz Lakes, but the Upper Watershed Lakes TMDL requires reductions in nutrients from internal sources to meet state lake water quality standards of 50 percent in Gleason Lake and 54 percent in Hadley.

Upstream Waterbodies

Headwater streams, lakes and wetlands contribute water and nutrients to downstream receiving waters impacting the quality of these water bodies. Lakes and wetlands with poor water quality ultimately contribute nutrients to downstream waters that can lead to eutrophication. Consequently, restoration of upstream water bodies is often a critical component of improving downstream water quality on a watershed scale.

Mooney Lake is upstream of Hadley Lake, which is tributary to Gleason Lake. Kreatz and Snyder Lakes are also upstream of Gleason Lake, which exceeds the state standard for total phosphorus. High-phosphorus discharge from these upstream



lakes likely contributes to elevated phosphorus concentrations to tributary lakes and eventually to Gleason Lake.

MANAGEMENT STRATEGIES

Informed by the identification and prioritization of conditions and issues in the subwatershed and an understanding of the drivers impacting its water resources, the District has developed general strategies to guide actions in the Gleason Lake subwatershed. These strategies are both short- and long-term, and establish a framework for the Gleason Lake subwatershed Implementation Plan programs and projects.

Wetland Restoration

Traditional approaches to wetland restoration focus on restoring wetland channels and hydrology to support a more diverse native plant population. While this strategy addresses ecological integrity within the wetland, it often overlooks the need to alter the cycles of wetland chemistry created by historic wetland alteration, which transform and release phosphorus to downstream waterbodies.

To address both ecological integrity and the release of phosphorus, wetland restoration must focus on modifying hydrology to support the native plant community while minimizing phosphorus export. This may include, but is not limited to, bypassing flow around the wetland, the addition of nutrient filters, soil engineering or augmentation to permanently sequester phosphorus, or the development of wetland treatment cells. Selected restoration options will depend on site specific wetland conditions and hydrology, and overall needs of the subwatershed system.

The District has identified one small wetland within in the watershed with high restoration potential and several small wetlands with moderate restoration potential.

Stormwater Management

Stormwater management will focus on reducing runoff volumes and rates, as well as reducing pollutant loading from runoff producing rain events. Stormwater management in the developed or developing urban and suburban areas will focus on retrofitting low impact development techniques such as ponds, filters, infiltration techniques, and other technologies where they are applicable. In the rural and agricultural areas, stormwater management will focus on buffers, improved agricultural practices such as conservation tillage, manure

Hadley Lake

management for animal agriculture and hobby farms, wetland restoration and fertilizer management.

In the Gleason Lake subwatershed, the focus will be on installing infiltration and load reduction BMPs, requiring stormwater pretreatment before discharge into any wetland, enhancing buffers along streambanks, regulating freeboard required on new developments and redevelopments, and requiring local plans to discuss flood prevention and mitigation. In addition, actions to limit new or reduce existing stormwater volumes to Mooney Lake will help to minimize adverse effects from high water levels.

Stream Channel Restoration

Stream restoration focuses on balancing stormwater conveyance to prevent flooding and channel erosion while providing high quality habitat for fish and macroinvertebrates. Restoration includes, where applicable, improving channel sinuosity, stabilizing streambanks, controlling peak flow velocities, increasing channel roughness for habitat and re-aeration, narrowing stream channels to improve wetted width and ecological baseflow, and increasing stream structure.

In the Gleason Lake subwatershed, there are limited options to restore streams to more natural conditions. However, County Ditches #15 and #32, Gleason Creek, and other channels should be comprehensively inspected to determine the extent of any current or potential erosion and restoration needs. In 2012, the District partnered with the City of Plymouth to complete a stream stabilization project.

Internal Sediment Phosphorus Control

Reducing or eliminating phosphorus release from sediments is often essential to meet water quality standards in lakes. There are several techniques available for controlling sediment phosphorus release including sediment phosphorus inactivation using a chemical such as aluminum, oxygenation to prevent sediment anoxia, hypolimnetic aeration and iron addition to prevent phosphorus release, or hypolimnetic withdrawal. While all the techniques can be effective, the application of aluminum to sediments using aluminum sulfate (alum) or a mixture of sodium aluminate and alum is typically the most cost effective approach for reducing sediment phosphorus release.

The 2014 TMDL determined that internal load plays a significant role in the water quality of Gleason and Hadley Lakes. Additional information such as bathymetry and sediment core release data is necessary to determine the most effective approach to internal load management in Hadley Lake. An alum treatment within Gleason Lake may reduce release of internal nutrient loads.

Restoration of Upstream Waterbodies

Upstream water bodies that are currently impaired can discharge large nutrient loads to downstream water bodies thereby contributing to downstream water quality impairments. Therefore, prior to, or concurrent with, significant efforts to restore downstream water quality, the water quality in upstream water bodies must be improved. Nutrient impaired upstream lakes may require external and internal nutrient reductions using the strategies listed in this section.

The 2014 Upper Watershed Lakes TMDL determined that phosphorus export from stream water bodies such as Mooney, Hadley, Kreatz and Snyder Lakes and several wetlands, was contributing to the impairment the water quality of Gleason Lake. Improvement to those upstream water bodies is essential to the improvement of Gleason Lake.

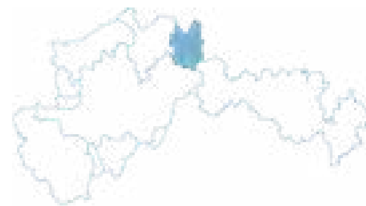
LAND USE

EXISTING CONDITIONS

Most of the subwatershed is within the city of Plymouth, with a portion of the City of Wayzata, and very small areas within Medina, Minnetonka, and Orono. The subwatershed is generally characterized by low density development, including many single-family homes (58%), water (9%), parks and open spaces (8%), and undeveloped land (7%). The subwatershed contains several lakes, including Gleason, Hadley, Mooney, Kreatz and Snyder. Some scattered wetlands are identified as having high vegetative diversity and wildlife habitat.

LOCAL PLANS AND PRIORITIES

As described in the District's goals (Sections 3.3), the District strives to implement its clean water objectives in ways that meaningfully contribute to the development of thriving communities. This is achieved through collaboration and integrated planning with public and private partners.



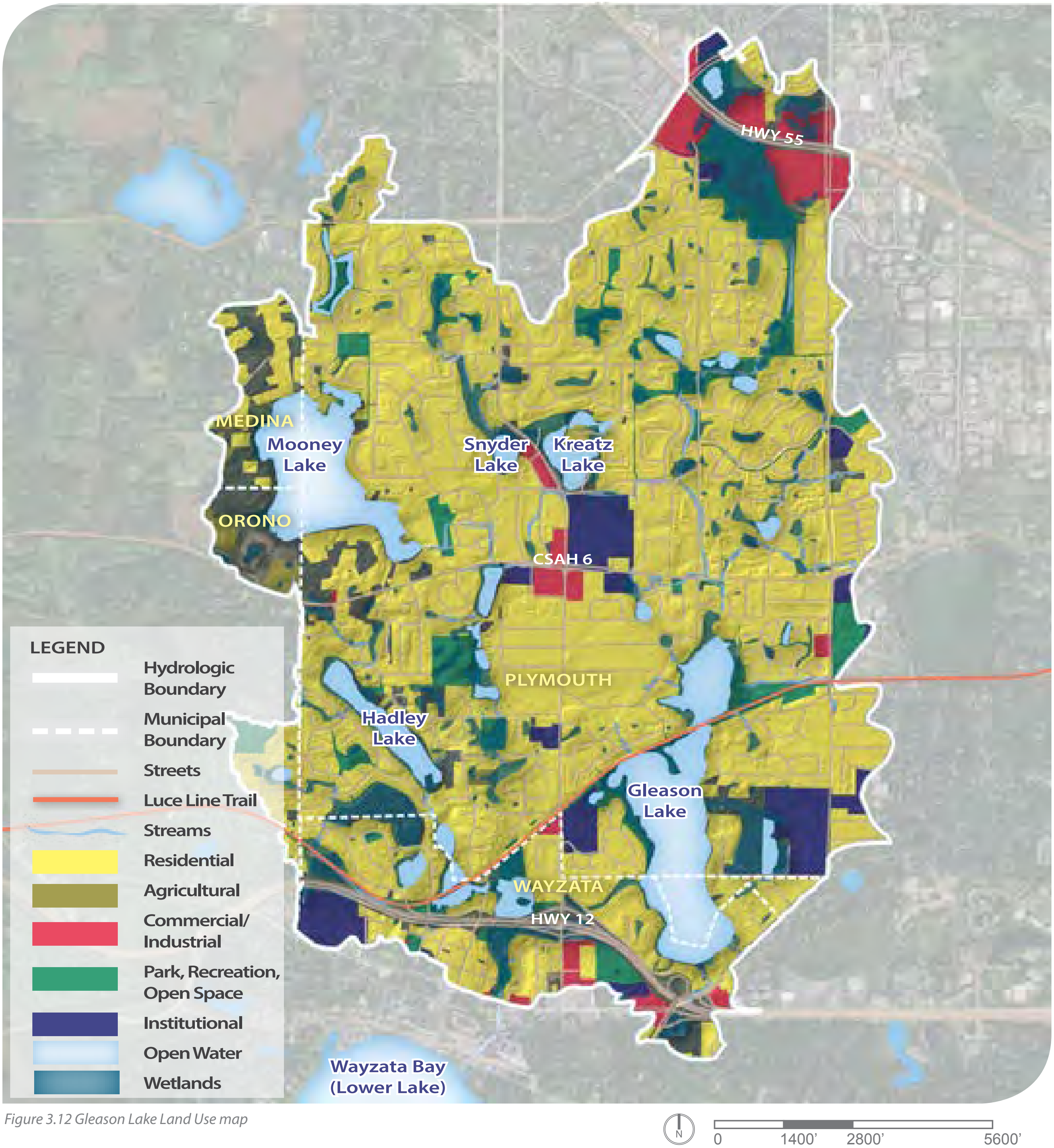


Figure 3.12 Gleason Lake Land Use map

As part of the development of this plan, the District reached out to its communities to gather information on local goals, plans, and priorities for 2018-2027 (see Appendix B for details on the public input process). This information was used to broadly characterize opportunities, and to inform the development of the District's implementation plans. The information received was used only as a guide during the development of this Plan to inform the District of opportunities for partnership on the near term horizon, and was not intended to be exhaustive or restrict future collaborative efforts.

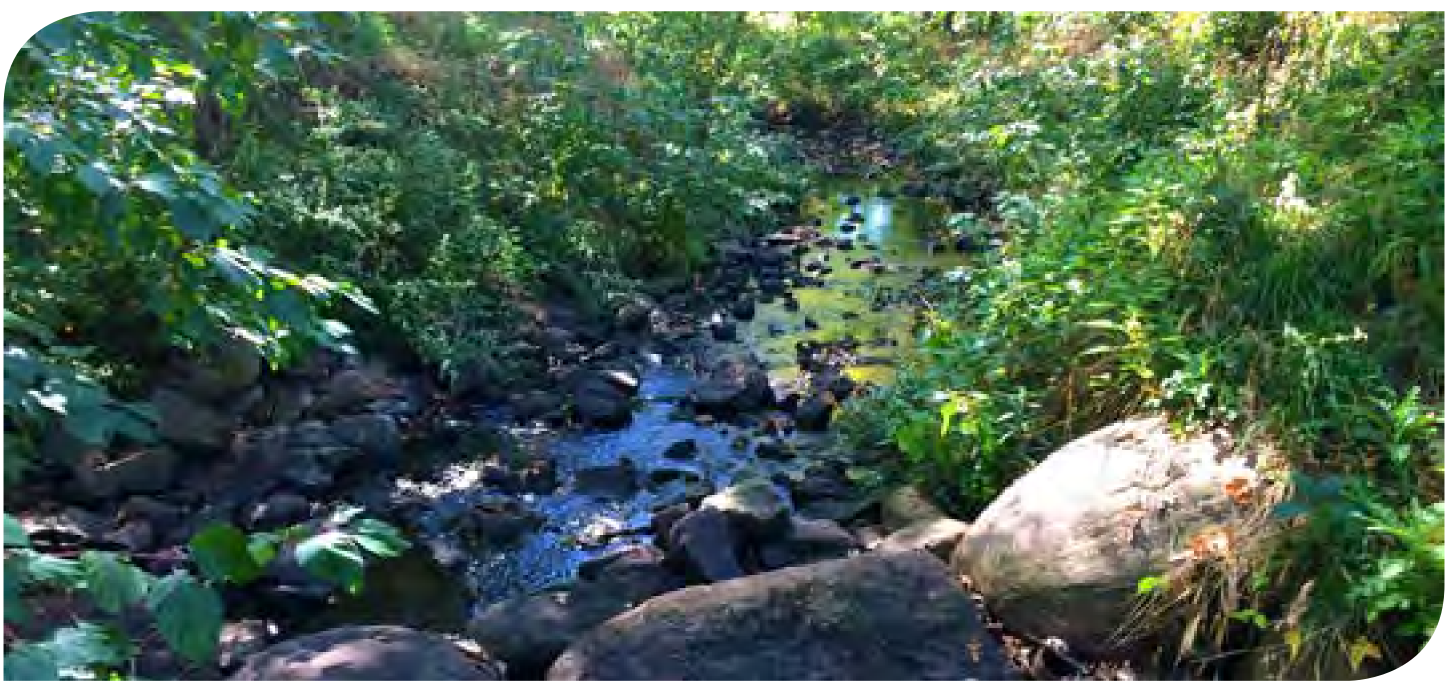
As discussed in Section 3.6, the District intends to cultivate a framework for two-directional coordination with communities on an ongoing basis, to stay apprised of emerging needs at a local level, and to identify and evaluate opportunities to implement management strategies outlined in this Plan over the next ten years. The District recognizes that local needs, opportunities and priorities may shift over time. Therefore, this Plan does not intend to capture or prescribe opportunities for partnership over a ten-year term.

Long term goals, growth and private development, and public investment in infrastructure differ across each community – and therefore, frameworks for ongoing coordination will be custom tailored based on the individual needs of each community. Coordination may occur at varying levels, through various means, with communities across the following areas:

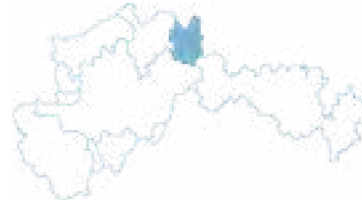
- Regulation of, and partnership with, private development
- Collaboration on public planning and investment (e.g. parks , roads, utilities)
- MS4 compliance
- Development and implementation of TMDLs

Through the information gathering processes of this Plan, the District was informed that the cities do not expect any major development to occur within the subwatershed in the near future, though there may be some pockets of residential infill. The cities will seek to incorporate stormwater Best Management Practices (BMPs) in municipal infrastructure projects, where possible. The City of Plymouth has a number of drainage improvement, stormwater management, and stream restoration projects identified in its 5-year CIP that may present opportunities for District partnership.

The City of Plymouth conducts some of its own water quality,



Chelsea Woods stream restoration



quantity, and effectiveness monitoring and also develops some education materials related to water resources. The District and City will seek to coordinate on these programmatic activities to minimize duplication of effort.

There are active lake associations for both Mooney and Gleason Lakes. The Gleason Lake Association conducts some monitoring of water quality and invasive species and has also undertaken some invasive vegetation management. The associations look to the District for technical assistance and guidance to support their management efforts.

IMPLEMENTATION PLAN

The goals set forth in this subwatershed plan will require an integrated set of programs and projects oriented toward the conservation and improvement of water resources within the watershed. The Implementation Priorities section generally describes the actions that the District and its partners will look to take in order to address the issues present in the subwatershed and achieve the goals as set forth in the plan. The Capital Improvement Plan (CIP) provides cost estimates and schedules for any proposed capital investments.

IMPLEMENTATION PRIORITIES

As described in previous sections, the Gleason Lake subwatershed has several issues relating to water quality, water quantity and ecological integrity. Four lakes in the subwatershed, Mooney, Kreatz, Gleason, and Hadley, are listed on the State's Impaired Waters list for excessive nutrients. One county ditch also has elevated levels of total phosphorus and chloride. Modeling predicts that the subwatershed will experience localized flooding during large rain or snowmelt events due to overtopping of infrastructure. There are areas of high quality wetland, which must be protected, but the lower watershed lacks high-quality wetland and habitat connectivity. There are also impaired macroinvertebrate and fish communities within the subwatershed, as well as invasive vegetation and low dissolved oxygen.

Based on these conditions, management strategies within Gleason Lake subwatershed will focus on promoting infiltration, reducing pollutant loading, improving biodiversity, and protecting existing resources. In past years, the District has worked in partnership with the cities in this subwatershed to implement regional stormwater management and stream restoration projects.

Gleason Lake

The Gleason Lake subwatershed is mostly developed and there is little anticipated near-term development within this subwatershed, so the District expects opportunities from land use change to be limited. The City of Plymouth has a number of drainage improvement, stormwater management, and stream restoration projects identified in its 5-year CIP that may present opportunities for District partnership. The Plan establishes a coordination framework through which the District will seek to maintain current knowledge of land use and capital planning by its LGUs, and of potential land use development and redevelopment activity.

As opportunities arise, the District will evaluate them against the resource needs and priorities defined throughout this plan and determine the appropriate response. The District has a wide range of services it can mobilize to address resource needs and support partner efforts, including data collection and diagnostics, technical and planning assistance, permitting assistance, education and capacity building, grants, and capital projects.

The inlet to Gleason Lake has elevated levels of total phosphorus and chloride. Gleason Creek, the outlet to Gleason Lake, also has elevated levels of chloride. The District will continue to monitor chloride levels and provide education and training for public and private applicators and residents on best practices for chloride use.

As noted in the previous section, there are active lake associations for Mooney and Gleason Lakes. The District will continue to work with its lake associations to provide education and technical assistance to build their capacity and target implementation efforts.

To allow the District the flexibility to respond to opportunities identified by the cities or other partners, or that may arise through land-use change, the capital improvement plan for this subwatershed includes a project for stormwater management. In the future, should the District or a partner determine that a larger or more concentrated scale of capital and program implementation may be needed, a discrete subwatershed planning process may be initiated to:

- » Provide high resolution diagnostic of watershed issues and drivers
- » Map current projected land use and infrastructure changes
- » Define a detailed and integrated capital and program implementation plan
- » Outline a funding strategy including program costs and sources

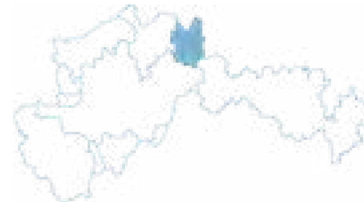
The details of such a plan would provide the information needed for the District to pursue a plan amendment under MN Rules 8410, thereby updating specific subwatershed components of this Plan.

CAPITAL IMPROVEMENT PLAN

The CIP is a planning tool. It also is a means to inform partners, District residents, and other interested parties as to the District's scope and priorities for its capital work over the planning period. A project's inclusion in the CIP does not mean that the project will be constructed, only that the District has identified it as an action that may be a cost-effective way for the District to achieve identified water resource goals. A project identified in the CIP always will need further review as to technical feasibility, cost and financing, consistency with local needs, and other policy considerations before a formal decision to proceed to construction is made. Section 3.5.5 describes the development and evaluation steps that will occur before the District will commit resources to a project.

Section 3.5.5 also describes how the District will review the CIP on an ongoing basis throughout the planning period. This review will allow the District to reassess described projects from a technical perspective, but also will involve broader policy considerations such as shifts in District priorities, decisions as to annual budget and levy levels, and the prospect of state and federal grant funds or financing. For this reason, projects may be added to and deleted from the CIP from year to year, in accordance with those procedures.

A critical component of any project will be the development of a funding strategy that identifies the sources, uses, and timing



of funds needed to successfully achieve identified goals. These plans will be developed in conjunction with the District's public and private partners as capital projects are advanced. Therefore, any costs identified within this Plan are projections. Intended expenditures will be refined during project development and budgeting, and among other things will reflect the District's intent to complement its ad valorem funds with other funding sources.

ISSUE

- Excess nutrients
- Low dissolved oxygen
- Elevated chloride concentrations
- Localized flooding
- Emergency pumping from Mooney Lake
- Degraded macroinvertebrate community
- Degraded and disconnected corridors

DRIVER

- Altered wetlands
- Stormwater runoff
- Altered channels
- Internal sediment phosphorous loading
- Water quality from upstream water bodies

STRATEGY

- Wetland restoration
- Stormwater management
- Stream channel restoration
- Internal sediment phosphorous control
- Restoration of upstream water bodies

IMPLEMENTATION PRIORITIES

- Resource protection through regulation
- Early coordination and integration with land use planning
- Opportunity-driven stormwater management projects/grants
- Education and training on best practices for chloride use
- Education and capacity-building for lake associations

Table 3.7 Gleason Lake Subwatershed CIP

Project	Stormwater Volume and Pollutant Load Reduction
Description	Implementation of opportunities to reduce stormwater volumes and nutrient loading to Gleason, Mooney, Hadley, and Snyder lakes, including but not limited to infiltration or filtration basins and devices, reforestation, revegetation, and stormwater detention or redirection.
Need	Four lakes in the subwatershed exceed state excess nutrient standards - Gleason, Hadley, Mooney, and Snyder. A TMDL identified a need to reduce external phosphorus loading by 64% (207 pounds) to Gleason Lake, 90% (58 lbs) to Mooney Lake, 41% (25 lbs) to Hadley Lake, and 33% (4 lbs) to Snyder Lake.
Outcome	Reduction of pollutant loading to Gleason, Hadley, Mooney, and Snyder lakes; reduction of stormwater runoff volume and rate and associated impacts; protection and enhancement of groundwater recharge, stream base flow, and wetland hydrology.
Estimated Cost	Capital costs: $600,000, excluding land, in 2017 dollars.
Potential Funding Sources	District levy, partner contributions, grants
Schedule	2018-2027

3.9.4 LAKE MINNETONKA SUBWATERSHED PLAN

INTRODUCTION

This subwatershed plan contains information specific to the Lake Minnetonka Subwatershed, including existing conditions and issues, drivers, management strategies, land use information, and an implementation plan. Information regarding the District's philosophy, goals, and implementation approach can be found in Sections 3.2-3.4 and should be reviewed first to provide context for the following subwatershed plan.

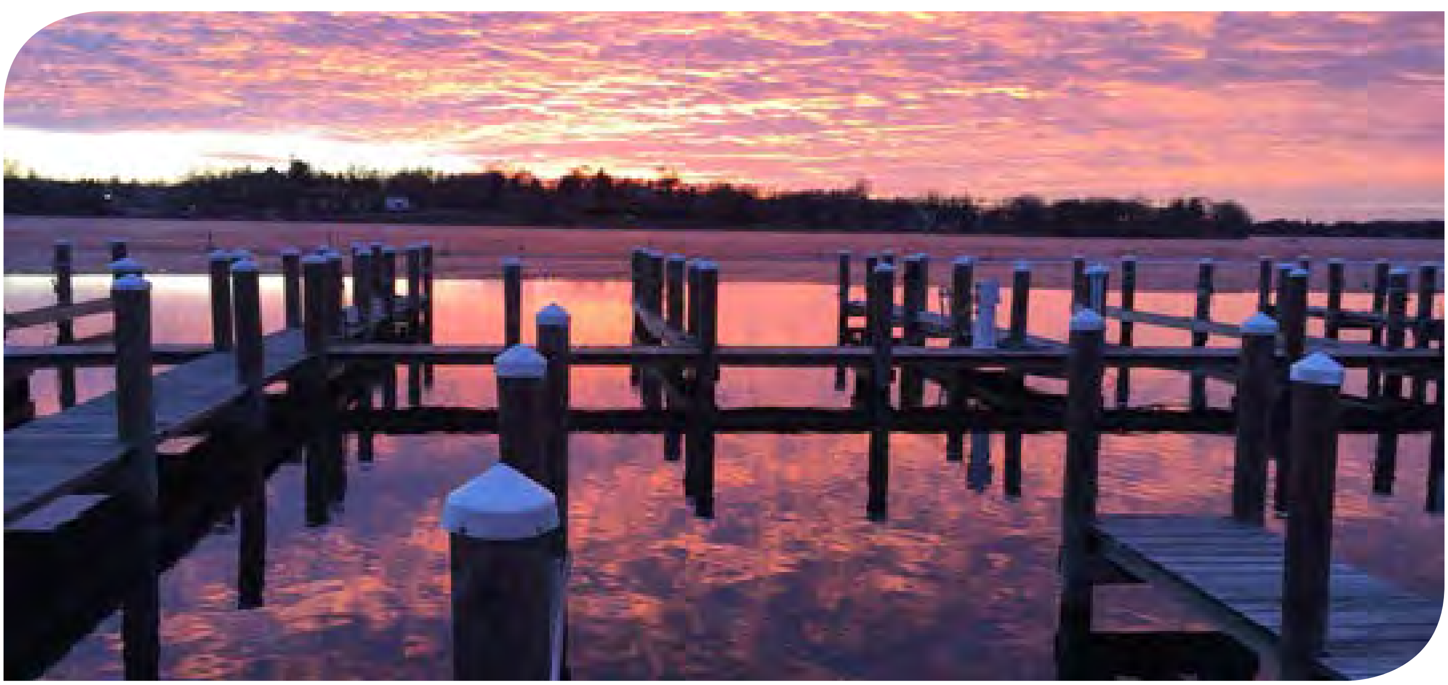
EXECUTIVE SUMMARY

Lake Minnetonka is a 50.8 square mile (32,515 acre) subwatershed located in the western portion of the MCWD and includes portions of the cities of Chanhassen, Deephaven, Excelsior, Greenwood, Long Lake, Minnetonka, Minnetonka Beach, Minnetrista, Mound, Orono, Shorewood, Spring Park, Tonka Bay, Victoria, Wayzata and Woodland.

The subwatershed is generally characterized by water (45%), most of which is Lake Minnetonka, and low density development (30%). The subwatershed also contains undeveloped land (13%), parks and open spaces (6%), and agricultural land (2%). Most land in the subwatershed is developed, although the upper subwatershed includes some large agricultural and forested areas, with wetlands scattered throughout.

Lake Minnetonka is the primary receiving water within the subwatershed. Drainage is conveyed from the watershed to Lake Minnetonka through several streams, including Gleason Creek, Long Lake Creek, Classen Creek, Painter Creek, and Six Mile Creek, as well as through smaller channels or storm sewers. The subwatershed outlets through a control structure on Grays Bay into Minnehaha Creek.

The Lake Minnetonka subwatershed has several issues relating to water quality, water quantity and ecological integrity. Four bays (Halsted, Jennings, West Arm, Stubbs) and Forest Lake are listed on the State's Impaired Waters List due to excess nutrients, and pursuant to an approved Total Maximum Daily Load (TMDL) require both external and internal load reductions. Impairments are generally a product of large tributary drainage areas (e.g. Six Mile Creek – Halsted, Painter Creek – Jennings) and the level of internal loading (phosphorus into the water column from organic sediments) which can be exacerbated by the presence of common carp and some aquatic plants.



Lake Minnetonka from LRT Trail

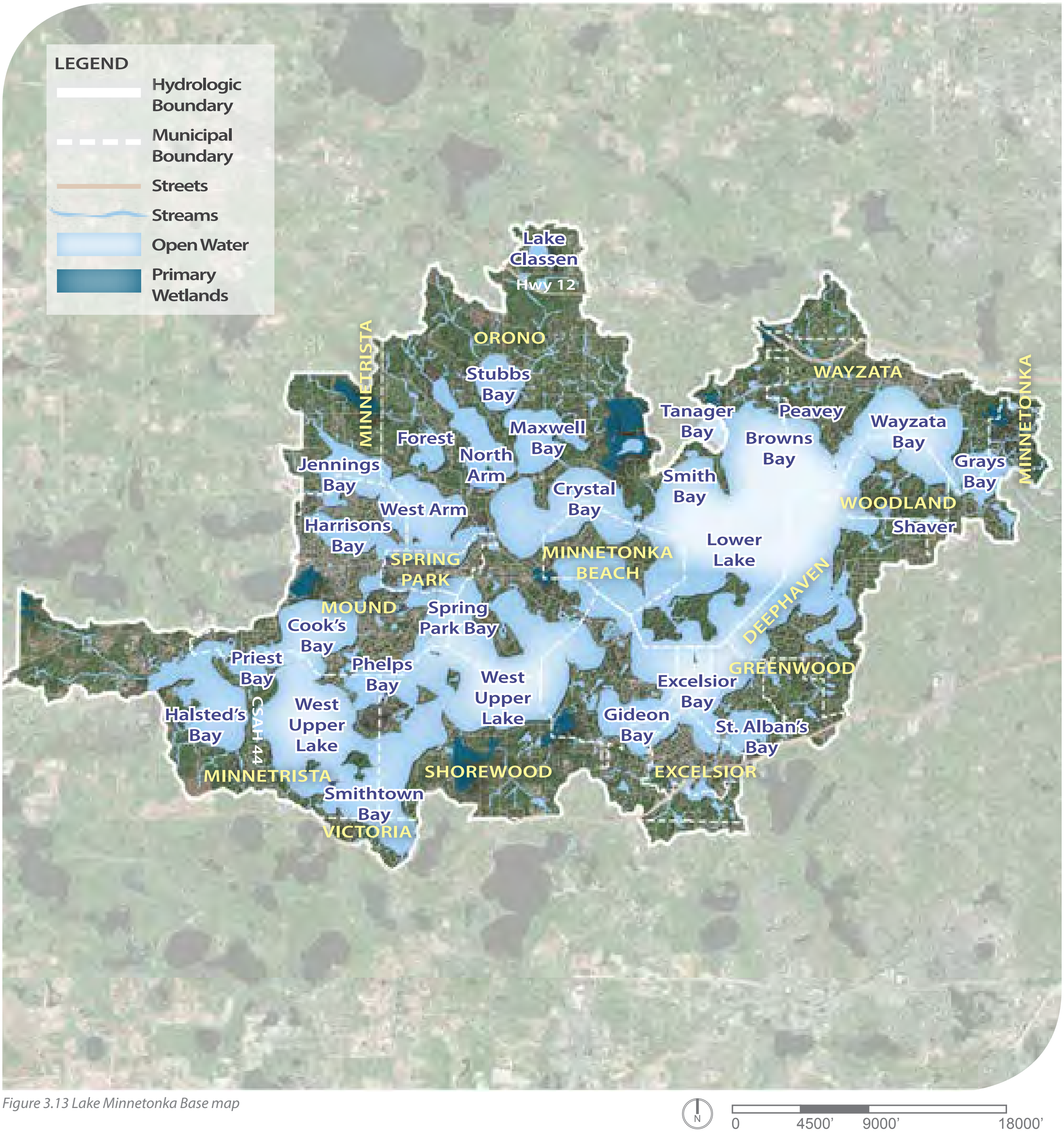


Figure 3.13 Lake Minnetonka Base map

Regarding water quantity, there are locations in the subwatershed within Lake Minnetonka's floodplain that are subject to localized flooding due to the volume of water received from tributary subwatersheds, which can cause lake levels to rise. Lake levels are managed through the operation of the Gray's Bay Dam, informed by existing lake level, downstream capacity in Minnehaha Creek, seasonal variation, and precipitation predicted through partnership with the National Weather Service.

Lake Minnetonka does contain aquatic invasive species, but overall, the subwatershed enjoys high ecological integrity with an excellent fish community in Lake Minnetonka and exceptional vegetative diversity in wetlands.

Management strategies within the subwatershed will focus on addressing impaired bays within Lake Minnetonka by reducing external loading to the lake from upstream tributary subwatersheds, and by addressing internal loading within the lake; protecting existing high value natural resources; and improving ecological integrity by promoting shoreline best management through partnership with local communities, shoreline contractors and landowners. This is summarized in the Implementation Plan.

RESOURCE NEEDS

EXISTING CONDITIONS AND ISSUES

This section of the Plan outlines existing conditions and water resource issues, categorized by water quality, water quantity, and ecologic integrity. Condition information was compiled from community input, monitoring data, special studies, the Hydrologic and Hydraulic Pollutant Loading Study (HHPLS), Minnehaha Creek and Upper Watershed Stream Assessments, the Functional Assessment of Wetlands (FAW), Total Maximum Daily Load (TMDL) studies, and state and regional land use and land cover data. A review of these conditions and data revealed several issues and concerns that may require action on the part of the District or its partners. More detailed information about the Lake Minnetonka subwatershed may be found in Volume 2: Land and Natural Resources Inventory.

Water Quality

Lakes and Streams

Four bays in Lake Minnetonka (Halsted Bay, Jennings Bay, Stubbs Bay and West Arm) and Forest Lake are listed on the State's Impaired Waters list for nutrients, with average summer phosphorus concentrations greater than the state standards. External loading from the watershed and internal loading from lake sediments are contributing to these concentrations. Peavey Lake is listed as impaired for chlorides.

Zebra mussels are present throughout the entire lake, and are likely influencing increases in water clarity throughout the lake and reductions in Chlorophyll-a in some areas of the lake.

At this time, no streams are listed as impaired. Classen Creek, which serves as the outlet of Lake Classen and flows to Stubbs Bay, and two other small streams are not listed as Impaired Waters for nutrients, but have high total phosphorus concentrations which exceed state river eutrophication standards for phosphorus.

Wetlands

There are wetlands in the subwatershed with high vegetative diversity that are sensitive to the quality of stormwater inputs.

Groundwater

There are areas of moderate to high aquifer sensitivity in the subwatershed. As development occurs and infiltration is proposed to meet water quality and volume control standards, special attention should be paid in areas of aquifer sensitivity and wellhead protection areas.

Water Quantity

The District's hydrologic model predicts several locations where trails or provide drives may overtop during large rain events.

Lake levels on Lake Minnetonka are managed by the Gray's Bay Dam. The lake outlets through an adjustable structure on Gray's Bay which controls Lake Minnetonka discharge into Minnehaha Creek. In an effort to reduce flooding on Lake Minnetonka and Minnehaha Creek the District operates this structure in accordance with the Headwaters Control Structure Management Policy and Operating Procedures, which was approved by the Minnesota DNR. The operating plan prescribes discharge zones based on the time of year, the existing lake level, creek capacity in Minnehaha Creek, and forecasted precipitation identified through partnership with the National Weather Service.

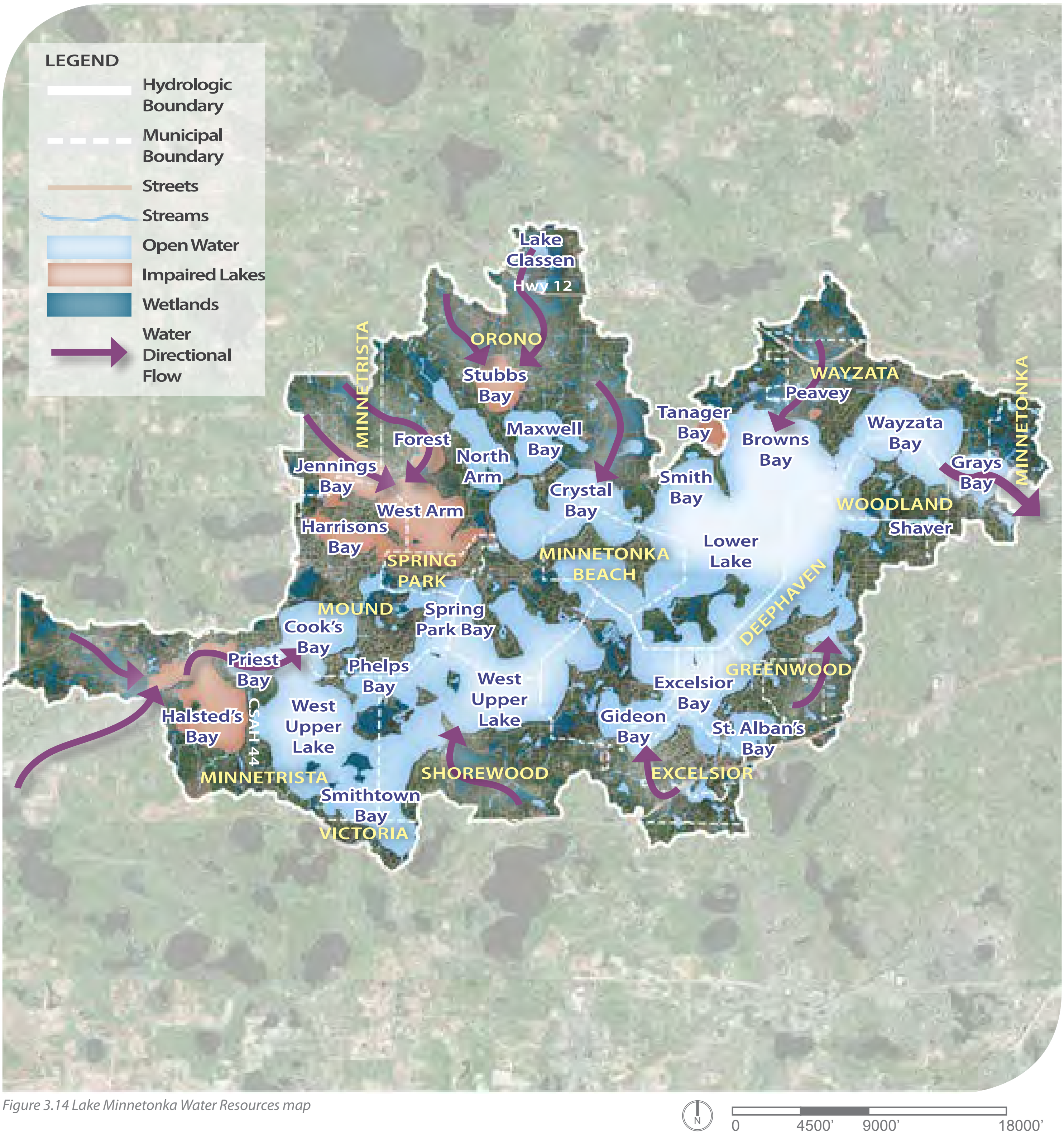


Figure 3.14 Lake Minnetonka Water Resources map

There are wetlands in the subwatershed that rely on steady inflow from surficial groundwater. Groundwater recharge is important within the subwatershed to maintain wetland hydrology and stream baseflow, as well as to recharge aquifers that supply public and private drinking water wells.

Ecological Integrity

Lakes and Streams

The Lake Minnetonka subwatershed enjoys moderate to high ecological integrity. Lake Minnetonka is the primary receiving water in the subwatershed. The fish community in Lake Minnetonka is excellent and is actively managed by the DNR. Invasive species are present within the lake, including zebra mussels, Eurasian watermilfoil, Curlyleaf Pondweed, Common Carp and Flowering Rush. Eurasian watermilfoil and Curlyleaf Pondweed can be found throughout the lake, but in varying densities, and often mixed in with abundant native plants. Common carp are present throughout the lake, but are generally overabundant in the degraded receiving bays of the lake, such as Halsted Bay. Flowering Rush is present, but limited in distribution around the lake and at low densities.

Classen Creek, the primary stream in the subwatershed, has locations of moderately complex habitat and morphology, but in general the stream is less complex and more altered. The creek contains a degraded macroinvertebrate community, which consists primarily of pollution-tolerant species, and is lacking certain classes of organisms. Monitoring reveals nutrient enrichment and low DO, which likely impact the macroinvertebrates in Classen Creek. The creek also contains a weir and generally has low flow, two factors that limit connectivity.

Wetlands

Scattered wetlands in the subwatershed have been classified as wetlands with high vegetative diversity and wildlife habitat, the largest of which are Classen Lake Marsh and French Lake Marsh. Only one wetland, which surrounds Lake Marion, is considered to have high restoration potential, but all are in need of protection. Conservation of wetlands is integral to achieving ecological integrity, water quality, stormwater management and floodplain management goals.

Uplands and Natural Corridors

Several locations within the subwatershed have been identified

Sunset over Lake Minnetonka, Jordan Black

Gray's Bay Dam

Tonka Bay shoreline

by Hennepin County and the DNR as important natural corridors containing high quality aquatic and upland habitat. For example, there are patches of intact sugar maple forest that must be protected. Many of the higher quality aquatic upland habitats are patchy and disconnected, and new connected habitat should be created when possible.

Shoreland within this subwatershed is heavily altered. A 2010 shoreland inventory found that of the 122 miles of Lake Minnetonka shoreline, over 65% was modified as rip-rap.

DRIVERS

A driver of water quality, water quantity, or ecological integrity is a driving force or stressor that causes a biological community or physical structure to change. Some example drivers include increased phosphorus loading, increased impervious areas, straightened channels, and drained wetlands. Some drivers are natural, such as storm events. Most are human-caused, either directly or as a side effect of some other change such as a land use change or removal of natural land cover. This section of the Plan outlines the main drivers of water quality, water quantity, and ecological integrity issues within the Lake Minnetonka subwatershed.

The principal water quality, water quantity, and ecological integrity issues within the Lake Minnetonka subwatershed are:

Water Quality

» Excess nutrients

Water Quantity

» Localized flooding

Ecological Integrity

» Degraded macroinvertebrate populations

» Altered shoreline

These issues are primarily the result of the following drivers:

» Altered wetlands

» Stormwater runoff

» Common carp

» Altered channels

» Internal sediment phosphorus loading

» Water quality from upstream waterbodies

Altered Wetlands

On a watershed scale, wetlands can act as sinks, sources, or transformers (particulate to dissolved) for nutrients like phosphorus. Historically, wetlands acted as nutrient sinks within a watershed, capturing and retaining nutrients, even as nutrient loads to the wetland were increased as land use intensified. However, as wetlands were ditched and drained to facilitate watershed drainage and land use change, they often converted from a sink for nutrients to sources, by increasing the breakdown of wetland soil and the conveyance of stormwater. These processes within altered wetlands can release large pools of stored nutrients, causing nutrient impairments in downstream surface waters.

Some wetlands in the subwatershed are of high quality, and do not appear to be significantly altered by ditching and draining. These wetlands are sensitive to the quality of stormwater inputs and rely on groundwater to maintain their hydrology. Altered wetlands upstream of Lake Minnetonka may be in part responsible for elevated phosphorus levels in some of Lake Minnetonka's bays. For example, the Six Mile Marsh wetland complex upstream of Halsted Bay contributes to Halsted Bay's impaired phosphorus concentrations.

Stormwater Runoff

Watershed runoff from rainfall events, or stormwater, can carry nutrients and other pollutants to surface waters leading to negative impacts in lakes, streams and wetlands. In urban and suburban areas, high proportions of impervious surfaces such as parking lots and driveways increase the volume and rate of stormwater runoff, which can cause flooding, and change stream flow in ways that negatively impact habitat for critical parts of the food-web like fish and macroinvertebrates. In rural areas drained for agriculture, the increased volume and peak flow of stormwater runoff causes similar negative impacts.

While the increased volume and rate of stormwater runoff can negatively impact physical conditions in receiving waters, the runoff also carries with it increased loads of pollution that

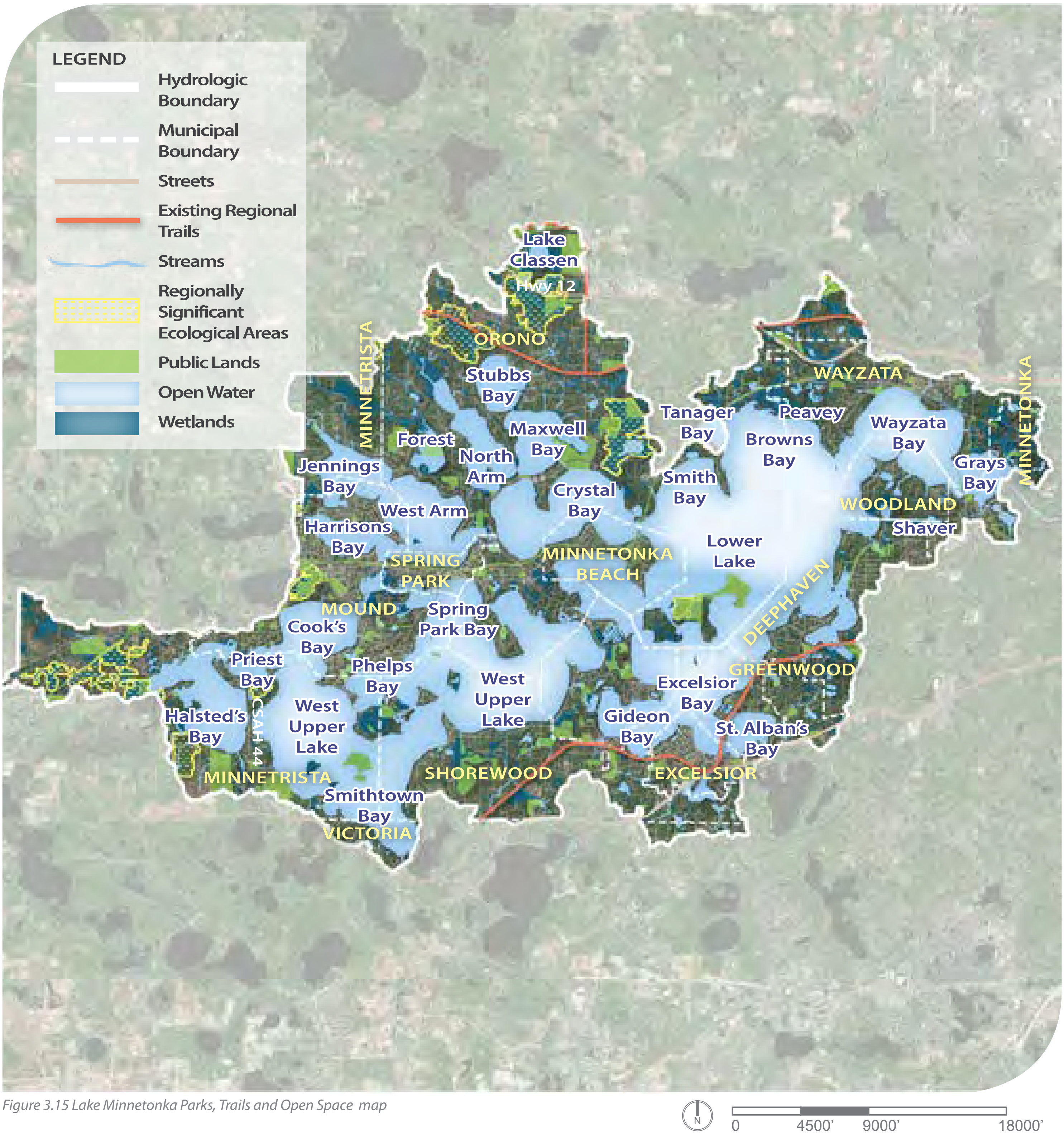


Figure 3.15 Lake Minnetonka Parks, Trails and Open Space map

negatively impact the quality of lakes, streams and wetlands. In urban and suburban areas, stormwater picks up excess nutrients, bacteria such as *E. coli,* chloride from road salt, and other pollutants causing toxicity to organisms or issues with excess nutrients (eutrophication). In more rural areas, stormwater mobilizes pollutants from manure and fertilizer including excess nutrients, bacteria, herbicides and pesticides.

These impacts heavily influence the conditions of surface waters because a healthy hydrologic condition is critical to supporting a healthy lake, stream or wetland. Generally, as impervious cover, altered drainage, and stormwater runoff within a watershed increases, the quality of lakes, streams and wetlands decreases.

The Lake Minnetonka subwatershed is almost fully developed with mostly single family residential uses, but also some agriculture in the western portion of the subwatershed. These land uses increase the volume of stormwater runoff and the phosphorus loads carried by this runoff. Four bays in Lake Minnetonka and Forest Lake exceed the state standard for total phosphorus, and runoff from lawns, streets and agriculture in the subwatershed is a significant source of excess nutrients and sediment.

Carp Management

Historically, carp management focused on removal of carp populations from impacted water bodies without any consideration of population dynamics such as reproduction, immigration, and emigration. More recent carp management techniques focus on integrated pest management where activities focus not only on removal, but also on the long-term prevention of carp reproduction and immigration into sensitive water bodies. These new techniques allow for sustainable control of carp populations to measurably improve shallow lake and wetland water quality, plant communities and overall ecological health.

Carp are known to be driving water quality and ecological issues in Halsted Bay and carp management is part of implementation plan for the Six Mile Creek–Halsted Bay Subwatershed. Surveys should be conducted to determine the abundance of common carp in the northwestern bays (Jennings, West Arm, Forest Lake) and could warrant an assessment of the tributary subwatersheds (Dutch Lake and Painter Creek) to inform management strategies. Carp management may need to occur prior to implementing other strategies to reduce internal loading.

Altered Channels

Historically, natural channels were straightened, widened and relocated to accommodate land use change. Channel alteration to improve watershed drainage can lead to a loss of physical habitat, increased peak flow velocities and downstream flooding, decreases in dissolved oxygen, and increased sediment transport which can negatively impact fish and macroinvertebrate communities.

Classen Creek, the primary stream in the Lake Minnetonka subwatershed, has been historically altered, which has degraded habitat complexity and channel morphology. The creek has a small earth dam and concrete weir, as well as several areas of significant streambank erosion. These factors probably contribute to the stream's degraded macroinvertebrate community. Other channels in the subwatershed have not been assessed, but have also been altered historically.

Internal Sediment Phosphorus Loading

Long term excessive loading of phosphorus to lakes can lead to phosphorus buildup in the sediments of the lake bed. Ultimately, this phosphorus can be released from the sediment back into the water. Further exacerbating the problem, released phosphorus is typically dissolved which is readily available for plant uptake and contributes directly to algae blooms. Sediment phosphorus release can lead to summer algae blooms, poor water clarity and, in severe cases, summer fish kills and harmful algal blooms. Restoration of water quality in lakes often requires significantly reducing phosphorus release from sediments.

Four bays in Lake Minnetonka (Halsted Bay, Jennings Bay, Stubbs Bay and West Arm) and Forest Lake exceed the state standard for total phosphorus and are listed as Impaired Waters. Internal phosphorus loading is likely contributing to these high phosphorus concentrations, especially in Halsted and Jennings Bays, which were secondary receiving waters for municipal wastewater treatment plants until the 1970s. Excess phosphorus loads from wastewater treatment plant discharge may still be present in the bottom sediments. The Upper Minnehaha Creek Watershed Nutrient and Bacteria TMDL requires a 70 and 79 percent reduction in internal load in Halsted and Jennings Bays, respectively.

Upstream Waterbodies

Headwater streams, lakes and wetlands contribute water and nutrients to downstream receiving waters impacting the quality of these water bodies. Lakes and wetlands with poor water quality ultimately contribute nutrients to downstream waters that can lead to eutrophication. Consequently, restoration of upstream water bodies is often a critical component of improving downstream water quality on a watershed scale.

Phosphorus export from upstream wetland and stream systems within the subwatershed may be a contributing source of phosphorus to Lake Minnetonka and other downstream water bodies. There are several tributary streams to Lake Minnetonka, including Long Lake Creek, Gleason Creek, Classen Creek, Painter Creek, and Six Mile Creek and associated wetland complexes are exporting and conveying excess nutrient and sediment loads to the bays of Lake Minnetonka.

MANAGEMENT STRATEGIES

Informed by the identification and prioritization of conditions and issues in the subwatershed and an understanding of the drivers impacting its water resources, the District has developed general strategies to guide actions in the Lake Minnetonka subwatershed. These strategies are both short- and long-term, and establish a framework for the Lake Minnetonka subwatershed Implementation Plan programs and projects.

Wetland Restoration

Traditional approaches to wetland restoration focus on restoring wetland channels and hydrology to support a more diverse native plant population. While this strategy addresses ecological integrity within the wetland, it often overlooks the need to alter the cycles of wetland chemistry created by historic wetland alteration, which transform and release phosphorus to downstream waterbodies.

To address both ecological integrity and the release of phosphorus, wetland restoration must focus on modifying hydrology to support the native plant community while minimizing phosphorus export. This may include, but is not limited to, bypassing flow around the wetland, the addition of nutrient filters, soil engineering or augmentation to permanently sequester phosphorus, or the development of wetland treatment cells. Selected restoration options will depend on site specific wetland conditions and hydrology, and overall needs of the subwatershed system.

Only one wetland within the Lake Minnetonka subwatershed, the wetland that surrounds Lake Marion, is considered to have high restoration potential. Other wetlands are not currently high priorities for restoration, but only a few have scored highly on vegetative diversity, wildlife habitat, or aesthetics. Outlet monitoring at certain wetlands could be performed to document phosphorus export, which could be followed by new assessments for restoration potential.

Stormwater Management

Stormwater management will focus on reducing runoff volumes and rates, as well as reducing pollutant loading from runoff producing rain events. Stormwater management in the developed or developing urban and suburban areas will focus on retrofitting low impact development techniques such as ponds, filters, infiltration techniques, and other technologies where they are applicable. In the rural and agricultural areas, stormwater management will focus on buffers, improved agricultural practices such as conservation tillage, manure management for animal agriculture and hobby farms, wetland restoration and fertilizer management.

The focus in the Lake Minnetonka subwatershed will be on reducing nutrient and sediment loading into upstream waterbodies, installing infiltration and load reduction BMPs, requiring stormwater pretreatment before discharge into any wetland, and continuing to address the legacy effects of wastewater treatment discharge into Halsted and Jennings Bays.

Carp Management

Historically, carp management focused on removal of carp populations from impacted water bodies without any consideration of population dynamics such as reproduction, immigration, and emigration. More recent carp management techniques focus on integrated pest management where activities focus not only on removal but also on the long-term

Flowering Rush by swimming buoy

Gray's Bay boardwalk, Malery Renee

Zebra Mussel

prevention of carp reproduction and immigration into sensitive water bodies. These new techniques allow for sustainable control of carp populations to measurably improve shallow lake and wetland water quality, plant communities and overall ecological health.

While common carp are known to be present, not much is known about their extent and whether they are impacting water quality. It is necessary to perform feasibility studies which include assessments of carp and other rough fish population and their migration patterns.

Stream Channel Restoration

Stream restoration focuses on balancing stormwater conveyance to prevent flooding and channel erosion while providing high quality habitat for fish and macroinvertebrates. Restoration includes, where applicable, improving channel sinuosity, stabilizing streambanks, controlling peak flow velocities, increasing channel roughness for habitat and re-aeration, narrowing stream channels to improve wetted width and ecological baseflow, and increasing stream structure.

Classen Creek and other channels in the watershed should be investigated for restoration potential. Given the elevated phosphorus levels and degraded macroinvertebrate community in Classen Creek, the creek likely would benefit from streambank stabilization, buffer enhancement, improvements to stream aeration, and habitat enhancement.

Internal Sediment Phosphorus Control

Reducing or eliminating phosphorus release from sediments is often essential to meet water quality standards in lakes. There are several techniques available for controlling sediment phosphorus release including sediment phosphorus inactivation using a chemical such as aluminum, oxygenation to prevent sediment anoxia, hypolimnetic aeration and iron addition to prevent phosphorus release, or hypolimnetic withdrawal. While all the techniques can be effective, the application of aluminum to sediments using aluminum sulfate (alum) or a mixture of sodium aluminate and alum is typically the most cost effective approach for reducing sediment phosphorus release.

Additional water quality monitoring data, sediment chemistry,

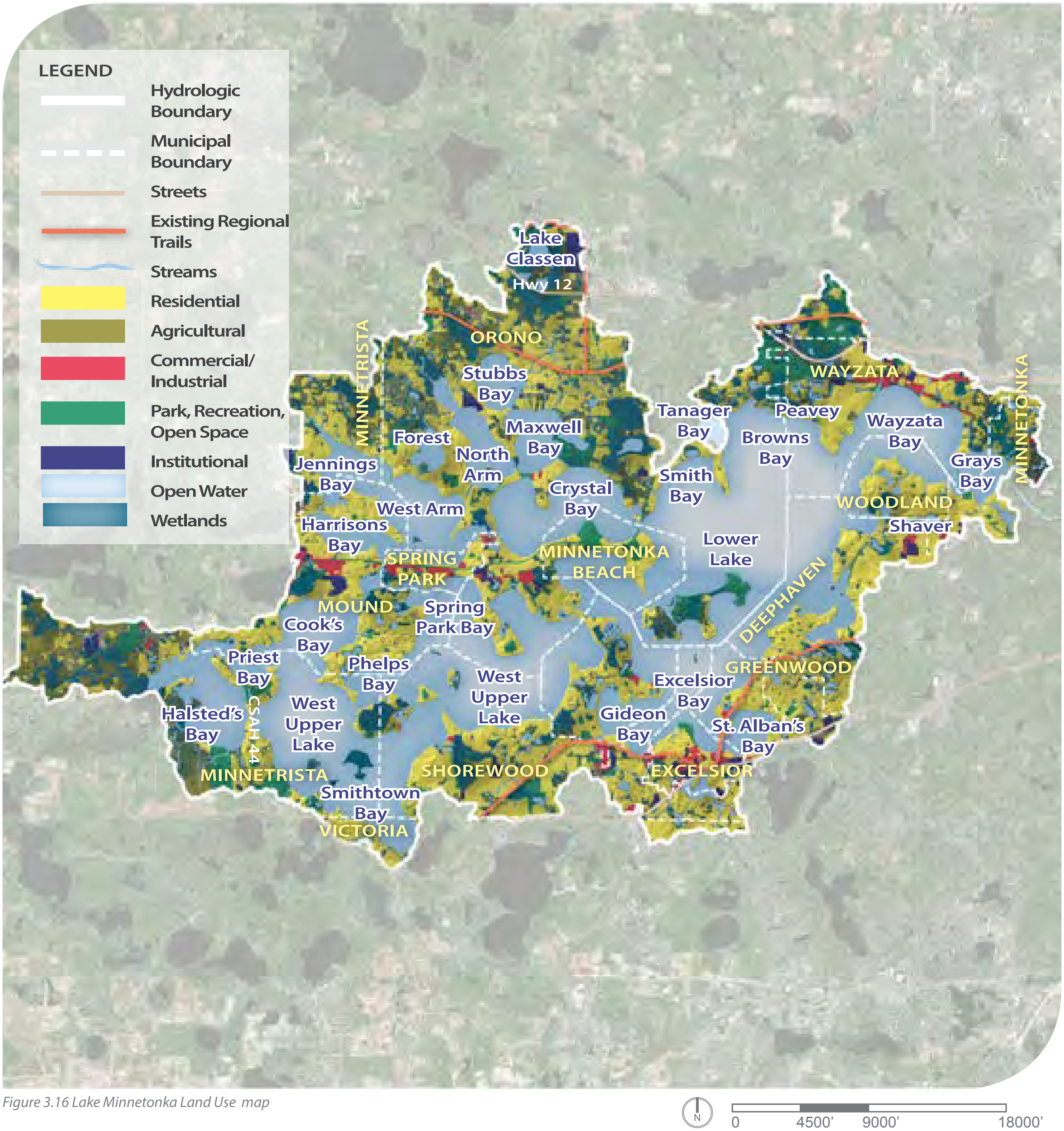


Figure 3.16 Lake Minnetonka Land Use map

and fish and aquatic vegetation surveys are necessary to evaluate the most appropriate techniques to improve water quality in Halsted and Jennings Bays, and other water bodies with internal phosphorus loading. Future alum treatment will be considered.

Restoration of Upstream Waterbodies

Upstream water bodies that are currently impaired can discharge large nutrient loads to downstream water bodies thereby contributing to downstream water quality impairments. Therefore, prior to, or concurrent with, significant efforts to restore downstream water quality, the water quality in upstream water bodies must be improved. Nutrient impaired upstream lakes may require external and internal nutrient reductions using the strategies listed in this section.

The Lake Minnetonka subwatershed is downstream from nine other subwatersheds, each of which outlets through streams, channels, and storm sewers into Lake Minnetonka. The focus will be on restoration of those upstream water bodies to improve the impaired bays and lakes and protect the current good water quality of the lower lake.

LAND USE

EXISTING CONDITIONS

The subwatershed includes portions of the cities of Chanhassen, Deephaven, Excelsior, Greenwood, Long Lake, Minnetonka, Minnetonka Beach, Minnetrista, Mound, Orono, Shorewood, Spring Park, Tonka Bay, Victoria, Wayzata and Woodland. The subwatershed is generally characterized by water (45%), most of which is Lake Minnetonka, and low density development (30%). The subwatershed also contains undeveloped land (13%), parks and open spaces (6%), agricultural land (2%).

LOCAL PLANS AND PRIORITIES

As described in the District's goals (Section 3.3), the District strives to implement its clean water objectives in ways that meaningfully contribute to the development of thriving communities. This is achieved through collaboration and integrated planning with public and private partners.

As part of the development of this plan, the District reached out to its communities to gather information on local goals, plans, and priorities for 2018-2027 (see Appendix B for details on the public input process). This information was used to broadly characterize opportunities, and to inform the development of the District's implementation plans. The information received was used only as a guide during the development of this Plan to inform the District of opportunities for partnership on the near term horizon, and was not intended to be exhaustive or restrict future collaborative efforts.

As discussed in Section 3.6, the District intends to cultivate a framework for two-directional coordination with communities on an ongoing basis, to stay apprised of emerging needs at a local level, and to identify and evaluate opportunities to implement management strategies outlined in this Plan over the next ten years. The District recognizes that local needs, opportunities and priorities may shift over time. Therefore, this Plan does not intend to capture or prescribe opportunities for partnership over a ten-year term.

Long term goals, growth and private development, and public investment in infrastructure differ across each community – and therefore, frameworks for ongoing coordination will be custom tailored based on the individual needs of each community. Coordination may occur at varying levels, through various means, with communities across the following areas:

» Regulation of, and partnership with, private development

» Collaboration on public planning and investment (e.g. parks , roads, utilities)

» MS4 compliance

» Development and implementation of TMDLs

Given the large size of the Lake Minnetonka subwatershed, it is useful to divide the subwatershed into subunits based on similar issues and priorities. The eastern portion of the subwatershed is the most developed, including the cities of Wayzata, Woodland, Deephaven, Greenwood, Excelsior, Minnetonka, Shorewood, Minnetonka Beach, and Tonka Bay. The water quality of Lake Minnetonka is better in this part of the subwatershed than it is farther west, but cities in this portion of the Lake are still concerned with stormwater management and low impact development and redevelopment. Other management priorities in this portion of the subwatershed are to become more flood resilient and to protect wetlands.

The northwestern portion of the watershed, which includes the cities of Orono, Minnetrista, Mound, and Spring Park, consists mostly of shoreline and large-lot residential properties. Priorities in this portion of the subwatershed include maintaining a more rural character and protecting natural resources such as naturalized shorelines of lakes. The City of Mound is interested in continuing to invest in development in the downtown area and redevelopment around Lake Minnetonka.

The southwestern portion of the subwatershed is the most rural and includes the cities of Mound, Minnetrista, and part of Victoria. The cities in this management area desire to maintain their rural character through low density development and proximity to nature and trails. They expect a need to accommodate development with investment in infrastructure such as roads and sewers, but they aim to protect and enhance natural resources.

IMPLEMENTATION PLAN

The goals set forth in this subwatershed plan will require an integrated set of programs and projects oriented toward the conservation and improvement of water resources within the watershed. The Implementation Priorities section generally describes the actions that the District and its partners will look to take in order to address the issues present in the subwatershed and achieve the goals as set forth in the plan. The Capital Improvement Plan (CIP) provides cost estimates and schedules for any proposed capital investments.

IMPLEMENTATION PRIORITIES

As described in previous sections, the Lake Minnetonka subwatershed has several issues relating to water quality, water quantity and ecological integrity. Four bays (Halsted, Jennings, West Arm, Stubbs) and Forest Lake are listed on the State's Impaired Waters List due to excess nutrients. Impairments are generally a product of large tributary drainage areas (e.g. Six Mile Creek – Halsted, Painter Creek – Jennings) and the level of internal loading (phosphorus into the water column from organic sediments) which can be exacerbated by the presence of common carp and some aquatic plants. There are locations in the subwatershed within Lake Minnetonka's floodplain that are subject to localized flooding due to the volume of water received from tributary subwatersheds, which can cause lake levels to rise. Lake Minnetonka contains aquatic invasive species, but overall, the subwatershed enjoys high ecological integrity with an excellent fish community in Lake Minnetonka and exceptional vegetative diversity in wetlands.

Based on these conditions, management strategies within the subwatershed will focus on addressing impaired bays within Lake Minnetonka by reducing external loading to the lake from upstream tributary subwatersheds and by addressing internal loading within the lake; protecting existing high value natural resources; and improving ecological integrity by promoting shoreline best management through partnership with local communities, shoreline contractors and landowners.

The eastern portion of the subwatershed is mostly developed, while areas in the west and north are still undergoing development. Some investment and roads and parks is planned throughout the subwatershed. Specific opportunity areas identified include downtown Mound, Excelsior Commons, and the Wayzata lakefront. The cities in the subwatershed acknowledge the importance of stormwater management and will look for opportunities to incorporate Best Management Practices (BMPs) as redevelopment and infrastructure investment occurs.

This Plan establishes a coordination framework through which the District will seek to maintain current knowledge of land use and capital planning by its LGUs, and of potential land use development and redevelopment activity. As opportunities arise, the District will evaluate them against the resource needs and priorities defined throughout this plan and determine the appropriate response. The District has a wide range of services it can mobilize to address resource needs and support partner efforts, including data collection and diagnostics, technical and planning assistance, permitting assistance, education and capacity building, grants, and capital projects.

The District manages lake levels on Lake Minnetonka through the operation of the Gray's Bay Dam, informed by existing lake level, downstream capacity in Minnehaha Creek, seasonal variation, and precipitation predicted through partnership with the National Weather Service.

The District will continue to promote and provide education to cities and residents on the value of native shoreline plantings. The District funded the development of the Lake Minnetonka Guide to Shoreline Gardens that is a useful resource for lakeshore homeowners.

The District may pursue a carp assessment for the northwestern bays of Lake Minnetonka (Jennings, West Arm, Forest Lake) and their tributary subwatersheds (Dutch Lake and Painter Creek). The goal of the assessment would be to understand the movement and recruitment patterns of carp in the system to inform management efforts. This work will be dependent on the District's ability to secure partner support and funding.

Other invasive species are also present within the lake, including zebra mussels, Eurasian watermilfoil, Curlyleaf Pondweed and flowering rush. The District does not actively manage for any of these species, but will continue to monitor any impacts on water quality or ecological integrity. The Lake Minnetonka Conservation District regularly harvests the Eurasian watermilfoil that grows densely in several bays and channels and inhibits boat traffic.

Peavey Lake is impaired for excess chlorides. The District will continue to monitor chloride levels and provide education and training for public and private applicators and residents on best practices for chloride use.

To allow the District the flexibility to respond to opportunities identified by the cities or other partners, or that may arise through land-use change, the capital improvement plan for this subwatershed includes a project for stormwater management. The CIP also includes a project to address Halsted Bay internal loading as part of the broader Six Mile Creek-Halsted Bay implementation plan discussed in section 3.9.11. In the future, should the District or a partner determine that a larger or more concentrated scale of capital and program implementation may be needed, a discrete subwatershed planning process may be initiated to:

- Provide high resolution diagnostic of watershed issues and drivers
- Map current projected land use and infrastructure changes

Canoe on Lake Minnetonka, Garrett Graves

ISSUE

- Excess nutrients
- Localized flooding
- Degraded macroinvertebrate community
- Altered shoreline

DRIVER

- Altered wetlands
- Stormwater runoff
- Common carp
- Altered channels
- Internal sediment phosphorous loading
- Water quality from upstream water bodies

STRATEGY

- Wetland restoration
- Stormwater management
- Stream channel restoration
- Internal sediment phosphorous control
- Restoration of upstream water bodies

IMPLEMENTATION PRIORITIES

- Address impaired bays through upstream restoration
- Carp assessment for Jennings, West Arm, and Forest Lake
- Early coordination and integration with land use planning
- Opportunity-driven stormwater management projects/grants
- Education and training on best practices for chloride use
- Education and capacity-building for lake associations
- Education on best practices for shoreline management
- Flood management through operation of Grays Bay Dam

» Define a detailed and integrated capital and program implementation plan

» Outline a funding strategy including program costs and sources

The details of such a plan would provide the information needed for the District to pursue a plan amendment under MN Rules 8410, thereby updating specific subwatershed components of this Plan.

CAPITAL IMPROVEMENT PLAN

The CIP is a planning tool. It also is a means to inform partners, District residents, and other interested parties as to the District's scope and priorities for its capital work over the planning period. A project's inclusion in the CIP does not mean that the project will be constructed, only that the District has identified it as an action that may be a cost-effective way for the District to achieve identified water resource goals. A project identified in the CIP always will need further review as to technical feasibility, cost and financing, consistency with local needs, and other policy considerations before a formal decision to proceed to construction is made. Section 3.5.5 describes the development and evaluation steps that will occur before the District will commit resources to a project.

Section 3.5.5 also describes how the District will review the CIP on an ongoing basis throughout the planning period. This review will allow the District to reassess described projects from a technical perspective, but also will involve broader policy considerations such as shifts in District priorities, decisions as to annual budget and levy levels, and the prospect of state and federal grant funds or financing. For this reason, projects may be added to and deleted from the CIP from year to year, in accordance with those procedures.

A critical component of any project will be the development of a funding strategy that identifies the sources, uses, and timing of funds needed to successfully achieve identified goals. These plans will be developed in conjunction with the District's public and private partners as capital projects are advanced. Therefore, any costs identified within this Plan are projections. Intended expenditures will be refined during project development and budgeting, and among other things will reflect the District's intent to complement its ad valorem funds with other funding sourc

Table 3.8 Lake Minnetonka Subwatershed CIP

Project	**Stormwater Volume and Pollutant Load Reduction**
Description	Implementation of opportunities to reduce stormwater volumes and nutrient loading to Lake Minnetonka, including but not limited to infiltration or filtration basins and devices, reforestation, revegetation, and stormwater detention or redirection.
Need	Four bays (Halsted, Jennings, West Arm, Stubbs) and Forest Lake are listed on the State's Impaired Waters List due to excess nutrients. A TMDL identified a need to reduce external phosphorus loading by 60% (116 pounds) to Forest Lake, 73% (2087 lbs) to Halsted Bay, 72% (1563 lbs) to Jennings Bay, and 51% (142 lbs) to Stubbs Bay.
Outcome	Reduction of pollutant loading to Lake Minnetonka; reduction of stormwater runoff volume and rate and associated impacts; protection and enhancement of groundwater recharge, stream base flow, and wetland hydrology.
Estimated Cost	Capital costs: $1,000,000, excluding land, in 2017 dollars.
Potential Funding Sources	District levy, partner contributions, grants
Schedule	2018-2027

Project	**Halsted Bay Internal Phosphorus Load Reduction**
Description	The Halsted Bay Internal Phosphorus Load Reduction project consists of an aluminum sulfate (alum) treatment on Halsted Bay to reduce internal phosphorus loading. A dosing study was completed in 2013 to estimate the required aluminum concentration to bind 90% of mobile phosphorus. It recommended the application of alum to Halsted Bay in three treatment zones ranging from 60 g Al/m2 to 140 g Al/m2.
Need	A Load Management Feasibility Study completed for Halsted's Bay determined that internal phosphorus loading provides 40% (2,705 pounds) of the phosphorus loading to Halsted Bay. The study recommended an 84% (2,278 pound) reduction in internal phosphorus loading.
Outcome	The alum application is proposed to reduce mobile sediment phosphorus by 90%, which would result in a parallel reduction in internal phosphorus loading.
Estimated Cost	Capital costs: $1,400,000 in 2017 dollars based on a 20 year project life.
Potential Funding Sources	District levy, partner contributions, grants
Schedule	2018-2027

Project	Stormwater Volume and Pollutant Load Reduction
Description	Implementation of opportunities to reduce stormwater volumes and nutrient loading to Lake Minnetonka, including but not limited to infiltration or filtration basins and devices, reforestation, revegetation, and stormwater detention or redirection.
Need	Four bays (Halsted, Jennings, West Arm, Stubbs) and Forest Lake are listed on the State's Impaired Waters List due to excess nutrients. A TMDL identified a need to reduce external phosphorus loading by 60% (116 pounds) to Forest Lake, 73% (2087 lbs) to Halsted Bay, 72% (1563 lbs) to Jennings Bay, and 51% (142 lbs) to Stubbs Bay.
Outcome	Reduction of pollutant loading to Lake Minnetonka; reduction of stormwater runoff volume and rate and associated impacts; protection and enhancement of groundwater recharge, stream base flow, and wetland hydrology.
Estimated Cost	Capital costs: $1,000,000, excluding land, in 2017 dollars.
Potential Funding Sources	District levy, partner contributions, grants
Schedule	2018-2027

Project	Halsted Bay Internal Phosphorus Load Reduction
Description	The Halsted Bay Internal Phosphorus Load Reduction project consists of an aluminum sulfate (alum) treatment on Halsted Bay to reduce internal phosphorus loading. A dosing study was completed in 2013 to estimate the required aluminum concentration to bind 90% of mobile phosphorus. It recommended the application of alum to Halsted Bay in three treatment zones ranging from 60 g Al/m2 to 140 g Al/m2.
Need	A Load Management Feasibility Study completed for Halsted's Bay determined that internal phosphorus loading provides 40% (2,705 pounds) of the phosphorus loading to Halsted Bay. The study recommended an 84% (2,278 pound) reduction in internal phosphorus loading.
Outcome	The alum application is proposed to reduce mobile sediment phosphorus by 90%, which would result in a parallel reduction in internal phosphorus loading.
Estimated Cost	Capital costs: $1,400,000 in 2017 dollars based on a 20 year project life.
Potential Funding Sources	District levy, partner contributions, grants
Schedule	2018-2027

3.9.5 LAKE VIRGINIA SUBWATERSHED PLAN

INTRODUCTION

This subwatershed plan contains information specific to the Lake Virginia Subwatershed, including existing conditions and issues, drivers, management strategies, land use information, and an implementation plan. Information regarding the District's philosophy, goals, and implementation approach can be found in Sections 3.2-3.4 and should be reviewed first to provide context for the following subwatershed plan.

EXECUTIVE SUMMARY

Lake Virginia is a 6.2 square mile (3,991 acre) subwatershed located in the southwestern portion of the MCWD and includes the cities of Chanhassen, Chaska, Shorewood, and Victoria. The subwatershed is generally characterized by low density development (26%), parks and open spaces (28%), water (22%), undeveloped land (12%), and agricultural uses (7%). Lake Minnewashta Regional Park and parts of the Minnesota Landscape Arboretum are within the subwatershed's boundaries. The Southwest Hennepin LRT Regional Trail also passes across the northwest corner of the subwatershed.

There are areas of high ecological value within corridors of aquatic and upland habitat. Thirty-nine percent of the wetlands in the subwatershed are classified as "preserve" by the Functional Assessment of Wetlands due to their exceptional or high vegetative diversity, or fish or wildlife habitat value.

Lakes Minnewashta and Virginia are the primary receiving waters within the subwatershed. Tamarack Lake and Lake St. Joe are additional lakes in the subwatershed. There is a small stream known as Minnewashta Creek that conveys discharge from Lake Minnewashta to Lake Virginia. The Lake Virginia subwatershed discharges by a small channel to Lake Minnetonka: Smithtown Bay.

The Lake Virginia subwatershed has several issues relating to water quality, water quantity and ecological integrity. Lake Virginia and Tamarack Lake are listed as Impaired Waters for excess nutrients and a TMDL identifying nutrient load reduction goals and suggested actions has been completed. Overall, the system has moderate ecological integrity. Low dissolved oxygen in Lake Virginia may be negatively impacting the fish community. Lakes Minnewashta and Virginia are also infested with Eurasian watermilfoil, Curlyleaf Pondweed and zebra mussels.

Management strategies within Lake Virginia subwatershed will focus on promoting infiltration, reducing pollutant loading, improving biodiversity and protecting existing resources. The District will collaborate on these management strategies with local and state government, developers, lake associations, citizens' groups and other parties. This is summarized in the Implementation Plan.

RESOURCE NEEDS

EXISTING CONDITIONS AND ISSUES

This section of the Plan outlines existing conditions and water resource issues, categorized by water quality, water quantity, and ecologic integrity. Condition information was compiled from community input, monitoring data, special studies, the Hydrologic and Hydraulic Pollutant Loading Study (HHPLS), Minnehaha Creek and Upper Watershed Stream Assessments, the Functional Assessment of Wetlands (FAW), Total Maximum Daily Load (TMDL) studies, and state and regional land use and land cover data. A review of these conditions and data revealed several issues and concerns that may require action on the part of the District or its partners. More detailed information about the Lake Virginia subwatershed may be found in Volume 2: Land and Natural Resources Inventory.

Water Quality

Lakes and Streams

Lake Minnewashta, Lake Virginia, Lake St. Joe and Tamarack Lake are lakes within the subwatershed. Minnewashta Creek conveys discharge from Lake Minnewashta to Lake Virginia.

Lake Virginia and Tamarack Lake are listed as Impaired Waters for excess nutrients, although Tamarack Lake varies from slightly below to slightly above the state standard. Lake Minnewashta and Lake St. Joe have historically met or bettered state water quality standards, although Lake St. Joe can experience algal blooms. Both Minnewashta and Virginia are listed as Impaired Waters for excess mercury in fish tissue, and the State of Minnesota has completed a statewide TMDL for those impairments.

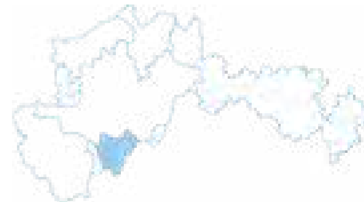


Figure 3.17 Lake Virginia Base map

Virginia and Lake Minnewashta have zebra mussels, which can influence water quality changes and food web changes when abundant. The zebra mussel population in Lake Virginia is small, and no zebra mussels have been found in the main body of Lake Minnewashta.

Minnewashta Creek outlet historically has relatively low TP concentrations and loading, although loading does show an increase during high flow years.

Wetlands

There are wetlands in the subwatershed with excellent and high vegetative diversity that are sensitive to the quality of stormwater inputs.

Groundwater

There are areas of aquifer sensitivity in the subwatershed. As development occurs and infiltration is proposed to meet water quality and volume control standards, special attention should be paid in areas of aquifer sensitivity and wellhead protection areas.

Water quantity

Several locations may experience flooding during large rain events, according to the District's model. There are wetlands in the subwatershed that rely on steady inflow from surficial groundwater. Portions of the subwatershed are within city Wellhead Protection Areas and there may be restrictions on infiltration in some sensitive areas. There are two landlocked subwatershed units that may in the future be considered for constructed outlets.

Ecological Integrity

Lakes and Streams

Fisheries range in health throughout the subwatershed. Lake Minnewashta is known for its fishing, but in Lake Virginia, where common carp and other rough fish are abundant, low dissolved oxygen may be impacting the fish community.

The aquatic vegetation community in Lake Minnewashta supports moderate species diversity, but contains aquatic invasive species, including Eurasian watermilfoil and Curlyleaf pondweed. The lake is also listed as infested for zebra mussels, but management has so far contained them to the channel area where the access is located. Lake Virginia also contains Eurasian watermilfoil, Curlyleaf pondweed and zebra mussels, although zebra mussels are generally found in low numbers. Tamarack Lake's aquatic vegetation community is degraded, showing low

Lake Minnewashta

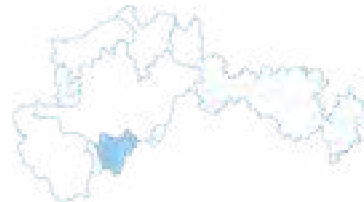
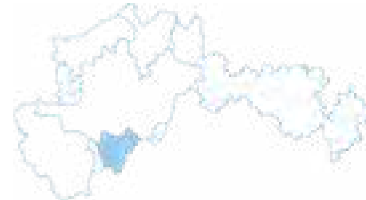


Figure 3.18 Lake Virginia Water Resources map

Figure 3.19 Lake Virginia Parks, Trails and Open Space map



species diversity often including non-native and/or intolerant species.

Wetlands

There are wetlands in the subwatershed with exceptional to high fish and wildlife habitat and exceptional to high vegetation quality. Many of these wetlands are within the boundary of Lake Minnewashta Regional Park or the Minnesota Landscape Arboretum and are already protected. Opportunities exist to protect the wetlands surrounding both Tamarack Lake and Lake St. Joe.

Uplands and Natural Corridors

There are areas of high ecological value within corridors of upland habitat. Some areas are protected within local and regional parks or the Landscape Arboretum, while other areas are privately owned.

DRIVERS

A driver of water quality, water quantity, or ecological integrity is a driving force or stressor that causes a biological community or physical structure to change. Some example drivers include increased phosphorus loading, increased impervious areas, straightened channels, and drained wetlands. Some drivers are natural, such as storm events. Most are human-caused, either directly or as a side effect of some other change such as a land use change or removal of natural land cover. This section of the Plan outlines the main drivers of water quality, water quantity, and ecological integrity issues within the Lake Virginia subwatershed.

The principal water quality, water quantity, and ecological integrity issues within the Lake Virginia subwatershed are:

Water Quality

- » Excess nutrients in Impaired Waters
- » Protecting good water quality in some lakes

Water Quantity

- » Localized flooding

Ecological Integrity

- » Protecting wetland and terrestrial corridors

These issues are primarily the result of the following drivers:

- » Altered wetlands
- » Common carp
- » Stormwater runoff
- » Altered channels
- » Internal sediment phosphorus loading

Altered Wetlands

On a watershed scale, wetlands can act as sinks, sources, or transformers (particulate to dissolved) for nutrients like phosphorus. Historically, wetlands acted as nutrient sinks within a watershed, capturing and retaining nutrients, even as nutrient loads to the wetland were increased as land use intensified. However, as wetlands were ditched and drained to facilitate watershed drainage and land use change, they often converted from a sink for nutrients to sources, by increasing the breakdown of wetland soil and the conveyance of stormwater. These processes within altered wetlands can release large pools of stored nutrients, causing nutrient impairments in downstream surface waters.

Many wetlands in the subwatershed are of high or exceptional quality, and do not appear to be significantly altered by ditching and draining. Minnewashta Creek does flow through a riparian wetland between Lakes Minnewashta and Virginia, but it is unclear whether that wetland impacts downstream nutrient loading. Several of the wetlands do receive stormwater and may be impacted in the future by that loading.

Carp

Invasive common carp negatively impact water quality and ecological conditions in surface waters when carp dominate fish communities. Carp impact aquatic systems by their bottom feeding behavior which uproots aquatic plants, re-suspends bottom sediments, and releases nutrients into the water column. This leads to decreased water clarity and a switch to a water state dominated by algae in shallow lakes and wetlands. This turbid water condition is the least ecologically diverse state, and is often characterized by a significant loss of natural vegetation, harmful algal blooms, and the release of phosphorus from resuspended sediments, all of which contribute to water quality impairments and the loss of fish and wildlife habitat.

Fish survey data is limited, but common carp appear to be abundant in Lake Virginia, where low dissolved oxygen is thought to be impacting more sensitive fish species. Carp could be partially responsible for Lake Virginia's impaired water quality, since bottom feeding by carp releases nutrients into Lake Virginia's water column. These nutrients could then be conveyed downstream to Lake Minnetonka: Smithtown Bay. The extent of the carp population and its migratory and spawning habits is not known.

Stormwater Runoff

Watershed runoff from rainfall events, or stormwater, can carry nutrients and other pollutants to surface waters leading to negative impacts in lakes, streams and wetlands. In urban and suburban areas, high proportions of impervious surfaces such as parking lots and driveways increase the volume and rate of stormwater runoff, which can cause flooding, and change stream flow in ways that negatively impact habitat for critical parts of the food-web like fish and macroinvertebrates. In rural areas drained for agriculture, the increased volume and peak flow of stormwater runoff causes similar negative impacts.

While the increased volume and rate of stormwater runoff can negatively impact physical conditions in receiving waters, the runoff also carries with it increased loads of pollution that negatively impact the quality of lakes, streams and wetlands. In urban and suburban areas, stormwater picks up excess nutrients, bacteria such as *E. coli*, chloride from road salt, and other pollutants causing toxicity to organisms or issues with excess nutrients (eutrophication). In more rural areas, stormwater mobilizes pollutants from manure and fertilizer including excess nutrients, bacteria, herbicides and pesticides.

These impacts heavily influence the conditions of surface waters because a healthy hydrologic condition is critical to supporting a healthy lake, stream or wetland. Generally, as impervious cover, altered drainage, and stormwater runoff within a watershed increases, the quality of lakes, streams and wetlands decreases.

Lake Virginia and Tamarack Lake are impaired for excess nutrients, and runoff from lawns, streets and agriculture in the subwatershed could be a source of nutrients and sediment to these lakes. The 2011 Lake Virginia TMDL requires a 27 percent reduction in phosphorus load from the watershed to meet state nutrient standards. The 2014 TMDL for Tamarack Lake does not require a specific load reduction, but recommends reducing nutrient loading from the subwatershed so that the lake may more consistently meet state standards.

Altered Channels

Historically, natural channels were straightened, widened and relocated to accommodate land use change. Channel alteration to improve watershed drainage can lead to a loss of physical habitat, increased peak flow velocities and downstream flooding, decreases in dissolved oxygen, and increased sediment transport which can negatively impact fish and macroinvertebrate communities.

Minnewashta Creek flows through several culverts along its 1.2 mile course to Lake Virginia, and these culverts impair connectivity in the Creek. Some reaches of the creek have also been channelized. No data exist on the biotic communities within Minnewashta Creek, but these channel alterations likely impair biotic communities.

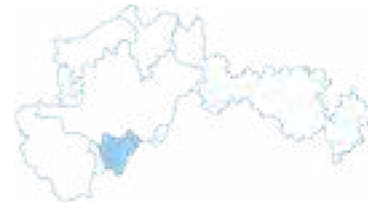
Internal Sediment Phosphorus Loading

Long term excessive loading of phosphorus to lakes can lead to phosphorus buildup in the sediments of the lake bed. Ultimately, this phosphorus can be released from the sediment back into the water. Further exacerbating the problem, released phosphorus is typically dissolved which is readily available for plant uptake and contributes directly to algae blooms. Sediment phosphorus release can lead to summer algae blooms, poor water clarity and, in severe cases, summer fish kills and harmful algal blooms. Restoration of water quality in lakes often requires significantly reducing phosphorus release from sediments.

No sediment release data are available, but the 2011 Lake Virginia TMDL determined that internal sediment release was not a significant factor in the Lake Virginia impairment, specifying just a five percent reduction of the internal nutrient load.

MANAGEMENT STRATEGIES

Informed by the identification and prioritization of conditions and issues in the subwatershed and an understanding of the



drivers impacting its water resources, the District has developed general strategies to guide actions in the Lake Virginia subwatershed. These strategies are both short- and long-term, and establish a framework for the Virginia Lake subwatershed Implementation Plan programs and projects.

Wetland Restoration

Traditional approaches to wetland restoration focus on restoring wetland channels and hydrology to support a more diverse native plant population. While this strategy addresses ecological integrity within the wetland, it often overlooks the need to alter the cycles of wetland chemistry created by historic wetland alteration, which transform and release phosphorus to downstream waterbodies.

To address both ecological integrity and the release of phosphorus, wetland restoration must focus on modifying hydrology to support the native plant community while minimizing phosphorus export. This may include, but is not limited to, bypassing flow around the wetland, the addition of nutrient filters, soil engineering or augmentation to permanently sequester phosphorus, or the development of wetland treatment cells. Selected restoration options will depend on site specific wetland conditions and hydrology, and overall needs of the subwatershed system.

Although many wetlands in the subwatershed have exceptional to high fish and wildlife habitat and vegetation quality, there are several wetlands that have high or moderate restoration potential. This includes a wetland through which Minnewashta Creek flows on its way to Lake Virginia. If restored, this wetland could improve vegetative diversity and provide connected habitat within the watershed in addition to potentially improving the water quality of Lake Virginia.

Carp Management

Historically, carp management focused on removal of carp populations from impacted water bodies without any consideration of population dynamics such as reproduction, immigration, and emigration. More recent carp management techniques focus on integrated pest management where activities focus not only on removal but also on the long-term prevention of carp reproduction and immigration into sensitive water bodies. These new techniques allow for sustainable control of carp populations to measurably improve shallow lake and wetland water quality, plant communities and overall ecological health.

Lake Minnewashta

While common carp are known to be present in Lake Virginia, not much is known about their extent or whether they are impacting water quality of Lake Virginia. To undertake a rough fish management program, it would be necessary to perform feasibility studies to assess carp and other rough fish populations and their migration patterns.

Stormwater Management

Stormwater management will focus on reducing runoff volumes and rates, as well as reducing pollutant loading from runoff producing rain events. Stormwater management in the developed or developing urban and suburban areas will focus on retrofitting low impact development techniques such as ponds, filters, infiltration techniques, and other technologies where they are applicable. In the rural and agricultural areas, stormwater management will focus on buffers, improved agricultural practices such as conservation tillage, manure management for animal agriculture and hobby farms, wetland restoration and fertilizer management.

In the Lake Virginia subwatershed, the focus will be on installing infiltration and load reduction BMPs, requiring stormwater pretreatment before discharge into any wetland, and protecting wetland vegetation quality and diversity by limiting the hydrological bounce from inflow to the wetlands.

Stream Channel Restoration

Stream restoration focuses on balancing stormwater conveyance to prevent flooding and channel erosion while providing high quality habitat for fish and macroinvertebrates. Restoration includes, where applicable, improving channel sinuosity, stabilizing streambanks, controlling peak flow velocities, increasing channel roughness for habitat and re-aeration, narrowing stream channels to improve wetted width and ecological baseflow, and increasing stream structure.

While opportunities to restore a more natural form and function are limited, Minnewashta Creek should be investigated for restoration potential, including need for streambank repair, buffer enhancement, and habitat enhancement.

Internal Sediment Phosphorus Control

Reducing or eliminating phosphorus release from sediments is often essential to meet water quality standards in lakes. There are several techniques available for controlling sediment phosphorus release including sediment phosphorus inactivation using a chemical such as aluminum, oxygenation to prevent sediment anoxia, hypolimnetic aeration and iron addition to prevent phosphorus release, or hypolimnetic withdrawal. While all the techniques can be effective, the application of aluminum to sediments using aluminum sulfate (alum) or a mixture of sodium aluminate and alum is typically the most cost effective approach for reducing sediment phosphorus release.

Additional information is necessary to evaluate management options for Lake Virginia. While the 2011 TMDL found that sediment release is likely not a significant driver of annual lake loading, the potential impacts of rough fish and invasive aquatic vegetation should be further investigated to establish the appropriate future course of action.

LAND USE

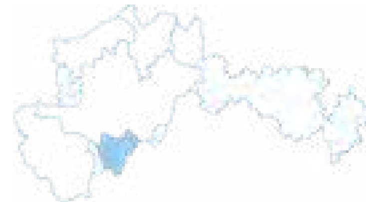
EXISTING CONDITIONS

The subwatershed includes a portion of the cities of Chanhassen, Chaska, Shorewood, and Victoria. Land use in the subwatershed is generally characterized by low density development (26%), parks and open spaces (28%), water (22%), undeveloped land (12%), and agricultural uses (7%). Lake Minnewashta Regional Park and parts of the Minnesota Landscape Arboretum are within the subwatershed's boundaries. The Southwest Hennepin LRT Regional Trail also passes across the northwest corner of the subwatershed.

LOCAL PLANS AND PRIORITIES

As described in the District's goals (Section 3.3), the District strives to implement its clean water objectives in ways that meaningfully contribute to the development of thriving communities. This is achieved through collaboration and integrated planning with public and private partners.

As part of the development of this plan, the District reached out to its communities to gather information on local goals, plans, and priorities for 2018-2027 (see Appendix B for details on the public input process). This information was used to broadly characterize opportunities, and to inform the development of the District's implementation plans. The information received was used only as a guide during the development of this Plan to inform the District of opportunities for partnership on the



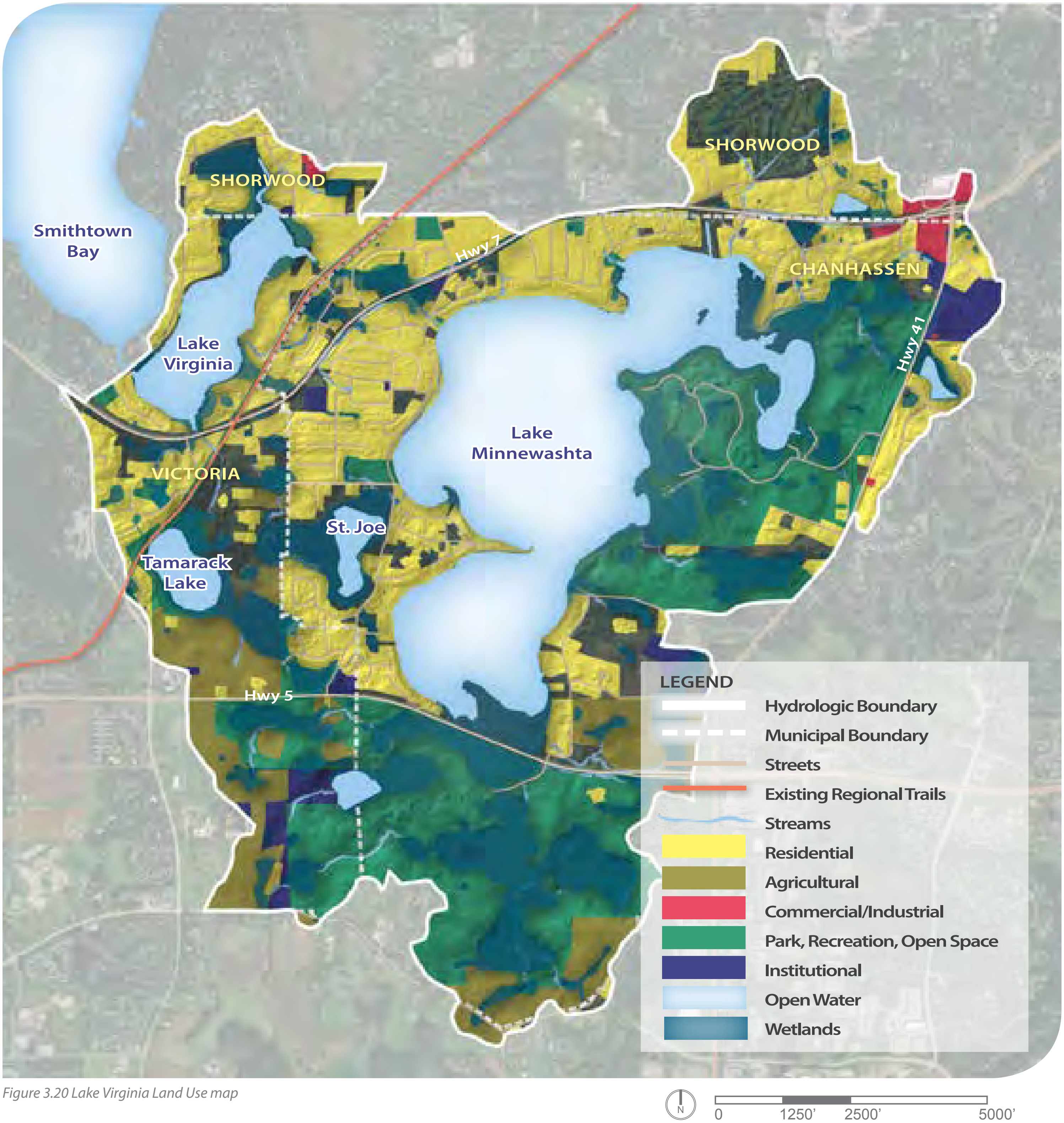


Figure 3.20 Lake Virginia Land Use map

near term horizon, and was not intended to be exhaustive or restrict future collaborative efforts.

As discussed in Section 3.6, the District intends to cultivate a framework for two-directional coordination with communities on an ongoing basis, to stay apprised of emerging needs at a local level, and to identify and evaluate opportunities to implement management strategies outlined in this Plan over the next ten years. The District recognizes that local needs, opportunities and priorities may shift over time. Therefore, this Plan does not intend to capture or prescribe opportunities for partnership over a ten-year term.

Long term goals, growth and private development, and public investment in infrastructure differ across each community – and therefore, frameworks for ongoing coordination will be custom tailored based on the individual needs of each community. Coordination may occur at varying levels, through various means, with communities across the following areas:

» Regulation of, and partnership with, private development

» Collaboration on public planning and investment (e.g. parks , roads, utilities)

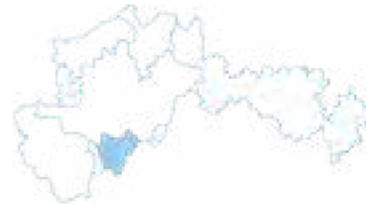
» MS4 compliance

» Development and implementation of TMDLs

Through the information gathering processes of this Plan, the District was informed that the subwatershed is mostly developed, and there is little anticipated for near-term development or infrastructure investment. There are septic systems on the east side of Lake Virginia that are a potential source of nutrients to the lake. Sanitary sewer has been installed, and residents are expected to connect over time as septic inspections indicate the need.

The Lake Minnewashta Preservation Association is an active association on Lake Minnewashta. The Association plans to continue to raise funds to perform invasive species treatments (e.g. Eurasian watermilfoil management) and is also working to develop a contingency fund for unanticipated events, such as the 2016 zebra mussel infestation.

Stream running to Lake Minnewashta



IMPLEMENTATION PLAN

The goals set forth in this subwatershed plan will require an integrated set of programs and projects oriented toward the conservation and improvement of water resources within the watershed. The Implementation Priorities section generally describes the actions that the District and its partners will look to take in order to address the issues present in the subwatershed and achieve the goals as set forth in the plan. The Capital Improvement Plan (CIP) provides cost estimates and schedules for any proposed capital investments.

IMPLEMENTATION PRIORITIES

As described in previous sections, Lake Virginia and Tamarack Lake are impaired for excess nutrients and low dissolved oxygen in Lake Virginia may be negatively impacting sensitive fish species. Common carp could be partially responsible for Lake Virginia's impaired water quality. Lake Virginia and Lake Minnewashta have been infested with Eurasian watermilfoil, Curlyleaf Pondweed and zebra mussels. The subwatershed also contains wetlands with exceptional to high fish and wildlife habitat and vegetation quality.

Based on these conditions, management strategies within the subwatershed will focus primarily on stormwater management to reduce pollutant loading, promoting infiltration, improving biodiversity, protecting existing resources, and evaluating the presence and managing the impact of common carp.

The Lake Virginia subwatershed is relatively small and there is little anticipated for near-term development or infrastructure investment, so opportunities from land use change may be limited. The Plan establishes a coordination framework through which the District will seek to maintain current knowledge of land use and capital planning by its LGUs, and of potential land use development and redevelopment activity.

As opportunities arise, the District will evaluate them against the resource needs and priorities defined throughout this plan and determine the appropriate response. The District has a wide range of services it can mobilize to address resource needs and support partner efforts, including data collection and diagnostics, technical and planning assistance, permitting assistance, education and capacity building, grants, and capital projects.

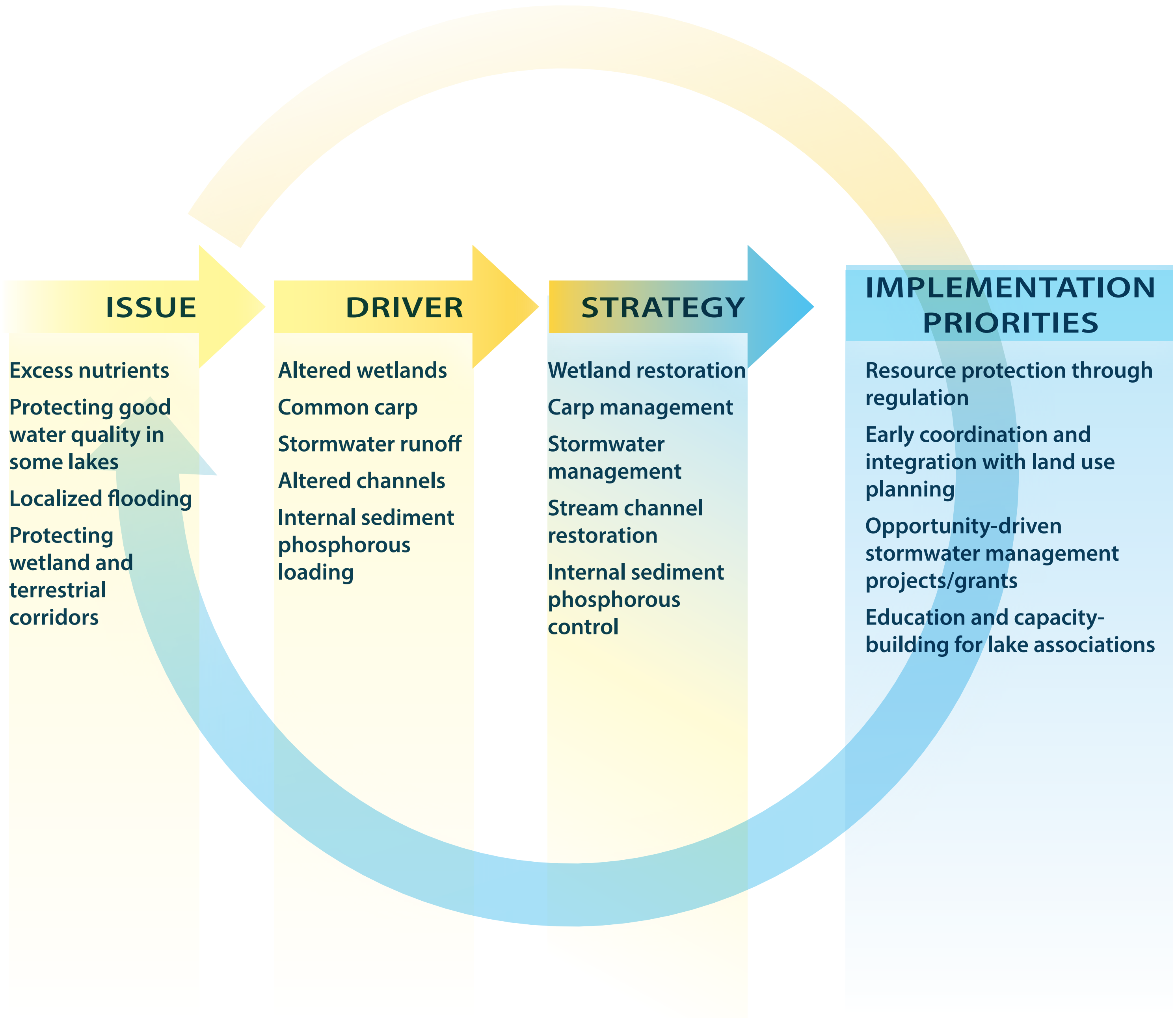
The District will pro-actively coordinate the permitting of future land use change with its LGUs to explore opportunities to create public-private partnerships to address stormwater management goals in ways that exceed regulatory requirements. As noted in the previous section, there is an active lake association for Lake Minnewashta. The District will continue to work with its lake associations to provide education and technical assistance to build their capacity and target implementation efforts. The District will continue to monitor any impacts or trends related to the zebra mussel infestation.

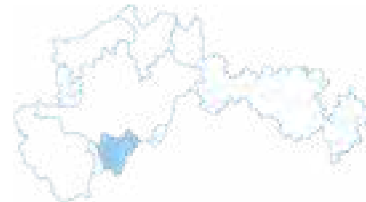
To allow the District the flexibility to respond to opportunities identified by the cities or other partners, or that may arise through land-use change, the capital improvement plan for this subwatershed includes a project for stormwater management. In the future, should the District or a partner determine that a larger or more concentrated scale of capital and program implementation may be needed, a discrete subwatershed planning process may be initiated to:

- Provide high resolution diagnostic of watershed issues and drivers
- Map current projected land use and infrastructure changes
- Define a detailed and integrated capital and program implementation plan
- Outline a funding strategy including program costs and sources
- The details of such a plan would provide the information needed for the District to pursue a plan amendment under MN Rules 8410, thereby updating specific subwatershed components of this Plan.

CAPITAL IMPROVEMENT PLAN

The CIP is a planning tool. It also is a means to inform partners, District residents, and other interested parties as to the District's scope and priorities for its capital work over the planning period. A project's inclusion in the CIP does not mean that the project will be constructed, only that the District has identified it as an action that may be a cost-effective way for the District to


ISSUE
Excess nutrients
Protecting good water quality in some lakes
Localized flooding
Protecting wetland and terrestrial corridors
DRIVER
Altered wetlands
Common carp
Stormwater runoff
Altered channels
Internal sediment phosphorous loading
STRATEGY
Wetland restoration
Carp management
Stormwater management
Stream channel restoration
Internal sediment phosphorous control
IMPLEMENTATION PRIORITIES
Resource protection through regulation
Early coordination and integration with land use planning
Opportunity-driven stormwater management projects/grants
Education and capacity-building for lake associations



achieve identified water resource goals. A project identified in the CIP always will need further review as to technical feasibility, cost and financing, consistency with local needs, and other policy considerations before a formal decision to proceed to construction is made. Section 3.5.5 describes the development and evaluation steps that will occur before the District will commit resources to a project.

Section 3.5.5 also describes how the District will review the CIP on an ongoing basis throughout the planning period. This review will allow the District to reassess described projects from a technical perspective, but also will involve broader policy considerations such as shifts in District priorities, decisions as to annual budget and levy levels, and the prospect of state and federal grant funds or financing. For this reason, projects may be added to and deleted from the CIP from year to year, in accordance with those procedures.

A critical component of any project will be the development of a funding strategy that identifies the sources, uses, and timing of funds needed to successfully achieve identified goals. These plans will be developed in conjunction with the District's public and private partners as capital projects are advanced. Therefore, any costs identified within this Plan are projections. Intended expenditures will be refined during project development and budgeting, and among other things will reflect the District's intent to complement its ad valorem funds with other funding sources.

Table 3.9 Lake Virginia Subwatershed CIP

Project	Stormwater Volume and Pollutant Load Reduction
Description	Implementation of opportunities to reduce stormwater volumes and nutrient loading to Lake Virginia, including but not limited to infiltration or filtration basins and devices, reforestation, revegetation, and stormwater detention or redirection.
Need	Lake Virginia exceeds state nutrient standards. A 2011 TMDL study identified a need to reduce phosphorus loading by 20% (77 pounds), most of which is from external sources (71 pounds).
Outcome	Reduction of pollutant loading to Lake Virginia; reduction of stormwater runoff volume and rate and associated impacts; protection and enhancement of groundwater recharge, stream base flow, and wetland hydrology.
Estimated Cost	Capital costs: $650,000, excluding land, in 2017 dollars.
Potential Funding Sources	District levy, partner contributions, grants
Schedule	2018-2027

3.9.6 LANGDON LAKE SUBWATERSHED PLAN

INTRODUCTION

This subwatershed plan contains information specific to the Langdon Lake Subwatershed, including existing conditions and issues, drivers, management strategies, land use information, and an implementation plan. Information regarding the District's philosophy, goals, and implementation approach can be found in Sections 3.2-3.4 and should be reviewed first to provide context for the following subwatershed plan.

EXECUTIVE SUMMARY

Langdon Lake is a 1.7 square mile (1,056 acre) subwatershed located along the western boundary of the MCWD and includes portions of the cities of Minnetrista and Mound. The subwatershed is generally characterized by low density development (32%), including many single-family homes, water (22%), parks and open spaces (21%), undeveloped land (18%), and agricultural uses (2%). The Dakota Rail Trail traverses this subwatershed on the north side of Langdon Lake, and Gale Woods Regional Park occupies a portion of the western subwatershed.

The western half of the subwatershed is dominated by a mosaic of forest and woodland, wetland, and open water, including Black Lake and Saunders Lake. The largely intact open space surrounding Black Lake and the north and west sides of Saunders Lake are classified as a Regionally Significant Ecological Area.

Langdon Lake is the primary receiving water within the subwatershed. Two other receiving waters within the subwatershed carry an informal lake designation: Saunders Lake and Flanagan Lake, both of which could be classified as wetlands. There is a small channel that conveys discharge from the outlet of Saunders Lake to Langdon Lake. Langdon Lake discharges through a culvert under Highway 110 into Lost Lake, which outlets into Lake Minnetonka: Cooks Bay. The subwatershed is bisected by a railroad corridor, which influences its hydrology.

Langdon Lake subwatershed has several issues relating to water quality, water quantity, and ecological integrity. Langdon Lake is impaired by excess nutrients, and a TMDL requires both external and internal load reductions. Water quality may be impacting the fish community in Langdon Lake, which has not been formally assessed since 1993, but is dominated by bullheads. Recent plant surveys show a degraded aquatic plant community, which in turn limits the fishery. In addition, culverts in the subwatershed need maintenance to ensure adequate conveyance and flood storage. Overall, the system enjoys moderate to high ecological integrity, with wetlands containing high vegetative diversity and extensive connected natural corridors containing high quality habitat. These areas should be protected.

Management strategies within the Langdon Lake subwatershed will focus on nutrient reductions, while promoting infiltration, reducing pollutant loading, improving biodiversity, and protecting existing resources. The District will collaborate on these management strategies with local and state government, developers, lake associations, citizens' groups and other parties to implement. This is summarized in the Implementation Plan.

RESOURCE NEEDS

EXISTING CONDITIONS AND ISSUES

This section of the Plan outlines existing conditions and water resource issues categorized by water quality, water quantity, and ecologic integrity. Condition information was compiled from community input, monitoring data, special studies, the Hydrologic and Hydraulic Pollutant Loading Study (HHPLS), Minnehaha Creek and Upper Watershed Stream Assessments, the Functional Assessment of Wetlands (FAW), Total Maximum Daily Load (TMDL) studies, and state and regional land use and land cover data. A review of these conditions and data revealed several issues and concerns that may require action on the part of the District or its partners. More detailed information about the Langdon Lake subwatershed may be found in Volume 2: Land and Natural Resources Inventory.

Water Quality

Lakes and Streams

Langdon Lake is listed on the State's Impaired Waters list for excessive nutrients. Internal loading (potentially impacted by a historic wastewater treatment plant) and external loading coming from stormwater runoff and the upstream wetland system may be contributing to these concentrations.

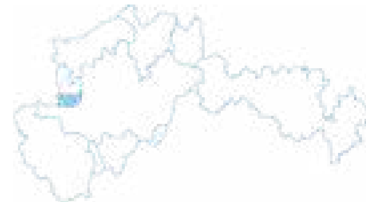


Figure 3.21 Langdon Lake Base map

At this time, no streams are listed as Impaired Waters. The Langdon Lake inlet and outlet streams are within the state river eutrophication standards.

Wetlands

There are wetlands in the subwatershed with high vegetative diversity that are sensitive to the quality of stormwater inputs.

Groundwater

There are areas of very high and high aquifer sensitivity in the subwatershed. As development occurs and infiltration is proposed to meet water quality and volume control standards, special attention should be paid in areas of aquifer sensitivity and wellhead protection areas.

Water Quantity

Culverts in the subwatershed and outlets on Flanagan and Saunders Lakes need maintenance to ensure adequate conveyance and flood storage.

Preservation of upstream storage in Flanagan and Saunders Lakes and other wetlands is necessary to provide downstream flood protection.

There are wetlands in the subwatershed that rely on steady inflow from surficial groundwater. Groundwater recharge is important within the subwatershed to maintain wetland hydrology and stream baseflow, as well as to recharge aquifers that supply public and private drinking water wells.

Portions of the subwatershed are within city Wellhead Protection Areas and there may be restrictions on infiltration in some sensitive areas.

Ecological Integrity

Lakes and Streams

The Langdon Lake subwatershed is notable for its ecological resources and large wetlands.

Langdon Lake is the primary receiving water in the subwatershed and is listed on the State's Impaired Waters list for excessive nutrients. The last fish survey was completed in 1993, but the community was dominated by bullheads at that time. The aquatic plant community is also degraded, which in turn impacts the fishery.

The Langdon Lake outlet stream has, for the most part, stayed at or above the DO standard. However, it has dipped below the

Saunders Lake

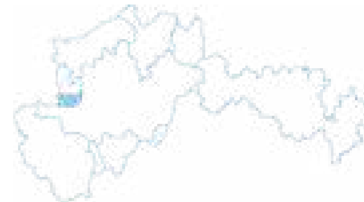
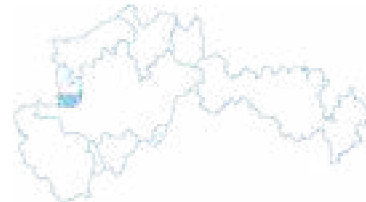


Figure 3.22 Langdon Lake Water Resources map

Figure 3.23 Langdon Lake Parks, Trails, and Open Space map



standard intermittently, probably due to low flow and high summer temperatures. There are no fish or aquatic vegetation data for the Langdon Lake inlet or outlet, but there is high connectivity in these streams, with no identified barriers, such as dams, weirs, or culverts.

Wetlands

Wetland assessments have classified a number of wetlands in the subwatershed as having excellent vegetative diversity and wildlife habitat. The highest vegetative diversity was found in the wetland complex associated with Flanagan Lake within the Gale Woods Regional Park and the wetlands riparian to Saunders Lake. These wetlands are in need of protection. Their conservation is integral to achieving ecological integrity, water quality, stormwater management and floodplain management goals.

Uplands and Natural Corridors

Nearly the entire western subwatershed has been identified as important conservation corridors worthy of protection by Hennepin County and the Metropolitan Council. The wide wetland areas along the western and northern areas of Langdon Lake have also been identified. The Dakota Rail Regional Trail may act as a barrier to wildlife migration between the north and south halves of the subwatershed.

DRIVERS

A driver of water quality, water quantity, or ecological integrity is a driving force or stressor that causes a biological community or physical structure to change. Some example drivers include increased phosphorus loading, increased impervious areas, straightened channels, and drained wetlands. Some drivers are natural, such as storm events. Most are human-caused, either directly or as a side effect of some other change such as a land use change or removal of natural land cover. This section of the Plan outlines the main drivers of water quality, water quantity, and ecological integrity issues within the Langdon Lake subwatershed.

The principal water quality, water quantity, and ecological integrity issues within the Langdon Lake subwatershed are:

Water Quality

» Excess nutrients

Water Quantity

» Maintenance of upstream flood storage

Ecological Integrity

» Protection of high quality wetlands

» Protection of high quality upland corridors

These issues are primarily the result of the following drivers:

» Altered wetlands

» Stormwater runoff

» Internal sediment phosphorus loading

» Water quality from upstream waterbodies

Altered Wetlands

On a watershed scale, wetlands can act as sinks, sources, or transformers (particulate to dissolved) for nutrients like phosphorus. Historically, wetlands acted as nutrient sinks within a watershed, capturing and retaining nutrients, even as nutrient loads to the wetland were increased as land use intensified. However, as wetlands were ditched and drained to facilitate watershed drainage and land use change, they often converted from nutrient sinks to sources, by increasing the breakdown of wetland soil and the conveyance of stormwater. These processes within altered wetlands can release large pools of stored nutrients, causing nutrient impairments in downstream surface waters.

Many wetlands in the subwatershed are of high quality. The primary concern in the subwatershed is the impact of discharge from the old Mound Wastewater Treatment Plant pond on the riparian wetland on the west side of the lake creating a pool of phosphorus in the wetland, which is available for release into the lake.

Stormwater Runoff

Watershed runoff from rainfall events, or stormwater, can carry nutrients and other pollutants to surface waters leading to negative impacts in lakes, streams, and wetlands. In urban and suburban areas, high proportions of impervious surfaces such as parking lots and driveways increase the volume and rate of stormwater runoff, which can cause flooding and change stream flow in ways that negatively impact habitat for critical parts of the food-web like fish and macroinvertebrates. In rural areas drained for agriculture, the increased volume and peak flow of stormwater runoff causes similar negative impacts.

While the increased volume and rate of stormwater runoff can negatively impact physical conditions in receiving waters, the runoff also carries with it increased loads of pollution that negatively impact the quality of lakes, streams, and wetlands. In urban and suburban areas, stormwater picks up excess nutrients, bacteria such as *E. coli*, chloride from road salt, and other pollutants causing toxicity to organisms or issues with excess nutrients (eutrophication). In more rural areas, stormwater mobilizes pollutants from manure and fertilizer including excess nutrients, bacteria, herbicides, and pesticides.

These impacts heavily influence the conditions of surface waters because a healthy hydrologic condition is critical to supporting a healthy lake, stream, or wetland. Generally, as impervious cover, altered drainage, and stormwater runoff within a watershed increases, the quality of lakes, streams, and wetlands decreases.

Langdon Lake exceeds the state standard for total phosphorus, and runoff from lawns, streets, and agriculture in the subwatershed could be a source of nutrients and sediment to the lake. The 2014 Langdon Lake TMDL requires a 27 percent reduction in nutrient loading from the subwatershed to meet state water quality standards.

Internal Sediment Phosphorus Loading

Long term excessive loading of phosphorus to lakes can lead to phosphorus buildup in the sediments of the lake bed. Ultimately, this phosphorus can be released from the sediment back into the water. Further exacerbating the problem, released phosphorus is typically dissolved which is readily available for plant uptake and contributes directly to algae blooms. Sediment phosphorus release can lead to summer algae blooms, poor water clarity, and in severe cases, summer fish kills and harmful algal blooms. Restoration of water quality in lakes often requires significantly reducing phosphorus release from sediments.

Langdon Lake exceeds the state standard for total phosphorus and is listed as an Impaired Water. The lake received wastewater effluent discharge from the Mound Wastewater Treatment Plant in the past (1963-1974), creating a pool of phosphorus in the sediments that is likely contributing to internal phosphorus loading. The 2014 TMDL requires a 21 percent reduction in internal load to meet state standards.

Upstream Waterbodies

Headwater streams, lakes, and wetlands contribute water and nutrients to downstream receiving waters impacting the quality of these water bodies. Lakes and wetlands with poor water quality ultimately contribute nutrients to downstream waters leading to eutrophication. Consequently, restoration of upstream water bodies is often a critical component of improving downstream water quality on a watershed scale.

Phosphorus export from the upstream wetland system within the watershed may be a contributing source of phosphorus to Langdon Lake, and further monitoring and investigation of conditions in Saunders Lake and its discharge should be considered.

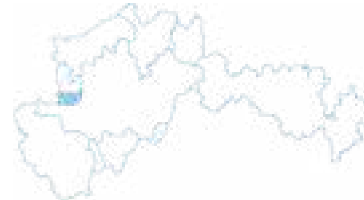
MANAGEMENT STRATEGIES

Informed by the identification and prioritization of conditions and issues in the subwatershed and an understanding of the drivers impacting its water resources, the District has developed general strategies to guide actions in the Langdon Lake subwatershed. These strategies are both short- and long-term, and establish a framework for the Langdon Lake subwatershed Implementation Plan programs and projects.

Wetland Restoration

Traditional approaches to wetland restoration focus on restoring wetland channels and hydrology to support a more diverse native plant population. While this strategy addresses ecological integrity within the wetland, it often overlooks the need to alter the cycles of wetland chemistry created by historic wetland alteration, which transform and release phosphorus to downstream waterbodies.

To address both ecological integrity and the release of phosphorus, wetland restoration must focus on modifying hydrology to support the native plant community while minimizing phosphorus export. This may include, but is not limited to, bypassing flow around the wetland, the addition



Langdon Lake

Saunders raingarden

Saunders Lake

of nutrient filters, soil engineering or augmentation to permanently sequester phosphorus, or the development of wetland treatment cells. Selected restoration options will depend on site specific wetland conditions and hydrology and overall needs of the subwatershed system.

Wetlands within the Langdon Lake subwatershed are not high priorities for restoration, as they are minimally disturbed and have high quality vegetation communities and wildlife habitat. However, outlet monitoring could be performed to document whether there is phosphorus export from the wetland system.

Stormwater Management

Stormwater management will focus on reducing runoff volumes and rates, as well as reducing pollutant loading from runoff producing rain events. Stormwater management in the developed or developing urban and suburban areas will focus on retrofitting low impact development techniques such as ponds, filters, infiltration techniques, and other technologies where they are applicable. In the rural and agricultural areas, stormwater management will focus on buffers, improved agricultural practices such as conservation tillage, manure management for animal agriculture and hobby farms, wetland restoration, and fertilizer management.

The focus in the Langdon Lake subwatershed will be on ensuring that wetlands are adequately buffered, installing infiltration and load reduction BMPs, requiring stormwater pretreatment before discharge into any wetland, and continuing to address the legacy effects of the Mound Wastewater Treatment Plant.

Internal Sediment Phosphorus Control

Reducing or eliminating phosphorus release from sediments is often essential to meet water quality standards in lakes. There are several techniques available for controlling sediment phosphorus release including sediment phosphorus inactivation using a chemical such as aluminum, oxygenation to prevent sediment anoxia, hypolimnetic aeration and iron addition to prevent phosphorus release, or hypolimnetic withdrawal. While all the techniques can be effective, the application of aluminum to sediments using aluminum sulfate (alum) or a mixture of sodium aluminate and alum is typically the most cost effective approach for reducing sediment phosphorus release.

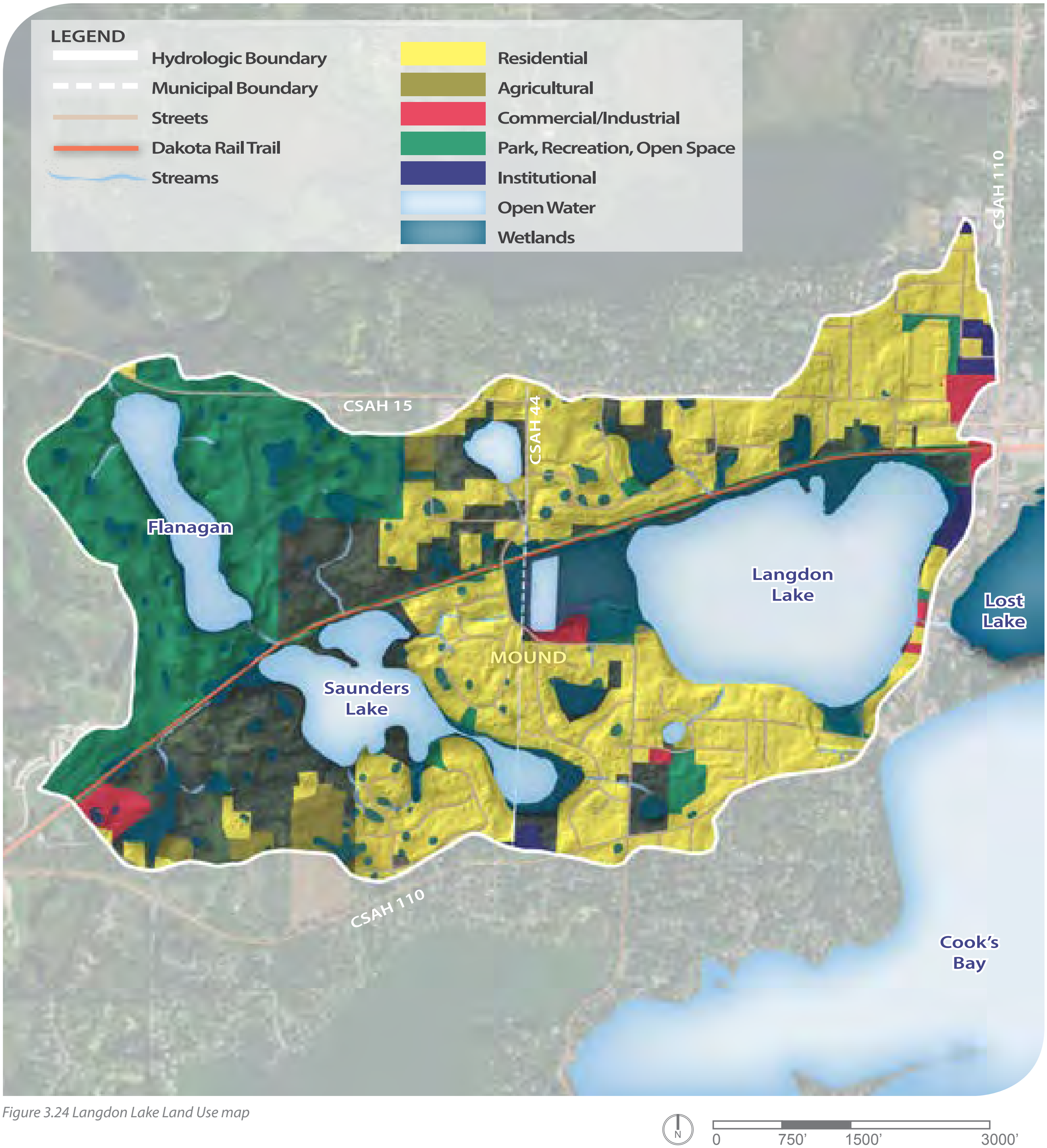
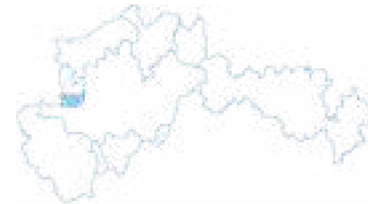


Figure 3.24 Langdon Lake Land Use map



Additional information is necessary to evaluate management options for Langdon Lake. Additional water quality monitoring data, sediment chemistry, and fish and aquatic vegetation surveys are necessary to evaluate the most appropriate techniques to improve water quality in this lake. A future alum treatment may be considered.

Restoration of Upstream Waterbodies

Upstream water bodies that are currently impaired can discharge large nutrient loads to downstream water bodies thereby contributing to downstream water quality impairments. Therefore, prior to, or concurrent with, significant efforts to restore downstream water quality, the water quality in upstream water bodies must be improved. Nutrient impaired upstream lakes may require external and internal nutrient reductions using the strategies listed in this section.

The wetland complexes upstream of Langdon Lake, including Flanagan and Saunders Lakes, should be investigated to determine if they have an impact on the water quality of Langdon Lake. Monitoring outflow from the wetland should occur to determine whether phosphorus concentrations are elevated, suggesting the wetlands are acting as sources rather than sinks of nutrients.

Watershed Protection

Several subwatersheds, especially in the western part of the watershed, are rapidly converting from undeveloped or rural land uses to developments which can increase impervious areas, reduce flood storage, increase pollutant loads, and eliminate or reduce biologically significant land cover. A critical strategy to maintain existing resources and critical functions is to protect these areas by minimizing the impacts of development. This is accomplished by conserving biologically significant upland areas, protecting high value wetlands, mimicking natural watershed hydrology, maintaining stream geomorphology, protecting stream buffers and riparian areas, and protecting critical fish and wildlife corridors.

There are high quality wetlands and uplands in the subwatershed. Much of the western subwatershed has been identified by the DNR as a Metropolitan Conservation Corridor, including areas within Three River Parks District's Gale Woods Regional Park. These natural areas are large and are part of a corridor of habitat between Dutch Lake, Long Lake/Little Long Lake and Whaletail Lake.

The focus in this subwatershed will be to preserve these high-value resources through Land Conservation where appropriate and with Three Rivers Park District as opportunities arise. In addition, the District will work with cities and developers to minimize disturbance during development and construction.

LAND USE

EXISTING CONDITIONS

The subwatershed includes portions of the cities of Minnetrista and Mound. The subwatershed is generally characterized by low density development (32%), including many single-family homes, water (22%), parks and open spaces (21%), undeveloped land (18%), and agricultural uses (2%). The Dakota Rail Trail traverses this subwatershed on the north side of Langdon Lake, and Gale Woods Regional Park occupies a portion of the western subwatershed.

LOCAL PLANS AND PRIORITIES

As described in the District's goals (Section 3.3), the District strives to implement its clean water objectives in ways that meaningfully contribute to the development of thriving communities. This is achieved through collaboration and integrated planning with public and private partners.

As part of the development of this plan, the District reached out to its communities to gather information on local goals, plans, and priorities for 2018-2027 (see Appendix B for details on the public input process). This information was used to broadly characterize opportunities, and to inform the development of the District's implementation plans. The information received was used only as a guide during the development of this Plan to inform the District of opportunities for partnership on the near term horizon, and was not intended to be exhaustive or restrict future collaborative efforts.

As discussed in Section 3.6, the District intends to cultivate a framework for two-directional coordination with communities on an ongoing basis, to stay apprised of emerging needs at a local level, and to identify and evaluate opportunities to implement management strategies outlined in this Plan over the next ten years. The District recognizes that local needs, opportunities and priorities may shift over time. Therefore, this Plan does not intend to capture or prescribe opportunities for partnership over a ten-year term.

Long term goals, growth and private development, and public investment in infrastructure differ across each community – and therefore, frameworks for ongoing coordination will be custom tailored based on the individual needs of each community. Coordination may occur at varying levels, through various means, with communities across the following areas:

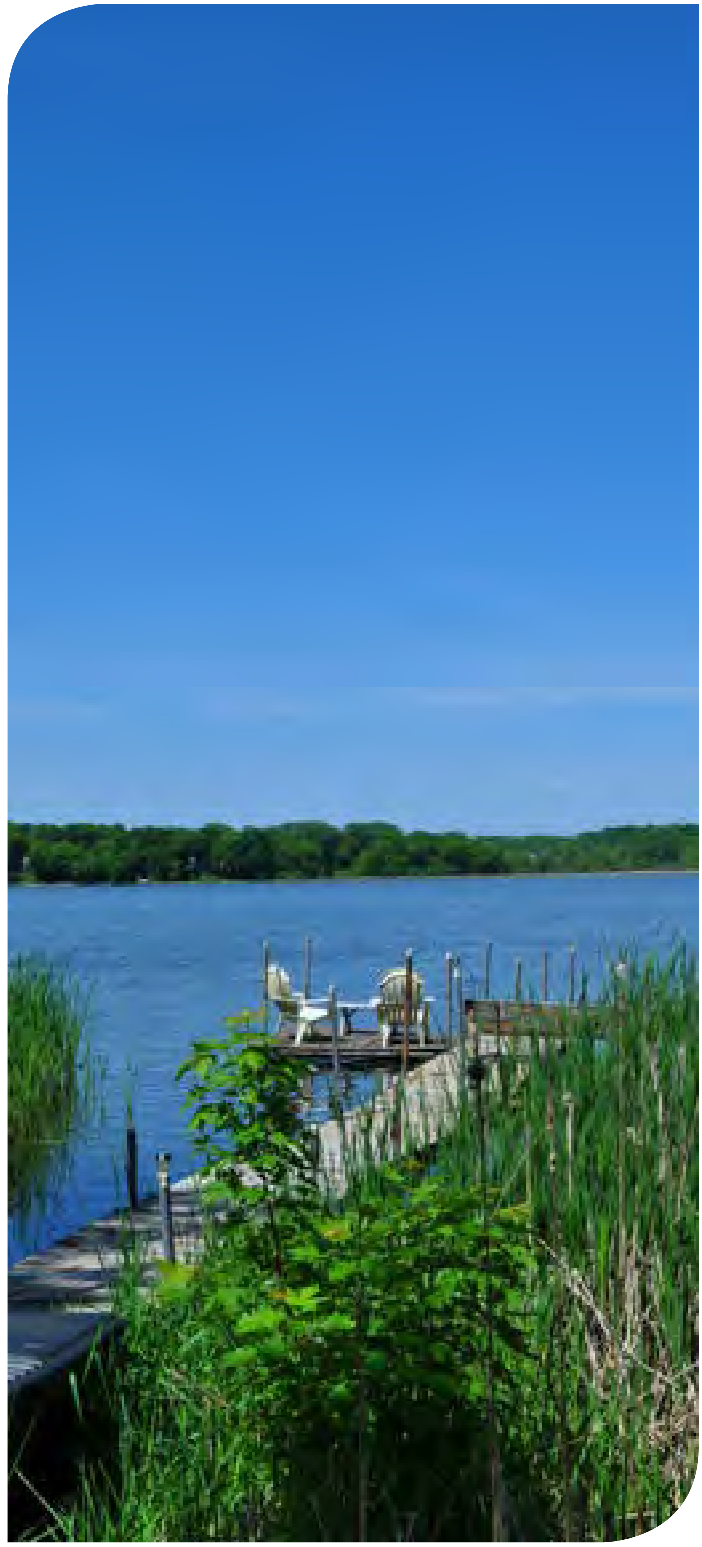
» Regulation of, and partnership with, private development

» Collaboration on public planning and investment (e.g. parks , roads, utilities)

» MS4 compliance

» Development and implementation of TMDLs

Through the information gathering processes of this Plan, one of the priorities identified by cities in the Langdon Lake Subwatershed was maintaining the area's rural character and access to natural resources. There is some redevelopment anticipated to the northwest of Langdon Lake, and the Metropolitan Council Environmental Services is planning to replace an interceptor sewer line along County Road 44. These projects may present opportunities to partner on stormwater management or other resource improvements.

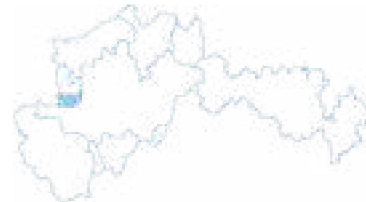

Langdon Lake

IMPLEMENTATION PLAN

The goals set forth in this subwatershed plan will require an integrated set of programs and projects oriented toward the conservation and improvement of water resources within the watershed. The Implementation Priorities section generally describes the actions that the District and its partners will look to take in order to address the issues present in the subwatershed and achieve the goals as set forth in the plan. The Capital Improvement Plan (CIP) provides cost estimates and schedules for any proposed capital investments.

Implementation Priorities

As described in previous sections, Langdon Lake is impaired by excess nutrients, however the inlet and outlet of Langdon Lake are within the state's eutrophication standards. The fish community in Langdon Lake and its inlet and outlet may be negatively impacted by nutrient enrichment, low dissolved oxygen, and reduced water clarity. The subwatershed also contains areas of high quality wetland and upland, including a regionally significant ecological area.



Based on these conditions, management strategies within the subwatershed will focus on reducing pollutant loading, maintaining wetland diversity and stormwater storage, monitoring phosphorus release from wetlands, investigating phosphorus treatment, and protecting existing resources.

The Langdon Lake subwatershed is relatively small. There is some redevelopment anticipated to the northwest of Langdon Lake, and the Metropolitan Council Environmental Services is planning to replace an interceptor sewer line along County Road 44. The Plan establishes a coordination framework through which the District will seek to maintain current knowledge of land use and capital planning by its LGUs, and of potential land use development and redevelopment activity.

As opportunities arise, the District will evaluate them against the resource needs and priorities defined throughout this plan and determine the appropriate response. The District has a wide range of services it can mobilize to address resource needs and support partner efforts, including data collection and diagnostics, technical and planning assistance, permitting assistance, education and capacity building, grants, and capital projects. The CIP for the subwatershed, detailed in the next section, includes a project for stormwater management should an opportunity arise through land use change or a partner initiative.

There are extensive high quality wetlands and uplands in the subwatershed primarily incorporated into Gale Woods Regional Park. The focus in this subwatershed will be to preserve similar high-value resources through Land Conservation, where appropriate, and by working with cities and developers to minimize disturbance during development and construction.

To allow the District the flexibility to respond to opportunities identified by the cities or other partners, or that may arise through land-use change, the capital improvement plan for this subwatershed includes a project for stormwater management. In the future, should the District or a partner determine that a larger or more concentrated scale of capital and program implementation may be needed, a discrete subwatershed planning process may be initiated to:

- Provide high resolution diagnostic of watershed issues and drivers
- Map current projected land use and infrastructure changes
- Define a detailed and integrated capital and program implementation plan
- Outline a funding strategy including program costs and sources

The details of such a plan would provide the information needed for the District to pursue a plan amendment under MN Rules 8410, thereby updating specific subwatershed components of this Plan.

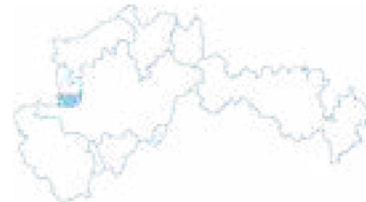
CAPITAL IMPROVEMENT PLAN

The CIP is a planning tool. It also is a means to inform partners, District residents, and other interested parties as to the District's scope and priorities for its capital work over the planning period. A project's inclusion in the CIP does not mean that the project will be constructed, only that the District has identified it as an action that may be a cost-effective way for the District to achieve identified water resource goals. A project identified in the CIP always will need further review as to technical feasibility, cost and financing, consistency with local needs, and other policy considerations before a formal decision to proceed to construction is made. Section 3.5.5 describes the development and evaluation steps that will occur before the District will commit resources to a project.

Section 3.5.5 also describes how the District will review the CIP on an ongoing basis throughout the planning period. This review will allow the District to reassess described projects from a technical perspective, but also will involve broader policy considerations such as shifts in District priorities, decisions as to annual budget and levy levels, and the prospect of state and federal grant funds or financing. For this reason, projects may be added to and deleted from the CIP from year to year, in accordance with those procedures.

A critical component of any project will be the development of a funding strategy that identifies the sources, uses, and timing of funds needed to successfully achieve identified goals. These plans will be developed in conjunction with the District's public and private partners as capital projects are advanced. Therefore, any costs identified within this Plan are projections. Intended


ISSUE
Excess nutrients
Maintenance of upstream flood storage
Protection of high quality wetlands
Protection of high quality upland corridors
DRIVER
Altered wetlands
Stormwater runoff
Internal sediment phosphorous loading
Water quality from upstream water bodies
STRATEGY
Wetland restoration
Stormwater management
Internal sediment phosphorous control
Restoration of upstream water bodies
Watershed protection
IMPLEMENTATION PRIORITIES
Resource protection through regulation
Early coordination and integration with land use planning
Opportunity-driven stormwater management projects/grants
Land conservation/corridor connection



expenditures will be refined during project development and budgeting, and among other things will reflect the District's intent to complement its ad valorem funds with other funding sources.

Table 3.10 Langdon Lake Subwatershed CIP

Project	Storm Water Pollutant Load Reduction
Description	Implementation of opportunities to reduce stormwater volumes and nutrient loading to Langdon Lake, including but not limited to infiltration or filtration basins and devices, reforestation, revegetation, and stormwater detention or redirection.
Need	Langdon Lake exceeds state excess nutrient standards. The 2014 TMDL identified a total phosphorus load reduction of 84 pounds, with 44 pounds from stormwater, for Langdon Lake to meet water quality standards.
Outcome	Reduction of pollutant loading to Langdon Lake; reduction of stormwater runoff volume and rate and associated impacts; protection and enhancement of groundwater recharge, stream base flow, and wetland hydrology.
Estimated Cost	Capital costs: $230,000, excluding land, in 2017 dollars.
Potential Funding Sources	District levy, partner contributions, grants
Schedule	2018-2027

3.9.7 LONG LAKE CREEK SUBWATERSHED PLAN

INTRODUCTION

This subwatershed plan contains information specific to the Long Lake Creek Subwatershed, including existing conditions and issues, drivers, management strategies, land use information, and an implementation plan. Information regarding the District's philosophy, goals, and implementation approach can be found in Sections 3.2-3.4 and should be reviewed first to provide context for the following subwatershed plan.

EXECUTIVE SUMMARY

Long Lake Creek Subwatershed is 11.9 square miles (7,619 acres) and located along the northern boundary of the MCWD and includes portions of the cities of Long Lake, Medina, Orono and Plymouth. The subwatershed is generally characterized by large areas of undisturbed land (37%) including large wetland and wooded areas, single family-residential in the central and eastern subwatershed (28%), lakes (9%), agriculture (10%), as well as park and open space (10%). The Luce Line Trail passes through this subwatershed, as well as the proposed Southwest Hennepin Regional Trail.

Several large wetlands in the subwatershed have been classified by the *Functional Assessment of Wetlands* as having exceptional vegetative diversity, including School Lake, and two DNR Scientific and Natural Areas, Wolsfeld Woods and Wood-Rill. The Minnesota Biological Survey has also identified both terrestrial and aquatic locations in the watershed with intact native plant communities and good biodiversity.

The headwaters of the subwatershed are Holy Name Lake in the east, and School Lake in the west. Each headwaters drains through streams that converge just north of Long Lake. Together both systems drain approximately 1600 acres into the primary inlet of Long Lake. Long Lake drains south into wetlands that discharge into Tanager Lake, which connects via a channel to Lake Minnetonka. One significant area is landlocked, Lydiard Lake.

Holy Name, School, Wolsfeld, Long, and Tanager Lakes are listed as impaired for excess nutrients, and are part of the Upper Minnehaha Creek TMDL. Upstream lakes and Long Lake's internal loading each provides around 25% of the phosphorus load to Long Lake, with stormwater runoff providing nearly 50%. Upstream lakes and stormwater provide nearly 77% of the phosphorus load to Tanager Lake, with the remaining portion mainly internal loading.

Management strategies within the Long Lake Creek subwatershed will focus on managing common carp, restoring upstream waterbodies, addressing internal loading, performing wetland restorations and managing stormwater runoff. In the past, the District has worked in partnership within this subwatershed to implement regional stormwater management through a series of constructed ponds, treated Long Lake for internal loading, restored natural shorelines, and restored and enhanced wetlands.

Regional partnerships are beginning to form between the Cities of Medina, Long Lake, Orono, Long Lake Waters Association and the MCWD. This partnership seeks to leverage the skills and resources of each entity, by collaborating and identifying shared priorities for the implementation of projects and programs to improve water quality in the Long Lake Creek Subwatershed. Common carp management has been identified as an initiative to prioritize in advance of internal load management, and concurrent with landscape restoration. This is summarized in the Implementation Plan.

RESOURCE NEEDS

EXISTING CONDITIONS AND ISSUES

This section of the Plan outlines existing conditions and water resource issues, categorized by water quality, water quantity and ecological integrity. Condition information was compiled from community input, monitoring data, special studies, the Hydrologic and Hydraulic Pollutant Loading Study (HHPLS), Minnehaha Creek and Upper Watershed Stream Assessments, the Functional Assessment of Wetlands (FAW), Total Maximum Daily Load (TMDL) studies, and state and regional land use and land cover data. A review of these conditions and data revealed several issues and concerns that may require action on the part of the District or its partners. More detailed information about the Long Lake subwatershed may be found in Volume 2: Land and Natural Resources Inventory.

Water Quality

Lakes and Streams

Holy Name, Long, School, Tanager and Wolsfeld Lakes are listed

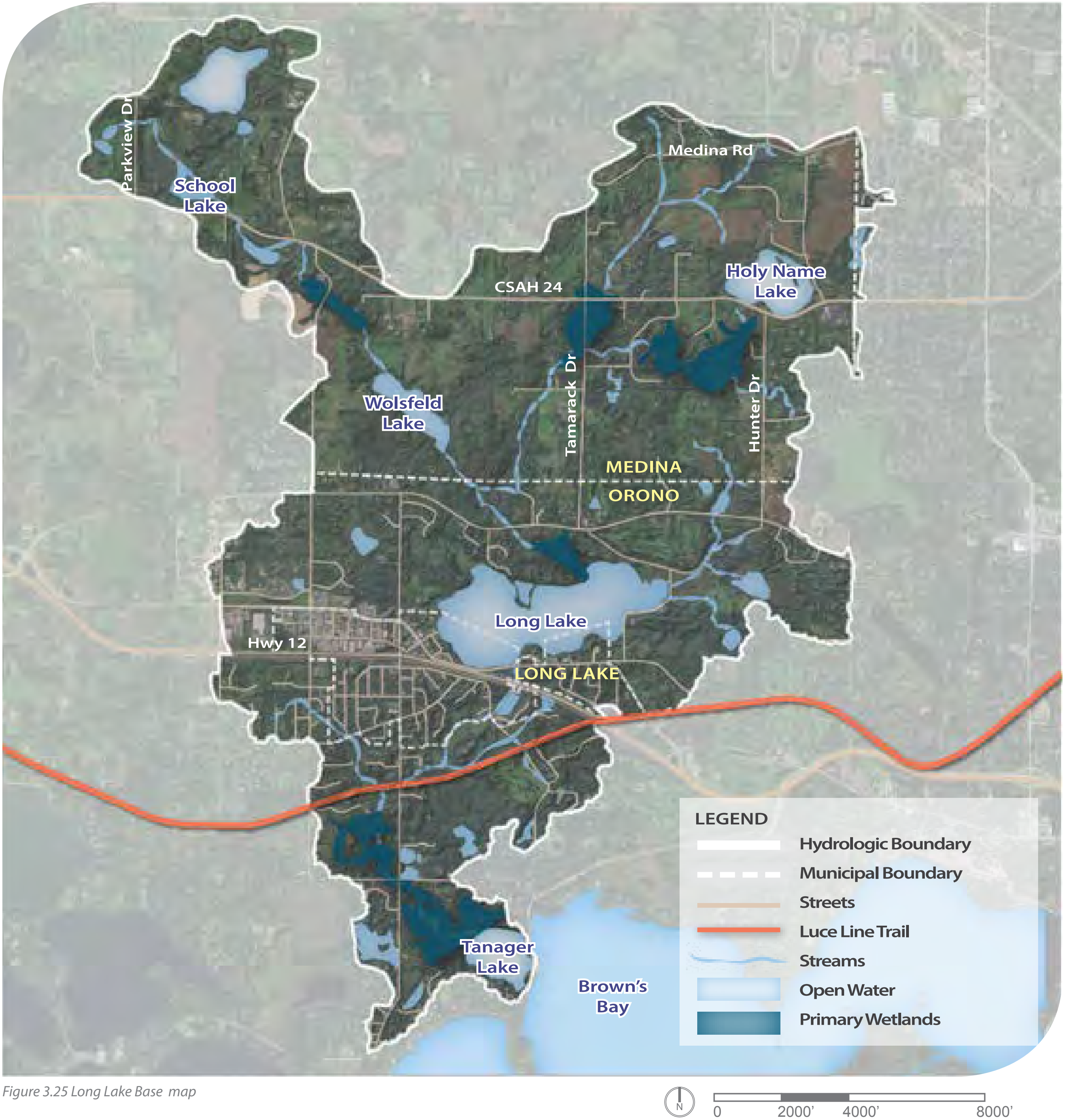


Figure 3.25 Long Lake Base map

as impaired for excess nutrients, and are part of the Upper Minnehaha Creek TMDL. While Long Lake Creek is not listed as an Impaired Water for nutrients, the stream exhibits high total phosphorus concentrations relative to the State River Eutrophication Standards.

Upstream lakes and internal loading each provides around 25% of the Phosphorus load to Long Lake, with stormwater runoff providing nearly 46%. External loading from stormwater and upstream lakes provide 77% of the phosphorus load to Tanager Lake, with the remaining portion mainly internal loading.

Wetlands

The Long Lake Creek Subwatershed is a wetland rich system, with wetlands occupying over 22% (1,647 acres) of the subwatershed. The majority of wetlands have been altered and degraded, providing a likely source of phosphorus export into to the watershed.

Groundwater

Many of the major wetlands in this subwatershed act as recharge-discharge wetlands. Groundwater recharge is important within the subwatershed to maintain wetland hydrology and stream baseflow, as well as to recharge aquifers that supply public and private drinking water wells.

Portions of the subwatershed have been designated by the Minnesota Department of Health (MDH) as a Drinking Water Supply Management Area and Wellhead Protection Area for City of Plymouth and City of Long Lake public wells. Much of this area is designated to be of low risk to contamination of the drinking water supply, with a small area located in a till deposit being of moderate risk.

Water Quantity

A series of channels and wetlands drain the western and eastern parts of the subwatershed, before joining together prior to discharging into Long Lake. Flow to Long Lake Creek is controlled by an outlet weir on Long Lake. Six storm sewer outfalls discharge into the creek, which flows through two large wetlands prior to discharging into Tanager Lake and then into Lake Minnetonka: Browns Bay.

Lydiard Lake is landlocked, with no natural outlet. Several locations in the system have been identified through the District's modeling and stream assessments as being vulnerable to localized flooding during large rain events.

Ecological Integrity

Lakes and Streams

Limited fish data exist for most lakes and streams, but a 2013

Long Lake wetland restoration

Figure 3.26 Long Lake Water Resources map

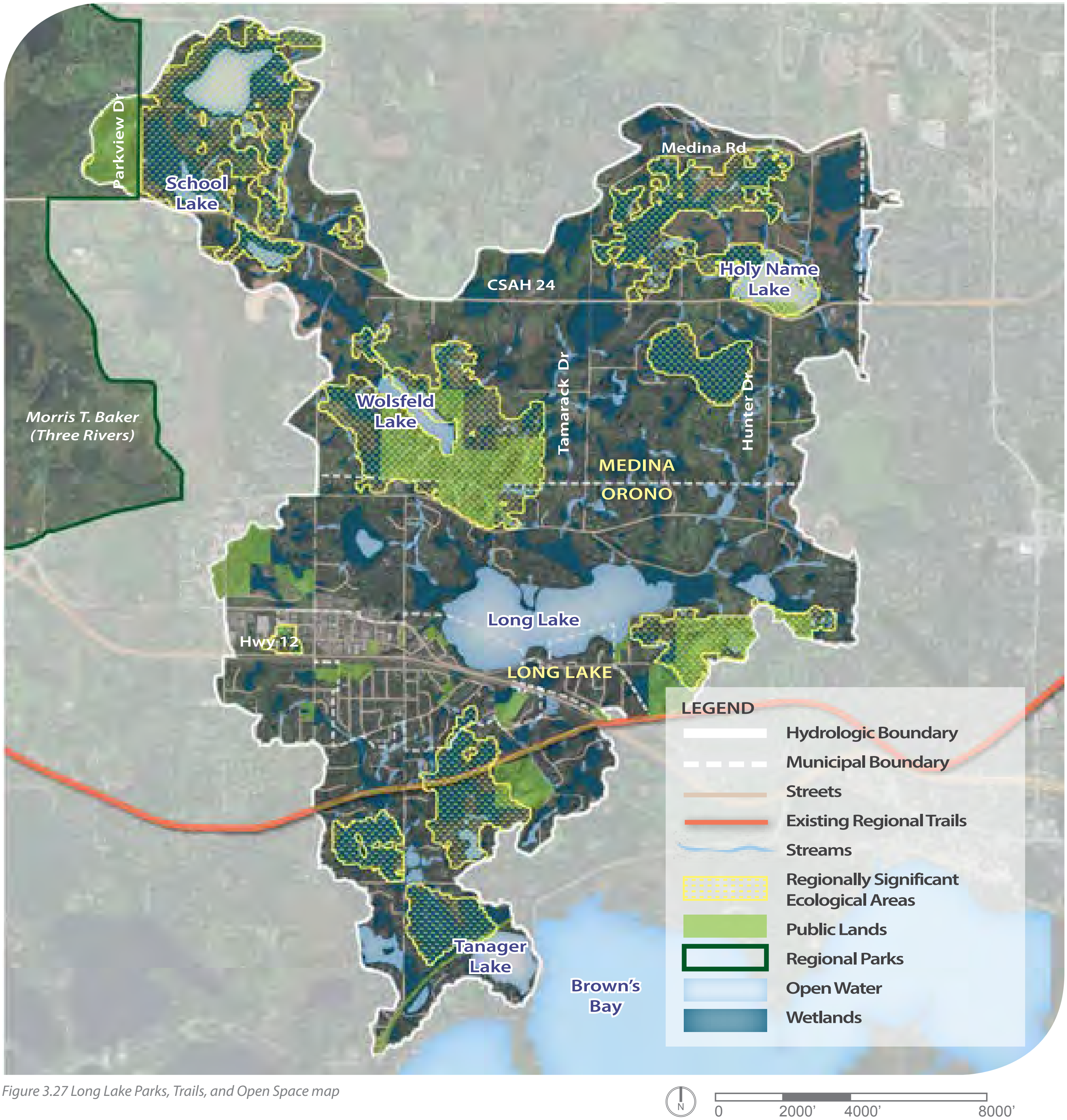


Figure 3.27 Long Lake Parks, Trails, and Open Space map

DNR survey on Long Lake found the walleye community was balanced but the low dissolved oxygen and high summer temperatures were potentially limiting growth and survival. A 2010 DNR survey on Long Lake Creek found the fish community was on the border of Poor to Good. Anecdotal information suggests Common Carp are abundant in the subwatershed and may be impacting water quality and ecological integrity.

Aquatic plant biodiversity, as measured by a Floristic Quality Index developed by the DNR, is borderline Poor to Good condition in Lydiard Lake, but Degraded in Long Lake, Dickey's and Wolsfeld. Eurasian watermilfoil and Curlyleaf Pondweed are present in the subwatershed, but not abundant.

Wetlands

Several large wetlands in the subwatershed have been classified by the Functional Assessment of Wetlands as having exceptional vegetative diversity, including School Lake, and two DNR Scientific and Natural Areas: Wolsfeld Woods and Wood-Rill. Their conservation is integral to achieving ecological integrity, water quality, stormwater management and floodplain management goals.

Uplands and Natural Corridors

The Minnesota Biological Survey has identified both terrestrial and aquatic locations in the watershed with intact native plant communities, and those with biodiversity significance. These locations should be considered for preservation and protection to maximize habitat and biodiversity.

Two DNR Scientific and Natural Areas are present in the subwatershed in Wolsfeld Woods and Wood-Rill. Upland, wetland and stream protection and restoration may preserve and enhance connections between these two features.

Drivers

A driver of water quality, water quality, or ecological integrity is a driving force or stressor that causes a biological community or physical structure to change. Some example drivers include increased phosphorus loading, increased impervious areas, straightened channels, and drained wetlands. Some drivers are natural, such as storm events. Most are human-caused, either directly or as a side effect of some other change such as a land use change or removal of natural land cover.

This section of the Plan outlines the main drivers of water quality, water quantity and ecological integrity issues within the Long Lake Creek subwatershed.

The principal water quality, water quantity, and ecological integrity issues within the Long Lake Creek subwatershed are:

Water Quality

- » Excess nutrients

Water Quantity

- » Localized flooding

Ecological Integrity

- » Mostly degraded aquatic plant communities
- » Degraded and disconnected wetland and terrestrial corridors

These issues are primarily the result of the following drivers:

- » Altered wetlands
- » Common carp
- » Stormwater runoff
- » Internal sediment phosphorus loading
- » Water quality from upstream waterbodies

Altered Wetlands

On a watershed scale, wetlands can act as sinks, sources, or transformers (particulate to dissolved) for nutrients like phosphorus. Historically, wetlands acted as nutrient sinks within a watershed, capturing and retaining nutrients, even as nutrient loads to the wetland were increased as land use intensified. However, as wetlands were ditched and drained to facilitate watershed drainage and land use change, they often converted from a sink for nutrients to sources, by increasing the breakdown of wetland soil and the conveyance of stormwater. These processes within altered wetlands can release large pools of stored nutrients, causing nutrient impairments in downstream surface waters.

There are a number of high-quality wetlands in the subwatershed. The two primary upper watershed tributary streams connect lakes and wetlands in a nearly continuous natural corridor that provides significant functions and values such as runoff storage and water quality treatment as well as habitat and natural resources values. Large wetlands riparian to Long Lake Creek attenuate flooding and provide water quality treatment upstream of Brown's Bay. Protection of these wetlands and corridors is essential to preserving their high level of functions and values and to prevent the negative impacts that follow alteration.

Carp

Invasive common carp negatively impact water quality and ecological conditions in surface waters when carp dominate fish communities. Carp impact aquatic systems by their bottom feeding behavior which uproots aquatic plants, re-suspends bottom sediments, and releases nutrients into the water column. This leads to decreased water clarity and a switch to a water state dominated by algae in shallow lakes and wetlands. This turbid water condition is the least ecologically diverse state, and is often characterized by a significant loss of natural vegetation, harmful algal blooms, and the release of phosphorus from re-suspended sediments, all of which contribute to water quality impairments and the loss of fish and wildlife habitat.

Carp have been observed throughout the system, and Tanager Lake, which is connected to the rest of the system, has been documented as having a very high abundance of carp. A subwatershed wide assessment should be conducted to determine its level of impact in each waterbody, and develop strategies for management.

Stormwater Runoff

Watershed runoff from rainfall events, or stormwater, can carry nutrients and other pollutants to surface waters leading to negative impacts in lakes, streams and wetlands. In urban and suburban areas, high proportions of impervious surfaces such as parking lots and driveways increase the volume and rate of stormwater runoff, which can cause flooding, and change stream flow in ways that negatively impact habitat for critical parts of the food-web like fish and macroinvertebrates. In rural areas drained for agriculture, the increased volume and peak flow of stormwater runoff causes similar negative impacts.

While the increased volume and rate of stormwater runoff can negatively impact physical conditions in receiving waters, the runoff also carries with it increased loads of pollution that negatively impact the quality of lakes, streams and wetlands. In urban and suburban areas, stormwater picks up excess nutrients, bacteria such as *E. coli*, chloride from road salt, and other pollutants causing toxicity to organisms or issues with excess nutrients (eutrophication). In more rural areas, stormwater mobilizes pollutants from manure and fertilizer including excess nutrients, bacteria, herbicides and pesticides.

These impacts heavily influence the conditions of surface waters because a healthy hydrologic condition is critical to supporting a healthy lake, stream or wetland. Generally as impervious cover, altered drainage, and stormwater runoff within a watershed increases, the quality of lakes, streams and wetlands decreases.

Holy Name, School, Wolsfeld, Long and Tanager Lakes are listed as impaired for excess nutrients. Stormwater runoff is noted in the TMDL as providing approximately 45% of the nutrient load to Long Lake. It also accounts for 15 to 51% of the loading to Wolsfeld, School and Tanager Lakes.

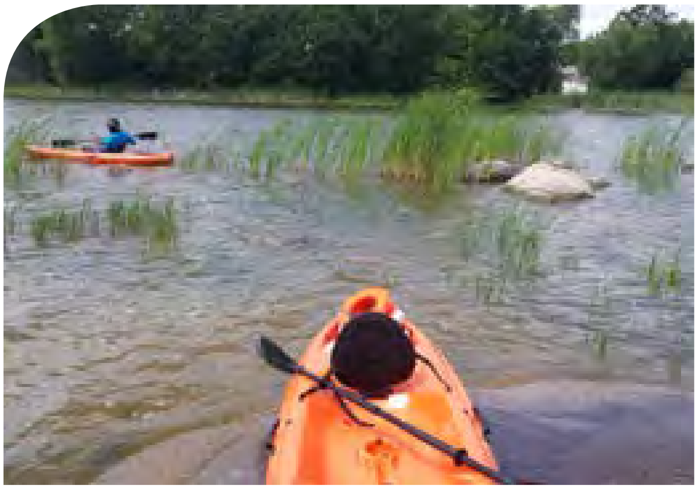
Internal Sediment Phosphorus Loading

Long term excessive loading of phosphorus to lakes can lead to phosphorus buildup in the sediments of the lake bed. Ultimately, this phosphorus can be released from the sediment back into the water. Further exacerbating the problem, released phosphorus is typically dissolved which is readily available for plant uptake and contributes directly to algae blooms. Sediment phosphorus release can lead to summer algae blooms, poor water clarity and, in severe cases, summer fish kills and harmful algal blooms. Restoration of water quality in lakes often requires significantly reducing phosphorus release from sediments.

According to the TMDL, internal loading accounts for almost 22% of the nutrient load to Long Lake, and also contributes 53% of loading to School Lake, 80% to Holy Name, 16% to Wolsfeld and 20% to Tanager Lake.

Upstream Waterbodies

Headwater streams, lakes and wetlands contribute water and nutrients to downstream receiving waters impacting the quality of these water bodies. Lakes and wetlands with poor water quality ultimately contribute nutrients to downstream waters



Kayaking

Seeding wild rice

Long Lake shoreline

that can lead to eutrophication. Consequently, restoration of upstream water bodies is often a critical component of improving downstream water quality on a watershed scale.

Upstream waterbodies are affecting water quality in several of the impaired lakes, contributing around 28% of the nutrient load to Wolsfeld, 25% to Long and 63% to Tanager Lake.

MANAGEMENT STRATEGIES

Informed by the identification and prioritization of conditions and issues in the subwatershed and an understanding of the drivers impacting its water resources, the District has developed general strategies to guide actions in the Long Lake Creek subwatershed. These strategies are both short- and long-term, and establish a framework for the Long Lake Creek subwatershed Implementation Plan programs and projects.

Wetland Restoration

Traditional approaches to wetland restoration focus on restoring wetland channels and hydrology to support a more diverse native plant population. While this strategy addresses ecological integrity within the wetland, it often overlooks the need to alter the cycles of wetland chemistry created by historic wetland alteration, which transform and release phosphorus to downstream waterbodies.

To address both ecological integrity and the release of phosphorus, wetland restoration must focus on modifying hydrology to support the native plant community while minimizing phosphorus export. This may include, but is not limited to, bypassing flow around the wetland, the addition of nutrient filters, soil engineering or augmentation to permanently sequester phosphorus, or the development of wetland treatment cells. Selected restoration options will depend on site specific wetland conditions and hydrology, and overall needs of the subwatershed system.

While higher quality wetlands are present in the upper watershed, there are several candidate wetland restoration sites in the lower watershed. These sites are riparian to Long Lake Creek, and stream stabilization and restoration could be incorporated into the restoration to reduce sediment and phosphorus loading to Tanager Lake downstream.

Carp Management

Historically, carp management focused on removal of carp populations from impacted water bodies without any consideration of population dynamics such as reproduction, immigration, and emigration. More recent carp management techniques focus on integrated pest management where activities focus not only on removal but also on the long-term prevention of carp reproduction and immigration into sensitive water bodies. These new techniques allow for sustainable control of carp populations to measurably improve shallow lake and wetland water quality, plant communities and overall ecological health.

A subwatershed wide carp assessment is needed to develop management strategies to sustainably control common carp in this system. Carp management is a pre-requisite before tackling other strategies to reduce internal loading.

Stormwater Management

Stormwater management will focus on reducing runoff volumes and rates, as well as reducing pollutant loading from runoff producing rain events. Stormwater management in the developed or developing urban and suburban areas will focus on retrofitting low impact development techniques such as ponds, filters, infiltration techniques, and other technologies where they are applicable. In the rural and agricultural areas, stormwater management will focus on buffers, improved agricultural practices such as conservation tillage, manure management for animal agriculture and hobby farms, wetland restoration and fertilizer management.

In the Long Lake Creek subwatershed, the focus will be on installing infiltration and load reduction BMPs in the developed areas of the subwatershed and agricultural BMPs to reduce nutrient, sediment, and bacterial loading from agricultural land uses in the upper watershed.

Internal Sediment Phosphorus Control

Reducing or eliminating phosphorus release from sediments is often essential to meet water quality standards in lakes. There are several techniques available for controlling sediment phosphorus release including sediment phosphorus inactivation using a chemical such as aluminum, oxygenation to prevent sediment anoxia, hypolimnetic aeration and iron addition to prevent phosphorus release, or hypolimnetic withdrawal. While all the techniques can be effective, the application of aluminum to sediments using aluminum sulfate (alum) or a mixture of sodium aluminate and alum is typically the most cost effective approach for reducing sediment phosphorus release.

Once common carp have been managed to lower densities, internal load reduction strategies such as alum treatment should be considered. Additional data will need to be collected to determine appropriate treatment options. The Upper Minnehaha Creek Watershed TMDL recommended internal phosphorus control for School, Long, Holy Name, and Tanager Lakes to help improve water quality.

Restoration of Upstream Waterbodies

Upstream water bodies that are currently impaired can discharge large nutrient loads to downstream water bodies thereby contributing to downstream water quality impairments. Therefore, prior to, or concurrent with, significant efforts to restore downstream water quality, the water quality in upstream water bodies must be improved. Nutrient impaired upstream lakes may require external and internal nutrient reductions using the strategies listed in this section.

Managing unique drivers in upstream waterbodies will benefit the system as a whole. Addressing internal loading in School Lake will benefit Wolsfeld Lake as well as other downstream lakes. Addressing various inputs into Wolsfeld Lake will benefit Long Lake and Tanager. Finally, addressing various inputs for Long Lake will benefit Tanager Lake.

Watershed Protection

Several subwatersheds, especially in the western part of the watershed, are rapidly converting from undeveloped or rural land uses to developments which can increase impervious areas, reduce flood storage, increase pollutant loads, and eliminate or reduce biologically significant land cover. A critical strategy to maintain existing resources and critical functions is to protect these areas by minimizing the impacts of development. This is accomplished by conserving biologically significant upland areas, protecting high value wetlands, mimicking natural watershed hydrology, maintaining stream geomorphology, protecting stream buffers and riparian areas, and protecting critical fish and wildlife corridors.

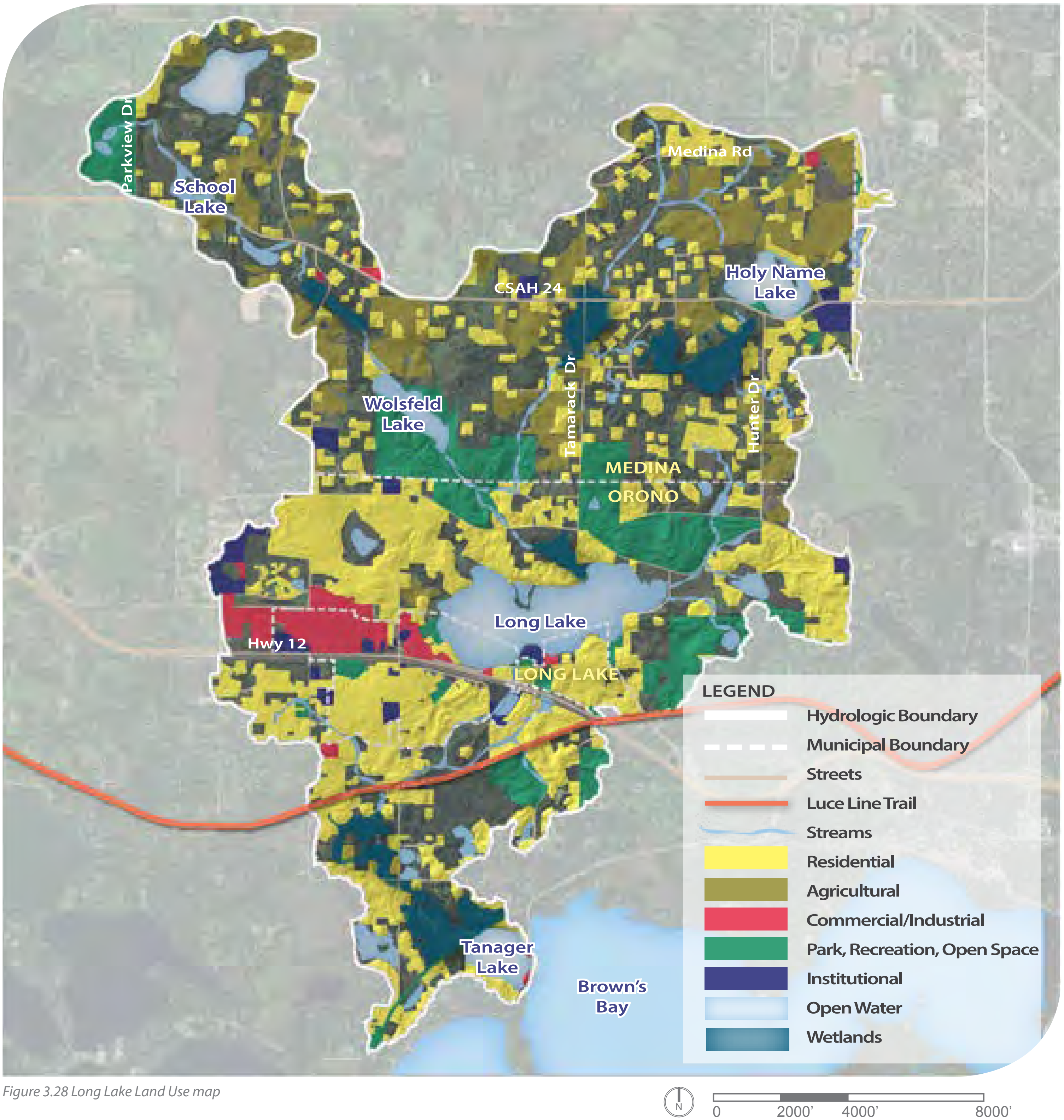


Figure 3.28 Long Lake Land Use map

There are significant natural resources in the subwatershed, including high-quality wetlands, intact native plant communities with biodiversity significance, and valuable connected corridors. Some of these areas are located within two DNR Scientific and Natural Areas, but other important natural resources are privately owned. The focus in this subwatershed will be to preserve these high-value resources through Land Conservation where appropriate and by working with cities and developers to minimize disturbance during development and construction.

LAND USE

EXISTING CONDITIONS

The subwatershed includes portions of the cities of Long Lake, Medina, Orono and Plymouth. The subwatershed is generally characterized by large areas of undisturbed land (37%) including large wetland and wooded areas, single family-residential in the central and eastern subwatershed (28%), lakes (9%), agriculture (10%), as well as park and open space (10%). The Luce Line Trail passes through this subwatershed, as well as the proposed Southwest Hennepin Regional Trail.

LOCAL PLANS AND PRIORITIES

As described in the District's goals (Sections 3.3), the District strives to implement its clean water objectives in ways that meaningfully contribute to the development of thriving communities. This is achieved through collaboration and integrated planning with public and private partners.

As part of the development of this plan, the District reached out to its communities to gather information on local goals, plans, and priorities for 2018-2027 (see Appendix B for details on the public input process). This information was used to broadly characterize opportunities, and to inform the development of the District's implementation plans. The information received was used only as a guide during the development of this Plan to inform the District of opportunities for partnership on the near term horizon, and was not intended to be exhaustive or restrict future collaborative efforts.

As discussed in Section 3.6, the District intends to cultivate a framework for two-directional coordination with communities on an ongoing basis, to stay apprised of emerging needs at a local level, and to identify and evaluate opportunities to implement management strategies outlined in this Plan over the next ten years. The District recognizes that local needs, opportunities and priorities may shift over time. Therefore, this Plan does not intend to capture or prescribe opportunities for partnership over a ten-year term.

Long term goals, growth and private development, and public investment in infrastructure differ across each community – and therefore, frameworks for ongoing coordination will be custom tailored based on the individual needs of each community. Coordination may occur at varying levels, through various means, with communities across the following areas:

- Regulation of, and partnership with, private development
- Collaboration on public planning and investment (e.g. parks , roads, utilities)
- MS4 compliance
- Development and implementation of TMDLs

Through the information gathering processes of this Plan, priorities identified by the cities in the Long Lake Creek subwatershed included protecting Long Lake and preserving the rural character of their communities. The cities may find opportunities to collaborate with the MCWD on these priorities by coordinating with the District on road reconstruction, redevelopment, and open space improvement projects expected in the area.

Regional partnerships are beginning to form among the Cities of Medina, Long Lake, and Orono; the Long Lake Waters Association; and the MCWD. This partnership seeks to leverage the skills and resources of each entity, by collaborating and identifying shared priorities for the implementation of projects and programs to improve water quality in the Long Lake Creek Subwatershed. Common carp management has been identified as an initiative to prioritize in advance of internal load management, and concurrent with landscape restoration.

IMPLEMENTATION PLAN

The goals set forth in this subwatershed plan will require an integrated set of programs and projects oriented toward the conservation and improvement of water resources within the

watershed. The Implementation Priorities section generally describes the actions that the District and its partners will look to take in order to address the issues present in the subwatershed and achieve the goals as set forth in the plan. The Capital Improvement Plan (CIP) provides cost estimates and schedules for any proposed capital investments.

IMPLEMENTATION PRIORITIES

As described in previous sections, Long, Holy Name, School, Tanager, and Wolsfeld Lakes are listed as impaired for excess nutrients. This is driven by a combination of wetlands acting as sources of phosphorus, the presence of common carp, internal loading and runoff and loading from upstream waterbodies. Based on these conditions, management strategies within the subwatershed will focus primarily on wetland restoration, management of common carp, and internal load management.

The Long Lake Creek subwatershed will experience planned development and infrastructure investments over the next 10-15 years. Communities within the subwatershed are currently updating their own comprehensive plans, which will help guide changes across the landscape. This Plan establishes a coordination framework through which the District will seek to maintain current knowledge of land use and capital planning by its LGUs, and of potential land use development and redevelopment activity.

As opportunities arise, the District will evaluate them against the resource needs and priorities defined throughout this plan and determine the appropriate response. The District has a wide range of services it can mobilize to address resource needs and support partner efforts, including data collection and diagnostics, technical and planning assistance, permitting assistance, education and capacity building, grants, and capital projects.

In the past, the District has worked in partnership within this subwatershed to implement regional stormwater management through a series constructed ponds, treated Long Lake for internal loading, restored natural shorelines, and restored and enhanced wetlands.

The District will pro-actively coordinate the permitting of future land use change with communities within the subwatershed to explore opportunities to create public-private partnerships to address wetland restoration and stormwater management goals in ways that exceed regulatory requirements.

Long Lake with restored wetlands and treatment ponds

Regional partnerships are beginning to form among the Cities of Medina, Long Lake, Orono, Long Lake Waters Association, and the MCWD. This partnership seeks to leverage the skills and resources of each entity, by collaborating and identifying shared priorities for the implementation of projects and programs to improve water quality in the Long Lake Creek Subwatershed. As opportunities are identified, the partners will define roles, responsibilities and possible sharing of costs. Common carp management has been identified as an initiative to prioritize in advance of internal load management, and concurrent with landscape restoration.

To allow the District the flexibility to respond to opportunities identified by the cities or other partners, or that may arise through land-use change, and given the scale, complexity and multi-jurisdictional nature of the geography, the capital improvement plan for this subwatershed includes a project listing for stormwater management. Carp management may be addressed on a programmatic basis and is therefore not included in the capital improvement tables. In the future, should the District or a partner determine that a larger or more concentrated scale of capital and program implementation be determined to be needed, a discrete subwatershed planning process may be initiated to:

- Provide high resolution diagnostic of watershed issues and drivers
- Map current projected land use and infrastructure changes
- Define a detailed and integrated capital and program implementation plan
- Outline a funding strategy including program costs and sources

The details of such a plan would provide the information needed for the District to pursue a plan amendment under MN Rules 8410, thereby updating specific subwatershed components of this Plan.

CAPITAL IMPROVEMENT PLAN

The CIP is a planning tool. It also is a means to inform partners, District residents, and other interested parties as to the District's scope and priorities for its capital work over the planning period. A project's inclusion in the CIP does not mean that the project will be constructed, only that the District has identified it as an action that may be a cost-effective way for the District to achieve identified water resource goals. A project identified in the CIP always will need further review as to technical feasibility, cost and financing, consistency with local needs, and other policy considerations before a formal decision to proceed to construction is made. Section 3.5.5 describes the development and evaluation steps that will occur before the District will commit resources to a project.

Section 3.5.5 also describes how the District will review the CIP on an ongoing basis throughout the planning period. This review will allow the District to reassess described projects from a technical perspective, but also will involve broader policy considerations such as shifts in District priorities, decisions as to annual budget and levy levels, and the prospect of state and federal grant funds or financing. For this reason, projects may be added to and deleted from the CIP from year to year, in accordance with those procedures.

A critical component of any project will be the development of a funding strategy that identifies the sources, uses, and timing of funds needed to successfully achieve identified goals. These plans will be developed in conjunction with the District's public and private partners as capital projects are advanced. Therefore, any costs identified within this Plan are projections. Intended expenditures will be refined during project development and budgeting, and among other things will reflect the District's intent to complement its ad valorem funds with other funding sources.

ISSUE

- Excess nutrients
- Localized flooding
- Mostly degraded aquatic plant communities
- Degraded and disconnected corridors

DRIVER

- Altered wetlands
- Common carp
- Stormwater runoff
- Internal sediment phosphorous loading
- Water quality from upstream water bodies

STRATEGY

- Wetland restoration
- Carp management
- Stormwater management
- Internal sediment phosphorous control
- Restoration of upstream water bodies
- Watershed protection

IMPLEMENTATION PRIORITIES

- Resource protection through regulation
- Early coordination and integration with land use planning
- Opportunity-driven stormwater management projects/grants
- Education and capacity-building for lake associations
- Partner with cities and Long Lake Waters Association on shared priorities

Table 3.11 Long Lake Creek Subwatershed CIP

Project	Stormwater Volume and Pollutant Load Reduction
Description	Implementation of opportunities to reduce stormwater volumes and nutrient loading to Long, School, Wolsfeld, Holy Name, and Tanager Lakes, including but not limited to infiltration or filtration basins and devices, reforestation, revegetation, and stormwater detention or redirection.
Need	Five lakes in the subwatershed exceed state excess nutrient standards - Long, School, Wolsfeld, Holy Name, and Tanager. A TMDL identified a need to reduce external phosphorus loading by 62% (411 pounds) to Long Lake, 81% (32 lbs) to School Lake, 82% (79 lbs) to Wolsfeld Lake, 96% (31 lbs) to Holy Name Lake, and 61% (106 lbs) to Tanager Lake.
Outcome	Reduction of pollutant loading to Long, School, Wolsfeld, Holy Name, and Tanager Lakes; reduction of stormwater runoff volume and rate and associated impacts; protection and enhancement of groundwater recharge, stream base flow, and wetland hydrology.
Estimated Cost	Capital Cost: $1,320,000.
Potential Funding Sources	District levy, partner contributions, grants
Schedule	2018-2027

Wetland restoration in the Long Lake Subwatershed

3.9.8 MINNEHAHA CREEK SUBWATERSHED PLAN

INTRODUCTION

This subwatershed plan contains information specific to the Minnehaha Creek Subwatershed, including existing conditions and issues, drivers, management strategies, land use information and an implementation plan. Information regarding the District's philosophy, goals, and implementation approach can be found in Sections 3.2-3.4 and should be reviewed first to provide context for the following subwatershed plan.

EXECUTIVE SUMMARY

The Minnehaha Creek subwatershed encompasses all of the MCWD downstream of the Grays Bay dam, and is commonly referred to as the "lower watershed." The subwatershed is 47.3 square miles (30,290 acres) in size and includes portions of the cities of Edina, Golden Valley, Hopkins, Minneapolis, Minnetonka, Plymouth, Richfield, St. Louis Park and Wayzata.

The predominant land use in the subwatershed is single family residential (52%), followed by parks and open space (15%), multi-family residential (8%), water (6%), commercial (5%), institutional (5%), and transportation (5%). The subwatershed is fully developed at typical urban and suburban densities and land uses, and contains a higher level of impervious cover on the land than any of the other ten subwatersheds in the District. Redevelopment and infill development have increased since the 2007 plan, with a notable increase in multi-family residential. Most of the remaining vacant or undetermined land is large wetland or woodland tracts.

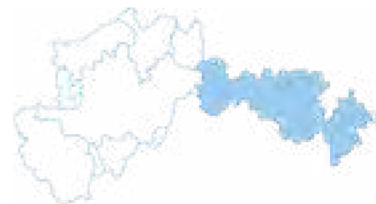
Development in this subwatershed has left relatively few large areas of undisturbed or minimally disturbed forest and wetland in the subwatershed. Three areas, including the Grays Bay outlet wetland complex; Diamond Lake; and a portion of the creek corridor in the Mississippi River gorge have been designated Regionally Significant Ecological Areas by the DNR. The Minnesota County Biological Survey (MCBS) did not identify any areas of biodiversity significance in the subwatershed. The creek corridor and the Chain of Lakes in the lower subwatershed are part of a DNR-designated Metro Conservation Corridor.

Formed at the outlet of Grays Bay in Lake Minnetonka and flowing approximately 23 miles to the Mississippi River, Minnehaha Creek is the primary stream within the subwatershed

Fisherman on Lake Harriet, Stan Waldhauser

Lake Calhoun

Falls at Minnehaha, Tom Dixon



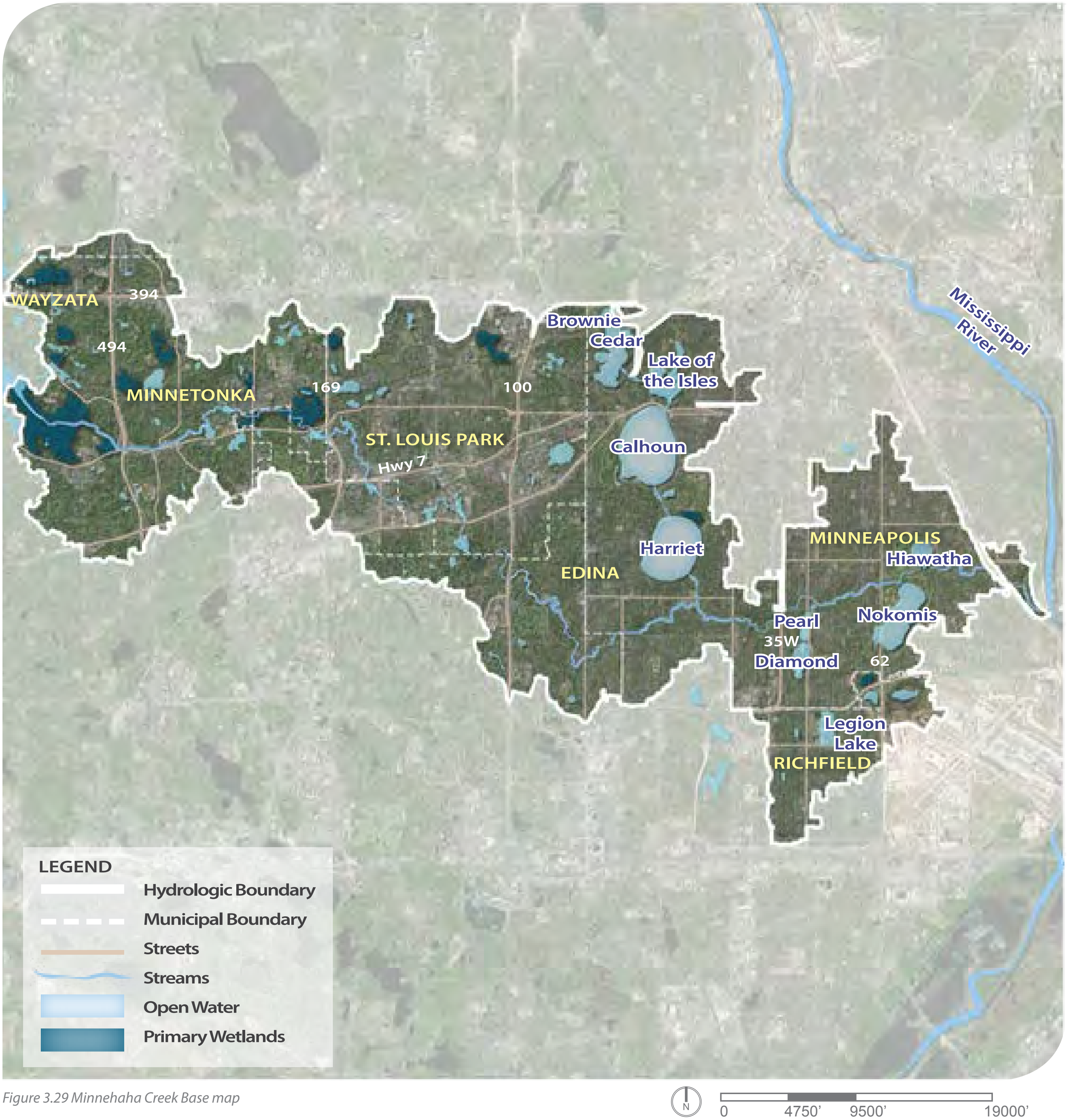


Figure 3.29 Minnehaha Creek Base map

and an iconic and historically significant resource that connects multiple communities and a system of urban parks, lakes and open space. As an outlet for Lake Minnetonka and the upper watershed, Minnehaha Creek must discharge large volumes of water during spring snowmelt runoff, summer and fall. Prior to its confluence at the Mississippi River, Minnehaha Creek flows through Lake Hiawatha and significantly influences water quality within the lake.

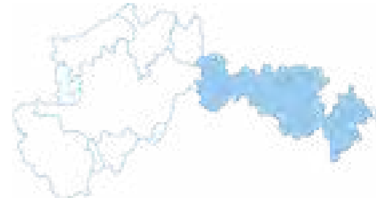
A significant area of the central portion of the subwatershed drains through the Minneapolis Chain of Lakes (Brownie, Cedar, Isles, Calhoun, and Harriet) and outlets via channel to Minnehaha Creek. Lake Nokomis is physically disconnected from Minnehaha Creek by a weir to reduce the influence of the creek on the lake's water quality and prevent the introduction of invasive species.

Within the Minnehaha Creek subwatershed, ditching of the stream channel, loss of wetlands, corridor fragmentation and increasing levels of impervious surfaces have disrupted fluvial processes; increased runoff volumes and pollutant loads; decreased infiltration and baseflow; and fragmented and degraded habitat; negatively impacting the ecological integrity of the stream and its riparian systems. As a result, Minnehaha Creek is listed as an impaired water for multiple parameters, including fecal coliform bacteria, chloride, low dissolved oxygen, and fish and macroinvertebrate communities. Further, due to the sediment and nutrient loads transported by Minnehaha Creek, downstream receiving waterbody Lake Hiawatha is impaired for excess nutrients, and, along with Minnehaha Creek, has an approved Total Maximum Daily Load (TMDL). Lake Nokomis also has an approved TMDL for excess nutrients and is one of four other lakes in the subwatershed that do not meet state water quality standards for nutrients.

Due to the system's altered hydrology (hard cover and altered wetlands) and upstream drainage area (Lake Minnetonka), several locations along Minnehaha Creek are known to flood during large or extended rain events. Overall, due to the size of the subwatershed and the urban characteristics of the area (developed, fragmented and altered), ecological integrity throughout the subwatershed is highly variable and generally considered to be lacking.

Management strategies within the Minnehaha Creek subwatershed will focus on stormwater management to reduce runoff volume and pollutant loading, stream restoration to stabilize streambanks and improve riparian buffers and habitat,

Greenway Boardwalk



Minnehaha Falls, Peter Stratmoen

and restoration of wetlands and ecological corridors in ways that reduce nutrient loading downstream to Lake Hiawatha while improving ecological integrity and corridor connectivity within the subwatershed.

Since 2010, the District has been working to manage regional stormwater, and expand and connect the riparian greenway in a manner mutually beneficial to the built environment. The District has been focusing on the most degraded section of Minnehaha Creek – between West 34th Street and Meadowbrook Lake in St. Louis Park and Hopkins – to implement a comprehensive corridor restoration that focuses on reducing pollutant loads, mitigating flashy hydrology, reconnecting the riparian corridor, and restoring the physical character of the stream channel.

This geography, known as the Minnehaha Creek Greenway, produced the highest pollutant loading per unit area of any other land area along the entire stream system. The effort to-date has yielded significant results, often through innovative public and private partnerships, resulting in hundreds of acres of regional stormwater management, nearly two miles of restored stream, over ten acres of wetland restoration, public access to over 50 acres of previously inaccessible green space, two miles of new trail network, and improved ecological integrity through a series of vegetative restorations and invasive species management.

Building on these efforts, the District will continue its focus within the Minnehaha Creek Greenway to complete the corridor restoration while also extending its efforts to other critical areas of high need within the Minnehaha Creek subwatershed. An example of identified opportunities in the subwatershed include stormwater management and stream restoration in the cities of Edina and Minneapolis. These opportunities, and others, are summarized in the Implementation Plan.

RESOURCE NEEDS

EXISTING CONDITIONS AND ISSUES

This section of the Plan outlines existing conditions and water resource issues, categorized by water quality, water quantity, and ecologic integrity. Condition information was compiled from community input, monitoring data, specialized studies, the Hydrologic and Hydraulic Pollutant Loading Study (HHPLS), Minnehaha Creek and Upper Watershed Stream Assessments, the Functional Assessment of Wetlands (FAW), Total Maximum Daily Load (TMDL) studies, and state and regional land use and land cover data. A review of these conditions and data revealed several issues and concerns that may require action on the part of the District or its partners. More detailed information about the Minnehaha Creek subwatershed may be found in Volume 2: Land and Natural Resources Inventory.

Water Quality

Lakes and Streams

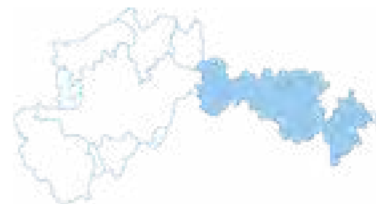
The Minnehaha Creek subwatershed includes the Chain of Lakes in Minneapolis and several other smaller lakes. Powderhorn Lake in Minneapolis does not drain to the creek, but rather is pumped to the Mississippi River.

Five lakes in the subwatershed are listed on the State's Impaired Waters list for exceeding the state standard for total phosphorus, with excessive nutrients being conveyed to them from the watershed. TMDLs have been completed for two of those lakes: Hiawatha and Nokomis. Powderhorn and Brownie had been listed previously, but were delisted in 2012 and 2010, respectively.

Two lakes – Powderhorn and Brownie – are impaired by excess chloride, likely from road salt. Diamond Lake is classified as a wetland, but is listed as impaired for chloride in the Twin Cities Metropolitan Area Chloride TMDL.

Minnehaha Creek is included on the State's Impaired Waters List due to excess chloride, fecal coliform concentrations, low dissolved oxygen, as well as impaired fish and macroinvertebrate communities. Total phosphorus concentrations on Minnehaha Creek are less than the state river eutrophication standards with the primary nutrient cycling concern for Minnehaha Creek being its conveyance of phosphorus load to Lake Hiawatha.

Minnehaha Creek was evaluated in-detail in 2003, and again in 2012, as part of the District's Minnehaha Creek Stream Assessment, which includes a physical inventory, erosion survey, and a fluvial geomorphic assessment to determine channel stability. Additional survey work was completed



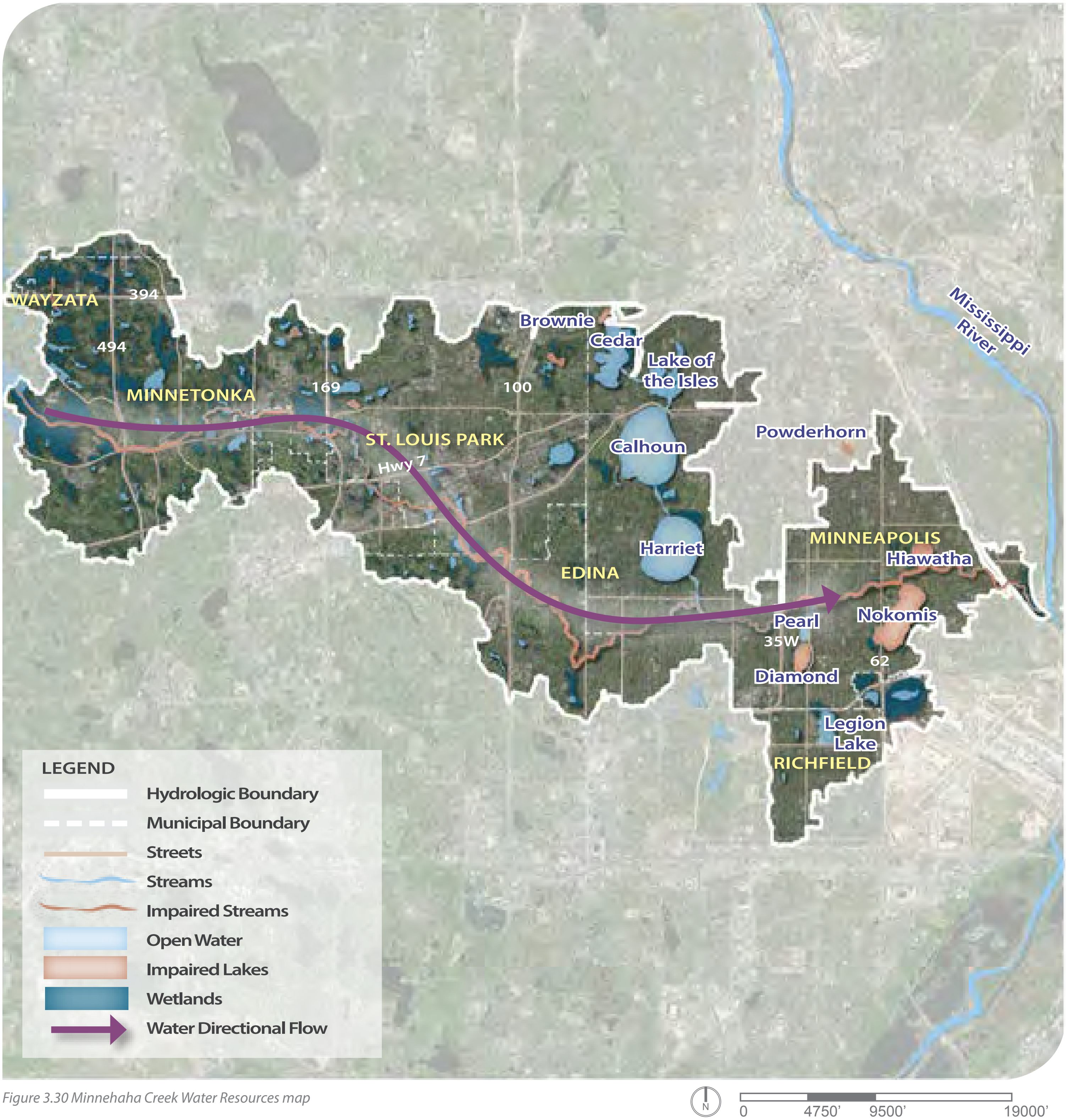


Figure 3.30 Minnehaha Creek Water Resources map

following the 2014 flood to assess damage. These assessments identify a number of areas that would benefit from restoration.

Wetlands

The Minnehaha Creek subwatershed has a large number of wetlands of various sizes distributed across the landscape, including several very large wetland complexes through which the creek flows. Wetlands, including lake systems, cover just over 12 percent of the subwatershed's surface.

The District's Functional Assessment of Wetlands (FAW) indicates that a number of systems score highly on vegetative diversity, fish and wildlife habitat, or aesthetics. Of the wetlands assessed for restoration potential, few wetlands throughout the subwatershed were found to have moderate or high restoration potential, and most of those are small.

No data are available yet to evaluate the ability of the wetlands in the subwatershed to cycle nutrients to and from the subwatershed. E-Grade will assess wetland soil chemistry, overall vegetative conditions, presence or absence of algal blooms, and condition of the buffer and area within 500 feet of the wetlands. Final results of the E-Grade evaluation will be reported in 2018.

Groundwater

The District has identified the infiltration potential of the upland areas within the subwatershed as high to medium with some areas of variability where the soils are organic in nature. Most of the lower subwatershed is classified by the Hennepin County Geologic Atlas as being of high to very high aquifer sensitivity. The upper subwatershed is classified as being generally of low to moderate sensitivity to pollution except directly along Minnehaha Creek and in the large Grays Bay wetland complex.

There are a number of springs and seeps in the Mississippi River gorge area, including Camp Coldwater Spring, the largest limestone bedrock spring in the Metro area. The 2014 Baseflow Study by the University of Minnesota found that there is significant interaction between the creek and shallow groundwater, with some sections primarily gaining water from groundwater inputs while other sections primarily lose water through infiltration.

Much of the subwatershed has been designated by the Minnesota Department of Health as Drinking Water Supply Management Area (DWSMA) and Wellhead Protection Area (WHPA) for various municipal public wells. The MDH has designated areas within the DWSMAs as very high to moderate risk and vulnerability to contamination of the drinking water supply.

Water Quantity

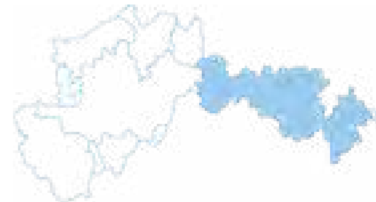
As an outlet for Lake Minnetonka and the upper watershed, Minnehaha Creek discharges large volumes of water during spring snowmelt runoff, summer and fall.

The District manages the Gray's Bay Dam which is an adjustable structure that controls Lake Minnetonka discharges into Minnehaha Creek. The District operates this structure in accordance with the Headwaters Control Structure Management Policy and Operating Procedures, approved by the Minnesota DNR. Operation of the Grays Bay dam is intended to emulate the historical discharge hydrograph and the natural outlet of Lake Minnetonka. The operating plan prescribes discharge zones based on the time of year, the existing lake level, creek capacity in Minnehaha Creek, and forecasted precipitation identified through partnership with the National Weather Service. In drier periods, Lake Minnetonka typically does not discharge water, and portions of the Creek may experience low or even no flow.

In addition to the Gray's Bay Dam, flow in the creek is controlled by numerous other structures, including major weirs at the Browndale Dam, West 54th Street, and Hiawatha Avenue. There are more than 100 bridge crossings, some of which provide a grade control substantial enough to create impoundments, which stagnate water upstream.

There are over 175 identified storm sewer outfalls larger than eight inches in diameter along the length of the creek. This infrastructure results in stormwater reaching the stream quickly, creating "flashy" storm discharges that quickly raise water levels in the creek. Most of these outfalls are located downstream of the Browndale Dam in Edina and Minneapolis.

Locations throughout the system have been identified through observation and the District's modeling and stream assessments as being vulnerable to localized flooding, and streambank



failure and erosion at outlets and culverts from forces created by high water velocity.

Several landlocked basins and many smaller landlocked pocket wetlands exist in the upper reaches of the Minnehaha Creek drainage area including large areas within the City of Minnetonka and portions of Hopkins, Edina and St. Louis Park.

Ecological Integrity

Lakes and Streams

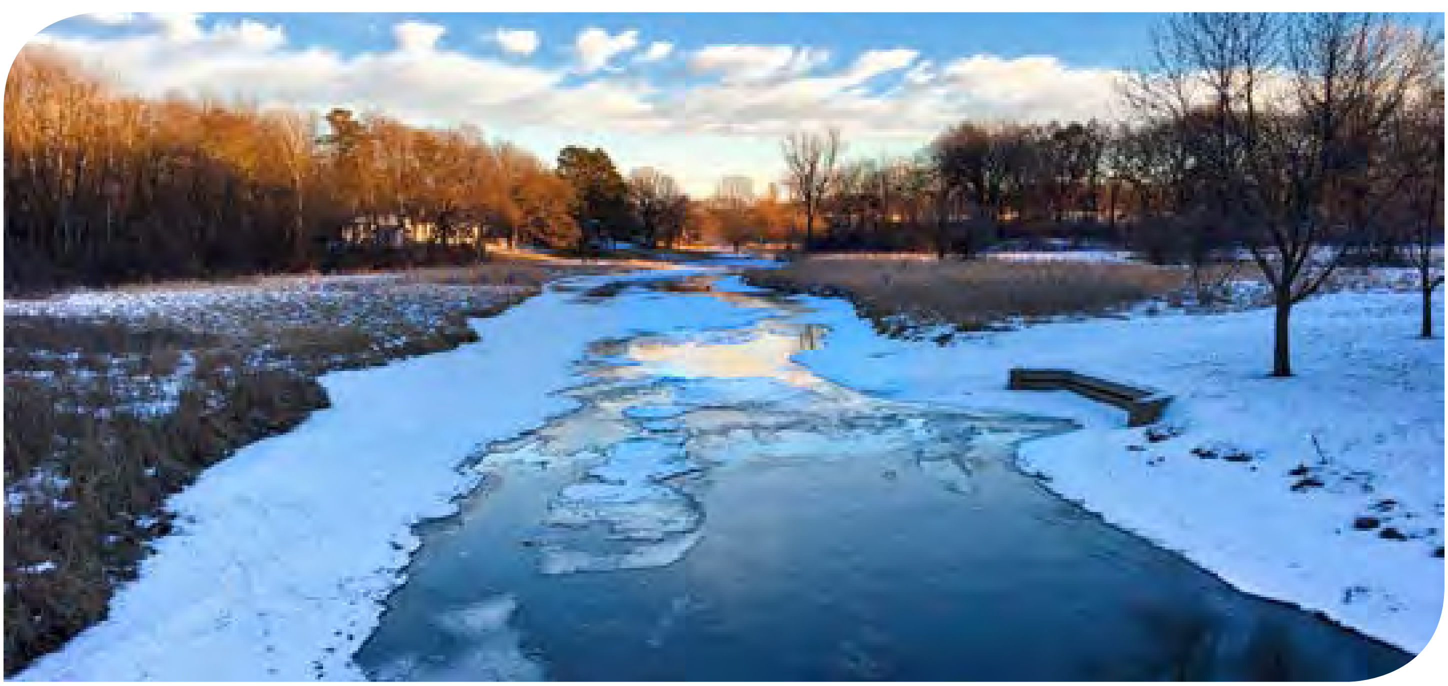
Due to the size of the Minnehaha Creek subwatershed and the urban characteristics of the area, ecological integrity throughout the subwatershed is highly variable and generally considered to be degraded.

Fish communities throughout the subwatershed are generally characterized as poor. With the exception of Cedar Lake (good) and Lake of the Isles (good), fish assessments in all other lake and stream surveys has resulted in either *poor* or *degraded* classifications.

Approximately 15 percent of the streambank is armored by concrete or masonry retaining walls, rip-rap, or other protection such as gabion baskets. These are generally for the purpose of controlling erosion and meandering to prevent loss of property, stabilizing steep banks, or protecting structures such as bridges and storm sewer outfalls. Many of these stream walls were presumably constructed by the Works Progress Administration (WPA) during or following the Great Depression.

Minnehaha Creek is listed on the State of Minnesota's 303(d) list of Impaired Waters for its impaired biotic community. Assessments of fish communities along the Creek consistently return classifications of *degraded* and *poor*, indicating stream disturbance and lack of conditions that support healthy riverine fish communities. Macroinvertebrate sampling along the Creek also classifies a majority of sites as *degraded*, meaning they are highly disturbed, with low species diversity and dominated by pollution-tolerant species.

Many factors contribute to issues associated with degraded ecological integrity including habitat complexity, connectivity, water quality, and hydrology. Stream hydrology is a critical factor in habitat diversity since a stream that is very flashy, that is, one that rises and falls very quickly in response to rain events, or that periodically is dry, stresses aquatic organisms.



Frozen Minnehaha Creek, Aldo Abelleira

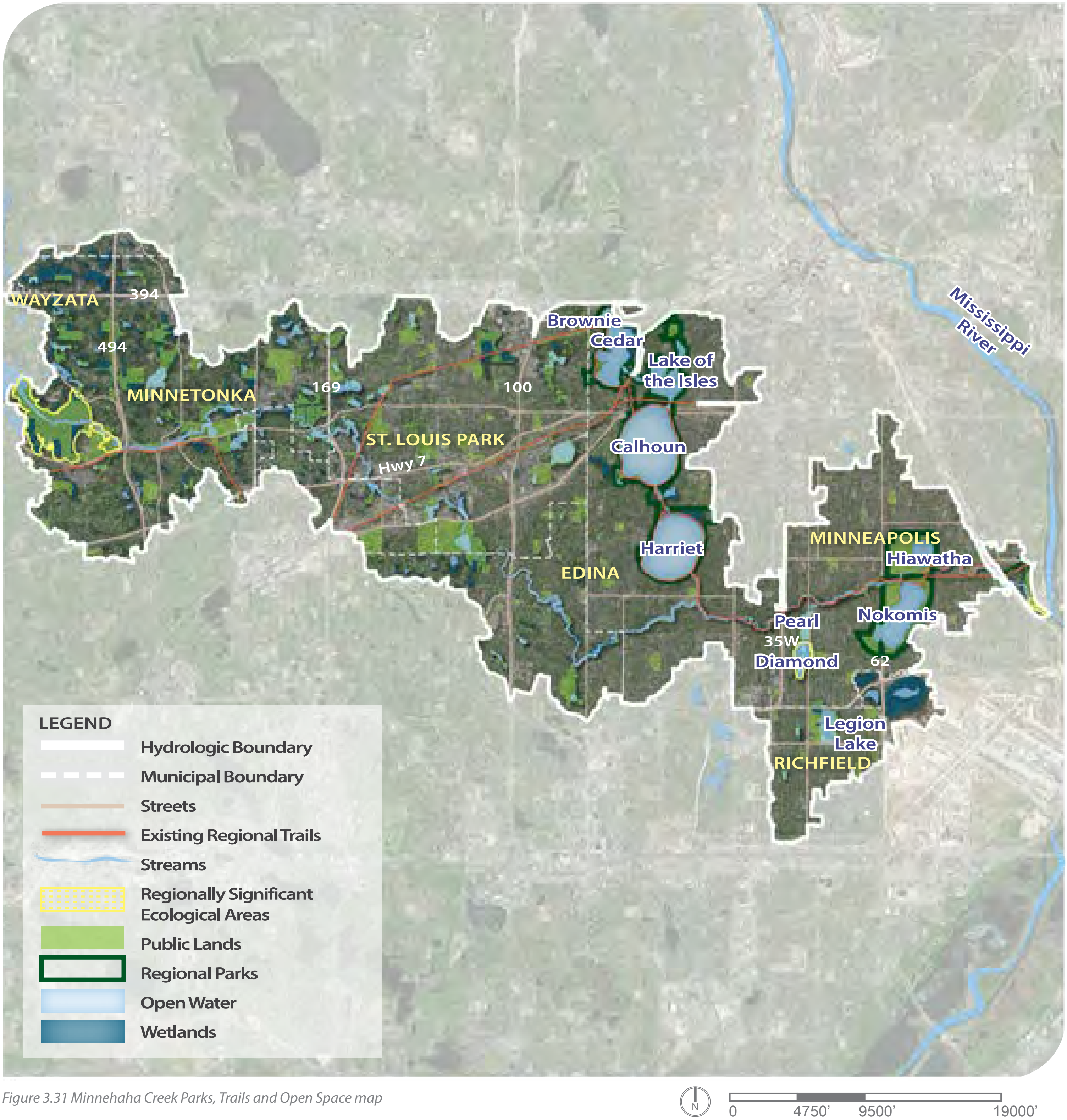
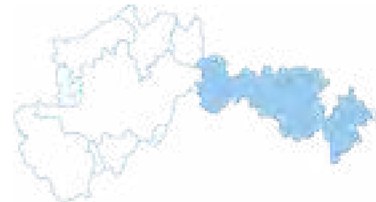
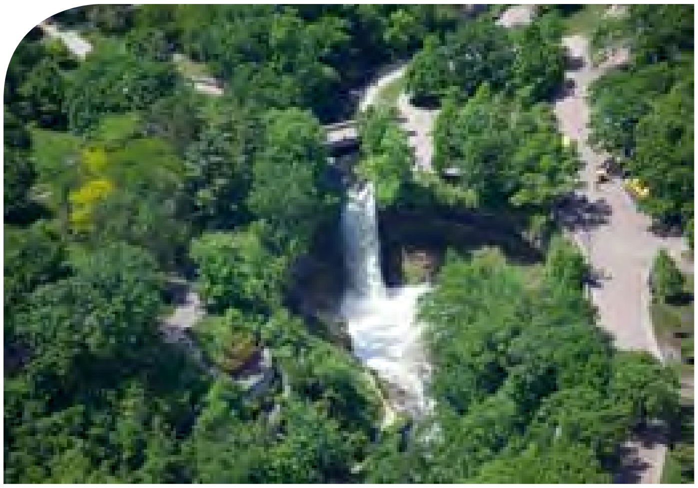


Figure 3.31 Minnehaha Creek Parks, Trails and Open Space map





Minnehaha Falls

Minnehaha Creek

Kayaks on the creek

Wetlands

Although a number of wetlands were identified in the District's Functional Assessment of Wetlands (FAW) as having exceptional to high aesthetic values, the vegetative communities within these wetlands is generally considered *poor* or *degraded*. Only a scattering of wetlands were identified as having exceptional to high vegetative diversity, which is expected given the urbanized nature of the subwatershed and the likelihood of wetland disturbance and hydrologic impacts. Wetlands riparian to, and in-line with, Minnehaha Creek as well as several wetlands adjacent to lakes were noted as having high fish habitat potential. Only a few of the larger wetlands were assessed as having high wildlife habitat potential, primarily because wetland size is an important factor.

Uplands and Natural Corridors

The Minnesota Biological Survey did not identify any areas of biodiversity significance in the uplands of this subwatershed.

The lower subwatershed – generally the area east of TH 169 – is developed with minimal areas of ecological significance. Regionally significant ecological areas are places where larger tracts of minimally disrupted land provide habitat complexity. The only such area in the Minnehaha Creek subwatershed is the large wetland complex at the outflow from Gray's Bay, which is the headwaters of Minnehaha Creek, and some wetlands and uplands connecting that complex to other larger wetlands in the upper subwatershed.

DRIVERS

A driver of water quantity, water quality, or ecological integrity is a driving force or stressor that causes a biological community or physical structure to change. Some example drivers include increased phosphorus loading, increased impervious areas, straightened channels, and drained wetlands. Some drivers are natural, such as storm events. Most are human-caused, either directly or as a side effect of some other change such as a land use change or removal of natural land cover. This section of the Plan outlines the main drivers of water quality, water quantity, and ecological integrity issues within the Minnehaha Creek subwatershed.

The principal water quality, water quantity, and ecological integrity issues within the Minnehaha Creek subwatershed are:

Water Quality

- Excess nutrients
- Increasing chloride concentrations
- Elevated E. Coli concentrations
- Low dissolved oxygen

Water Quantity

- Disrupted hydrology
- Localized flooding
- Stream flashiness

Ecological Integrity

- Degraded fish community
- Degraded macroinvertebrate community
- Degraded and disconnected wetland and terrestrial corridors

These issues are primarily the result of the following drivers:

- Stormwater runoff
- Altered channels
- Altered wetlands
- Internal sediment phosphorus loading

Stormwater Runoff

Watershed runoff from rainfall events, or stormwater, can carry nutrients and other pollutants to surface waters leading to negative impacts in lakes, streams and wetlands. In urban and suburban areas, high proportions of impervious surfaces such as parking lots and driveways increase the volume and rate of stormwater runoff, which can cause flooding, and change stream flow in ways that negatively impact habitat for critical parts of the food-web like fish and macroinvertebrates.

While the increased volume and rate of stormwater runoff can negatively impact physical conditions in receiving waters, the runoff also carries with it increased loads of pollution that negatively impact the quality of lakes, streams and wetlands. In urban and suburban areas, stormwater picks up pollutants such as excess nutrients, bacteria (e.g., *E. coli*), chloride from road salt, and toxic pollutants. In more rural areas, stormwater mobilizes pollutants from animal waste and fertilizer including excess nutrients, bacteria, herbicides and pesticides.

These impacts heavily influence the conditions of surface waters because a healthy hydrologic condition is critical to supporting a healthy lake, stream or wetland. Generally as impervious cover, altered drainage, and stormwater runoff within a watershed increases, the quality of lakes, streams and wetlands decreases.

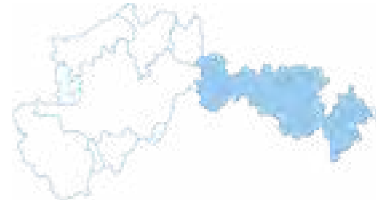
Five lakes in the subwatershed – Hiawatha, Nokomis, Twin, Cobblecrest and Windsor – are listed on the State's Impaired Waters list for exceeding the state standard for total phosphorus, with excessive nutrients being conveyed to them from the watershed. Two lakes – Powderhorn and Brownie – are impaired by excess chloride, likely from road salt.

Also noted earlier are the impairments that impact Minnehaha Creek including excess chloride, fecal coliform concentrations and low dissolved oxygen as well as impaired fish and macroinvertebrate communities. Total phosphorus concentrations on Minnehaha Creek are less than the state river eutrophication standards with the primary nutrient cycling concern for Minnehaha Creek being its transport of phosphorus load to Lake Hiawatha.

Altered Channels

Historically, natural channels were straightened, widened and relocated to accommodate land use change. Channel alteration to improve watershed drainage can lead to a loss of physical habitat, increased peak flow velocities and downstream flooding, decreases in dissolved oxygen, and increased sediment transport which can negatively impact fish and macroinvertebrate communities.

Minnehaha Creek was ditched, altered and utilized as a stormwater conveyance system as urban expansion occurred throughout the western metro area. Alterations to Minnehaha Creek have resulted in a disruption of natural stream processes such as sediment transport and channel migration. These unnatural stream characteristics, coupled with the impact



Sunset on creek at Burwell House, Aldo Abelleira created by in-stream impoundments – Browndale dam and Arden Park – result in habitat and ecological issues that have resulted in impairments throughout the stream system for dissolved oxygen, and fish and macroinvertebrate communities.

Altered Wetlands

On a watershed scale, wetlands can act as sinks, sources, or transformers (particulate to dissolved fraction) for nutrients like phosphorus. Historically, wetlands acted as nutrient sinks within a watershed, capturing and retaining nutrients, even as nutrient loads to the wetland were increased as land use intensified. However, as wetlands were ditched and drained to facilitate watershed drainage and land use change, they often converted from a sink for nutrients to sources, by increasing the breakdown of wetland soil and the conveyance of stormwater. These processes within altered wetlands can release large pools of stored nutrients, causing nutrient impairments in downstream surface waters.

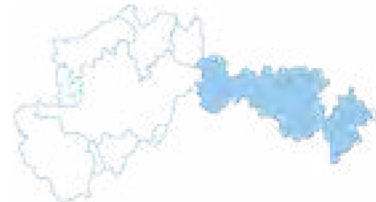
Minnehaha Creek flows through a number of large wetland complexes between its headwaters at the outlet of Lake Minnetonka to its confluence with the Mississippi River. Historic alterations to Minnehaha Creek, as well as urbanization throughout the subwatershed, have disrupted the natural hydrology of most of the wetlands within this region. Impacts such as this result in altered wetland systems that maintain poor or degraded vegetative communities, lack high level habitat potential, have reduced storage ability during flood events, and may contribute to elevated nutrient concentrations moving throughout the system.

Internal Sediment Phosphorus Loading

Long term excessive loading of phosphorus to lakes can lead to phosphorus buildup in the sediments of the lake bed. Ultimately, this phosphorus can be released from the sediment back into the water. Further exacerbating the problem, released phosphorus is typically dissolved which is readily available for plant uptake and contributes directly to algae blooms. Sediment phosphorus release can lead to summer algae blooms, poor water clarity and, in severe cases, summer fish kills and harmful algal blooms. Restoration of water quality in lakes often requires significantly reducing phosphorus release from sediments.

Data suggest that all of the deep lakes within the subwatershed deal with some level of internal phosphorus loading. A variety

MCWD water gauge



of these regionally significant resources – Cedar, Calhoun, Harriet, Lake of the Isles and Nokomis – have received some level of internal loading treatment during the previous 20 years. Internal phosphorus loading is likely a contributing factor to the seasonal fluctuation in phosphorus concentrations within these systems as well as the other deep lakes systems within the Minnehaha Creek subwatershed.

MANAGEMENT STRATEGIES

The District has developed general strategies to guide actions in the Minnehaha Creek subwatershed, informed by the identification and prioritization of conditions and issues in the subwatershed and an understanding of the drivers impacting its water resources. These strategies are both short- and long-term, and establish a framework for the programs and projects utilized in the Minnehaha Creek subwatershed Implementation Plan. To better understand the strategies and efforts of the District and its partners within the Minnehaha Creek subwatershed, it is important to recognize the recent work in this subwatershed and the integration and alignment of natural resource management strategies with the goals of our communities.

Focal Subwatershed Planning

As noted throughout this plan, the District's overarching organizational strategy is founded in its Balanced Urban Ecology policy. This policy was established as the District's fundamental philosophy and way of doing business – developed to guide all future planning and watershed management activities in order to achieve its mission of protecting and improving land and water.

The overarching strategy described in Balanced Urban Ecology is a vision of integration with government agencies, private landowners and developers, and philanthropic partners through multi-jurisdictional partnerships, emphasizing the economic and social value that natural systems generate for the built environment. It further describes how our work will be strengthened through these collaborative efforts not only to offer greater community impact, but to produce creative public-private funding opportunities that will leverage scarce resources and maximize benefits.

The origin of the Balanced Urban Ecology policy lies within the Minnehaha Creek subwatershed, in the most urbanized section of Minnehaha Creek in Hopkins and St. Louis Park, now referred to as the Minnehaha Creek Greenway. As the landscape in this stretch was developed over the past 80 years, wetlands were filled and the creek was straightened, creating a significant tension between the natural and built environments that degraded water quality, increased flood risk and limited recreational access.

A routine permit application by Methodist Hospital in St. Louis Park sparked a series of natural resource improvements that has become one of the largest urban stream restorations in Twin Cities' history. This corridor initiative provides multiple natural resource and community benefits including restoration of the natural channel hydrology and riparian environment, removal of significant pollutant loads from the creek, downstream Lake Hiawatha and the Mississippi River, access to green space, community connections and job creation.

When Methodist Hospital approached the MCWD with a permit application for its new heart and vascular center, there was an opportunity to align goals. The MCWD restored curves to the straightened stream, improving wildlife habitat and flood storage. The hospital complemented the restoration with a boardwalk to link environmental and human health.

Just upstream, the boardwalk and trail system in the Minnehaha Creek Preserve is a natural oasis in the middle of an urban area. This restoration was achieved in partnership with the City of St. Louis Park, which approached the MCWD to address erosion issues on the creek. The MCWD leveraged state Clean Water Grant funds, obtained donated easements from private landowners and developed project agreements with the City to restore 30 acres of industrialized creek corridor into habitat and parkland, provide stormwater treatment for 80 acres of urban hard surface and connect the residents of 600 housing units to transit and local businesses.

Further upstream, the MCWD worked with the City of Hopkins to transform Cottageville Park from a hidden, troubled pocket park into an expanded playground and community space with a restored creek running through it. Subsurface facilities incorporated into the park restoration provide stormwater treatment for new low-income housing adjacent to the park. Police calls related to park activity, which previously accounted for 20 percent of all City crime, essentially ceased.

As communities' needs change, so does their landscape. What once was a satisfactory use of land often gives way to new ways of doing business. The site of a large cold storage warehouse for decades, 325 Blake Road in Hopkins is a key opportunity for the City to achieve its community development goals in the Blake Road corridor. The MCWD responded to the City's request to collaborate by purchasing the 17-acre site. The property will be made available for redevelopment as guided by the City's vision, while providing for the restoration of another 1,000 feet of Minnehaha Creek riparian corridor along with a regional stormwater management basin that will treat 270 acres of urban stormwater previously discharged untreated directly to the creek. Through coordination among the City of Hopkins, the Metropolitan Council and the MCWD, the stormsewer work to bring this water to the Blake Road property has been incorporated into a programmed sanitary sewer project, resulting in substantial public cost savings.

For businesses to thrive, they often must grow. Japs-Olson Company, one of St. Louis Park's larger employers situated adjacent to the MCWD's Minnehaha Creek Preserve land, encountered several obstacles as it sought to expand its printing business. Rather than contribute to these growing pains with rigid application of regulations, the District worked in partnership to find innovative solutions.

As the result of a series of agreements that also involved the Cities of Hopkins and St. Louis Park, the MCWD received 3.6 acres of land to expand greenspace and provide a trailhead connection to the Preserve, and maintains a constructed wetland basin to treat stormwater from the Japs-Olson expansion along with adjacent road right-of-way previously untreated. The Japs-Olson expansion was finished ahead of schedule and allowed for the creation of 150 jobs.

For the MCWD, outcomes of these partnership efforts included restoration of a substantial length of creek sinuosity, riparian wetland and floodplain; treatment of runoff from several hundred fully developed acres of urban land that previously discharged untreated to the creek; and the creation of both passive and active recreational sites connected to the water environment and integrated with public education about the natural environment. Continued implementation of these management strategies in alignment with the goals of our

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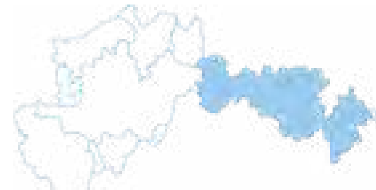
Figure 3.32 Greenway Plan



MINNEHAHA CREEK GREENWAY

local partners will continue to produce greater community impact than if pursued with a singular focus on water resource improvement.

Stormwater Management

Stormwater management will focus on reducing runoff volumes and rates, as well as reducing pollutant loading from runoff producing rain events. Stormwater management in the developed or developing urban and suburban areas will focus on retrofitting low impact development techniques such as ponds, filters, infiltration techniques, and other technologies where they are applicable. In the rural and agricultural areas, stormwater management will focus on buffers, improved agricultural practices such as conservation tillage, manure management for animal agriculture and hobby farms, wetland restoration and fertilizer management.

The most impactful driver of water quality within the Minnehaha Creek subwatershed, stormwater runoff, and its ability to transport excess nutrients and pollutants, negatively impacts lakes, streams and wetlands throughout the region. The overall strategy for protecting water quality within the subwatershed is to reduce pollutant loading and stormwater runoff volume from the landscape. This can be done in a variety of ways, such as installation and load reduction Best Management Practices (BMPs); retrofitting developed areas with BMPs as infrastructure and development/redevelopment opportunities arise; regulating freeboard required on new developments and redevelopments; encourage property owners to incorporate BMPs on their own properties; requiring stormwater pretreatment before discharge into any wetland; enhancing buffers along streambanks; and requiring local plans to discuss flood prevention and mitigation.

In highly developed areas such as the Minnehaha Creek subwatershed, the disruption to the naturally occurring water cycle creates challenges in addressing runoff. Beyond treating rainfall where it falls with site specific BMPs, a proven method for stormwater management is implementation of regional stormwater management opportunities – where large areas of runoff can be directed and treated in a singular location.

In the Minnehaha Creek subwatershed, this has proven to be an effective method and will continue to be a focus for the District and its partners. In the short term, regional stormwater management opportunities have been identified in the Minnehaha Creek Greenway at 325 Blake Road, at Arden Park in the City of Edina, and at numerous locations along the Minnehaha Parkway Regional Trail in the City of Minneapolis. Efforts will be made to advance these opportunities while continuing to work with our public and private partners to explore additional prospects that have yet to be identified.

Stream Channel Restoration

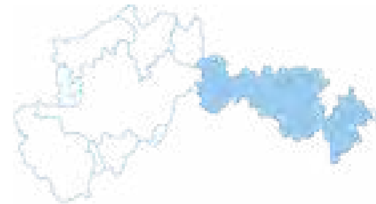
Stream restoration focuses on balancing stormwater conveyance to prevent flooding and channel erosion while providing high quality habitat for fish and macroinvertebrates. Restoration includes, where applicable, improving channel sinuosity, stabilizing streambanks, controlling peak flow velocities, increasing channel roughness for habitat and re-aeration, narrowing stream channels to improve wetted width and ecological baseflow, and increasing stream structure.

Minnehaha Creek maintains a history of man-made alterations as the urban landscape changed, resulting in a disruption of natural stream processes and degraded and fragmented habitat. While stormwater management is an effective tool in addressing stream flashiness and erosive velocities, stream channel restoration provides the opportunity to reinstate a more natural system design within a previously manipulated ecosystem.

A total of approximately one mile of Minnehaha Creek has been restored over the last decade to a meandering channel to reduce peak flows, reconnect the stream to its floodplain, limit erosion, and enhance habitat. Additional reaches of Minnehaha Creek would benefit from channel restoration, streambank stabilization, buffer enhancement, and habitat improvement. MCWD and its partners have been exploring restoration opportunities at Meadowbrook Golf Course, Arden Park in Edina, and various locations along the Minnehaha Parkway in Minneapolis, while continuing to investigate other reaches of the stream where restoration potential exists.

Wetland Restoration

Traditional approaches to wetland restoration focus on restoring wetland channels and hydrology to support a more diverse native plant population. While this strategy addresses ecological integrity within the wetland, it often overlooks the need to alter the cycles of wetland chemistry created by historic



Minnehaha Creek Preserve

Sailboats on Lake Calhoun

Cottageville Park playground

wetland alteration, which transform and release phosphorus to downstream waterbodies.

To address both ecological integrity and the release of phosphorus, wetland restoration must focus on modifying hydrology to support the native plant community while minimizing phosphorus export. This may include, but is not limited to, bypassing flow around the wetland, the addition of nutrient filters, soil engineering or augmentation to permanently sequester phosphorus, or the development of wetland treatment cells. Selected restoration options will depend on site specific wetland conditions and hydrology, and overall needs of the subwatershed system.

Most of the wetlands within the Minnehaha Creek subwatershed have been altered and disrupted. The District, with its many partners, has worked to restore multiple wetland systems in recent years. MCWD continues to assess and explore wetland function and ecosystems, and will target restoration efforts in ways that provide the greatest benefit to water quality, quantity and ecological integrity, while integrating these efforts within the developed community.

Internal Sediment Phosphorus Control

Reducing or eliminating phosphorus release from sediments is often essential to meet water quality standards in lakes. There are several techniques available for controlling sediment phosphorus release including sediment phosphorus inactivation using a chemical such as aluminum, oxygenation to prevent sediment anoxia, hypolimnetic aeration and iron addition to prevent phosphorus release, or hypolimnetic withdrawal. While all the techniques can be effective, the application of aluminum to sediments using aluminum sulfate (alum) or a mixture of sodium aluminate and alum is typically the most cost effective approach for reducing sediment phosphorus release.

In recent years, the District has partnered to address internal phosphorus loading through a variety of creative management strategies. In Lake Nokomis, an enhanced fish stocking program was implemented to reduce the number of rough fish (bullhead) rooting in the lake sediment by increasing predator fish (walleye) that feed on them. The Taft Lake – Legion Lake project creates a nutrient reduction treatment chain to address phosphorus loading entering upstream Legion Lake (buffers and infiltration systems) before an alum injection system directly treats Taft Lake internal nutrient loads.

MCWD will continue to assess management options for lake systems throughout the subwatershed. Additional water quality monitoring data, sediment chemistry, and fish and aquatic vegetation surveys are necessary to evaluate the most appropriate techniques to improve water quality.

Watershed Protection

Within the Minnehaha Creek subwatershed, redevelopment of urban and suburban areas provides an opportunity to address previous land use decisions and their negative impact on natural resources. Watershed protection is a critical component to ensure that change on the landscape is leveraged to find greater opportunity for the built environment while layering in water resource protection and ecological enhancement.

LAND USE

EXISTING CONDITIONS

The Minnehaha Creek subwatershed encompasses all of the MCWD downstream of the Grays Bay dam, and is commonly referred to as the "lower watershed." The subwatershed is 47.3 square miles in size and includes portions of the cities of Edina, Golden Valley, Hopkins, Minneapolis, Minnetonka, Plymouth, Richfield, St. Louis Park and Wayzata.

The predominant land use in the subwatershed is single family residential (52%), followed by parks and open space (15%), multi-family residential (8%), water (6%), commercial (5%), institutional (5%), and transportation (5%). The subwatershed is fully developed at typical urban and suburban densities and land uses and contains a higher level of impervious cover on the land than any of the other ten subwatersheds in the District. Redevelopment and infill development have increased since the 2007 plan, notably with an increase in multi-family residential. Most of the remaining vacant or undetermined land is large wetland or woodland tracts.

LOCAL PLANS AND PRIORITIES

As described in the District's goals (Section 3.3), the District strives to implement its clean water objectives in ways that meaningfully contribute to the development of thriving communities. This is achieved through collaboration and integrated planning with public and private partners.

As part of the development of this plan, the District reached out to its communities to gather information on local goals, plans, and priorities for 2018-2027 (see Appendix B for details on the public input process). This information was used to broadly characterize opportunities, and to inform the development of the District's implementation plans. The information received was used only as a guide during the development of this Plan to inform the District of opportunities for partnership on the near term horizon, and was not intended to be exhaustive or restrict future collaborative efforts.

As discussed in Section 3.6, the District intends to cultivate a framework for two-directional coordination with communities on an ongoing basis, to stay apprised of emerging needs at a local level, and to identify and evaluate opportunities to implement management strategies outlined in this Plan over the next ten years. The District recognizes that local needs, opportunities and priorities may shift over time. Therefore, this Plan does not intend to capture or prescribe opportunities for partnership over a ten-year term.

Long term goals, growth and private development, and public investment in infrastructure differ across each community – and therefore, frameworks for ongoing coordination will be custom tailored based on the individual needs of each community. Coordination may occur at varying levels, through various means, with communities across the following areas:

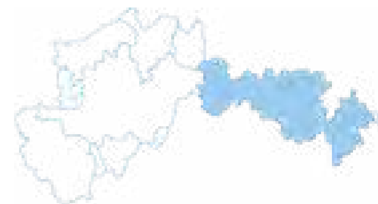
» Regulation of, and partnership with, private development

» Collaboration on public planning and investment (e.g. parks , roads, utilities)

» MS4 compliance

» Development and implementation of TMDLs

Development in this subwatershed has left few large areas of undisturbed or minimally disturbed forest and wetland in the subwatershed. Three areas, including the Grays Bay outlet wetland complex; Diamond Lake; and a portion of the creek corridor in the Mississippi River gorge have been designated



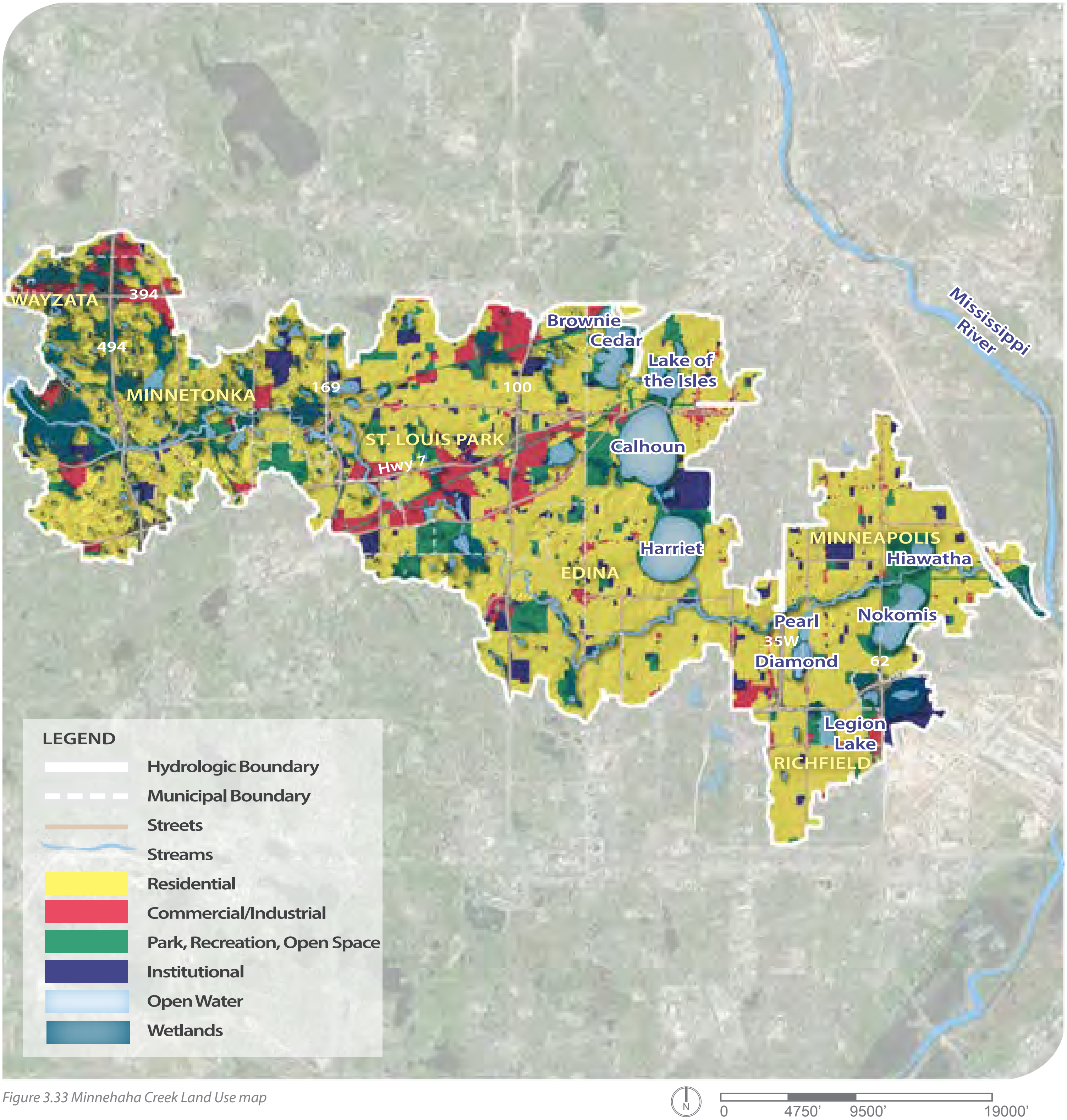


Figure 3.33 Minnehaha Creek Land Use map

Regionally Significant Ecological Areas by the DNR. Although the Minnesota County Biological Survey (MCBS) did not identify any areas of biodiversity significance in the subwatershed, the creek corridor and the Chain of Lakes in the lower subwatershed are part of a DNR-designated Metro Conservation Corridor and will continue to influence land use investment and natural resource enhancement due to the significant value within this urban environment. The Minneapolis Park and Recreation Board has been developing master plans for portions of the creek corridor and Chain of Lakes with the District serving in a technical advisory role.

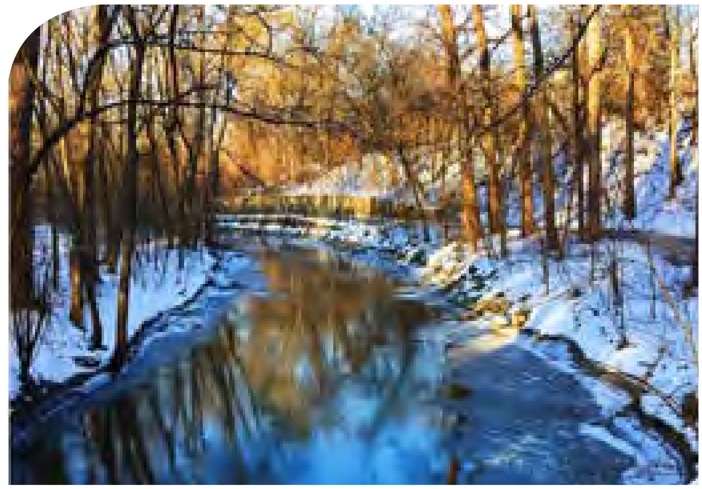
Over the course of the next ten years, cities and agencies in the Minnehaha Creek subwatershed are expecting to make various infrastructure investments, ranging from road reconstruction and mass transportation projects to park, greenspace, trail, and stormwater management improvements. The goals of our partners, both public and private, and the investments they are planning serve as collaborative opportunities not only to enhance community impact, but to produce creative public-private funding opportunities that will leverage scarce resources and maximize benefits.

It is also evident that throughout the Minnehaha Creek subwatershed, cities place high value on connecting their communities to parks, trails, and natural landscapes, and intend to leverage redevelopment within their communities to improve these connections. With early effort and strengthened communications, cities and private investors will find opportunities to coordinate with the District to further integrate stormwater management, natural resource restoration, and community connections into municipal infrastructure projects and ongoing redevelopment.

There are also a number of active lake and stream associations in the subwatershed, including the East Calhoun Community Organization, Friends of Bass Lake, Friends of Diamond Lake, Friends of Lake Calhoun, Friends of Lake Hiawatha, Friends of Lake Nokomis, and Friends of Minnehaha Creek.

IMPLEMENTATION PLAN

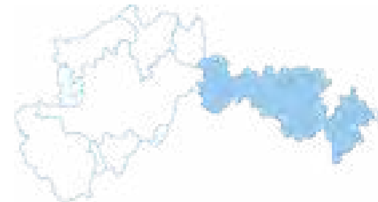
The goals set forth in this subwatershed plan will require an integrated set of programs and projects oriented toward the



Minnehaha Creek in the winter, climbbikerun

Minnehaha Falls sunrise

Cottageville Park



conservation and improvement of water resources within the watershed. The Implementation Priorities section generally describes the actions that the District and its partners will look to take in order to address the issues present in the subwatershed and achieve the goals as set forth in the plan. The Capital Improvement Plan (CIP) provides cost estimates and schedules for any proposed capital investments.

IMPLEMENTATION PRIORITIES

As described in previous sections, within the Minnehaha Creek Subwatershed, ditching of the stream channel, loss of wetlands, corridor fragmentation and increasing levels of impervious surfaces have disrupted fluvial processes; increased runoff volumes and pollutant loads; decreased infiltration and baseflow; and fragmented and degraded habitat; negatively impacting the ecological integrity of the stream and its riparian systems. As a result, Minnehaha Creek is listed as an impaired water for multiple parameters, including fecal coliform bacteria, chloride, low dissolved oxygen, and fish and macroinvertebrate communities.

Further, due to the sediment and nutrient loads transported by Minnehaha Creek, downstream receiving waterbody Lake Hiawatha is impaired for excess nutrients, and, along with Minnehaha Creek, has an approved TMDL. Lake Nokomis also has an approved TMDL for excess nutrients and is one of four other lakes in the subwatershed that do not meet state water quality standards for nutrients.

Due to the system's altered hydrology (hard cover and altered wetlands) and upstream drainage area (Lake Minnetonka), several locations along Minnehaha Creek are known to flood during large or extended rain events. Overall, due to the size of the subwatershed and the urban characteristics of the area (developed, fragmented and altered), ecological integrity throughout the subwatershed is highly variable and generally considered to be lacking.

Based on the water resource needs that exist in the subwatershed and the opportunity to build upon our many successful partnerships with both public and private entities, the District has identified the Minnehaha Creek Subwatershed as a priority area to focus implementation efforts in this plan cycle. The focus within the subwatershed will be stormwater management to reduce volume and pollutant loading, stream restoration to stabilize streambanks and improve riparian buffers and habitat, and restoration of wetlands and ecological corridors in ways that reduce nutrient loading downstream to Lake Hiawatha while improving ecological integrity and corridor connectivity within the subwatershed.

As noted in previous sections, the District has been focusing on the most degraded section of Minnehaha Creek – between West 34th Street and Excelsior Boulevard in St. Louis Park and Hopkins – to implement a comprehensive corridor restoration that focuses on reducing pollutant loads, mitigating flashy hydrology, reconnecting the riparian corridor, and restoring the physical character of the stream channel. While the District and its partners continue implementation in the Minnehaha Creek Greenway, with projects such as 325 Blake Road and Meadowbrook Golf Course, these efforts continue to expand. Throughout the Minnehaha Creek subwatershed, collaborative opportunities are being explored in other critical areas of high need. Two examples of this are the efforts taking shape in the cities of Edina and Minneapolis.

In Edina, the City and District have been working together to vision a restored Arden Park in a way that layers multiple natural resource benefits together with community benefits. The project includes restoration of over 2,000 feet of Minnehaha Creek stream channel, including removal of one of the last two dams on the creek, and the potential to treat over 100 acres of regional stormwater runoff that currently flows untreated to the creek – all which attract and improve conditions for fish, birds and other wildlife. These efforts are layered with multiple benefits for the community: connecting people visually and physically to the creek with vegetation restoration; providing formal and informal access to new fishing throughout the park; making in-creek recreation more accessible to a larger cross section of users (tubers, kayakers, paddle boarders); providing safer, easier access to the creek; and a new, multi-purpose shelter building.

In Minneapolis, the District is working with the City of Minneapolis and the Minneapolis Park and Recreation Board (MPRB) on a multi-jurisdictional concept plan and capital improvement plan to improve the natural and built environments within the Minnehaha Creek corridor. This partnership will look to master plan future improvements of the Minnehaha Parkway Regional Trail on Minnehaha Creek – a 253 acre, 5.3 mile parkway with more than 1.4 million visits per year – with the layered goals of regional stormwater management, flood mitigation, and creek and riparian improvements.

Reminiscent of the work throughout the Minnehaha Creek Greenway, these projects strive to correct historic impacts and balance the needs of natural resources while achieving the goals set forth by the communities, their residents, and other public and private partners. The CIP in the following section includes these and other identified project opportunities. With these and all other implementation efforts, the District will bring together the municipalities, Minneapolis Park and Recreation Board, and other affected stakeholders to align goals and develop a specific systems plan.

In addition to these planning and implementation efforts, the District has a wide range of services it can mobilize to address resource needs and support partner efforts as opportunities arise, including data collection and diagnostics, technical and planning assistance, permitting assistance, education and capacity building, and grants.

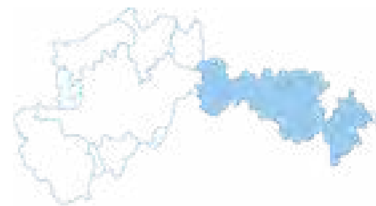
Minnehaha Creek, Powderhorn Lake, and Brownie Lake are listed as impaired for excess chlorides. The District will continue to monitor chloride levels and provide education and training for public and private applicators and residents on best practices for chloride use.

As noted in the previous section, there are a number of active lake associations in the subwatershed. The District will continue to work with its lake associations to provide education and technical assistance to build their capacity and target implementation efforts.

CAPITAL IMPROVEMENT PROGRAM

The CIP is a planning tool. It also is a means to inform partners, District residents, and other interested parties as to the District's scope and priorities for its capital work over the planning period. A project's inclusion in the CIP does not mean that the project will be constructed, only that the District has identified it as an action that may be a cost-effective way for the District to achieve identified water resource goals. A project identified in the CIP always will need further review as to technical feasibility, cost and financing, consistency with local needs, and other policy considerations before a formal decision to proceed to construction is made. Section 3.5.5 describes the development

Headwaters of Minnehaha Creek



ISSUE

- Excess nutrients
- Localized flooding
- Mostly degraded aquatic plant communities
- Degraded and disconnected corridors

DRIVER

- Altered wetlands
- Common carp
- Stormwater runoff
- Internal sediment phosphorous loading
- Water quality from upstream water bodies

STRATEGY

- Wetland restoration
- Carp management
- Stormwater management
- Internal sediment phosphorous control
- Restoration of upstream water bodies
- Watershed protection

IMPLEMENTATION PRIORITIES

- Resource protection through regulation
- Early coordination and integration with land use planning
- Opportunity-driven stormwater management projects/grants
- Education and capacity-building for lake associations
- Partner with cities and Long Lake Waters Association on shared priorities

and evaluation steps that will occur before the District will commit resources to a project.

Section 3.5.5 also describes how the District will review the CIP on an ongoing basis throughout the planning period. This review will allow the District to reassess described projects from a technical perspective, but also will involve broader policy considerations such as shifts in District priorities, decisions as to annual budget and levy levels, and the prospect of state and federal grant funds or financing. For this reason, projects may be added to and deleted from the CIP from year to year, in accordance with those procedures.

A critical component of any project will be the development of a funding strategy that identifies the sources, uses, and timing of funds needed to successfully achieve identified goals. These plans will be developed in conjunction with the District's public and private partners as capital projects are advanced. Therefore, any costs identified within this Plan are projections. Intended expenditures will be refined during project development and budgeting, and among other things will reflect the District's intent to complement its ad valorem funds with other funding sources.

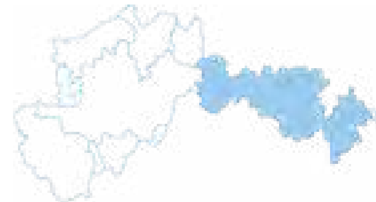
Table 3.12 Minnehaha Creek Subwatershed CIP

Project	**Minnehaha Creek FEMA Flood Damage Repairs**
Description	Streambank restoration and repair of streambank erosion and other flood damage resulting from 2014 flooding.
Need	The 2014 flooding along Minnehaha Creek caused flood damage in the cities of Edina and Minneapolis. The District coordinated review of the flood damage with the Federal Emergency Management Agency (FEMA). FEMA approved 35 sites to receive federal funding to implement flooding repairs. The project would repair streambank erosion and other flood damages identified by the District and FEMA in 2014.
Outcome	Stabilized streambanks with both bioengineering and hard armoring to reduce erosion and protect the stream channel; Improve ecological integrity of the stream corridor through this reach; enhance riparian habitat and native vegetative communities.
Estimated Cost	$920,000
Potential Funding Sources	District levy and Federal Emergency Management Agency (FEMA) grant
Schedule	2017-2018

Project	325 Blake Road Regional Stormwater and Greenway
Description	Opportunity to manage approximately 270 acres of regional stormwater runoff at 325 Blake Road. The project requires construction of onsite stormwater management facilities to treat inflow from two diversion structures – Powell Road and Lake Street – which are already in place. The project also includes restoration of four to six acres of industrial land along Minnehaha Creek to restored greenway and riparian corridor.
Need	Minnehaha Creek is listed as an impaired water for multiple parameters, including fecal coliform bacteria, chloride, low dissolved oxygen, and fish and macroinvertebrate communities. Further, due to the sediment and nutrient loads transported by Minnehaha Creek, downstream receiving waterbody Lake Hiawatha is impaired for excess nutrients, and, along with Minnehaha Creek, has an approved TMDL. The TMDL report calls for a reduction of 1,907 lbs/year throughout the subwatershed in order for Lake Hiawatha to meet an in-lake nutrient concentration of 50 ug/L. The TMDL draft report also identifies a need to reduce bacterial (E. coli) loading in order to meet the state standard. At this time with our current understanding, the best approaches for addressing excess bacteria loads appear to be source reduction or volume control practices. The District has been focusing on the most degraded section of Minnehaha Creek – between West 34th Street and Meadowbrook Lake in St. Louis Park and Hopkins – to implement a comprehensive corridor restoration that focuses on reducing pollutant loads, mitigating flashy hydrology, reconnecting the riparian corridor, and restoring the physical character of the stream channel. In 2011 the District made a strategic acquisition of land at 325 Blake Road as part of a regional scale effort to establish the Minnehaha Greenway. This effort identified opportunities for area wide stormwater improvement, ecological restoration of the Minnehaha Creek riparian zone and corridor linkage with upstream/downstream restoration projects. Portions of the site not utilized for watershed restoration will be sold for redevelopment to capture a return on the initial investment.

Outcome	The site and project represent a critical piece of the District's larger strategic initiative within the Minnehaha Creek Greenway focused on improving the quality and managing the quantity of stormwater runoff; enhancing the ecological integrity of the stream system; and facilitating broader community goals of economic development and livability by allowing the restored stream system to be integrated into the developed landscape. This project will implement over 270 acres of regional stormwater treatment to address water quality and quantity entering Minnehaha Creek, restore riparian and stream channel habitat, and expand the Minnehaha Creek Greenway while providing access to upstream and downstream project initiatives. The project is estimated to achieve a phosphorus reduction of 181 lbs/year and a volume reduction of 11.83 acre-feet/year. These estimates will be refined through project feasibility and design.
Estimated Cost	$2,750,000
Potential Funding Sources	District levy and Minnesota Public Facilities Authority (50%)
Schedule	2018-2019

Project	**Meadowbrook Golf Course Ecological Restoration**
Description	Partnership with the Minneapolis Park and Recreation Board (MPRB) to reconfigure and enhance Meadowbrook Golf Course to restore and improve the ecological integrity of the Minnehaha Creek stream corridor, and connect the Minnehaha Creek Greenway through MPRB land to the City of Edina parks and trails system.
Need	Minnehaha Creek is listed as an impaired water for multiple parameters, including fecal coliform bacteria, chloride, low dissolved oxygen, and fish and macroinvertebrate communities. Further, due to the sediment and nutrient loads transported by Minnehaha Creek, downstream receiving waterbody Lake Hiawatha is impaired for excess nutrients, and, along with Minnehaha Creek, has an approved TMDL. The TMDL report calls for a reduction of 1,907 lbs/year throughout the subwatershed in order for Lake Hiawatha to meet an in-lake nutrient concentration of 50 ug/L. The TMDL report also identifies a need to reduce bacterial (E. coli) loading in order to meet the state standard. At this time with our current understanding, the best approaches for addressing excess bacteria loads appear to be source reduction or volume control practices. Situated within the most degraded section of Minnehaha Creek – between West 34th Street and Meadowbrook Lake in St. Louis Park and Hopkins – the project addresses historic issues such as ditching of the stream channel, loss of wetlands, corridor fragmentation, and fragmented and degraded habitat, all of which negatively impact the ecological integrity of the stream and its riparian systems and contribute to impairments of Minnehaha Creek.

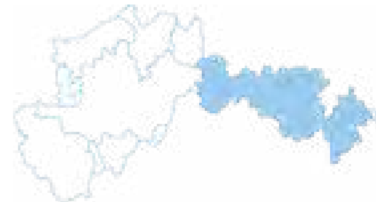


Outcome	Improve ecological integrity of the stream corridor through this reach; improve ecological integrity of upland within the golf course and improve wetland function and value on site; improve water quality for Minnehaha Creek and downstream Lake Hiawatha; maintain or increase flood storage capacity to improve golf course resilience and reduce flood severity of adjacent neighborhoods; connect Minnehaha Creek Greenway trails through MPRB land to City of Edina parks and trails system in a manner that respects adjoining landowners' interests.
Estimated Cost	$2,200,000
Potential Funding Sources	District levy, Minneapolis Park and Recreation Board, and Hennepin County grant funding
Schedule	2018-2019

Project	**Arden Park Stream Restoration**
Description	Partnership with the City of Edina to restore Arden Park and the Minnehaha Creek corridor through the park. . The project includes stream restoration, including the removal of one of the last two dams on the creek, regional stormwater management, habitat improvements, and enhanced parkland to provide stream accessibility and recreation opportunities.
Need	Minnehaha Creek is listed as an impaired water for multiple parameters, including fecal coliform bacteria, chloride, low dissolved oxygen, and fish and macroinvertebrate communities. Further, due to the sediment and nutrient loads transported by Minnehaha Creek, downstream receiving waterbody Lake Hiawatha is impaired for excess nutrients, and, along with Minnehaha Creek, has an approved TMDL. The TMDL report calls for a reduction of 1,907 lbs/year throughout the subwatershed in order for Lake Hiawatha to meet an in-lake nutrient concentration of 50 ug/L. The TMDL report also identifies a need to reduce bacterial (E. coli) loading in order to meet the state standard. At this time with our current understanding, the best approaches for addressing excess bacteria loads appear to be source reduction or volume control practices. The grade control structure is a known contributor to existing impairments, acting as a barrier to fish passage and creating an impoundment that causes accumulation of sediment, thus degrading upstream aquatic habitat (Minnehaha Creek Stream Assessment 2003, 2012). The dam has altered the function and value of the creek system by removing connectivity to habitat for spawning and forage, while increasing residence time of water and surface area making the water warmer. These impediments increase algal growth and accumulation of decaying vegetation, which uses oxygen and creates an environment that is harmful for fish and macroinvertebrates.

Outcome	Improve ecological integrity of the stream corridor through this reach; improve ecological integrity of upland within the park; implement regional stormwater management for approximately 100 acres; expand and enhance recreation opportunities, safety, and community connections to Minnehaha Creek. The project is estimated to achieve a phosphorus reduction of 29.5 lbs/year and a volume reduction of 10 acre-feet/year. These estimates will be refined through project feasibility and design.
Estimated Cost	$4,100,000
Potential Funding Sources	District levy, City of Edina, and grant opportunities
Schedule	2018-2019

Project	**Greenway to Cedar Trail Connection and Streambank Restoration**
Description	Partnership with the City of St. Louis Park to enhance Minnehaha Creek Greenway connections to the Cedar Regional trail and restore a degraded section of Minnehaha Creek through streambank stabilization and vegetative enhancement.
Need	Minnehaha Creek is listed as an impaired water for multiple parameters, including fecal coliform bacteria, chloride, low dissolved oxygen, and fish and macroinvertebrate communities. Further, due to the sediment and nutrient loads transported by Minnehaha Creek, downstream receiving waterbody Lake Hiawatha is impaired for excess nutrients, and, along with Minnehaha Creek, has an approved TMDL. The Minnehaha Creek Greenway is bisected by rail and regional trail, without access to upstream and downstream restoration initiatives. The rail line and train bridge crossing at Minnehaha Creek not only acts as an impediment to community connections by blocking access to the regional trail and Greenway, the stream channel at this location was historically manipulated, causing stream bank degradation and unnatural riparian structure.
Outcome	Improve ecological integrity of the stream corridor through this reach; improve stream channel stabilization; enhance riparian habitat and native vegetative communities; expand and enhance recreation opportunities, safety, and community connections to Minnehaha Creek and the Minnehaha Creek Greenway.
Estimated Cost	$510,000
Potential Funding Sources	District levy, City of St. Louis Park, and grant opportunities
Schedule	2019-2020

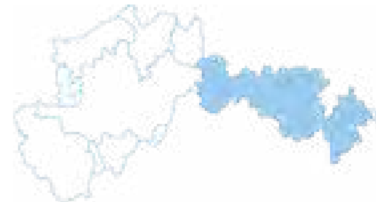


Project	Boone-Aquila Floodplain
Description	Floodplain restoration and stormwater management project developed in coordination with public and private partners to address localized flooding and stormwater runoff in the Minnehaha Creek Greenway.
Need	Minnehaha Creek is listed as an impaired water for multiple parameters, including fecal coliform bacteria, chloride, low dissolved oxygen, and fish and macroinvertebrate communities. Further, due to the sediment and nutrient loads transported by Minnehaha Creek, downstream receiving waterbody Lake Hiawatha is impaired for excess nutrients, and, along with Minnehaha Creek, has an approved TMDL. The TMDL report calls for a reduction of 1,907 lbs/year throughout the subwatershed in order for Lake Hiawatha to meet an in-lake nutrient concentration of 50 ug/L. The TMDL report also identifies a need to reduce bacterial (E. coli) loading in order to meet the state standard. At this time with our current understanding, the best approaches for addressing excess bacteria loads appear to be source reduction or volume control practices. The District has been focusing on the most degraded section of Minnehaha Creek – between West 34th Street and Meadowbrook Lake in St. Louis Park and Hopkins – to implement a comprehensive corridor restoration that focuses on reducing pollutant loads, mitigating flashy hydrology, reconnecting the riparian corridor, and restoring the physical character of the stream channel. Historic development within this corridor resulted in large areas of floodplain fill, areas of localized flooding and impervious surfaces constructed within the floodplain and riparian zone of Minnehaha Creek.
Outcome	Improve ecological integrity of the stream corridor through this reach; expand floodplain storage in degraded section of Minnehaha Creek; enhance riparian habitat and native vegetative communities; expand and enhance recreation opportunities, safety, and community connections to Minnehaha Creek and the Minnehaha Creek Greenway.
Estimated Cost	$500,000
Potential Funding Sources	District levy, public and private partner contributions, and grant opportunities
Schedule	2019-2020

Project	Cottageville Park Phase II Riparian Restoration
Description	Continued implementation of the Minnehaha Creek Greenway corridor restoration that will focus on reconnecting the riparian corridor, and restoring the physical character of the stream channel on an expanded portion of Cottageville Park.

Need	Minnehaha Creek is listed as an impaired water for multiple parameters, including fecal coliform bacteria, chloride, low dissolved oxygen, and fish and macroinvertebrate communities. Further, due to the sediment and nutrient loads transported by Minnehaha Creek, downstream receiving waterbody Lake Hiawatha is impaired for excess nutrients, and, along with Minnehaha Creek, has an approved TMDL. Recent work within the most degraded section of Minnehaha Creek – between West 34th Street and Meadowbrook Lake in St. Louis Park and Hopkins – included implementation of Cottageville Park to address regional stormwater, stability of the Minnehaha Creek channel, and ecological restoration, all issues within the Minnehaha Creek subwatershed. Cottageville Park is an amenity on Minnehaha Creek that provides recreation, greenspace and trails, with an opportunity to expand these efforts to surrounding property, further protecting and enhancing the stream corridor.
Outcome	Improve ecological integrity of the stream corridor through this reach; improve stream channel stabilization; enhance riparian habitat and native vegetative communities; expand and enhance recreation opportunities, safety, and community connections to Minnehaha Creek and the Minnehaha Creek Greenway.
Estimated Cost	$280,000
Potential Funding Sources	District levy, partner contributions, and grant opportunities
Schedule	2019-2020

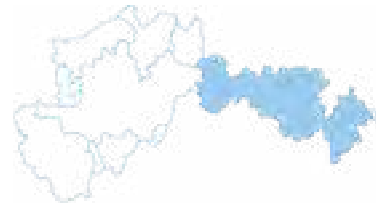
Project	**West Blake Greenway Enhancement**
Description	Opportunity to expand the Minnehaha Creek Greenway and restore a degraded section of Minnehaha Creek through streambank stabilization, wetland and upland restoration, and vegetative enhancement.
Need	Minnehaha Creek is listed as an impaired water for multiple parameters, including fecal coliform bacteria, chloride, low dissolved oxygen, and fish and macroinvertebrate communities. Further, due to the sediment and nutrient loads transported by Minnehaha Creek, downstream receiving waterbody Lake Hiawatha is impaired for excess nutrients, and, along with Minnehaha Creek, has an approved TMDL. The Minnehaha Creek Greenway is bisected by multiple county roads and state highways, including Blake Road and Highway 7. These roadways create barriers for wildlife by diminishing continuity and access to upstream and downstream restoration initiatives. The crossings at Minnehaha Creek also are an impediment to community connections by blocking access to upstream and downstream Greenway trails. The stream channel at this location flows into a large wetland complex that was historically manipulated, causing stream bank degradation and unnatural riparian and wetland structure.



Outcome	Improve ecological integrity of the stream corridor through this reach; improve stream channel stabilization; enhance riparian habitat and native vegetative communities; expand and enhance recreation opportunities, safety, and community connections to Minnehaha Creek, local wetland environments and the Minnehaha Creek Greenway.
Estimated Cost	$420,000
Potential Funding Sources	District levy, partner contributions, and grant opportunities
Schedule	2020-2021

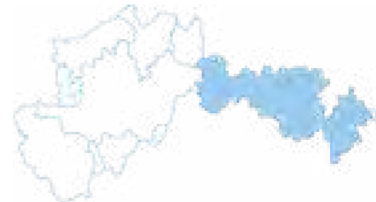
Project	**Meadowbrook Greenway Expansion**
Description	Opportunity to expand the Minnehaha Creek Greenway through the restored Meadowbrook Golf Course to downstream parks and open space areas within the City of Edina.
Need	Minnehaha Creek is listed as an impaired water for multiple parameters, including fecal coliform bacteria, chloride, low dissolved oxygen, and fish and macroinvertebrate communities. Further, due to the sediment and nutrient loads transported by Minnehaha Creek, downstream receiving waterbody Lake Hiawatha is impaired for excess nutrients, and, along with Minnehaha Creek, has an approved TMDL. Access to the Minnehaha Creek Greenway presently ends at Excelsior Boulevard in St. Louis Park, north of adjacent Meadowbrook Golf Course. The roadway and golf course create barriers for wildlife by diminishing continuity and access to upstream restoration initiatives and downstream parkland, open space, and Meadowbrook Lake. The golf course on Minnehaha Creek also acts as an impediment to community connections by blocking access to upstream and downstream Greenway trails. As part of this plan the stream channel at this location is projected to be restored in 2018-2019, restoring ecological integrity, adding riparian structure, and providing a new greenway and conservation corridor.
Outcome	Enhance riparian habitat and native vegetative communities; expand and enhance recreation opportunities, safety, and community connections to Minnehaha Creek, Meadowbrook Lake and the Minnehaha Creek Greenway.
Estimated Cost	$950,000
Potential Funding Sources	District levy, partner contributions, and grant opportunities
Schedule	2020-2021

Project	Hiawatha Golf Course Restoration
Description	Partnership with the Minneapolis Park and Recreation Board (MPRB) and City of Minneapolis to reconfigure and enhance Hiawatha Golf Course to restore and improve the ecological integrity of the Minnehaha Creek stream corridor, address direct stormwater discharge to Lake Hiawatha, address localized flooding issues within the City, and further connect the community to new trail and recreation opportunities on MPRB land.
Need	Minnehaha Creek is listed as an impaired water for multiple parameters, including fecal coliform bacteria, chloride, low dissolved oxygen, and fish and macroinvertebrate communities. Further, due to the sediment and nutrient loads transported by Minnehaha Creek, downstream receiving waterbody Lake Hiawatha is impaired for excess nutrients, and, along with Minnehaha Creek, has an approved TMDL. The TMDL report calls for a reduction of 1,907 lbs/year throughout the subwatershed in order for Lake Hiawatha to meet an in-lake nutrient concentration of 50 ug/L. The TMDL report also identifies a need to reduce bacterial (E. coli) loading in order to meet the state standard. At this time with our current understanding, the best approaches for addressing excess bacteria loads appear to be source reduction or volume control practices. Catalyzed by flooding in Spring 2014 and the need to work with the Federal Emergency Management Agency (FEMA) on restoration of land and property damaged by flooding, the MPRB has designated the Hiawatha Golf Course a priority location for long-term investments and improvement, and includes this site in its ecological systems plan that establishes a vision to make parks and public lands more environmentally friendly. In addition, the City has undertaken a flood reduction study for this area with goals that include reducing and managing localized flooding and achieving pollutant load reductions toward meeting the Lake Hiawatha/Minnehaha Creek TMDL. The City is also evaluating hydraulic, hydrologic and groundwater contributions to the ponds on the Hiawatha Golf Course.
Outcome	Improve ecological integrity of the stream corridor through this reach; improve stream channel stabilization; expand floodplain storage; address stormwater management issues; enhance riparian habitat and native vegetative communities; expand and enhance recreation opportunities, safety, and community connections to Minnehaha Creek and Lake Hiawatha.
Estimated Cost	$1,940,000
Potential Funding Sources	District levy, partner contributions, and grant opportunities
Schedule	2020-2021



Project	Minnehaha Parkway Stormwater Management
Description	Partnership with the Minneapolis Park and Recreation Board (MPRB) and City of Minneapolis to implement regional stormwater management by diverting direct storm sewer discharge along the Minnehaha Parkway into the buffer and riparian area for filtration/infiltration.
Need	Minnehaha Creek is listed as an impaired water for multiple parameters, including fecal coliform bacteria, chloride, low dissolved oxygen, and fish and macroinvertebrate communities. Further, due to the sediment and nutrient loads transported by Minnehaha Creek, downstream receiving waterbody Lake Hiawatha is impaired for excess nutrients, and, along with Minnehaha Creek, has an approved TMDL. The TMDL report calls for a reduction of 1,907 lbs/year throughout the subwatershed in order for Lake Hiawatha to meet an in-lake nutrient concentration of 50 ug/L. The TMDL report also identifies a need to reduce bacterial (E. coli) loading in order to meet the state standard. At this time with our current understanding, the best approaches for addressing excess bacteria loads appear to be source reduction or volume control practices. In addition, the 2003 and 2012 Minnehaha Creek Stream Assessment(s) identified two major issues impacting water quality and biotic integrity in the Creek: flashy storm event flows that often result in streambank erosion; and low base flows, which reduce habitat and limit biotic integrity. The high percent of impervious surface in this urbanized subwatershed has reduced the amount of stormwater that naturally infiltrates to surficial groundwater and which helps sustain base flow. This stormwater is efficiently conveyed to the creek through stormsewers, which results in the flashy flows. The extensive storm sewer network that drains directly to Minnehaha Creek transports sediment, nutrient and pollutant loads, creating discharges that enter the stream system and flow to downstream Lake Hiawatha.
Outcome	Improve ecological integrity of the stream corridor through this reach; improve stream channel stabilization; intercept and remove storm sewer outfalls; address stormwater management issues; enhance riparian habitat and native vegetative communities; expand native vegetation communities and reduce maintenance of parkland; enhance base flow conditions in Minnehaha Creek; expand and enhance recreation opportunities on Minnehaha Creek and Lake Hiawatha. The project is estimated to achieve a phosphorus reduction of 229 lbs/year, total suspended solids reduction of 34.1 tons, and a volume reduction of 5.2 acre-feet/year. These estimates will be refined through project feasibility and design.
Estimated Cost	$1,400,000
Potential Funding Sources	District levy, partner contributions, and grant opportunities
Schedule	2021-2022

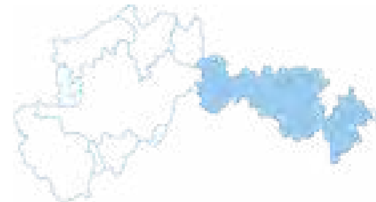
Project	Stormwater Volume and Pollutant Load Reduction
Description	Implementation of opportunities to reduce stormwater volumes and nutrient loading to Minnehaha Creek and Lake Hiawatha, including but not limited to infiltration or filtration basins and devices, reforestation, revegetation, and stormwater detention or redirection.
Need	Minnehaha Creek is listed as an impaired water for multiple parameters, including fecal coliform bacteria, chloride, low dissolved oxygen, and fish and macroinvertebrate communities. Further, due to the sediment and nutrient loads transported by Minnehaha Creek, downstream receiving waterbody Lake Hiawatha is impaired for excess nutrients, and, along with Minnehaha Creek, has an approved TMDL. The TMDL report calls for a reduction of 1,907 lbs/year throughout the subwatershed in order for Lake Hiawatha to meet an in-lake nutrient concentration of 50 ug/L. The TMDL report also identifies a need to reduce bacterial (E. coli) loading in order to meet the state standard. At this time with our current understanding, the best approaches for addressing excess bacteria loads appear to be source reduction or volume control practices. In addition, the 2003 and 2012 Minnehaha Creek Stream Assessment(s) identified two major issues impacting water quality and biotic integrity in the Creek: flashy storm event flows that often result in streambank erosion; and low base flows, which reduce habitat and limit biotic integrity. The high percent of impervious surface in this urbanized subwatershed has reduced the amount of stormwater that naturally infiltrates to surficial groundwater and which helps sustain base flow. This stormwater is efficiently conveyed to the creek through stormsewers, which results in the flashy flows. Specific project locations and methods will be identified and implemented to reduce nutrient and bacterial loading to Minnehaha Creek and thus to Lake Hiawatha; decrease peak discharge rates in Minnehaha Creek to reduce streambank erosion; and increase baseflow in the Creek to improve its biotic integrity. These projects are intended to reduce annual volume and peak flows discharged to the Creek; increase infiltration to surficial groundwater; and reduce nutrient and bacterial export to the Creek. Identifying specific implementation sites under this capital project element will be an ongoing process informed by refined technical knowledge of pollutant sources and geomorphological phenomena, available land and willing public or private partners. Priorities are set foremost by diagnosing the spatial distribution of pollutant loading to Minnehaha Creek.



Outcome	Improve ecological integrity of the stream corridor through this reach; improve stream channel stabilization; intercept and remove storm sewer outfalls; address existing stormwater management issues; minimize new pollutant loads conveyed by runoff and generated within Minnehaha Creek; minimize new volumes generated by new development; protect stream base flows and wetland and surficial groundwater hydrology; enhance riparian habitat and native vegetative communities.
Estimated Cost	$2,450,000
Potential Funding Sources	District levy, partner contributions, and grant opportunities
Schedule	2018-2027

Project	**Channel/Streambank Restoration**
Description	The District will undertake channel/streambank restoration projects to improve ecological integrity, natural aesthetic and recreational value of Minnehaha Creek including but not limited to: removing or modifying grade controls to allow fish passage and a more natural hydrologic condition; preserving and expanding wooded/vegetated riparian buffers along the entire stream length; reconstructing or re-meandering channel and floodplain where space allows to improve geomorphic/hydrologic form and function and in-stream habitat; stabilizing banks using bioengineering techniques; establishing areas to preserve and enhance view-sheds; and establishing recreational corridor connectivity through passive uses such as trails and vistas.
Need	Minnehaha Creek is listed as an impaired water for multiple parameters, including fecal coliform bacteria, chloride, low dissolved oxygen, and fish and macroinvertebrate communities. Further, due to the sediment and nutrient loads transported by Minnehaha Creek, downstream receiving waterbody Lake Hiawatha is impaired for excess nutrients, and, along with Minnehaha Creek, has an approved TMDL. The 2003 and 2012 Minnehaha Creek Stream Assessment(s) identified numerous areas of erosion along the length of the creek, as well as a general lack of steam complexity and lack of habitat for macroinvertebrates and fish largely driven by stream aggradation in impounded areas often upstream of artificial grade controls. The District will investigate improvement opportunities to high-priority reaches including those identified in the Stream Assessment. Priority reaches are those where stream restoration could improve streambank stability to "Good" as measured by Pfankuch stability rating relative to Rosgen stream type, or those where the Stream Visual Assessment Protocol (SVAP) mean score could be improved to 5.0 or better, or by one full point. The 2018 FEMA flood repair projects are an example of a project opportunity and could expand to include additional channel/streambank restoration elements that would be coordinated with the City of Minneapolis and the Minneapolis Park and Recreation Board.

Outcome	Stabilize streambanks with bioengineering to reduce erosion; improve riparian zone with native vegetation; improve fish and macroinvertebrate habitat; improve ecological integrity of the stream corridor.
Estimated Cost	$3,120,000
Potential Funding Sources	District levy, partner contributions, and grant opportunities
Schedule	2018-2027



3.9.9 PAINTER CREEK SUBWATERSHED PLAN:

INTRODUCTION

This subwatershed plan contains information specific to the Painter Creek Subwatershed, including existing conditions and issues, drivers, management strategies, and an implementation plan. Information regarding the District's philosophy, goals, and implementation approach can be found in Volume 3, Sections 2-8 and should be reviewed first to provide context for the following subwatershed plan.

EXECUTIVE SUMMARY

This Implementation Plan for the Painter Creek subwatershed summarizes issues of water quality, water quantity, and ecological integrity. The Plan identifies what is driving these issues, and outlines a roadmap of management strategies to guide the implementation efforts of the District, and its public and private partners.

Painter Creek is a 13.5 square mile (8,667 acre) subwatershed located along the northwestern boundary of the Minnehaha Creek Watershed District (MCWD or District) and includes portions of the cities of Medina, Orono, Maple Plain, Independence and Minnetrista.

The subwatershed is generally characterized by large areas of undisturbed land (37%) including numerous large wetland systems and wooded areas, agricultural uses (19%), low density development (19%), and the 2,700 acre Baker Park (19%) owned by Three Rivers Park District. The Luce Line Trail traverses this subwatershed on the north side of Painter Marsh.

Large areas of undisturbed or minimally disturbed forest and wetland including Baker Park Reserve and Painter Marsh, have been designated Regionally Significant Ecological Areas by the DNR. Several areas have been found by the Minnesota County Biological Survey to be of moderate to high biodiversity significance, including tamarack swamp complexes east of Katrina Lake.

The headwaters of the subwatershed is Katrina Lake (202 Acres), a shallow marsh system located within Three Rivers Park District's Baker Park Reserve, which drains via Painter Creek through a series of large interconnected wetland systems into Jennings Bay on Lake Minnetonka.

This system delivers high phosphorus loads to Jennings Bay on Lake Minnetonka, which is listed as impaired for excess nutrients due to loading coming from Painter Creek and internal loading from within Jennings Bay. The lower reaches of Painter Creek are also impaired by excess *E. coli* bacteria. The subwatershed experiences some localized flooding due to the system's altered hydrology (hard cover and altered wetlands) and conveyance systems (culverts and ditches). Overall, the system enjoys moderate to high ecological integrity, with areas of high quality wetland and upland, including several regionally significant ecological areas.

Management strategies within the Painter Creek subwatershed will focus on restoring wetland and stream systems in ways that reduce nutrient loading downstream to Jennings Bay, while improving ecological integrity and corridor connectivity within the subwatershed.

The MCWD has previously established a partnership with the United States Army Corps of Engineers (USACE), which identified the potential restoration of four of the major wetland marsh systems within this subwatershed under the Federal Section 206 Program. Before this work is advanced, MCWD will develop a specific systems plan for this subwatershed in partnership with local municipalities and landowners. This is summarized in the Implementation Plan.

RESOURCE NEEDS

EXISTING CONDITIONS AND ISSUES

This section of the Plan outlines existing conditions and water resource issues, categorized by water quality, water quantity, and ecologic integrity. Condition information was compiled from community input, monitoring data, special studies, the Hydrologic and Hydraulic Pollutant Loading Study (HHPLS), Minnehaha Creek and Upper Watershed Stream Assessments, the Functional Assessment of Wetlands (FAW), Total Maximum Daily Load (TMDL) studies, and state and regional land use and land cover data. A review of these conditions and data revealed several issues and concerns that may require action on the part of the District or its partners. More detailed information about the Painter Creek subwatershed may be found in Volume 2: Land and Natural Resources Inventory.

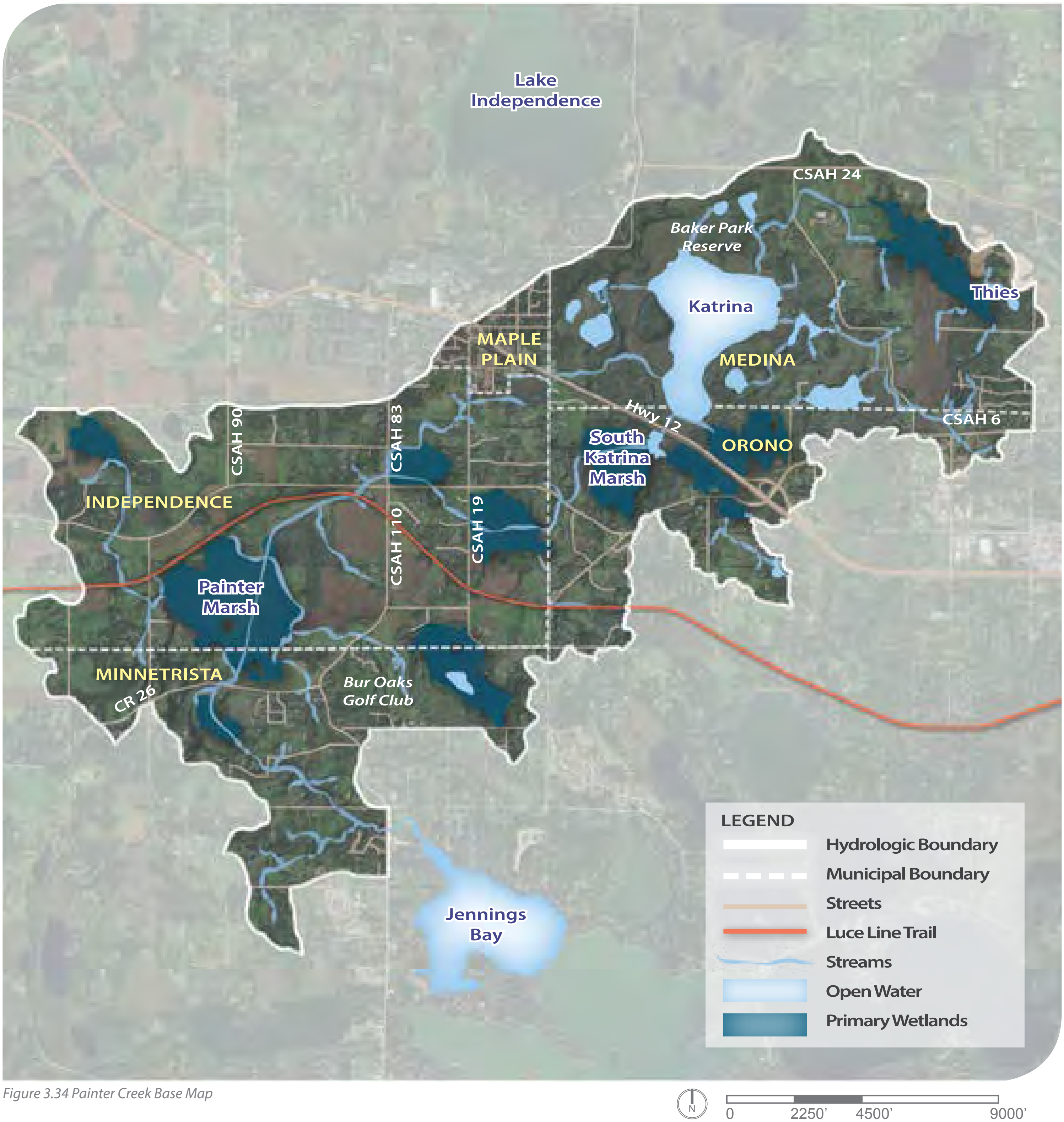


Figure 3.34 Painter Creek Base Map

Water Quality

Lakes and Streams

The Painter Creek subwatershed is a wetland dominated system with no lakes within the principal drainage area (Katrina Lake is classified as a wetland).

While Painter Creek is not listed as an Impaired Water for nutrients, the stream exhibits significantly high total phosphorus concentrations, and exceeds state river eutrophication standards. Phosphorus loads increase from upstream to downstream, and dissolved oxygen can fall below state standards during low flows.

Based on MCWD monitoring data, it is estimated that Painter Creek contributes between 33% - 50% of the total annual phosphorus load to Jennings Bay on Lake Minnetonka, which is listed as an Impaired Water.

Painter Creek exceeds state standards for *E. coli* bacteria concentration. A Total Maximum Daily Load (TMDL) Study was completed in 2014.

Wetlands

The Painter Creek Subwatershed is a wetland rich system, containing approximately 2,500 acres of wetlands.

Based on monitoring data, many of the major wetland marsh systems on the main stem of Painter Creek are a source of dissolved phosphorus, due to their historic hydrologic alternation and current degraded state.

Many of the wetlands are high quality, are designated as regionally significant, and have been identified as having exceptional vegetative diversity, fish and wildlife habitat.

Groundwater

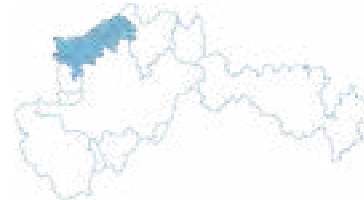
There are a number of areas in the subwatershed that are highly sensitive to aquifer impacts, particularly the wetlands along the main stem of the Painter Creek corridor. As development occurs and infiltration is proposed to meet water quality and volume control standards, special attention should be paid in areas of aquifer sensitivity and wellhead protection areas.

Water Quantity

Drainage is conveyed through the subwatershed through culverts and small channels to wetlands, most of which are ditched and drain to Painter Creek.

Locations throughout the system have been identified through observation and the District's modeling and stream assessments as being vulnerable to localized flooding, and

Katrina Marsh, Erdahl Aerial Photos



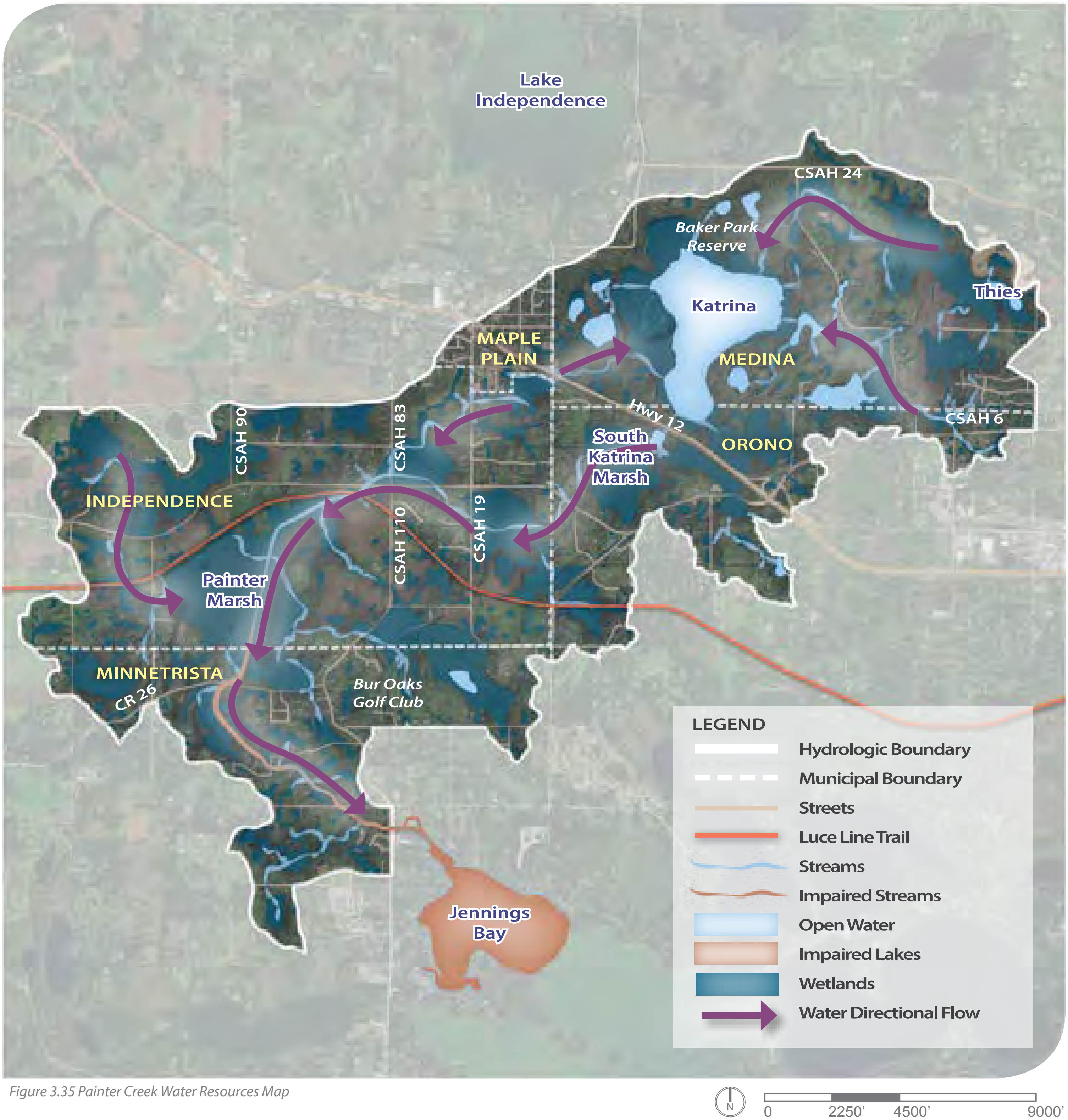


Figure 3.35 Painter Creek Water Resources Map

erosion from high velocities, causing streambank failure and erosion at outlets and culverts.

Many of the major wetlands in this subwatershed act as recharge-discharge wetlands. Groundwater recharge is important within the subwatershed to maintain wetland hydrology and stream baseflow, as well as to recharge aquifers that supply public and private drinking water wells.

Ecological Integrity

Lakes and Streams

Most of the subwatershed is characterized by large open areas of woodland, grassland, and wetlands punctuated by agriculture and low density development.

Limited fish data suggest the stream maintains a moderately healthy fishery, but it is likely due to colonization from Jennings Bay. The macroinvertebrate data show a highly degraded community impacted by poor water quality, low dissolved oxygen, and lack of habitat.

Wetlands

Wetland assessments have classified a number of wetlands in the subwatershed as having excellent to high vegetative diversity and habitat, in need of protection. Their conservation is integral to achieving ecological integrity, water quality, stormwater management and floodplain management goals.

Uplands and Natural Corridors

Several areas within the subwatershed (see Figure 3.97 in Volume 2 for locations) have been found by the Minnesota County Biological Survey to be of moderate to high biodiversity significance, including tamarack swamp complexes east of Katrina Lake. Some of these are located within the Baker Park Reserve, while others are privately held. The high quality locations that are outside the regional park should be considered for preservation and protection to maximize habitat and biodiversity.

Large areas of undisturbed or minimally disturbed forest and wetland, including Baker Park Reserve and Painter Marsh, have been designated Regionally Significant Ecological Areas by the DNR. These two areas are connected by Painter Creek. Upland, wetland, and stream protection and restoration may preserve and enhance connections between these two features.

DRIVERS

A driver of water quality, water quantity, or ecological integrity is a driving force or stressor that causes a biological community or physical structure to change. Some example drivers include increased phosphorus loading, increased impervious areas, straightened channels, and drained wetlands. Some drivers are natural, such as storm events. Most are human-caused, either directly or as a side effect of some other change such as a land use change or removal of natural land cover. This section of the Plan outlines the main drivers of water quality, water quantity, and ecological integrity issues within the Painter Creek subwatershed.

The principal water quality, water quantity, and ecological integrity issues within the Painter Creek subwatershed are:

Water Quality

» Excess nutrients

» Low dissolved oxygen

» Elevated E. coli concentrations

Water Quantity

» Localized flooding

Ecological Integrity

» Degraded macroinvertebrate community

» Degraded and disconnected wetland and terrestrial corridors

These issues are primarily the result of the following drivers:

» Altered wetlands

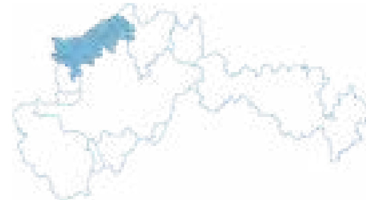
» Common carp

» Stormwater runoff

» Altered channels

» Internal sediment phosphorus loading

» Upstream waterbodies



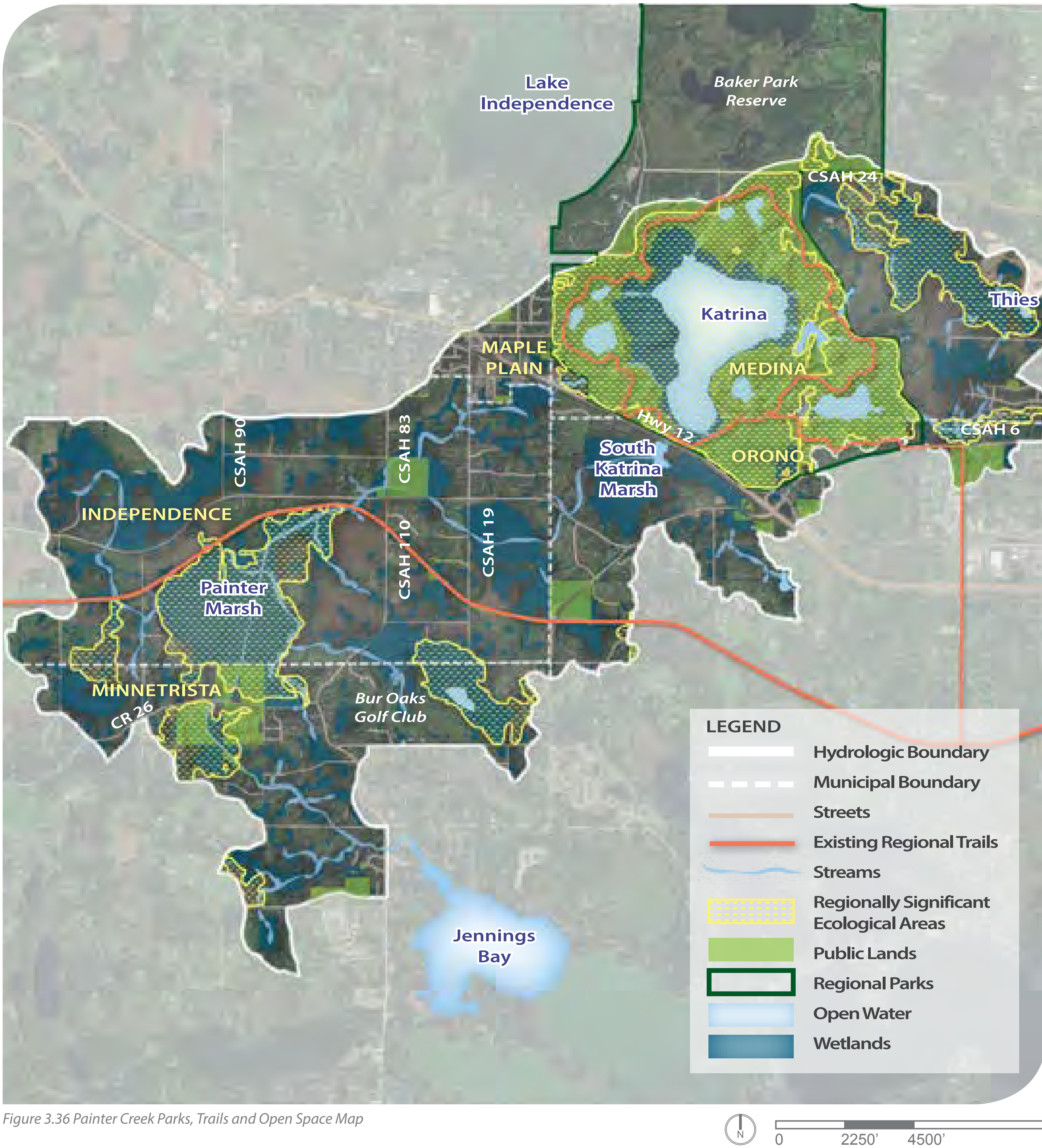


Figure 3.36 Painter Creek Parks, Trails and Open Space Map

Altered Wetlands

On a watershed scale, wetlands can act as sinks, sources, or transformers (particulate to dissolved) for nutrients like phosphorus. Historically, wetlands acted as nutrient sinks within a watershed, capturing and retaining nutrients, even as nutrient loads to the wetland were increased as land use intensified. However, as wetlands were ditched and drained to facilitate watershed drainage and land use change, they often converted from a sink for nutrients to sources, by increasing the breakdown of wetland soil and the conveyance of stormwater. These processes within altered wetlands can release large pools of stored nutrients, causing nutrient impairments in downstream surface waters.

Painter Creek is a county ditch that flows through a number of wetlands between its headwaters at the outlet of Lake Katrina to its mouth at Jennings Bay. This ditching has partially drained and disrupted the natural hydrology of these wetlands. Water quality monitoring shows elevated concentrations of nutrients in Painter Creek, and this wetland alteration may be one of the sources of excess phosphorus in the stream, which contributes to the impairment of Jennings Bay.

Carp

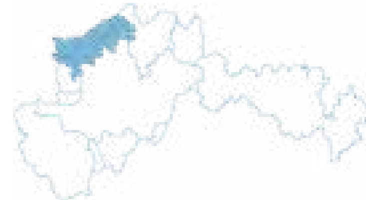
Invasive common carp negatively impact water quality and ecological conditions in surface waters when carp dominate fish communities. Carp impact aquatic systems by their bottom feeding behavior which uproots aquatic plants, re-suspends bottom sediments, and releases nutrients into the water column. This leads to decreased water clarity and a switch to a water state dominated by algae in shallow lakes and wetlands. This turbid water condition is the least ecologically diverse state, and is often characterized by a significant loss of natural vegetation, harmful algal blooms, and the release of phosphorus from resuspended sediments, all of which contribute to water quality impairments and the loss of fish and wildlife habitat.

There has been only one fish survey completed on Painter Creek below Painter Marsh, and carp were found to be relatively abundant. There are weirs and culverts along Painter Creek that may function as barriers, but carp are persistent and known to travel long distances to spawn. The fish may be using Painter Creek to move between Lake Minnetonka and spawning areas in the deeper wetlands upstream. Bottom feeding in the deeper

A prairie in Painter Creek subwatershed

Painter marsh, Erdahl Aerial Photos

Painter Creek weir



wetlands could release nutrients into the wetland water column, which could then be conveyed by Painter Creek to Jennings Bay. The extent of the carp population and its migratory and spawning habits is not known.

Stormwater Runoff

Watershed runoff from rainfall events, or stormwater, can carry nutrients and other pollutants to surface waters leading to negative impacts in lakes, streams and wetlands. In urban and suburban areas, high proportions of impervious surfaces such as parking lots and driveways increase the volume and rate of stormwater runoff, which can cause flooding, and change stream flow in ways that negatively impact habitat for critical parts of the food-web like fish and macroinvertebrates. In rural areas drained for agriculture, the increased volume and peak flow of stormwater runoff causes similar negative impacts.

While the increased volume and rate of stormwater runoff can negatively impact physical conditions in receiving waters, the runoff also carries with it increased loads of pollution that negatively impact the quality of lakes, streams and wetlands. In urban and suburban areas, stormwater picks up excess nutrients, bacteria such as *E. coli*, chloride from road salt, and other pollutants causing toxicity to organisms or issues with excess nutrients (eutrophication). In more rural areas, stormwater mobilizes pollutants from manure and fertilizer including excess nutrients, bacteria, herbicides and pesticides.

These impacts heavily influence the conditions of surface waters because a healthy hydrologic condition is critical to supporting a healthy lake, stream or wetland. Generally as impervious cover, altered drainage, and stormwater runoff within a watershed increases, the quality of lakes, streams and wetlands decreases.

Painter Creek contains high levels of *E. coli*. The TMDL concluded that the primary source of these bacteria was fecal matter from the horses, cattle, chickens, turkeys, geese, deer, ducks and other domesticated animals and wildlife in the subwatershed. Rain and snowmelt conveys this waste to the stream, where it is a source not only of bacteria but also of nutrients. Runoff from agriculture and pasture lands also conveys nutrients and sediment to the Creek, where they contribute to high phosphorus concentrations in the Creek and downstream Jennings Bay.

Altered Channels

Historically, natural channels were straightened, widened and relocated to accommodate land use change. Channel alteration to improve watershed drainage can lead to a loss of physical habitat, increased peak flow velocities and downstream flooding, decreases in dissolved oxygen, and increased sediment transport which can negatively impact fish and macroinvertebrate communities.

Painter Creek is Hennepin County Ditch #10, established in 1905 to provide drainage for agriculture, a function which continues today. For much of its length, it is a straight, trapezoidal channel that provides minimal fish and macroinvertebrate habitat. The macroinvertebrate communities in Painter Creek are highly degraded, and lacking the variety that would be expected in a natural, less-altered stream with better habitat. The stream is low in dissolved oxygen, and those species that are present are pollution-tolerant. The Painter Creek Stream Assessment found several locations on the Creek with streambank erosion that would benefit from stabilization.

Internal Sediment Phosphorus Loading

Long term excessive loading of phosphorus to lakes can lead to phosphorus buildup in the sediments of the lake bed. Ultimately, this phosphorus can be released from the sediment back into the water. Further exacerbating the problem, released phosphorus is typically dissolved which is readily available for plant uptake and contributes directly to algae blooms. Sediment phosphorus release can lead to summer algae blooms, poor water clarity and, in severe cases, summer fish kills and harmful algal blooms. Restoration of water quality in lakes often requires significantly reducing phosphorus release from sediments.

Lake Katrina has elevated levels of total phosphorus. No sediment release data are available, but as a deep wetland, it likely experiences moderate to high internal phosphorus loading.

Upstream Waterbodies

Headwater streams, lakes and wetlands contribute water and nutrients to downstream receiving waters impacting the quality of these water bodies. Lakes and wetlands with poor water quality ultimately contribute nutrients to downstream waters that can lead to eutrophication. Consequently, restoration of upstream water bodies is often a critical component of improving downstream water quality on a watershed scale.

Lake Katrina has elevated levels of total phosphorus. Agriculture and large-lot residential properties contribute phosphorus and sediment to the lake. As a wetland, Katrina has not been officially listed as an Impaired Water, but its high-phosphorus discharge is likely contributing to elevated phosphorus concentrations in Painter Creek and excess phosphorus loads to Jennings Bay.

MANAGEMENT STRATEGIES

Informed by the identification and prioritization of conditions and issues in the subwatershed and an understanding of the drivers impacting its water resources, the District has developed general strategies to guide actions in the Painter Creek subwatershed. These strategies are both short- and long-term, and establish a framework for the Painter Creek subwatershed Implementation Plan programs and projects.

Focal Subwatershed Planning

As noted throughout this plan, the District's overarching organizational strategy is founded in its Balanced Urban Ecology policy. It describes a vision of integration with government agencies, private landowners and developers, and philanthropic partners through multi-jurisdictional partnerships, emphasizing the economic and social value that natural systems generate for the built environment. It further describes how our work will be strengthened through these collaborative efforts to not only offer greater community impact, but to produce creative public-private funding opportunities that will leverage scarce resources and maximize benefits.

Based on the water resource needs that exist in the subwatershed, the scale and complexity of the system, and the opportunity to partner with and access funding for wetland restoration work through the United States Army Corps of Engineers (USACE) as described below, the District has identified the Painter Creek Subwatershed as a priority area to focus implementation efforts in this plan cycle. The District's focus within the subwatershed will be on restoring wetland and stream systems in ways that reduce nutrient loading downstream to Jennings Bay of Lake Minnetonka, while improving ecological integrity and corridor connectivity within the subwatershed.

Similar to its approach in the Six Mile Creek-Halsted Bay subwatershed, before any work is advanced, the District will work with the municipalities and affected landowners to develop a specific systems plan for this subwatershed that integrates and aligns the District's goals and plans with those of its partners. This coordination effort is expected to begin in 2018.

Wetland Restoration

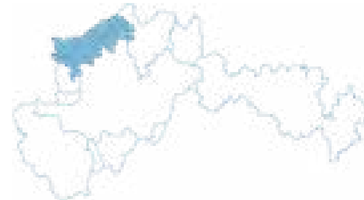
Traditional approaches to wetland restoration focus on restoring wetland channels and hydrology to support a more diverse native plant population. While this strategy addresses ecological integrity within the wetland, it often overlooks the need to alter the cycles of wetland chemistry created by historic wetland alteration, which transform and release phosphorus to downstream waterbodies.

To address both ecological integrity and the release of phosphorus, wetland restoration must focus on modifying hydrology to support the native plant community while minimizing phosphorus export. This may include, but is not limited to, bypassing flow around the wetland, the addition of nutrient filters, soil engineering or augmentation to permanently sequester phosphorus, or the development of wetland treatment cells. Selected restoration options will depend on site specific wetland conditions and hydrology, and overall needs of the subwatershed system.

In 2009, the District completed an outlet weir modification at the outlet of Painter Marsh and a stream meandering to return a portion of Painter Creek downstream of Highway 26 to a more natural shape and restore native vegetation in its surrounding wetland. This project was intended to reduce erosion and sedimentation in the main channel, improve water quality, and improve habitat. The District has been working with the United States Army Corps of Engineers (USACE), which identified the potential restoration of four of the major wetland marsh systems within this subwatershed under the Federal Section 206 Program. Before this work is advanced, MCWD will develop a specific systems plan for this subwatershed in partnership with local municipalities and landowners.

Carp Management

Historically, carp management focused on removal of carp populations from impacted water bodies without any



Painter Creek

consideration of population dynamics such as reproduction, immigration, and emigration. More recent carp management techniques focus on integrated pest management where activities focus not only on removal but also on the long-term prevention of carp reproduction and immigration into sensitive water bodies. These new techniques allow for sustainable control of carp populations to measurably improve shallow lake and wetland water quality, plant communities and overall ecological health.

While carp are known to be present in Painter Creek downstream of Painter Marsh, not much is known about their extent and whether they are impacting upstream wetland complexes and Lake Katrina. As the wetland marsh system restoration projects are advanced, carp and other rough fish population and migration patterns will be assessed.

Stormwater Management

Stormwater management will focus on reducing runoff volumes and rates, as well as reducing pollutant loading from runoff producing rain events. Stormwater management in the developed or developing urban and suburban areas will focus on retrofitting low impact development techniques such as ponds, filters, infiltration techniques, and other technologies where they are applicable. In the rural and agricultural areas, stormwater management will focus on buffers, improved agricultural practices such as conservation tillage, manure management for animal agriculture and hobby farms, wetland restoration and fertilizer management.

The focus in the Painter Creek subwatershed will be on ensuring Painter Creek and its tributaries are adequately buffered, proper manure management is practiced in the riparian areas, and stormwater runoff volume from developed areas is reduced to limit export of nutrients and sediment into Painter Creek, Lake Katrina, and Jennings Bay.

Stream Channel Restoration

Stream restoration focuses on balancing stormwater conveyance to prevent flooding and channel erosion while providing high quality habitat for fish and macroinvertebrates. Restoration includes, where applicable, improving channel sinuosity, stabilizing streambanks, controlling peak flow velocities, increasing channel roughness for habitat and re-aeration, narrowing stream channels to improve wetted width and ecological baseflow, and increasing stream structure.

Approximately 2,000 feet of Painter Creek have already been restored to a meandering channel to reduce peak flows, limit erosion, and enhance habitat. Additional reaches of the stream downstream of Painter Marsh would benefit from streambank stabilization, buffer enhancement, and habitat improvement.

Internal Sediment Phosphorus Control

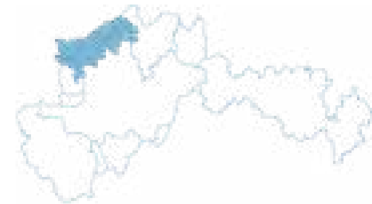
Reducing or eliminating phosphorus release from sediments is often essential to meet water quality standards in lakes. There are several techniques available for controlling sediment phosphorus release including sediment phosphorus inactivation using a chemical such as aluminum, oxygenation to prevent sediment anoxia, hypolimnetic aeration and iron addition to prevent phosphorus release, or hypolimnetic withdrawal. While all the techniques can be effective, the application of aluminum to sediments using aluminum sulfate (alum) or a mixture of sodium aluminate and alum is typically the most cost effective approach for reducing sediment phosphorus release.

Additional information is necessary to evaluate management options for Lake Katrina. Additional water quality monitoring data, sediment chemistry, and fish and aquatic vegetation surveys likely are necessary to evaluate the most appropriate techniques to improve water quality in that wetland.

Restoration of Upstream Waterbodies

Upstream water bodies that are currently impaired can discharge large nutrient loads to downstream water bodies thereby contributing to downstream water quality impairments. Therefore, prior to, or concurrent with, significant efforts to restore downstream water quality, the water quality in upstream water bodies must be improved. Nutrient impaired upstream lakes may require external and internal nutrient reductions using the strategies listed in this section.

Lake Katrina is the headwaters of Painter Creek, and its water quality influences the Creek. In addition, Painter Creek flows through several wetland complexes, each of which may be contributing to conditions in the Creek and nutrient loading into Jennings Bay. Previous studies have emphasized the need for a whole-subwatershed approach to managing water quality



in these upstream water bodies. The District work with the USACE to identify the potential restoration of four of the major wetland marsh systems within this subwatershed will guide management strategies for this complex system.

Watershed Protection

Several subwatersheds, especially in the western part of the watershed, are rapidly converting from undeveloped or rural land uses to developments which can increase impervious areas, reduce flood storage, increase pollutant loads, and eliminate or reduce biologically significant land cover. A critical strategy to maintain existing resources and critical functions is to protect these areas by minimizing the impacts of the development. This is accomplished by conserving biologically significant upland areas, protecting high value wetlands, mimicking natural watershed hydrology, maintaining stream geomorphology, protecting stream buffers and riparian areas, and protecting critical fish and wildlife corridors.

There are areas of biodiversity significance and mostly intact native communities in the subwatershed. Most of these are located within the Baker Park Regional Reserve, but some areas are privately held. Painter Creek and riparian wetlands function as a connecting corridor through the subwatershed. The focus in this subwatershed will be to preserve high-value resources through Land Conservation where appropriate and by working with cities and developers to enhance stream and wetland buffers and to minimize disturbance during development and construction.

LAND USE

EXISTING CONDITIONS

The subwatershed includes portions of the cities of Medina, Orono, Maple Plain, Independence, and Minnetrista. Land use in the subwatershed is generally characterized by large areas of undisturbed land (37%) including numerous large wetland systems and wooded areas, agricultural uses (19%), low density development (19%), and the 2,700 acre Baker Park (19%) owned by Three Rivers Park District. The Luce Line Trail traverses this subwatershed on the north side of Painter Marsh.

LOCAL PLANS AND PRIORITIES

As described in the District's goals (Section 3.3), the District strives to implement its clean water objectives in ways that meaningfully contribute to the development of thriving communities. This is achieved through collaboration and integrated planning with public and private partners.

As part of the development of this plan, the District reached out to its communities to gather information on local goals, plans, and priorities for 2018-2027 (see Appendix B for details on the public input process). This information was used to broadly characterize opportunities, and to inform the development of the District's implementation plans. The information received was used only as a guide during the development of this Plan to inform the District of opportunities for partnership on the near term horizon, and was not intended to be exhaustive or restrict future collaborative efforts.

As discussed in Section 3.6, the District intends to cultivate a framework for two-directional coordination with communities on an ongoing basis, to stay apprised of emerging needs at a local level, and to identify and evaluate opportunities to implement management strategies outlined in this Plan over the next ten years. The District recognizes that local needs, opportunities and priorities may shift over time. Therefore, this Plan does not intend to capture or prescribe opportunities for partnership over a ten-year term.

Long term goals, growth and private development, and public investment in infrastructure differ across each community – and therefore, frameworks for ongoing coordination will be custom tailored based on the individual needs of each community. Coordination may occur at varying levels, through various means, with communities across the following areas:

» Regulation of, and partnership with, private development

» Collaboration on public planning and investment (e.g. parks , roads, utilities)

» MS4 compliance

» Development and implementation of TMDLs

Through the information gathering processes of this Plan, one of the priorities identified by cities in the Painter Creek Subwatershed was maintaining the area's rural character

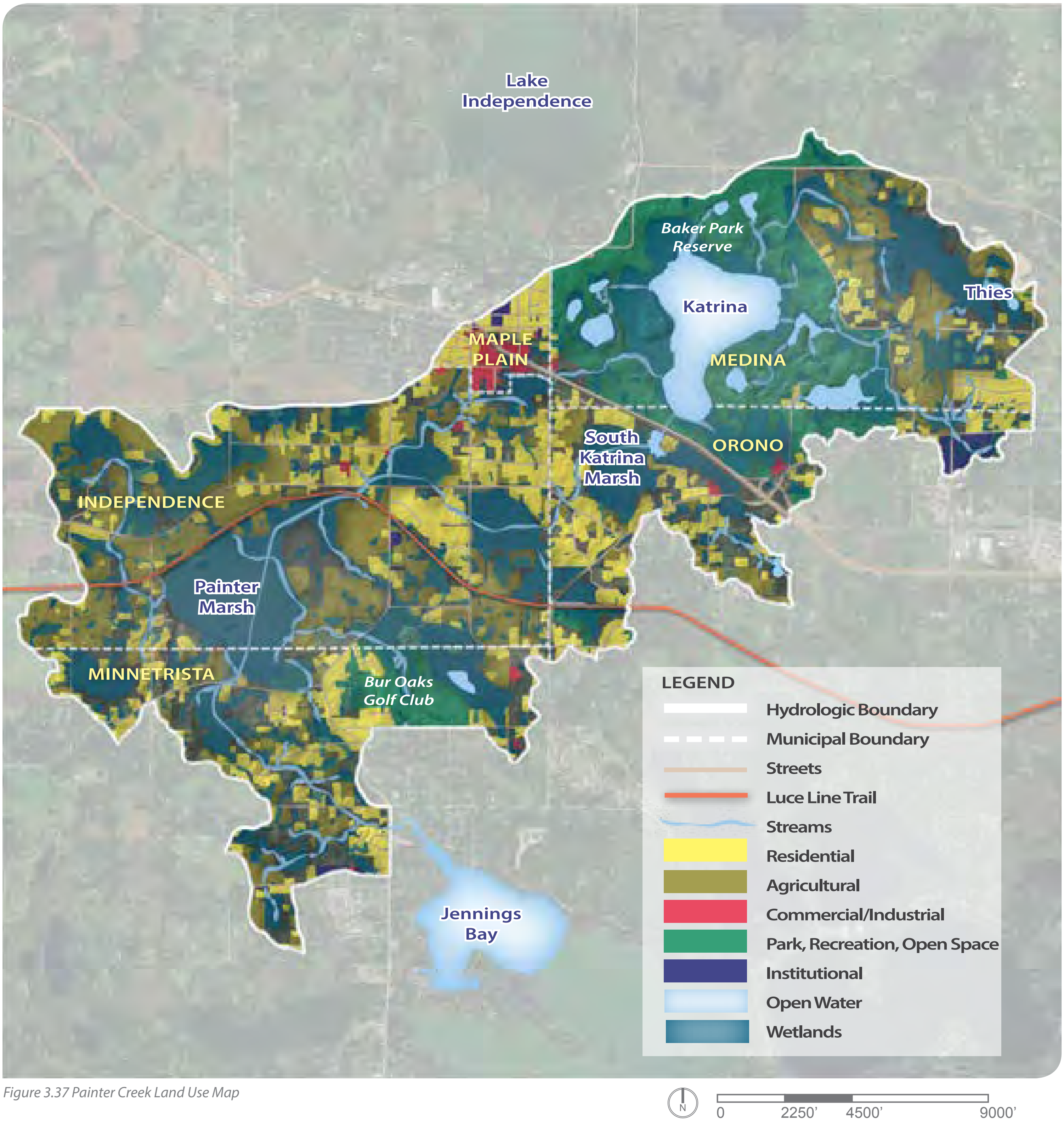
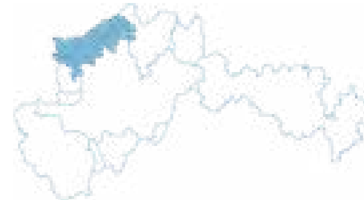


Figure 3.37 Painter Creek Land Use Map



and access to open space. Little near-term development or infrastructure investment is anticipated within this subwatershed. The City of Medina and Three Rivers Park District expressed interest in partnering to improve manure management in the subwatershed and to address some areas of local flooding. The cities also voiced interest in continuing to utilize the District as a technical resource.

There is an opportunity for the District and the United States Army Corps of Engineers to continue a previously-established partnership to pursue the restoration of four major wetland marsh systems within the Painter Creek Subwatershed. The proposed restoration work could be eligible for funding under the federal Section 206 Program.

IMPLEMENTATION PLAN

The goals set forth in this subwatershed plan will require an integrated set of programs and projects oriented toward the conservation and improvement of water resources within the watershed. The Implementation Priorities section generally describes the actions that the District and its partners will look to take in order to address the issues present in the subwatershed and achieve the goals as set forth in the plan. The Capital Improvement Plan (CIP) provides cost estimates and schedules for any proposed capital investments.

IMPLEMENTATION PRIORITIES

As described in previous sections, the Painter Creek Subwatershed contains a number of large wetlands, many of which have been ditched or otherwise altered, that are connected by Painter Creek. The system delivers high phosphorus loads to Jennings Bay of Lake Minnetonka, which is listed as impaired and requires the second largest load reduction in the District. Painter Creek is also impaired by excess *E. coli* bacteria. The subwatershed includes areas of high quality wetland and upland, including several regionally significant ecological areas. The MCWD has previously established a partnership with the United States Army Corps of Engineers (USACE), which identified the potential restoration of four of the major wetland marsh systems under the Federal Section 206 Program.

Based on the water resource needs that exist in the subwatershed and the opportunity to partner with and access funding through the USACE, the District has identified the Painter Creek Subwatershed as a priority area to focus implementation efforts in this plan cycle. The focus within the subwatershed will be on restoring wetland and stream systems in ways that reduce nutrient loading downstream to Jennings Bay of Lake Minnetonka, while improving ecological integrity and corridor connectivity within the subwatershed.

The CIP in the following section includes the four specific wetland restorations that have been identified by the USACE. The partnership with the USACE requires the District, as the local sponsor, to have land rights over the project areas. A number of these land rights have already been secured though easement or fee title. Part of the planning effort over the next plan cycle will be to work with the landowners around these wetlands to obtain the remaining land rights needed to complete the restoration work.

As noted in previous sections, this subwatershed contains a number of high value wetlands and uplands, including Baker Park Reserve and Painter Marsh which have been designated as Regionally Significant Ecological Areas by the DNR. These two areas, as well as the proposed USACE wetland restoration projects, are all connected by Painter Creek, presenting an opportunity to further preserve and enhance this valuable corridor through land conservation and capital improvement initiatives. The District's CIP includes additional wetland restoration, stream restoration, and stormwater management projects beyond the four defined USACE projects in order to explore these restoration opportunities for additional water quality, water quantity, and ecological integrity benefit.

The District may pursue a carp assessment for the Painter Creek subwatershed as part of a larger assessment for the northwestern bays of Lake Minnetonka and their tributary subwatersheds. The goal of the assessment would be to understand the movement and recruitment patterns of carp in the system to inform management efforts. This work will be dependent on the District's ability to secure partner support and funding.

As noted previously, Painter Creek is impaired by excess *E. coli* bacteria and has an approved TMDL. The focus for addressing this impairment will be to work with the municipalities and

ISSUE

- Excess nutrients
- Low dissolved oxygen
- Elevated *E. coli* concentrations
- Localized flooding
- Degraded macroinvertebrate community
- Degraded and disconnected corridors

DRIVER

- Altered wetlands
- Common carp
- Stormwater runoff
- Altered channels
- Internal sediment phosphorous loading
- Upstream water bodies

STRATEGY

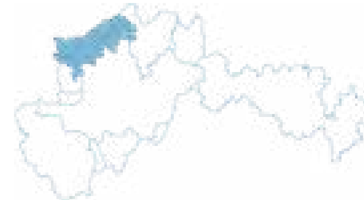
- Focal subwatershed planning
- Wetland restoration
- Carp management
- Stormwater management
- Stream channel restoration
- Internal sediment phosphorous control
- Restoration of upstream water bodies
- Watershed protection

IMPLEMENTATION PRIORITIES

Coordination and planning with partners to implement:

- Wetland restoration
- Stream channel restoration
- Land conservation/ corridor connection
- Carp assessment/ management
- Stormwater management
- Buffers and manure management to reduce *E. coli*

Resource protection through regulation



key landowners to ensure that Painter Creek and its tributaries are adequately buffered and proper manure management is practiced in the riparian areas.

Before any of the above work is advanced, the District will bring together the municipalities, Three Rivers Park District, and other affected landowners to align goals and develop a specific systems plan for this subwatershed. In addition to this District-led planning effort, the District has a wide range of services it can mobilize to address resource needs and support partner efforts as opportunities arise, including data collection and diagnostics, technical and planning assistance, permitting assistance, education and capacity building, and grants.

CAPITAL IMPROVEMENT PLAN

The CIP is a planning tool. It also is a means to inform partners, District residents, and other interested parties as to the District's scope and priorities for its capital work over the planning period. A project's inclusion in the CIP does not mean that the project will be constructed, only that the District has identified it as an action that may be a cost-effective way for the District to achieve identified water resource goals. A project identified in the CIP always will need further review as to technical feasibility, cost and financing, consistency with local needs, and other policy considerations before a formal decision to proceed to construction is made. Section 3.5.5 describes the development and evaluation steps that will occur before the District will commit resources to a project.

Section 3.5.5 also describes how the District will review the CIP on an ongoing basis throughout the planning period. This review will allow the District to reassess described projects from a technical perspective, but also will involve broader policy considerations such as shifts in District priorities, decisions as to annual budget and levy levels, and the prospect of state and federal grant funds or financing. For this reason, projects may be added to and deleted from the CIP from year to year, in accordance with those procedures.

A critical component of any project will be the development of a funding strategy that identifies the sources, uses, and timing of funds needed to successfully achieve identified goals. These plans will be developed in conjunction with the District's public and private partners as capital projects are advanced. Therefore, any costs identified within this Plan are projections. Intended expenditures will be refined during project development and budgeting, and among other things will reflect the District's intent to complement its ad valorem funds with other funding sources.

Rolling Hills restoration in the Painter Creek subwatershed

Table 3.13 Painter Creek Subwatershed CIP

Project	Potato Marsh Restoration
Description	The Potato Marsh project will consist of scraping a formerly farmed and degraded 45-acre wetland to lower its bottom elevation and create deeper pools. A new weir will be constructed at the outlet of Painter Creek with stoplogs to adjust water depth. Tamarack trees and a native wetland vegetation community will re-established through planting and seeding, and will be maintained through water-level alteration via the weir. Upstream bank erosion will be repaired, as well.
Need	The current condition of the altered wetland is a hybrid cattail and reed canary grass monoculture with sediment laden inflows due to streambank erosion. The surrounding landscape is dominated by large agricultural tracts, but the upper watershed contains large areas of undisturbed forests and high-quality wetlands. Baker Park Reserve and a large area in the lower subwatershed are also part of a DNR-designated Metro Conservation Corridor. The Minnesota Biological Survey identifies several areas outside of the project area in the subwatershed as areas of moderate or high biodiversity significance, including a tamarack swamp complex east of Lake Katrina and patches of maple-basswood and oak forest.
Outcome	The project will provide hydrologic and vegetative tamarack swamp restoration and creation of more diverse open water habitat, improved overall wetland function, reduction of sediment inflows by natural upstream erosion protection, increased stormwater and runoff retention period, groundwater filtration, decreased sediment loads resulting from deeper wetland pools, and increased phosphorus absorption throughout the system. This project will be the first in the expansion and connection of an existing natural resource corridor connecting the upper Painter Creek subwatershed and the lower Painter Creek subwatershed.
Estimated Cost	Capital costs: $870,000, excluding land, in 2017 dollars.
Potential Funding Sources	MCWD levy, USACE Section 206, partner contributions, grants
Schedule	2019 with project monitoring activities and effectiveness evaluation to continue for 5 years past project completion.

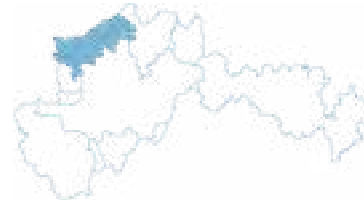
Project	SOBI Marsh Restoration
Description	The SOBI Marsh project includes construction of a swale along the existing channel of Painter Creek and scraping of surrounding areas to expose the native seedbed within the 120-acre wetland. In select areas with existing erosion, natural bank erosion protection including planting and placement of scraped material will occur. Additional scraped material will be used to enlarge two existing hills. No modification of existing culverts and no weir construction is planned.
Need	The current condition of SOBI Marsh is an altered wetland with a hybrid cattail and reed canary grass monoculture and areas of bank erosion. This project location provides a vital link between the South Katrina Marsh wetland restoration and the Potato Marsh wetland restoration.

Outcome	The project will undertake a hydrologic and vegetative wetland restoration and creation of more diverse open water habitat. Sediment inflows will be reduced by natural bank erosion protection. This specific project will provide a critical hydraulic balance to upstream and downstream project components and supports the systems approach of restoration of the larger wetland complex.
Estimated Cost	Capital costs: $240,000, excluding land, in 2017 dollars
Potential Funding Sources	MCWD levy, USACE Section 206, partner contributions, grants
Schedule	2020 with project monitoring activities and effectiveness evaluation to continue for 5 years past project completion.

Project	**Upper and Lower Painter Marsh Restoration**
Description	The Upper Painter Marsh project will include construction of a swale and restoration of the streambed along the known historic channel of Painter Creek. The 65-acre wetland will be restored by scraping surrounding portions of the hybrid cattail and reed canary grass monoculture and exposing the native plant seedbank. The Lower Painter Marsh project includes construction of meanders along the existing channel of Painter Creek and a wetland scrape over a large area of the 430-acre wetland. Scraped material will be used to enlarge an existing island. Water levels will be controlled by the proposed replacement of the Lower Painter Marsh weir to create open water areas.
Need	A straightened and ditched Painter Creek stream channel causes flashy storm flows and increased erosion, sediment loads, and decreased habitat integrity. Uncontrolled agricultural runoff leads to high nutrient levels and a monoculture of hybrid cattail and reed canary grass. The current condition of the Lower Painter Marsh is an altered wetland with a hybrid cattail and reed canary grass monoculture. The Painter Creek stream channel has been straightened and ditched, which leads to flashy storm flows and high sediment loading.
Outcome	The project will undertake a hydrologic and vegetative wetland restoration and creation of more diverse open water habitat. Returning Painter Creek to its historic stream channel will mimic the historic hydro-period, slow storm flows, settle out sediments, and provide a critical hydraulic balance to upstream and downstream project components. Deeper water areas will provide vital habitat during dry and low flow conditions.
Estimated Cost	Capital costs: $2,800,000, excluding land, in 2017 dollars
Potential Funding Sources	MCWD levy, USACE Section 206, partner contributions, grants
Schedule	2021 with project monitoring activities and effectiveness evaluation to continue for 5 years past project completion.

Project	South Katrina Marsh Restoration
Description	The South Katrina Marsh project includes replacement of the existing weir to create open water areas. The existing stream channel will be converted into a swale and an additional swale will be created to direct flows to the south of the marsh into deeper water. Flows will eventually move from deeper pools to a level spreader distributing water throughout the wetland. Excavated material will be used to create two islands approximately 1-2 feet above the weir elevation. The total wetland restoration area is 134 acres.
Need	The current condition of South Katrina Marsh is an altered wetland with a hybrid cattail and reed canary grass monoculture.
Outcome	The project will provide a hydrologic and vegetative wetland restoration and creation of more diverse open and shallow water habitats. The deeper pools and level spreaders will slow flow, settle out sediments, and create greater habitat diversity. Construction of swales and scraping of cattail and reed canary grass biomass will decrease the monoculture, expose the native plant seedbed, and increase plant diversity.
Estimated Cost	Capital costs: $1,270,000
Potential Funding Sources	MCWD levy, USACE Section 206, partner contributions, grants
Schedule	2022 with project monitoring activities and effectiveness evaluation to continue for 5 years past project completion.

Project	**Wetland Restoration and Channel/Streambank Restoration**
Description	The District will undertake wetland and channel/streambank restoration projects complementary to identified USACE Section 206 projects. Reaches of the Painter Creek channel that were ditched in the early 1900's will be restored by realigning to the natural channel configuration, bio-engineering banks, and establishing a more diverse vegetative cover. Hydrology and vegetation will be restored and managed within wetlands contiguous to ditched sections of Painter Creek.
Need	The Section 206 projects present opportunities for expansion or enhancement of the identified projects or construction of additional projects creating a stronger corridor link between established and identified project sites. The hydrology of this wetland system is highly degraded with ditched and straightened stream sections creating flashy, nutrient-laden flows eventually contributing to high phosphorus in Jennings Bay. Water levels and nutrient levels lead to invasive species monocultures. MCWD concluded that significant reduction of nutrient transport will be possible only by first restoring some of the ditched wetland and straightened Painter Creek channel accompanied by projects to reduce nutrient concentrations in the water.
Outcome	Complementary projects will enhance and strengthen the planned or existing projects and create a stronger corridor connection. The stream restoration work will restore some of the natural hydrology, create open water areas, and increase wetland and habitat diversity along approximately 6,200 lineal feet of ditched channel. Wetland restoration will restore natural hydrology, increase wetland flora diversity, de-channelize flow, and improve habitat diversity.



Estimated Cost	Wetland Restoration Capital Cost: $330,000, excluding land, in 2017 dollars. Channel/Streambank Restoration Capital Cost: $2,990,000, excluding land, in 2017 dollars.
Potential Funding Sources	MCWD levy, partner contributions, grants
Schedule	2018-2027

Project	**Stormwater Volume and Pollutant Load Reduction**
Description	Implementation of opportunities to reduce stormwater volumes and nutrient loading to Painter Creek, including but not limited to infiltration or filtration basins and devices, reforestation, revegetation, and stormwater detention or redirection.
Need	Painter Creek has long been known to be a significant transporter of nutrient loading to Jennings Bay and the West Arm of Lake Minnetonka contributing to an excess nutrient impairment of these basins. Annual nutrient loads range in the thousands of pounds per year. Some likely reasons for high sediment and nutrient transport are ditching of wetlands and channel straightening, historical and current agricultural land use, and runoff. Stormwater from agricultural land is a significant source, along with decades of discharges from the Maple Plain Treatment Plant (1951 to 1986) into the Painter Creek subwatershed. Discharge from the plant was measured by MPCA at .24 MGD with an effluent phosphorus load in 1969/70 of 4,130 pounds.
Outcome	Reduction of pollutant loading to Painter Creek and downstream Jennings Bay; reduction of stormwater runoff volume and rate and associated impacts; protection and enhancement of groundwater recharge, stream base flow, and wetland hydrology.
Estimated Cost	Capital Cost: $980,000
Potential Funding Sources	District levy, partner contributions, grants
Schedule	2018-2027

3.9.10 SCHUTZ LAKE SUBWATERSHED PLAN

INTRODUCTION

This subwatershed plan contains information specific to the Schutz Lake Subwatershed, including existing conditions and issues, drivers, management strategies, land use information, and an implementation plan. Information regarding the District's philosophy, goals, and implementation approach can be found in Sections 3.2-3.4 and should be reviewed first to provide context for the following subwatershed plan.

EXECUTIVE SUMMARY

Schutz Lake is a 1.5 square mile (969 acre) subwatershed located in the southwestern portion of the MCWD. Land within this geography is entirely within the City of Victoria. The subwatershed is generally characterized by parks and open spaces (25%), low density development (24%), agricultural uses (15%), institutional uses (12%), water (11%), and undeveloped land (7%). The Carver Park Reserve abuts the northwesterly portion of the lake, the Southwest Hennepin LRT Regional Trail crosses the subwatershed, and portions of the southern subwatershed belong to the University of Minnesota Horticultural Research Center and Landscape Arboretum.

In one area on the west side of the subwatershed (within the Carver Park Reserve), there is a large patch of maple-basswood forest that has been designated a high-value native plant community by the Minnesota Biological Survey. The larger area within Carver Park Reserve has been designated by the DNR as a regionally significant ecological area within the Metro area.

Schutz Lake is the primary receiving water within the subwatershed. The upper watershed drains north through Schutz Creek via a series of culverts, under Highway 5 to Schutz Lake.

Schutz Lake subwatershed has several issues relating to water quality, water quantity and ecological integrity. Water quality in Schutz Lake meets state standards, but chlorophyll-a, a measure of algae, is increasing. Schutz Creek has elevated levels of total phosphorus. Schutz Creek's annual water yield also appears to be increasing, and modeling predicts that flooding may occur at a damaged culvert during large rain events. Overall, the system has somewhat degraded ecological integrity. Schutz Lake has degraded fish and aquatic vegetation communities and Schutz Creek has degraded macroinvertebrate communities and low connectivity. However, the Schutz Creek corridor includes wetlands that with restoration could improve vegetative diversity and provide connected habitat for the subwatershed.

Management strategies within the Schutz Lake subwatershed will focus on promoting stormwater management to reduce runoff volumes and pollutant loads, stabilizing stream channels, and improving and protecting ecological integrity. The District will collaborate on these management strategies with local and state government, developers, lake associations, citizens' groups and other parties to implement. This is summarized in the Implementation Plan.

RESOURCE NEEDS

EXISTING CONDITIONS AND ISSUES

This section of the Plan outlines existing conditions and water resource issues, categorized by water quality, water quantity, and ecologic integrity. Condition information was compiled from community input, monitoring data, special studies, the Hydrologic and Hydraulic Pollutant Loading Study (HHPLS), Minnehaha Creek and Upper Watershed Stream Assessments, the Functional Assessment of Wetlands (FAW), Total Maximum Daily Load (TMDL) studies, and state and regional land use and land cover data. A review of these conditions and data revealed several issues and concerns that may require action on the part of the District or its partners. More detailed information about the Schutz Lake subwatershed may be found in Volume 2: Land and Natural Resources Inventory.

Water Quality

Lakes and Streams

The Schutz Lake subwatershed has one major lake, one major stream, and a few riparian wetlands. While Schutz Lake is not listed as an Impaired Water for nutrients, a trend analysis suggests that algal blooms are becoming more frequent, as there has been a statistically significant increase in summer average chlorophyll-a concentration.

While Schutz Creek does not exceed state eutrophication standards, it has elevated levels of total phosphorus that exceed the nutrient component of the state eutrophication standard.

Figure 3.38 Schutz Lake Base map

Wetlands
As outlined by the District's Functional Assessment of Wetlands, the subwatershed contains some large, Preserve classification wetlands that provide a high level of water quality protection for downstream waterbodies such as Schutz Lake. Several wetlands with moderate restoration potential exist within the central drainage area of the geography and may have the potential to be improved to provide enhanced ecological value and water quality treatment. Wetlands in the subwatershed are sensitive to the quality of stormwater inputs.

Groundwater
There are areas of moderate to high aquifer sensitivity in the subwatershed. As development occurs and infiltration is proposed to meet water quality and volume control standards, special attention should be paid in areas of aquifer sensitivity and wellhead protection areas.

Water Quantity
Annual water yield from the subwatershed into Schutz Lake Creek may be increasing, as a trend analysis on streamflow data in Schutz Creek showed a statistically significant increase in annual water yield.

Water quantity has caused erosion within the channels and culverts that convey flow through the system. A damaged culvert under a minor drive off Highway 7 may overtop during large rain events, according to the District's hydrologic model.

There are wetlands and streams in the subwatershed that rely on steady inflow from surficial groundwater.

Ecological Integrity
Lakes and Streams
Schutz Lake has degraded fish and aquatic vegetation communities. The fish community shows obvious signs of disturbance compared to other similar lakes, which may be due to the presence of common carp. The vegetation community has very low species richness and is infested with Eurasian watermilfoil.

Schutz Creek has a degraded macroinvertebrate community, which lacks certain classes of organisms and consists primarily of pollution-tolerant species. The creek also has low connectivity due the presence of culverts at Highway 5 and at the trail crossing.

Wetlands
The Schutz Creek corridor includes wetlands with vegetative communities that range in quality. Those of poor quality are heavily infested with buckthorn, reed canary grass, and Canadian wood-nettle, and those of better quality provide fish habitat and should be protected. Restoration of many of these wetlands could improve vegetative diversity and provide connected habitat for the subwatershed.

Uplands and Natural Corridors
Within the Carver Park Reserve on the west side of the lake is a large patch of maple-basswood forest that has been designated on the Minnesota Biological Survey as being a high-value native plant community. The larger area within Carver Park Reserve has been designated by the DNR as a regionally significant ecological area within the Metro area. In addition, the southern subwatershed contains part of the University of Minnesota Horticultural Research Center and Landscape Arboretum.

DRIVERS
A driver of water quality, water quantity, or ecological integrity is a driving force or stressor that causes a biological community or physical structure to change. Some example drivers include increased phosphorus loading, increased impervious areas, straightened channels, and drained wetlands. Some drivers are natural, such as storm events. Most are human-caused, either directly or as a side effect of some other change such as a land use change or removal of natural land cover. This section of the Plan outlines the main drivers of water quality, water quantity, and ecological integrity issues within the Schutz Lake subwatershed.

The principal water quality, water quantity, and ecological integrity issues within the Schutz Lake subwatershed are:

Water Quality
- Excess nutrients

Water Quantity
- Increasing annual volume from the upper subwatershed

Ecological Integrity

» Degraded stream macroinvertebrate community

» Degraded fish and aquatic vegetation communities

These issues are primarily the result of the following drivers:

» Altered wetlands

» Common carp

» Stormwater runoff

» Altered channels

» Internal sediment phosphorus loading

Altered Wetlands

On a watershed scale, wetlands can act as sinks, sources, or transformers (particulate to dissolved) for nutrients like phosphorus. Historically, wetlands acted as nutrient sinks within a watershed, capturing and retaining nutrients, even as nutrient loads to the wetland were increased as land use intensified. However, as wetlands were ditched and drained to facilitate watershed drainage and land use change, they often converted from a sink for nutrients to sources, by increasing the breakdown of wetland soil and the conveyance of stormwater. These processes within altered wetlands can release large pools of stored nutrients, causing nutrient impairments in downstream surface waters.

There are few wetlands in the Schutz Lake subwatershed. There is a large wetland complex that serves as the headwaters to Schutz Creek. This wetland has low to moderate vegetative diversity, which may be a legacy of historical agricultural runoff. Water quality monitoring shows elevated concentrations of total phosphorus in Schutz Creek, and elevated chlorophyll-a, indicating elevated levels of algae, in Schutz Lake. Wetland alteration may be a source of phosphorus to Schutz Creek.

Carp

Invasive common carp negatively impact water quality and ecological conditions in surface waters when carp dominate fish communities. Carp impact aquatic systems by their bottom feeding behavior which uproots aquatic plants, re-suspends bottom sediments, and releases nutrients into the water column. This leads to decreased water clarity and a switch to a water state dominated by algae in shallow lakes and wetlands. This turbid water condition is the least ecologically diverse state, and is often characterized by a significant loss of natural vegetation, harmful algal blooms, and the release of phosphorus

Schutz Lake

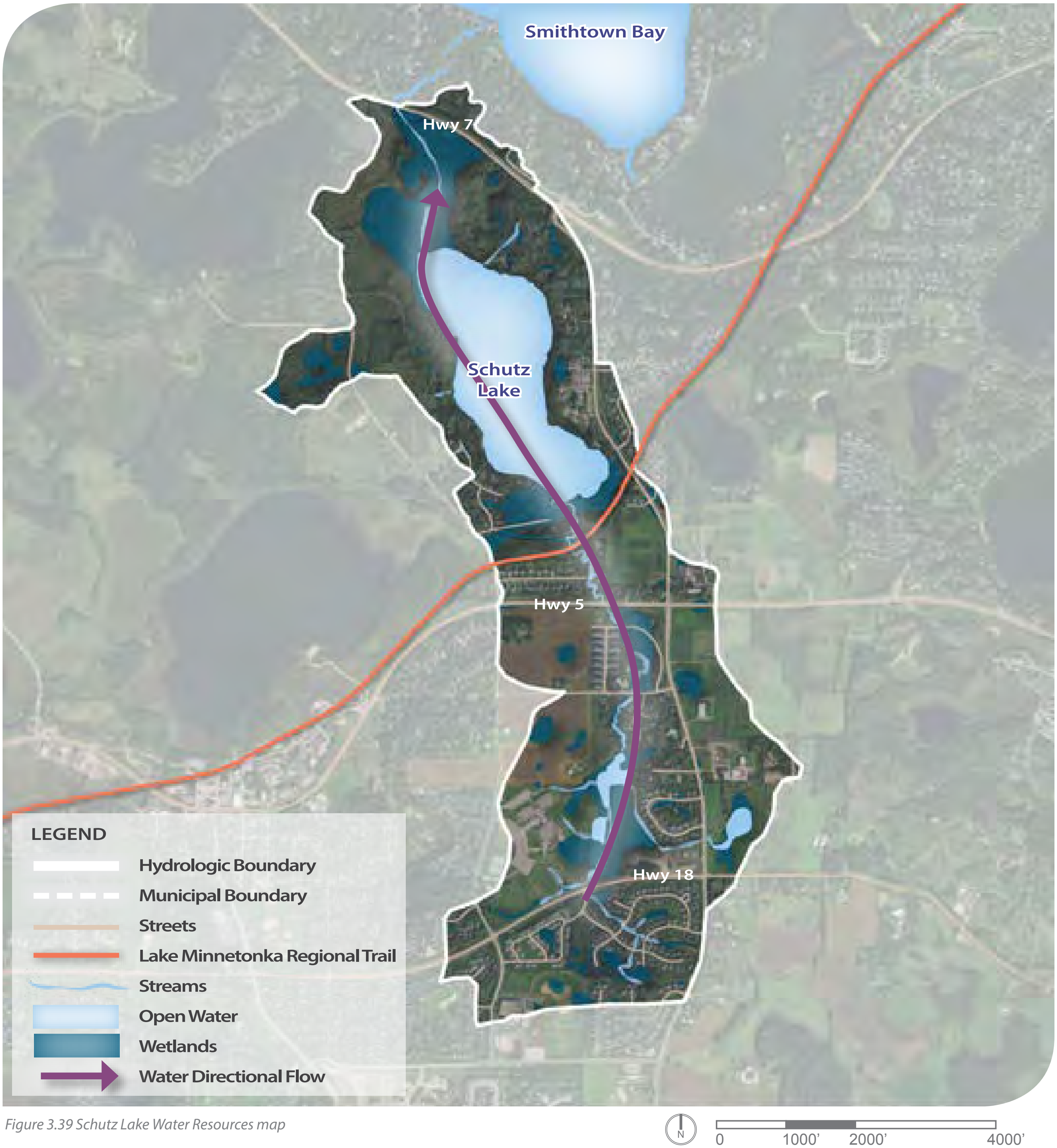
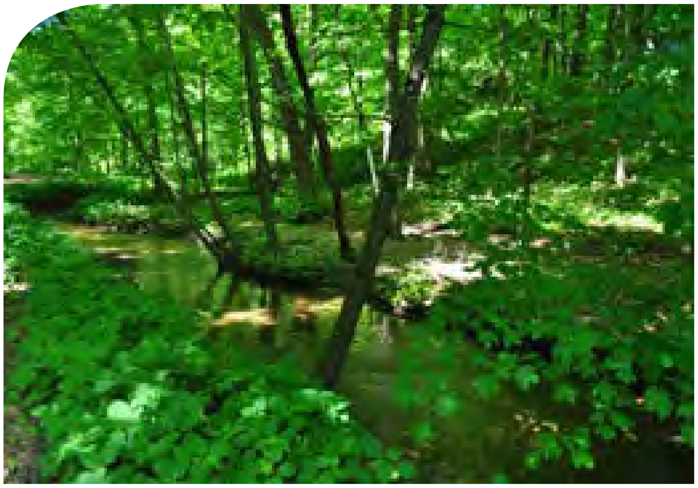


Figure 3.39 Schutz Lake Water Resources map



Schutz Creek

Schutz Lake

Schutz Lake

from resuspended sediments, all of which contribute to water quality impairments and the loss of fish and wildlife habitat.

Schutz Lake has signs of potential carp impact, with its degraded aquatic plant and fish community. The status of carp in the lake is unknown, and assessing the population would be the first step towards determining the impact carp may be having on the lake.

Stormwater Runoff

Watershed runoff from rainfall events, or stormwater, can carry nutrients and other pollutants to surface waters leading to negative impacts in lakes, streams and wetlands. In urban and suburban areas, high proportions of impervious surfaces such as parking lots and driveways increase the volume and rate of stormwater runoff, which can cause flooding, and change stream flow in ways that negatively impact habitat for critical parts of the food-web like fish and macroinvertebrates. In rural areas drained for agriculture, the increased volume and peak flow of stormwater runoff causes similar negative impacts.

While the increased volume and rate of stormwater runoff can negatively impact physical conditions in receiving waters, the runoff also carries with it increased loads of pollution that negatively impact the quality of lakes, streams and wetlands. In urban and suburban areas, stormwater picks up excess nutrients, bacteria such as *E. coli*, chloride from road salt, and other pollutants causing toxicity to organisms or issues with excess nutrients (eutrophication). In more rural areas, stormwater mobilizes pollutants from manure and fertilizer including excess nutrients, bacteria, herbicides and pesticides.

These impacts heavily influence the conditions of surface waters because a healthy hydrologic condition is critical to supporting a healthy lake, stream or wetland. Generally, as impervious cover, altered drainage, and stormwater runoff within a watershed increases, the quality of lakes, streams and wetlands decreases.

Schutz Creek has elevated levels of total phosphorus and Schutz Lake has elevated concentrations of chlorophyll-a, a proxy for algae. Runoff from lawns and streets in the subwatershed conveys nutrients and sediment to surface waters. Monitoring data in Schutz Creek show a statistically significant increase in annual runoff volume conveyed from the developing upper subwatershed. Runoff from the subwatershed is a likely source of phosphorus to Schutz Creek and Lake, which can cause algae blooms.

Altered Channels

Historically, natural channels were straightened, widened and relocated to accommodate land use change. Channel alteration to improve watershed drainage can lead to a loss of physical habitat, increased peak flow velocities and downstream flooding, decreases in dissolved oxygen, and increased sediment transport which can negatively impact fish and macroinvertebrate communities.

Schutz Creek runs through culverts at Highway 5 and at the trail crossing, impairing connectivity in the creek. The creek was also likely channelized at some point. Schutz Creek has a degraded macroinvertebrate community and elevated total phosphorus concentrations. A stream assessment found that there were multiple types of habitat present and the stream morphology was rich, indicating that the poor water quality may be the primary stressor on aquatic life in the Creek.

Internal Sediment Phosphorus Loading

Long term excessive loading of phosphorus to lakes can lead to phosphorus buildup in the sediments of the lake bed. Ultimately, this phosphorus can be released from the sediment back into the water. Further exacerbating the problem, released phosphorus is typically dissolved which is readily available for plant uptake and contributes directly to algae blooms. Sediment phosphorus release can lead to summer algae blooms, poor water clarity and, in severe cases, summer fish kills and harmful algal blooms. Restoration of water quality in lakes often requires significantly reducing phosphorus release from sediments.

No sediment release data are available for Schutz Lake, but based on historical agriculture in this area, there may be pools of phosphorus in the sediments and available for release. An increasing trend in algal blooms could be related to these legacy impacts, or to the increased nutrient loading from the subwatershed. Additional sediment release, aquatic vegetation, and fish data are necessary to determine the probable role of each in internal loading and the appropriate course of action.

MANAGEMENT STRATEGIES

Informed by the identification and prioritization of conditions and issues in the subwatershed and an understanding of the drivers impacting its water resources, the District has developed general strategies to guide actions in the Schutz Lake subwatershed. These strategies are both short- and long-term, and establish a framework for the Schutz Lake subwatershed Implementation Plan programs and projects.

Wetland Restoration

Traditional approaches to wetland restoration focus on restoring wetland channels and hydrology to support a more diverse native plant population. While this strategy addresses ecological integrity within the wetland, it often overlooks the need to alter the cycles of wetland chemistry created by historic wetland alteration, which transform and release phosphorus to downstream waterbodies.

To address both ecological integrity and the release of phosphorus, wetland restoration must focus on modifying hydrology to support the native plant community while minimizing phosphorus export. This may include, but is not limited to, bypassing flow around the wetland, the addition of nutrient filters, soil engineering or augmentation to permanently sequester phosphorus, or the development of wetland treatment cells. Selected restoration options will depend on site specific wetland conditions and hydrology, and overall needs of the subwatershed system.

The wetland complex at the headwaters of Schutz Creek should be evaluated for potential nutrient export. Numerous wetlands within the subwatershed have high or moderate restoration potential, and if restored, could improve vegetative diversity and provide connected habitat.

Carp Management

Historically, carp management focused on removal of carp populations from impacted water bodies without any consideration of population dynamics such as reproduction, immigration, and emigration. More recent carp management techniques focus on integrated pest management where activities focus not only on removal but also on the long-term prevention of carp reproduction and immigration into sensitive water bodies. These new techniques allow for sustainable

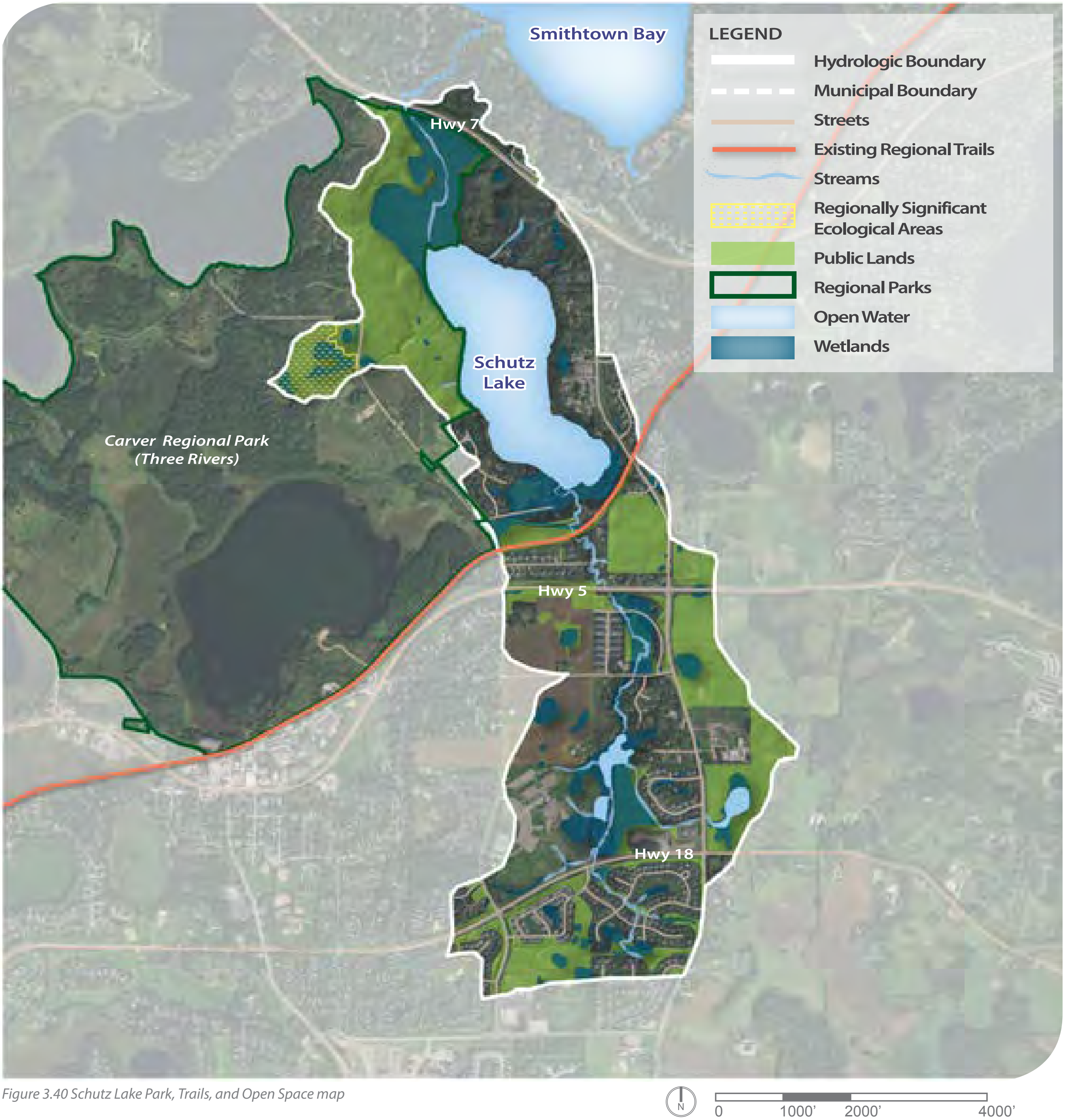


Figure 3.40 Schutz Lake Park, Trails, and Open Space map

control of carp populations to measurably improve shallow lake and wetland water quality, plant communities and overall ecological health.

Schutz Lake has signs of potential carp impact, with its degraded aquatic plant and fish community. The status of carp in the lake is unknown, and assessing the population would be the first step towards determining the impact carp may be having on the lake. If carp are found to be impacting the system, given the small size of the subwatershed, a simple assessment could be performed that would inform management strategies.

Stormwater Management

Stormwater management will focus on reducing runoff volumes and rates, as well as reducing pollutant loading from runoff producing rain events. Stormwater management in the developed or developing urban and suburban areas will focus on retrofitting low impact development techniques such as ponds, filters, infiltration techniques, and other technologies where they are applicable. In the rural and agricultural areas, stormwater management will focus on buffers, improved agricultural practices such as conservation tillage, manure management for animal agriculture and hobby farms, wetland restoration and fertilizer management.

In the Schutz Lake subwatershed, the focus will be on installing stormwater management practices that reduce the volume and pollutant load being delivered from the upper watershed, primarily south of Highway 5.

Stream Channel Restoration

Stream restoration focuses on balancing stormwater conveyance to prevent flooding and channel erosion while providing high quality habitat for fish and macroinvertebrates. Restoration includes, where applicable, improving channel sinuosity, stabilizing streambanks, controlling peak flow velocities, increasing channel roughness for habitat and re-aeration, narrowing stream channels to improve wetted width and ecological baseflow, and increasing stream structure.

Schutz Creek may be investigated for restoration potential to address bank erosion and issues surrounding the culverts that serve as part of the conveyance system. A partial stream assessment did not reveal significant issues and noted that there was robust habitat available. Given the elevated phosphorus levels in the stream, the entire length would benefit from assessment to determine need and opportunity for streambank stabilization, buffer enhancement, and habitat improvement.

Internal Sediment Phosphorus Control

Reducing or eliminating phosphorus release from sediments is often essential to meet water quality standards in lakes. There are several techniques available for controlling sediment phosphorus release including sediment phosphorus inactivation using a chemical such as aluminum, oxygenation to prevent sediment anoxia, hypolimnetic aeration and iron addition to prevent phosphorus release, or hypolimnetic withdrawal. While all the techniques can be effective, the application of aluminum to sediments using aluminum sulfate (alum) or a mixture of sodium aluminate and alum is typically the most cost effective approach for reducing sediment phosphorus release.

Not enough data are available to determine of internal sediment phosphor load requires management. Sediment cores would assist in assessing potential sediment release rates. Aquatic vegetation and fish surveys would also provide valuable data to determine what role biological management would play in controlling internal load.

LAND USE

EXISTING CONDITIONS

The subwatershed includes a portion of the city of Victoria. Land use in the subwatershed is generally characterized by parks and open spaces (25%), low density development (24%), agricultural uses (15%), institutional uses (12%), water (11%), and undeveloped land (7%). The Carver Park Reserve abuts the northwesterly portion of the lake, the Southwest Hennepin LRT Regional Trail crosses the subwatershed, and portions of the southern subwatershed belong to the University of Minnesota Horticultural Research Center and Landscape Arboretum.

LOCAL PLANS AND PRIORITIES

As described in the District's goals (Sections 3.3), the District strives to implement its clean water objectives in ways that meaningfully contribute to the development of thriving communities. This is achieved through collaboration and integrated planning with public and private partners.

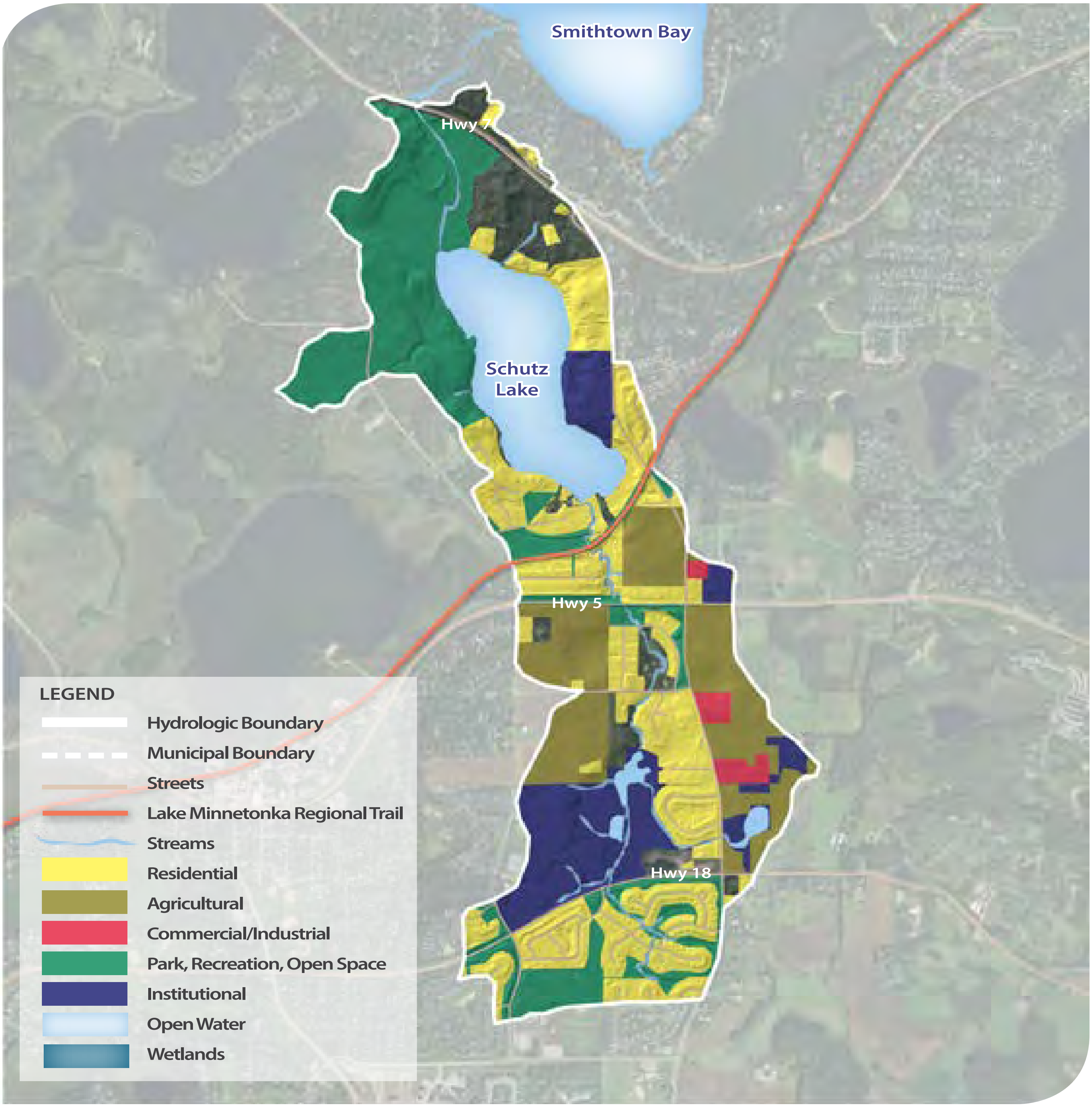
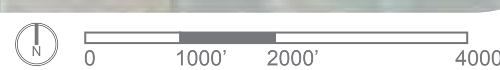


Figure 3.41 Schutz Lake Land Use map



As part of the development of this plan, the District reached out to its communities to gather information on local goals, plans, and priorities for 2018-2027 (see Appendix B for details on the public input process). This information was used to broadly characterize opportunities, and to inform the development of the District's implementation plans. The information received was used only as a guide during the development of this Plan to inform the District of opportunities for partnership on the near term horizon, and was not intended to be exhaustive or restrict future collaborative efforts.

As discussed in Section 3.6, the District intends to cultivate a framework for two-directional coordination with communities on an ongoing basis, to stay apprised of emerging needs at a local level, and to identify and evaluate opportunities to implement management strategies outlined in this Plan over the next ten years. The District recognizes that local needs, opportunities and priorities may shift over time. Therefore, this Plan does not intend to capture or prescribe opportunities for partnership over a ten-year term.

Long term goals, growth and private development, and public investment in infrastructure differ across each community – and therefore, frameworks for ongoing coordination will be custom tailored based on the individual needs of each community. Coordination may occur at varying levels, through various means, with communities across the following areas:

» Regulation of, and partnership with, private development

» Collaboration on public planning and investment (e.g. parks , roads, utilities)

» MS4 compliance

» Development and implementation of TMDLs

There is an active lake association for Schutz Lake that has expressed interest in working with the City of Victoria and the District to address the issues outlined in this plan. The City of Victoria will be working pro-actively with the District to identify opportunities to manage stormwater volumes and pollutant loads, stabilize erosion within the stream and stormwater conveyance system, and to develop funding strategies to implement feasible solutions.

IMPLEMENTATION PLAN

The goals set forth in this subwatershed plan will require an integrated set of programs and projects oriented toward the conservation and improvement of water resources within the watershed. The Implementation Priorities section generally describes the actions that the District and its partners will look to take in order to address the issues present in the subwatershed and achieve the goals as set forth in the plan. The Capital Improvement Plan (CIP) provides cost estimates and schedules for any proposed capital investments.

IMPLEMENTATION PRIORITIES

As described in previous sections, Schutz Lake is not impaired but does exhibit a trend of increasing concentrations of chlorophyll-a, and increasing annual water yields – likely due to development that has occurred in the last ten years. Increased quantities of water may also be causing erosion within the channel and around culverts which convey water through the system. These issues may be combining with the potential for internal loading, possibly exacerbated by the presence of common carp, to continue stressing Schutz Lake.

Based on these conditions, management strategies within the subwatershed will focus primarily on stormwater management to reduce runoff volumes and pollutant loads, assessing and stabilizing erosion within the stream channel and conveyance system, and evaluating and managing the presence and impact of common carp.

The Schutz Lake subwatershed is relatively small and little near-term development or infrastructure investment is anticipated, so opportunities from land use change may be limited. However, the Plan establishes a coordination framework through which the District will seek to maintain current knowledge of land use and capital planning by its LGUs, and of potential land use development and redevelopment activity.

As opportunities arise, the District will evaluate them against the resource needs and priorities defined throughout this plan and determine the appropriate response. The District has a wide range of services it can mobilize to address resource needs and support partner efforts, including data collection and diagnostics, technical and planning assistance, permitting

ISSUE

- Excess nutrients
- Increasing runoff volume
- Degraded macroinvertebrate community
- Degraded fish and aquatic vegetation

DRIVER

- Altered wetlands
- Common carp
- Stormwater runoff
- Altered channels
- Internal sediment phosphorous loading

STRATEGY

- Wetland restoration
- Carp management
- Stormwater management
- Stream channel restoration
- Internal sediment phosphorous control

IMPLEMENTATION PRIORITIES

- Resource protection through regulation
- Early coordination and integration with land use planning
- Opportunity-driven stormwater management projects/grants
- Education and capacity-building for lake associations

assistance, education and capacity building, grants, and capital projects.

The District will pro-actively coordinate the permitting of future land use change with the City of Victoria to explore opportunities to create public-private partnerships to address stormwater management goals in ways that exceed regulatory requirements. The District will continue working with the Lake Association to identify local resident led implementation opportunities that align with this subwatershed plan.

To allow the District the flexibility to respond to opportunities identified by the cities or other partners, or that may arise through land-use change, the capital improvement plan for this subwatershed includes a project for stormwater management. In the future, should the District or a partner determine that a larger or more concentrated scale of capital and program implementation may be needed, a discrete subwatershed planning process may be initiated to:

» Provide high resolution diagnostic of watershed issues and drivers

» Map current projected land use and infrastructure changes

» Define a detailed and integrated capital and program implementation plan

» Outline a funding strategy including program costs and sources

The details of such a plan would provide the information needed for the District to pursue a plan amendment under MN Rules 8410, thereby updating specific subwatershed components of this Plan.

CAPITAL IMPROVEMENT PLAN

The CIP is a planning tool. It also is a means to inform partners, District residents, and other interested parties as to the District's scope and priorities for its capital work over the planning period. A project's inclusion in the CIP does not mean that the project will be constructed, only that the District has identified it as an action that may be a cost-effective way for the District to achieve identified water resource goals. A project identified in the CIP always will need further review as to technical feasibility, cost and financing, consistency with local needs, and other policy considerations before a formal decision to proceed to construction is made. Section 3.5.5 describes the development and evaluation steps that will occur before the District will commit resources to a project.

Schutz Creek

Section 3.5.5 also describes how the District will review the CIP on an ongoing basis throughout the planning period. This review will allow the District to reassess described projects from a technical perspective, but also will involve broader policy considerations such as shifts in District priorities, decisions as to annual budget and levy levels, and the prospect of state and federal grant funds or financing. For this reason, projects may be added to and deleted from the CIP from year to year, in accordance with those procedures.

A critical component of any project will be the development of a funding strategy that identifies the sources, uses, and timing of funds needed to successfully achieve identified goals. These plans will be developed in conjunction with the District's public and private partners as capital projects are advanced. Therefore, any costs identified within this Plan are projections. Intended expenditures will be refined during project development and budgeting, and among other things will reflect the District's intent to complement its ad valorem funds with other funding sources.

Schutz Lake

Table 3.14 Schutz Lake Subwatershed CIP

Project	Stormwater Volume and Pollutant Load Reduction
Description	Implementation of opportunities to reduce stormwater volumes and nutrient loading to Schutz Lake, including but not limited to infiltration or filtration basins and devices, reforestation, revegetation, and stormwater detention or redirection.
Need	While Schutz Lake is not currently impaired for excess nutrients, total phosphorus concentrations are very near state water quality standards. Schutz Lake receives stormwater runoff from a developing area south of the Lake via Schutz Lake Creek where further phosphorus load reductions are needed to protect water quality.
Outcome	Reduction of pollutant loading to Schutz Lake; reduction of stormwater runoff volume and rate and associated impacts; protection and enhancement of groundwater recharge, stream base flow, and wetland hydrology.
Estimated Cost	Capital costs: $250,000, excluding land, in 2017 dollars.
Potential Funding Sources	District levy, partner contributions, grants
Schedule	2018-2027

3.9.11 SIX MILE-HALSTED BAY SUBATERSHED PLAN

INTRODUCTION

This subwatershed plan contains information specific to the Six Mile Creek-Halsted Bay Subwatershed, including existing conditions and issues, drivers, management strategies, land use information, and an implementation plan. Information regarding the District's philosophy, goals, and implementation approach can be found in Sections 3.2-3.4 and should be reviewed first to provide context for the following subwatershed plan.

EXECUTIVE SUMMARY

The Six Mile Creek-Halsted Bay Subwatershed spans 27 square miles on the western edge of the Minnehaha Creek Watershed District. Within this large subwatershed are numerous jurisdictions and public agencies, including the Cities of St. Bonifacius, Waconia, Victoria, and Minnetrista, Laketown Township, both Hennepin and Carver Counties, and Three Rivers Park District, which owns Carver Park Reserve, a 3,700 acre park within the subwatershed.

The subwatershed is characterized by abundant and interconnected water resources, flat topography, and planned land use conversion from agriculture to suburban residential. The principal land uses within the Six Mile Creek-Halsted Bay Subwatershed are parks and open space (25%), agriculture (24%), undeveloped land (22%), water (14%), and low density development (12%).

Large areas of undisturbed or minimally disturbed forest and grassland are located within Carver Park Reserve. A majority of the land within Carver Park Reserve is designated by the DNR as a "regionally significant ecological area", as are other corridors around the large lake and wetland systems outside of the park. Areas designated as having high biodiversity significance by the Minnesota County Biological Survey include several wetland complexes in and adjacent to Carver Park.

The Six Mile Creek-Halsted Bay Subwatershed contains approximately 14 lakes and hundreds of acres of wetlands, all connected by Six Mile Creek, which has been heavily ditched and modified. The system begins at Pierson Lake in Laketown Township, and moves towards Victoria through Wassermann Lake, then through a large wetland complex into East Auburn Lake, which is partially within Carver Park Reserve. Carver Park Reserve contains six lakes and numerous marshes, all of which drain into North Lundsten Lake then through a water control structure into Parley Lake. Water then flows through Parley and Mud Lakes, and finally through the large Six Mile Marsh complex into Halsted Bay of Lake Minnetonka.

The system has six lakes that do not meet state water quality standards for nutrients. The receiving water, Halsted Bay, requires the largest phosphorus load reduction in the District. Other water bodies have high phosphorus levels without being listed as impaired, either because they exhibit fluctuation around state standards or they have been designated as wetlands by the Minnesota Pollution Control Agency, which designates impaired water bodies and allocates required load reductions.

Degraded water quality and ecological integrity within this system are driven by both historical land use and ongoing system stressors. Many waterbodies with elevated phosphorus are driven at least in part by internal sediment release of phosphorus stored in the lake bed. This sediment phosphorus release may be exacerbated by the presence of invasive common carp, which are abundant throughout the system. The principal source of watershed nutrient loading throughout most of the system is degraded wetlands that export phosphorus due to historic hydrologic modification. Stormwater from both agricultural and developed land uses also drives some water quality issues, though proportionately less than other sources in the watershed.

Management strategies will include carp control, wetland restoration, internal load management, and coordination with public infrastructure investment to improve stormwater management. The location and timing of the implementation of these management strategies will be driven by resource need, opportunity cost, partner support, and available land and financing.

Given the subwatershed scale, abundance of natural resources, complexity of the geography, interconnected water resource issues, and existing partnerships in the area, the subwatershed was adopted in 2015 by the MCWD Board of Managers as a priority for planning and implementation. The implementation

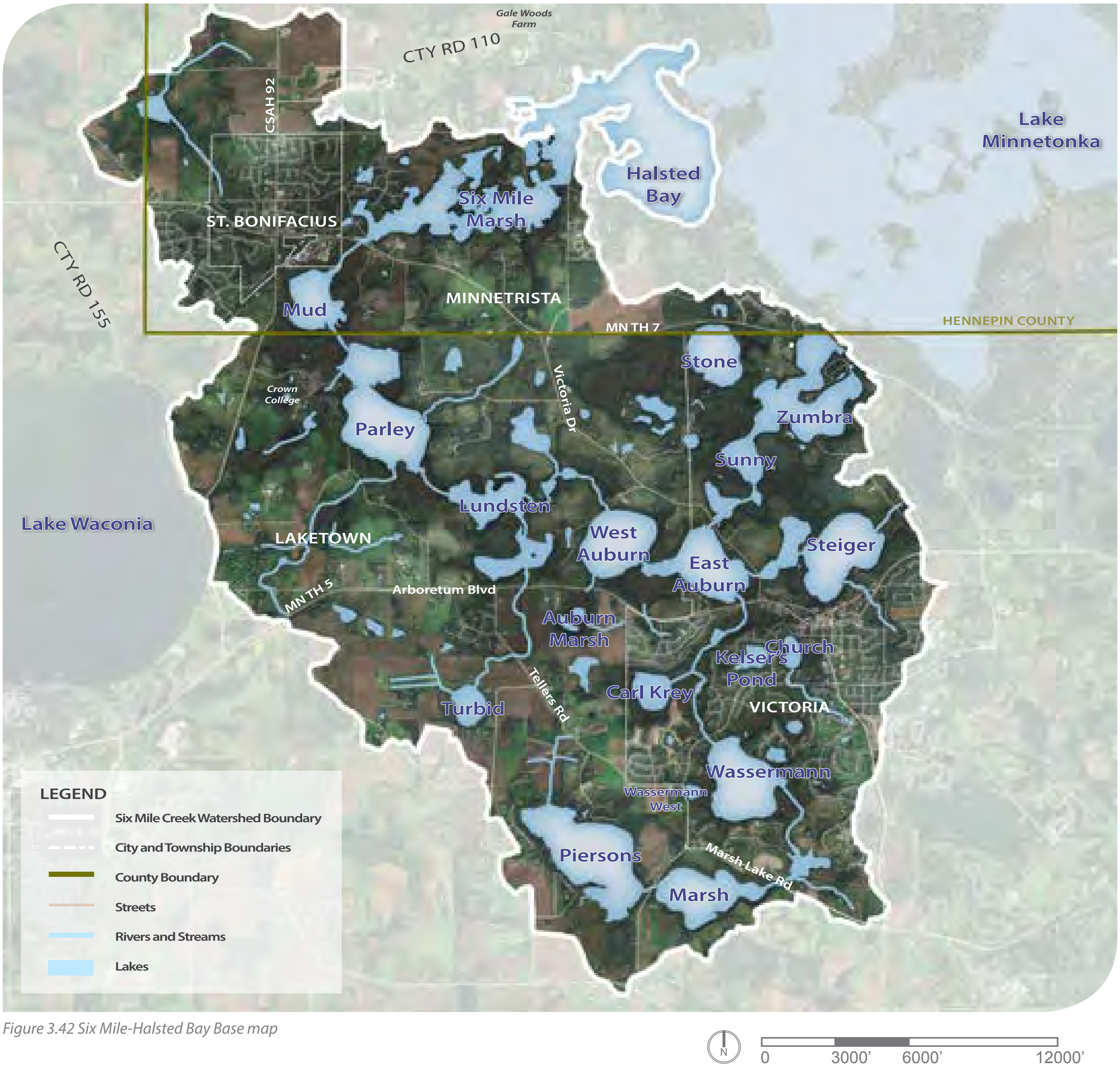


Figure 3.42 Six Mile-Halsted Bay Base map

plan for this subwatershed has been developed in coordination with the Six Mile Creek-Halsted Bay Planning Partnership, composed of policy makers and staff from the public agencies within the geography including:

- City of Victoria
- City of Minnestrista
- City of St. Bonifacius
- City of Waconia
- Laketown Township
- Carver County
- Hennepin County
- Three Rivers Park District

MCWD first convened the Partnership to develop a coordinated, multi-jurisdictional plan to address complex and interconnected water resource issues in the geography. The plan integrates natural resource improvements into other, non-water public investments including parks and recreation, growth and development, and infrastructure investment. The goal of the plan is to not only improve water resource outcomes directly, but also generate secondary benefits that address local planning priorities.

The Partnership will continue to work together to guide and prioritize implementation after this plan has been adopted. The District will routinely convene the Partnership to evaluate implementation progress and provide updates on projects and opportunities the District intends on pursuing. The District will seek support from the Partnership as it pursues external funding sources such as grants and financing. The District will also support members of the Partnership as they develop their own comprehensive plans, land use ordinances, investment strategies, and other local initiatives.

RESOURCE NEEDS

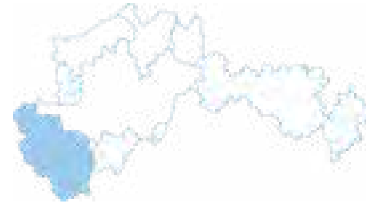
EXISTING CONDITIONS AND ISSUES

This section of the Plan outlines existing conditions and water resource issues, categorized by water quality, water quantity,

Rural landscape

Six Mile Creek

Lake Wasserman, looking west, Erdahl Aerial Photos



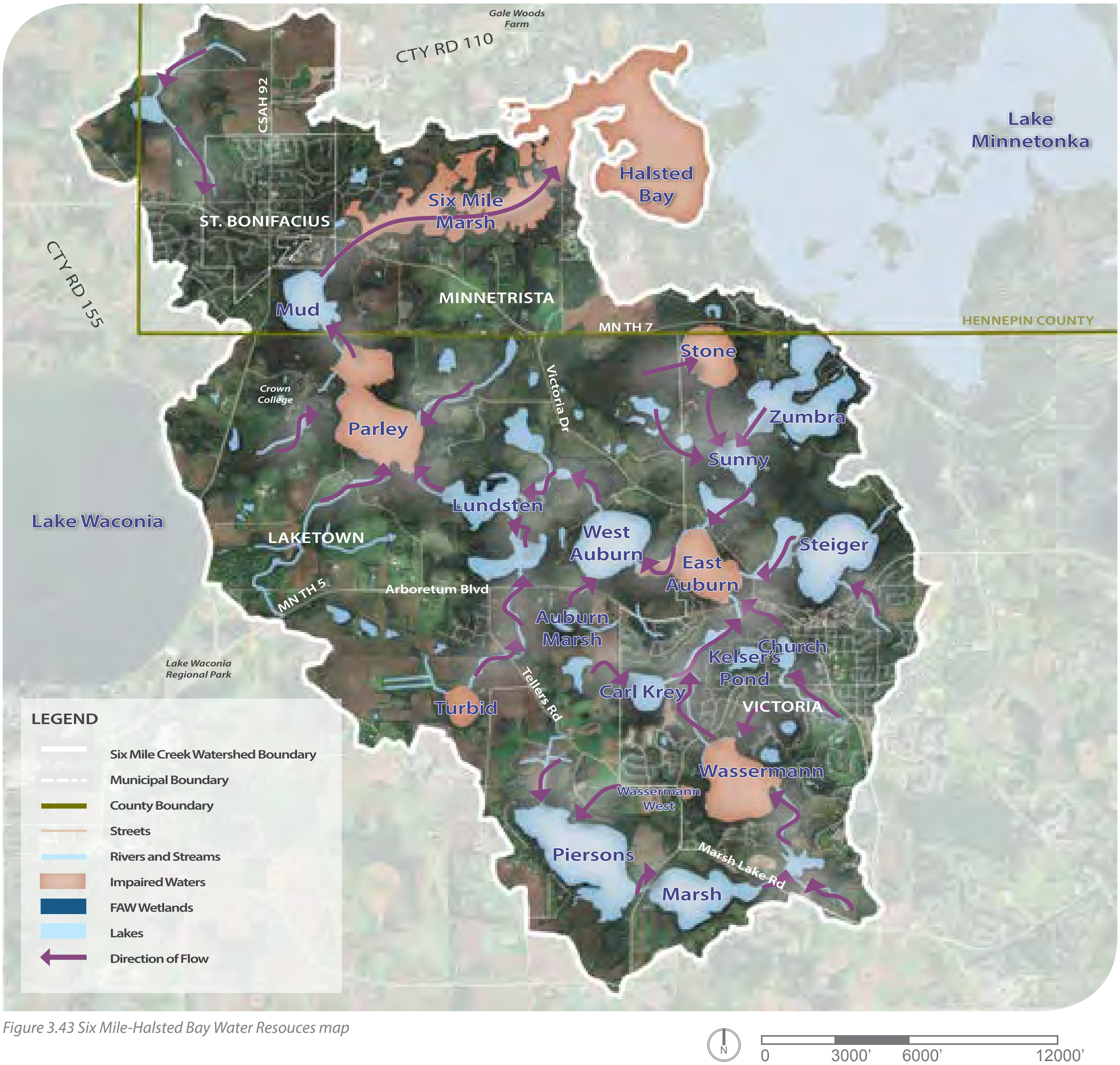


Figure 3.43 Six Mile-Halsted Bay Water Resouces map

and ecologic integrity. Condition information was compiled from community input, monitoring data, specialized studies, the Hydrologic and Hydraulic Pollutant Loading Study (HHPLS), the Six Mile Diagnostic Study, the Six Mile Creek Carp Assessment, the Functional Assessment of Wetlands (FAW), Total Maximum Daily Load (TMDL) studies, and state and regional land use and land cover data. A review of these conditions and data revealed several issues and concerns that may require action on the part of the District or its partners. More detailed information about the Six Mile Creek-Halsted Bay subwatershed may be found in Volume 2: Land and Natural Resources Inventory.

Water Quality

Lakes and Streams

East Auburn, Parley, Stone, Turbid and Wasserman Lakes are impaired for excessive nutrients, requiring load reductions under approved TMDLs. Mud Lake and South Lundsten have high nutrient concentrations but are classified as wetlands, so the state standards for lakes do not apply. Several other waterbodies within the system fluctuate around state standards for water quality and clarity but remain unlisted.

In Six Mile Creek, the reach between Mud Lake and Halsted Bay is listed as an impaired water for excess nutrients with a TMDL forthcoming. Dissolved oxygen levels frequently fall below the 5 mg/L necessary to sustain aquatic life.

Wetlands

Abundant and interconnected wetland complexes are characteristic of the Six Mile Creek-Halsted Bay geography. While many provide crucial ecosystem services, altered hydrology and monotypic vegetation communities lead many others to be exporters of phosphorus. These wetlands are driving degrading water quality in some of the largest lakes within the geography, including East Auburn, Wassermann, and Parley.

Groundwater

There are areas of high and very high aquifer sensitivity throughout the watershed, some of which correspond to anticipated development areas.

Water Quantity

Lakes and Streams

The Six Mile Creek-Halsted Bay subwatershed is characterized by its flat topography and extensive water resources. The lack of gradation between waterbodies generates backflow conditions between certain waterbodies when the flow pattern reverses direction, causing flooding and pollutant loading concerns.

Lakes and streams within the subwatershed have altered hydrology. Changes to inlet and outlet structures, altered rates of overland flow and recharge, and modification to stream alignment and shoreland zones generate secondary impacts to water quality and ecological integrity by modifying stream flow regime and lake levels.

Wetlands

The MCWD Functional Assessment of Wetlands (FAW) found that wetlands within the Six Mile Creek-Halsted Bay system generally function well for flood storage capacity and maintenance of hydrologic regime, with some exception for flood storage in the less developed areas in and around Minnetrista. However, the flow regime of many of the wetlands has been modified, driving symptoms that impact both the water quality and ecological integrity indicators for wetlands.

Groundwater

A majority of the wetlands within the Six Mile Creek-Halsted Bay system rely, at least in part, on recharge from surficial groundwater sources, rendering them sensitive to changes in groundwater supply.

Ecological Integrity

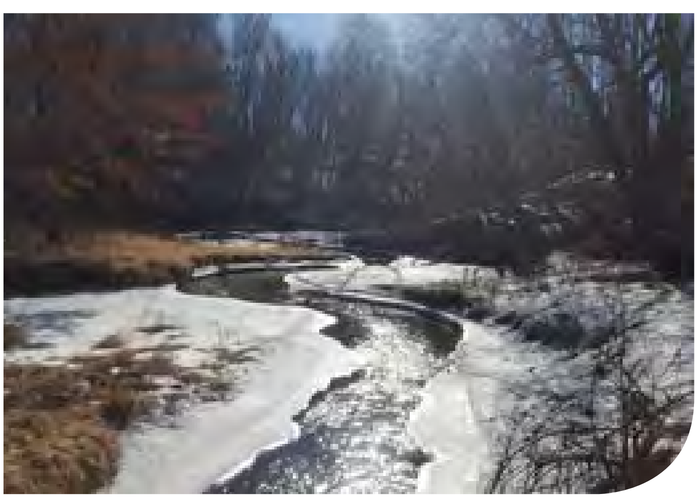
Lakes and Stream

Many of the lakes within the subwatershed have shallow lake characteristics, including large littoral areas. These characteristics can drive dense vegetation, both native and non-native. Aquatic vegetation supports habitat for aquatic species, food web interactions, and nutrient cycling, but can have adverse impacts, particularly when non-native species are present.

Aquatic plant biodiversity and habitat diversity range across the lakes in the subwatershed. These ecosystem services were recently assessed through the District's E-Grade Program, and while plant communities in some lakes provided for good conditions, several others were classified as poor or degraded. Eurasian watermilfoil and Curlyleaf pondweed are present in most lakes, but at varying abundances.

Marsh Lake, Erdahl Aerial Photos

Six Mile Marsh prairie restoration



Six Mile Creek

The fish communities in the numerous lakes also were assessed through the District's E-Grade Program, and most were classified as poor to degraded communities.

Shoreline integrity varies widely across the subwatershed. Shoreline within the Carver Park system is largely intact given the public ownership by a natural resources agency, but private development in the City and Township areas can impact the continuity of buffering along the shoreline, which protects lakes from erosion and preserves habitat.

Six Mile Creek is heavily altered, having been ditched and widened over time. The stream generally lacks biodiversity and has degraded habitat characteristics.

Wetlands

With 5,127 acres of wetlands within the geography, a range of vegetative and biodiversity conditions exist within this system. Wetland assessments have identified many with low vegetative diversity and non-native species. Much of the wetland acreage still provides moderate support to wildlife and fisheries. There are a number of high- and moderate-quality wetlands in the subwatershed, many of which are situated in a nearly continuous natural corridor that provides significant functions and values such as runoff storage and water quality treatment as well as habitat and natural resources values, and should be prioritized for protection.

Upland and Natural Corridors

The Three Rivers Park District's Carver Park Reserve covers much of the central subwatershed, preserving not only numerous lakes and wetlands, but also large swaths of forest and prairie. Large areas of undisturbed or minimally disturbed forest and wetland in the subwatershed have been designated Regionally Significant Ecological Areas by the DNR, including nearly all of the Carver Park Reserve. The Minnesota Biological Survey (MBS) identified several areas of moderate or high biodiversity significance both within and outside of the regional park. The MBS also identified both terrestrial and aquatic locations in the watershed with intact native plant communities. The Metropolitan Council has identified large areas within the subwatershed as important conservation corridors.

DRIVERS

A driver of water quality, water quantity, or ecological integrity is a driving force or stressor that causes a biological community or physical structure to change. Some example drivers include increased phosphorus loading, increased impervious areas, straightened channels, and drained wetlands. Some drivers are natural, such as storm events. Most are human-caused, either directly or as a side effect of some other change such as a land use change or removal of natural land cover. This section of the Plan outlines the main drivers of water quality, water quantity, and ecological integrity issues within the Six Mile Creek-Halsted Bay subwatershed.

The principal water quality, water quantity, and ecological integrity issues within the Minnehaha Creek subwatershed are:

- » Water Quality
- » Excess nutrients
- » Low dissolved oxygen
- » Phosphorus export wetlands

Water Quantity

- » Modified hydrology
- » Localized flooding

Ecological Integrity

- » Degraded fish community
- » Degraded macroinvertebrate community
- » Degraded and disconnected wetland and terrestrial corridors

The issues are driven primarily by the following factors

- » Common carp
- » Altered wetlands
- » Water quality from upstream waterbodies
- » Stormwater runoff
- » Altered channels
- » Internal sediment phosphorus loading

Common Carp

Invasive common carp negatively impact water quality and ecological conditions in surface waters when carp dominate fish communities. Carp impact aquatic systems by their bottom feeding behavior which uproots aquatic plants, re-suspends bottom sediments, and releases nutrients into the water column. This leads to decreased water clarity and a switch to a water state dominated by algae in shallow lakes and wetlands. This turbid water condition is the least ecologically diverse state, and is often characterized by a significant loss of natural vegetation, harmful algal blooms, and the release of phosphorus from resuspended sediments, all of which contribute to water quality impairments and the loss of fish and wildlife habitat.

For most lakes, carp densities need to be kept below 100 kg/ha to prevent declining water quality and ecological integrity. The 2016 University of Minnesota Six-Mile Creek Subwatershed Carp Assessment provides a detailed assessment of carp populations in the Six Mile system, with many waterbodies greatly exceeding the damaging threshold.

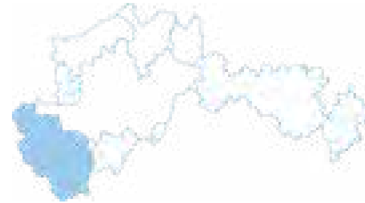
Altered Wetlands

On a watershed scale, wetlands can act as sinks, sources, or transformers (particulate to dissolved) for nutrients like phosphorus. Historically, wetlands acted as nutrient sinks within a watershed, capturing and retaining nutrients, even as nutrient loads to the wetland were increased as land use intensified. However, as wetlands were ditched and drained to facilitate watershed drainage and land use change, they often converted from a sink for nutrients to sources, by increasing the breakdown of wetland soil and the conveyance of stormwater. These processes within altered wetlands can release large pools of stored nutrients, causing nutrient impairments in downstream surface waters.

In the Six Mile Creek-Halsted Bay Subwatershed, altered wetlands are a principal driver of degraded water quality for Wassermann, Turbid, East Auburn, South Lundsten, Parley, and Mud Lakes and Halsted Bay. Altered wetlands also reduce available habitat for migratory waterfowl and other bird species within the area.

Upstream Waterbodies

Headwater streams, lakes and wetlands contribute water and nutrients to downstream receiving waters impacting the quality



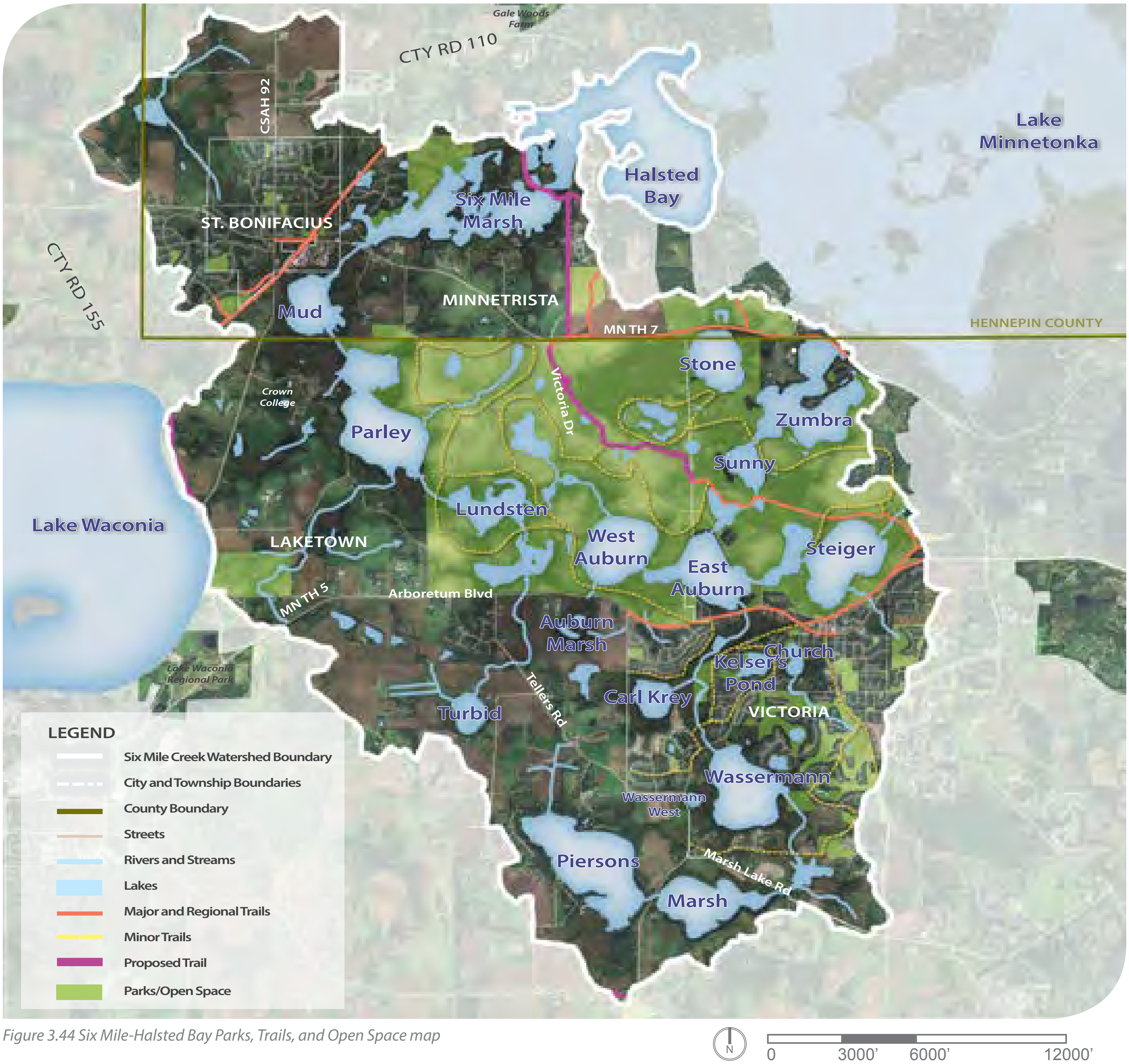


Figure 3.44 Six Mile-Halsted Bay Parks, Trails, and Open Space map

of these water bodies. Lakes and wetlands with poor water quality ultimately contribute nutrients to downstream waters that can lead to eutrophication. Consequently, restoration of upstream water bodies is often a critical component of improving downstream water quality on a watershed scale.

Six Mile is particularly challenged in this regard because in several cases the upstream waterbodies are either not listed as impaired because they are classified as wetlands or are held to shallow water body standards which allow for higher nutrient concentrations, even if their downstream waterbodies are held to stricter standards.

Stormwater Runoff

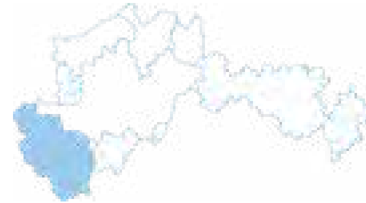
Watershed runoff from rainfall events, or stormwater, can carry nutrients and other pollutants to surface waters leading to negative impacts in lakes, streams and wetlands. In urban and suburban areas, high proportions of impervious surfaces such as parking lots and driveways increase the volume and rate of stormwater runoff, which can cause flooding, and change stream flow in ways that negatively impact habitat for critical parts of the food-web like fish and macroinvertebrates. In rural areas drained for agriculture, the increased volume and peak flow of stormwater runoff causes similar negative impacts.

While the increased volume and rate of stormwater runoff can negatively impact physical conditions in receiving waters, the runoff also carries with it increased loads of pollution that negatively impact the quality of lakes, streams and wetlands. In urban and suburban areas, stormwater picks up excess nutrients, bacteria such as *E. coli*, chloride from road salt, and other pollutants causing toxicity to organisms or issues with excess nutrients (eutrophication). In more rural areas, stormwater mobilizes pollutants from manure and fertilizer including excess nutrients, bacteria, herbicides and pesticides.

These impacts heavily influence the conditions of surface waters because a healthy hydrologic condition is critical to supporting a healthy lake, stream or wetland. Generally as impervious cover, altered drainage, and stormwater runoff within a watershed increases, the quality of lakes, streams and wetlands decreases.

The Six-Mile-Halsted Bay System experiences water resource issues from both developed areas and agricultural land uses. Areas of Victoria and most of St. Bonifacius were developed

Six Mile-Halsted Bay Subwatershed



before today's more rigid stormwater standards were in place and continue to drive declining water quality in receiving waterbodies.

There are several areas in the subwatershed where ongoing agricultural land use continues to drive declining water quality in receiving waterbodies. More prominently, however, are impacts still felt today from the historic agricultural land use the subwatershed, including high concentrations of phosphorus built up in waterbodies leading to internal sediment release and degraded and hydrologically altered wetland complexes that act as sources or transformers of nutrient pollution.

Altered Channels

Historically, natural channels were straightened, widened and relocated to accommodate land use change. Channel alteration to improve watershed drainage can lead to a loss of physical habitat, increased peak flow velocities and downstream flooding, decreases in dissolved oxygen, and increased sediment transport which can negatively impact fish and macroinvertebrate communities.

Six Mile Creek is classified as a public drainage system and has been heavily modified over time, principally to serve agricultural land which formerly dominated the landscape.

Internal Sediment Phosphorus Loading

Long-term excessive loading of phosphorus to lakes can lead to phosphorus buildup in the sediments of the lake bed. Ultimately, this phosphorus can be released from the sediment back into the water. Further exacerbating the problem, released phosphorus is typically dissolved which is readily available for plant uptake and contributes directly to algae blooms. Sediment phosphorus release can lead to summer algae blooms, poor water clarity and, in severe cases, summer fish kills and harmful algal blooms. Restoration of water quality in lakes often requires significantly reducing phosphorus release from sediments.

Lakes where internal sediment release is or may be a driver in the Six Mile Creek-Halsted Bay include Marsh, Wasserman, Church, North and South Lundsten, Turbid, Parley, and Mud Lakes, and Halsted Bay. In some of these lakes, internal release is proportionately small to other factors but still significant for achieving phosphorus reduction goals.

MANAGEMENT STRATEGIES

Informed by the identification and prioritization of conditions and issues in the subwatershed and an understanding of the drivers impacting its water resources, the District has developed general strategies to guide actions in the Six Mile Creek-Halsted Bay subwatershed. These strategies are both short- and long-term, and establish a framework for the programs and projects utilized in the Six Mile Creek-Halsted Bay subwatershed Implementation Plan. To best understand the strategies and efforts of the District and its partners within the Six Mile Creek-Halsted Bay subwatershed, it is important to recognize the recent work in this subwatershed and the integration and alignment of natural resource management strategies with the goals of our communities.

Focal Subwatershed Planning

As noted throughout this plan, the District's overarching organizational strategy is founded in its Balanced Urban Ecology policy. This policy was established as the District's fundamental philosophy and way of doing business – developed to guide all future planning and watershed management activities in order to achieve its mission of protecting and improving land and water.

The overarching strategy described in Balanced Urban Ecology policy is a vision of integration with government agencies, private landowners and developers, and philanthropic partners through multi-jurisdictional partnerships, emphasizing the economic and social value that natural systems generate for the built environment. It further describes how our work will be strengthened through these collaborative efforts to not only offer greater community impact, but to produce creative public-private funding opportunities that will leverage scarce resources and maximize benefits.

Following the success in applying the Balanced Urban Ecology policy in the Minnehaha Creek Subwatershed, the District turned to The Six Mile Creek-Halsted Bay Subwatershed in 2014 as the next geography in which to apply these lessons of partnership, integration, and flexibility. The Six Mile Creek-Halsted Bay was selected as an implementation priority due to its abundant natural resources, complex water resource issues that cross jurisdictional boundaries, the anticipated growth and development pressure in the coming decades, the existing support and partnerships, and the geography's connection to Halsted Bay of Lake Minnetonka. It was also noted that the scale, complexity, and multiple jurisdictions would warrant an approach in which the District routinely convenes area partners to adaptively manage capital project implementation.

In 2013, the District conducted a comprehensive diagnostic assessment to gain a clearer picture of the issues and drivers within this geography. One of those drivers identified included invasive common carp, prompting the District to contract with the University of Minnesota to conduct an assessment of the recruitment, concentration, and movement patterns of carp in the system to inform subsequent management activities. These studies, along with other District wide studies and specialized assessments, serve as the backbone of understanding the interplay of issues, drivers, and management strategies in the Six Mile Creek-Halsted Bay subwatershed.

Beginning in early 2016, the District convened a group of public sector stakeholders in the subwatershed including the City of Victoria, City of Minnestrista, City of St. Bonifacius, City of Waconia, Laketown Township, Carver County, Carver County Soil and Water Conservation District, Hennepin County, and Three Rivers Park District to form the Six Mile Creek-Halsted Bay Subwatershed Partnership. As expressed in the resolution of support adopted by these partner agencies in March of 2017, the purpose of this Partnership is twofold:

» Develop and adopt a subwatershed plan that identifies key water resource issues and strategies, identifies natural resource corridors, and accommodates local growth and development planning; and

» Establish a framework for plan implementation, memorializing routine re-engagement of the Partners for the purposes of aligning plans and priorities, forecasting upcoming projects, and establishing investment strategies, including sources of external funding, to be incorporated into capital improvement plans;

Through one on one meetings with individual agencies and meetings with the whole Partnership committee, the Partnership has established a shared baseline knowledge of principal water resource issues, provided the District with an understanding of local conditions and priorities that influence each agency's role in implementation, and guided the District in determining management strategies and how they can be implemented in synergy with local planning and development initiatives. The Partnership has established a shared vision for the subwatershed that preserves and enhances natural resources; wisely anticipates the growth and development of vibrant communities; promotes the preservation of distinctive areas; recognizes that natural systems can serve to underpin local identity and sense of place; builds strong community connections through transportation infrastructure, trails, parks, and schools; and integrates natural and built systems to enhance the long term social and economic value of communities.

With the adoption of this plan, the Partnership will continue to play a critical role in working with the District towards its implementation. The implementation plan section provides a more detailed overview of the implementation approach for Six Mile and how activities will be prioritized on a rolling basis across the subwatershed as resources allow. The District will routinely convene the Partnership to:

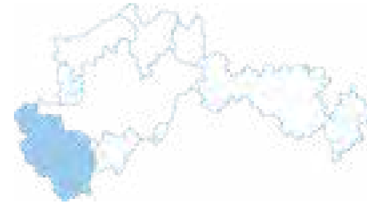
» Adaptively evaluate capital project opportunities and assess them against the established goals of the Partnership;

» Align local plans and initiatives with the goals of the District and the Partnership, including local surface water plans, comprehensive plans, and area plans;

» Coordinate on non-District capital improvements such as transportation projects, new development, utility updates, etc. to pro-actively identify opportunities to layer in water quality and natural resource benefit; and

» Support the District as it pursues external funding resources to support capital project implementation.

Implementation of the following management strategies within the Six Mile Creek-Halsted Bay Subwatershed will not be linear – the subwatershed is large and interconnected, and many of the drivers of natural resource degradation are highly interdependent, requiring an adaptive management approach and continual evaluation of program effectiveness. While some implementation opportunities can be well forecast, others will emerge in real time as land use changes, funding and land becomes available, and the system adjusts to the first phases of project implementation.



Lundsten and Auburn Lakes, Erdahl Aerial Photos

Rural landscape

Parley Lake, looking west, Erdahl Aerial Photos

Carp Management

Historically, carp management focused on removal of carp populations from impacted water bodies without consideration of population dynamics such as reproduction, immigration, and emigration. More recent carp management techniques focus on integrated pest management where activities focus not only on removal but also on the long-term prevention of carp reproduction and immigration into sensitive water bodies. These new techniques allow for sustainable control of carp populations to measurably improve shallow lake and wetland water quality, plant communities and overall ecological health.

Wetland Restoration

Traditional approaches to wetland restoration focus on restoring wetland channels and hydrology to support a more diverse native plant population. While this strategy addresses ecological integrity within the wetland, it often overlooks the need to alter the cycles of wetland chemistry created by historic wetland alteration that transforms and releases phosphorus to downstream waterbodies.

To address both ecological integrity and the release of phosphorus, wetland restoration must focus on modifying hydrology to support the native plant community while minimizing phosphorus export. This may include, but is not limited to, bypassing flow around the wetland, the addition of nutrient filters, soil engineering or augmentation to permanently sequester phosphorus, or the development of wetland treatment cells. Selected restoration options will depend on site specific wetland conditions and hydrology, and overall needs of the subwatershed system.

Stormwater Management

Stormwater management will focus on reducing runoff volume and rate, as well as reducing pollutant loading from runoff producing rain events. Stormwater management in the developed or developing urban and suburban areas will focus on retrofitting low impact development techniques such as ponds, filters, infiltration techniques, and other technologies where they are applicable. In the rural and agricultural areas, stormwater management will focus on buffers, improved agricultural practices such as conservation tillage, manure management for animal agriculture and hobby farms, wetland restoration and fertilizer management.

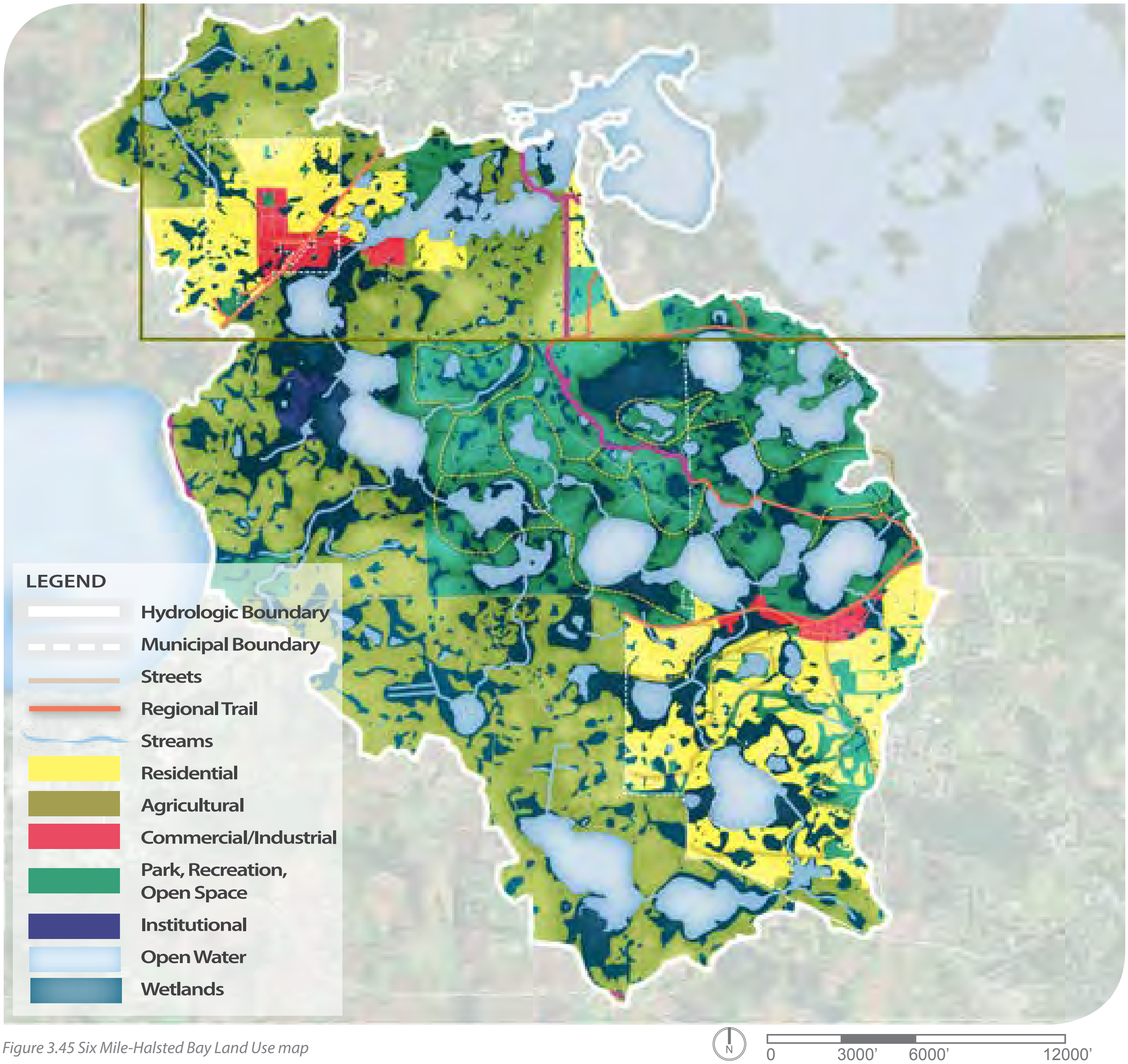


Figure 3.45 Six Mile-Halsted Bay Land Use map

Stream Channel Restoration

Stream restoration focuses on balancing stormwater conveyance to prevent flooding and channel erosion while providing high quality habitat for fish and macroinvertebrates. Restoration includes, where applicable, improving channel sinuosity, stabilizing streambanks, controlling peak flow velocities, increasing channel roughness for habitat and re-aeration, narrowing stream channels to improve wetted width and ecological baseflow, and increasing stream structure.

Internal Sediment Phosphorus Control

Reducing or eliminating phosphorus release from sediments is often essential to meet water quality standards in lakes. There are several techniques available for controlling sediment phosphorus release including sediment phosphorus inactivation using a chemical such as aluminum, oxygenation to prevent sediment anoxia, hypolimnetic aeration and iron addition to prevent phosphorus release, or hypolimnetic withdrawal. While all the techniques can be effective, the application of aluminum to sediments using aluminum sulfate (alum) or a mixture of sodium aluminate and alum is typically the most cost effective approach for reducing sediment phosphorus release.

Whole Lake Drawdown

One of the limiting factors for a healthy, diverse submersed aquatic vegetation community in shallow lakes is loose, unconsolidated sediments that are high in nutrients. During restoration of a nutrient enriched shallow lake, whole lake drawdown is often required if the plant community does not respond to nutrient and rough fish management. The goal of whole lake drawdown is to expose as many of the lakes sediments as possible during late summer to promote sediment consolidation and denitrification. During drawdown, the submersed aquatic vegetation seed bed is reinvigorated, resulting in significant sprouting and growth of submersed aquatic vegetation.

Watershed Protection

Several subwatersheds, especially in the western part of the watershed, are rapidly converting from undeveloped or rural land uses to developments which can increase impervious areas, reduce flood storage, increase pollutant loads, and eliminate or reduce biologically significant land cover. A critical strategy to maintain existing resources and critical functions is to protect these areas by minimizing the impacts of development. This is accomplished by conserving biologically significant upland areas, protecting high value wetlands, mimicking natural watershed hydrology, maintaining stream geomorphology, protecting stream buffers and riparian areas, and protecting critical fish and wildlife corridors.

The District has a strategic interest in protecting and creating greenway corridors through the Six Mile Creek-Halsted Bay subwatershed. According to the American Planning Association, interconnected systems of parks and open space:

- Provide a higher level of benefit for people, wildlife, and the economy than do parks in isolation
- Help preserve essential ecological function and protect biodiversity
- Can help shape urban form and buffer incompatible uses
- Can reduce costs for stormwater management, flood control, transportation, and other forms of built infrastructure

The District will pro-actively evaluate opportunities to acquire, through fee or easement, properties suitable for greenway connection in coordination with City and County partners. It will also support similar efforts, through acquisition or regulation, by partners that generate new and preserve existing linkages. The District will cross reference conservation corridors developed by other agencies as properties are considered for protection.

LAND USE

EXISTING CONDITIONS

The Six Mile Creek-Halsted Bay subwatershed contains three cities – St. Bonifacius, Minnetrista, and Victoria, and Laketown Township. These communities span two counties: St. Bonifacius and Minnetrista are in Hennepin County and Victoria and Laketown Township are in Carver County. The City of Waconia is currently outside of the District boundaries, but will be annexing land currently within the Laketown Township portion of the District. Three Rivers Park District's Carver Park Reserve, at 3,700 acres, also constitutes a large portion of the land area of the subwatershed.

The principal land uses with the Six Mile Creek-Halsted Bay subwatershed are parks and open space (25%), agriculture (24%), undeveloped land (22%), water (14%), and low density development (12%).

This subwatershed is one of the least developed within the District. Historically, agriculture has been the predominant land use within the Six Mile Creek-Halsted Bay geography, principally crop (alfalfa and corn) and dairy operations. Agricultural production has driven substantial change to pre-settlement hydrology – ditching and straightening the channel through and between wetland reaches, laying drain tiles to keep agricultural fields clear of water, creating new channels to facilitate drainage, and modifying groundwater recharge while increasing withdrawals.

Beginning in the 1950s, pockets of residential development began to emerge in the landscape, particularly in and around the area that is now St. Bonifacius and in the City of Victoria. Today, the Six Mile Creek-Halsted Bay subwatershed is anticipated to be one of the fastest growing regions of the District. The Metropolitan Council 2015 system statement – which will serve as the basis for the 2040 city comprehensive plans – anticipates that the area will grow by approximately 45% in the coming decades.

The area of highest anticipated residential development is in and around the City of Victoria in what is now Laketown Township. The Cities of Victoria, Chaska, and Waconia have an orderly annexation agreement which over time will lead to the annexation of all of present day Laketown Township. Laketown will dissolve as a governmental unit when it is no longer economically viable.

The northern portion of the subwatershed will have less anticipated development in the near term. St. Bonifacius is approximately one square mile and is nearly entirely built out. The City of Minnetrista anticipates some growth but most of the area within Six Mile Creek-Halsted Bay will remain agricultural under an urban reserve classification.

Parks and Trails are a dominant feature on the Six Mile Creek-Halsted Bay landscape. The 3,700 acre Carver Park Reserve provides significant recreational opportunity while preserving high quality ecological areas and buffering many of the lakes and wetlands from development impacts. The City of Victoria is connected from the east by the Lake Minnetonka Regional Trail, and the City has a network of local trails and bike friendly roads that spur from the regional trail's termination point. In the Northern portion of the geography, the Dakota Regional Trail, which spans from New Lester to Wayzata, runs through St. Bonifacius and Minnetrista. In addition to these existing regional corridors, Three Rivers Park District has plans for a new regional trail that would connect Carver Park to Baker Park in Maple Plain. The City of Victoria's 2030 Comprehensive Plan anticipates the extension of the Lake Minnetonka regional trail along highway 5 towards Waconia and a regional trail spur running south-east towards Chaska.

LOCAL PLANS AND PRIORITIES

City of Minnetrista

The City of Minnetrista will experience limited development within the near term planning horizon, with the exception of possible commercial development along highway 7 and some residential expansion from Woodland Cove on Halsted Bay and Hunter's Crest in the northwest Mud Lake drainage area. The City also anticipates roadway expansion and improvements, which can be critical coordination opportunities as they have the potential to trigger stormwater regulations and impact wetlands.

From a water resource perspective, the City will continue to support the identification of implementation opportunities and funding sources to address the Halsted Bay TMDL.

City of St. Bonifacius

The City of St. Bonifacius is geographically small and almost entirely built out. There is only one area with potential for new development, and otherwise the City anticipates some single parcel redevelopments, dependent upon private real estate transactions. The City has noted that the single vacant parcel would require wetland mitigation and may present a partnership opportunity with the District. The City notes that new development outside of its jurisdiction will impact traffic and potentially require infrastructure investment. The City also has interest in improving its trail and sidewalk networks.

Principal water resource concerns for the City include degraded

wetlands to the northwest and challenges associated with maintaining stormwater infrastructure.

City of Victoria

The City of Victoria is a fast growing community with substantial new development at the urban fringe as land is annexed into Victoria from Laketown Township. The City has two potential growth corridors: South of Marsh Lake Road towards Chaska, and West of highway 43 and Wassermann Lake, including the area around Carl Krey. The City will coordinate closely with the District to incorporate natural resource improvements with new development, particularly as much of the anticipated growth corridors correspond with Wassermann, Marsh, Pierson and Carl Krey. As the City develops, it will focus on connecting people to natural areas through the development of a trail system and green corridors around the lakes.

The City shares many of the identified natural resource priorities with the District, including addressing the Wassermann impairment and protecting non-impaired water bodies. Additionally, the City would like to move increasingly towards regional stormwater management within new developments, in coordination with the District.

City of Waconia

The City of Waconia does not anticipate growth within the Six Mile Creek-Halsted Bay geography for another 15-20 years. The City of Waconia is a growing community, though the growth projections have been slowed for the upcoming planning cycle, as they have in many exurban communities. The City of Waconia prioritizes the efficient use of land and extends infrastructures service only to areas where these services can be provided in a cost effective manner. This means maintaining compact and regular growth patterns and preserving exurban farm land and natural areas. Areas outside of the current City will continue to be zoned by Carver County, but the City advises no multi-lot subdivisions should be permitted in advance of City development.

The City does not yet have specific water resource concerns within the Six Mile Creek-Halsted Bay subwatershed, but in general the City is working to identify and execute upgrades to existing older infrastructure in the City core and implement innovative water management strategies in newer developments.

Laketown Township

The Cities of Victoria, Waconia, and Chaska have an orderly annexation agreement that would result in the complete annexation of Laketown Township over time. The Laketown Board has limited authority over land use and relies on County zoning. As the land develops and is annexed, the Township

Six Mile Marsh prairie restoration, Erdahl Aerial Photos would like to see natural resources protected and improved concurrent with or in advance of new infrastructure installation. The Township is particularly invested in protecting and improving Pierson and its drainage area, through direct capital investment and addressing potential sewerage service failures.

Three Rivers Park District

Three Rivers Park District (TRPD) is Hennepin County's regional parks authority. Carver Park Reserve is one of three parks that lies outside of Hennepin County, its taxing jurisdiction. The Property was acquired through donation. The property contains a nature center, historic farm, and extensive bike, pedestrian and equestrian trails. Many of the subwatershed's high value resources are located within the park, and the park serves an important protection role for these resources. There are no major changes to land use anticipated within the park, but TRPD does have long term plans to extend a regional trail north out of Carver Park to Baker Park in Maple Plain, which may present coordination opportunities over the coming years.

TRPD is a mission-driven organization focused on promoting environmental stewardship through recreation and education within its nature-based park system. As such, it shares many of the District's water resource priorities, including managing carp and preserving high quality natural resources within and adjacent to its parkland.

Lake Associations

There are three active lake associations within the subwatershed: Area Partnership for Pierson Lake Enhancement, Wasserman Lake Association, and Lake Zumbra-Sunny Association. The District has engaged with each of these associations on concerns specific to their respective waterbodies and will continue to engage with them through the Watershed Association Initiative and through implementation of this Subwatershed Plan.

WATER RESOURCE MANAGEMENT UNIT

Due to its size, complex drainage patterns and nutrient interactions, and mosaic of jurisdictions and authorities, the District divided the subwatershed into five management units for planning purposes. These management units reflect both the jurisdictional boundaries and the distinguishing natural resource interactions. Each management unit discussion below walks through the issues, drivers and strategies framework in more detail and with specific reference to primary water bodies of concern and specific management strategies. Management strategies within this section were further informed by coordination with the Six Mile Creek-Halsted Bay Subwatershed Partnership.

PIERSON-MARSH-WASSERMANN

The Pierson Marsh Wassermann management unit begins in the south-western corner of the subwatershed in Laketown Township and runs through the City of Victoria, terminating near downtown Victoria at Carver Park Reserve. Pierson Lake is the headwaters of the system and has a small drainage area with agriculture and rural residential development. Pierson Lake outlets at its southern edge and runs into Marsh Lake, a shallow, natural-resource lake with no shoreline development. Marsh runs through several large wetland complexes into Wassermann Lake, which is also the edge of Victoria's current City line. Wassermann drains towards East Auburn through several large wetland and pond complexes. A separate drainage runs from Church Lake and Victoria's downtown into East Auburn.

Existing Conditions and Issues

The Pierson-Marsh Wassermann system is the headwaters of the Six Mile Creek-Halsted Bay subwatershed. Pierson Lake has good water quality and is largely a protection area. Marsh exhibits elevated phosphorus at its lake outlet, indicating possible internal release. Wassermann is impaired for nutrients and requires 62% or 470 lbs/year total phosphorus reduction to meet state deep water quality standards.

The smaller lakes along the creek north of Wassermann are generally of good water quality, with the exception of Church Lake, which has fluctuated around state standards for quality and clarity, likely associated with upstream pollutant loading.

The area contains many large wetland complexes. There are a number of complexes immediately adjacent to agricultural land use that are poor quality, likely due to altered hydrology and associated vegetation impacts. The large wetland complex

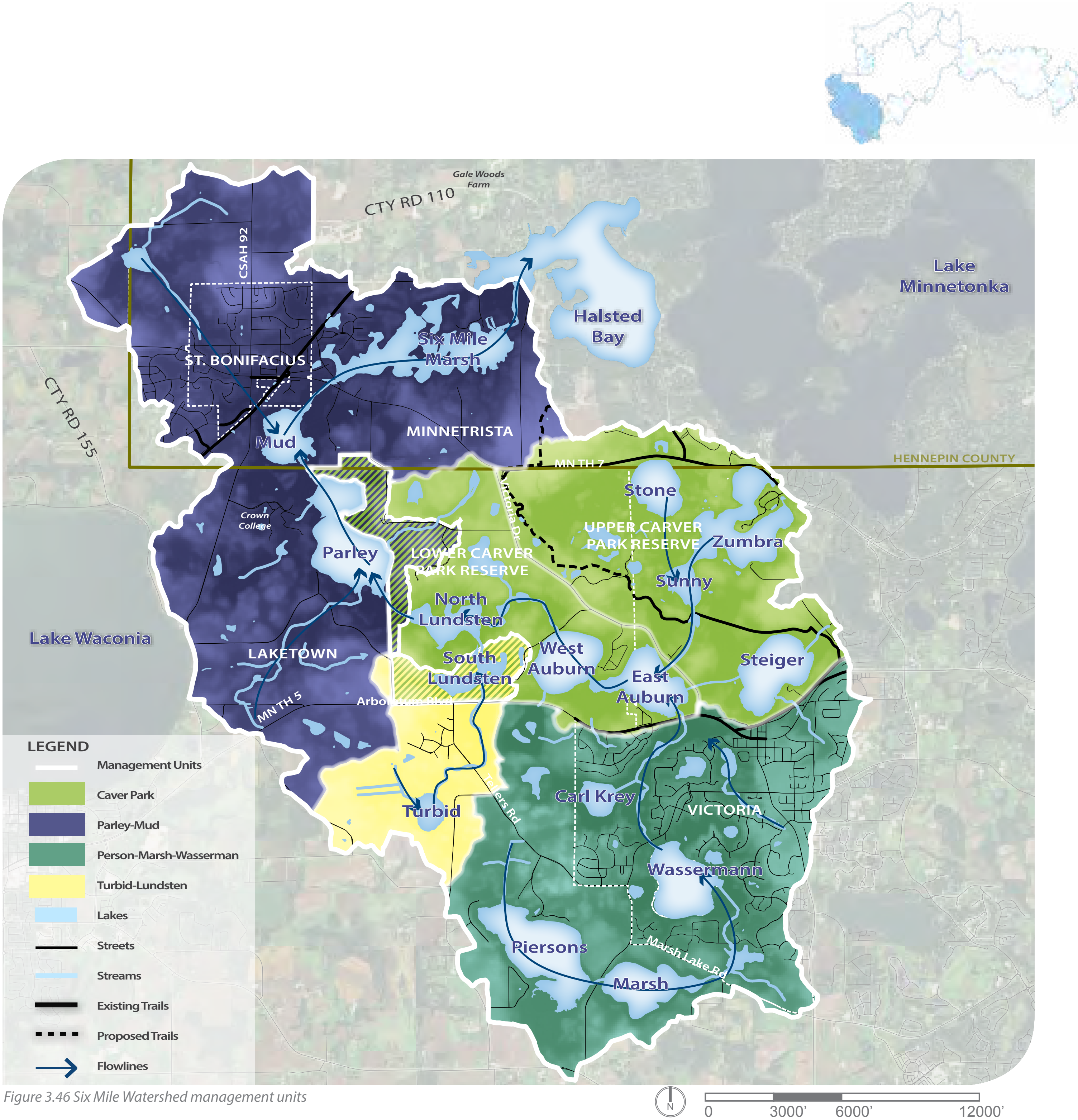


Figure 3.46 Six Mile Watershed management units

running along the creek between Wassermann north of highway 43 to highway 5 is likely a significant source of external phosphorus loading to East Auburn Lake.

Marsh is a shallow lake with 100% littoral area, resulting in abundant plan growth of both native and non-native species. Its shoreline currently is fully intact and is largely wetland fringed.

Wassermann has a degraded aquatic plant community and a poor fish community.

Anecdotal evidence suggests that Pierson Lake's fishery has improved since a 2011 carp removal effort.

Drivers

Pierson has a small subwatershed and much of the phosphorus loading is from stormwater runoff from the surrounding agricultural landscapes. The agricultural drainage has been heavily modified through the introduction of drain tiles and ditches. Carp within the lake are currently below the impact threshold but it remains connected to spawning areas and needs to therefore be monitored while carp reproduction remains active.

The elevated phosphorus levels at the outlet of Marsh Lake indicate that internal loading is the likely driver of moderately elevated phosphorus levels, which could be attributed to carp or internal release. The U of M carp assessment identified Marsh as a potential carp nursery, fueling the adult carp population in Pierson and Wassermann. The properties adjacent to Marsh will likely experience suburban development in the coming decade, including a roadway improvement to Marsh Lake Road which will likely facilitate additional residential development, potentially impacting water quality and the currently intact shoreline integrity.

Wassermann's poor water quality is driven by both internal and external phosphorus loading. The principal external sources are wetland complexes draining to the lake. Internal loading is partially driven by decades of accumulation of phosphorus-laden sediment from the surrounding drainage area, which was almost entirely agriculture and rural residential until the 1990s. The high density of carp in Wassermann further drives the internal release of phosphorus, in addition to negatively impacting the clarity and plant vegetation.

This management unit will face significant growth pressure in the coming decades as both Waconia to the east and Victoria to the west grow in population and annex land in Laketown Township under an orderly annexation agreement, which they share with Chaska. The primary growth corridors for Victoria's 2040 Comprehensive Plan are east towards Waconia and South towards Chaska. Development in this area will present opportunities to preserve and enhance natural resources systems and enforce District rules designed to minimize the impact of new development, in some cases resulting in improved conditions over current agricultural use.

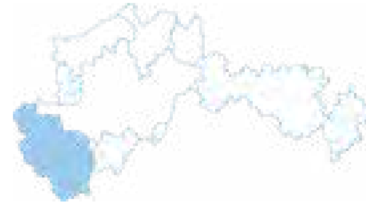
Development will be a significant factor in natural resource protection and enhancement in the coming decades. District stormwater rules can result in improved water resource outcomes, particularly when transitioning from agriculture. Development will provide opportunities to coordinate on wetland enhancements, create contiguous natural resource corridors, and generate other water quality projects. However, development can also have adverse impacts by altering natural hydrology and creating wetland fill. Some categorical exceptions to the District phosphorus rules may cause increased pollutant loading. This drainage area will experience the most land use change in the near time of any other area of the subwatershed given Victoria's projected growth and annexation.

Management Strategies

Carp Management

Carp management will be a principal strategy within this management unit. Refer to the Six Mile Carp Management Plan for a detailed overview of the carp management approach. Strategies presented in the management plan will include:

- Aeration of Marsh Lake to prevent winterkill and reduce carp recruitment
- Temporary barrier at the outlet of Wassermann to prevent fish from reentering Wassermann from downstream lakes during management
- Adult biomass removal in Wassermann Lake. Piersons



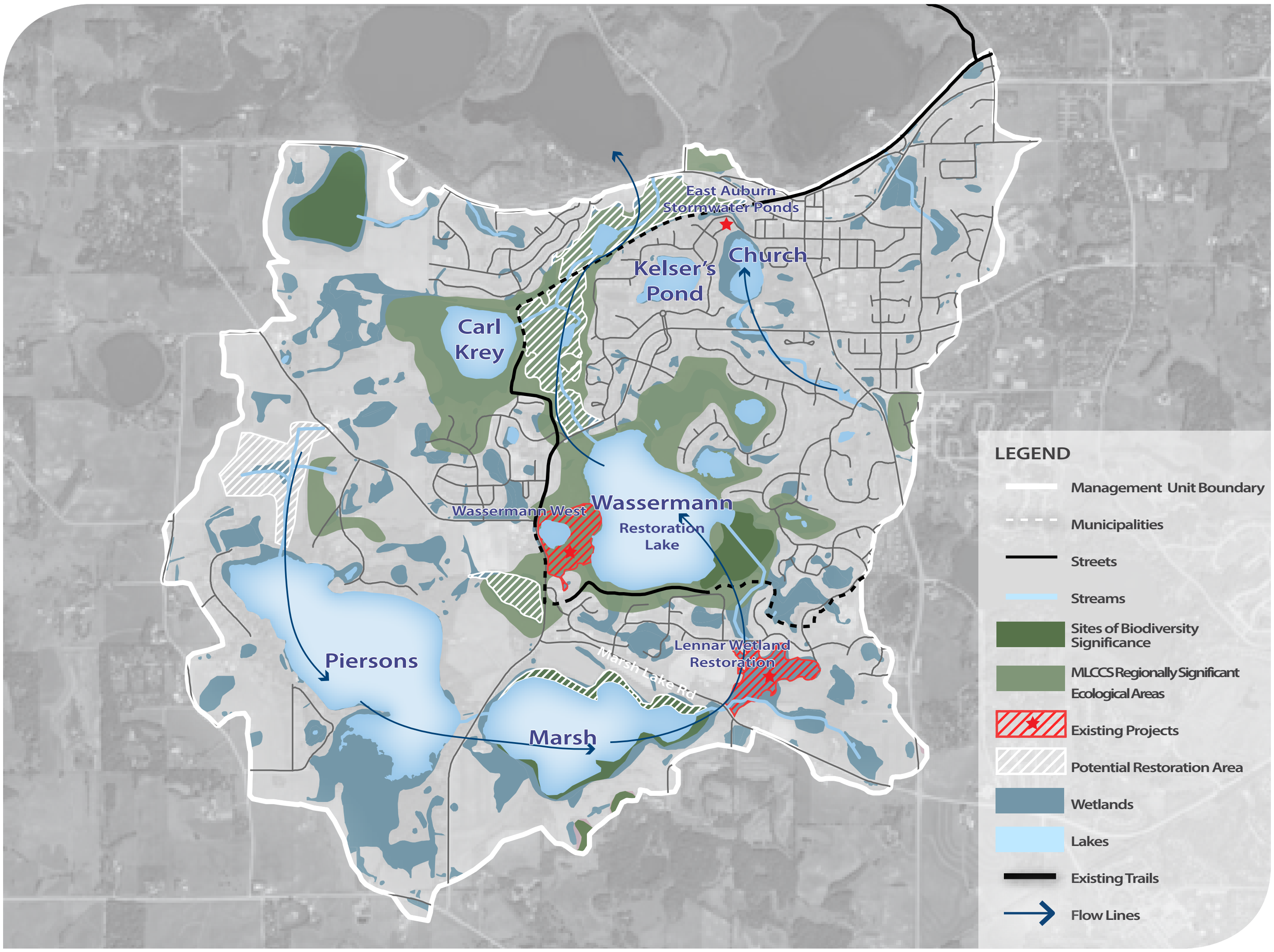
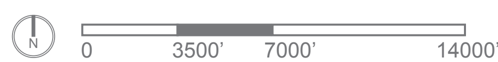


Figure 3.47 Pierson-Marsh-Wasserman Management Unit map



Lake is currently below the threshold, and should be monitored periodically, but no further action is needed at this point.

Stormwater Management

As new developments occur in the City, Victoria will increasingly work to identify regional stormwater solutions. Regional stormwater management can improve water resource outcomes over site by site management by incorporating areas that may otherwise be exempt from regulatory compliance and by treating the entire drainage area upfront, bringing the area into compliance immediately.

In the developed areas of downtown, there may be opportunities for retrofitting or enhancing existing stormwater facilities to improve treatment capacity of stormwater above existing regulatory requirements.

The District will not employ agricultural best management practices programs as a principal strategy, but it will provide technical support to agencies and landowners seeking to take advantage of such programs.

Wetland Restoration

There are several large wetland areas that will be targeted for phosphorus load reduction, including those north of Pierson Lake, between Marsh and Wassermann, and along the creek between highway 43 to highway 5. Strategies may include hydrologic alteration, vegetation enhancement, soil amendments, or outlet filtration. Some of the wetland complexes that are identified phosphorus export wetlands are on City-owned outlots, facilitating restoration.

Internal Sediment Phosphorus Control

Internal phosphorus loading is a significant source of nutrient pollution in Wassermann Lake. The 2013 Six Mile Diagnostic recommends alum dosing to provide internal load control. Carp tend to stir up bottom sediments in littoral areas and can reduce the effectiveness of alum, so carp control must precede alum treatment. Marsh Lake may be a target for similar internal control.

Landscape Protection and Restoration

Urban growth is anticipated to continue in this management unit. The District will evaluate opportunities on an ongoing basis for strategic acquisition in fee or conservation easement to ensure that natural resource protection and development goals are compatible. Priority landscape areas in this management unit may include:

- » Shoreline protection on Marsh and Pierson Lakes
- » Preserve wetland complexes in exurban areas
- » Degraded, hydrologically altered wetlands
- » Areas with steep slopes adjacent to water resources
- » Areas otherwise identified through District studies and evaluation (E-Grade, etc)

City of Victoria has interest in connecting people through development of trails, which can be strategically integrated into land use planning and acquisitions.

Mud Lake, looking southwest, Erdahl Aerial Photos

Lundsten Lake

Piersons Lake, Erdahl Aerial Photos

UPPER CARVER PARK RESERVE

Upper Carver Park includes Lakes Zumbra, Stone, Sunny, and Steiger. The management unit is almost entirely within Carver Park and all lakes exhibit good water quality. Both Zumbra and Stone are headwaters lakes with relatively small drainage areas that drain into Sunny Lake, Zumbra directly and Stone through a wetland complex. Sunny then flows towards East Auburn through a large wetland complex. Steiger receives drainage from downtown Victoria, then drains through a separate wetland complex, also into East Auburn. Given that the land is owned almost entirely by Three Rivers Park District as a park preserve, the water quality within this drainage area can be anticipated to remain stable.

Existing Conditions and Issues

All lakes within the subwatershed have good to excellent water quality. Though Stone was identified as exceeding state nutrient standards and has an adopted TMDL, it has improved every year since 2000 and should be considered a protection watershed. Zumbra has excellent water quality and a small watershed that keeps it well buffered from watershed loading. Steiger does have somewhat elevated phosphorus levels, but has not seen any concerning trend over the monitoring time period and continues to be in good health overall.

Phosphorus concentrations jump significantly between both Sunny and East Auburn and Steiger and East Auburn, indicating the wetlands are contributing phosphorus to surface water. These wetlands are important target areas for nutrient pollution reduction.

This drainage area experienced localized flooding associated with the 2014 high water event. Further investigation found that in heavy rain events, Sunny Lake rises faster that Zumbra and creates backwater flooding into Lake Zumbra. The District will continue to investigate possible solutions and mitigation strategies.

The aquatic plant communities in Sunny, Steiger and Stone are in poor condition, and the Fish IBI score for Steiger is classified as poor. Sunny and Stone cannot be assessed by the Fish IBI due to their size and depth. Zumbra generally has a good aquatic plant and fish community.

Though there is some private ownership within Carver Park Reserve and a few drainages to Carver lakes that enter from outside the Park proper, overall the management unit is held almost entirely by Three Rivers Park District and there are therefore no major land use issues facing the management unit. It is possible that the agricultural legacy within the Park has some impact on existing impairments, but without land use change and with Three Rivers sharing natural resource protection as foundational to its mission, land use itself will not be a significant factor in the management unit.

Drivers

For the most part, water quality within this management unit is stable and good, likely in part due to the substantial natural resource buffer the Carver Park Reserve provides.

Steiger Lake's moderate water quality is likely driven in part by stormwater runoff from downtown Victoria. This area of Victoria is fully built out, but as redevelopment occurs under more stringent stormwater rules some reduction may be achievable.

The four lakes also have relatively low carp populations. The 2016 U of M Carp Assessment confirmed that the carp populations within these lakes are largely isolated from one another due to a rather complex series of water control structures. Future changes to or replacements of these structures should consider the impact on carp populations.

Strategies

Wetland Restoration

The wetland complexes running from the outlets of Sunny and Steiger to East Auburn need to be evaluated for wetland restoration to control phosphorus export. A complementary project may be the construction of a lake outflow bypass pipe, which would circumvent the degraded wetland complex for water leaving Sunny and Steiger. However, this idea may have fish passage or wetland hydrology implications that would need to be further evaluated. There are other restorable wetlands within Carver Park Reserve that may be considered for restoration to improve habitat function and value on an opportunity driven basis.

Carp Management

Sunny Lake is a potential carp nursery location and will be

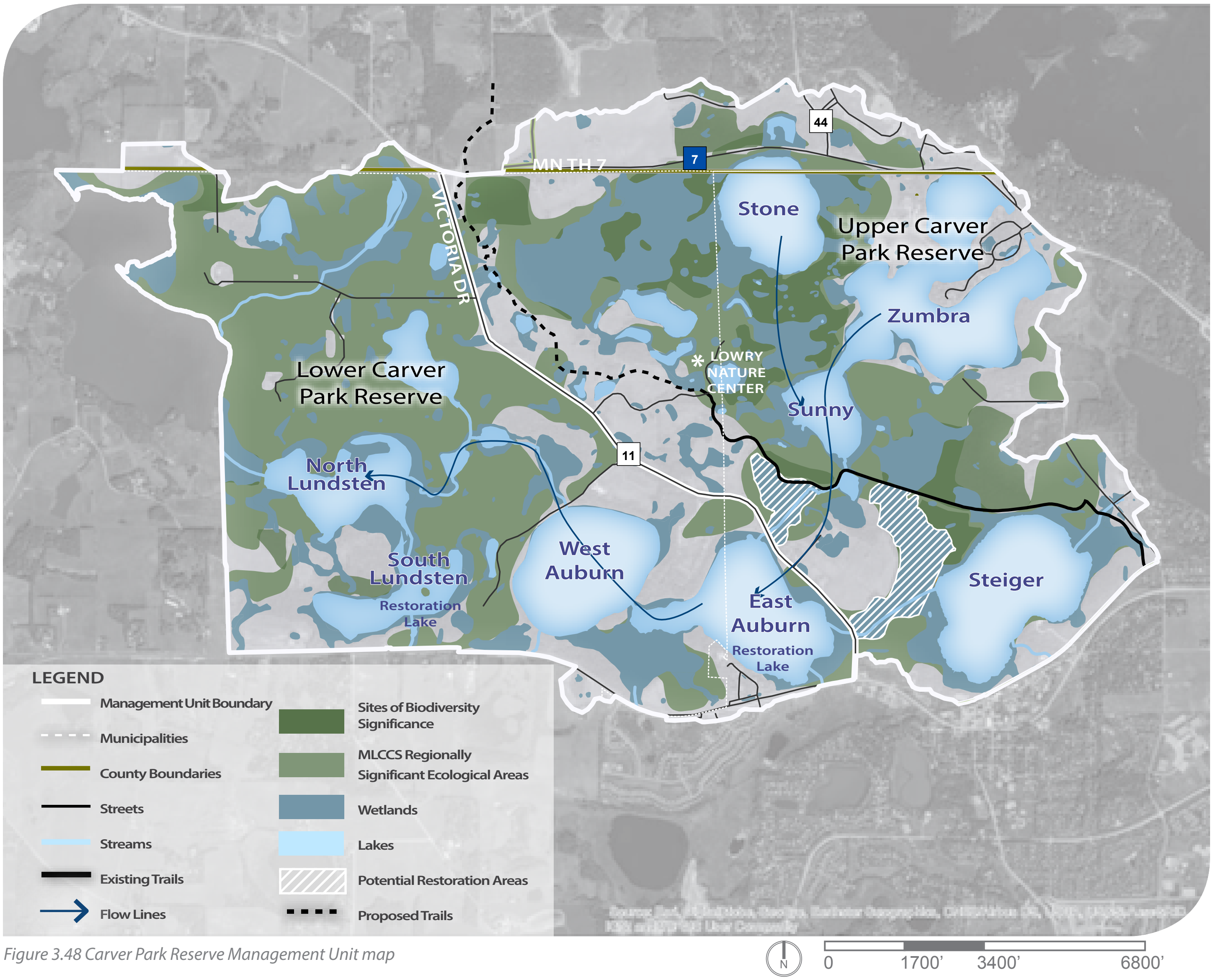


Figure 3.48 Carver Park Reserve Management Unit map

considered for winter aeration, or at least monitored annually for carp recruitment. The current barrier at the Zumbra outlet is also in need of repair, and should be fortified as it currently overtops in high water conditions. Minimal adult biomass removal is needed in Steiger, Zumbra and Sunny to bring population levels to the desired threshold. Stone Lake is already below the threshold, and requires no management actions.

Landscape Protection and Restoration

As TRPD works to acquire land to develop the regional trail connection between Carver and Baker Parks, there may be opportunities where new trail connections correspond with resources or potential project locations within the Six Mile Creek-Halsted Bay geography. The District and TRPD will coordinate acquisitions in the trail corridor to identify potentially mutually beneficial acquisition opportunities

LOWER CARVER PARK RESERVE

The lower Carver Park Reserve management unit includes East Auburn, West Auburn, and North Lundsten Lakes. East Auburn receives drainage from both the Wassermann and Upper Carver Park management units and its water quality is substantially impacted by its being a collection point for the upper watershed. North Lundsten is a very shallow lake with an average depth of 4.4 feet and a very short residence time. It receives drainage from both West Auburn and South Lundsten.

Existing Conditions and Issues

East Auburn is impaired for nutrient pollution and has an adopted TMDL requiring a load reduction of 546 lbs/year. Both West Auburn and North Lundsten demonstrate relatively good water quality, though North Lundsten has demonstrated some eutrophic indicators and elevated phosphorus levels.

Wetlands within this drainage area are generally high quality and classified as Preserve. They are well buffered from degradation given their location within Carver Park. Auburn Marsh, a wetland draining to West Auburn, is identified by the DNR biological survey as a site of biodiversity significance. Much of the drainage area has also been identified as MLCCS regionally significant ecological areas and DNR regionally significant ecological areas.

These lakes all consist of poor aquatic plant communities, and Fish IBI scores for East and West Auburn indicate a poor fish community. North Lundsten cannot be assessed with the Fish IBI tool due to its size and depth.

The drainage area is located entirely within Carver Park Reserve and there will therefore be no development or significant land use change.

Drivers

East Auburns' impairment is driven largely by the phosphorus exporting wetlands in both the Wassermann and Upper Carver Park drainage areas. Upstream lakes are also a significant factor in East Auburn's impairment, with Church and Wassermann Lakes contributing approximately 36% of the load to East Auburn. These lakes will need to meet state water quality standards for East Auburn to meet standards.

Observations of elevated phosphorus levels in North Lundsten are driven primarily by phosphorus export from South Lundsten, which is a highly eutrophic waterbody. There do appear to be different levels at the inlet and outlet of North Lundsten, which indicates some amount of internal loading driving North Lundsten's elevated phosphorus levels.

Six Mile Marsh, looking east, Erdahl Aerial Photos

Though carp do not seem to be a principal driver of water quality issues within the Lower Carver Park drainage area, carp biomass is moderately high in both West and East Auburn and North Lundsten. North Lundsten is also a potential carp recruitment area, and warrants winter aeration to prevent winterkill.

Strategies

Carp Management

Adult biomass removal will be necessary to reduce the carp density below the damaging threshold in all three lakes in this system. South Lundsten is the principal nursery for this area, along with some contribution from North Lundsten, so aeration of those lakes will need to precede removal activities. Multiple removal methods could be utilized to reduce adult carp populations in these lakes, including winter or open water seining, box-net trapping and trapping of carp in channels used for migration.

Wetland Restoration

Wetlands driving poor water quality within East Auburn are those beginning at the outlets of Wassermann, Sunny, and Steiger and draining to East Auburn. These wetland complexes will be evaluated for bypassing flow around the wetland, the addition of nutrient filters, soil engineering or augmentation to permanently sequester phosphorus, or the development of wetland treatment cells.

Internal Load Management

The contribution of internal loading to North Lundsten's elevated phosphorus levels should be further evaluated and alum may be employed to address downstream loading concerns. Eventually, whole lake drawdown may be used to reset the shallow lake ecology following successful carp management.

Upstream Lake Improvements

Restoration of upstream lakes in the Pierson-Marsh-Wassermann corridor will be critical in addressing East Auburn's impairment, with upstream lakes contributing approximately 32% of the phosphorus load into East Auburn.

It seems that the elevated phosphorus levels in North Lundsten are driven almost entirely by the highly degraded South Lundsten, which in turn drives the impairment of Parley Lake. Though South Lundsten is classified as a wetland and therefore not subject to lake water quality standards, its degraded state drives other impairments and therefore nutrient reductions need to be prioritized.

TURBID-SOUTH LUNDSTEN

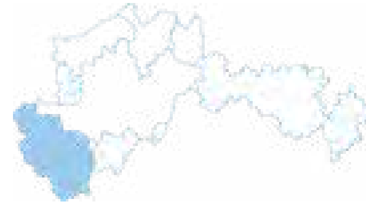
The Turbid-South Lundsten management unit lies just west of Victoria in Laketown Township. Though Turbid and Pierson Lake are approximately one mile away from each other, they are hydrologically disconnected, with their tributaries flowing in opposite directions. This management unit is relatively small and contains only two waterbodies connected by a low gradient stream flowing through several degraded wetland complexes. A majority of the land in this management unit is in Laketown Township, though South Lundsten is entirely within Carver Park Reserve. Outside of Carver Park Reserve, the land is almost entirely agricultural with one single family subdivision, Rolling Meadows. The subwatershed is in the long-term growth trajectory of Victoria, though likely outside of the next 20 year plan cycle.

Existing Conditions and Issues

Turbid Lake is at the headwaters of the management unit. It has a large littoral area, despite being a deep lake. Turbid is impaired for nutrients and requires both internal and external load reduction. South Lundsten is a larger, shallow lake, with extremely high phosphorus concentrations. Because it is classified for TMDL purposes as a wetland there are no mandated reductions for this waterbody.

Wetlands within this drainage area are largely degraded and water quality monitoring along the creek indicates they are significant contributors to elevated phosphorus in both water bodies. Much of the land around South Lundsten and within Carver Park Reserve has been identified by DNR as having biodiversity significance or as a regionally significant ecological corridor.

The aquatic plant community in South Lundsten is considered poor, while the community in Turbid is considered degraded. Neither lake is large enough or deep enough to be assessed with the Fish IBI tool.



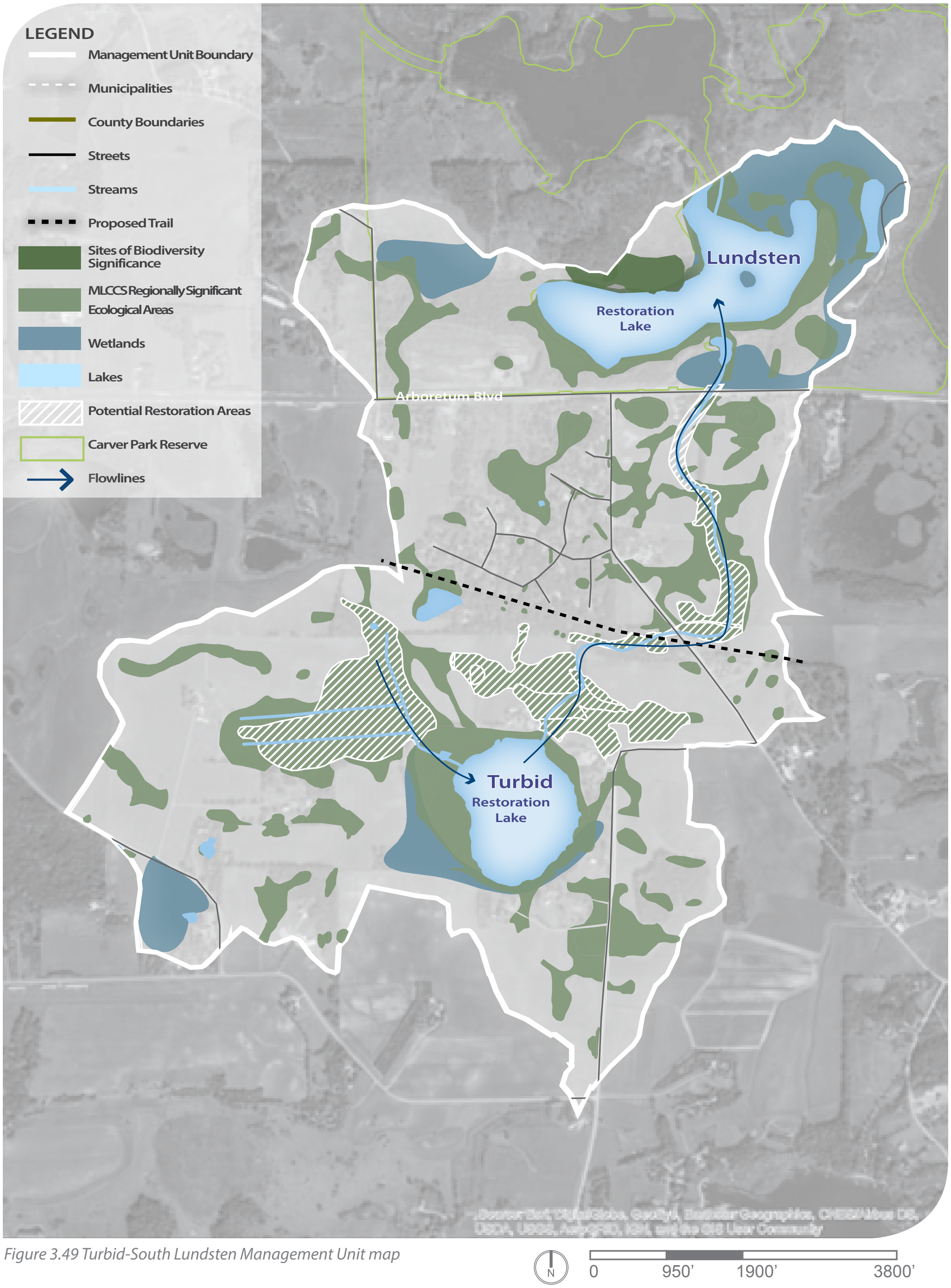


Figure 3.49 Turbid-South Lundsten Management Unit map

Land use within this management unit is agricultural and residential. The management unit is near what eventually will be the western edge of the City of Victoria, but is not anticipated to develop within the near-term. As such, implementation activities will likely precede development.

Drivers

Turbid's and South Lundsten's poor water quality are driven by similar factors. Nutrient loading to Turbid Lake is dominated by internal loading, representing 65% of the phosphorus load to the lake. Watershed loading represents the other major contribution to nutrient pollution, principally from the large wetland complex to the west of the Lake.

South Lundsten experiences an extremely high internal phosphorus release rate. Watershed loading is also quite high, though it is proportionately only 17% of the total load. Much of the watershed loading can be attributed to the degraded wetland complexes between the two waterbodies.

Carp biomass is high in Turbid and moderate in South Lundsten. Both lakes are also production areas, with South Lundsten being an active and highly productive carp nursery for the upper watershed system.

Strategies

Carp Management

The Turbid-Lundsten Corridor is high priority for near-term carp management activities. Both lakes require aeration to prevent ongoing carp recruitment. South Lundsten in particular has been identified as a principal recruitment area, with carp dispersing as far as Wassermann from this lake. Once these systems are aerated, adult removal may also be prudent.

Wetland Restoration

Two feasibility studies completed in 2010 identify a multi-phased wetland and stream restoration project to substantially reduce watershed loading to both Turbid and South Lundsten Lakes. The project includes wetland restoration and hydrologic modification in the drainage area to Turbid Lake and in the wetland and stream corridor between Turbid and South Lundsten. The project may have secondary benefits of restricting carp movements between the two waterbodies. The project may be implemented concurrent with or in advance of development reaching this area of the subwatershed.

Landscape Restoration and Preservation

The proposed wetland restoration within this subwatershed will result in changes in hydrology that will increase wetland acreage, in some cases on land that is currently within agricultural production. The District may employ its land conservation program to maximize the opportunity for this project to address downstream loading concerns. These wetland areas would eventually be deeded to the City of Victoria when this area develops, so the District would work in close coordination not only with the landowners, but also with the City, which eventually will have jurisdiction in this area.

PARLEY-MUD-HALSTED

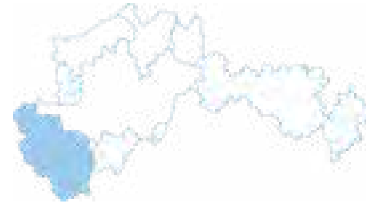
The Parley-Mud-Halsted management unit constitutes the whole lower watershed drainage area. With a dam between North Lundsten and Parley Lakes, this management unit is hydrologically disconnected from the upper subwatershed. In this drainage, water flows from Parley into Mud, then travels approximately 3 miles through Six Mile Marsh into Halsted Bay. The drainage area is mostly within Hennepin County in Minnetrista and St. Bonifacius, but some of the Parley lakeshed is currently in Laketown Township in an area that eventually will be annexed by the City of Waconia as it grows east.

Existing Conditions and Issues

Both Parley and Mud Lakes are highly eutrophic shallow lakes with high total phosphorus concentrations. Parley Lake has an approved TMDL requiring a reduction of 1,270 lbs/ year, or a 44% reduction. Mud Lake has very high phosphorus, but is considered a wetland for TMDL development purposes. Both lakes have degraded and low diversity vegetative communities.

Halsted Bay has an approved TMDL requiring the largest phosphorus load reduction in the District. It routinely falls well above state standards for nutrient concentrations, Chlorophyll-a, and clarity. The plant community of Halsted Bay is highly degraded and dominated by Eurasian water milfoil, coontail, and Curly-leaf pondweed.

This management unit contains numerous large wetland complexes, including Six Mile Marsh, which spans the three miles from Mud Lake to Halsted Bay. There are numerous other large, degraded wetlands that likely are a significant source of phosphorus pollution into the lakes.



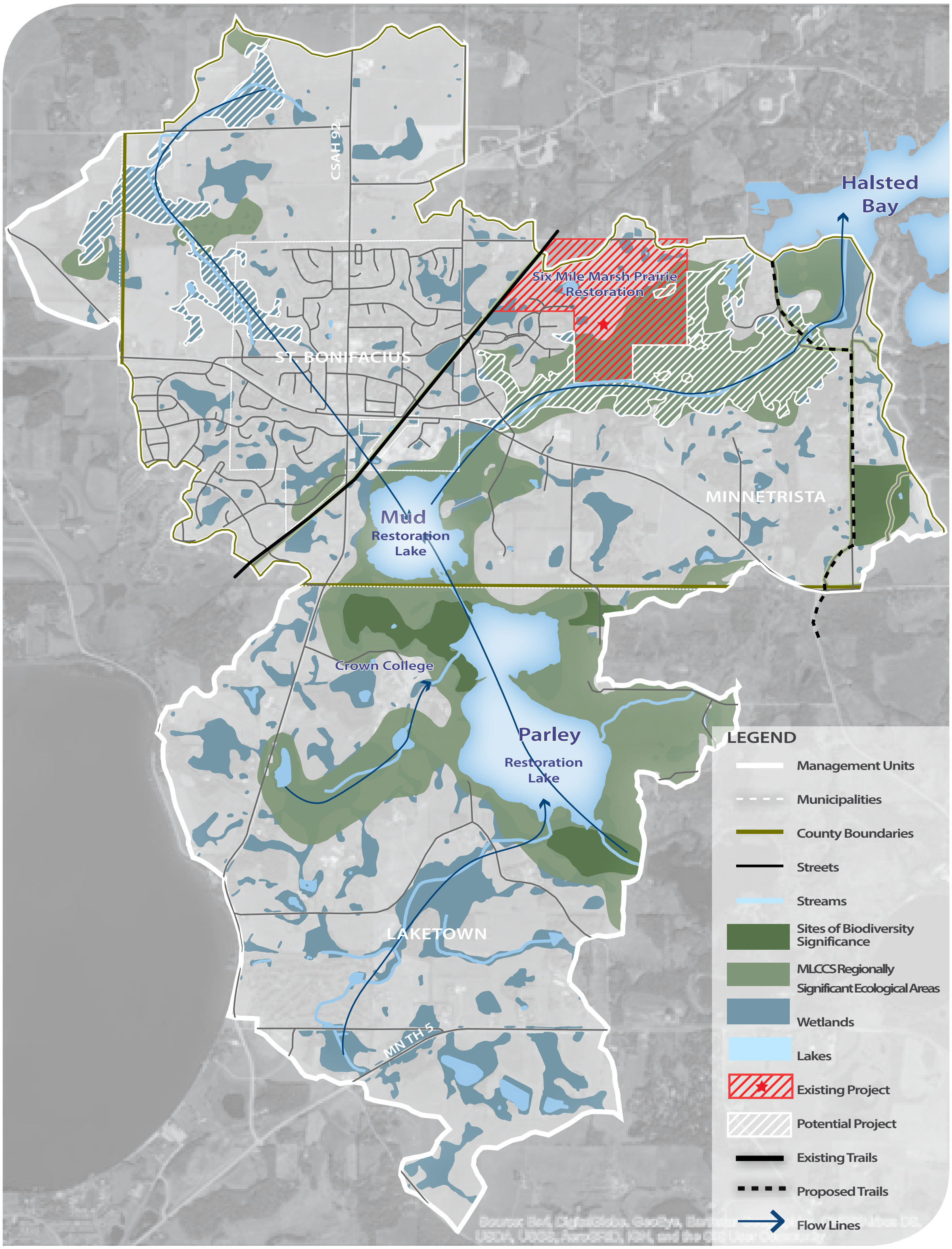


Figure 3.50 Parley-Mud-Halsted Management Unit map

Land use within this management unit is mostly rural residential and agricultural. The City of St. Bonifacius, a one square mile community just north of Mud Lake, is almost entirely built out with some redevelopment anticipated and a few remaining vacant parcels. The population center at St. Bonifacius also supports several residential developments just across the City line in Minnetrista. Little land use change is anticipated in the near term in the Minnetrista area except on some specific parcels adjacent to St. Bonifacius and along Six Mile Marsh.

Drivers

2006 monitoring observed very high levels of primarily orthophosphorus coming from the drainage directly east. Modeling of Parley Lake indicates that it is driven by internal loading (17%), loading form the direct drainage area (38%), and loading from upstream North Lundsten Lake (41%). Several wetlands in the direct drainage area have been identified as potential sources of phosphorus loading, but require additional analysis. In total, Parley requires a 44% reduction, with the greatest reduction needed being in internal loading (61%).

Mud Lake experiences elevated phosphorus levels driven by both watershed loading and inputs from upstream Parley Lake. Internal loading is proportionately small but not insubstantial.

Halsted Bay is driven principally by loading from Six Mile Creek (50%), followed by internal loading (40%). A 2017 technical evaluation provided a more in-depth analysis of the loading from Six Mile Creek to determine the respective contributions from Mud Lake itself as compared with Six Mile Marsh. The results indicate that Six Mile Marsh contributes about 4-8% of the load, which is significant for a single phosphorus source. More significantly, the analysis found the wetland to be a significant transformer of phosphorus, settling out particulate phosphorus and releasing dissolved, which is more difficult to treat.

Carp are a significant factor in this system. Carp populations are very high in all three lakes, particularly in Halsted Bay itself, where the U of M researchers found carp concentrations higher than observed anywhere else in the Center's history. Carp move freely between the three lakes. The carp assessment identified three likely recruitment areas within the management unit: Mud Lake, Big SOB, and a pond on Crown College campus. The landowner of Big SOB has already begun aeration. Some carp are able to migrate from South Lundsten into Parley Lake, but traveling back upstream is restricted by the dam.

Strategies

Carp Management

Managing carp in this 3-lake system will require a multi-pronged and adaptive approach. The 2017 U of M Carp Assessment recommends the following approach:

- Installation of a permanent barrier along Six Mile Marsh to create two distinct carp management units, Parley-Mud and Halsted Bay
- Control recruitment through aeration or barriers to block access to Mud Lake, and either aeration or hydrologic separation of Crown College pond. Continue to aerate SOB Lake.
- Adult biomass removal following successful suppression of recruitment.

Internal Load Control

Following successful reduction of the adult carp population, alum may be used to address ongoing internal phosphorus release in Mud and Parley.

Alum will also be a strategy for reduction of internal phosphorus release in Halsted Bay. While typically the recommendation would be to control carp populations first, it may be feasible in Halsted Bay to apply alum in the deep areas of the lake while carp populations are still high in the littoral zone.

Whole Lake Drawdown

Following or concurrent with reductions in the adult carp population in both Mud and Parley Lakes, whole lake drawdown may be considered to restore plant vegetation and return the lakes to a clear water state.

Wetland Restoration

Restoration of large, degraded wetlands draining to both Mud and Parley Lakes will be principal strategies for reducing watershed loading. There are several, smaller wetlands identified in the Mud Lake Drainage Assessment that will also be targeted concurrent with local development and investment.

Stormwater Management

The 2017 Mud Lake Assessment identified existing stormwater facilities in the City of St. Bonifacius that could be retrofitted with enhanced filtration facilities to increase its effectiveness at removing phosphorus pollution. Retrofitting existing facilities will be coordinated with local priorities and infrastructure investments. The Mud Lake Assessment also provides a detailed analysis of the most cost effective retrofit opportunities.

Application of agricultural best management practices will also be an important strategy within the Mud and Parley Lake drainage areas. The District will support agency partners and landowners in identifying resources to implement agricultural best practices but will not play a direct role in implementation of agricultural practices.

Alum Injection Facility

While the goal ultimately is to fully restore upstream Mud and Parley Lakes, the process for doing so will take years of implementation and require leveraging significant external funding. In 2012, the District evaluated the feasibility of a structural solution to phosphorus loading in Halsted Bay and identified the option to build an offline alum injection facility that would treat water moving through the creek before entering Halsted Bay, substantially reducing the large load coming through Six Mile Marsh. The lifecycle of such a solution would be approximately 30 years, providing an interim solution while the upstream system is restored.

Landscape Protection and Restoration

Minimal urban and suburban growth is anticipated in this management unit which limits the implementation opportunities to leverage local development growth for greater natural resource benefit. The District will continue to leverage this approach where applicable in coordination with the Cities of St. Bonifacius, Minnetrista, and Waconia, but in the near term land acquisition will be a strategy principally applied to achieve watershed load reductions and wetland restorations as outlined above.

IMPLEMENTATION PLAN

The goals set forth in this subwatershed plan will require an integrated set of programs and projects oriented toward conserving and improving water resources within the watershed. The Implementation Priorities section generally describes the actions that the District and its partners will look to take in order to address the issues present in the

Six Mile Marsh, looking west, Erdahl Aerial Photos subwatershed and achieve the goals as set forth in the plan. The Capital Improvement Plan (CIP) provides cost estimates and schedules for any proposed capital investments.

IMPLEMENTATION PRIORITIES

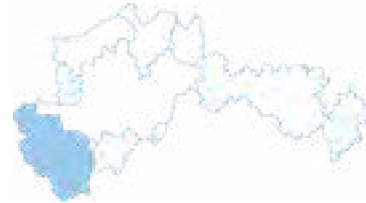
As described in previous sections, the Six Mile Creek-Halsted Bay Subwatershed is a large subwatershed, spanning 27 square miles, with an extensive lake, wetland, and stream system. It is one of the headwaters of Lake Minnetonka, the most heavily used recreation lake in the State, with Six Mile Creek terminating in Halsted Bay of Lake Minnetonka, a highly impaired Bay requiring the largest phosphorus load reduction in the District.

The system upstream of Halsted Bay is a complex network of shallow and moderately deep lakes – many of which have a large littoral area – and hydrologically altered wetlands. Five of the upstream lakes are impaired for phosphorus. Each lake impairment is driven by a complex interplay of internal load, degraded wetlands, and upstream waterbody contribution, largely driven by historic agricultural land use in the area.

Given the need to address the impairment of both Halsted Bay and the upstream lake system, the abundant and interconnected natural resources, the range of jurisdictions covered by this large geography, the pace of residential growth in the area, and the existing relationships and partnerships with public and private agencies operating in this area, the District has identified the Six Mile Creek-Halsted Bay subwatershed as a priority area to focus implementation efforts in this plan cycle. The District has convened a group of agency partners in the region to identify priorities for the development of this plan as well as moving forward with implementation of the plan.

The capital improvement plan (CIP) for the subwatershed identifies projects that have undergone some level of feasibility and are anticipated for project initiation within the next five years. These include projects identified in the last plan cycle that feasibility work now proposes to be a good investment, as well as several projects (East Auburn Stormwater Enhancement and Wassermann West) that have been initiated as plan development has been underway.

Rural landscape



The CIP also includes a number of implementation strategies – stormwater management, wetland restoration, internal sediment phosphorus control, whole lake drawdown, and stream channel restoration – that have been identified as critical components of the subwatershed's protection and restoration but that have not yet undergone preliminary feasibility. Projects opportunities within these implementation strategies will be evaluated on an ongoing basis in coordination with the Six Mile Creek-Halsted Bay subwatershed partnership and based on factors such as available funding, land rights, opportunities to integrate the work with other agency priorities, common sense sequencing of priorities, and cost-benefit analyses.

As previously noted, Common Carp are very abundant within this system and exhibit high mobility between lakes. Carp can render other management activities for shallow lake restoration, including alum and vegetation management, ineffective, and carp management therefore needs to be a principal and near term implementation priority. Carp management is programmatic and not reflected in the CIP, but is nevertheless a critical piece of the lake restoration work to reestablish nutrient budgets and support in-lake habitat.

When carp have been brought below the ecological damage threshold of 100 kg/ha, management of internal or sediment phosphorus release will be employed. In some lakes where high phosphorus and carp activity have caused the lake to shift from a clear to turbid lake state (including Mud and Parley), whole lake drawdown may be further employed to allow for the reestablishment of lake bed vegetation critical to support game and non-game fish species.

The watershed has over 5,000 acres of wetlands, many of which are ecologically degraded and contribute nutrient pollution to downstream waterbodies. Restoration of any given wetland may be based on whether land rights need to be and can be acquired, available funding, and ecological lift and water quality benefit achieved by restoration. The District is currently developing a GIS-based tool in partnership with the US Army Corps of Engineers that will enable the District to rapidly evaluate wetlands for multiple restoration parameters to assist in this prioritization framework.

As land converts from agricultural land use to residential, stormwater regulations will, in many cases, result in improved water quality over predevelopment conditions. However, the District will continue to work with its City and County partners through the development process to identify opportunities to surpass regulatory standards, particularly where it may address an existing TMDL or known water quality issues.

Many of the aforementioned strategies will be used to restore this headwater system. While this work will have immediate benefit within the Six Mile Creek subwatershed itself, long term this restoration should also address the 50% of the watershed load to Halsted Bay coming from Six Mile Creek. H0wever, given the long term nature of this restoration and the current condition of Halsted Bay, an interim solution may be considered. The District has completed preliminary feasibility for an alum treatment system that would provide immediate water quality benefit to Halsted Bay. The alum treatment facility should be located at the terminus of Six Mile Marsh, which is responsible for transforming the particulate phosphorus leaving Mud Lake to dissolved phosphorus, which can be more difficult to remove and requires some level of chemical treatment. The implementation of the alum facility will depend on the District's ability to secure external funding support through grants or state appropriations.

IMPLEMENTATION AND FUNDING STRATEGY

The Six Mile Creek-Halsted Bay Subwatershed was identified as a priority implementation focus for the 2018-2027 Plan cycle due, in part, to the complexity and scale of fully implementing the restoration and protection strategy outlined in this plan in order to preserve the headwaters of Lake Minnetonka. The District realized early on in shifting its focus into this geography that it would require not only support from its local public and private partners, but also a diversified funding strategy that would effectively leverage financial assistance from a variety of sources.

The District's intent as it becomes more effective at implementing high impact natural resources projects is to diversify its funding sources. The District has historically relied on its ad valorum tax levy to support its capital improvement program, but increasingly will look to use its tax levy as one component of multi-sourced project funding. This will include leveraging grants, county financing, and partner funding for

ISSUE

Excess nutrients

Low dissolved oxygen

Phosphorous export wetlands

Modified hydrology

Localized flooding

Degraded fish community

Degraded macroinvertebrate community

Degraded and disconnected corridors

DRIVER

Common carp

Altered wetlands

Water quality from upstream water bodies

Stormwater runoff

Altered channels

Internal sediment phosphorous loading

STRATEGY

Focal subwatershed planning

Carp management

Wetland restoration

Stormwater management

Stream channel restoration

Internal sediment phosphorous control

Whole lake drawdown

Watershed protection

IMPLEMENTATION PRIORITIES

Coordination with Six Mile-Halsted Bay Partnership to implement:

- Carp management
- Wetland restoration
- Stormwater management
- Stream channel restoration
- Internal sediment phosphorous control
- Whole lake drawdown
- Land conservation/ corridor connection

Resource protection through regulation

Education and capacity-building for lake associations project elements that meet their mission and goals.

Ultimately, the scope and scale of implementation within the Six Mile Creek-Halsted Bay geography will be contingent upon successfully leveraging external grant and funding resources. There are two broad categories of external grants that will be pursued by the District and its partners:

» State and regional grants applicable for individual, site specific projects or eligible project elements

» State and federal funding available to larger scale, programmatic implementation efforts that aggregate management strategies across the geography

As an example of the latter category, a grouping of Six Mile Creek-Halsted Bay stream and wetland restoration initiatives may be directly eligible for USACE Section 206 Habitat Restoration funds, whereas a single wetland project would not. In this instance, projects would need to be aggregated and evaluated in a way that meets the specific federal Section 206 evaluation criteria. Other identified programmatic funding opportunities include Lessard Sams Outdoor Heritage Council and the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

The District will work with the Six Mile Creek-Halsted Bay Subwatershed Partnership as it pursues external funding sources. In some cases, members of the Partnership will be stronger applicants for a given source, in which case the District will support their application. Relationships with third-party partnership such as US Fish and Wildlife Service and the Minnesota Waterfowls Association will enhance the District's reach into pools where watershed districts have not historically been as competitive.

CAPITAL IMPROVEMENT PROGRAM

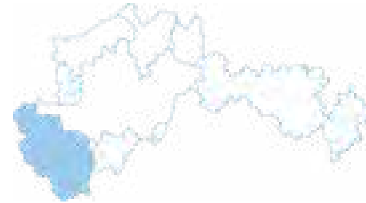
The CIP is a planning tool. It also is a means to inform partners, District residents, and other interested parties as to the District's scope and priorities for its capital work over the planning period. A project's inclusion in the CIP does not mean that the project will be constructed, only that the District has identified it as an action that may be a cost-effective way for the District to achieve identified water resource goals. A project identified in the CIP always will need further review as to technical feasibility, cost and financing, consistency with local needs, and other policy considerations before a formal decision to proceed to construction is made. Section 3.5.5 describes the development and evaluation steps that will occur before the District will commit resources to a project.

Section 3.5.5 also describes how the District will review the CIP on an ongoing basis throughout the planning period. This review will allow the District to reassess described projects from a technical perspective, but also will involve broader policy considerations such as shifts in District priorities, decisions as to annual budget and levy levels, and the prospect of state and federal grant funds or financing. For this reason, projects may be added to and deleted from the CIP from year to year, in accordance with those procedures.

Table 3.15 Six Mile-Halsted Bay Subwatershed CIP

Project	East Auburn Stormwater Enhancement Project
Description	Design and construction of stormwater enhancements to two existing ponds in the City of Victoria. Enhancements are intended to include the installation of an iron-enhanced sand filtration bench and a filtration bench.
Need	East Auburn exceeds state nutrient standards. A TMDL identified a need to reduce nutrient loading in East Auburn by 626 lbs/yr, with 200 lbs/year needing to come from upstream waterbodies.
Outcome	Reduction of nutrient export from downtown Victoria and upstream Church Lake to East Auburn Lake; native vegetative enhancements in the buffer and upland areas. The project is estimated to achieve a phosphorus reduction of 39 lbs/year. This estimate will be refined through project feasibility and design.
Estimated Cost	Capital Costs: $170,000 in 2017 dollars.
Potential Funding Sources	BWSR Clean Water Legacy grant, City of Victoria
Schedule	2017-2018

Project	Wassermann West External Load Reduction and Landscape Restoration
Description	Design and implementation of strategies to reduce landscape phosphorus loading through the use of aluminum sulfate (alum), vegetative restoration, and/or hydrologic alternation; preservation and restoration of vegetative community in wetland and upland areas through land acquisition, development of restoration plan; programmed public access to Lake Wassermann for public use and enjoyment.
Need	Lake Wassermann exceeds state nutrient standards. An adopted TMDL requires a 470 lbs/yr reduction in phosphorus loading. This site is estimated to be responsible for 7% of the total phosphorus load at approximately 75 lbs. The site features a diversity of vegetative and wetland communities and has been recognized as a restoration priority by several agencies, including the MLCCS, MnDNR, City of Victoria, and MCWD.
Outcome	Reduction of nutrient export to Lake Wassermann; enhanced recreation access to Lake Wassermann; preservation and enhancement of shoreline, upland, and wetland buffers; vegetative wetland restoration. The project is estimated to achieve a phosphorus reduction of 64 lbs/year. This estimate will be refined through project feasibility and design.
Estimated Cost	Capital costs:$2,250,000, excluding land, in 2017 dollars
Potential Funding Sources	District levy, City of Victoria, and/or regional, state, and federal grants
Schedule	2018-2019



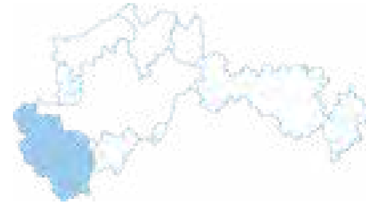
Project	Pierson Lake Headwaters Restoration
Description	Removal of drain tile system; design and construction of outlet control structures; wetland establishment/restoration including site preparation, invasive species control, seeding, and maintenance; feasibility, design, and construction of stormwater management practices; stream restoration
Need	Pierson Lake is good quality, but 85% of its nutrient pollution is attributed to the drainage area north of the Lake. The area around Pierson Lake is anticipated to develop over the coming years as the City of Victoria expands into Laketown Township. This project will address the largest single source of phosphorus to a high value waterbody while protecting degraded wetlands from future development impacts.
Outcome	Reduced phosphorus loading to Pierson Lake; increased clarity in the north bay of Pierson Lake; enhanced wetland vegetative diversity creating waterfowl and non-game bird habitat; enhanced corridor connection. Phosphorus load reduction estimates will be developed during project feasibility and design.
Estimated Cost	Capital costs: $320,000, excluding land, in 2017 dollars
Potential Funding Sources	District levy, partner contributions, grants
Schedule	2019-2021

Project	Turbid-Lundsten Wetland Restoration
Description	Restoration of wetlands around Turbid and Lundsten Lakes through hydrologic modification, changes to storage capacity, and vegetation restoration; design and construction of soluble phosphorus filtration system; hydrologic modification to eliminate open water ditch downstream of Turbid; pond retrofit at South Lundsten inlet. Phase I will restore wetland upstream of Turbid Lake and Phase II will restore wetland and construct pond filtration downstream of Turbid Lake.
Need	Turbid Lake exceeds state nutrient standards. An adopted TMDL requires a 138 lbs/yr reduction in nutrient loading, or 55%. Though the TMDL identified internal loading as the principal driver of the impairment, a 2010 feasibility study found that reductions of 34 lb of phosphorus could be achieved through restoration upstream of Turbid Lake and 27 lb could be removed through downstream restoration to the benefit of South Lundsten. Water quality in South Lundsten is very poor and drives downstream water quality issues, including in Parley Lake which is impaired for water quality and clarity. South Lundsten is considered a wetland and therefore is not subject to lake standards but reducing its nutrient concentration is critical to downstream waterbodies that are impaired, including Parley Lake which exceeds state nutrient standards.
Outcome	Reduction of nutrient export to Turbid, South Lundsten, North Lundsten and Parley Lakes; Increase wetland biodiversity and habitat diversity, improve flood storage potential, and reduce phosphorus export; limit carp movement. These projects are estimated to achieve a phosphorus reduction of 93 lbs/year (Phase I 43 lbs, Phase II 50 lbs). These estimates will be refined through project feasibility and design.
Estimated Cost	Capital costs, phase I: $2,870,000, excluding land, in 2017 dollars. Capital costs, phase II: $230,000, excluding land, in 2017 dollars.

Potential Funding Sources	District levy, partner contributions, grants
Schedule	2019-2021

Project	**Mud Lake Watershed Load Reductions**
Description	Addressing watershed nutrient load to Mud Lake through wetland restorations, regional stormwater treatment, and enhancement of existing stormwater facilities. Phosphorus sources to Mud Lake are diffuse and implementation will take place in a phased approach, targeting the most cost-effective and highest impact projects first.
Need	The 2013 Six Mile Diagnostic identified Mud Lake as having very poor water quality, driven by a combination of internal loading, upstream lake water quality, and watershed loading. Reductions between 78% and 95% (1,864 lbs/yr – 2,258 lbs/yr) from the direct watershed are needed to shift the ecological condition of Mud Lake and address downstream impacts to Halsted Bay. Though Mud Lake is classified as a wetland and therefore not required to meet lake standards for nutrient concentrations, Halsted Bay requires the largest phosphorus load reduction in the District and about half of its load comes from upstream Mud Lake. The implementation approach was developed through a BWSR Clean Water Legacy grant which sought to identify nutrient sources and the most cost-effective means to address nutrient concentrations in Mud Lake.
Outcome	Reduced nutrient loading to Mud Lake and Halsted Bay; hydraulic and vegetative wetland restoration. Phosphorus load reduction estimates will be developed during project feasibility and design.
Estimated Cost	Capital costs, phase I: $1,120,000 excluding land, in 2017 dollars. Capital costs, phase II: $480,000 excluding land, in 2017 dollars. Capital costs, phase III: $1,490,000 excluding land, in 2017 dollars.
Potential Funding Sources	District levy, partner contributions, grants
Schedule	2019 - 2025

Project	**Wassermann Lake Internal Load Management**
Description	Application of alum to sediments to inactivate sediment release
Need	Lake Wassermann exceeds state nutrient standards. An adopted TMDL requires a 470 lbs/yr reduction in phosphorus loading, with 88% coming from internal sediment release. The 2013 Six Mile Diagnostic modeled an annual internal release rate of 374/lbs year. Alum can only be applied once the carp population has been significantly reduced and the recruitment is being managed through aeration or physical barriers.
Outcome	Reduction in phosphorus load from internal sources; improved water clarity; more abundant aquatic vegetation community. Phosphorus load reduction estimates will be developed during project feasibility and design.
Estimated Cost	Capital costs: $310,000 in 2017 dollars.



Potential Funding Sources	District levy, partner contributions, grants
Schedule	2020-2022

Project	**East Auburn Wetland Restoration**
Description	Restoration of up to five degraded wetland complexes draining to East Auburn from Steiger, Sunny, and Wassermann Lakes targeting nutrient reduction.
Need	East Auburn Lake exceeds state nutrient standards. An adopted TMDL requires a total reduction of 626 lb, 410 lb of which are from watershed sources. The 2013 Six Mile Diagnostic attributes 57% of the total watershed load to the drainage area, and further analysis indicates that a vast majority of the source of the drainage area loading is from these large, degraded wetland complexes. Further analysis will be required to determine the relative impact of each of the five complexes to determine the restoration priority and scope.
Outcome	Reduced nutrient loading to East Auburn; Hydrologic and vegetative wetland restoration; enhanced habitat; enhanced aesthetic value tying into a high value recreation area (Carver Park). Phosphorus load reduction estimates will be developed during project feasibility and design.
Estimated Cost	Capital costs: $990,000, excluding land, in 2017 dollars
Potential Funding Sources	District levy, partner contributions, grants
Schedule	2020-2021

Project	**Halsted Bay Watershed Load Management**
Description	Off-line alum treatment facility situated adjacent to Six Mile Marsh to treat upstream phosphorus load into Halsted Bay of Lake Minnetonka
Need	Halsted Bay of Lake Minnetonka greatly exceeds state nutrient standards. An adopted TMDL requires a 2,087 lb reduction from external sources (73%) to meet clean water standards. 50% of the total phosphorus load comes from upstream Mud Lake, driven by both watershed load and internal sediment release. Six Mile Marsh acts to transform phosphorus from particulate to dissolved, which requires chemical treatment to remove it from the water column. A 2013 feasibility study found that operating an off-line alum treatment facility would provide the most cost-effective means to reduce phosphorus loading into the Bay in the short term. Long term restoration of the upstream Parley-Mud system would allow the alum treatment facility to be brought off line at the end of its design horizon of 30 years.
Outcome	Reduced nutrient loading to Halsted Bay of Lake Minnetonka. The project is estimated to achieve a phosphorus reduction of 1,600 lbs/year. This estimate will be refined through project feasibility and design.
Estimated Cost	Capital Costs: $13,050,000

Potential Funding Sources	District levy, partner contributions, grants, state appropriations
Schedule	2022-2025

Project	**Wetland Restoration**
Description	May include bypassing flow around the wetland, the addition of nutrient filters, soil engineering or augmentation to permanently sequester phosphorus, or the development of wetland treatment cells. Selected restoration options will depend on site specific wetland conditions and hydrology, and overall needs of the subwatershed system. The selection process will be facilitated by a partnership with the US Army Corps to develop a restoration prioritization tool with input from agency partners including the Six Mile Creek-Halsted Bay Subwatershed Partnership, the US Fish and Wildlife Service, and state agencies including BWSR and the DNR. The level of implementation (i.e. acres restored) will depend on the District's ability to secure external grants or other funding.
Need	The Six Mile Creek-Halsted Bay subwatershed has six lakes that exceed state nutrient standards (Wassermann, Turbid, East Auburn, Parley, Stone, and Halsted Bay), with others close to the limit of in-lake nutrient concentrations. The 2013 Six Mile Diagnostic identified hydraulically altered and degraded wetlands as a principal source of external phosphorus to waterbodies subwatershed-wide, principally in Wassermann, Turbid, East Auburn, South Lundsten, Parley, Mud, and Halsted Bay. The Six Mile Creek-Halsted Bay Subwatershed has thousands of acres of wetlands that not only play a critical role in nutrient cycling, but also provide habitat, forage, and breeding ground for the migratory and non-game bird species abundant within this subwatershed. Prioritization of wetland restoration opportunities will be based on water quality and natural resource impact, ownership (public vs. private), and available funding.
Outcome	Increased nutrient retention, enhanced vegetation diversity, supportive waterfowl and non-game bird habitat, enhanced corridor connection.
Estimated Cost	Capital costs: $3,000,000, excluding land, in 2017 dollars.
Potential Funding Sources	District levy, partner contributions, grants
Schedule	2018-2027

Project	Stormwater Volume and Pollutant Load Reduction
Description	Regional treatment or other best management practices that augment treatment capacity and add ecosystem service value concurrent with regional growth and development, including but not limited to infiltration or filtration basins and devices, reforestation, revegetation, and stormwater detention or redirection.
Need	Six lakes exceed state nutrient standards. A TMDL identified the need to reduce external loading by 30 lbs to Wassermann (though the 2013 Six Mile Diagnostic identifies a much higher external load), 27 lbs to Parley, 33 lbs to Turbid, 420 lbs to East Auburn, and 2,087 lbs to Halsted Bay. Other waterbodies may be targeted for stormwater management as a protection measure against development impacts. The District will typically play a technical and grant assistance role in developing stormwater management projects but may be more heavily involved where the associated water quality and natural resource benefit is highest.
Outcome	Reduction of pollutant loading to subwatershed lakes; reduction of stormwater runoff volume and rate and associated impacts; protection and enhancement of groundwater recharge, stream base flow, and wetland hydrology.
Estimated Cost	Capital costs: $2,000,000, excluding land, in 2017 dollars
Potential Funding Sources	District levy, partner contributions, grants
Schedule	2018-2027

Project	Stream Channel Restoration
Description	Stream restoration may include bank stabilization, grade control, culvert modification, and floodplain/riparian management.
Need	Six Mile Creek has been heavily ditched and modified over time. The 2012 Minnehaha Creek Stream Assessment identified a number of opportunities for stream restoration to manage sediment and nutrient loading and provide in-stream and riparian ecological benefit. Stream restoration projects may be carried out in concert with wetland restoration projects, as much of the stream acreage is associated with marsh areas.
Outcome	Reduced sediment and nutrient loading to downstream waterbodies, reconnection of stream bank to riparian marshes.
Estimated Cost	Capital costs: $870,000, excluding land, in 2017 dollars.
Potential Funding Sources	District levy, partner contributions, grants
Schedule	2018-2027

Project	Internal Load Management

Description	Application of aluminum sulfate or similar chemicals in order to inactivate sediment phosphorus release from the lakebed
Need	The 2013 Six Mile Diagnostic identified lakes in which internal sediment phosphorus release is a significant driver of water quality issues. A TMDL identified the need to reduce internal loading by 442 lbs (88%) to Wassermann, 971 lbs (61%) to Parley, and 104 lbs (77%) to Turbid. South Lundsten also needs internal load management to address its contribution to the impairment of Parley Lake. All of these lakes currently exceed the carp population concentration where ecological damage occurs. Carp also reduce the effectiveness of alum by re-suspending bottom sediments that have been sealed by alum, so no internal load treatments can be complete until the carp population has been brought below that threshold.
Outcome	Reduced internal nutrient release; increased water clarity; reemergence of submersed aquatic vegetation.
Estimated Cost	Capital costs: $980,000 in 2017 dollars.
Potential Funding Sources	District levy, partner contributions, grants
Schedule	2018-2027

Project	**Whole Lake Drawdown**
Description	Hydrologically manipulate lake levels to temporarily expose lake bed sediments to promote the growth of healthy submersed aquatic vegetation communities.
Need	South Lundsten, Parley and Mud Lakes have very high carp populations and nutrient concentrations which jointly have created turbid lake conditions wherein the lake lacks submerged aquatic vegetation, is dominated by rough fish, and is characterized by turbid water from sediment resuspension and algal production. Whole lake drawdown is needed to reestablish a biotic community supportive of a clear shallow lake state and address internal loading in all three lakes. Whole lake drawdown is the final step in a long term shallow lake management strategy and will be implemented only after other compounding issues have been addressed including carp management, reduced watershed nutrient loading, reduced loading from upstream waterbodies. Internal load management can be done concurrently or in advance, dependent upon timing of other factors.
Outcome	Reduce internal sediment and nutrient loading; reemergence of submerged aquatic vegetation; establishment of healthy fishery
Estimated Cost	Capital cost: $770,000 in 2017 dollars.
Potential Funding Sources	District levy, partner contributions, grants
Schedule	2018-2027

3.10 IMPLEMENTATION TABLES

Table 3.16 summarizes the District's programs, their general activities, approximate annual budgets, funding sources, and schedule. More detailed descriptions for each of these programs can be found in Section 3.5. The subwatershed plans in Section 3.9 describes specific implementation actions that may be undertaken by the District and its partners.

Table 3.17 summarizes the District's Capital Improvement Plan (CIP), including the subwatershed where the project is located, project name, estimated cost, potential funding sources, and schedule. More detailed descriptions for each project can be found in the Subwatershed Plans in section 3.9. The CIP is a planning tool. It also is a means to inform partners, District residents, and other interested parties as to the District's scope and priorities for its capital work over the planning period. A project's inclusion in the CIP does not mean that the project will be constructed, only that the District has identified it as an action that may be a cost-effective way for the District to achieve identified water resource goals. A project identified in the CIP always will need further review as to technical feasibility, cost and financing, consistency with local needs, and other policy considerations before a formal decision to proceed to construction is made. Section 3.5.5 describes the development and evaluation steps that will occur before the District will commit resources to a project.

Section 3.5.5 also describes how the District will review the CIP on an ongoing basis throughout the planning period. This review will allow the District to reassess described projects from a technical perspective, but also will involve broader policy considerations such as shifts in District priorities, decisions as to annual budget and levy levels, and the prospect of state and federal grant funds or financing. For this reason, projects may be added to and deleted from the CIP from year to year, in accordance with those procedures. A critical component of any project will be a funding strategy that identifies the sources, uses, and timing of funds needed to successfully achieve identified goals. These plans will be developed in conjunction with the District's public and private partners as capital projects are advanced. Therefore, any costs identified within this Plan are projections. Intended expenditures will be refined during project development and budgeting, and among other things will reflect the District's intent to complement its ad valorem funds with other funding sources.

Table 3.16 District program activities, budgets, funding sources, and schedule

Program Activities	Approximate Annual Budget	Funding Sources*	Schedule
Education and Communications	**$1,000,000**	**MCWD Levy**	**Ongoing**
Build support for District policy, programs, and projects Engage and educate communities on water resource issues Provide knowledge and skills needed to adopt clean water practices			
Incentive Programs	**$500,000**	**MCWD Levy**	**Ongoing**
Administer grants to facilitate green infrastructure projects			
Land Conservation	**$2,500,000**	**MCWD Levy**	**Ongoing**
Continue proactive efforts to conserve lands of high value for water resource protection and enhancement			
Permitting	**$650,000**	**MCWD Levy**	**Ongoing**
Administer permits Field inspection and compliance enforcement Identify opportunities and build partnerships			
Planning	**$1,000,000**	**MCWD Levy**	**Ongoing**
Plan and implement capital projects Develop policy and coordinate with District partners Maintain internal program coordination and alignment			
Project Maintenance and Land Management (PMLM)	**$750,000**	**MCWD Levy**	**Ongoing**
Maintain District capital projects, lands, and infrastructure Provide technical assistance to partners and landowners Inspect and maintain ditches under MCWD jurisdiction			
Research and Monitoring	**$1,000,000**	**MCWD Levy**	**Ongoing**
Collect and analyze data to inform management efforts Carp management AIS early detection, rapid response, and support of partner efforts			
Capital Improvement Program	**$3,500,000**	**See Table 3.18**	
See Table 3.18			

*See Section 3.4.4 for more information on funding sources

Six Mile Creek-Halsted Bay Subwatershed

Table 3.17 2018-2027 Capital Improvement Program

Subwatershed	Capital Projects	Estimated Cost
District-wide	Land Conservation	See Table 3.17
Christmas Lake	Stormwater Volume and Pollutant Load Reduction	$200,000
Dutch Lake	Stormwater Volume and Pollutant Load Reduction	$780,000
Gleason Lake	Stormwater Volume and Pollutant Load Reduction	$600,000
Lake Minnetonka	Halsted Bay Internal Phosphorus Load Reduction	$1,400,000
Lake Minnetonka	Stormwater Volume and Pollutant Load Reduction	$1,000,000
Lake Virginia	Stormwater Volume and Pollutant Load Reduction	$650,000
Langdon Lake	Stormwater Volume and Pollutant Load Reduction	$230,000
Long Lake Creek	Stormwater Volume and Pollutant Load Reduction	$1,320,000
Minnehaha Creek	Minnehaha Creek FEMA Flood Damage Repairs	$920,000
Minnehaha Creek	325 Blake Road Regional Stormwater and Greenway	$2,750,000
Minnehaha Creek	Meadowbrook Golf Course Ecological Restoration	$2,200,000
Minnehaha Creek	Arden Park Stream Restoration	$4,100,000
Minnehaha Creek	Greenway to Cedar Trail Connection and Streambank Restoration	$510,000
Minnehaha Creek	Boone-Aquilla Floodplain	$500,000
Minnehaha Creek	Cottageville Park Phase II Riparian Restoration	$280,000
Minnehaha Creek	West Blake Greenway Enhancement	$420,000
Minnehaha Creek	Meadowbrook Greenway Expansion	$950,000
Minnehaha Creek	Hiawatha Golf Course Restoration	$1,940,000
Minnehaha Creek	Minnehaha Parkway Stormwater Management	$1,400,000
Minnehaha Creek	Stormwater Volume and Pollutant Load Reduction	$2,450,000
Minnehaha Creek	Channel/Streambank Restoration	$3,120,000
Painter Creek	Potato Marsh Restoration	$ 870,000
Painter Creek	SOBI Marsh Restoration	$240,000
Painter Creek	Upper and Lower Painter Marsh Restoration	$2,800,000
Painter Creek	South Katrina Marsh Restoration	$1,270,000
Painter Creek	Stormwater Volume and Pollutant Load Reduction	$980,000
Painter Creek	Stream Restoration	$2,990,000
Painter Creek	Wetland Restoration	$330,000

Potential Funding Sources*	Proposed Implementation Year
MCWD Levy, partner contributions, grants	2018-2027
MCWD levy, partner contributions, grants	2018-2027
MCWD levy, partner contributions, grants	2018-2027
MCWD levy, partner contributions, grants	2018-2027
MCWD levy, partner contributions, grants	2018-2027
MCWD levy, partner contributions, grants	2018-2027
MCWD levy, partner contributions, grants	2018-2027
MCWD levy, partner contributions, grants	2018-2027
MCWD levy, partner contributions, grants	2018-2027
MCWD levy, partner contributions, grants	2018
MCWD levy, partner contributions, grants	2018-2019
MCWD levy, partner contributions, grants	2018-2019
MCWD levy, partner contributions, grants	2018-2019
MCWD levy, partner contributions, grants	2019-2020
MCWD levy, partner contributions, grants	2019-2020
MCWD levy, partner contributions, grants	2019-2020
MCWD levy, partner contributions, grants	2020-2021
MCWD levy, partner contributions, grants	2020-2021
MCWD levy, partner contributions, grants	2020-2021
MCWD levy, partner contributions, grants	2021-2022
MCWD levy, partner contributions, grants	2018-2027
MCWD levy, partner contributions, grants	2018-2027
MCWD levy, USACE Section 206, partner contributions, grants	2019
MCWD levy, USACE Section 206, partner contributions, grants	2020
MCWD levy, USACE Section 206, partner contributions, grants	2021
MCWD levy, USACE Section 206, partner contributions, grants	2022
MCWD levy, partner contributions, grants	2018-2027
MCWD levy, partner contributions, grants	2018-2027
MCWD levy, partner contributions, grants	2018-2027

Schutz Lake	Stormwater Volume and Pollutant Load Reduction	$250,000
Six Mile Creek-Halsted Bay	East Auburn Stormwater Enhancement Project	$170,000
Six Mile Creek-Halsted Bay	Wassermann West External Load Reduction and Landscape Restoration	$2,250,000
Six Mile Creek-Halsted Bay	Pierson Lake Headwaters Restoration	$320,000
Six Mile Creek-Halsted Bay	Turbid-Lundsten Wetland Restoration	$3,100,000
Six Mile Creek-Halsted Bay	Mud Lake Watershed Load Reductions	$3,090,000
Six Mile Creek-Halsted Bay	Wassermann Internal Load Management	$310,000
Six Mile Creek-Halsted Bay	East Auburn Wetland Restoration	$990,000
Six Mile Creek-Halsted Bay	Halsted Bay Watershed Load Management	$13,050,000
Six Mile Creek-Halsted Bay	Wetland Restoration	$3,000,000
Six Mile Creek-Halsted Bay	Stormwater Volume and Pollutant Load Reduction	$2,000,000
Six Mile Creek-Halsted Bay	Whole Lake Drawdown	$770,000
Six Mile Creek-Halsted Bay	Internal Load Management	$980,000
Six Mile Creek-Halsted Bay	Stream Restoration	$870,000

*See Section 3.4.4 for more information on funding sources

MCWD levy, partner contributions, grants	2018-2027
MCWD levy, partner contributions, grants	2018
MCWD levy, partner contributions, grants	2018-2019
MCWD levy, partner contributions, grants	2019-2021
MCWD levy, partner contributions, grants	2019-2021
MCWD levy, partner contributions, grants	2019-2025
MCWD levy, partner contributions, grants	2020-2022
MCWD levy, partner contributions, grants	2020-2021
MCWD levy, partner contributions, grants	2022-2025
MCWD levy, partner contributions, grants	2018-2027
MCWD levy, partner contributions, grants	2018-2027
MCWD levy, partner contributions, grants	2018-2027
MCWD levy, partner contributions, grants	2018-2027
MCWD levy, partner contributions, grants	2018-2027

APPENDIX A
LOCAL WATER PLAN REQUIREMENTS

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LOCAL WATER PLAN REQUIREMENTS

APPENDIX A: LOCAL WATER PLAN REQUIREMENTS

APPENDIX A: LOCAL WATER PLAN REQUIREMENTS

Section 3.6 of this Plan describes the District's approach to local water management plan requirements, the role of local plans in achieving land and water goals, and the District's procedures for review and approval of these plans. The following sections detail the specific requirements against which the District will review local water plans.

1. DATA AND INFORMATION

The District maintains certain regional data systems that it makes available to its LGUs and others for their own benefit and for consistency across the watershed. An LGU should identify these data systems in its local plan and describe their application to LGU activity in order for the District to ensure that the LGU is aware of these systems and that they are being used for common intended purposes. These systems, with a brief description of their applications, are as follows:

» Hydrology and hydraulics (H&H) model - provides information on regional flood elevations and hydraulics

» Waterbody flood elevations derived from Atlas 14 precipitation data – provides information on base flood elevations for new structures and flood sensitive areas

» Functional Assessment of Wetlands (FAW) – provides data on wetland functions and values, establishes management classifications based on quality and sensitivity, and identifies restoration opportunities

» Stream Assessments – provides data on biological and physical condition of District streams

» Hydrologic Data reports – provides data on water quality, water quantity, and ecological integrity conditions and trends for District resources

In addition to information the District is requiring, Minnesota Rules 8410.0160 specifies certain local data and information that the local plan must include. These combined requirements are as follows:

» A summary of water resource management-related agreements, including joint powers agreements, into which the LGU has entered with watershed management organizations, adjoining LGUs, private parties or others.

» Maps of current and projected land use .

» Maps of drainage areas under current and future planned land use with paths, rates and volumes of stormwater runoff.

» A stormwater conveyance map meeting standards of the current MS4 general permit and indicating an outfall or a connection at the LGU boundary.

» An inventory of public and private stormwater management facilities including the location, facility type and party responsible for maintenance (e.g., landowner, homeowner's association, LGU, other third party).

» A listing and summary of existing or potential water resource-related problems wholly or partly within LGU corporate limits. A problem assessment consistent with Minnesota Rules 8410.0045, subpart 7, is to be completed for each. This includes but is not limited to:

- Areas of present or potential future local flooding
- Landlocked areas
- Regional storage needs

Finally, Minnesota Rules 8410.0160 requires that the local plan include: (a) an executive summary stating highlights of the local water plan; and (b) a statement of the process to amend the local plan. The latter must be consistent with Minnesota Statutes 103B.235.

2. LGU HOUSEKEEPING

The purpose of this section is for the LGU to describe its land, facilities and operations; assess the contribution to pollutant load, water quality impacts or demand on water resources; and identify potential actions to address these. Potential actions may be unilateral or may involve cooperation with property owners, the District or other partners.

2.1 Land

The local plan is to inventory real property owned by the LGU. A map may be used, coordinates can be provided or each parcel or tract may be located by other means. The inventory should classify properties in useful terms such as developed parcels, land suited to development or redevelopment, right of way, dedicated outlots, park and recreational land, and nondevelopable or conservation land. The inventory should indicate locations of facilities and operations identified in the LGU SWPPP, as noted below.

The purpose of this inventory is to assist the District, and the District and LGU together, in scanning opportunities for stormwater management retrofit, engagement in conservation development, regional stormwater management, water reuse, water-related recreation, conservation corridors, leveraged public investment in adjacent lands, and similar land-based initiatives. With this inventory, the LGU should discuss what it sees, from its perspective, as: (i) water resource issues and opportunities associated with its properties; and (ii) potential opportunities to coordinate with the District or other partners.

2.2 Facilities and Operations

In the NPDES MS4 stormwater pollution prevention program (SWPPP) that the Minnesota Pollution Control Agency requires each LGU to prepare, the LGU is required to inventory facilities that it owns or operates and municipal operations that may contribute pollutants to groundwater or surface waters. It then is required to describe best management practices that it commits to implement to address potential water resource impacts.

The SWPPP requirement is comprehensive. It includes the following types of facilities:

» Composting and recycling sites, landfills and solid waste handling and transfer

» Hazardous waste handling, transfer and disposal

» Pesticide storage

» Salt, sand and materials storage yards or facilities

» Equipment and vehicle fueling, storage, washing and maintenance facilities

» Public works yards

» Public parking lots

» Parks, public golf courses and public swimming pools

And the following operations:

» Waste disposal and storage, including dumpsters

» Vehicle fueling, washing and maintenance

» Cleaning of maintenance equipment, building exteriors and dumpsters, and the disposal of associated waste and wastewater

» Street and parking lot sweeping

» Landscaping, park, golf course and lawn maintenance

» Road maintenance, including pothole repair, road shoulder maintenance, pavement marking, sealing and repaving

» Right-of-way maintenance, including mowing

» Application of herbicides, pesticides, and fertilizers

» Cold-weather operations, including snow removal, sand use, and application of deicing compounds

» Management of temporary and permanent stockpiles of materials such as street sweepings, snow, salt and other deicing materials, sand and sediment removal piles

» Emergency response, including spill prevention plans

This information is of substantial interest to the District. For example, it will assist the District to understand potential pollution sources within specific catchments and subwatersheds; assist the District to identify project, cost-share and educational opportunities; and provide data for planning associated with subwatershed-based implementation plans. Taken together, the information from all local plans within the District will give the District a watershed-wide inventory of LGU practices that is likely to be very useful in assessing and prioritizing potential District actions or programs pertaining to municipal operations, and in identifying LGUs that may be useful contacts for such matters.

The District does not intend to create any added burden related to transmittal of this information. Therefore, in the text or as an attachment, the local plan may simply incorporate the inventory and description of practices from its SWPPP. However, to the extent the SWPPP inventory is not current, the LGU should supplement it as necessary.

The LGU also is invited to discuss issues or opportunities related to particular facilities or operations where the District's technical assistance, LGU/District cooperation, shared facilities/services with other LGUs or other forms of collaboration with other interested parties may result in water resource benefits.

2.3 Stormwater Management Facilities

Under its NPDES MS4 permit administered by the Minnesota Pollution Control Agency, the LGU is required to prepare a map that locates, among other things, all structural stormwater best management practices within the LGU's stormwater conveyance system. In addition, it is required to prepare an inventory of all stormwater management basins within its political boundaries, whether owned by the LGU or otherwise.

The local plan is to include this map and inventory, with any adjustments so that it is current. As the public agency with the responsibility to understand and manage hydrologic systems and water quality issues at a regional level, the District requires this information for its regional system-level understanding and, more specifically, to assist in maintaining its watershed hydrologic and hydraulic models accurate and current. In addition, the District has offered and will continue to offer assistance to LGUs in matters of stormwater facility maintenance, including deferred maintenance of private facilities and potential collaborative means to fund and perform future maintenance of public and private facilities efficiently.

For each basin and other stormwater management practice contained in the map and inventory, the local plan is to identify the party responsible to maintain the practice; state whether the practice is in maintained condition (or that the LGU does not know); and, for those practices that the LGU is responsible to maintain, the date of next maintenance, if maintenance is programmed.

In addition, the LGU is asked to describe its approach to maintenance of stormwater management practices constructed in conjunction with private development. This includes: (a) whether the LGU assumes maintenance responsibility and, if so, under what circumstances; (b) the LGU's program to inspect practices and secure maintenance by private parties; (c) the means by which the LGU funds its maintenance and inspection activities; and (d) other means of funding that are within its legal authority but that it does not presently use.

Finally, noted above is the issue of deferred maintenance of public and private stormwater management practices. Each LGU is invited to discuss the scope of its knowledge on this issue with regard to practices within its boundaries. The District intends to explore the problem of deferred maintenance and potential approaches to reduce the scope of deferred maintenance. The District's interest presumes cooperation with interested LGUs and consideration of alternative procedures and funding mechanisms. The LGU is invited to include in its local plan any consideration is has given to this issue and any information that may be useful in exploring a cooperative approach with the District.

3. LAND USE PLANNING AND DEVELOPMENT REGULATION

Under the Metropolitan Land Planning Act (MLPA), by December 31, 2018, each land use authority (LUA) must revise its local comprehensive land use plan (CLUP). The law requires that once the CLUP is approved by the Metropolitan Council and adopted by the LUA, the LUA must amend its development code to be consistent with the CLUP. Further, the MLPA requires that in order for the Metropolitan Council to approve a CLUP, it must contain the local water plan approved by the District.

The most substantial policy shift from the previous WMP to this one is the District's effort to more closely integrate land use planning and water resource management. Land use, and how it is planned and executed, is what most directly determines water quality and quantity conditions within the hydrologic system. The thrust of the District's Balanced Urban Ecology approach is to integrate water resource goals into LGU land use planning, private development and redevelopment intentions, and LUA development regulation in order to be alert to, and exploit, opportunities to achieve multiple public and private goals with well-timed and efficient investments.

The District's interest in LGU land use planning and development regulation, then, is threefold:

- First, to establish a framework to be informed as to current LGU land use and infrastructure planning and enable early coordination of land use and water resource management. The purpose here is to incorporate regional water resource considerations before broader patterns of land development are fixed or regional infrastructure investments are programmed. Planning coordination also allows for District and LGU exploration of methods to manage development impacts at a regional level.

» Second, to foster LGU development regulation that integrates water resource protection. Integration allows for public goals often seen as competing (economic development, landowner rights, protection of natural systems) to be favorably reconciled and sets clear expectations so that development and redevelopment may proceed with a more limited risk of disruption due to water resource compliance requirements arising after site plans have been fixed and invested in. It also facilitates managing development footprints and targeting park dedications to: (i) support supra-parcel priority resources and conservation corridors; and (ii) advance water-related recreation and use goals.

» Third, to identify and capitalize on project opportunities that can result in beneficial water resource outcomes while also serving goals of the LGU and other public and private partners such as infrastructure and operations cost savings, economic and jobs development, park and public space improvements, amenity and property value enhancements, and public recreational and educational benefits.

3.1 Land Use Planning

To serve the above purposes, the District asks that the local water plan include the content that follows. This content will constitute a baseline for the District to understand the LGU's planning status and procedures. Combined with the LGU/District coordination plan described in Section 5, below, this will allow the District to understand and participate usefully in the LGU's land use planning efforts to achieve the described goals.

Local plan content is as follows:

1. Identify those areas within or adjacent to the LGU that the LGU has designated in its CLUP for potential development or redevelopment within the CLUP planning horizon. This includes planned rezoning, land assembly, and infrastructure extension or expansion.
2. List and describe completed or programmed small area plans and similar planning activities to assess the LGU's role with respect to defined-area redevelopment.
3. Describe the procedures by which the LGU plans, programs and implements each of the following:
    - Transportation infrastructure
    - Sewer and water infrastructure
    - Park and recreation land acquisition and management
    - Conservation land acquisition and management
    - The description should include the date of the most recent approved capital implementation or land acquisition and management program, the frequency of program updating, the internal procedures to develop and approve the implementation program and to implement specific actions, and how programming and implementation is coordinated with other LGU activities.
4. Provide links to small area/redevelopment plans, capital implementation programs, and land acquisition and management plans listed pursuant to items 2 and 3.

3.2 Development Regulation

The LGU's application of its zoning and subdivision codes can integrate water resource and conservation protection in a number of ways. In this section, the LGU is asked to evaluate its official controls with respect to the integration of such concerns and specifically consider means of improving this integration.

The following are some elements of a local development code that can maximize overall public water resource benefit without inhibiting private development of property:

» Regulatory tools that create incentives to consolidate development footprint to protect resources (e.g., conservation development, clustering, density credits, transfer of development rights).

» Dedication or development fees applied to support acquisition or consolidation of public park, recreation or conservation land, particularly as directed toward acquiring or protecting priority water resource areas.

» Setbacks and/or vegetated buffer requirements with respect to wetland or other surface waters, reconciled with other terms of its development code that restrict development footprint to prioritize waterbody protection where feasible.

» Controls on mature tree removal.

The LGU is invited, in its local plan, to review these or similar measures that it has adopted or is considering and to indicate any role the District might play in evaluating or implementing such measures.

Also, several aspects of the interplay between LGU and District development regulation arise systematically. The District seeks to resolve these in the best way and, for that purpose, will benefit from certain specific information relating to LGU regulatory programs. The local plan therefore is requested to inform the District on the following:

» Does the LGU development review process incorporate voluntary or obligatory low-impact site design review? If so, what is the process and would it accommodate District participation?

» Does the LGU require that stormwater management practices, wetlands or wetland buffers be platted on outlots? If not, what are the obstacles to doing so?

» Does the LGU assume maintenance responsibility for stormwater management practices within residential, industrial or other subdivisions? Explain the LGU's policy and practice, and how the LGU funds the obligations it assumes.

» In its role as the Safe Drinking Water Act public water supplier, does the LGU have an approved and operative wellhead protection plan? How does it implement the plan? Does it have an established policy as to where and when infiltration will not be required or permitted as a stormwater management practice?

» Describe provisions of official controls or LGU practices that make applicants aware of District permitting requirements.

Finally, in the local water plan, the LGU is to identify other regulatory mandates concerning water resources under which it operates. For each, the LGU should briefly describe its legal role and responsibility, if any; its legal compliance status; and other implementing roles that are not legally mandated, but that it elects to perform. This may be presented in tabular form if the LGU chooses. Finally, the LGU is invited to identify any District assistance or coordination that would benefit its implementation of any particular program. The following should be specifically addressed:

» NPDES MS4 stormwater program

» Total Maximum Daily Load program

» Federal and state anti-degradation requirements

» Safe Drinking Water Act/state wellhead protection program

» National Flood Insurance Program

» State floodplain management law

» State shoreland management law

» Minnesota Wetland Conservation Act

4. IMPLEMENTATION PROGRAM

Minnesota Rules 8410.0160 requires that the local plan contain a local implementation program. According to the state rule, the program must:

» Describe nonstructural, programmatic, and structural solutions to water resource problems identified under Section 1, above.

» Present these implementation elements in a table that briefly describes each element, details the schedule, estimated cost and funding sources for the element, and includes annual budget totals.

» Break out within this table a capital improvement program that sets forth, by year, details of each contemplated capital improvement including schedule, estimated cost and funding source.

» Prioritize implementation elements consistent with the principles of Minnesota Rules 8410.0045, subpart 1.A, and District priorities as described in the WMP and communicated to the LGU.

Each LGU should include an implementation program as in its judgment will meet these legal requirements. The District will not place great emphasis on this table. The District's emphasis is to establish a framework of communication and collaboration to develop and exploit opportunities as they arise. The implementation program framework as formed by the state rule contemplates a more static process of identifying projects in advance and then constructing them over the planning period. While the District will find it useful to know of any such LGU plans, it will be more interested to look to the partnering framework that the LGU creates in its local plan to complement this WMP. Under the state rule, the District must find that the local implementation program will not jeopardize the achievement of WMP goals. Provided a programmed action is not in direct conflict with a District goal, the District is not likely to find that an LGU program fails to meet this criterion.

5. LGU/DISTRICT COORDINATION PLAN

The crux of the District's approach to water resource management is communication and coordination with its LGUs. The goal is to maintain awareness of needs and opportunities and to implement programs and projects that: (i) develop out of coordinated, subwatershed-based planning; (ii) reflect the cooperation of other public and private partners; (iii) align investments; and (iv) secure a combined set of District, LGU and partner goals.

The LGU, in its local plan, is asked to describe the elements of a coordination plan that the LGU and District can implement at a staff level to achieve this goal. The District looks to the LGU in the first instance to propose a plan that is reasonable in the demands it places on LGU staff but that connects the LGU and the District in ways that efficiently provide for timely coordination.

The following are elements that the coordination plan should address:

» An annual meeting to review water resource plan implementation

» Mutual transmittal of the annual NPDES MS4 report

» How the District can receive notice of and consult with the LGU on its land use, infrastructure, park and recreation, and capital improvement planning efforts

» LGU notice to the District:

- Updates to LGU road and infrastructure implementation programs
- Updates to park and recreation plans
- Institution and completion of small area plans and other focused development or redevelopment actions
- Significant alterations within the LGU MS4 system (to maintain currency of the District watershed-wide hydrology and hydraulics model)

» District notice to the LGU:

- WMP amendments
- Annual capital improvement program updates

» District notice of significant events related to prospective development/redevelopment and receipt of proposed preliminary plats

» Regulatory coordination

- Ensuring applicants are aware of permitting authority of both bodies
- Mutual notice of development/redevelopment applications filed
- Pre-application meetings
- Sharing of complaint information
- Coordinating compliance inspections
- Coordinating on enforcement
- Providing for District consultation with Technical Evaluation Panel when LGU is the Wetland Conservation Act LGU

» Partnership or coordination as to public communications and education

» Which LGU staff positions are to be made aware of the coordination plan

The LGU's proposed coordination plan should identify specific departments or staff positions that will constitute appropriate points of contact, and should provide some clarity as to the timing of coordination actions in relation to LGU decisionmaking procedures. The District will work with LGU staff during local plan review to reach consensus on a simple but adequate coordination plan. A separate coordination plan document will be created and adopted as a part of LGU local water plan approval by the District Board of Managers.

APPENDIX B
STAKEHOLDER INPUT PROCESS

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STAKEHOLDER INPUT PROCESS

APPENDIX B: STAKEHOLDER INPUT PROCESS

1. INTRODUCTION

Accomplishing the District's mission to collaborate with public and private partners to protect and improve land and water requires an understanding of the goals and priorities of our communities. The production of the District's 2007 Comprehensive Water Resources Management Plan involved an extensive, scientific analysis of the Watershed District and robust stakeholder engagement process to build a technical understanding of land and water resources. The approach for the District's 2018-2027 Watershed Management Plan (Plan) builds upon the previous plan's analyses, now emphasizing collaboration with communities within the watershed to align water resource priorities with local land use goals. The process to develop this partnership-based approach included community guidance through committees, events, publications, and special meetings for information sharing to establish the partnership framework put forth.

2. PROCESS SUMMARY

The desired partnership framework guided by the District's Balanced Urban Ecology Policy is successful through voluntary participation, information sharing of local priorities and plans, and collaboration between the District and the Local Government Units (LGU's). Opportunities to participate in the development of the Plan to build the framework for this type of collaboration were provided to LGU technical staff, policy makers, and the general public.

The formal process began with an invitation to LGU's, counties, agencies, and others to attend a kickoff meeting to learn about the goals for the Plan update and how to participate in the development of the Plan. The invitation was delivered by direct mail, direct email, press release published in news print, District website, and emailed through District list serve.

Three kickoff meetings were hosted with a total of 82 attendees representing 22 cities, Carver County, Hennepin County, MN Board of Water and Soil Resources, MN Department of Natural Resources, Fresh Water Society, Lake Minnetonka Conservation District, Metropolitan Council, Minneapolis Park and Recreation Board, and Three Rivers Park District, and interested members of the public. District staff presented the scope and objectives of the Plan update and asked attendees to indicate their interest in serving on one of the advisory committees to provide their guidance, local knowledge, and priorities throughout plan development.

As part of this initial outreach and engagement effort, self-selected policy makers and technical staff were appointed to the Policy Advisory Committee and Technical Advisory Committee, respectively. The District also used its annually appointed Citizen Advisory Committee. Each committee had seven meetings, facilitated by District staff, in which the committees reviewed and discussed elements of the District's Plan as they were being developed. The District corresponded with the committee members through email to provide updates, provide committee meeting agendas, meeting summaries, and opportunities for comment at key milestones. The meeting agendas, presentations, and minutes were posted on the website.

In addition to the advisory committee meetings, the District hosted subwatershed meetings with a new invitation to technical staff, policy makers, and interested public including Lake Association members, to gather input on local issues, priorities, and plans. Other opportunities to stay involved, track the process, and learn about the Plan as it was developed included events for municipal land use planners and policy makers, publications, and website and social media updates.

3. STATUTORY REQUIREMENTS

As required per Minnesota Rules part 8410.0045, subpart 3, the District sent notification to each county, city, township, soil and water conservation district, known stakeholders, and plan review agencies of Plan initiation and an invitation to attend a kick-off meeting. The invitation was sent through mail, email, announced through a press release, and posted on the District website. As part the Plan development kickoff meetings, solicitation for participation in advisory committees was made. Committee structure, notification, schedule, and agenda topics are further described below. Members of these committees were appointed as defined in Minnesota Statues 2016, sections 103D.331 and 103D.337 and Minnesota Rule part 8410.0045, subpart 2, and part 8410.0105, subpart 1, item D.

As required by 8410.0045, subpart 3 and 4, on April 22, 2015 prior to Plan development, the District requested information on management expectations, priority issues, summaries of relevant water management goals, and water resource information from the Plan review agencies and requested information related to local water management goals, issues, official controls, programs and priorities from Hennepin and Carver County, Cities, Townships, Soil and Water Conservation Districts, MN DOT, Minneapolis Park and Recreation Board, and Three Rivers Park District. Information was requested to be submitted by June 22, 2015 and was used to guide the planning process and align efforts with local partners (Section 10). On September 24, 2015 the District Board of Managers held a public meeting to review and discuss the input received as required by 8410.0045, subpart 5. The meeting was posted on the District's website and publicly noticed for two weeks. As described below, in addition to this official request for information, the District hosted several other events with city/agency staff and policy makers to solicit local plans and priorities which are reflected in each subwatershed plan.

4. PUBLIC OPINION SURVEY, SELF-ASSESSMENT AND STRATEGIC PLANNING

4.1 PUBLIC OPINION SURVEY

To assess public opinion on effectiveness of District project and programs and understand general public priorities for the organization to guide future efforts, the District conducted a public opinion survey in February 2015. A random-sample of 600 District residents were contacted by telephone and asked a series of questions about their attitudes and awareness of water quality issues, the MCWD, and its work.

The survey found 98 percent of residents consider protecting water quality either "very" or "somewhat" important. Seventy-nine percent said the water quality in their neighborhoods has become better or stayed the same over the past five to ten years and 65 percent rate the water quality of their local lakes, streams and wetlands as excellent or good.

Residents generally view the MCWD as an effective organization. Sixty-three percent of District residents said they were aware of the MCWD and 76 percent believe it is effective in protecting water quality. Ninety-seven percent of respondents consider the MCWD a credible source for information about water quality issues and 93 percent said it is a good idea to have a single-purpose agency like the MCWD charged with protecting water quality.

4.2 SELF-ASSESSMENT

As part of the process of developing the District's Plan, the District conducted an internal self-assessment to review the District's performance under its 2007 Plan. The findings of the self-assessment were used to inform the District's Plan draft, which seeks to address some of the challenges experienced through execution of the 2007 Plan. The self-assessment included a series of facilitated discussions with District staff and Board.

The assessment found that the 2007 Plan was grounded in sound science and was very technically focused. However, challenges and limitations to that Plan were identified as a lack of focus, prioritization, and clarity of mission and goals. Staff identified that the Plan was too specific and prescriptive, which limited the District's ability to integrate water resource priorities with land use change. The staff also noted that District programs were isolated from each other, causing lack of internal alignment and coordination. Overall, staff acknowledged that progress has been made to address these challenges and expressed excitement about the District's trajectory and future opportunity to work with the Board to cultivate increased program alignment and focus. It was identified that the District's mission statement should be reconsidered, to communicate purpose and excitement, and that the potential for a vison statement should be considered as part of the Plan process.

4.3 STRATEGIC PLANNING

Following the staff and Board discussions through the self-assessment, the MCWD Board and staff began a strategic planning process in October of 2015. The purpose of this process was to evaluate and improve the alignment, focus, and effectiveness of the District's programming. The District began by developing and adopting new Vision and Mission statements for the organization as well as goals and guiding principles to align with the strategic direction of the Plan and the guiding policy of Balanced Urban Ecology. The District staff then went through a process to evaluate and align its programs with the new Mission. Staff reported their findings to the MCWD Board at publicly-noticed meetings throughout the process. The resulting 2017 Strategic Alignment Report was adopted by the Board of Mangers on February 9, 2017. This Board resolution defined the MCWD organizational strategy to accomplish its mission and set strategic direction for MCWD programs to work in support of this strategy. This strategy has been further developed and defined through the development of the Plan.

5. COMMITTEE STRUCTURE

5.1 PURPOSE

Three committees were formed consisting of a Policy Advisory Committee, Technical Advisory Committee, and Citizen Advisory Committee as discussed in Section 2. The primary role for the committees was to provide input and guidance on how the District can maximize the effectiveness of its programs and capital investments to add value to partner initiatives across the watershed and cost-effectively achieve complementary public and private goals.

5.2 NOTIFICATION AND COMMUNICATION

Committee members where solicited from Hennepin and Carver Counties, Cities and Townships within MCWD, Carver Soil and Water Conservation District, Minneapolis Park and Recreation Board, and Three Rivers Park District through email and in person at the kickoff meetings. Members were self-selected through the solicitation described. Committee members, meeting schedule, and agenda topics are listed below. All committee meetings were noticed through email. Agendas, presentations, and meeting minutes where posted to the District website after the meetings.

5.3 COMMITTEES

Policy Advisory Committee Members

Name	Organization
Councilor Bob Stewart	City of Edina
Mayor Marvin Johnson	City of Independence
Councilor/Mayor Marty Schneider	City of Long Lake
Administrator Scott Johnson	City of Medina
Councilor Linea Palmisano	City of Minneapolis
Councilor Patty Acomb	City of Minnetonka
Mayor Lisa Whalen	City of Minnetrista
Mayor Lili McMillan	City of Orono
Mayor Scott Zerby	City of Shorewood
Councilor Jeff Clapp	City of Tonka Bay
Mayor Tom O'Conner	City of Victoria
Councilor Sliv Carlson	City of Woodland
Central Region Manager Terri Yearwood	Department of Natural Resources
Commissioner Stephanie Musich	Minneapolis Park & Recreation Board
Commissioner Gene Kay	Three Rivers Park District

Policy Advisory Committee Schedule

Meeting Date	Agenda Topics
2015-08-04	Summary of kickoff meetings, Plan development process and schedule, committee's role, and future agenda topics.
2015-10-20	Overview of the Plan development process, introduction to the District's internal strategic planning framework, outline of the proposed Plan structure. The primary purpose of the meeting was to provide additional context for the committee before delving into different elements of implementation framework over next four meetings. An update on the Six Mile Creek-Halsted Bay planning process was also provided.
2015-12-15	Presentation on the topic of integrating land-use and water planning, an overview of the two-track approach as a model to improve integration, examples from guest speakers about how the approach is currently being used. Staff reiterated that a primary goal of the District's Plan update process is to develop a framework that continues to meaningfully integrate the District's work with that of other public and private sector partners and the District is seeking the Committee's help in developing this framework.
2016-02-23	Discussion of the District's two-track approach which is an implementation model to improve the integration of land-use and water planning. Requested committee input on how to better coordinate with Cities. Reviewed Described the planning process proposed for the Six Mile Creek-Halsted Bay subwatershed. Presented new MCWD vision, mission and goals.
2016-04-26	Review of two-track approach implementation model, continued the process of developing the implementation framework for the Plan by asking committees to consider changes that could be made by the District or its partners to policies/procedures/programs to support partnership and integration. A list of ideas was provided in advance. Reviewed local Plan requirements. Reviewed outreach efforts.
2016-06-21	Discussed potential role for the District for various management topics of emerging or recurring concern, asking the committee their priority for each and what they felt the District role should be and provided a written survey regarding each.
2017-03-21	Review and discuss the District's implementation model and partnership framework, including coordination and Local Water Plans, overview of Plan structure and status, reviewed draft schedule for review.

Technical Advisory Committee Members

Name	Organization
Terry Jeffery	City of Chanhassen
Ross Bintner, Jessica Wilson	City of Edina
Nate Stanley	City of Hopkins
Lois Eberhart	City of Minneapolis
Liz Stout	City of Minnetonka
Bob Bean	Cities of Deephaven, Greenwood, Orono, Mound, St. Bonifacius, and Woodland
Derek Asche	City of Plymouth
Erick Francis	City of St. Louis Park
Cara Geheren	City of Victoria
Mike Kelly	City of Wayzata
Kristin Larson	Carver County
Randy Anhorn	Hennepin County Environmental Services
Steve Christopher	Board of Water and Soil Resources
Kate Drewry	Department of Natural Resources
Karen Jensen	Metropolitan Council
Rachael Crabb, Deb Pilger	Minneapolis Park & Recreation Board
John Barten, Rich Brasch	Three Rivers Park District

Technical Advisory Committee Schedule

Meeting Date	Agenda Topics
2015-08-05	Summary of kickoff meetings, Plan development process and schedule, committee's role, and future agenda topics.
2015-10-21	Overview of the Plan development process, introduction to the District's internal strategic planning framework, outline of the proposed Plan structure. The primary purpose of the meeting was to provide additional context for the committee before delving into different elements of implementation framework over next four meetings. An update on the Six Mile Creek-Halsted Bay planning process was also provided.
2015-12-16	Presentation on the topic of integrating land-use and water planning, an overview of the two-track approach as a model to improve integration, examples from guest speakers about how the approach is currently being used. Staff reiterated that a primary goal of the District's Plan update process is to develop a framework that continues to meaningfully integrate the District's work with that of other public and private sector partners and the District is seeking the Committee's help in developing this framework.
2016-02-24	Discussion of the District's two-track approach which is an implementation model to improve the integration of land-use and water planning. Described the planning process proposed for the Six Mile Creek-Halsted Bay subwatershed. Presented new MCWD vision, mission and goals.
2016-04-27	Review of two-track approach implementation model, continued the process of developing the implementation framework for the Plan by asking committees to consider changes that could be made by the District or its partners to policies/procedures/programs to support partnership and integration. A list of ideas was provided in advance. Reviewed local Plan requirements. Reviewed outreach efforts.
2016-06-22	Discussed potential role for the District for various management topics of emerging or recurring concern, asking the committee their priority for each and what they felt the District role should be and provided a written survey regarding each.
2017-03-22	Review and discuss the District's implementation model and partnership framework, including coordination and Local Water Plans, overview of Plan structure and status, reviewed draft schedule for review.

Citizen Advisory Committee Members

Name	City of Residence	Terms Served
Bradley Coulthart	Minneapolis	2017
Brian Girard	Orono; Deephaven	2015, 2016, 2017
Cassandra Ordway	Long Lake	2017
Chris Dovolis	Minnetonka Beach	2015, 2016
Colin Cox	St. Louis Park	2015, 2016, 2017
Craig Wilson	Hopkins	2017
Cristina Palmisano	Minneapolis	2015
David Oltmans	Minneapolis	2015, 2016, 2017
Elizabeth Crow	Minneapolis	2017
Gerald Ciardelli	St. Louis Park	2015, 2016, 2017
Jacqueline Di Giacomo	Tonka Bay	2015, 2016, 2017
John Grams	Minnetonka	2017
Joseph Lofgren	Minneapolis	2015, 2016
Joseph Lutz	Minnetonka	2016
Linda Jahnke	St. Louis Park	2017
Marc Rosenberg	Minnetonka	2015, 2016, 2017
Neil Weber	Long Lake	2015, 2016, 2017
Peter Rechelbacher	Wayzata	2015, 2016, 2017
Richard Manser	Edina	2015, 2016, 2017
Richard Nyquist	Edina; Minneapolis	2016, 2017
Sliv Carlson	Woodland	2015, 2016, 2017
Steve Mohn	Eden Prairie	2015, 2016, 2017
Valerie McGruder	Minnetonka	2016
William Bushnell	Minnetrista	2015, 2016, 2017

Citizen Advisory Committee Schedule

Meeting Date	Agenda Topics
2015-03-11	Plan Introduction, Plan development process and schedule, committee's role advancing partnership approach, and future agenda topics.
2015-08-12	Review Plan scope and objectives of improving implementation model and how the District and communities can work together, review two-track approach, public process and timeline.
2015-11-18	Review of Plan development process, review organizational strategic planning framework, and plan structure.
2016-01-13	Presentation on the topic of integrating land-use and water planning, an overview of the two-track approach as a model to improve integration, and MCWD vision, mission, goals.
2016-03-09	Review two-track approach model, draft criteria for focal geography selection, briefing of Six Mile Creek-Halsted Bay subwatershed planning as example of planning model, tools and opportunities for responsive-track planning.
2016-07-13	Discuss topics of emerging or recurring concern and get committee input on appropriate role for the District.
2017-04-12	Presentation and distribution of draft Plan material, request for preliminary feedback to inform process as Plan is advanced for public release.

6. SIX MILE CREEK HALSTED BAY COMMITTEE STRUCTURE

6.1 PURPOSE

A separate advisory committee was convened for the development of an implementation plan for the Six Mile Creek-Halsted Bay Subwatershed. The Six Mile Creek-Halsted Bay Subwatershed Partnership included both policy makers and staff from all agencies operating within this geography, including the cities of Victoria, St. Bonifacius, Minnestrista and Waconia, Laketown Township, Three Rivers Park District, Carver County Soil and Water Conservation District, and Hennepin and Carver Counties.

The objective of the Partnership is to improve how the District coordinates with its partner agencies in that geography by identifying their goals and missions, regulations and authorities, and plans for development and growth. The implementation plan reflects the District's goals, the existing plans of its partners, and a framework for how the participating agencies will work together to implement the plan. The lessons learned from this process will serve as the implementation model for future focal geographies.

6.2 NOTIFICATION AND COMMUNICATION

District staff reached out to each public agency operating within this geography and asked them to identify both a staff person and policy maker to serve on the committee. Committee members and meeting schedule are listed below. Agendas, presentation, and minutes were distributed to members follow each meeting.

6.3 COMMITTEES

Six Mile Creek Halsted Bay Subwatershed Partnership Members

Name	Organization
Thomas Funk	City of Victoria
Cara Geheren	City of Victoria
Shawn Ruotsinoja	City of St. Bonifacius
Robert Bean	City of St. Bonifacius
Lisa Whalen	City of Minnetrista
David Abel	City of Minnetrista
Lane Braaten	City of Waconia
Mike Klingelhutz	Laketown Township
Angela Smith	Three Rivers Park District
Richard Brasch	Three Rivers Park District
Kristin Larson	Carver County
Mike Wanous	Carver County Soil and Water Conservation District
Randy Anhorn	Hennepin County

Six Mile Creek Halsted Bay Subwatershed Partnership Schedule

Meeting Date	Agenda Topics
May 4, 2016	District planning framework overview, review of conditions in Six Mile Creek-Halsted Bay subwatershed, planning schedule and approach.
July 2016	One on one meetings with each agency to discuss their local plans and goals.
November 10, 2016	Overview of principal water resource issues and drivers, preliminary mapping of subwatershed opportunities.
January 19, 2017	Draft purpose statement/resolution of support to formally establish the Six Mile Creek-Halsted Bay Subwatershed Partnership.
March 2, 2017	Subwatershed plan framework, small group participatory mapping to identify opportunity areas.
May 8, 2017	CIP structure and financing approach.

7. SUBWATERSHED MEETINGS

7.1 PURPOSE

To further identify local issues, priorities, and plans and create a road map for functionally integrating land use and water planning with its communities, the District hosted a series of subwatershed meetings with communities throughout the watershed. The enthusiasm and depth of local knowledge that was provided was very helpful as the District works towards its goal of increased integration of regional clean water objectives with local plans and priorities. This valuable information directly influenced the general posture of the subwatershed plans within the Plan, and informed other more immediate opportunities for collaboration.

7.2 NOTICE AND COMMUNICATION

City policymakers, City staff, advisory committee members, Board of Managers, District staff, Lake Associations, Minneapolis Park and Recreation Board (MPRB) staff, and Three Rivers Park District (TRPD) staff were invited via electronic mail. Meeting schedule and information requested is summarized below.

7.3 GROUPINGS AND SCHEDULE

Subwatershed Community Meetings

Date	Subwatershed	City/Agency Invited Attendees
December 5, 2016	Dutch Lake, Langdon Lake, Lake Minnetonka	Mound, Minnetrista, Saunders Lake HOA, Dutch Lake Association
December 6, 2016	Gleason Lake, Lake Minnetonka	Plymouth, Wayzata, Gleason Lake Association, Mooney Lake Association
December 7, 2016	Lake Virginia, Schutz Lake, Christmas Lake, Lake Minnetonka	Victoria, Chanhassen, TRPD, Christmas Lake Association, Minnewashta Lake Association, Virginia Lake Association, Schutz Lake Association
December 12, 2016	Painter Creek, Lake Minnetonka	Medina, Independence, Maple Plain, Minnetrista, Orono, TRPD, Jennings Cove Neighborhood Association
December 13, 2016	Minnehaha Creek, Lake Minnetonka	Minnetonka, Hopkins, St. Louis Park, Edina, Minneapolis, MPRB, Richfield, Golden Valley, Lake Associations: Hiawatha, Bass, Minnehaha Creek, Diamond Lake, Calhoun, Harvey, Nokomis, Powderhorn, Linden Hills Neighborhood Association

7.4 INFORMATION REQUESTED

Following a staff presentation, which included an overview of the geography, resources, land use, and priorities from the draft subwatershed plans, requested information included:

- » Local goals/priorities – both water and non-water related
- » Plans for land use change – infrastructure, transportation, economic development, parks, development projections
- » Areas of opportunity for future partnerships

The information was requested through facilitated small group discussion with each community or group, recorded on maps, and shared with the subwatershed group at each meeting. Community priorities from these meetings are reflected within the subwatershed plans.

8. EVENTS

8.1 KICKOFF MEETINGS

The District hosted a series of three Plan development kickoff meetings for county, city, township, soil and water conservation district, known stakeholders, and plan review agencies to invite participation in the Plan development process. At this meeting staff reviewed Plan objectives which include increasing program effectiveness and project implementation, and improved coordination with our communities. The meeting also included solicitation for committee participation and a review of process and schedule for Plan development.

8.2 BOAT TOUR FOR ELECTED OFFICIALS

The MCWD and the University of Minnesota Extension co-hosted an event for local policymakers on August 3, 2016. The event served both as a part of the Extension's Nonpoint Education for Municipal Officials program and as an opportunity for the District to provide a preview of the District's approach for the Plan, illustrating the District's partnership model to local policymakers through project examples.

8.3 PLANNERS BREAKFAST

The MCWD hosted a meeting at the District offices on September 22, 2016, inviting land use and water planning staff from cities, counties, Metropolitan Council, Minnesota Department of Transportation, Three Rivers Park District, and Minneapolis Park and Recreation Board to hear ideas on how to integrate our planning efforts and coordinate early to align plans and investments to maximize environmental, economic, and community benefits. District staff provided an introduction to the integrated planning approach of the Plan. Case studies in the Six Mile Creek–Halsted Bay and the Minnehaha Creek Greenway priority implementation areas were co-presented by District staff and city staff from Victoria and St. Louis Park, respectively. These case studies were examples of successful early coordination on redevelopment and co-planning that resulted in both natural resource and community benefits.

9. PUBLICATIONS

9.1 PURPOSE AND DISTRIBUTION

The MCWD produced three publications of professional quality as another way to share information about the Plan development. The publications were mailed to agency staff, elected officials, administrators, and water resource professionals within the District, sent electronically through the District list-serve, and available in electronic form on the District website. The publications provided easy to read information about the Plan process, schedule, goals, and approach.

9.2 COMPREHENSIVE PLAN KICKOFF BROCHURE, JANUARY 2015

As part of the initial outreach and invitation for county, city, agency, and public participation in the Plan, the Comprehensive Plan Brochure was a four-page color production that served as an initial notice of the Plan update, introduction to the implementation philosophy, scope and schedule, and solicitation for committee involvement.

9.3 2017 COMPREHENSIVE PLAN PREVIEW BOOKLET, AUGUST 2016

This 26-page booklet explains the District's collaborative approach to join with others to align plans and investments to maximize natural resource and community benefits. The implementation concepts of focus and flexibility are discussed in detail with project examples and testimonials from District partners.

9.4 2016 MCWD YEAR IN REVIEW

BROCHURE

An annual communication to MCWD constituents, the 11-page 2016 Year in Review highlighted the December 2016 subwatershed meetings and the Plan approach of information sharing, co-planning, and working in partnership with our communities. The publication also highlighted the Six Mile Creek-Halsted Bay Planning Partnership and the focal geography approach.

10. SUMMARY OF INFORMATION SUBMITTED PER MN RULES 8410.0045 REQUEST

As required per MN Rules Chapter 8410, on April 23, 2015 the District requested information related to local water management issues, goals and priorities from the state agencies, cities, counties, and other stakeholders. The District received submittals from several cities and agencies, and a summary of the submittals is provided below.

City of Edina:

- » Referred to links to the City's Comprehensive Plan, recent major amendment that added the Lakes and Ponds Policy, and Wellhead Protection Plan.
- » City staff is considering policy options in a few related areas:
    - Education and engagement partnership agreements with local WDs to meet MS4 requirements.
    - Residential redevelopment and the increasing imperviousness of the landscape that result
    - Aging infrastructure and sanitary infiltration and inflow
    - Floodplain risk management

City of Excelsior:

- » Sent the City's updated stormwater ordinance.

City of Independence:

- » Local Water-Related Issues:
    - Impairments of Painter Creek for E. coli and Jennings Bay for nutrients.
- » Water Management Goals:
    - Goal 1: Preserve, maintain and improve aesthetic, physical, chemical and biological composition of surface waters and groundwater within the City.
    - Goal 2: Achieve an annual load reduction of 79 pounds of phosphorus in the Painter Creek Watershed.
- » Official Controls:
    - Require infiltration of 1.0" on new impervious surface on appropriate sites
    - Sediment and erosion control ordinance
    - Stream and wetland buffer requirements dependent on quality
    - SWPPP requirements for development
    - Street sweeping
    - Annual SWPPP inspections on storm ponds and pollution control devices
- » Programs:
    - Implement the Wetland Conservation Act
    - PUD allowances
    - Capital Improvement Program
    - Pursue grant opportunities when available

City of Medina:

- » Local Water-Related Issues:
    - Nutrient impairments in several lakes;
    - High water conditions on Mooney and Wolsfeld lakes;
    - Possible erosion and instability in numerous channels.
- » Water Management Goals:
    - Manage land disturbance and increased impervious surfaces to prevent flooding and adverse impacts to water resources.
    - Maintain existing runoff volumes so that runoff from development does not increase volume

loading to wetlands, lakes and streams.

- Control the rate of stormwater runoff from development to reduce downstream flooding and erosion and protect water resources.
- Provide adequate storage and conveyance of runoff to protect the public safety and minimize property damage.
- Reduce the nutrient and sediment loads over current conditions.
- Prevent sediment from construction sites from entering the City's surface water resources.
- Protect the City's wetlands, lakes, streams and groundwater to preserve the functions and values of these resources for future generations.
- Protect and preserve wetlands to maintain or improve their function and value.
- Manage lakes to improve water quality and protect resource values.
- Improve water quality, provide wildlife habitat and protect the resource value of streams.
- Address target pollutants identified in TMDL studies to improve the quality of impaired waters.

» Official Controls:

- Manure ordinance in zoning code which provides BMPs for manure management and requires no net increase in runoff from the site and setback requirements
- Require infiltration of 1.1" on new impervious surface on appropriate sites
- Optional volume control with irrigation
- Stream and wetland buffer requirements dependent on quality
- SWPPP requirements for development

» Programs:

- Stormwater Utility fee to fund projects related to water quality and quantity and active grant requests.
- Stormwater Project Capital Improvement Program
- Medina Stormwater Design Manual: new development requires rate and volume control as well as water quality standards (20% reduction from existing conditions)
- Erosion and Sediment Control Program
- Implement the Wetland Conservation Act

City of Minneapolis:

» Minneapolis would like to partner with MCWD and the other stakeholders on discussions of the following:

- Flood control/Flood mitigation -- including the topics of public safety, implications for public and private property, implications for shoreline/bank destabilization, implications for water quality degradation, issues related to aging infrastructure, opportunities for upstream storage enhancements, cost-benefit analysis of viable alternatives, and minimizing recurrence to improve quality of life
- Outfalls -- definition of roles and responsibilities, opportunities for outfall upgrades that benefit public safety, water quality, shoreline/bank stabilization, and cost-benefit of viable alternatives
- Water quality -- especially on cost-benefit analysis of viable alternatives that address impaired waters, and on focusing projects/policies on actual benefit to the water body
- Stream bank restoration projects – work with municipalities to review opportunities/issues related to structural integrity of bridges and other public infrastructure
- TAC opportunity – discuss establishment of a permanent TAC consisting of representatives of the member municipalities, that would meet regularly to discuss selected MCWD initiatives and provide feedback/expertise/concerns from the municipal perspective
- Modeling – continue sharing of data, models, floodplain modifications, capital project information and other relevant items that promote timely and accurate H&H and water quality models

City of Minnetonka:

» Sent City's 2010 Water Resources Management Plan (Goals and Policies), 2014 MS4 permit and TMDL compliance schedule, and 2010 Stormwater Management Design Guidelines and Standards document.

City of Wayzata:

» City goals and priorities:

- Continue to provide pertinent educational materials to the general public and contractors related to stormwater management.
- Work with MCWD to create a "laundry list" of BMPs and their treatment value to assist developers/ homeowners in site design.
- Continue to look to retrofit stormwater management into its own Capital Improvement projects to meet City and District phosphorus removal goals.

City of Woodland:

» City priorities:

- Protection of shoreline and maintaining high quality surface waters and groundwater
- Coordination of AIS control
- Stormwater management and pollution prevention
- Wetland management and protection
- Review and clarification of wetland rules for individual properties
- Maintaining good communication between MCWD and City
- Shavers Lake Restoration

Hennepin County, Environment and Energy Department:

» Sent County's draft Natural Resources Strategic Plan.

Metropolitan Council Environmental Services:

» Include policies related to the protection of area water resources with the end goal of water sustainability, consistent with the Council's new policy plans.

» Include quantifiable and measurable goals and policies that address water quantity, water quality, recreation, fish and wildlife, enhancement of public participation, groundwater, wetlands, and erosion issues.

» Address the issues and problems in the watershed and include projects or actions and funding to address the issues and problems. At a minimum the watershed should address:

- Any problems with lake and stream water quality and quantity including information on impaired waters in the watershed and the District's role in addressing the impairments,
- Flooding issues in the watershed,
- Storm water rate control issues in the watershed,
- Impacts of water management on the recreation opportunities,
- Impact of soil erosion problems on water quantity and quality,
- The general impact of land use practices on water quantity and quality
- Policies and strategies related to monitoring of area water resources
- Policies and strategies related to use of best management practices
- Issues concerning the interaction of surface water and groundwater in the watershed
- A list of the requirements for local surface water management plans
- Erosion and sediment control standards and requirements
- Volume reduction goals at least as restrictive as requirements in the NPDES construction general permit, and,
- Capital improvement plan with itemized list of actions, estimated costs, and timeline.

Minneapolis Park and Recreation Board:

» Goals for the future of the MCWD system and our local issues are:

- Recovery from 2014 flood
  - Repair previously completed reach projects
  - Repair new erosion

        - Identify and rectify incipient problem areas
    - Progress on Impairments and TMDL projects
        - Phosphorus
        - Bacteria
        - Chloride
        - Biota
    - Preserve base flow to protect stream biota
    - Plan for future floods - Preserve flood storage
    - Trash reduction
    - Preserve historic elements, while naturalizing creek
    - Retain AIS focus
- » Policy-related goals for the next-generation plan are:
    - To more closely align the MPRB CIP plan with the MCWD CIP plan, in order to more effectively partner on projects that meet our common goals.
    - To have MPRB area masterplans recognized in future MCWD planning processes.
    - To balance recreational use and the historic landscape of the MPRB system with environmental issues and water quality improvements to the system.
    - To address illicit discharge to receiving waters that occur across jurisdictional boundaries.
    - That MCWD addresses mitigating flood issues that may be exacerbated by changing rainfall patterns.
- » List of MPRB water-quality-related programs and activities that take place within MCWD boundaries:
    - Canines for Clean Water (address bacteria loading)
    - WQ education tabling at Neighborhood events (annual, number of sites varies)
    - Goose control (address bacteria loading)
    - Lake Monitoring Program (chemistry, aquatic plants, phytoplankton, zooplankton)
    - Beach Monitoring Program (11 MPRB beaches within MCWD boundaries)
    - Stormwater monitoring partnership with City of Minneapolis, two annually -monitored sites within MCWD
    - Xerxes Ave stream monitoring station (rating-curve creation, flow monitoring, flow-paced sampling)
    - Vegetation management (parkland, riparian, and shoreline)
    - Periodic training for MPRB staff (pesticide applicators license, chloride applicators certification, pertinent water quality training topics)
    - Aquatic Invasive Species early detection program, Boat inspection program, Education Program (in partnership with MCWD)
    - Groundwater level monitoring

MN Board of Water and Soil Resources:

- » The Total Maximum Daily Load (TMDL) studies that have been completed should guide implementation planning.
- » The Plan should include reference to the Twin Cities Metropolitan Area Chloride TMDL and incorporate elements of Chloride Management Plan.
- » BWSR would like to see the Plan focus on addressing impaired waters in the upper watershed. Partnership with Hennepin County Dept. of Energy and Environment, Carver Soil & Water Conservation District, and University of Minnesota Extension is encouraged.
- » The District should establish a policy on its approach to in-lake treatment systems.

MN Department of Agriculture:

- » Referred to MDA website and handout "Drainage Recommendations for Local Water Management Plans" (noting that recommendations are intended more for outstate areas).
    - Consider developing a Comprehensive Drainage Management Plan
    - Create a permanent Drainage Advisory Committee
    - Develop a system-wide inventory of culverts and open tiles

- Establish drainage co-efficients based on engineering data
- Encourage development and implementation of Drainage Water Management Plans
- Consider demonstration sites for drainage BMPs
- Consider both short- and long-term storage

MN Department of Natural Resources:

» DNR priority issues:

- Integrated water resource management - focus on achieving healthy watersheds through a "whole-system" approach that considers hydrology, biology, connectivity, geomorphology and water quality.
- Groundwater sustainability - would like to see the District play a stronger role in promoting groundwater use conservation.
- Aquatic invasive species - encourage the District to continue its leadership role in this area.
- Governor's buffer initiative - consider what role the District could play in implementation of the new "Governors Buffer Initiative".
- Stream and lake bank stabilization and restoration - encourages MCWD to consider stream dynamics when planning steam stabilization or restoration projects.
- Consideration of plant communities, rare species, and special features - recommends using assessment data relating to special natural resource features when completing long-range watershed planning efforts.