Surface Water Management Plan

A INTRODUCTION

1 Purpose

The Surface Water Management Plan must meet all the needs and requirements imposed on the City in a single, comprehensive manner. This plan addresses water resources concerns and is in compliance with the plan components of the four watershed management organizations (WMO) that impact Plymouth.

Many water quality plans developed on the basis of a storm drainage philosophy offer only "end of pipe (treatment) solutions." The City's strategy takes into account the characteristics of Plymouth (Appendix A) and focuses on pollution prevention first and storm water treatment second. The plan goes beyond reacting to problems after they occur by implementing proactive programs and policies to protect surface water. The City annually assesses the condition of water resources and develops strategies for achieving realistic, attainable, implementable and affordable goals.

As the city continues to develop and begins to redevelop, problems associated with increased runoff volumes, sedimentation and storm water discharge into city lakes, streams, and wetlands must be addressed. Historically, surface water management within Plymouth consisted primarily of managing the quantity of water. Major storm drainage improvements were first undertaken in the mid 1960s in accordance with a City drainage plan. Facilities were constructed in the south Parkers Lake, Beacon Heights and Garland Lane/14th Avenue areas under the initial plan. This plan was subsequently updated in 1973. The updated plan presented an overall layout of major drainage facilities in Plymouth, including storm sewers, ponding areas and major drainage ways. The purpose of the 1973 plan was to provide an adequate and economical means of conveying storm water runoff. The City completed a revision to the 1973 plan in 1980. The 1980 plan was based on platting and development proposals, storm drainage improvements and the City's Land Use Plan. It provided information on storm sewer and open channel sizes, storm water flows, pond storage volumes and water levels and detailed cost analyses. It also established regional ponding and rate control policies which are still effective today in addressing water quantity-related issues. The City's drainage system closely follows the 1980 Storm Drainage Plan and has been generally accepted by the WMOs.

Today, it is not just the quantity but the quality of surface water that is of increasing importance. There are numerous entities involved in surface water management and environmental protection including federal, state, and regional agencies. Continued implementation of programs to reduce both point and non-point pollution in surface water are essential to reaching established goals set by the various regulatory agencies. This plan builds on environmental and water resource inventories, monitoring data, citizen input, ordinances and other available information. It is the framework for implementation of best management practices (BMPs), programs and policies to manage surface water to meet established goals for water resources in the future.

The City has made numerous efforts to address the quantity and the quality of surface water in Plymouth to protect and enhance its natural resources. These efforts include:

- The Surface Water Management Plan;
- City Code;
- City Engineering Guidelines (2008);
- Floodplain Overlay District (2004);
- Shoreland Management Overlay District (2002);
- Wetlands District (2004);
- Annual Water Quality Monitoring;
- Parkers Lake Watershed and Lake Management Plan (1993);
- Plymouth Natural Area Survey (1994);
- Wetland Inventory and Ordinance (1994);
- Hennepin County Ground Water Plan (1994);
- Erosion Control Ordinance (1994, 2003, 2008);
- Medicine Lake Watershed Implementation Plan (2001);
- Hydrologic and Hydraulic Study of the 2020 Urban Expansion Area (2001);
- Storm Water Pollution Prevention Plan (2008);
- Adoption of a pond maintenance policy (2005);
- Land resource inventory (2006);

- Acquisition of significant natural areas (Northwest Greenway) for public purposes based on the *Natural Resources Inventory* (2007);
- Non-degradation Report (2007);
- Adoption of Wellhead Protection Plan (2007);
- Compliance with the Municipal Separate Strom Sewer System Permit issued by the Minnesota Pollution Control Agency;
- Annual aquatic vegetation surveys;
- Shoreland Restoration Program;
- Curlyleaf management in Medicine Lake;
- Watershed assessments; and
- Adoption of TMDL plans.

All of these documents aid the City in carrying out its surface water plans.

Federal and state law, including the federal Clean Water Act (1972) and its subsequent updates, as well as the Metropolitan Surface Water Management Act (1982) set the foundation for surface water and non-point pollution treatment. The purpose of the 1982 state law is to reduce, to the greatest practical extent, public expenditures related to quantity of storm water runoff. Responding to the state mandate, each watershed unit in the metropolitan area was charged with completing a watershed management plan. As a result, numerous watershed management organizations (WMOs) were formed, either as formal watershed districts or as Joint Powers Agreement WMOs. Each watershed in turn requires the preparation of local or community watershed plans to achieve consistency in water resources management.

Minnesota Rules Chapter 8410 (BWSR, 1992) were promulgated to provide additional direction to WMOs and to ensure the incorporation of water quality and wetland components into watershed plans. In response to the 8410 Rules, the WMOs undertook plan revisions. Table 1 illustrates the status of watershed plans which affect Plymouth. Figure 1 shows the boundaries of the four watersheds in the city.

TABLE 1. Watershed Plan Status

Watershed Management Organization	Original Plan Date	Current Plan Date
Minnehaha Creek	May 26, 1993	July 5, 2007
Bassett Creek	July 26, 1989	Sept. 16, 2004
Shingle Creek	April 25, 1990	May 13, 2004
Elm Creek	May 25, 1990	Dec. 8, 2004

Figure 1

Watershed Districts

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The Metropolitan Council also has a role in water resources management at the local level. Current Metropolitan Council goals and policies pertaining to water resources management are addressed in its 2030 Water Resources Management Policy Plan. This plan includes a significant water quality goal – that the quality of water leaving the metropolitan area be as good as the quality of water entering the area, and in compliance with federal and state regulations.

The Metropolitan Council has been involved in local water resources management for nearly two decades. In the 1990s, the Metropolitan Council adopted an interim non-point source strategy that it implements through the comprehensive plan amendment process. The Metropolitan Council may require a city that has not adopted the interim nonpoint strategy to modify a proposed amendment to its comprehensive plan. In addition, the 1990 State Legislature (Minnesota Statutes 473.157) charged the Metropolitan Council with the adoption of "target pollution loads" for all watersheds in the metropolitan area. This has resulted in a total maximum daily load (TMDL) program for all impaired waters in the state.

Impairments are documented by the Minnesota Department of Natural Resources (DNR). Impaired waters in Plymouth are listed in Table 2. Several TMDL plans have been completed and the Metropolitan Council continues to work with the Minnesota Pollution Control Agency (MPCA) to prepare these plans on a priority basis. The Metropolitan Council asks every community to officially adopt the strategy and make it part of their comprehensive plan. The basic elements of the strategy are adoption of: 1) design standards for the construction of new detention ponds; 2) a management practice design manual equivalent in content to MPCA's *Protecting Water Quality in Urban Areas*; and 3) DNR's shoreland regulations consistent with the DNR implementation strategy. Plymouth has adopted all required strategies.

TABLE 2. Plymouth Impaired Waters.

Water	Affected use	Impairment
Bass Creek	Aquatic Life	Fish IBI[1]
Bassett Creek	Aquatic Life	Fish IBI
Bassett Creek	Aquatic Recreation	Fecal Coliform
Shingle Creek	Aquatic Life	Chloride
Shingle Creek	Aquatic Life	Invertebrate IBI
Shingle Creek	Aquatic Life	Low Oxygen
Bass Lake	Aquatic Recreation	Excess Nutrients
Medicine Lake	Aquatic Recreation	Excess Nutrients
Medicine Lake	Aquatic Consumption	Mercury FCA[2]
Parkers Lake	Aquatic Consumption	Mercury FCA
Pike Lake	Aquatic Recreation	Excess Nutrients
Pike Lake	Aquatic Consumption	Mercury FCA
Pomerleau Lake	Aquatic Recreation	Excess Nutrients
Schmidt Lake	Aquatic Recreation	Excess Nutrients

Source: Minnesota Pollution Control Agency, 2008

[1]Index of biological integrity
[2]Fish consumption advisory

In 1995, legislative changes (Minnesota Statutes 103B) added the Metropolitan Council as a review agency for local water resources management plans. The Metropolitan Council review is concurrent with the WMO review, providing a regional overview to the process.

In the last several years, attitudes have shifted from compliance to more long-term, pro-active planning. The City's wetland inventory and ordinance and the *Natural Resources Inventory* prepared by Hennepin County are evidence of the proactive stance that today defines the City's approach to responsible development and natural resources management. Citizens have also become more attuned to natural resource management. A 2004 citywide survey showed that with respect to environmental concerns, residents were most concerned about water quality and mosquito control. Other concerns included urban wildlife management, invasive plants (buckthorn), noise and light pollution, air quality, and solid waste/recycling.

2 MISSION STATEMENT

The water resources mission statement stipulates:

The Plymouth City Council envisions a community in which the quality of life is enhanced by a natural and healthy environment and by infrastructure designed and maintained to protect property investment. Toward that end, the Plymouth Surface Water Management Plan provides a single, comprehensive strategy which addresses the City's existing and future water resource needs in a proactive manner. The plan promotes citizen and industry participation and education and provides clear direction for properly managing the quantity and quality of surface water runoff and surface and groundwater resources.

3 GOALS AND POLICIES

The City has identified citywide and water body goals for surface water planning and management functions. These goals were generated using the City's lake ranking system, which takes into account watershed, in-lake, and public use characteristics, as well as an assessment of each of the four watersheds in Plymouth and an analysis of 39 sub-watersheds. The goals were established in accordance with the purposes of the water management programs required by State Statute Sections 103B.201 – 103B.251. Furthermore, they are in conformance with the goals of the watershed management organizations having jurisdiction in Plymouth including the Elm Creek, Shingle Creek and Bassett Creek WMOs and the Minnehaha Creek Watershed District. Policies follow each goal.

Based on the goals listed below, the need for best management practices is determined based on the ranking of the receiving lake (high, medium or low), the anticipated land use change and the existing water quality treatment potential. The major plan goals, falling into two major categories (citywide goals and water body goals) are:

a City Wide Goals and Policies

(1) Water Quantity (i.e., Flood Control) – Reduce the potential for flooding and minimize related public capital and maintenance expenditure necessary to control excessive volumes and rates of

runoff.

(i) Constructed detention ponds should be relied upon to limit runoff to pre-development flow rates and to control downstream flooding where feasible; natural basins and green corridors may also be used.

(ii) In Northwest Plymouth, for new and redevelopments which require review by the Elm Creek Watershed Management Commission, the Elm Creek stream flows will be limited to pre-development in-stream flow rates and the project shall comply with extended detention requirements.

(iii) The City encourages regional detention areas, whenever practical.

(iv) Emergency overflows, outlets to drainage systems or other provisions shall be provided if the available storm water storage capacity is inadequate to prevent flooding of adjacent structures.

(v) Encroachment into the flood plain and flood way (volume) below 100-year flood levels shall be prohibited without mitigating action that will preserve the storage capacity, prevent a surcharge in the flood profile, and minimize excessive velocities.

(vi) The minimum building elevation (lowest floor elevation) for all structures must be two feet above the established 100-year water level in accordance with Plymouth Engineering Guidelines.

(vii) Increased volumes of runoff due to development or redevelopment should be minimized by limiting impervious cover and encouraging infiltration of at least 0.5” of rainfall from new impervious surface where soil conditions are appropriate or modifiable.

(viii) The City shall promote the use of alternative landscape techniques and materials to reduce rates and volumes of runoff and may require maintenance agreements for such features.

(ix) The City shall acquire easements covering ponds, wetlands, flood plains, streams, and ditches as part of land development proposals.

(x) The City shall maintain the drainage system for flood prevention and water flow including excavation, facility management, stream and channel restoration, and removal of debris obstructing water conveyance facilities.

(xi) The City shall promote disconnection of on-site impervious surfaces to the City's drainage system.

(xii) The City recognizes the 100-year flood elevations of the Watershed Management Organizations, if available.

(xiii) Development and redevelopment projects greater than 0.5 acres shall demonstrate rate control of surface water for the 2,10, and 100-year storm, consistent with Engineering Guidelines.

(2) Water Quality – Achieve water quality standards in lakes, streams, and wetlands consistent with intended use and classification.

(i) Development and redevelopment projects shall demonstrate that runoff generated is properly treated on- or off-site for total suspended solids (TSS), total phosphorous (TP; 60% removal), and water volume levels to meet, at a minimum, National Urban Runoff Program and non-degradation standards (no net increase in TSS, TP, water volume from existing conditions) using wet detention or other appropriate BMPs.

(ii) Public road and utility projects that disturb greater than 2.5 acres must consider BMPs to improve water quality. If more than 0.5 acres of additional impervious surface is created, it shall be demonstrated that the runoff generated is properly treated on- or off-site for phosphorus and total suspended solid levels to meet non-degradation standards. Post development nutrient loads must remain at or below the pre-project levels using City approved BMPs such as wet detention ponds or other appropriate BMPs.

(iii) Proposed development or redevelopment must identify all reasonable steps to avoid negative water quality impacts and mitigate with appropriate BMPs to prevent water quality in receiving waters from falling below established standards.

(iv) The City shall maintain a response plan to minimize the impact of hazardous spills.

(v) The City will take an active role in developing regional water quality ponds, whenever practical.

(vi) The City shall supplement its regulatory approach with an education-based approach to achieve proper yard care measures that will reduce nutrient loadings to lakes, creeks and wetlands and to reduce the impacts of animal waste.

(vii) The City shall promote the reduction or minimization of impervious areas.

(viii) The City will balance protection of wetlands, use of wetlands to protect the water quality of other water resources (i.e. other wetlands, lakes, streams), and use of wetlands to provide flood control.

(ix) The City shall promote the use of alternative landscape techniques and materials to reduce negative water quality impacts.

(x) The City will manage its properties in accordance with appropriate and innovative BMPs as an example for its citizens.

(xi) Developments and re-developments may be subject to review and compliance with the regulations of the Bassett Creek, Elm Creek, Minnehaha Creek, or Shingle Creek watershed management organizations.

(3) Erosion Control – Minimize soil erosion through plan review, education, enforcement, and management.

(i) Erosion control plans shall be required for grading activities in excess of 50 cubic yards or 10 cubic yards in a shoreland district.

(ii) The City shall continue implementing an erosion control enforcement program for development, redevelopment, individual parcels, and other activities that may cause eroded soils to leave the property where it was generated.

(iii) The City shall use regulatory measures to control erosion and sediment to extend the effective life of water resource facilities and reduce pollutant loadings.

(iv) The City shall develop proactive measures, such as education incentives and recognition of erosion control efforts, to prevent soil erosion.

(v) The City shall be guided by the MPCA Manual – Protecting Water Quality in Urban Areas (1989), as amended, the Minnesota Stormwater Manual (2005), as amended, and the National Pollutant Discharge Elimination System (NPDES) standards, as amended.

(4) Wetlands – Maintain the amount of wetland acreage and improve the wetland functions and values within the city, where feasible.

(i) The City shall administer wetland protection and mitigation in accordance with the Minnesota Wetland Conservation Act, as amended, and the Citys Wetland District as described in the Plymouth Zoning Ordinance.

(ii) For development which creates impervious surface, water quality treatment must be provided prior to discharge to wetlands.

(iii) The artificial water level fluctuation (bounce) in wetlands resulting from storm water runoff shall be managed in accordance with the City's wetland classifications.

(iv) Where open water areas are permitted to be excavated in wetlands for the purpose of creating habitat diversity and to promote restoration, the excavation shall be done in conformance with DNR regulations and the Minnesota Wetland Conservation Act.

(v) The City will identify restorable wetlands.

(vi) The City will endeavor to enhance wetlands concurrently with drainage projects, to improve functions and values, where feasible.

(vii) Due to MPCA requirements imposing control of water volume, wetland banking for impacts resulting from "fill" will be discouraged.

(5) Public Participation, Information, and Education – Increase public involvement and knowledge in management of water resources.

(i) The City will use a public involvement process in resource management decision-making (the Environmental Quality Committee).

(ii) The City will use a variety of media, including newsletters, local cable television and the City's web site, and watershed management organizations to disseminate information and messages regarding storm water.

(iii) The City will work with existing public and private resources to increase public participation in surface water management.

(iv) The City will establish model interpretive sites for public education.

(v) The City will continue to manage public education programs, including but not limited to, programs for alternative landscapes and aquatic plant management.

(6) Monitoring – Continue to support a comprehensive water resources monitoring program.

(i) The City will conduct in-lake monitoring programs to develop baseline and long-term water quality records for all city lakes, as well as Bassett, Elm, Plymouth, and Shingle Creeks.

(iii) The City will cooperate with all public agencies to conduct monitoring projects.

(iv) The City will establish citizen monitoring programs.

(7) Maintenance and Inspection – Preserve the function, quantity, and quality of water resource facilities through routine inspections, regular maintenance activities, and administration of the Minnesota Wetland Conservation Act.

(i) The City will inspect its drainage system for compliance with the requirements of the MPCA and the City's Pond Maintenance Policy.

(ii) The City shall require maintenance of privately constructed water quality treatment ponds as outlined in any applicable pond maintenance agreement.

(iii) The City shall require adequate access to public and private surface water facilities (ponds, etc.) for maintenance purposes.

(8) Recreation, Fish, and Wildlife – Support water recreation activities and improve fish and wildlife habitat by implementation of programs which will improve water quality.

(i) Natural areas and wildlife habitat intended for preservation shall be protected during construction by appropriate BMPs.

(ii) Preserve vegetative buffers around wetlands and riparian areas to provide habitat for wildlife.

(iii) Support programs for controlling exotic and invasive species of plants and animals.

(iv) Design and construct lake outlets to provide a barrier to upstream migration of rough fish whenever practical.

(v) The City recognizes the need to balance water recreational activity with water quality and habitat issues.

(vi) The City will explore new opportunities to integrate surface water-based recreation activities and wildlife interests within wildlife corridors.

(vii) The City encourages the protection of threatened and endangered species and areas of significant natural communities as identified by the Natural Resources Inventory and consistent with the Minnesota Department of Natural Resources.

(9) Groundwater – Prevent contamination of the aquifers and promote groundwater recharge including water conservation practices to maintain base flows in streams.

(i) The City shall develop and implement controls to protect identified wellhead areas.

(ii) The City shall promote proper well abandonment.

(iii) The City will consider alternatives to conventional storm water detention to enhance groundwater recharge through infiltration.

(iv) Design and installation of on-site wastewater systems shall be in accordance with the standards set forth in Minnesota Rules, Chapter 7080 and the Individual Sewage Treatment System (ISTS) Act.

(v) The City will implement and enforce the current Water Emergency and Conservation Plan.

(vi) The City shall promote and demonstrate the use of alternative landscape techniques and materials to reduce dependency on groundwater supplies.

(10) Finance – Regularly evaluate and monitor funding sources used to finance water resources management activities.

(i) The City shall continue to help fund surface water management through the surface water utility fee.

(ii) The City will actively pursue grants, donations, in-kind contributions, and watershed resources to help fund surface water management.

(iii) The City shall assist citizens and businesses in their efforts to improve water quality, decrease water quantity and/or improve the functions and values of surface water resources.

b Water Body Goals (Streams and Lakes)

(1) Bass Creek

(i) Work toward reaching goals as set forth in any future EPA approved-TMDL Implementation Plan.

(2) Bassett Creek

(i) Work toward reaching goals as set forth in any future EPA approved-TMDL Implementation Plan.

(3) Elm Creek

(i) The flow rate in Elm Creek shall be maintained at pre-development flow rates for the 2-, 10- and 100-year rainfall events. The City will work toward the in-stream goals established by the Elm Creek Watershed Management Commission: total phosphorous – 250 mg/l; total suspended solids – 25 mg/l; total nitrogen – 3 mg/l; chemical oxygen demand – 100 mg/l.

(ii) Incorporate the Elm Creek Watershed Management Commission extended detention requirements for new development and redevelopment.

(4) Shingle Creek

(i) Work toward in-stream goals to reduce chloride concentrations and meet the EPA-approved TMDL Implementation Plan for Chloride.

(ii) Work toward reaching goals as set forth in any future EPA-approved TMDL Implementation Plan.

(5) Bass Lake

(i) Work toward an in-lake average total phosphorus concentration of 38 - 60µg/l, secchi depths greater than 2.4 – 4.6 feet, and chlorophyll-a concentrations below 10 – 30µg/l.

(ii) Work toward reaching goals as set forth in any future EPA-approved TMDL Implementation Plan.

(6) Gleason Lake

(i) Work toward an in-lake average total phosphorus concentration of near 60µg/l, secchi depths greater than 2.4 feet, and chlorophyll-a concentrations below 30µg/l.

(7) Lake Camelot

(i) Work toward an in-lake average total phosphorus concentration of 38 - 60µg/l, secchi depths greater than 2.4 – 4.6 feet, and chlorophyll-a concentrations below 10 – 30µg/l.

(ii) Work toward reaching goals as set forth in any future EPA-approved TMDL Implementation Plan.

(8) Lost Lake

(i) Work toward an in-lake average total phosphorus concentration of 38 - 60µg/l, secchi depths greater than 2.4 – 4.6 feet, and chlorophyll-a concentrations below 10 – 30µg/l.

(ii) Work toward reaching goals as set forth by the MPCA and BCWMC (Level II).

(iii) Work toward reaching goals as set forth in any future EPA-approved TMDL Implementation Plan.

(9) Medicine Lake

(i) Increase clarity and work toward an in-lake average total phosphorus concentration of 38µg/l , secchi depths greater than 4.6 feet, and chlorophyll-a concentrations below 10µg/l.

(ii) Work toward reaching goals as set forth in any future EPA-approved TMDL Implementation Plan.

(10) Mooney Lake

(i) Work toward an in-lake average total phosphorus concentration of near 60µg/l, secchi depths greater than 2.4 feet, and chlorophyll-a concentrations below 30µg/l.

(11) Parkers Lake

(i) Reduce phosphorus loadings at storm water inlet points and work toward an in-lake average total phosphorus concentration of 38µg/ 1, secchi depths greater than 4.6 feet, and chlorophyll-a concentrations below 10µg/l.

(ii) Work toward reaching goals as set forth in any future EPA-approved TMDL Implementation Plan.

(12) Pike Lake

(i) Work toward an in-lake average total phosphorus concentration of 38 - 60µg/l, secchi depths greater than 2.4 – 4.6 feet, and chlorophyll-a concentrations below 10 – 30µg/l.

(ii) Work toward reaching goals as set forth in any future EPA-approved TMDL Implementation Plan.

(13) Pomerleau Lake

(i) Work toward an in-lake average total phosphorus concentration of 38 - 60µg/l, secchi depths greater than 2.4 – 4.6 feet, and chlorophyll-a concentrations below 10 – 30µg/l.

(ii) Work toward reaching goals as set forth in any future EPA-approved TMDL Implementation Plan.

(14) Schmidt Lake

(i) Work toward an in-lake average total phosphorus concentration of 38 - 60µg/l, secchi depths greater than 2.4 – 4.6 feet, and chlorophyll-a concentrations below 10 – 30µg/l.

(ii) Work toward reaching goals as set forth in any future EPA-approved TMDL Implementation Plan.

(15) Turtle Lake

(i) Work toward an in-lake average total phosphorus concentration of 38 - 60µg/l, secchi depths greater than 2.4 – 4.6 feet, and chlorophyll-a concentrations below 10 – 30µg/l.

(ii) Work toward reaching goals as set forth by the MPCA and BCWMC (Level II).

(iii) Work toward reaching goals as set forth in any future EPA-approved TMDL Implementation Plan.

4 IMPLEMENTATION

Implementation of the Surface Water Management Plan is based on the established citywide and water body goals. The process of developing an implementation plan for each of the goals is based on four steps: 1) development of goal statements that meet or exceed the rules of the four WMOs; 2) identification of issues or barriers related to achieving the goal; 3) identification of solutions corresponding to each of the issues or barriers; and 4) development of specific action steps, including identification of resources, measurement, schedule and cost.

Implementation involves a series of value-based decisions, such as: ***Should the quality of a wetland be sacrificed to improve the quality of a lake? Should development be controlled to preserve significant nature features?*** By developing priorities, cost estimates, schedules and a fully-functional geographic information system (GIS), the City has the tools to reach goals that are realistic, attainable, implementable, and affordable. There are hundreds of ponds and wetlands to inspect and maintain. More inspection and maintenance is expected, along with monitoring, public involvement and capital improvement. Table 3 summarizes the estimated expenditures (operating budget and capital improvements program) of the implementation program through 2030.

TABLE 3. Implementation Plan Summary

Year	Estimated Expenditures
2008	$3,600,000
2009	$3,000,000
2010	$2,900,000
2011	$3,200,000
2012	$3,150,000
2013	$3,200,000
2014 – 2030	$3,300,000
Total	**$75,150,000**

a Future Needs of the City

The Surface Water Management Plan is a major step toward integrating previous city, WMO, state, and federal efforts to manage water resources. Although the City has an existing Comprehensive Drainage Plan (1980) and an existing storm drainage system, much of the drainage system constructed prior to 1991 discharges directly into lakes or wetlands. Maintenance and infrastructure planning needs to be done and development or redevelopment needs to be carefully planned to protect existing water resources.

The focus of development projects will be in Northwest Plymouth in the Elm and Shingle Creek watersheds. The opportunity to develop in an environmentally sensitive manner is possible in this area and this plan develops strategies to accommodate development and protect natural features at the same time.

The focus for redevelopment projects in Plymouth is expected to be in the Bassett Creek and Minnehaha Creek watersheds and to a lesser extent, Shingle Creek watershed. Two major constraints to water resource management include existing land use and outdated construction of the existing drainage systems. Resolution will require costly system retrofits or reconstruction to develop water quality treatment solutions.

b Implementation Strategies

Description	Timing
Storm Water Management – Continue to implement the 1980 Storm Drainage Plan in the design of drainage facilities in the city.	Ongoing
Water Resources Management – Major projects to be conducted within the next five years are listed in the Capital Improvements Program.	Ongoing
Northwest Plymouth – Encourage creative development to reduce impervious cover and increase infiltration, and control runoff rates to existing levels and minimize runoff volumes.	Ongoing
Developed/Redeveloped Areas – Implement sound emerging techniques with redevelopment; eliminate products and materials which contain pollutants; educate citizens on yard and pet waste and water fowl (geese); and use appropriate best management practices.	Ongoing

Goals and Policies

A INTRODUCTION

A ***goal*** is a desired end toward which water management efforts are directed. This section of the plan identifies ten goals for water resources planning and management functions. The goals of this plan were established in accordance with the purposes of the water management programs required by Minnesota Statute 103B, current and future land use (Figure 2 and Figure 3) and in conformance with the goals of the watershed management organizations having jurisdiction in Plymouth including the Elm Creek, Shingle Creek, Bassett Creek WMOs and the Minnehaha Creek Watershed District. Goals have been established for each of the eight major lakes and Bass Creek, Bassett Creek, Elm Creek, and Shingle Creek. The goals are not necessarily listed in any order of priority. Additionally, each goal has several corresponding policies. A ***policy*** is a governing principle that provides the means for achieving established goals.

Specific action and implementation plans have been developed for each of the eight major lakes and Bass Creek, Bassett Creek, Elm Creek, and Shingle Creek. The action plans identify problems related to achieving the stated goal and solutions for addressing the problems. The implementation plan corresponds directly to the stated goal and policies, and to the solutions identified for each of the eight major lakes and Bass Creek, Bassett Creek, Elm Creek, and Shingle Creek. The implementation plans include specific activity steps, available resources, means of measuring the completion of the activity step, a target date for completion and an estimated budget.

There are nearly 30 major goals established for the Surface Water Management Plan. Ten city-wide goals are applied uniformly across the City and corresponding policies to those ten goals have been developed. The ten goals that follow include subwatershed-specific action plans that apply the City-wide goals and policies and are

Figure 2. Current Land Use Map.

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Figure 3. Proposed 2030 Land Use Map.

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geared towards water resource management activities necessary to achieve established objectives for each of the eight major lakes and Elm Creek. The Implementation Plan that follows each City-wide goal and subwatershed-specific action plans describes program costs and priorities.

B CITY WIDE GOALS AND POLICIES

1. WATER QUANTITY, I.E., FLOOD CONTROL – REDUCE THE POTENTIAL FOR FLOODING AND MINIMIZE RELATED PUBLIC CAPITAL AND MAINTENANCE EXPENDITURES NECESSARY TO CONTROL EXCESSIVE VOLUMES AND RATES OF RUNOFF.

a. Floodplain Overlay District

The Plymouth Floodplain Overlay District (Section 21660 of the Zoning Code) establishes Floodplain Overlay Districts based upon the Flood Insurance Study, City of Plymouth, Minnesota, (dated November 1977), the Federal Emergency Management Agency (FEMA) flood insurance maps (dated September 2, 2004) (Figure 4), Flood Boundary and Floodway Maps (dated May 15, 1978), and flood profiles published by the United States Department of Housing and Urban Development, and two technical studies published by McCombs-Knutson Associates, Inc., entitled: A Reevaluation of Flooding Potential on a Portion of Plymouth Creek west of Vicksburg Lane (through the proposed R.P.U.D. of Plymouth Hills Estates); GarLar Properties, Plymouth, Minnesota, November 1982" and, A Reevaluation of Flooding Potential on a portion of Plymouth Creek, Plymouth, Minnesota, September, 1982" (37th Avenue North to Vicksburg Lane). These studies contain data consistent with standards established by the Minnesota Department of Natural Resources. Available rates and volumes for ponding within the

City's drainage system are provided in Appendix B. The regulations contained within the ordinance are intended to manage area suitable for development of varying types as permitted in the underlying zoning district.

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Figure 4. Federal Emergency Management Agency Flood Insurance Map.

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b. 1980 Storm Drainage Plan

In 1980, a storm drainage plan was completed for Plymouth (Appendix C). The 1980 plan has been accepted by the WMOs in terms of flow rate and 100-year water level identification, thereby meeting the requirements of the law. The 1980 plan represented a regional approach to storm water management. The reality of development added numerous on-site ponds in lieu of the regional ponds in the 1980 plan. Development essentially produced the same overall result, while at the same time adding numerous storm water ponds to the landscape. Currently, the City also utilizes a geographic information system (GIS) to monitor and inspect the storm sewer system (Figure 5).

No new water quantity modeling was completed as part of this plan. The 1980 plan has consistently produced conservative results. The plan has been enforced to establish regional ponds. However, where regional facilities did not exist at the time of development, on-site ponding was required, resulting in a system which today offers significantly more storage and ponding areas than envisioned in the 1980 plan.

Storm water management deals with just one component of the hydrologic cycle - surface runoff. Large amounts of energy are directed towards alleviating significant negative impacts of surface runoff and flooding on the cultural, water, and natural resources. The primary management strategy is still detention in both existing natural (wetland) and constructed basins. However, this does not remedy the negative impact on lake quality from storm sewer runoff. A variety of other chemical, physical and structural techniques are required to meet water quality goals. Furthermore, with an increased emphasis on the valuation of wetlands, pretreatment of discharges to wetlands is required. The approach to water quality management relates directly to water quantity, wetland management, erosion control, and land development strategies.

Figure 5. Storm Sewer System.

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c. Public Ditch Systems

Figure 6 illustrates public ditches in Plymouth. These ditches are a vital part of the City's formal drainage system. Their continued maintenance should be considered a concern for the responsible agency. The Metropolitan Surface Water Management Act (M.S. ээ 103B.201 to 103B.251 - the act) authorizes WMOs to accept the transfer of County or joint County drainage systems, and to construct all new systems and improvements of existing systems. The act further authorizes WMOs to use the powers of M.S. c. 103E (i.e., the drainage code), 103D (watershed law), or the act itself in carrying out projects on public drainage systems.

Additionally, Hennepin County is the recognized authority for all judicial ditch systems not previously transferred to another governmental unit, including responsibilities for permitting, maintenance and repair related activities. In the future, ditch maintenance responsibilities may be transferred to the City.

d. Soils

Soils in Plymouth are generally clay to clay loam with spotty sand lenses in the south and southwestern portions of the City (Figure 7.) Infiltration best management practices will be difficult to incorporate in clay and clay loam areas. Other best management practices may be required to meet water quantity goals for projects in these areas.

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Figure 6. Public Ditches

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Figure 7. Soil Classifications.

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TABLE 4. Water Quantity Policies.

Subject:	Surface water, rate and volume management
Purpose:	Manage storm water runoff
Goal:	Reduce the potential for flooding and minimize related public capital and maintenance expenditure necessary to control excessive volumes and rates of runoff.
Policy 1:	Constructed detention ponds should be relied upon to limit runoff to pre-development flow rates and to control downstream flooding where feasible; natural basins and green corridors may also be used.
Policy 2:	In Northwest Plymouth, for new developments and redevelopments which require review by the Elm Creek Watershed Management Commission, the Elm Creek stream flows will be limited to pre-development in-stream flow rates and the project shall comply with extended detention requirements.
Policy 3:	The City encourages regional detention areas, whenever practical.
Policy 4:	Emergency overflows, outlets to drainage systems or other provisions shall be provided if the available storm water storage capacity is inadequate to prevent flooding of adjacent structures.
Policy 5:	Encroachment into the flood plain and flood way (volume) below the 100-year flood levels shall be prohibited without mitigating action that will preserve the storage capacity, prevent a surcharge in the flood profile, and minimize excessive velocities.
Policy 6:	The minimum building elevation (lowest floor elevation) for all structures must be a minimum of 2 feet above the established 100-year water levels in accordance with Plymouth Engineering Guidelines.
Policy 7:	Increased volumes of runoff due to development or redevelopment should be minimized by limiting impervious cover and encouraging infiltration of at least 0.5” of rainfall from new impervious surface where soil conditions are appropriate or modifiable.
Policy 8:	The City shall promote the use of alternative landscape techniques and materials to reduce rates and volumes of runoff and may require maintenance agreements for such features.
Policy 9:	The City shall acquire easements covering ponds, wetlands, flood plains, streams, and ditches as part of land development proposals.
Policy 10:	The City shall maintain the drainage system for flood prevention and water flow including excavation, facility management, stream and channel restoration, and removal of debris obstructing water conveyance facilities.
Policy 11:	The City shall promote a disconnection of on-site impervious surfaces to the City’s drainage system.

Policy 12: The City recognizes the 100-year flood elevations of the Watershed Management Organizations, if available.

Policy 13: Development and redevelopment projects greater than 0.5 acres shall demonstrate rate control of surface water for the 2, 10, and 100 year storm, consistent with City Engineering Guidelines.

TABLE 5. Water Quantity Implementation Plan.

Activity Steps	Resources	Measurement	Implementation Year	Est. Cost
Update Plymouth engineering guidelines to address both peak runoff rates and runoff volumes	• Plymouth Engineering Guidelines	• Updated engineering guidelines	2009-2019	$10,000
Implement a Pond Maintenance Program	• City maintenance staff • Field review • Reports of resident complaints	• Map of problem areas • Completed projects	2009-2019	$500,000
Develop a model site to establish, promote and monitor the effectiveness of alternative landscape features.	• Available Alternative landscape resources • See Goals 2 and 9	• Site acquired • Site developed • Monitoring data	2015	$200,000
Complete a feasibility study for updating the City's surface water drainage plan	• 1980 Storm Drainage Plan • 2000 Water Resources Management Plan • Non-degradation Report	• Completed study	2011	$24,500

2. WATER QUALITY – ACHIEVE WATER QUALITY STANDARDS IN LAKES, STREAMS, AND WETLANDS CONSISTENT WITH INTENDED USE AND CLASSIFICATION.

To achieve water quality standards in lakes, streams, and wetlands, the City may utilize it's Storm Water Pollution Prevention Program (SWPPP) (Appendix D) and Non-Degradation Plan (Appendix E) in addition to other programs or regulations applicable to the City of Plymouth. Although there are many contributors to poor water quality including TSS and mercury, nutrient loading appears to be the main contributor in Plymouth.

a. Nutrients

Water quality is directly related to nutrients. Nutrients, principally phosphorous, must be controlled to achieve water quality goals. Phosphate fertility of soil arises through mineralization of phosphorous-containing rock. Phosphorous cycling is a sedimentary cycle. Soil phosphorous arising from a geochemical process is stored primarily in an inorganic form, with lesser amounts in the organic form. Excess phosphate which cannot be assimilated by biological processes is adsorbed to soil particles. Under natural conditions, phosphorous transport to surface water principally occurs via decomposition of litter into surface waters and erosional forces. Thus, one of the major sources of phosphate in surface water is through soil erosion. Phosphorous is almost always the limiting factor to plant growth. Increase the phosphorous and the plant species dominating the lake shore, open water, or marsh will certainly shift to favor those plants which can best take advantage of the increased supply of phosphorous.

Phosphorous export can be controlled in four ways:

1. The first involves adopting City ordinances to control erosion. The City's erosion control ordinances, Section 425 and Section 526 of the City Code, is an effective tool for reducing total suspended solids loading.

2. Good housekeeping practices of individual property owners can reduce phosphorous loading. Housekeeping practices are a way for individuals to make a difference. According to the Minneapolis Chain of Lakes Clean Water Partnership, many people do not realize that organic materials, like leaves and grass clippings, fertilizer and pesticides, and pet waste can disrupt the fragile ecosystem of a lake. Leaves and grass clippings that make their way to lakes are doing even more damage than fertilizers, pesticides and motor oils, according to the Minneapolis Chain of Lakes Clean Water Partnership. Once in the lakes, these organic materials decay, releasing phosphorus. The excess phosphorus increases algae growth, inhibiting the growth of other aquatic plants. When algae die and decay, they exert a biological oxygen demand (BOD) on the lake, depleting available oxygen for fish. The following housekeeping methods are suggested:

- Composting. It is the surest way to keep leaves and grass clippings off streets, out of storm drains and out of lakes. Compost locations should be away from surface waters.
- Mulching. Allow chopped leaves and grass clippings to remain on the lawn. The nutrients provided will reduce the need for commercial fertilizers.

3. In northwest Plymouth, and other scattered areas of the City, homes continue to be served by on-site waste water systems instead of the City’s sanitary sewer system. An un-maintained system can represent a significant threat to water quality, especially when they

are adjacent to significant wetlands and/or lakes. It is the responsibility of the property owner to maintain the system in proper working order.

4. Large expenditures are made to alleviate the symptoms of excess phosphorous in our water resources. Fertilizers which were originally developed for maximizing agricultural crop yield are subsequently being used for small gardens and lawns, although the need and/or benefits are not always clear.

Fertilizer may be necessary for a healthy lawn, but the nutrients in fertilizer can be harmful to lakes and wetlands. Phosphorus from fertilizers runs off lawns and ends up area lakes and wetlands. One pound of phosphorus can yield 300-500 pounds of algae. Algae can turn a lake green and damage or even kill the lake's ecosystem. Fifteen to thirty percent of phosphorus in urban runoff comes from lawns. In general, the soils in Plymouth are already rich in phosphorus. Applying the right fertilizer, in the right amount, ensures a healthier lawn and healthier lakes and wetlands.

Some tips for fertilizer application include:

- Test soils before applying fertilizer to determine what nutrients are needed.
- Use phosphorus-free fertilizers, unless specific soil tests indicate a deficiency in phosphorus concentration.
- Follow the directions exactly.
- Aerate lawns to promote root growth.
- Keep fertilizers off hard surfaces. Sweep up fertilizer that falls on side walks, driveways and streets.

The State of Minnesota and the City of Plymouth restrict the use of phosphorous fertilizers. Care should be taken by both homeowners and businesses when applying fertilizer to avoid conflicts with state law or city code.

TABLE 6. Water Quality Policies.

Subject:	Water Quality in lakes, streams, and wetlands
Purpose:	To protect and improve water quality, if necessary
Goal:	Achieve water quality standards in lakes, streams, and wetlands consistent with intended use and classification.

Policy 1: Development and re-development projects shall demonstrate that the runoff generated is properly treated on or off site for total suspended solids (85% removal), phosphorus (60% removal) and water volume levels to meet, at a minimum, National Urban Runoff Program (NURP) and non-degradation standards, using wet detention or other appropriate BMPs for projects that disturb:

1. Commercial, industrial, institutional, residential, or public developments greater than 0.5 acres.
2. Redevelopment greater than 0.5 acres.
3. Additionally, any redevelopment greater than 2.5 acres in size must first incorporate on or off site NURP standards, using wet detention or other appropriate BMPs.
4. Any development or redevelopment must first treat surface water through the use of BMPs such as ponding, prior to discharge into wetlands.

Policy 2: Public road and utility projects that disturb greater than 2.5 acres must consider BMPs to improve water quality. If more than 0.5 acres of additional impervious surface is created, they shall demonstrate that the runoff generated is properly treated on or off site for phosphorus and total suspended solid levels to meet non-degradation standards. Post-development nutrient loads must remain at or below the pre-project levels using City approved BMPs such as wet detention ponds or other appropriate BMPs.

Policy 3: Proposed development or redevelopment must identify all reasonable steps to avoid negative water quality impacts and mitigate with appropriate BMPs to prevent water quality in receiving water bodies from falling below established standards.

Policy 4: The City shall maintain a response plan to minimize the impact of hazardous spills.

Policy 5: The City will take an active role in developing regional water quality ponds whenever practical.

Policy 6: The City shall supplement its regulatory approach with and education-based approach to achieve proper yard care measures that will reduce nutrient loadings to lakes, creeks, and wetlands and to reduce the impacts of animal waste.

Policy 7: The City shall promote the reduction or minimization of impervious areas.

Policy 8: The City will balance protection of wetlands, utilization of wetlands to protect the water quality of other water resources (i.e. lake, stream, wetland), and use of wetlands to provide flood control.

Policy 9: The City will promote the use of alternative landscape techniques and materials to reduce negative water quality impacts.

Policy 10: The City will manage its properties in accordance with appropriate and innovative BMPs.

Policy 11: Developments and re-developments may be subject to review and compliance with the regulations of the Bassett Creek, Elm Creek, Minnehaha Creek, or Shingle Creek watershed management organizations.

TABLE 7. Water Quality Implementation Plan.

Activity Steps	Resources	Measurement	Implementation Year	Est. Cost
Revise Plymouth engineering guidelines to address both peak runoff rates and runoff volumes.	• Current Engineering Guidelines • Workshops	• Updated engineering guidelines	2009-2019	$10,000
Include BMPs with street reconstruction projects where feasible.	• City Staff	• Number of BMPs	2009-2019	$1,000,000
Maintain a hazardous spill response plan	• Police/Fire Departments • Training	• Spill mitigation	2009-2019	$10,000
Develop regional water quality ponds where feasible	• Capital Improvement Plan • Comprehensive Plan • City Staff	• Number of regional water quality ponds	2016	$2,000,000
Implement standards during the development review process	• City Staff	• BMPs in new and redevelopment	2009-2019	$0
Provide funding for shoreline restorations, if feasible	• City Staff • MN DNR • WMOs	• Acreage of restored shoreline	2010, 2012, 2014, 2016, 2018	$250,000
Replace gravel public access on Schmidt Lake	• City staff • MN DNR • SCWMC	• New access	2010	$20,000

3. EROSION CONTROL – MINIMIZE SOIL EROSION THROUGH PLAN REVIEW, EDUCATION, ENFORCEMENT, AND MANAGEMENT.

Water quality problems are frequently linked to high phosphorus concentrations. As discussed in the previous section, phosphorous cycling is a "sedimentary" cycle. Phosphorous bound to soil particles can be readily transported to lakes, streams, wetlands, or ponds where is available to aquatic plants for growth.

Soil erosion also can create pond and drainage way performance and maintenance issues. Ponds and drainage facilities are impacted by erosion and sediment from a variety of sources, including construction sites and street sanding in the winter. The coarse sediment accumulates in ditches and ponds where runoff velocities are low. Usually a sand delta appears at a storm sewer outfall which is a visible indication of the effectiveness of erosion and sediment control measures and road maintenance activities of the past winter. As the sediment builds up over time, it reduces the runoff carrying capacity of the drainage system and the pollutant removal capabilities of ponds by reducing the storage volume below the normal water elevation. Extending the life of facilities involves source control and elimination of the material that causes the problem. Regulatory aspects will control a major portion of the sediment. Street maintenance standards, the other component, can be managed with an effective sweeping program.

Additionally, stream bank erosion occurs as a result of increasing peak flow rates or sustained high flows which can severely damage stream bank vegetation, cause bottom scour and accelerate the erosion process. Each of the Watershed Organizations as well as the City of Plymouth is specifically addressing this issue. The City's erosion control ordinances, Section 425 and 526 of the City Code, are effective tools against reducing total suspended solids loading if properly enforced. Generally, these ordinances are consistent with the requirements of the Minnesota Pollution Control Agency and the Minnesota Stormwater Manual.

TABLE 8. Erosion Control Policies.

Subject:	Control of erosion and sedimentation
Purpose:	To manage erosion and sedimentation
Goal:	Minimize soil erosion through plan review, education, enforcement, and management.
Policy 1:	Erosion control plans shall be required for grading activities in excess of 50 cubic yards or 10 cubic yards in a shoreland district.
Policy 2:	The City shall continue implementing an erosion control enforcement program for development, redevelopment, individual parcels, and other activities that may cause eroded soils to leave the property where it was generated.
Policy 3:	The City shall use regulatory measures to control erosion and sediment to extend the effective life of water resources facilities and reduce pollutant loadings.
Policy 4:	The City shall develop proactive measures such as education, incentives and recognition of erosion control efforts to prevent soil erosion.
Policy 5:	The City shall be guided by the MPCA Manual – Protecting Water Quality in Urban Areas (1989), as amended, the Minnesota Stomrwater Manual (2005), as amended, and the National Pollutant Discharge Elimination System (NPDES), as amended, standards.

TABLE 9. Erosion Control Implementation Plan.

Activity Steps	Resources	Measurement	Implementation Year	Est. Cost
Continue to modify erosion control ordinances to meet the needs of the City and for consistency with State and Federal requirements.	• Current Ordinances • Workshops	• Updated City Code	2014	$5000
Review development and redevelopment plans for consistency with City policies	• City Staff	• Number of plans reviewed	2009-2019	$50,000
Continue to implement an erosion control inspection program	• City Staff	• Number of inspections • Number of administrative fees	2009-2019	$150,000

4. WETLANDS – MAINTAIN THE AMOUNT OF WETLAND ACREAGE AND IMPROVE THE WETLAND FUNCTIONS AND VALUES WITHIN THE CITY, WHERE FEASIBLE.

Natural resources and wetlands were inventoried separately in the City of Plymouth in 2006 and 1994 (Appendix F). Sites were named according to distinct plant communities; community referring to particular aggregations of plants and animals. Because of the relatively immobile nature of plants and their fundamental role in energy flow in ecosystems, communities are typically named according the predominant plant species.

The term wetland refers to all wet depressional areas, regardless of the vegetative structure or overall natural community type (Figure 8). Site specific data are located in files at Plymouth City Hall. An explanation of the evaluation method is in the Plymouth Wetland Inventory (Peterson, 1994). Sites are mapped in the Plymouth GIS. Each low area within relatively large forest tracts was identified separately in the wetland inventory; protection of these wetlands will depend on the overall forest management strategy. Several of the wetland natural areas were also part of the wetland inventory (Table 10)

Table 10. Plymouth Wetlands by Classification (from Appendix F).

Wetland Class	Number of Basins	% of Total Basins	Total Acreage	Total Acreage (%)
Exceptional	43	5.4	487.4	17.1
High	131	16.3	1451.9	50.8
Medium	501	62.4	807.6	28.3
Low	95	11.8	82.9	2.9
Storm Water	22	2.7	6.3	0.2
Upland/Undesignated	11	1.4	20.5	0.7
Totals		*100.0*		*100.0*

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Figure 8. Wetland Classifications.

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The wetland management addresses the type, quality, functions, and values of certain wetlands. Wetland enhancements to improve the type, quality, functions, and values of wetlands will be proposed where feasible and in compliance with applicable rules and regulations. The City's wetland regulations (Section 21670 of the zoning ordinance) establishes standards for wetland protection including wetland buffers. Additionally, the City of Plymouth acts as the local government unit (LGU) for administration of the state's Wetland Conservation Act.

TABLE 11. Wetland Policies.

Subject:	Wetland Management
Purpose:	To utilize, protect, preserve, and enhance wetlands.
Goal:	Maintain the amount of wetland acreage and improve the wetland functions and values within the City, where feasible.
Policy 1:	The City shall administer wetland protection and mitigation in accordance with the Minnesota Wetland Conservation Act, as amended, and the City's Wetland District as described in the Zoning Ordinance (Section 21670).
Policy 2:	For development which creates impervious surface, water quality treatment must be provided prior to discharge to wetlands.
Policy 3:	The artificial water level fluctuation (bounce) in wetlands resulting from storm water runoff shall be managed in accordance with the City's wetland classifications.
Policy 4:	Where open water areas are permitted to be excavated in wetlands for the purpose of creating habitat diversity and to promote restoration, the excavation shall be done in conformance with DNR regulations and the Minnesota Wetland Conservation Act.
Policy 5:	The City will identify all restorable wetlands.
Policy 6:	The City will endeavor to enhance wetlands concurrently with drainage projects, to improve functions and values, where feasible.
Policy 7:	The City shall administer wetland buffers consistent with the City's Wetland District as described in the Zoning Ordinance (Section 21670). Additionally, Elm Creek shall have a minimum 50' buffer consistent with Elm Creek Watershed Management Commission policies.
Policy 8:	Due to MPCA requirements imposing control of water volume, wetland banking for impacts resulting from "fill", will be discouraged.

TABLE 12. Wetlands Implementation Plan.

Activity Steps	Resources	Measurement	Implementation Year	Est. Cost
Continue to act as LGU for administration of the Wetland Conservation Act, as amended.	• City Staff • BWSR • Hennepin County • MN DNR • Army COE	• Annual reporting to BWSR and Hennepin County	2009-2019	$100,000
Provide wetland enhancement projects	• City Staff • CIP	• Number of wetlands enhanced	2009-2019	$250,000
Provide Water Resources Grants for projects that improve wetland buffer habitat	• City Staff • Workshops	• Number of grants	2009-2019	$50,000

5. PUBLIC PARTICIPATION, INFORMATION, AND EDUCATION – INCREASE PUBLIC INVOLVEMENT AND KNOWLEDGE IN MANAGEMENT OF WATER RESOURCES.

Public involvement is a strategy which recognizes a desire for involvement in decisions which affect any facet of the community. It creates and implements opportunities for the public to participate in the processes which lead to decision-making.

Any individual or group whose actions affect other people, even to the smallest degree, can benefit from public involvement. Examples would include engineers, managers, governmental agencies, business owners, public officials, and residents. Additionally, any individual or group who is affected by the action of others can benefit. Examples of this group would include residents, businesses, special interest groups, consumers, and employees.

The City envisions the following six steps to successful public involvement:

1. <u>Prioritize communications.</u> Commitment to involving the public requires allocation of resources to provide the development and utilization of effective communication skills (i.e., public speaking and conflict management).
2. <u>Acquire knowledge and skills to effectively work with the public.</u> Achieving public involvement is dependent upon the application of the most appropriate methodology which will facilitate maximum effective participation of the people affected. Different methods are effective with different groups depending on the circumstances. Thus, holding a meeting and/or mailing a newsletter may be insufficient.
3. <u>Accurately identify all affected segments of the public.</u> Promote the self-identification of "potentially affected individuals."
4. <u>Develop an awareness of public issues.</u> Analyze the motivations, fears, concerns and desires of the people affected. Such awareness

allows for a proactive structuring of information and helps determine which public involvement techniques will be most productive.

5. Involve the public in the process. Conduct the initiative/project in full view of the public. Actively provide people opportunities to participate in that process and give their input.

6. Share considerations which determine the course of action. Recap the goals and desired outcomes and communicate the considerations which determine the recommended course of action. It is essential the public witness that the issues raised from their participation is reflected in these considerations and have received thoughtful and respectful analysis.

The City's web site is an alternative medium to provide municipal information to both City residents and those people who live outside Plymouth. In 1996, the City put a web site in place (http://www.ci.plymouth.mn.us) and the water resources management plan can be accessed from this site. Because the plan has such a wide audience from engineers and planners, to developers and citizens, to scientists and educators, electronic access to the text and mapping creates understanding, linking records management to Public Works.

TABLE 13. Public participation, information, and education policies.

Subject:	Enhancement of public participation, information, and education.
Purpose:	Encourage active community involvement in water resources management
Goal:	Increase public involvement and knowledge in management of water resources.
Policy 1:	The City will use a public involvement process in resource management decision-making (the Environmental Quality Committee).
Policy 2:	The City will use a variety of media, including newsletters, local cable television, City's website, and watershed management organizations to disseminate information and messages regarding storm water.
Policy 3:	The City will work with existing public and private resources to increase public participation in surface water management.
Policy 4:	The City will establish model interpretive sites for public education.
Policy 5:	The City will continue to manage public education programs, including but not limited to, programs for alternative landscapes and aquatic plant management.

TABLE 14. Public Participation, Information, and Education Implementation Plan.

Activity Steps	Resources	Measurement	Implementation year	Est. Cost
Continue to publicize and support the existing Environmental Quality Committee (EQC)	• City Council • EQC Annual Plan • City Staff	• Meetings • Recommendations to City Council • Annual reporting	2009-2019	$40,000
Conduct a public education program to develop an understanding of issues and concerns and to encourage participation in implementation of the Surface Water Management Plan	• City staff • Lake Associations • Environmental Quality Fair • WMO's	• Meetings	2009-2019	$60,000
Conduct public education programs regarding lake water quality and the lake ranking systems presented in this plan (Appendix G)	• City staff • Lake associations • Three Rivers Park District	• Meetings • Lake plan revisions	2009-2019	$50,000
Prepare articles regarding the Surface Water Management Plan	• City newsletter • Local paper • Minneapolis Star & Tribune	• Number of articles	2009-2019	$20,000
Involve civic groups, neighborhoods, business, industry and schools to promote activities which improve water quality	• City staff • Civic events • Schools • Newsletters	• Presentations • Attendance at civic events	2009-2019	$30,000
Update the City's website	• City staff	• Website updates	2009-2019	$50,000
Pursue education related grants	• City staff • Federal, State, Regional, and Local authorities • Application materials	• Completed applications • Grant awards	2009-2019	$100,000

6. MONITORING – CONTINUE TO SUPPORT A COMPREHENSIVE WATER RESOURCES MONITORING PROGRAM.

This plan must be supported through monitoring the water resources facilities necessary to support water quantity and water quality initiatives. Principles of monitoring include the need to:

- Make prevention of water quality degradation the focus;
- Understand the importance of research;
- Think long term;
- Let citizens make a difference;
- Make partnerships work for water;
- Put public health and safety first;
- Focus on the resource;
- Educate;
- Manage water's interconnections; and
- Manage hydrologic units.

Water resources monitoring is not a one-dimensional activity. Monitoring takes different forms and has different characteristics, depending on its purpose and intended uses. Typically, three general types of monitoring are conducted. These are: 1) ambient; 2) compliance; and 3) special research or study monitoring.

Ambient monitoring focuses on describing baseline conditions and possible trends in water quality or quantity. Ambient monitoring provides "early warnings" of problems or resources needing particular attention. Ambient monitoring also gives the information needed to evaluate the effectiveness of management programs and projects.

Compliance monitoring is usually done in response to a specific statute, ordinance, or rule. Depending on the regulatory program, this monitoring may be conducted either by the regulated community or the regulatory agency. It is probably the least useful for determining water quality baselines and trends.

Special research and study monitoring is conducted to develop basic information about a specific issue, concern, or theme where such information is missing or incomplete. Monitoring results must be used carefully to make broad-based conclusions because it is often short-term in nature. Still, when compliance and special research and project monitoring data are properly integrated with ambient data, more complete analysis of ambient conditions or trends will result.

Monitoring in Plymouth is completed annually by the City of Plymouth (Figure 9), DNR, Three Rivers Park District, and the WMOs. Private interests also do a certain amount of monitoring based on an interest in better understanding and utilizing the resource. The future contribution of local governments to water data collection must be recognized, encouraged, and developed.

a. Lake Monitoring

Continuous lake water quality data for many of Plymouth's lakes is under development to establish baseline water quality. There is a need to expand the existing monitoring at the local level and also a need for the City to acquire additional water quality data to assist with implementation of total maximum daily load plans (TMDL) and other water resource projects.

Lake monitoring takes place over a seven-month growing season (April through October). The objective of the monitoring is to

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Figure 9. Monitoring locations.

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establish long-term baseline water quality and plant diversity data for selected water bodies in Plymouth. Parameters such as total phosphorus, total nitrogen, chlorophyll a, and others can be routinely monitored, using a combination of physical sample collection for laboratory analysis and automated data collection equipment.

Lake monitoring also includes the "Citizen Lake Monitoring Program" (CLMP). The CLMP is a cooperative program combining the technical resources of the MPCA and volunteer efforts of citizens to collect water quality data on lakes. Volunteers collect water transparency data using a Secchi disk on a once-per-week frequency. Long term transparency monitoring helps detect signs of water quality degradation. Data compiled from Secchi readings is used by MPCA staff to prepare water quality reports, compile trends analysis, plan lake protection strategies and define lake characteristics by region (MPCA). There is a one-time fee for volunteers, to cover the cost of equipment. Volunteers receive instructions on using the disk, data sheets and a copy of annual lake water quality reports in their region.

b. Stream Monitoring

The City acknowledges the stream monitoring efforts in Plymouth by the Elm Creek Watershed Management Commission, the Shingle Creek Watershed Management Commission and the Bassett Creek Water Management Commission. Currently, the City of Plymouth funds the monitoring of 11 stream reaches by Three Rivers Park District.

c. Wetland Monitoring

The Metropolitan Council sponsored “Citizen Assisted Monitoring Program (CAMP)” is similar to the CLMP, except that it is regional, not statewide, in nature. Through the CAMP program, water quality samples are collected for basic water chemistry analysis by Metropolitan Council.

Land use changes and landscape level activities will influence the functional status of wetlands. Changes in the amount of surrounding open space, surface water systems, and groundwater can lead to changes in wetland bio-diversity, habitat, dominant vegetative cover, and hydrology. Indicators of wetland dynamics that could be monitored are described below.

<u>Macrophytes</u>

- Monitor active growth and the seed bank of wetlands serving as ”nurse” wetlands; look for frequency of native nurse species and invasive species. Sample once yearly during the growing season.

<u>Algae</u>

- Monitor algae populations in open water areas as chlorophyll a concentrations; sample twice in June and twice in August.

<u>Phosphorous</u>

- Monitor total and available phosphorus in the free sediment, rhizosphere of the dominant macrophyte, and the water; sample mid- to late May and late August.

<u>Hydrology</u>

- Monitor outflow and inflow of headwater area wetland basins and water elevation; sample elevations once in April and

August; sample outflow and inflow once during spring runoff, twice in midsummer and once during a 5-year or greater event.

Keystone species and/or community level indicators

- Selection is based on management goal for the wetland and the particular species assemblage of the wetland.

Baseline wetland monitoring is conducted in an effort to correlate floristic or habitat quality with water quality. This will allow the establishment of reference wetlands reflective of a high quality or an impacted condition. From baseline conditions, goal setting and integrated management strategies for protection, conservation or water quality treatment can be developed.

TABLE 15. Monitoring Policies.

Subject:	Surface Water Monitoring Program
Purpose:	To make informed, data-supported water resource management decisions at the local level.
Goal:	Continue to support a comprehensive surface water monitoring program.
Policy 1:	The City will conduct in-lake monitoring programs to develop baseline and long-term water quality records for all city lakes, as well as Bassett, Elm, Plymouth, and Shingle Creeks.
Policy 2:	The City will cooperate with all public agencies to conduct monitoring projects.
Policy 3:	The City will establish citizen monitoring programs.

TABLE 16. Monitoring Implementation Plan.

Activity Steps	Resources	Measurement	Implementation Year	Est. Cost
Continue to Implement a Surface Water Monitoring Program	• City staff • Surface Water Management Plan • Water Resources Budget • WMOs • Metropolitan Council • Lake Associations • Hennepin County • Schools • Three Rivers Park District	• Annual monitoring reports	2009-2019	$750,000
Establish citizen assisted surface water monitoring programs	• City staff • MPCA • Met Council • WMOs • Hennepin County	• Regular monitoring reports	2009-2019	$20,000
Update GIS database	• City staff • LOGIS	• Electronic map access to monitoring data	2012	$12,000
Establish a process for collection and retrieval of water quality data on GIS	• Existing filing system • GIS records management • City Staff	• Data acquisition model	2013	$5,000

7. MAINTENANCE AND INSPECTION – PRESERVE THE FUNCTION, QUANTITY, AND QUALITY OF WATER RESOURCE FACILITIES THROUGH ROUTINE INSPECTIONS, REGULAR MAINTENANCE ACTIVITIES, AND ADMINISTRATION OF THE WETLAND CONSERVATION ACT.

The primary responsibility for maintenance and inspection is at the local level, within public works, however, other jurisdictions are involved. For example, the Bassett Creek Watershed Management Commission ”exercises jurisdiction over outflow conveyors” (defined as all storm water conveyors leading from designated storage facilities (not along trunk lines) to trunk lines. Inspections help to spot potential problems before they become major problems. Routine maintenance reduces the long-term costs related to drainage system maintenance, while achieving water quantity and water quality goals. The application of development standards ensures consistency in the work produced and the documentation of the constructed systems. Appropriate land use controls can be used to maximize the preservation of the natural drainage systems and to control increases in runoff rate, volume and pollutant loading. The City of Plymouth implements a Pond Maintenance Policy (Appendix H), including maintenance of the Plymouth Creek Fish Barrier and the Medicine Lake outlet structure, as approved by the City Council in 2005 and administers wetland mitigation inspections in accordance with the Wetland Conservation Act.

a. Pond Maintenance

The City's drainage system consists of 1100 basins, either natural (wetland) or water quality ponds (man-made). Per Minnesota Pollution Control Agency permit requirements for Municipal Separate Storm Sewer Systems (MS4), twenty percent of the City's drainage system is inspected each year. Inspections of each basin as well as any associated storm sewer, identifies sediment deltas, pipe separations, water depth, obstructions, and other characteristics of the area as they relate to flood protection and water flow. Photographs are also taken and all the data is coordinated into a GIS for easy access. Any problems or needs are prioritized to provide for water flow and flood protection for City residents.

Additionally, for water quality ponds, the City has set a standard for dredging of 50% capacity meaning when a water quality pond has lost 50% of its volume, it is eligible to be dredged to provide the intended water quality benefits. Since 1995, the City has required pond maintenance agreements with private pond owners for ponds constructed to meet City standards for TSS and phosphorus from development. The agreements were intended to ensure that ponds be kept in good operating condition and that routine maintenance occurs. The City has, however, provided a means for pond owners to dissolve the maintenance agreements, thereby making the City responsible for maintenance in accordance with the Pond Maintenance Policy.

Pond maintenance raises questions about the nature of the accumulated sediment, whether or not it is contaminated, and methods for disposal. Research in Florida (Yousef, et. al, 1991) focused on sediment accumulation rates, heavy metal enrichment (Cd, Cr, Cu, Fe, Pb, Ni and Zn) and leaching of metals from sediments using a Toxicity Characteristics Leaching Procedure (TCLP), developed by USEPA, from bottom sediments in detention /retention ponds. The two-year study of nine ponds found the following;

- Accumulated top sediments showed a higher percent volatile matter, and nutrient and heavy metal content than the more dense underlying soil.

- Metals are retained in the sediment.
- TCLP results suggest that these sediments are not hazardous waste.
- Land disposal of the sediments could be possible on non-agricultural land, within diked areas or depressions in the vicinity of the pond, or transferred to landfills.
- Based on empirical data, the cycle for pond clean out averaged 25 years.

The accumulation rate equation (Yousef) developed from the study is as follows:

$$\boxed{\textbf{Accumulation rate} = \mathbf{a(Pond\ area/Drainage\ area)\ (100)^{-b} + c}}$$

or $$\mathbf{Y = aX^{-b} + c}$$

where Y = cm/yr

a = 2.287

X = pond area as a percent of drainage area

b = 1.474

c = 1.0

The rate of accumulation in Plymouth may be higher due to sand/salt application in the winter. Currently, dredged materials are taken to the City's yard waste facility where toxicity testing is done on a regular basis.

b. Street Sweeping

The City of Plymouth operates an enhanced street sweeping program.

In the spring, broom sweepers or vacuum assisted sweepers are used to clean debris from all City streets. Depending on weather, sweeping begins in late March or early April. Additionally, the City contracts with a private company to sweep the streets three additional times during the year with a vacuum assist sweeper. Vacuum assist sweepers are specialized to collect the smallest particles from road surfaces and are more efficient that broom sweepers. The Minnehaha Creek Watershed District also requires fall sweeping of streets and parking lots.

TABLE 17. Maintenance and Inspection Policies.

Subject:	Maintenance and inspection of drainage system.
Purpose:	To maximize system performance.
Goal:	Preserve the function, quantity, and quality of water resource facilities through routine inspections, regular maintenance activities, and administration of the wetland conservation act.
Policy 1:	The City will inspect its drainage system for compliance with the requirements of the MPCA and the City's Pond Maintenance Policy.
Policy 2:	The City shall require maintenance of privately constructed water quality treatment ponds as outlined in any applicable Pond Maintenance Agreement.
Policy 3:	The City shall require adequate access to public and private surface water facilities (ponds, etc.) for maintenance purposes.

TABLE 18. Maintenance and Inspection Implementation Plan.

Activity Steps	Resources	Measurement	Implementation Year	Est. Cost
Annually inspect 20% of the surface water facilities per MPCA and Pond Maintenance Policy requirements	• City staff • Specialized equipment	• Annual reporting to MPCA • Photo documentation • List of required easements	2009-2019	$100,000
Develop and implement an annual work program for system maintenance identified by annual inspections	• City staff • Pond Maintenance GIS • Annual inspection report	• Prioritization of drainage issues • Written work orders • Documentation of improvements • Equipment acquisition	2009-2019	$750,000
Acquire and preserve easements for the purpose of maintenance	• Property records • Annual inspection report	• Written easement descriptions • Executed easements	2009-2019	$250,000
Continue to implement and enhanced street sweeping program	• City staff • Utility record drawings • GIS • Ice control practices	• Tons of sediment collected	2009-2019	$1,000,000
Continue to implement maintenance of BMPs (rain gardens, ponds, shoreline restorations, etc…) associated with City projects	• City staff	• Documentation of maintenance	2009-2019	$300,000

8. RECREATION, FISH, AND WILDLIFE – SUPPORT WATER RECREATION ACTIVITIES AND IMPROVE FISH AND WILDLIFE HABITAT BY IMPLEMETNATION OF PROGRAMS WHICH WILL IMPROVE WATER QUALITY.

a. Recreation

In 1990, MPCA completed a questionnaire survey related to negative lake user perception. The survey involved 200 participants within MPCA's Citizen Lake Monitoring Program. The survey focused on individual perception of both the physical appearance of their lake, along with the perceived impacts on whole-body contact (i.e., swimming). Results were analyzed as a function of Secchi disc transparency and clearly indicated how citizen perception drops with water transparency.

Studies dating back to the early 1970's found power boat engines could produce significant stirring of bottom sediments in shallow lakes. Those same studies found that the activity of a 100 hp outboard motor causes significant increases in turbidity, orthophosphorus and total phosphorus. As power boats stir up the nutrient-rich bottom sediments, such as those in Medicine Lake, phosphorus can be released, accelerating algae growth. The same studies establish a clear relationship between engine size and mixing depth. Mixing depth is defined as the maximum depth at which the engine stirred up the water.

Although the scientific literature cannot resolve the political issues related to power boat controls, power boating is likely to have harmful impacts on shallow lakes.

Table 19. Mixing depth of power boats.

Horsepower	Mixing Depth
10	6 feet
28	10 feet
50	15 feet

b. Fish and Wildlife

The Minnesota Department of Natural Resources responsibility for fish and wildlife management comes from Minnesota Statutes. Section 84.941 states "It is the policy of the state that fish and wildlife are renewable natural resources to be conserved and enhanced through planned scientific management, protection and utilization." Section 97A.045 states "The commissioner shall make special provisions for the management of fish and wildlife to ensure recreational opportunities for anglers and hunters." The mission of the Division of Fish and Wildlife is "to protect and manage Minnesota's fish, wildlife, native plants and their communities for their intrinsic values and long term benefits to the people of Minnesota."

The goal of the DNR Division of Fish and Wildlife (DFW)-Section of Fisheries is to protect and enhance the fishery resource and the aquatic biological community for their long term recreational, ecological, aesthetic, and economic benefits to the state. DNR is the agency with exclusive responsibility for the management of fisheries in the waters of the state. The concept of ecosystem management requires that not just a species of interest be managed in a given water body, but that all plants, animals, and the physical and chemical constituents of the environment be part of the management program. Ecosystem management can involve habitat management and fish stocking.

Habitat management on the part of the DNR, involves several components:

- Stream habitat protection and improvement;
- Stream and Lake Crossings (roadways, utilities);
- Stream Channelization;
- Water Appropriation (from surface waters);
- Aeration:
- *Winter Aeration* is generally supported by DNR when it benefits and/or does not harm the fishery; and
- *Summer Aeration* should be used with caution, because the impacts these systems have on nutrient dynamics and fisheries is difficult to predict on individual lakes. Summer aeration may be beneficial, neutral, or detrimental to the fishery, depending on the lake and the system used;
- Shoreland Modification;
- Spawning Area Development and Management;
- Aquatic plant management;
- Artificial habitat structures/fish attractors;
- Lake Surveys and Fish Population Assessments; and
- Creel Surveys.

DNR will stock fish on a case by case basis, if justified in several situations including newly rehabilitated waters, winterkill lakes, or to introduce or maintain desirable species, compatible with the management of the indigenous fishes, to balance predatory species with prey.

Fishery and Water Quality

Perhaps the best indicators of water quality are the yellow and black bullheads. Yellow bullheads are found in abundance in lakes with clear water. In contrast, black bullheads reach their greatest abundance in very turbid, eutrophic waters. Similarly, northern pike are more abundant in clear water because vision is an important factor for feeding. Members of the sunfish family also reach their highest abundance in clear, clean waters. Where small- or largemouth bass, rock bass, bluegill and pumpkinseed sunfish are common, the lake is likely to be in good condition. Of these, sunfish, smallmouth bass and rock bass are usually associated with the highest quality. White and black crappies are more tolerant of a wide range of conditions. Both reach higher numbers in turbid water. However, presence of black crappie should not be taken as a sign of poor water quality. Walleye usually do not do well in small, clear lakes.

Additionally, rough fish (fish which forage on the bottom sediments of a lake) such as carp and contribute to re-suspension of nutrients and sediments into the water column resulting in poor water quality.

Trophic State Index

The term "trophic status" refers to the level of productivity (i.e. growth) of a lake. Carlson's Trophic State Index (TSI) is one means available to examine the relationship between total phosphorus, chlorophyll a, and Secchi disk readings to determine the overall trophic status of a lake. Individual TSI values can be calculated from the following equations:

Total phosphorus TSI (TSIP) = 14.42 ln(TP average) + 4.15

Chlorophyll a TSI (TSIC) = 9.81 ln(Chlorophyll a average) + 30.6

Secchi disk TSI (TSIS) = 60 - [14.41 ln(Secchi average)]

Public Access

Recreation from a fisheries perspective means public access and fishing piers. Public access is not present for all of Plymouth's eight major water bodies. Currently, public accesses are present for Medicine, Parkers, and Schmidt Lake. A map of the location of all existing and proposed local, regional, state, and federal parks is included as Figure 10.

Wildlife Habitat

Open Water versus Habitat

Wetlands and associated habitat are often lost because of misdirected management efforts and related detrimental water level modifications. According to Weller (1981), increased water levels often are cited as desirable goals because the general feeling is that such marshes are more attractive to wildlife. In reality, they are just more attractive to man, both aesthetically and economically.

The increase in property value adjacent to ponds and wetlands averages about 10 percent and may be as high as 30 percent (Anon. 1995). Stevens (1995) found that respondents to a New England study were willing to pay an average of between $74 and $80 per year over a five year period for wetlands providing flood protection, water supply and water pollution control (defined herein as public works values) and between $81 and $96 per year for wetlands containing rare species of plants. This trend is evident in Plymouth, considering the recent referendum targeted at acquisition of significant natural areas. Stevens calls most of this value "non-use" or existence value. He cautions that failure to consider nonuse values in decision making can therefore understate the value of preservation by substantial margins.

Figure 10. Federal, State, Regional, Local, and future parks.

Back of Figure 10.

There is a distinct relationship between wetland ecology and open water. Table 20 illustrates this relationship.

Table 20. Wildlife Habitat Factors Related to Open Water.

	Degree of Open Water		
Factor	< 12%	50-75%	>80%
Water Depth	Shallow	Medium	Deep
Vegetation	Dense	Moderate	Sparse
Vegetation type	Cattail Monoculture	Cattail fringe with hard-stem shore	Hardstem shore with no cattails
Bird populations	Numerous	Many	Few
Bird species richness	Few	Many	Few
Muskrats	Few	Many	Few

The most crucial force dramatically influencing changes in wetland vegetation and associated wildlife communities may be changing water depth. Changing water level is the deciding influence on what plants grow where and what plant life forms dominate. Changing water levels also create stress for established plants.

Muskrat Problems

Weller (1981) reports that the second major influence on wetland vegetation is a product of the activity of herbivores such as muskrats that eat out large areas of vegetation used for lodges and food. Muskrat activity creates large area of open water, diminishing vegetation and related habitats. Weller (1981) writes that "because of the physiological nature of most emergent plants, such cuttings will not regrow if they are flooded by even an inch of water - and they die in a year or so for lack of oxygen in spite of much food resources stored in the rhizomes and tubers." If not flooded, the cuttings do regrow, though not always to the same density. The available management tools include trapping and reduction of winter water levels. In an urban setting, there is minimal natural predation.

Goose Problems

Although many people enjoy seeing Canada geese, the birds often wear out their welcome when they become too numerous on lawns, parks and golf courses. Yards, beaches and docks become fouled with their feces. The fecal matter may contribute to poorer water quality (See Goal 2 - Water Quality).

According to DNR (1996), there are several means for controling geese:

- *Hazing*, or frightening geese.
- *Bird Scare Tape.* Also called bird flash tape, this ribbon of shiny Mylar is usually red on one side and silver on the other. Twisted ribbon, installed in two rows, with the top row about two feet above the ground is recommended. Bird scare tape is most effective with small numbers of geese that have mowed grass areas that they can move to.
- *ReJex-iT*[R] is the only registered Canada goose repellent for turf and lawns, according to DNR (1996).
- *Energized Fencing.* Energized fencing is useful in situations more severe than hazing or bird scare tape can handle. Portable fencing is preferred by most home owners, according to DNR (1996)
- *Barrier Fencing.* Woven wire, chicken wire, plastic snow fence, chain link, netting or picket are all examples of barrier fence materials. The fence should have openings no larger than 3 inches by 3 inches, and be about 30 inches high.

- *Landscaping.* Landscaping can be used to make areas less attractive to geese, and is considered the most effective long-term and environmentally sound method of reducing goose problems (DNR, 1996). Examples include hedges, a dense strip of naturally occurring trees and shrubs (20-30 feet wide) or an unmowed. shoreline buffer of native grasses and/or wild flowers that grow 20 - 30 inches tall in a 20-30-foot-wide strip.
- *Population Management.* The disadvantage to all the points above is that the problem is simply relocated to another area. DNR (1996) identifies hunting as the most effective way to control populations.
- *Egg treatment.* In Seattle, Washington, goose eggs are sought out and brushed with mineral oil which effectively suffocates the embryo. The long-term effectiveness relies on the habit of geese of returning back year after year to the water body or general area where they were born. Reducing the number of birds that will return in subsequent years reduces the overall population in that area.

Aquatic Plant Management

Aquatic plants are an essential part of lake and wetland communities. Aquatic plants:

- Remove coliform bacteria and nutrients from the water and lake bottom;
- Help prevent shoreline erosion by breaking up wave action;
- Provide natural food and shelter for fish and wildlife;
- Are one of the primary producers in the aquatic food chain; and affect the chemical, physical and biological characteristics of our lakes. For instance, a one-acre stand of bulrush can remove an amount of phosphorus equal to that present in wastewater created by 33 persons during the four-month growing season.

Permitting

The DNR requires permits for controlling or destroying aquatic plants or invertebrates in protected waters or wetlands. The permit program is based on Minnesota Rules, Department of Natural Resources, Chapter 6280 Aquatic Nuisance Control. The permits do not allow the following:

- Destroying or preventing the growth of vegetation by placing mats or plastic sheets or similar material on the bed of protected waters.
- Destruction of aquatic vegetation within posted spawning areas.
- Improving the appearance or aesthetics of undeveloped shoreline through aquatic plant removal.
- Aquatic plant control where the vegetation does not interfere with swimming, boating, or other aquatic recreational activity.

DNR Permits are required to:

- Cut and pull by hand or mechanically control vegetation;
- Apply herbicides or algaecides in protected waters;
- Move a bog of any size that is free floating or lodged in any area other than its original location;
- Destroy emergent aquatic vegetation in protected waters;
- Transplant aquatic plants into protected waters; and
- Use any type machine that mechanically sifts lake bottom materials from protected waters lakeward of the ordinary high water level.

Chemical Control of aquatic plants

According to Chapter 6280, the lesser of fifteen percent (in home rule charter or statutory City, or a town only) of the littoral area or 100 feet of shoreline per individual riparian property owner may be treated. There is an associated fee with the permit.

A straightforward and proven way to reverse the buildup of aquatic plants in recreational water bodies involves controlling a key nutrient, phosphorus, with alum (aluminum sulfate). Alum has been widely used to clarify and purify drinking water. A single treatment with alum generally prevents algae blooms for two to five years or more, depending on how much phosphorus enters the lake and its hydraulic residence time.

Aquatic plants need many nutrients. An over abundance of phosphorus from runoff frees algae and plants to grow excessively. Controlling phosphorus levels limits its availability as a nutrient and halts biomass growth. If watershed management alone cannot eliminate algae blooms and other signs of eutrophication, the next step may be to bind phosphorus in the sediments with alum.

Alum is injected under water, usually in a rigid polyvinyl chloride (PVC) pipe. When alum is applied near the water surface, it improves clarity and removes phosphorus in the water column, as well as inactivating phosphorus in sediment. In severely stressed, hypereutrophic lakes, alum is most effectively dispensed near the bottom to treat sediment which becomes a nutrient sink, rather than a source. Alum reacts with lake water to form two precipitates - aluminum hydroxide in reaction with the water itself and aluminum phosphate in reaction with dissolved organic and inorganic phosphates. The gelatinous aluminum hydroxide floc clarifies the water column by sweeping suspended solids and colloids from the water column as it sinks. When this floc reaches the bottom, it reacts with phosphorus in the sediment, binding the nutrient as insoluble aluminum phosphate complex. As this aluminum phosphate floc sits on the bottom, it coats the sediment as a thin layer that coalesces the fine sediment and limits suspension of phosphorus -rich silt by waves, currents or boating activity. Aluminum phosphate is a stable molecule that is unavailable as a plant nutrient. It will not revert back to a nutrient form under anoxic or anaerobic conditions often found in the lowest layer of a lake or in its bottom sediments.

Alum treatment requires extensive planning, in particular to determine the amount of alum needed. Appropriate permits from the DNR are needed. Published values of batch applications, or the application from a boat or barge, range from $600 to $2,500 per acre.

Some locales treat lakes with copper sulfate ($CuSO_4$A $5H_2O$). The cupric ions (Cu^{2+}) inhibit both respiration and photosynthesis in algae. Copper sulfate is more toxic in soft, acid water than in alkaline water. Copper sulfate is an excellent algicide, but it is without appreciable residual toxicity. Although copper sulfate may be quite effective in reducing phytoplankton abundance in lakes and ponds, it does little for the long-term condition. In other words, phytoplankton photosynthesis quickly returns to pre-treatment levels. As dead algae fall to the bottom and decompose, their phosphorus content is released to support another round of plant growth. In addition, the dissolved oxygen content (DO) of the lake/pond may be lowered or completely depleted. Concentrations of copper sulfate used for phytoplankton control are seldom directly toxic to fish, but they do kill large numbers of invertebrate fish food organisms.

Weed harvesting falls into two categories; mechanical and non-mechanical. Mechanical harvesting entails a barge-like machine to cut and collect lake weeds. Harvesters need at least two feet of freeboard to operate, creating a lot of floating vegetation. Most operations dispose of aquatic plants by using a shore conveyor, a transport barge or by making multiple trips to shore. Mechanical harvesting can produce weed fragments. Approximately 5 to 15 percent of the total cutting cannot be cleaned up immediately because of wind and wave action that wash the vegetation away. A partial solution is to use a cutter, because plants are not stacked on the back of the unit weighing it down like they are with a harvester. A cutter can work in as little as 9 inches of water.

Non-mechanical harvesting includes hand-harvesting (pulling), raking, hand-held weed cutters and dragging. Non-mechanical harvesting can be highly effective. Careful pulling and hand raking can remove roots as well as stems and leaves, thereby minimizing re-growth of the plants for several years.

Whole-lake or hypolimnetic (bottom water) aeration has been utilized to improve water quality. In general, whole lake aeration is used to avoid winter fish kill. *Winter Aeration* is generally supported by DNR (Anon., 1993) when it benefits and/or does not harm the fishery. *Summer Aeration* should be used with caution, because the impacts these systems have on nutrient dynamics and fisheries is difficult to predict on individual lakes. (Anon., 1993) Summer aeration may be beneficial, neutral, or detrimental to the fishery, depending on the lake and the system.

Curlyleaf Pondweed

Curlyleaf Pondweed is a submerged aquatic plant not native to Minnesota. Curlyleaf Pondweed tends to grow in the late winter or early spring which gives it a competitive advantage over native plants.

Curlyleaf pondweed undergoes senescence in late June or early July. This senescence results in phosphorus release into the water column where it is readily taken up by algae resulting in severe algae blooms and poor water quality. The City of Plymouth partnered with the Army Corps of Engineers, Minnesota Department of Natural Resources, Three Rivers Park District, and various civic groups from 2004-2008 to complete a whole in-lake pilot project on Medicine Lake for the treatment of Curlyleaf Pondweed. The project significantly reduced the amount of Curlyleaf Pondweed in Medicine Lake and improved water clarity conditions, however, Curlyleaf Pondweed was replaced by Eurasian Watermilfoil.

Purple Loosestrife

Purple loosestrife *Lythrum salicara L.* is a perennial plant of European origin that is invading and degrading wetlands all across North America. Purple loosestrife forms dense, monotypic stands that replace native plant species in wetlands and lake shore habitats, degrading food, shelter, and nesting sites for native wildlife. The plant will grow in up to seven feet of water. Purple loosestrife's high seed production (each plant can produce 120,000 seeds) produces large seed banks that can last for many years, allowing the plant to recover quickly after disturbance.

Common native plants such as cattails, sedges, smartweed and others cannot compete with purple loosestrife. Consequently, animals that rely on native plant vegetation for food, shelter, and breeding areas are displaced. Loosestrife infested wetlands are also less suitable to waterfowl because of the elimination of nesting sites and valuable food plants (waterfowl do not feed on loosestrife). Wetland mammals, like muskrats cannot utilize the plant in any way. Loosestrife is thought to be a poor nutrient assimilator.

Currently there are no chemical or mechanical means that provide long-term control of established stands of purple loosestrife. However, biological control, the use of natural enemies to control a pest, shows promise as a long-term method of reducing the effects of purple loosestrife on native aquatic environments.

Conventional Control

Efforts to control these infestations mechanically or with herbicides (like Rodeo) are very costly, must be repeated annually and do not provide long-term control. Conventional control, including cutting, burning, water level manipulation and herbicide treatment, have been largely unsuccessful except where small, isolated stands can be removed by hand or treated with herbicide. While conventional methods do kill purple loosestrife plants, once it has become established, its large seed banks, which are nearly impossible to destroy, allow rapid reestablishment. Each cut segment can generate a new plant.

Biological Control

Biological techniques reunite pest species, like purple loosestrife, with their natural enemies, such as insects, and can keep many plant species from becoming pests. Successful biological control will not eradicate purple loosestrife, but it will significantly reduce the plant's negative effects on native species. Four species of European insects have been released in North America to control purple loosestrife since 1992; one root-mining weevil, one flower-feeding weevil, and two leaf eating beetles. Of the species, the root-mining weevil and the leaf eating beetles will be the most important for the control of purple loosestrife due to the damage they cause to plant roots, leaves and stems.

Eurasian Watermilfoil

Eurasian watermilfoil is a submerged aquatic plant native to Europe and Asia. Since its introduction to North America, during the 1940's, it has spread to nearly 40 states and three Canadian provinces. In Minnesota, milfoil was first discovered in Lake Minnetonka in 1987. By 1992, 55 Minnesota lakes had Eurasian watermilfoil infestations. Eurasian watermilfoil is a perennial plant that spreads by vegetative propagation. It spreads when the plant fragments into pieces, which can taker root and grow into new plants. Milfoil plants break into fragments naturally or when watercraft goes through milfoil beds. Water currents can carry fragments within and between water bodies.

Eurasian watermilfoil can severely limit water recreational activities such as swimming, boating and fishing. It forms dense rooted mats of vegetation that reach the water surface. It can shade and crowd out native plants, reducing the biodiversity of aquatic ecosystems and harming fish and wildlife. There is little hard evidence so far for negative ecological impacts. However, given these concerns, it is necessary to confine this exotic plant and limit its spread in Minnesota.

Current attempts to eradicate or control milfoil in Minnesota rely primarily on herbicides. However, in consideration of public and professional concerns regarding herbicides, DNR has begun to investigate alternative control methods. According to DNR (Anon. 1993), efforts should now be made towards an Integrated Pest Management (IPM) approach for milfoil control that could ultimately include a combination of biological controls, improved use of herbicides and alternative methods such as mechanical control.

The DNR plan includes four major goals:

1. Contain milfoil in Minnesota to existing water bodies and prevent the establishment of new infestations.
2. Eradicate or control milfoil infestations in Minnesota in a way that does as little harm as possible to lake ecosystems.
3. Support and conduct research needed to improve milfoil

management

4. Ensure that milfoil is considered in lake management.

TABLE 21. Recreation, Fish, and Wildlife Policies.

Subject:	Surface water based recreational and wildlife interests
Purpose:	To support water recreational uses, and fish and wildlife habitat through implementation of water quality improvements.
Goal:	Support water recreation activities and improve fish and wildlife habitat by implementation of programs which will improve water quality.
Policy 1:	Natural areas and wildlife habitat intended for preservation shall be protected during construction by appropriate BMPs.
Policy 2:	Preserve vegetative buffers around wetlands and riparian areas to provide habitat for wildlife.
Policy 3:	The City shall support programs for controlling exotic and invasive species of plants and animals.
Policy 4:	Design and construct lake outlets to provide a barrier to upstream migration of rough fish whenever practical.
Policy 5:	The City recognizes the need to balance water recreational activity with water quality and habitat issues.
Policy 6:	The City will explore new opportunities to integrate surface water based recreation activities and wildlife interests within wildlife corridors.
Policy 7:	The City encourages the protection of threatened and endangered species and areas of significant natural communities as identified by the Natural Resources Inventory and consistent with the Minnesota Department of Natural Resources.

TABLE 22. Recreation, Fish, and Wildlife Implementation Plan.

Activity Steps	Resources	Measurement	Implementation Year	Est. Cost
Identify appropriate public access for water bodies and pursue development of feasible sites	• City staff • DNR • Neighborhood groups • Lake Associations	• Feasibility study • Public Involvement • Agency participation • Improved access	2015	$50,000
Continue partnership with the DNR to manage Purple Loosestrife	• City staff • DNR • Volunteers	• Identification of infestation areas and inclusion on GIS mapping system • Control and reduction measures on the basis of annually observed aeras	2009-2019	$50,000
Discuss aquatic vegetation management	• City Staff • Lake Associations • DNR • Army Corps of Engineers	• Recommendation to the City Council on the role of the City in aquatic vegetation mangement	2009	$0
Complete fish survey's for various lakes	• MN DNR	• Completed survey	2009	$75,000

9. GROUNDWATER – PREVENT CONTAMINATION OF THE AQUIFERS AND PROMOTE GROUNDWATER RECHARGE INCLUDING WATER CONSERVATION PRACTICES TO MAINTAIN BASE FLOWS IN STREAMS.

a. Wellhead Protection Plan

The City of Plymouth has delineated wellhead protection areas and drinking water supply management areas for the drinking water supply wells operated by the City (Appendix I). The delineation was performed in accordance with rules (Minnesota Rules 4720.5100 to 4720.5580) for preparing and implementing wellhead protection measures for public water supply wells. The rules are administered by the Minnesota Department of Health, and the results are described in Appendix I.

The City of Plymouth obtains its drinking water supply from 15 wells completed in the Prairie du Chien – Jordan aquifer and one well completed in the Jordan aquifer only.

Wellhead Protection Areas (WHPAs) for the City of Plymouth wells were delineated using a groundwater model based on the Minnesota Pollution Control Agency Northwest Province Metropolitan Area Ground-Water Flow Model (Seaberg and Hansen, 2000) with appropriate modifications to improve the simulation in the vicinity of the City of Plymouth wells. This model simulates groundwater flow in the Prairie Du Chien – Jordan aquifer system near the City of Plymouth wells. The model input set runs using the groundwater flow code MLAEM, version 5.1.08. The MLAEM model was used to delineate capture zones for all active city of Plymouth public water supply wells. The drinking water supply management area (DWSMA) was determined by overlaying the boundaries of the WHPAs on a map showing property parcel boundaries and roadways. The DWSMA was delineated using these features as boundaries.

The amount of geologic protection documented in well logs from the water supply wells, water chemistry data, and regional information is sufficient to classify 11 City of Plymouth wells as not vulnerable. As far as can be determined, however, the City of Plymouth wells meet the construction standards of the State Well Code and are not considered a likely avenue for contamination to reach the aquifer from which they pump. Aquifer vulnerability for the DWSMA ranges from high to very low, based on the amount to geologic protection between the water bearing unit and the surface.

The City of Plymouth promotes water conservation practices such as rain barrels, rain gardens, and rain gauges for sprinkler systems through its Water Resources Grant Program.

TABLE 23. Groundwater Policies.

Subject:	Groundwater Protection
Purpose:	To protect groundwater by understanding and accounting for groundwater/surface water interactions.
Goal:	Prevent contamination of the aquifers and promote groundwater recharge including water conservation practices to maintain base flows in streams.
Policy 1:	The City shall develop and implement controls to protect identified wellhead areas.
Policy 2:	The City shall promote proper well abandonment.
Policy 3:	The City will consider alternatives to conventional storm water detention to enhance groundwater recharge through infiltration.
Policy 4:	Design and installation of on-site waste water systems shall be in accordance with the standards set forth in Minnesota Rules, Chapter 7080 and the Individual Sewage Treatment System (ISTS) Act.
Policy 5:	The City will implement and enforce the current Water Emergency and Conservation Plan.
Policy 6:	The City shall promote and demonstrate the use of alternative landscape techniques and materials to reduce dependency on groundwater supplies.

TABLE 24. Groundwater Implementation Plan.

Activity Steps	Resources	Measurement	Target Date	Est. Cost
Update private well and ISTS data	• Hennepin County • MPCA	• Completed data record incorporated into GIS	2009-2019	$40,000
Inventory areas of ground water discharge	• City staff • GIS	• Completed data records in GIS	2015	$3,000
Include available alternative landscape design guidelines in developer packets and as part of grading plan review	• Available alternative landscape resources • Approved BMP list	• Completed City packet for re-distribution	2010	$10,000
Revisit water conservation plans to verify current practices are in compliance with plan	• Water Conservation Plan	• Documentation of discrepancies	2012	$15,000
Develop a model site to establish, promote and monitor the effectiveness of alternative landscape features	• Available alternative landscape resources	• Site acquired • Site developed • Site monitored	2010	$10,000

10. FINANCE – REGULARLY EVALUATE AND MONITOR FUNDING SOURCES USED TO FINANCE WATER RESOURCES MANAGEMENT ACTIVITIES.

The major categories of available funding sources are (1) Ad Valorem Taxes; (2) Special Assessments; (3) System Development Charges (Building Permits, Land Development Fees and Land Exaction); (4) User charges (surface water utility fee); and (5) Grants.

The cost to implement and enforce local controls and standards has been generally estimated in Table 3. The estimated annual cost of implementation of specified programs other than the CIP is summarized in Appendix J. Funding for surface water management projects in the City of Plymouth is primarily achieved through the surface water utility fee as detailed in Chapter VII, Section 725 of the City Code. The City's surface water utility fee is based on the rate of a single-family residence. In 2008 the surface water utility fee for single family residences was $4.66/month. The surface water utility fee is applicable to 16,416 single family parcels, 1365 acres of multi-family parcels, and 1888 acres of commercial/industrial parcels.

The City does not typically levy for surface water utility projects. Should revenues generated by the City's surface water utility be reduced for any reason, levy limits would likely impact the ability of the City to complete projects. The City's Capital Improvements Program (Appendix K) details local implementation of each water resources capital improvement project.

a. Ad Valorem Tax

General Taxes

General taxation is the most common revenue source used to finance government services, including minor maintenance measures for drainage and water quality facilities. Using property taxes has the effect of spreading the cost over the entire tax base of a community. The Bassett Creek, Elm Creek, and Shingle Creek Watershed Management Organizations utilize ad valorem taxes to fund regional water quality projects such as stream restorations provided the project is a part of their CIP.

Special Tax District

The tax district is similar to the administrative structure under general taxation except that all or part of the community may be placed in the tax district. The principle is to better correlate improvement costs to benefited or contributing properties.

b. Special Assessments

Municipalities are familiar with the use of special assessments to finance special services from maintenance to construction of capital improvements. The assessments are levied against properties benefiting from the special services. The philosophy of this method is that the benefited properties pay in relation to benefits received.

c. Storm Drainage System Development Charge

As land is developed or built upon, surface water runoff and pollution loading increases. Administrative and capital costs can be recovered at the time of building permit issuance or land development approval. A City can require dedication of land for ponding or drainage purposes. The land, however, must be from the parcel being developed.

Trunk charges or System Development Charges (SDCs) are one time charges paid by new development to finance the construction of public facilities. SDCs are generally used for four basic reasons.

1. To shift the burdens from existing development to new development;
2. To synchronize the construction of new or expanded facility capacity with the arrival of new development;
3. To subject new development decisions to pricing discipline; and
4. To respond to anti-tax sentiments.

There are seven factors to determine the proportionate share of costs to be borne by new development:

1. The cost of existing facilities.
2. The means by which existing facilities have been financed.
3. The extent to which new development has already contributed to the cost of providing needed capacity
4. The extent to which existing development will, in the future, contribute to the cost of providing existing facilities used community-wide or by non-occupants of new development.
5. The extent to which new development should receive credit for providing, at its cost, facilities the community has provided in the past without charge to other development in the service area.
6. Extraordinary costs incurred in serving new development
7. The time-price differential inherent in fair comparisons of amounts of money paid at different times.

Planning is extremely important, both from a land use and a surface water management perspective. Of particular importance within the water resources management plan is the capital improvements program (CIP). For improvements to be funded in part through SDCs, the CIP should offer an adequate policy foundation. In essence, the CIP serves to strengthen the relationship between SDCs and public policy by clearly stating those policies and the role of SDCs in effecting them. CIP's normally include a three step planning process.

1. Preparation of an inventory and assessment;
2. Determination of policies and needs; and
3. Development of an implementation strategy.

To adequately address the issue of Storm Drainage Trunk Charges for New Development, or SDCs, a comprehensive review of the existing water resources management plan would be conducted to consider the elements discussed above. Next, a CIP would be refined from the existing document. Work with legal counsel would be undertaken to establish the legal basis for SDCs. Finally, the SDC determination will be made based on development needs, land use and total systems cost. Lastly, a public information element will be used to introduce the system to the community. The public information element will illustrate the approach as equitable and will dispel any myths or criticisms that may exist.

d. User Charges

User charges, which support surface water utilities, are a mechanism by which a City can generate funds through billings similar to water and sewer billings. The principle is to charge for services rendered to properties generating runoff, as well as the service to properties being protected from the effects of runoff, without consideration to an increase in market value of the property.

Implementation of a storm water utility is broken into three phases: (1) Concept Development, (2) Implementation and (3) Billing. Concept Development involves research and analysis of funding options and funding needs. A storm water funding feasibility report includes a summary of all findings and recommendations including a preliminary implementation Plan.

During implementation, action plans for each component of the utility implementation are developed. The action plans identify tasks, resources, responsibilities, schedules and measurements. A link between the recommended rate structure and the data base is developed during Implementation. The public involvement plan is implemented prior to presenting a draft ordinance to the City Council. With public support in place, the ordinance is finalized in the Billing phase.

Billing applies adopted rates to individual accounts, resulting in an interface between real estate records and the billing system. Standard operating procedures are developed to document the process for updating the data base interface and billing system. On-call support is developed to ensure a smooth transition to new billing procedures and investigation of credits and appeals.

e. Grants

Grants are available for surface water management and non-point source pollution. However, it is generally not a good financial practice to rely on grants for a service program. This source of revenue is not dependable and requires speculation as to its availability. Grants are useful but should only be used to supplement a planned local revenue source. Examples of some available grants include

Environmental Protection Agency (EPA): 604b - Urban Water Quality Grant

The EPA's 604b Grant Program is targeted at water quality improvements in urban areas. The grant is not a cost share program, but does require local participation. The grant is generally administered through the state.

Environmental Protection Agency (EPA): Underground Injection Control Program

The U. S. Environmental Protection Agency's Underground Injection Control (UIC) program involves inventories of ground water protection areas in the City to address abandoned drainage or domestic disposal wells which are potentially harmful to underground sources of drinking water. The results of the questionnaire can provide a great deal of information on the degree of risk to the City's underground sources of drinking water. The EPA has provided funding and training for volunteers to implement the UIC program at the local level.

Environmental Protection Agency (EPA): Environmental Education Grant

The EPA's Environmental Education Grant, enacted in 1991, is targeted at cities or organizations in the amount of $25,000 or less. The Environmental Education Grant is intended to finance local education initiatives related to the nature environment. Grants are awarded on a 50/50 cost share basis.

Environmental Protection Agency (EPA): Clean Lakes Grant

The Federal Clean Lakes Grant is the next step in lake restoration following the State Clean Water Partnership Program. This program can include significantly more funding than the state program and can be used for development and implementation of lake restoration plans. Clean Lakes funding is administered through the MPCA.

Environmental Protection Agency (EPA): Section 319 - Clean Water Act

Funding through EPA's Section 319 program supports state programs but is potentially available for urban BMP and project implementation coordination. The grants program includes a spring application period (May to June) for the state. The program is significant in that it can fund implementation (i.e., construction) rather than funding planning efforts or studies. Available funds may involve either full or matching funds.

U.S. Army Corps of Engineers: Section 22 Planning Assistance to States Programs

Funds are a 50/50 cost share. The program is administered through state planning. Eligible projects are given to COE to prepare a cost estimate for preliminary design. The estimate is negotiated with the "customer". The "customer" provides 50 percent cost share in the form of cash. The COE then completes the preliminary design or study. These funds are applicable on an as-available basis. The COE is not always customer focused; timeliness and reliability must be balanced against technical expertise and financial participation.

Wallop-Breaux Funds

The program is called Wallop-Breaux, referring to the 1984 amendments to the Dingell-Johnson program and named for its primary sponsors, Senator Malcolm Wallop (R-WY) and Senator John Breaux (D-LA). Its formal name is the Aquatic Resources Trust

Fund, of which part is used for sportfishing enhancement ($215.3 million, in 1992) and part is used for boating safety in each state ($70 million, in 1992). Wallop-Breaux is an example of a user-pay/user-benefit program, where taxes on an activity are strictly reinvested back into the activity's maintenance.

The Internal Revenue Service collects the money and gives it to the U. S. Fish and Wildlife Service. After taking a percentage off the top for administration, the service gives money to each state based on its relative size and the number of resident fishermen. No state receives more than 5 percent of the total, or less than 1 percent.

To obtain Wallop-Breaux funds, the state sends a proposal to the U. S. Fish and Wildlife Service office in its region. The project must be "substantial in character and design," but there is no requirement that the project directly benefits sport fishermen. In 1991, 32.4 percent went to surveys and research. About half of the 6 percent the service takes pays for the staff that administers the funds. The rest of the $12 million a year in administrative money is used for various special projects. Wallop-Breaux is supposed to be new money for new fishery improvements, but some of the money is being used to replace state funding from licenses and the general treasury. The U. S. Fish and Wildlife Service views itself as simply a conduit of dollars to the states.

Pittman-Robertson - Federal Aid in Wildlife Restoration Act

Funded by an excise tax on angling and hunting equipment, this program helps raise the revenue necessary to fund specific restoration projects by state fish and wildlife agencies.

Sport Fish Restoration Act

States receive federal aid monies for fisheries management, administered by the U. S. Fish and Wildlife Service on a 75 percent (federal) and 25 percent (state) basis. The federal share is from excise taxes and the state share is mainly from sportfishing licenses.

DNR's Flood Hazard Mitigation Program

Up to 50 percent cost sharing is available through the bonding program. As with PFA funds, this alternative best applies to a phased construction scenario, since the state funding is on the biennium.

Metropolitan Council Water Quality Initiative Grant

Annually, Metropolitan Council sponsors the Water Quality Initiative grant program. Initially focused on improving water quality of the Minnesota River, the program expanded in 1996 to consider larger, regional based applications. The program includes both technical and educational grant categories. A maximum of $100,000 is available, with up to three grant periods. A 25 percent match is required. Applications have historically been due in March. A revised version of this program was initiated in the fall of 1999.

Metropolitan Livable Communities Fund

The Metropolitan Livable Communities Fund is focused on projects that demonstrate alternative forms of urban design and development that promotes more efficient use of land and regional services. This funding source could be geared towards water quality restoration and/or retrofitting treatment into a redeveloping setting. An example is the Phalen Village in St. Paul, where the Restoration of Ames Lake near a mostly vacant shopping center, was funded in 1996.

MPCA Low Interest Loans

Typically used for wastewater treatment and collection systems, MPCA's State Revolving Loan Fund dollars can be used for watersheds or non-point source control. PFA administers the State Revolving Loan Program for MPCA. MPCA recently adopted rules to facilitate application of this program. In addition, by using the loan program, the City can save the administrative costs related to the bonding process. Furthermore, PFA typically waives the interest payment in the first two years of the 20-year loan period. There is no dollar limit or competition for these funds.

MPCA Clean Water Partnership

MPCA receives federal matching funds for preserving and protecting lakes and for enhancing their public use and enjoyment, under the Federal Clean Lakes Program. The MPCA's Clean Water Partnership Program (CWP) provides matching funds for lake improvement projects and nonpoint source pollution abatement. The grant program is very competitive and the grant administration can be time consuming and expensive.

Miscellaneous Funding Sources

- DNR Outdoor Recreation Grant Program
- DNR Natural and Scenic Area Grant Program
- DNR Shoreland Restoration Grant Program
- LCMR Legislative Commission Minnesota Resources
- Metropolitan Council Environmental Partnership Grant

TABLE 25. Finance Policies.

Subject:	Fund Surface Water Management
Purpose:	To adequately finance management activities in an equitable manner.
Goal:	Regularly evaluate and monitor funding sources used to finance water resources management activities.
Policy 1:	The City shall continue to help fund surface water management through the surface water utility fee.
Policy 2:	The City will actively pursue grants, donations, in-kind contributions, and watershed resources to help fund surface water management.
Policy 3:	The City shall assist citizens and businesses in their efforts to improve water quality, decrease water quantity and/or improve the functions and values of surface water resources.

TABLE 26. Finance Implementation Plan.

Activity Steps	Resources	Measurement	Implementation Year	Est. Cost
Finance water resources management activites through the surface water utility fee	• Surface Water Management Plan • City budget process and assessment policy • Capital Improvement Program (CIP)	• Council approval • Customer service • CIP Implementation • Annual budget component	2009-2019	$10,000

C OFFICIAL CONTROLS

Entities currently having some level of administration responsibility within the City of Plymouth include the City of Plymouth, Bassett Creek WMO, Elm Creek WMO, Minnehaha Creek WMO, Shingle Creek WMO, Hennepin County, Mn DNR, MPCA, BWSR, USACOE, and the Metropolitan Council. Incidentally, the City of Plymouth lies completely within the MUSA boundary.

The City's responsibilities include, but are not limited to:

- Comprehensive Plan updates;
- Surface Water Management Plan updates;
- Ordinance review and amendment;
- Local plat review and amendments;
- Permits;
- Administration of WCA;
- Groundwater – wells;
- Participation and cooperation with the programs of the WMOs, Mn DNR, and Three Rivers Park District;
- Financing Alternatives;
- Capital Improvements; and
- Pond Maintenance

The City Code contains the regulatory procedures and protections for surface water management. Several of the codes that relate to surface water management are incorporated by reference into this plan and are listed below (Table 27). The City's regulatory controls satisfy state and local requirements for water resource management. No new regulatory controls are required to ensure plan implementation per Minnesota Statue 103B and Minnesota Rule 8410. Updates to City Code or changes to the Surface Water Management Plan may result in a plan amendment. Procedures for amending the Surface Water Management Plan are outlined in Appendix L.

Table 27. City code relating to surface water management.

Official Control	City Code
Floodplain Overlay District	Chapter 21 – Section 21660
Shoreland Management Overlay District	Chapter 21 – Section 21665
Wetland District	Chapter 21 – Section 21670
Erosion Control	Chapter 4 – Section 425 Chapter 5 – Section 526
Natural Preserves	Chapter 8 – Section 811

The four watershed management organizations (Bassett, Elm, Minnehaha, Shingle) are responsible for:

- Monitoring;
- Local plan review and approval;
- Projects of regional significance;
- Verification of local plan implementation; and
- Project review for compliance with WMO standards.

Although the City of Plymouth Surface Water Management Plan is in compliance with each of the four WMOs, the WMOs retain review authority for development and redevelopment for projects. Thresholds for review of projects by each WMO can be found in Table 28.

Table 28. Review thresholds for WMOs for development and redevelopment projects.

WMO	Review threshold
Bassett Creek	*Residential:* New – 2 acres and 4 units Redevelopment – 10 acres and 4 units *Other:* New development – 0.5 acres Redevelopment – 5 acres Grading **-** >200 yds or more than 10,000 sq. ft.
Elm Creek	*Residential:* Over 8 acres or over 5 acres and more than 2 units/acre.

	Other: Over one acre
Minnehaha Creek	*Erosion Control:* > 5000 square feet or > 50 cubic yards *Floodplain Alteration:* Any activity within the 100-yr flood plain *Wetland Protection:* Any excavation within a wetland *Dredging:* Any dredging in the bed banks or shores of a protected water or wetland *Shoreline and streambank improvement:* All shoreline and streambank improvements, including but not limited to rip rap, retaining walls, sheet piling, and boat ramps. Also, all sand blanket projects including family beaches. *Stream and Lake Crossings:* Placement of roads, highways, or utilities in the bed of a protected water or wetland; or construction of a bridge, or related crossing of a water, waterway, or wetland; or placement of a culvert or similar structure in the bed or channel of a protected water or wetland. *Stormwater Management:* All residential, commercial, institutional, industrial, or public land development projects that will increase the area of impervious surface or change land contours to alter the drainage ways, increase peak runoff rates, or affect the quality of stormwater flows. Single family homes, additions of garages, decks, etc. are exempt from this rule but may require a permit under one of the other rules.
Shingle Creek	*Residential:* Over 15 acres *Other:* Over 5 acres

Watershed Assessments

A INTRODUCTION

Minnesota Statue 103B.235 requires the City of Plymouth to update its Surface Water Management Plan in conformance with the Watershed Management Plans of Bassett Creek (2004), Elm Creek (2003), Minnehaha Creek (2007), and Shingle Creek (2004). Per statute, required contents of the plan include a description of the existing and proposed physical environment and land use (Figure 2 and Figure 3), subwatersheds (Figure 11), defined drainage areas complete with volumes, rates and paths of stormwater runoff; identification of areas for stormwater storage; water quality protection methods to meet established Watershed Management Plan standards; and a best management practice (BMP) implementation program.

Watershed assessments are intended to facilitate decision making and goal setting. The subwatershed analyses are based on the ranking of the receiving waters, degree of anticipated land use change and extent of storm water treatment within the subwatershed. Ultimately, the focus of the watershed assessments is to provide a preliminary screening of the City's urban runoff pollutant characteristics, provide a means to estimate TSS removal efficiencies of storm water ponds, and prioritize maintenance improvements to meet overall planning objectives.

Assessment of the watersheds is done by analyzing ponding (dead storage capacity of ponds and wetlands), ecology (recognizing variations in wetland and lake quality, resulting in varying degrees of protection), and development potential (future density and anticipated land use changes) within each watershed.

1. LAKE RANKING

The impacts of storm water runoff, both quality and quantity, represent a major threat to the long-term health of water resources. Baseline data for most of the lakes exists or is being collected. The relationship between runoff

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Figure 11. Subwatershed Districts.

Back of Figure 11.

volume and land use practices (i.e. impervious percentage) is well understood and documented. Similarly, and more recently, research has established the pollutant loading associated with land us practices. Lake ranking methodology for the eight lakes in Plymouth is described in detail in Appendix G. Watershed, in-lake, and public use characteristics were used to rank each of the eight lakes in Plymouth.

2. LAND USE CHANGE

Data analysis of current land use, future land use, and impervious surface coverages is used to determine the impact of development in each of the identified subwatersheds. In particular, GIS is used to analyze changes in the percent of impervious cover by comparing existing land use to future land use. The changing land use can be used to compare subwatersheds.

3. TREATMENT DEFICIENCY

a. Ponding

Plymouth is in the North Central Hardwoods Forest Ecoregion. The City's pond maintenance database consists of over 1100 NURP ponds and natural basins (wetlands). This database includes information on pond size, maintenance issues, depth, potential for treatment, photos, and other data pertinent to surface water such as storm sewer record plans. Pond size and dead storage are two factors used to determine surface water treatment needs throughout the City.

b. Ecology

The City of Plymouth Wetland Inventory (1994) and ordinance did not account for direct storm water runoff discharges to wetlands. However, by examining the storm water drainage base maps, it is clear that some of our wetlands currently receive direct storm water discharges. It is the City's intent to protect exceptional and high quality wetlands to the maximum extent practicable. Measures must be taken to prevent additional, untreated storm water from entering the most valuable resources. The City recognizes that water levels can change within wetlands due to storm water runoff and can impact the wetlands as a resource. Therefore, the City utilizes a wetland comparison to evaluate the "treatment deficiency" within each drainage area of the City.

i. Treatment Capacity versus Treatment Potential

Treatment capacity is defined in this plan as the estimated pollutant removal capability of the existing system. Treatment is a function of dead storage volume available in ponds and wetlands. Dead storage volume promotes settling of suspended solids, associated nutrients, and heavy metals such as copper, the element most commonly found in urban runoff that is most toxic to aquatic organisms.

Treatment potential refers to the estimated pollutant removal that *could* exist, based on the actual area of wetlands and various wetland types, assuming that a volume of dead storage is or could be made available to achieve pollutant removal efficiency standards.

The treatment potential in Plymouth is great with over 1100 ponds and wetlands. However, the treatment capacity is not documented; in most cases only pond/wetland surface area data exists. Very little pond depth information is available. Additionally, with the 1994 Wetland Inventory comes the recognition that the City should not exploit the water quality treatment potential of all of its wetlands to improve the quality of the lakes and creeks, even if a particular wetland is providing treatment of runoff today.

ii. Effective Percent Impervious

The correlation between land use practices and water resource impacts depends, in part, on the treatment capacity of the upstream subwatersheds. To make resource management decisions, both the treatment capacity and the treatment potential of the contributing watershed must be investigated. A relationship exists between land use practices and runoff impacts. The relationship is a function of both impervious cover and the extent and distribution of ponds and wetlands, as well as their treatment capacity and treatment potential. With a watershed impact/response relationship in place, the City can develop regulatory controls for allowable land use practices and require mitigation for sub-standard development. An effective percent impervious (EPI) threshold could be established, defining the minimal impact level of urbanization. The EPI would represent a target to be achieved with best management practices for development which exceed the minimal impact level.

Utilizing wetlands as a key component to water quality improvements within the context of treatment capacity and treatment potential raises several important questions:

- Which are the most important resources?
- To what degree should they be protected, restored or maintained?
- How should the existing system be relied upon?
- What other measures should be taken?
- What are the projects necessary to maximize treatment potential?
- What additional treatment is necessary to achieve the plan goals?

Treatment potential begins to answer at least some of the questions above. Treatment potential represents the "best case scenario" for treatment based on the existing landscape and the City wetland classification. Treatment potential excludes wetlands classified as exceptional and those wetlands associated with high priority natural areas from consideration as water quality treatment facilities, even if they exhibit high or exceptional water quality attributes. This helps to ensure the biological integrity of those wetlands. Next, based on the area of the remaining ponds and wetlands, treatment potential is estimated by assuming that a volume of dead storage sufficient to achieve NURP removal standards could be provided. The treatment potential varies by wetland classification.

iii. Water Quality Modeling

Methodology based on the National Urban Runoff Program (NURP) and the P8 Urban Catchment Model (version 1.1) was used to identify the appropriate level of treatment for urban storm water. Using this approach, a recommended minimum pollutant removal efficiency for urban storm water treatment is determined. Based on this standard, the existing treatment capacity and treatment potential of each subwatershed can be estimated.

The P8 model was used to develop a relationship between pollutant loading based on the impervious fraction and the wet-pond surface area requirements, assuming optimum dead storage conditions to approach NURP removal standards. The impervious fraction for each land use type used in the analysis is shown in Table 29.

TABLE 29. P8 Inputs by Land Use Type.

Land Use Type	Impervious Fraction
Agriculture	2%
Apartment	65%
Commercial	85%
Farm	5%
Industrial	72%
Multi-family	65%
Park	10%
Residential	30%
Right of Way	50%
Railroad	85%
Vacant	0%
Mobile Home	38%
Water bodies	100%

The P8 model requires the input of the impervious fraction of each land use type. An impervious fraction was generated for each subwatershed via a GIS using existing land use. Information from a variety of sources including the 1980 plan and the 1994 wetland inventory were used to describe existing ponds.

Analysis of required pond size, expressed in terms of the impervious percentage of the contributing watershed, yields a relationship of pond area to impervious contributing area. The relationship is based on an 85 percent Total Suspended Solid (TSS) removal, and standard design-mode parameters of the P8 model.

An 85 percent TSS removal value was used in the analysis versus the 90 percent NURP standard, recognizing that there may not be adequate detention time in many wetlands to achieve the 90 percent removal discussed by the EPA (1983). Additionally, depending on the quality of the wetland, extended detention on a frequent basis, which would be the case for effective water quality treatment, may be detrimental to diverse vegetation and sensitive habitats.

MPCA's document *Protecting Water Quality in Urban Areas* presents a relationship between removal efficiencies and detention time (Table 30). Although constructed storm water ponds may have appropriate detention time, they represent only a fraction of a watershed's treatment potential. Although the NURP TSS removal goal can be met with detention times less than 48 hours, the total phosphorus (TP) removal goal requires detention times that begin to approach 72 days. The City's drainage system relies heavily on wetlands for water quality treatment. Extended water level fluctuations and detention time can have a detrimental impact on wetland vegetation. A detention time of 36 hours was chosen, corresponding to an 85 percent TSS removal. The 36-hour detention time was chosen as a period short enough to minimize negative vegetative/habitat impacts.

TABLE 30. Pollutant removal Versus Detention Time (MPCA, 1989).

	Detention Time (hours)				
Parameter	24	36	41	48	>48
TSS	78%	85%	90%	93%	>93%
Total Phosphorus	50%	56%	57%	58%	65%

From this analysis, the following relationships were developed to assess the treatment potential and the required treatment for each subwatershed. Analysis of required pond size expressed in terms of the impervious percentage of the contributing watershed yields the relationship of 1 acre of treatment pond is necessary for every 15.8 acres of impervious contributing area (or a ratio of 0.063). The relationship is based on an 85% removal rate for TSS, and standard design-mode parameters of the P8 model. Based on this relationship, the following equations have been developed, where "I" is the percent impervious expressed in decimal form (i.e., for 10 percent impervious, use I = 0.10).

EQ 1: Required Treatment Pond Size (Acre) = 0.063 x Acres of Imp. Surface

EQ 2: Total Suspended Solids (TSS) Loading (Lbs/Acre) = 613.79 x I

EQ 3: Total Phosphorus (TP) Loading (Lbs/Acre) = 0.186 x I

iv. <u>Effective Acreage Factor</u>

In an effort to qualitatively estimate the percentage of wetland acreage that could be utilized for water quality treatment, a "test" watershed was analyzed. From the report *Parkers Lake Watershed and Lake Management Plan* (Barr, 1993), the existing treatment capacity is estimated to be removing 16 percent of the total phosphorus from storm water runoff. A target removal for total phosphorus of 56 percent, which corresponds to the 85 percent TSS removal in Table 30, was used in the analysis of effective acreage factors (EAFs). On that basis, the existing system in the Parkers Lake Subwatershed is removing 16/56 or 28.57 percent of the target removal.

There is a total of 510.7 acres of impervious cover in the Parkers Lake Subwatershed. The required treatment area would be 510.7 acres x 0.063, or 32.17 acres of treatment pond area. The existing system in the total contributing area to Parkers Lake is only producing about 28.57 percent of the desired treatment. The "effective acreage" is calculated as the ratio of actual treatment to required treatment. “Effective acreage”, from a water quality perspective, is 28.57 percent x 32.17 acres, or 9.19 acres.

To determine the qualitative “effective acreage factor” (EAF) for each wetland type, five assumptions were made:

1. Exceptional wetlands are not counted, i.e. EAF = 0. (Coincidentally, the Parkers Lake Subwatershed has no exceptional quality wetlands).
2. The EAF for wetlands classified as low quality recognizes that they are already impacted significantly by storm water, (i.e., serving a water quality function), but may not be functioning at 100 percent removal efficiency due to limited natural dead storage, design deficiencies, and/or level of maintenance.
3. The EAF for wetlands classified as high quality is set to be 1/3 of the low quality wetland EAF, recognizing that although many wetlands classified as “high quality” currently provide treatment, there are other functions and values besides water quality treatment that should be protected. High quality wetlands are not likely to be modified to any significant extent to improve their pollutant removal efficiency, especially when there are low and medium classified wetlands that could be relied on for water quality purposes.
4. The EAF for medium quality wetlands should fall between the low and high quality factors, therefore an initial factor of 2/3 of the low quality factor was selected.
5. Storm water ponds have an EAF factor of 1.

Based on the 1994 Wetland Inventory, there are 5.8 acres of high quality wetland, 14.1 acres of medium quality wetland, and 1.2 acres of low quality wetland, and 0.06 acre of storm water ponding within the Parkers Lake Subwatershed.

Applying the five assumptions listed above, and using the “effective acreage” of 9.19 acre, the EAF for the high, medium and low quality wetlands can be solved for as follows:

EQ 4. $EA = (H * X) + (M * Y) + (L * Z) + S$

where: H = High Quality Wetlands Acres

M = Medium Quality Wetlands Acres

L = Low Quality Wetlands Acres

S = Storm Water Ponds

EA = Effective Acreage

X = EAF for High Quality Wetlands

Y = EAF for Medium Quality Wetlands

Z = EAF for Low Quality Wetlands

Substituting in EQ 4, based on the five assumptions and the wetland characteristics, yields the following:

$$(5.8 * Z/3) + (14.1 * 2Z/3) + (1.2 * Z) + 0.06 = 9.19$$

sloving for Z:

Z = 0.73 (low quality EAF)

X = (Z/3) = 0.24 (high quality EAF)

Y = (2Z/3) = 0.49 (medium quality EAF)

EAF's are then round to 0.75, 0.25, and 0.50 for simplicity. To calculate the "effective acreage" of water quality treatment, multiply the acres of each wetland category by its EAF (1, 0.75, 0.50, 0.25 for storm water ponds, low quality wetlands, medium quality wetlands, and high quality wetlands, respectively).

4. PRIORITIZATION

Prioritization of future ponding or other best management practices is dependent upon the determination of treatment deficiencies within each subwatershed and/or drainage area. The prioritization methodology for addressing future ponding or other best management practice needs is based on three factors:

1. The rank of the receiving lake (Bass, Pike, Schmidt, Pomerleau, Parkers, Medicine, Gleason, Mooney).
2. The degree of anticipated land use change in terms of impervious percentage.
3. The current treatment deficiency.

The values for each of these factors are summarized in Table 31.

Table 31. Prioritization Factors.

Receiving Lake Ranking	**Value**
High	High
Medium	Medium
Low	Low
Degree of Anticipated Land Use Change	**Value**
High	High
Moderate	Medium
Minimal	Low
Current Treatment Deficiency	**Value**
Treatment Area > 90% of required	Low
Treatment Area > 50% and < 90% of required	Medium
Treatment Area < 50% of required	High

In the watershed assessments that follow, this methodology is used to determine the priorities for each of the three factors in Table 31. Combining the subwatershed analysis in the implementation section of the plan provides a tool for deciding where improvements should be made on a prioritized basis (Table 32). The implementation plan includes a means for combining the three factors to establish a single priority system.

Table 32. Subwatershed Priority Categories.

Subwatershed Priority	Values (from Table 31)
High	Minimum of one high and no lows OR
	High in receiving water ranking and treatment deficiency
Medium	Neither High nor Low
Low	No Highs and two or more lows

B BASSETT CREEK WATERSHED

The Bassett Creek Watershed covers approximately 31 square miles in central Hennepin County. For Plymouth, the predominant water features in the urbanized Bassett Creek Watershed are Medicine Lake, Parkers Lake, Plymouth Creek, and Bassett Creek. These features have significant park systems adjoining them.

Plymouth Creek begins about 1000 feet north of County Road 24, and becomes more of a defined stream at Highway 55. Plymouth Creek parallels the highway as it flows southeasterly towards Medicine Lake. Bassett Creek itself begins as the Medicine Lake outlet, flowing southeasterly through Golden Valley and Minneapolis to the Mississippi River.

1. BASSETT CREEK WATERSHED MANAGEMENT ORGANIZATION

Bassett Creek and its three branches cross nine cities: Plymouth, Medicine Lake, Golden Valley, Robbinsdale, Crystal, New Hope, Minnetonka, St. Louis Park, and Minneapolis. In downtown Minneapolis, the creek discharges into the Mississippi River below St. Anthony Falls.

Prior to the adoption of a formal joint powers agreement, the cities in the Bassett Creek watershed acted together as a committee, which was formed to study flood control issues in the watershed. In 1968, the Bassett Creek Flood Control Commission was formed by adoption of a joint powers agreement between the nine communities in the watershed. In 1984, the Bassett Creek Flood Control Commission revised its joint powers agreement and created the Bassett Creek Watershed Management Commission (BCWMC). Again in 1993, the BCWMC revised its joint powers agreement, which will remain in effect until 2015. The BCWMC Board of Commissioners consists of nine commissioners and nine alternates appointed by the member cities. The term of each commissioner and alternate is three years. Regular meetings of the BCWMC are held on the third Thursday of each month. The powers and duties of the BCWMC are outlined in the joint powers agreement (Appendix M).

The Metropolitan Water Management Act requires local units of government in the seven-county metropolitan area to prepare and implement watershed management plans through membership in a watershed management organization. A watershed management organization can be organized as either a watershed district, a function of county government, or a joint powers agreement organization (such as the BCWMC).

The BCWMC's general goals fall under the categories of water quality, flood control, erosion and sediment control, stream restoration, wetland management, groundwater, public ditches, and public involvement and information. The goals are to:

- Manage the water resources of the watershed, with input from the public, so that the beneficial uses of wetlands, lakes, and streams remain available to the community.
- Improve the quality of stormwater runoff reaching the Mississippi River by reducing the nonpoint source pollution (including sediment) carried as stormwater runoff.
- Protect and enhance fish and wildlife habitat and maintain shoreland integrity.
- Reduce flooding along the Bassett Creek trunk system.
- Protect human life, property, and surface water systems that could be damaged by flood events.
- Regulate stormwater runoff discharges and volumes to minimize flood problems, flood damages, and the future costs of stormwater management systems.
- Provide leadership and assist member cities with coordination of intercommunity stormwater runoff planning and design.
- Prevent erosion and sedimentation to the greatest extent possible to protect the BCWMC's water resources from increased sediment loading and associated water quality problems.
- Implement soil protection and sedimentation controls whenever necessary to maintain health, safety, and welfare.

- Implement stream restoration measures whenever necessary to maintain health, safety, and welfare.
- Maintain or enhance the natural beauty and wildlife habitat value of Bassett Creek.
- Achieve no net loss of wetlands in the BCWMC, in conformance with the Minnesota WCA and associated rules.
- Protect the quantity and quality of groundwater resources.
- Manage public ditches in a manner that recognizes their current use as urban drainage systems.
- Raise awareness of the watershed's existence and the role that the BCWMC plays in protecting water quality and preserving the watershed's health and aesthetics.
- Enable the target audiences to have confidence in the BCWMC's expertise and participate in a meaningful way in the planning process and ongoing projects conducted by the BCWMC.
- Raise awareness of the impact that individuals, businesses, and organizations have upon water quality and motivate these audiences to change personal/corporate behavior that has a negative impact on water quality and the watershed.

Additionally, the BCWMC implements capital improvement projects (Table 33) funded by an ad-velorum tax.

Table 33. BCWMC Capital Improvement Projects 2009-2014.

BCWMC CIP Project		Plymouth SWMP Subwatershed
ML-1.	Construct wet detention pond for subwatershed BC94B1.	Medicine Lake
ML-2.	Reduce Goose Loadings by 75%.	Medicine Lake
ML-6.	Construct wet detention pond for Subwatershed BC94B2.	Medicine Lake
PC-1.	Plymouth Creek Restoration Downstream Reach	Medicine Lake

PC-2. Plymouth Creek Restoration
Upstream Reach .... Medicine Lake

PL-6. Improvements to storm water basin in
PL-A13 near Circle Park. .... South Parkers Lake

NL-2. Dredge pond NB-07. .... North Branch

NL-3. Divert Lancaster Lane storm sewer. ...... North Branch

In 2005, the City of Plymouth completed an inventory of erosion and sediment along the Bassett Creek trunk system, including Plymouth Creek. Completion of the inventory is required by the BCWMC prior to accessing Channel Maintenance Funds as disbursed by the BCWMC. The City is responsible for updating this inventory as necessary.

2. SUBWATERSHEDS

The portion of the Bassett Creek Watershed that covers Plymouth includes 18 subwatersheds. The identified subwatersheds are:

- Upper Plymouth Creek
- Turtle Lake
- Middle Plymouth Creek
- Fernbrook Lane
- North Parkers Lake
- South Parkers Lake
- Parkers Lake
- Sunset Hills Pond/Cavanaugh Lake
- Plymouth Creek Southwest
- Lower Plymouth Creek
- West Medicine Lake
- North Medicine Lake
- Northeast Medicine Lake
- South Medicine Lake
- Medicine Lake
- Bassett Creek
- Lost Lake

- North Branch

The subwatersheds (Figure 12) are based on receiving waters or on the amount of anticipated land use change to occur in the future. Each subwatershed has been further divided into numerous drainage areas that generally correspond to the 1980 drainage plan. Each identified drainage area includes at least one pond, wetland or water body that receives storm water. When more than one water body is identified within a drainage area, it is probable that there are no City records available that indicate the contributing area to each water body.

For each subwatershed, a corresponding table and figure describes the drainage, wetland classes, and the treatment potential based on the amount of ponding available. Within the table, the drainage area treatment status column is the ratio of effective treatment to the required ponding for the direct tributary drainage area. The treatment deficiency column illustrates when the required ponding exceeds the effective acreage, indicating the need for additional treatment. Additionally, the treatment deficiency column carries downstream into the next drainage area by adding to the required ponding in the downstream drainage area. The total required ponding is the sum of the required drainage area ponding and upstream ponding deficiencies.

Because treatment deficiency within each subwatersehd only accounts for ponding, consideration will need to be given to "pre-treatment", Wetland Conservation Act, and other best management practice requirements which are current policies or regulations when assessing the actual treatment deficiency of a drainage area. Currently, the City of Plymouth requires pre-treatment of surface water prior to discharge into any wetlands, which is intended to further protect water quality.

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Figure 12. Bassett Creek Subwatersheds

Back of Figure 12.

a. Upper Plymouth Creek Subwatershed

Table 34. Upper Plymouth Creek Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Bassett Creek	
Receiving Water Ranking	Medicine/High	
Treatment Deficiency	Low	
Land Use Change	High	
Priority Status	**Medium**	
Receives runoff from:	Headwater	Figure 13
Downstream-most water body:	BC-12	Figure 13
Discharges to:	Middle Plym Creek	Figure 13
Exceptional Quality Wetlands	54.8 acres	Table 35
High Quality Wetlands	185.5 acres	Table 35
Medium Quality Wetlands	54.4 acres	Table 35
Low Quality Wetlands	1.5 acres	Table 35
Storm Water Ponds	10.5 acres	Table 35
Effective Treatment (Cuml. Area)	31.4 acres	Table 35
General Hydrologic Soil Group	Variable	
Total # of Drainage Areas	13	Figure 13
Drainage Area	1710.9 acres	
Impervious Acreage	503.8 acres	Table 35
Impervious percentage	29.5%	

Location

The Upper Plymouth Creek subwatershed is located in west central Plymouth. The subwatershed is split by Highway 55 and follows County Road 24 on the south side, extending into and including part of Medina. The subwatershed extends northeasterly where it is generally bounded by Vicksburg Lane and by 49th Avenue.

Background

Much of the infrastructure proposed south of Highway 55 in the 1980 plan has been constructed. A hydrologic study for drainage area BC-8 to review flow rates, drainage areas, and flooding was completed in 1996. Recommended improvements from the study resulted in flow rates that are lower than the 1980 plan. Water flow and ponding improvements were completed in BC12 in 2005. No specific problem areas were noted during the preparation of this plan.

Significant resources within the Upper Plymouth Creek Subwatershed include Plymouth Creek, approximately 230 acres of high and exceptional quality wetlands, as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). Exceptional quality wetlands are present in areas BC1 and BC3.

Surface water treatment

Surface water treatment potential was analyzed for the Upper Plymouth Creek Subwatershed and associated drainage areas (Table 35 and Figure 13). Although no specific problems were noted during the preparation of this plan, the BC-13A drainage area could be considered for future treatment. The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 35. Upper Plymouth Creek Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
M3	1.9	0.1	0.1	-	-	-	5.6	-	5.6	1.4	1178.7	0.0	LOW
BC1	63.3	4.0	4.0	0.1	0.3	9.1	6.2	32.5	48.1	6.3	158.4	0.0	LOW
BC2	20.3	1.3	1.3	-	-	2.4	-	-	2.4	1.2	93.7	0.1	LOW
BC4	22.4	1.4	1.4	-	-	4.3	-	-	4.3	2.1	150.1	0.0	LOW
BC5	8.6	0.5	0.5	-	-	1.2	1.2	-	2.4	0.9	163.6	0.0	LOW
BC3	56.3	3.6	3.6	0.7	0.9	6.1	7.3	22.2	37.2	6.2	170.1	0.0	LOW
BC6	20.8	1.3	1.3	0.1	-	0.0	21.3	-	21.5	5.5	414.9	0.0	LOW
BC8	13.4	0.8	0.8	0.6	-	5.4	11.6	-	17.7	6.3	739.4	0.0	LOW
BC7	22.6	1.4	1.4	0.9	0.2	3.8	58.8	-	63.7	17.6	1234.0	0.0	LOW
BC9	17.1	1.1	1.1	-	-	7.8	1.9	-	9.7	4.4	402.1	0.0	LOW
BC10	11.7	0.7	0.7	0.1	-	2.5	-	-	2.6	1.3	178.8	0.0	LOW
BC11	193.1	12.2	12.2	7.0	-	8.2	47.6	-	62.8	23.0	188.3	0.0	LOW
BC12	38.2	2.4	2.4	0.7	0.2	2.9	24.0	-	27.8	8.3	342.3	0.0	LOW
BC13A	**14.1**	**0.9**	**0.9**	**0.2**	**-**	**0.7**	**-**	**-**	**0.9**	**0.5**	**56.1**	**0.4**	**MED**

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Figure 13. Upper Plymouth Creek Subwatershed.

Back of Figure 13.

In conclusion, the Upper Plymouth Creek Subwatershed is considered to be a medium-priority for implementation of projects based on a high receiving water ranking, low treatment deficiency, and high anticipated land use change. Drainage area BC13A would benefit from additional best management practices.

b. Turtle Lake Subwatershed

Table 36. Turtle Lake Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Bassett Creek	
Receiving Water Ranking	Medium	
Treatment Deficiency	Low	
Land Use Change	High	
Priority Status	**Low**	
Receives runoff from:	BC14, 15, 16, 16A	Figure 14
Downstream-most water body:	Turtle Lake	Figure 14
Discharges to:	BC13	Figure 14
Exceptional Quality Wetlands	0.0 acres	Table 37
High Quality Wetlands	39.6 acres	Table 37
Medium Quality Wetlands	14.3 acres	Table 37
Low Quality Wetlands	0.6 acres	Table 37
Storm Water Ponds	25.4 acres	Table 37
Effective Treatment (Cuml. Area)	28 acres	Table 37
General Hydrologic Soil Group	B, B/D, C/D	
Total # of Drainage Areas	4	Figure 14
Drainage Area	409.4 acres	
Impervious Acreage	136.0 acres	Table 37
Impervious percentage	33.2%	

Location

The Turtle Lake subwatershed is generally bounded by Vicksburg Lane to the west, County Road 9 (Rockford Road) to the south, 46th Avenue to the north and Fernbrook Lane to the east.

Background

The infrastructure in place generally conforms to the 1980 Storm Drainage Plan. The Bassett Creek Watershed Management Commission completed a Lake Management Plan for Turtle Lake in 1995. The report presented several site-specific BMPs to reduce total phosphorous loading, sediment loading, and floatable materials into the lake. Some of the identified practices for Turtle Lake involve dredging, including dredging within the northerly wetland to treat inflows to the lake, and complete lake dredging.

Significant resources within the Turtle Lake Subwatershed include Turtle Lake itself, approximately 40 acres of high quality wetlands as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). High quality wetlands are present in BC16A, BC15, and BC14.

Three specific problems within the subwatershed were identified during preparation of this plan. Purple Loosestrife is present in the north wetland, the Turtle Lake outlet may be in adequate, and the water quality is below BCWMC standards.

Surface water treatment

Surface water treatment potential was analyzed for the Turtle Lake Subwatershed and associated drainage areas (Table 37 and Figure 14). No specific problems were noted during the preparation of this plan. The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water ponding and wetland acreage/type.

Table 37. Turtle Lake Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
BC16	39.3	2.5	2.5	0.4	0.1	6.7	-	-	7.3	3.9	156.4	0.0	LOW
BC16A	13.1	0.8	0.8	5.8	-	-	0.1	-	5.9	5.8	703.7	0.0	LOW
BC15	11.9	0.8	0.8	19.6	-	1.0	0.3	-	20.9	20.2	2677.7	0.0	LOW
BC14	**14.2**	**0.9**	**0.9**	**-**	**0.5**	**-**	**39.2**	**-**	**39.7**	**10.2**	**1130.2**	**0.0**	**LOW**

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Figure 14. Turtle Lake Subwatershed and Drainage Areas.

Back of Figure 14.

In conclusion, the Turtle Lake Subwatershed is considered to be a low-priority for implementation of projects based on med/high receiving water ranking, low treatment deficiency, and low anticipated land use change. The City of Plymouth has, however, included a project in the most recent Capital Improvement Program (2009-2013) to determine the appropriate outlet elevation and type for Turtle Lake.

Table 38. Turtle Lake Management Plan

Subject:	Turtle Lake Management Plan
Purpose:	Protect and preserve Turtle Lake consistent with its water quality goals.
Goal:	1. Reduce phosphorus loadings at storm water inlet points, increase clarity and work toward an in-lake average total phosphorus concentration of 38-60 μg/l , secchi depths 2.4-4.6 feet, and chlorophyll-a concentrations within 10-30 μg/l. 2. Work toward reaching goals set forth by the MPCA and BCWMC (Level II). 3. Work toward reaching goals as set forth in an future EPA approved TMDL Implementation Plan.

Problems:

1. Turtle Lake lacks historical water quality monitoring and it is undetermined if it meets all lake water quality goals.
2. Due to the developed nature of the Turtle Lake subwatershed, few options exist for structural BMPs.
3. The outlet elevation for Turtle Lake needs to be reviewed.

Solutions:

1. Operate an enhanced street sweeping program.
2. Incorporate structural BMPs where feasible.
3. Study opportunities for wetland enhancements within the watershed.
4. Require surface water treatment for development and redevelopment projects which exceed 0.5 acres.

5. Discuss opportunities for aquatic vegetation management.
6. Implement any EPA approved TMDL Plan.
7. Implementing surface water quality monitoring.
8. Provide education to City residents on water quality.
9. Complete a study on the outlet elevation for Turtle Lake.

Table 39. Turtle Lake Implementation Plan

Implementation Item	Resources	Measurement	Target Date	Est. Cost
1. Operate an enhanced street sweeping program	• City staff	• Lbs. of material removed from the streets	SEE TABLE 18	SEE TABLE 18
2. Incorporate structural BMPs where feasible.	• City staff • BCWMC • Feasability study	• Number of BMPs and their modeled efficiency	SEE TABLE 5	SEE TABLE 5
3. Study opportunities for wetland enhancements within the Parkers Lake watershed	• City staff • BWSR • MN DNR • BCWMC • Feasibility Study	• Acreage of wetland enhancements	SEE TABLE 12	SEE TABLE 12
4. Require surface water treatment to NURP standards for development or redevelopment projects that exceed 0.5 acres	• City staff • Surface Water Management Plan	• Improved quality of surface water runoff	2009-2016	$0
5. Discuss opportunities for aquatic vegetation management	• City Staff • EQC • Residents	• Number of meetings	2009	$0
6. Implement any EPA approved TMDL implementation plan	• City staff • MPCA • EPA • BCWMC	• EPA approved TMDL • Implementation of items		
7. Implementing surface water quality monitoring	• City staff • Three Rivers Park Dist.	• Annual Water Quality Monitoring Report	SEE TABLE 16	SEE TABLE 16
8. Education	• City staff • BCWMC • Three Rivers Park Dist.	• Number of promotions and mailers	SEE TABLE 14	SEE TABLE 14

9. Turtle Lake Outlet Study	• City staff • BCWMC • CIP	• Report findings	2011	$35,000

c. Middle Plymouth Creek Subwatershed

Table 40. Middle Plymouth Creek Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Bassett Creek	
Receiving Water Ranking	Medicine/High	
Treatment Deficiency	Low	
Land Use Change	High	
Priority Status	**High**	
Receives runoff from:	Turtle Lake, UPC	Figure 15
Downstream-most water body:	BC39	Figure 15
Discharges to:	Lower Plym Creek	Figure 15
Exceptional Quality Wetlands	0.0 acres	Table 41
High Quality Wetlands	120.9 acres	Table 41
Medium Quality Wetlands	50.9 acres	Table 41
Low Quality Wetlands	15.4 acres	Table 41
Storm Water Ponds	2 acres	Table 41
Effective Treatment (Cuml. Area)	30.8 acres	Table 41
General Hydrologic Soil Group	B & C/D	
Total # of Drainage Areas	18	Figure 15
Drainage Area	1583.6 acres	
Impervious Acreage	724.3 acres	Table 41
Impervious percentage	45.7%	

Location

The Middle Plymouth Creek subwatershed is located in the center of Plymouth, bisected north-south by I-494 and east-west by Highway 55. The subwatershed receives water from the Upper Plymouth Creek and Turtle Lake Subwatersheds, before discharging to the Lower Plymouth Creek Subwatershed. The subwatershed is generally bounded to the north by County Road 9, to the west by Vicksburg Lane and to the south by Campus

Drive.

Background

This subwatershed generally conforms to the 1980 Storm Drainage Plan, including a water level control dike in area BC18. A flood control and infrastructure project was completed in 2007 within BC18 near 38th Avenue and Harbor Lane. Several problem drainage areas were identified including BC20 (need positive drainage), BC13 (raise pond for water quality), and erosion repair along I-494. Additionally, much of the land use is commercial/industrial and the associated surface water runoff generally continues to tax the conveyance and water quality systems. Rain gardens were installed in areas BC21 and BC27 in 2004 to help mitigate surface water runoff.

Significant resources within the Middle Plymouth Creek Subwatershed include Plymouth Creek, approximately 120 acres of high quality wetlands, a control dike in BC18, as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). High quality wetlands are present in BC18, BC23, BC39A, and BC39.

Surface water treatment

Surface water treatment potential was analyzed for the Middle Plymouth Creek Subwatershed and associated drainage areas (Table 41 and Figure 15). Specific problems were noted in areas BC20 and BC13. The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water ponding and wetland acreage/type.

Table 41. Middle Plymouth Creek Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
BC13	33.4	2.1	2.1	0.2	3.9	1.0	-	-	5.0	3.6	168.3	0.0	LOW
BC17	13.3	0.8	0.8	-	-	8.3	-	-	8.3	4.2	497.3	0.0	LOW
BC17A	5.8	0.4	0.4	0.1	0.3	-	-	-	0.4	0.3	91.9	0.0	LOW
BC17B	1.7	0.1	0.1	-	-	0.4	-	-	0.4	0.2	133.0	0.0	LOW
BC13B	20.0	1.3	1.3	0.2	0.2	-	-	-	0.4	0.3	23.9	1.0	HIGH
BC20	115.8	7.3	7.3	-	-	8.8	-	-	8.8	4.4	60.1	2.9	MED
BC19A	21.7	1.4	4.3	-	-	3.2	-	-	3.2	1.6	36.6	2.7	HIGH
BC19	37.7	2.4	5.1	-	3.1	6.6	-	-	9.7	5.7	110.6	0.0	LOW
BC18	104.1	6.6	7.6	-	1.9	1.2	61.5	-	64.5	17.4	229.9	0.0	LOW
BC22A	8.3	0.5	0.5	-	-	-	-	-	0.0	0.0	0.0	0.5	HIGH
BC21	50.1	3.2	3.2	-	-	-	-	-	0.0	0.0	0.0	3.2	HIGH
BC22	15.2	1.0	4.7	-	5.6	-	-	-	5.6	4.2	89.9	0.5	MED
BC23	64.0	4.0	4.0	-	0.2	5.0	0.9	-	6.0	2.8	70.0	1.2	MED
BC27	51.0	3.2	4.9	-	-	16.2	-	-	16.2	8.1	165.2	0.0	LOW
BC40	43.4	2.7	2.7	1.0	0.3	-	-	-	1.3	1.2	44.7	1.5	HIGH
BC39A	15.1	1.0	2.5	-	-	-	29.8	-	29.8	7.4	301.1	0.0	LOW
BC48	63.9	4.0	4.0	-	-	-	-	-	0.0	0.0	0.0	4.0	HIGH
BC41	21.7	1.4	5.4	0.5	-	0.3	-	-	0.8	0.7	12.7	4.7	HIGH
BC39	**38.2**	**2.4**	**7.1**	**-**	**-**	**-**	**28.8**	**-**	**28.8**	**7.2**	**100.6**	**0.0**	**LOW**

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Figure 15. Middle Plymouth Creek Subwatershed and Drainage Areas.

Back of Figure 15.

In conclusion, the Middle Plymouth Creek Subwatershed is considered to be a medium-priority for implementation of projects based on a high receiving water ranking, low treatment deficiency, and high anticipated land use change. Three drainage areas (BC22A, BC21, and BC48) have no identified storage. Drainage areas BC40, BC48, BC41, BC21, BC22A, and BC19A would benefit from best management practices. The City of Plymouth's most recent Capital Improvements Program (2009-2013) lists a surface water drainage improvement project for the Ranchview/Medina Road wetland in 2009. Implementation of best management practices should be closely coordinated with the BCWMC.

d. Fernbrook Lane Subwatershed

Table 42. Fernbrook Lane Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Bassett Creek	
Receiving Water Ranking	Parkers/High	
Treatment Deficiency	High	
Land Use Change	Low	
Priority Status	**High**	
Receives runoff from:	Headwater	Figure 16
Downstream-most water body:	Parkers Lake	Figure 16
Discharges to:	Plymouth Creek SW	Figure 16
Exceptional Quality Wetlands	0.0 acres	Table 43
High Quality Wetlands	0.0 acres	Table 43
Medium Quality Wetlands	4.35 acres	Table 43
Low Quality Wetlands	1.16 acres	Table 43
Storm Water Ponds	0.0 acres	Table 43
Effective Treatment (Cuml. Area)	3.0 acres	Table 43
General Hydrologic Soil Group	B; B/D; C/D	
Total # of Drainage Areas	9	Figure 16
Drainage Area	491.2 acres	
Impervious Acreage	305.9 acres	Table 43

Impervious percentage	62.3%

<u>Location</u>

The Fernbrook Lane subwatershed is located in south central Plymouth. Bordered on the east by I-494, to the north by Highway 55, to the south by County Road 6 and to the west by Fernbrook Lane, this subwatershed covers a large industrial area that ultimately drains to Parkers Lake.

<u>Background</u>

The 1980 Storm Drainage Plan shows all infrastructure as existing at the time of that plan. No significant changes to the drainage system have been made although a pre-treatment device was installed at the intersection of Fernbrook Lane and 27th Avenue in 2008. Addtionally, a 96-inch storm sewer drains the area, discharging to Parkers Lake. A rip-rap enclosure was placed at the 96-inch outlet in 2003 to collect sediment and debris.

Significant resources within the Fernbrook Lane Subwatershed are few. The large conveyance system efficiently drains the subwatershed to Parkers Lake, without much pre-treatment.

<u>Surface water treatment</u>

Surface water treatment potential was analyzed for the Fernbrook Lane Subwatershed and associated drainage areas (Table 43 and Figure 16). Although no specific problems other than total suspended solid loading from the 96-inch outlet were noted during the preparation of this plan, much of the subwatershed area could be considered for future treatment. The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 43. Fernbrook Lane Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
PL1	54.3	3.4	3.4	-	-	-	-	-	0.0	0.0	0.0	3.4	HIGH
PL2	52.4	3.3	6.8	-	0.2	0.1	-	-	0.2	0.1	2.1	6.6	HIGH
PL3	30.7	1.9	8.6	-	-	1.4	-	-	1.4	0.7	8.0	7.9	HIGH
PL4	33.4	2.1	2.1	-	0.5	1.7	-	-	2.2	1.2	57.0	0.9	MED
PL5	42.1	2.7	11.4	-	-	0.2	-	-	0.2	0.1	0.9	11.3	HIGH
PL7	23.1	1.5	1.5	-	0.6	-	-	-	0.6	0.4	28.2	1.1	HIGH
PL8	23.8	1.5	1.5	-	-	1.0	-	-	1.0	0.5	33.2	1.0	HIGH
PL6	36.1	2.3	15.7	-	-	-	-	-	0.0	0.0	0.0	15.7	HIGH
PL6A	**10.2**	**0.6**	**16.3**	**-**	**-**	**-**	**-**	**-**	**0.0**	**0.0**	**0.0**	**16.3**	**HIGH**

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Figure 16. Fernbrook Lane Subwatershed.

Back of Figure 16

In conclusion, the Fernbrook Lane Subwatershed is considered to be a high-priority for implementation of projects based on a high receiving water ranking, high treatment deficiency, and low anticipated land use change. The entire subwatershed would benefit from best management practices. Implementation of best management practices should be closely coordinated with the BCWMC.

e. North Parkers Lake Subwatershed

Table 44. North Parkers Lake Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Bassett Creek	
Receiving Water Ranking	Parkers/High	
Treatment Deficiency	High	
Land Use Change	Medium	
Priority Status	**High**	
Receives runoff from:	PL9/PL10	Figure 17
Downstream-most water body:	PL10	Figure 17
Discharges to:	Parkers Lake	Figure 17
Exceptional Quality Wetlands	0.0 acres	Table 45
High Quality Wetlands	1.5 acres	Table 45
Medium Quality Wetlands	5.7 acres	Table 45
Low Quality Wetlands	0.0 acres	Table 45
Storm Water Ponds	0.6 acres	Table 45
Effective Treatment (Cuml. Area)	3.8 acres	Table 45
General Hydrologic Soil Group	B; B/D; C/D	
Total # of Drainage Areas	2	Figure 17
Drainage Area	188.6 acres	
Impervious Acreage	98.2 acres	Table 45
Impervious percentage	52.0%	

Location

The North Parkers Lake subwatershed lies west of and adjacent to Fernbrook Lane, between 26th Avenue and County Road 6. The subwatershed is generally bounded to the west by Vicksburg Lane.

Background

The 1980 Storm Drainage Plan anticipated a trunk storm sewer system for drainage areas PL9 and PL10. The existing system is a series of ponds and wetlands in the upper part of the subwatershed, and a combination of pipes and open channels in the lower watershed. The system ultimately discharges to Parkers Lake east of the park entrance and north of the boat launch. An undersized sediment trap lies between the outfall and the lake.

Few significant resources exist within the North Parkers Lake Subwatershed. There are approximately 1.5 acres of high quality wetlands as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). The high quality wetland is present in PL9.

The major problem identified is at the outfall from PL10. The existing 48-inch RCP discharges into an on-line sediment trap/open channel that is undersized from a hydraulics standpoint. Under low flows, the sediment is deposited or settled out of the water column before reaching the lake. However, high flows simply flush the system clean, defeating the purpose of the treatment system. A low flow/high flow system may maximize the treatment effects at this location.

Surface water treatment

Surface water treatment potential was analyzed for the North Parkers Lake Subwatershed and associated drainage areas (Table 45 and Figure 17). Although no specific problems were noted during the preparation of this plan, the PL-10 drainage area could be considered for future treatment. The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 45. North Parkers Lake Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
PL9	52.5	3.3	3.3	-	-	4.9	1.5	-	6.3	2.8	84.2	0.5	MED
PL10	**45.7**	**2.9**	**3.4**	**-**	**-**	**0.9**	**-**	**-**	**0.9**	**0.4**	**12.9**	**3.0**	**HIGH**

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Figure 17. North Parkers Lake Subwatershed.

Back of Figure 17.

In conclusion, the North Parkers Lake Subwatershed is considered to be a high-priority for implementation of projects based on a high receiving water ranking, high treatment deficiency, and low land use change. Drainage area PL10 would benefit from additional surface water treatment. Implementation of best management practices should be closely coordinated with the BCWMC.

f. South Parkers Lake Subwatershed

Table 46. South Parkers Lake Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Bassett Creek	
Receiving Water Ranking	Medicine/High	
Treatment Deficiency	High	
Land Use Change	High	
Priority Status	**Medium**	
Receives runoff from:		Figure 18
Downstream-most water body:	N/A	Figure 18
Discharges to:	Parkers Lake	Figure 18
Exceptional Quality Wetlands	0.0 acres	Table 47
High Quality Wetlands	0.0 acres	Table 47
Medium Quality Wetlands	3.6 acres	Table 47
Low Quality Wetlands	0.0 acres	Table 47
Storm Water Ponds	0.0 acres	Table 47
Effective Treatment (Cuml. Area)	1.8 acres	Table 47
General Hydrologic Soil Group	B; B/D; A	
Total # of Drainage Areas	5	Figure 18
Drainage Area	258.2 acres	
Impervious Acreage	80.0 acres	Table 47
Impervious percentage	31.0%	

Location

The South Parkers Lake subwatershed lies directly south of Parkers Lake generally between Vicksburg Lane and I-494. A portion of this subwatershed extends south into Minnetonka.

Background

The existing system conforms very closely to the system proposed in the 1980 Storm Drainage Plan. One problem area that had been noted was severe erosion around the inflow point to Parkers Lake. This area was addressed by City staff in 2005 when a combination of storm sewer pipe and open channel with check dams was constructed to repair the channel.

Few significant resources within the South Parkers Lake Subwatershed. No high or exceptional quality wetlands exist, however, valuble areas may be identified in the Natural Resources Inventory (Appendix F).

Surface water treatment

Surface water treatment potential was analyzed for the South Parkers Lake Subwatershed and associated drainage areas (Table 47 and Figure 18). Although no specific problems were noted during the preparation of this plan, the PL15 and PL16 drainage areas could be considered for future treatment. The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 47. South Parkers Lake Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
PL14	5.3	0.3	0.3	-	-	0.5	-	-	0.5	0.2	71.3	0.1	MED
PL13	12.0	0.8	0.9	-	-	1.0	-	-	1.0	0.5	56.2	0.4	MED
PL12	9.2	0.6	0.6	-	-	2.2	-	-	2.2	1.1	187.8	0.0	LOW
PL15	14.5	0.9	0.9	-	-	-	-	-	0.0	0.0	0.0	0.9	HIGH
PL16	**39.0**	**2.5**	**3.4**	**-**	**-**	**-**	**-**	**-**	**0.0**	**0.0**	**0.0**	**3.4**	**HIGH**

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Figure 18. South Parkers Lake Subwatershed and Drainage Areas.

Back of Figure 18.

In conclusion, the South Parkers Lake Subwatershed is considered to be a high-priority for implementation of projects based on a high receiving water ranking, high treatment deficiency, and high land use change. Drainage areas PL15 and PL16 would benefit from best management practices. Implementation of best management practices should be closely coordinated with the BCWMC.

g. Parkers Lake Subwatershed

Table 48. Parkers Lake Subwatershed Characteristics.

	Characteristic	Plan Reference
Watershed	Bassett Creek	
Receiving Water Ranking	Parkers/High	
Treatment Deficiency	High	
Land Use Change	Low	
Priority Status	**High**	
Receives runoff from:	NPL/FL/SPL	Figure 19
Downstream-most water body:	Parkers Lake	Figure 19
Discharges to:	Plym Creek SW	Figure 19
Exceptional Quality Wetlands	0.0 acres	Table 50
High Quality Wetlands	4.3 acres	Table 50
Medium Quality Wetlands	0.4 acres	Table 50
Low Quality Wetlands	0.0 acres	Table 50
Storm Water Ponds	0.0 acres	Table 50
Effective Treatment (Cuml. Area)	1.3 acres	Table 50
General Hydrologic Soil Group	B	
Total # of Drainage Areas	1	Figure 19
Drainage Area	212.8 acres	
Impervious Acreage	25.1 acres	Table 50
Impervious percentage	11.8%	
Impaired Water	Parkers Lake	
Impairment	Mercury FCA	
EPA Approved TMDL	None	

Location

The Parkers Lake subwatershed lies in south central Plymouth, directly east of Shenandoah Lane and south of County Road 6.

Background

The existing system conforms very closely to the system proposed in the 1980 Storm Drainage Plan. Parkers Lake is the most significant resource in this subwatershed (Table 49). The City has a full service park facility, including a swimming beach, on the northwest side of the lake. The park has a boat launch and a public canoe rack. The park is the site of several City celebrations including "Fire and Ice" and hosts 37,000 swimmer-hours in the summer. The City owns approximately 75% of the lakeshore.

Significant resources within the Parkers Lake Subwatershed include Parkers Lake itself, approximately 4.32 acres of high quality wetlands, as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). High quality wetlands are present in PL11.

Table 49. Parkers Lake data.

Lake Data	
DNR ID:	27-0107
Public Water #:	107P
Drainage Basin Area:	1153 Acres
Lake Area	97 Acres
Drainage Basin Area to Lake Area Ratio:	11:1
Maximum Depth:	37 feet
Water Clarity:	6.9 feet
Phosphorus:	48 ppb
Chlorophyll a:	37 ppb
Winter Kill Status:	None
Park Information:	Parkers Lake Park

Abundant Aquatic Plants

Sago pondweed
Mud plantain

Exotic Aquatic Plants

Eurasian Watermilfoil

Curlyleaf pondweed

DNR Fish Management Plan
Largemouth Bass (primary)
Bluegill Sunfish (secondary)

The lake has been historically land locked. In 1981 a gravity outlet was constructed to the east (pond BC-20) which has its own pumped outlet eventually discharging to Medicine Lake. The majority of the Parkers Lake Subwatershed is served by a 96-inch storm sewer, draining the central industrial park north of the lake, and discharging into the northeast corner of the lake.

Several studies through both the City of Plymouth and the BCWMC have analyzed the water quality of Parkers Lake. The established water quality goal for Parkers Lake is to reach an in-lake phosphorous concentration of 38 µg/l.

<u>Surface water treatment</u>
Surface water treatment potential was analyzed for the Parkers Lake Subwatershed and associated drainage areas (Table 50 and Figure 19). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 50. Parkers Lake Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
PL11	**128.6**	**8.1**	**8.1**	**-**	**-**	**0.4**	**4.32**	**-**	**4.8**	**1.3**	**16.0**	**6.8**	**HIGH**

Figure 19. Parkers Lake Subwatershed

Back of Figure 19.

In conclusion, the Parkers Lake Subwatershed is considered to be a high-priority for implementation of projects based on a high receiving water ranking, high treatment deficiency, and low land use change. Improvements should be closely coordinated with the BCWMC.

Table 51. Parkers Lake Management Plan

Subject: Parkers Lake Management Plan

Purpose: Protect and preserve Parkers Lake consistent with its City ranking and water quality goals.

Goal:

1. Reduce phosphorus loadings at storm water inlet points, increase clarity and work toward an in-lake average total phosphorus concentration of 38μg/l , secchi depths greater than 4.6 feet, and chlorophyll-a concentrations below 10μg/l.
2. Work toward reaching goals as set forth in an future EPA approved TMDL Implementation Plan.

Problems:

1. Parkers Lake does not meet all lake water quality goals.
2. Parkers Lake has a substantial amount of Eurasian Watermilfoil.
3. The Parkers Lake watershed lacks surface water treatment.
4. Due to the developed nature of the Parkers Lake subwatershed, few options exist for structural BMPs.
5. Parkers Lake is listed as an impaired water.

Solutions:

1. Operate an enhanced street sweeping program.
2. Offer grant funds for shoreline restorations and other water quality BMPs.
3. Incorporate structural BMPs where feasible.
4. Study opportunities for wetland enhancements within the watershed.
5. Require surface water treatment for development and redevelopment projects which exceed 0.5 acres.
6. Discuss opportunities for aquatic vegetation management.
7. Implement any EPA approved TMDL Plan.
8. Continue implementing surface water quality monitoring.
9. Provide education to City residents on water quality.
10. Discuss the impact of sediment deltas on lake water quality.
11. Work cooperatively with the BCWMC to implement items in the BCWMC CIP including improvements to basin PL-A13 near Circle Park.

Table 52. Parkers Lake Implementation Plan

Implementation Item	Resources	Measurement	Target Date	Est. Cost
1. Operate an enhanced street sweeping program	• City staff	• Lbs. of material removed from the streets	SEE TABLE 18	SEE TABLE 18
2. Grant Funds for shoreline restorations and other water quality BMPs	• City staff • MN DNR • BCWMC	• Acreage of restored shoreline or other BMP projects.	SEE TABLE 7	SEE TABLE 7
3. Incorporate structural BMPs where feasible.	• City staff • BCWMC • Feasability study	• Number of BMPs and their modeled efficiency	SEE TABLE 5	SEE TABLE 5
4. Study opportunities for wetland enhancements within the Parkers Lake watershed	• City staff • BWSR • MN DNR • BCWMC • Feasibility Study	• Acreage of wetland enhancements	SEE TABLE 12	SEE TABLE 12
5. Require surface water treatment to NURP standards for development or redevelopment projects that exceed 0.5 acres	• City staff • Surface Water Management Plan	• Improved quality of surface water runoff	2009-2016	$0
6. Discuss opportunities for aquatic vegetation management	• City Staff • EQC • Residents	• Number of meetings	2009	$0
7. Implement any EPA approved TMDL implementation plan	• City staff • MPCA • EPA • BCWMC	• EPA approved TMDL • Implementation of items		
8. Continue implementing surface water quality monitoring	• City staff • Three Rivers Park Dist.	• Annual Water Quality Monitoring Report	SEE TABLE 16	SEE TABLE 16

9. Education	• City staff • BCWMC • Three Rivers Park Dist.	• Number of promotions and mailers	SEE TABLE 14	SEE TABLE 14
10. Discuss the impact of sediment deltas on lake water quality	• City staff • EQC • Residents	• Number of meetings	2009	$0
11. Work cooperatively with the BCWMC to implement items in their CIP.	• City staff • BCWMC	• Completed projects	2009-2016	SEE TABLE 33

h. Sunset Hills Pond/Cavanaugh Lake Subwatershed

Table 53. Sunset Hills Pond/Cavanaugh Lake Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Bassett Creek	
Receiving Water Ranking	Medicine/High	
Treatment Deficiency	High	
Land Use Change	Low	
Priority Status	**High**	
Receives runoff from:	Minnetonka	Figure 20
Downstream-most water body:	BC66	Figure 20
Discharges to:	Plym Creek SW	Figure 20
Exceptional Quality Wetlands	0.0 acres	Table 54
High Quality Wetlands	3.6 acres	Table 54
Medium Quality Wetlands	0.5 acres	Table 54
Low Quality Wetlands	0.1 acres	Table 54
Storm Water Ponds	0.0 acres	Table 54
Effective Treatment (Cuml. Area)	1.3 acres	Table 54
General Hydrologic Soil Group	B; C/D	
Total # of Drainage Areas	1	Figure 20
Drainage Area	107.4 acres	
Impervious Acreage	44.6 acres	Table 54
Impervious percentage	41.5%	

Location

The Sunset Hills Pond/Cavanaugh Lake subwatershed is located in southeastern Plymouth. The subwatershed extends south into Minnetonka. Cavanaugh Lake sits directly north of the Sunset Hill Elementary School, west of Pineview Lane and south of 5th Avenue.

Background

The existing system generally follows the improvements proposed in the 1980

Storm Drainage Plan. Sunset Hill Pond/Cavanaugh Lake was addressed in a study entitled Sunset Hills Pond (Cavanaugh Lake), North Rice Pond, South Rice Pond, Medicine Lake prepared for the BCWMC in 1995. No specific problems were noted in the subwatershed during the preparation of this plan.

Significant resources within the Sunset Hills Pond/Cavanaugh Lake Subwatershed include Cavanaugh Lake itself, approximately 3.6 acres of high quality wetlands, as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F).

Surface water treatment

Surface water treatment potential was analyzed for the Sunset Hills Pond/Cavanaugh Lake Subwatershed and associated drainage areas (Table 54 and Figure 20). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 54. Sunset Hills Pond/Cavanaugh Lake Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
BC66	**44.6**	**2.8**	**2.8**	**0.0**	**0.1**	**0.6**	**3.6**	**0.0**	**4.3**	**1.3**	**45.3**	**1.5**	**HIGH**

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Figure 20. Sunset Hill Pond/Cavanaugh Lake Subwatershed

Back of Figure 20.

In conclusion, the Sunset Hills Pond/Cavanaugh Lake Subwatershed is considered to be a high-priority for implementation of projects based on a high receiving water ranking, high treatment deficiency, and low land use change. Improvements should be closely coordinated with the Bassett Creek Watershed Management Commission.

i. Plymouth Creek Southwest Subwatershed

Table 55. Plymouth Creek Southwest Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Bassett Creek	
Receiving Water Ranking	Medicine/High	
Treatment Deficiency	High	
Land Use Change	Low	
Priority Status	**High**	
Receives runoff from:	PL11/BC66	Figure 21
Downstream-most water body:	BC44	Figure 21
Discharges to:	LPC-BC43	Figure 21
Exceptional Quality Wetlands	3.2 acres	Table 56
High Quality Wetlands	33.8 acres	Table 56
Medium Quality Wetlands	14.9 acres	Table 56
Low Quality Wetlands	4.2 acres	Table 56
Storm Water Ponds	0.5 acres	Table 56
Effective Treatment (Cuml. Area)	13.8 acres	Table 56
General Hydrologic Soil Group	B	
Total # of Drainage Areas	19	Figure 21
Drainage Area	873.7 acres	
Impervious Acreage	389.1 acres	Table 56
Impervious percentage	44.5%	

Location

The Plymouth Creek Southwest subwatershed is located in south-central Plymouth. Bounded generally to the west by I-494 and centered along a railroad grade, the Plymouth Creek Southwest subwatershed receives runoff from Parkers Lake and the Sunset Hill Pond/Cavanaugh Lake subwatersheds.

Background

Most of the existing drainage system was in place at the time the 1980 Storm Drainage Plan was prepared, including the major trunk storm sewer system that discharges under Highway 55 at the railroad grade and into the Lower Plymouth Creek Subwatershed. No specific studies related to this subwatershed were identified during plan preparation nor were any specific problem areas identified.

Significant resources within the Plymouth Creek Southwest Subwatershed include approximately 37 acres of exceptional and high quality wetlands, as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). Exceptional quality wetlands are located in drainage area BC52.

Surface water treatment

Surface water treatment potential was analyzed for the Plymouth Creek Southwest Subwatershed and associated drainage areas (Table 56 and Figure 21). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water ponding and wetland acreage/type.

Table 56. Plymouth Creek Southwest Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
BC52	25.7	1.6	1.6	-	-	1.8	3.1	3.2	8.1	1.7	103.2	0.0	LOW
BC51	8.1	0.5	0.5	-	-	0.2	2.4	-	2.6	0.7	139.0	0.0	LOW
BC50	24.6	1.6	1.6	-	0.7	-	14.3	-	15.0	4.1	262.0	0.0	LOW
BC49	43.7	2.8	2.8	-	1.1	2.9	-	-	4.0	2.3	81.7	0.5	MED
BC54	8.3	0.5	0.5	-	-	-	-	-	0.0	0.0	0.0	0.5	HIGH
BC55	34.0	2.2	3.2	-	-	-	-	-	0.0	0.0	0.0	3.2	HIGH
BC56	27.6	1.7	4.9	-	-	-	-	-	0.0	0.0	0.0	4.9	HIGH
BC53	15.5	1.0	1.0	-	-	2.3	-	-	2.3	1.1	116.4	0.0	LOW
BC65A	36.1	2.3	2.3	-	-	1.0	-	-	1.0	0.5	21.7	1.8	HIGH
BC65	11.0	0.7	0.7	-	-	0.6	2.5	-	3.0	0.9	129.2	0.0	LOW
BC64	13.5	0.9	2.6	-	-	2.0	-	-	2.0	1.0	37.1	1.7	HIGH
BC63	30.4	1.9	3.6	-	0.2	-	3.9	-	4.1	1.1	31.1	2.5	HIGH
BC62	8.1	0.5	0.5	-	-	-	-	-	0.0	0.0	0.0	0.5	HIGH
BC60	4.1	0.3	3.2	-	-	2.0	-	-	2.0	1.0	31.0	2.2	HIGH
BC59	7.6	0.5	7.6	-	-	-	7.6	-	7.6	1.9	25.0	5.7	HIGH
BC61	8.1	0.5	0.5	-	-	0.8	-	-	0.8	0.4	76.4	0.1	MED
BC57	12.2	0.8	6.6	-	-	1.4	-	-	1.4	0.7	10.6	5.9	HIGH
BC46	51.8	3.3	3.3	0.5	-	-	-	-	0.5	0.5	15.2	2.8	HIGH
BC58	5.0	0.3	9.0	-	0.1	-	-	-	0.1	0.1	0.8	9.0	HIGH
BC44	**13.7**	**0.9**	**9.8**	**-**	**2.1**	**-**	**-**	**-**	**2.1**	**1.6**	**16.1**	**8.2**	**HIGH**

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Figure 21. Plymouth Creek Southwest Subwatershed.

Back of Figure 21

In conclusion, the Plymouth Creek Southwest Subwatershed is considered to be a high-priority for implementation of projects based a high receiving water ranking, high treatment deficiency, and low land use change. In addition, the proximity to Medicine Lake strongly influences the status. Numerous drainage areas are impacted by substandard surface water treatment. Improvements should be closely coordinated with the BCWMC.

j. Lower Plymouth Creek Subwatershed

Table 57. Lower Plymouth Creek Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Bassett Creek	
Receiving Water Ranking	Medicine/High	
Treatment Deficiency	Low	
Land Use Change	Low	
Priority Status	**Medium**	
Receives runoff from:	MPC/PC SW	Figure 22
Downstream-most water body:	BC43	Figure 22
Discharges to:	Medicine Lake	Figure 22
Exceptional Quality Wetlands	0.0 acres	Table 58
High Quality Wetlands	74.4 acres	Table 58
Medium Quality Wetlands	5.9 acres	Table 58
Low Quality Wetlands	1.0 acres	Table 58
Storm Water Ponds	0.4 acres	Table 58
Effective Treatment (Cuml. Area)	20.9 acres	Table 58
General Hydrologic Soil Group	A; B	
Total # of Drainage Areas	4	Figure 22
Drainage Area	518.2 acres	
Impervious Acreage	236.4 acres	Table 58
Impervious percentage	45.6%	

Location

The Lower Plymouth Creek subwatershed lies between Medicine Lake and I-494 in southeastern Plymouth. The subwatershed is bisected northwest to southeast by Highway 55, and is on the receiving end of discharge from about two-thirds of the total contributing area to Medicine Lake. BC43 is the downstream-most water body, discharging directly to Medicine Lake.

Background

The existing system conforms very closely to the system proposed in the 1980 Storm Drainage Plan. No specific studies regarding the Lower Plymouth Creek subwatershed were identified during the preparation of this plan nor were any specific problems noted within this subwatershed.

Significant resources within the Lower Plymouth Creek Subwatershed include 74.4 acres of high quality wetland, as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). The large high quality wetland is present in BC43.

Surface water treatment

Surface water treatment potential was analyzed for the Lower Plymouth Creek Subwatershed and associated drainage areas (Table 58 and Figure 22). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 58. Lower Plymouth Creek Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
BC47	146.3	9.3	9.3	-	-	-	-	-	0.0	0.0	0.0	9.3	HIGH
BC42	40.7	2.6	11.8	-	-	2.2	-	-	2.2	1.1	9.4	10.7	HIGH
BC42A	13.2	0.8	0.8	-	1.0	3.7	-	-	4.7	2.6	307.6	0.0	LOW
BC45	9.4	0.6	0.6	-	-	-	-	-	0.0	0.0	0.0	0.6	HIGH
BC43	**26.8**	**1.7**	**13.0**	**-**	**-**	**-**	**74.4**	**-**	**74.4**	**18.6**	**142.9**	**0.0**	**LOW**

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Figure 22. Lower Plymouth Creek Subwatershed.

Back of Figure 22

In conclusion, the Lower Plymouth Creek Subwatershed is considered to be a medium-priority for implementation of projects based on a high receiving water ranking, low treatment deficiency, and low land use change. Drainage areas BC47, BC42, and BC45 would benefit from best management practices. The City of Plymouth's most recent Capital Improvements Program (2009-2013) lists a water quality pond project near West Medicine Lake Park for 2008-2009 and streambank repairs on Plymouth Creek in 2010. Improvements should be closely coordinated with the BCWMC.

k. West Medicine Lake Subwatershed

Table 59. West Medicine Lake Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Bassett Creek	
Receiving Water Ranking	Medicine/High	
Treatment Deficiency	Low	
Land Use Change	Low	
Priority Status	**Medium**	
Receives runoff from:	BC26A, BC26	Figure 23
Downstream-most water body:	Medicine Lake	Figure 23
Discharges to:	Medicine Lake	Figure 23
Exceptional Quality Wetlands	0.0 acres	Table 60
High Quality Wetlands	6.2 acres	Table 60
Medium Quality Wetlands	17.8 acres	Table 60
Low Quality Wetlands	0.0 acres	Table 60
Storm Water Ponds	0.0 acres	Table 60
Effective Treatment (Cuml. Area)	3.2 acres	Table 60
General Hydrologic Soil Group	B; C/D	
Total # of Drainage Areas	2	Figure 23
Drainage Area	193.8 acres	
Impervious Acreage	49.6 acres	Table 60
Impervious percentage	25.6%	

Location

The West Medicine Lake subwatershed lies southeast of the I-494/County Road 9 interchange, directly adjacent to the north end of Medicine Lake. Surface water treatment is provided on either side of Northwest Boulevard.

Background

The existing system conforms very closely to the system proposed in the 1980 Storm Drainage Plan. Generally, ditch-culvert systems exist where trunk storm sewers were shown in the 1980 plan. No specific studies regarding the West Medicine Lake Subwatershed were noted during the preparation of this plan.

Significant resources within the West Medicine Lake Subwatershed include 6.2 acres of high quality wetland, as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). The high quality wetlands are present in BC26 and BC26A.

Surface water treatment

Surface water treatment potential was analyzed for the West Medicine Lake Subwatershed and associated drainage areas (Table 60 and Figure 23). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 60. West Medicine Lake Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
BC26A	30.0	1.9	0.2	-	-	3.6	4.3	-	7.9	2.9	1425.0	0.0	LOW
BC26	**19.6**	**1.2**	**1.2**	**-**	**-**	**14.3**	**1.9**	**-**	**16.2**	**7.6**	**613.5**	**0.0**	**LOW**

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Figure 23. West Medicine Lake Subwatershed.

Back of Figure 23

In conclusion, the West Medicine Lake Subwatershed is considered to be a medium-priority for implementation of projects based on a high receiving water ranking, low treatment deficiency and low land use change. Improvements should be closely coordinated with the Bassett Creek Watershed Management Commission.

I. North Medicine Lake Subwatershed

Table 61. North Medicine Lake Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Bassett Creek	
Receiving Water Ranking	Medicine/High	
Treatment Deficiency	High	
Land Use Change	Low	
Priority Status	**High**	
Receives runoff from:		Figure 24
Downstream-most water body:	BC34	Figure 24
Discharges to:	Medicine Lake	Figure 24
Exceptional Quality Wetlands	19.0 acres	Table 62
High Quality Wetlands	0.0 acres	Table 62
Medium Quality Wetlands	28.1 acres	Table 62
Low Quality Wetlands	0.0 acres	Table 62
Storm Water Ponds	1.8 acres	Table 62
Effective Treatment (Cuml. Area)	15.9 acres	Table 62
General Hydrologic Soil Group	B	
Total # of Drainage Areas	9	Figure 24
Drainage Area	486.8 acres	
Impervious Acreage	207.5 acres	Table 62
Impervious percentage	42.6%	

Location

The North Medicine Lake subwatershed is located between 48th Avenue and

39th Avenue, directly north of Medicine Lake. The upper reaches of the subwatershed lie between Schmidt Lake and Curtis Lake. County Road 9 splits the subwatershed into north and south halves.

Background

The existing system conforms very closely to the system proposed in the 1980 Storm Drainage Plan. In some areas, the 1980 Storm Drainage Plan proposed trunk storm sewer has been replaced with a ditch/culvert system, particularly north of County Road 9, in BC30. No specific studies were identified during the preparation of this plan. Drainage problems existed at the County Road 9 underpass and were remedied with a capital improvement project in 2008.

Surface water treatment

Surface water treatment potential was analyzed for the North Medicine Lake Subwatershed and associated drainage areas (Table 62 and Figure 24). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Significant resources within the North Medicine Lake Subwatershed include 19.0 acres of exceptional quality wetland, as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). The exceptional quality wetlands are present in BC29 and BC34.

Table 62. North Medicine Lake Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
BC32	14.7	0.9	0.9	-	-	1.7	-	-	1.7	0.9	91.2	0.1	LOW
BC32A	6.3	0.4	0.5	-	-	4.8	-	-	4.8	2.4	499.3	0.0	LOW
BC33	4.3	0.3	0.3	-	-	7.4	-	-	7.4	3.7	1370.1	0.0	LOW
BC31	7.6	0.5	0.5	-	-	4.7	-	-	4.7	2.4	490.4	0.0	LOW
BC30	59.6	3.8	3.8	1.0	-	4.0	-	-	5.0	3.0	79.5	0.8	MED
BC25	13.1	0.8	0.8	-	-	1.6	-	-	1.6	0.8	97.7	0.0	LOW
BC28	31.2	2.0	2.0	0.2	-	1.7	-	-	1.9	1.0	52.2	1.0	MED
BC29	23.2	1.5	3.2	0.1	-	1.9	-	15.0	17.0	1.1	33.0	2.1	HIGH
BC34	**47.5**	**3.0**	**5.1**	**0.5**	**-**	**0.3**	**-**	**4.0**	**4.8**	**0.6**	**12.3**	**4.5**	**HIGH**

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Figure 24. North Medicine Lake Subwatershed

Back of Figure 24

In conclusion, the North Medicine Lake Subwatershed is considered to be a high-priority for implementation of projects based on a high receiving water ranking, high treatment deficiency and low land use change. Improvements to protect the exceptional wetland in BC88 from existing impervious surface should be closely coordinated with the Bassett Creek Watershed Management Commission.

m. Northeast Medicine Lake Subwatershed

Table 63. Northeast Medicine Lake Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Bassett Creek	
Receiving Water Ranking	Medicine/High	
Treatment Deficiency	Medium	
Land Use Change	Low	
Priority Status	**Medium**	
Receives runoff from:		Figure 25
Downstream-most water body:	BC88	Figure 25
Discharges to:	Medicine Lake	Figure 25
Exceptional Quality Wetlands	70.1 acres	Table 64
High Quality Wetlands	19.4 acres	Table 64
Medium Quality Wetlands	27.8 acres	Table 64
Low Quality Wetlands	31.0 acres	Table 64
Storm Water Ponds	1.0 acres	Table 64
Effective Treatment (Cuml. Area)	11.4 acres	Table 64
General Hydrologic Soil Group	B	
Total # of Drainage Areas	14	Figure 25
Drainage Area	662.9 acres	
Impervious Acreage	219.4 acres	Table 64
Impervious percentage	33.1%	

Location

The Northeast Medicine Lake subwatershed extends from 45th Avenue, south of Schmidt Lake to just south of 36th Avenue where it discharges to Medicine Lake. The subwatershed is generally bounded to the west by Larch Lane and extends about one-quarter mile east of Zachary Lane

Background

While the current drainage patterns generally reflect those of the 1980 Storm Drainage Plan, the existing system relies on a significant amount of open channel flow as opposed to the storm sewers proposed in the 1980 Storm Drainage Plan. No specific studies related to the subwatershed were noted during the preparation of this plan nor were any specific problems areas identified.

Surface water treatment

Surface water treatment potential was analyzed for the Northeast Medicine Lake Subwatershed and associated drainage areas (Table 64 and Figure 25). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Significant resources within the Northeast Medicine Lake Subwatershed include 70.1 acres of exceptional quality wetland, as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). The exceptional quality wetland is present in BC88.

Table 64. Northeast Medicine Lake Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
BC85	7.7	0.5	0.5	-	-	0.3	-	-	0.3	0.1	25.7	0.4	HIGH
BC86	23.7	1.5	1.9	-	-	2.9	4.2	-	7.1	2.5	133.8	0.0	LOW
BC83	4.1	0.3	0.3	0.2	-	-	-	-	0.2	0.2	77.5	0.1	MED
BC84	9.4	0.6	0.7	-	-	3.9	-	-	3.9	2.0	300.8	0.0	LOW
BC87A	3.7	0.2	0.8	-	-	0.6	-	-	0.6	0.3	35.7	0.5	HIGH
BC87	12.2	0.8	0.8	-	-	0.6	-	-	0.6	0.3	40.3	0.5	HIGH
BC82	19.3	1.2	1.2	0.2	-	2.3	-	-	2.5	1.4	112.9	0.0	LOW
BC80	14.9	0.9	0.9	-	0.4	6.6	-	-	7.0	3.6	383.6	0.0	LOW
BC80B	13.1	0.8	0.8	-	-	3.6	-	-	3.6	1.8	213.4	0.0	LOW
BC80A	9.9	0.6	0.6	-	-	3.3	-	-	3.3	1.6	262.5	0.0	LOW
BC81	28.0	1.8	2.2	0.4	-	1.1	12.4	-	13.9	4.0	179.7	0.0	LOW
BC89	15.8	1.0	1.0	-	-	0.8	2.5	-	3.2	1.0	99.6	0.0	LOW
BC90	24.1	1.5	1.5	-	2.6	-	-	-	2.6	2.0	128.8	0.0	LOW
BC88	**33.6**	**2.1**	**2.1**	**0.2**	**0.1**	**2.0**	**0.4**	**70.1**	**72.7**	**1.3**	**62.0**	**0.8**	**MED**

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Figure 25. Northeast Medicine Lake Subwatershed and Drainage Areas.

Back of Figure 25

In conclusion, the Northeast Medicine Lake Subwatershed is considered to be a medium-priority for implementation of projects based on a high receiving water ranking, medium treatment deficiency, and low land use change. Improvements should be closely coordinated with the BCWMC.

n. South Medicine Lake Subwatershed

Table 65. South Medicine Lake Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Bassett Creek	
Receiving Water Ranking	Medicine/High	
Treatment Deficiency	Low	
Land Use Change	Medium	
Priority Status	**Medium**	
Receives runoff from:		Figure 26
Downstream-most water body:	BC78	Figure 26
Discharges to:	Medicine Lake	Figure 26
Exceptional Quality Wetlands	0.0 acres	Table 66
High Quality Wetlands	81.7 acres	Table 66
Medium Quality Wetlands	35.0 acres	Table 66
Low Quality Wetlands	5.8 acres	Table 66
Storm Water Ponds	0.0 acres	Table 66
Effective Treatment (Cuml. Area)	17.1 acres	Table 66
General Hydrologic Soil Group	B; C/D	
Total # of Drainage Areas	11	Figure 26
Drainage Area	694.6 acres	
Impervious Acreage	282.5 acres	Table 66
Impervious percentage	40.7%	

Location

The South Medicine Lake subwatershed is located between Evergreen Lane on the east and Pineview Lane to the west. The subwatershed takes in runoff from Minnetonka and discharges through an open channel/culvert system under Highway 55 and into Medicine Lake.

Background

The drainage system was already in place when the 1980 Storm Drainage Plan was prepared. No specific studies relative to this subwatershed were identified during the preparation of this study. A flooding problem has been noted at the Mn DOT culvert crossings under Highway 55 just east of West Medicine Lake Drive in BC78. Currently, the City of Plymouth is coordinating with Mn DOT to replace the culvert in 2008 and provide improved water flow and flood protection in the immediate area.

Surface water treatment

Surface water treatment potential was analyzed for the South Medicine Lake Subwatershed and associated drainage areas (Table 66 and Figure 26). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Significant resources within the South Medicine Lake Subwatershed include 81.7 acres of high quality wetland, as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). The high quality wetlands are present in BC71, BC77, BC79, and BC78.

Table 66. South Medicine Lake Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
BC76	12.4	0.8	0.8	-	-	-	-	-	0.0	0.0	0.0	0.8	HIGH
BC72	10	0.6	1.4	-	-	8.1	-	-	8.1	4.1	286.5	0.0	LOW
BC68	10.9	0.7	0.7	-	0.2	1.1	-	-	1.3	0.7	103.0	0.0	LOW
BC71	42.4	2.7	2.7	-	1.9	-	22.7	-	24.7	7.1	265.7	0.0	LOW
BC74	44.7	2.8	2.8	-	-	12.9	-	-	12.9	6.4	227.6	0.0	LOW
BC77A	23.6	1.5	1.5	-	0.1	6.6	-	-	6.7	3.4	226.1	0.0	LOW
BC75A	23.3	1.5	1.5	-	1.9	-	-	-	1.9	1.4	98.3	0.0	LOW
BC75	5.7	0.4	0.4	-	0.3	3.9	-	-	4.2	2.2	564.5	0.0	LOW
BC77	22.3	1.4	1.4	-	-	-	9.7	-	9.7	2.4	172.1	0.0	LOW
BC79	54.8	3.5	3.5	-	1.3	1.3	27.5	-	30.1	8.5	245.1	0.0	LOW
BC78	**32.5**	**2.1**	**2.1**	**-**	**-**	**1.1**	**21.8**	**-**	**22.8**	**6.0**	**290.4**	**0.0**	**LOW**

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Figure 26. South Medicine Lake Subwatershed.

Back of Figure 26

In conclusion, the South Medicine Lake Subwatershed is considered to be a medium-priority for implementation of projects based on a high receiving water ranking, low treatment deficiency and medium land use change. The City of Plymouth's most recent Capital Improvements Program (2009-2013) lists a surface water improvement project to increase water flow within this subwatershed for 2009. Improvements should be closely coordinated with the Bassett Creek Watershed Management Commission.

o. Medicine Lake Subwatershed

Table 67. Medicine Lake Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Bassett Creek	
Receiving Water Ranking	Medicine/High	
Treatment Deficiency	High	
Land Use Change	Low	
Priority Status	**High**	
Receives runoff from:	LPC, WML. NML NEML, & SML	Figure 27
Downstream-most water body:	BC78	Figure 27
Discharges to:	Bassett Creek	Figure 27
Exceptional Quality Wetlands	28.2 acres	Table 69
High Quality Wetlands	0.0 acres	Table 69
Medium Quality Wetlands	30.9 acres	Table 69
Low Quality Wetlands	1.7 acres	Table 69
Storm Water Ponds	0.8 acres	Table 69
Effective Treatment (Cuml. Area)	10.3 acres	Table 69
General Hydrologic Soil Group	NA	
Total # of Drainage Areas	11	Figure 27
Drainage Area	1920.4 acres	
Impervious Acreage	385.8 acres	Table 69
Impervious percentage	20.0%	

Impaired Water	Medicine Lake
Impairment	Nutrients
	Mercury FCA
EPA Approved TMDL	None

Location

The Medicine Lake subwatershed is located in southeast Plymouth. It is the largest lake in the City and Plymouth Creek is the main inlet into the lake. Medicine Lake serves as the headwaters to Bassett Creek.

Background

The drainage system generally conforms to the proposed system presented in the 1980 Storm Drainage Plan. Medicine Lake is the most significant resource within this subwatershed (Table 68). Medicine Lake is a heavily used recreational water body, with residents, neighbors and visitors using the trails, parks, and beaches located along the shores of the Lake. Stakeholders include the City of Plymouth, Army Corps of Engineers, Minnesota Department of Natural Resources, Bassett Creek Watershed Management Commission, Minnesota Pollution Control Agency, 224 households of the Association of Medicine Lake Area Citizens (AMLAC), City residents, and others.

Medicine Lake is currently listed as an impaired water for excess nutrients. A total maximum daily load plan for phosphorous loading is currently under development through the Minnesota Pollution Control Agency.

Table 68. Medicine Lake data.

Lake Data	
DNR ID:	27-0104
Public Water #:	104P
Drainage Basin Area:	10,946 Acres
Lake Area	898 Acres
Drainage Basin Area to Lake Area Ratio:	12:1
Maximum Depth:	49 feet

Water Clarity:	4.4 feet
Phosphorus:	60 ppb (2007)
Chlorophyll a:	35 ppb (2007)
Winter Kill Status:	None
Park Information:	Clifton E. French Park East Medicine Lake Park West Medicine Lake Park

Abundant Aquatic Plants
Canada Waterweed
Flatstem Pondweed
Wild Celery
Coontail
Northern Watermilfoil
Sago Pondweed

Exotic Aquatic Plants
Eurasian Watermilfoil
Curlyleaf pondweed
Purple Loosestrife

DNR Fish Management Plan
Largemouth Bass, Northern Pike (primary)
Bluegill Sunfish, Black Crappie (secondary)

The BCWMC recognizes Medicine lake as one of the most important resources in the watershed and the need to establish a long-term plan to improve its water quality. Water quality goals were first established in 1974 and have continued to be refined since. Commission-proposed improvements in Medicine Lake include, but are not limited to, a rough fish barrier, water quality ponding, and herbicide treatments of Curlyleaf pondweed.

Water quality monitoring of Medicine Lake is substantial. Records of water quality monitoring date back over 30 years. Currently, water quality monitoring is completed by the City of Plymouth through the Three Rivers Park District. Monitoring includes eleven (11) stream monitoring sites and one (1) in-lake monitoring station. Data collected includes flow, TSS, phosphorous, nitrogen, secchi depth, chlorophyll a, among others.

Numerous problems exist within the Medicine Lake Watershed, preventing the achievement of water quality goals. Erosion problems exist at County Road 9/61 intersection, Wood Creek, Timber Creek, and Plymouth Creek. The water quality at the mouth of Plymouth Creek is poor and could be improved. The watershed is substantially developed and new requirements should be placed on development and redevelopment to reduce the volume, TSS, and phosphorus discharge from upstream.

<u>Surface water treatment</u>

Surface water treatment potential was analyzed for the Medicine Lake Subwatershed and associated drainage areas (Table 69 and Figure 27). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Significant resources within the Medicine Lake Subwatershed include 28.2 acres of exceptional quality wetland, as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). The exceptional quality wetland is in BC35.

Table 69. Medicine Lake Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
BC38	10.4	0.7	0.7	-	-	1.0	-	-	1.0	0.5	74.2	0.2	MED
BC95	43.4	2.7	2.7	-	-	18.6	-	-	18.6	9.3	339.3	0.0	LOW
BC96A	10.5	0.7	0.7	-	-	-	-	-	0.0	0.0	0.0	0.7	HIGH
BC98	28.0	1.8	2.4	-	-	-	-	-	0.0	0.0	0.0	2.4	HIGH
BC93	15.1	1.0	1.0	-	0.3	-	-	-	0.3	0.2	22.8	0.7	HIGH
BC91	31.2	2.0	2.0	0.8	-	-	-	-	0.8	0.8	39.0	1.2	HIGH
BC94	28.2	1.8	3.7	-	0.9	0.5	-	-	1.5	1.0	25.8	2.8	HIGH
BC96	31.7	2.0	2.0	-	-	4.7	-	-	4.7	2.3	117.0	0.0	LOW
BC92	11.6	0.7	0.7	-	0.4	1.3	-	-	1.7	0.9	127.8	0.0	LOW
BC99	14.5	0.9	0.9	-	-	-	-	-	0.0	0.0	0.0	0.9	HIGH
BC35	**161.3**	**10.2**	**16.5**	**-**	**0.1**	**4.7**	**-**	**28.2**	**33.0**	**2.4**	**14.6**	**14.1**	**HIGH**

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Figure 27. Medicine Lake Subwatershed

Back of Figure 27

In conclusion, the Medicine Lake Subwatershed is considered to be a high-priority for implementation of projects based on a high receiving water ranking, high treatment deficiency and low land use change. Priority for improvements should be where there are obvious issues such as streambank erosion and curlyleaf pondweed. The City of Plymouth's most recent Capital Improvements Program (2009-2013) lists an erosion repair project for Timber Creek. Medicine Lake has a high degree of public use and improvements should be closely coordinated with the Bassett Creek Watershed Management Commission.

Table 70. Medicine Lake Management Plan

Subject:	Medicine Lake Management Plan
Purpose:	Protect and preserve Medicine Lake consistent with its City ranking and water quality goals.
Goal:	1. Increase clarity and work toward an in-lake average total phosphorus concentration of 38μg/l , secchi depths greater than 4.6 feet, and chlorophyll-a concentrations below 10μg/l. 2. Work toward reaching goals as set forth in any future EPA approved TMDL Implementation Plan.

Problems:

1. Medicine Lake does not meet all lake water quality goals.
2. Medicine Lake has a substantial amount of aquatic invasive species.
3. The Medicine Lake watershed lacks surface water treatment.
4. Due to the developed nature of the Medicine Lake subwatershed, few options exist for structural BMPs.
5. Medicine Lake is listed as an impaired water.

Solutions:

1. Operate an enhanced street sweeping program.
2. Offer grant funds for shoreline restorations and other water quality BMPs.
3. Incorporate structural BMPs where feasible.
4. Study opportunities for wetland enhancements within the watershed.
5. Require surface water treatment for development and redevelopment projects which exceed 0.5 acres.
6. Discuss opportunities for aquatic vegetation management.
7. Implement any EPA approved TMDL Plan.
8. Continue implementing surface water quality monitoring.
9. Provide education to City residents on water quality.
10. Discuss the impact of sediment deltas on lake water quality.
11. Work cooperatively with the BCWMC to implement items in the BCWMC CIP.
12. Evaluate the effect of rough fish on Medicine Lake.

Table 71. Medicine Lake Implementation Plan

Implementation Item	Resources	Measurement	Target Date	Est. Cost
1. Operate and enhanced street sweeping program	• City staff	• Lbs. of material removed from the street	SEE TABLE 18	SEE TABLE 18
2. Grant Funds for shoreline restorations and other water quality BMPs	• City staff • MN DNR • BCWMC	• Acreage of restored shoreline or other BMP projects.	SEE TABLE 7	SEE TABLE 7
3. Incorporate structural BMPs where feasible.	• City staff • BCWMC • Feasability study	• Number of BMPs and their modeled efficiency	SEE TABLE 5	SEE TABLE 5
4. Study opportunities for wetland enhancements within the Medicine Lake watershed	• City staff • BWSR • MN DNR • BCWMC • Feasibility Study	• Acreage of wetland enhancements	SEE TABLE 12	SEE TABLE 12
5. Require surface water treatment to NURP standards for development or redevelopment projects that exceed 0.5 acres	• City staff • Surface Water Management Plan	• Improved quality of surface water runoff	2009-2016	$0
6. Discuss opportunities for aquatic vegetation management	• City Staff • EQC • Residents	• Number of meetings	2009	$0
7. Implement any EPA approved TMDL implementation plan	• City staff • MPCA • EPA • BCWMC	• EPA approved TMDL • Implementation of items		
8. Continue implementing surface water quality monitoring	• City staff • Three Rivers Park Dist.	• Annual Water Quality Monitoring Report	SEE TABLE 16	SEE TABLE 16

9. Education	• City staff • BCWMC • Three Rivers Park Dist.	• Number of promotions and mailers	SEE TABLE 14	SEE TABLE 14
10. Discuss the impact of sediment deltas on lake water quality	• City staff • EQC • Residents	• Number of meetings	2009	$0
11. Work cooperatively with the BCWMC to implement items in their CIP.	• City staff • BCWMC	• Completed projects	2009-2016	SEE TABLE 33
12. Fish survey	• MN DNR	• Fish survey	2009	SEE TABLE 22

p. Bassett Creek Subwatershed

Table 72. Bassett Creek Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Bassett Creek	
Receiving Water Ranking	Low	
Treatment Deficiency	Low	
Land Use Change	High	
Priority Status	**Medium**	
Receives runoff from:	Medicine Lake	Figure 28
Downstream-most water body:	BC105	Figure 28
Discharges to:	Golden Valley	Figure 28
Exceptional Quality Wetlands	0.0 acres	Table 73
High Quality Wetlands	50.0 acres	Table 73
Medium Quality Wetlands	25.1 acres	Table 73
Low Quality Wetlands	3.8 acres	Table 73
Storm Water Ponds	4.1 acres	Table 73
Effective Treatment (Cuml. Area)	17.1 acres	Table 73
General Hydrologic Soil Group	NA	
Total # of Drainage Areas	8	Figure 28
Drainage Area	703.4 acres	
Impervious Acreage	312.7 acres	Table 73
Impervious percentage	44.4%	
Impaired Water	Bassett Creek	
Impairment	Fish IBI	
	Fecal Coliform	

Location

The Bassett Creek subwatershed is located in the southeastern corner of Plymouth. Medicine Lake is the headwater for Bassett Creek that drains southeasterly through Golden Valley and Minneapolis to the Mississippi River.

Background

The existing drainage system was generally in-place when the 1980 Storm Drainage Plan was written. No specific studies were noted during the preparation of this plan, however Bassett Creek is listed as an impaired water by the State of Minnesota. Stream monitoring will be conducted in 2008. It may be necessary to complete a total maximum daily load plan for an aquatic life impairment.

Significant resources within the Bassett Creek Subwatershed include 99.1 acres of exceptional and high quality wetland, as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). The exceptional and high quality wetlands are present in BC102, BC105, and BC106.

Surface water treatment

Surface water treatment potential was analyzed for the Bassett Creek Subwatershed and associated drainage areas (Table 73 and Figure 28). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 73. Bassett Creek Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
BC101	19.2	1.2	1.2	-	-	-	-	-	0.0	0.0	0.0	1.2	HIGH
BC102	105.5	6.7	7.9	0.2	2.6	13.6	-	49.1	65.5	8.9	113.0	0.0	LOW
BC103	56.8	3.6	3.6	2.7	0.6	8.1	-	-	11.4	7.2	199.6	0.0	LOW
BC102A	9.6	0.6	0.6	-	-	-	-	-	0.0	0.0	0.0	0.6	HIGH
BC104	45.0	2.8	3.5	-	0.7	3.4	-	-	4.1	2.2	63.7	1.3	MED
BC105	**22.1**	**1.4**	**2.6**	**-**	**-**	**-**	**13.3**	**-**	**13.3**	**3.3**	**125.9**	**0.0**	**LOW**
BC106	**20.3**	**1.3**	**1.3**	**-**	**-**	**-**	**36.7**	**-**	**36.7**	**9.2**	**715.2**	**0.0**	**LOW**
BC107	**34.4**	**2.2**	**2.2**	**-**	**-**	**-**	**-**	**-**	**0.0**	**0.0**	**0.0**	**2.2**	**HIGH**

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Figure 28. Bassett Creek Subwatershed and Drainage Areas.

Back of Figure 28.

In conclusion, the Bassett Creek Subwatershed is considered to be a medium-priority for implementation of projects based on a low receiving water ranking, low treatment deficiency and high land use change. Additional treatment is needed along the Highway 55 corridor, especially in BC106 and BC107. The City's most recent Capital Improvements Program (2009-2013) lists a drainage repair project near the Hedberg Aggregate site in 2010. Bassett Creek is also listed as in impaired water. Improvements should be closely coordinated with the BCWMC.

q. Lost Lake Subwatershed

Table 74. Lost Lake Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Bassett Creek	
Receiving Water Ranking	Low	
Treatment Deficiency	High	
Land Use Change	Low	
Priority Status	**Medium**	
Receives runoff from:		Figure 29
Downstream-most water body:	Lost Lake	Figure 29
Discharges to:	North Branch	Figure 29
Exceptional Quality Wetlands	0.0 acres	Table 75
High Quality Wetlands	0.0 acres	Table 75
Medium Quality Wetlands	0.0 acres	Table 75
Low Quality Wetlands	0.0 acres	Table 75
Storm Water Ponds	0.0 acres	Table 75
Effective Treatment (Cuml. Area)	0.0 acres	Table 75
General Hydrologic Soil Group	B	
Total # of Drainage Areas	1	Figure 29
Drainage Area	51.6 acres	
Impervious Acreage	15.9 acres	Table 75
Impervious percentage	30.8%	

Location

The Lost Lake subwatershed is located directly southeast of the Zachary Lane/County Road 9 intersection in east-central Plymouth.

Background

The drainage system generally conforms to the 1980 Storm Drainage Plan. The Lost Lake outlet, along the south side of County Road 9 is a combination of pipe and open channel. The Lost Lake Watershed and Lake Management Plan was prepared for the Bassett Creek Watershed Management Commission in 1996. The report concludes that structural BMPs intended to improve lake quality are not practical or cost effective. The lake has a low watershed area to lake area ratio (39 acres to 22 acres) which usually indicates the potential for good water quality. With a maximum depth of only 6.5 feet and a mean depth of 3.5, the recreation opportunities are somewhat limited. No specific problems were noted during preparation of this plan other than poor water quality.

Surface water treatment

Surface water treatment potential was analyzed for the Lost Lake Subwatershed and associated drainage areas (Table 75 and Figure 29). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Significant resources within the Lost Lake Subwatershed include Lost Lake itself and adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). No wetlands are documented within this subwatershed.

Table 75. Lost Lake Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
NB9	**15.9**	**1.0**	**1.0**	**-**	**-**	**-**	**-**	**-**	**0.0**	**0.0**	**0.0**	**1.0**	**HIGH**

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Figure 29. Lost Lake Subwatershed

Back of Figure 29.

In conclusion, the Lost Lake Subwatershed is considered to be a medium-priority for implementation of projects based on a low receiving water ranking, high treatment deficiency and low land use change. Due to past efforts by the Homeowners Association and the BCWMC, the priority status supports activities in this subwatershed based, in part, on recommendations set forth in the Lost Lake Watershed and Lake Management Plan. Improvements should be closely coordinated with the BCWMC.

Table 76. Lost Lake Management Plan

Subject:	Lost Lake Management Plan
Purpose:	Protect and preserve Lost Lake consistent with its water quality goals.
Goal:	1. Reduce phosphorus loadings at storm water inlet points, increase clarity and work toward an in-lake average total phosphorus concentration of 38-60 μg/l , secchi depths 2.4-4.6 feet, and chlorophyll-a concentrations within 10-30 μg/l. 2. Work toward reaching goals set forth by the MPCA and BCWMC (Level II). 3. Work toward reaching goals as set forth in an future EPA approved TMDL Implementation Plan.

Problems:

1. Lost Lake lacks historical water quality monitoring and it is undetermined if it meets all lake water quality goals.
2. Due to the developed nature of the Lost Lake subwatershed, few options exist for structural BMPs.

Solutions:

1. Operate an enhanced street sweeping program.
2. Incorporate structural BMPs where feasible.
3. Study opportunities for wetland enhancements within the watershed.
4. Require surface water treatment for development and redevelopment projects which exceed 0.5 acres.

5. Discuss opportunities for aquatic vegetation management.
6. Implement any EPA approved TMDL Plan.
7. Implement surface water quality monitoring.
8. Provide education to City residents on water quality.

Table 77. Lost Lake Implementation Plan

Implementation Item	Resources	Measurement	Target Date	Est. Cost
1. Operate an enhanced street sweeping program	• City staff	• Lbs. of material removed from the streets	SEE TABLE 18	SEE TABLE 18
2. Incorporate structural BMPs where feasible.	• City staff • BCWMC • Feasability study	• Number of BMPs and their modeled efficiency	SEE TABLE 5	SEE TABLE 5
3. Study opportunities for wetland enhancements within the Parkers Lake watershed	• City staff • BWSR • MN DNR • BCWMC • Feasibility Study	• Acreage of wetland enhancements	SEE TABLE 12	SEE TABLE 12
4. Require surface water treatment to NURP standards for development or redevelopment projects that exceed 0.5 acres	• City staff • Surface Water Management Plan	• Improved quality of surface water runoff	2009-2016	$0
5. Discuss opportunities for aquatic vegetation management	• City Staff • EQC • Residents	• Number of meetings	2009	$0
6. Implement any EPA approved TMDL implementation plan	• City staff • MPCA • EPA • BCWMC	• EPA approved TMDL • Implementation of items		
7. Implementing surface water quality monitoring	• City staff • Three Rivers Park Dist.	• Annual Water Quality Monitoring Report	SEE TABLE 16	SEE TABLE 16
8. Education	• City staff • BCWMC • Three Rivers Park Dist.	• Number of promotions and mailers	SEE TABLE 14	SEE TABLE 14

r. North Branch Subwatershed

Table 78. North Branch Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Bassett Creek	
Receiving Water Ranking	Low	
Treatment Deficiency	High	
Land Use Change	Low	
Priority Status	**Medium**	
Receives runoff from:	Lost Lake	Figure 30
Downstream-most water body:	NB7	Figure 30
Discharges to:	New Hope	Figure 30
Exceptional Quality Wetlands	21.1 acres	Table 79
High Quality Wetlands	2.9 acres	Table 79
Medium Quality Wetlands	18.0 acres	Table 79
Low Quality Wetlands	1.8 acres	Table 79
Storm Water Ponds	0.0 acres	Table 79
Effective Treatment (Cuml. Area)	8.9 acres	Table 79
General Hydrologic Soil Group	NA	
Total # of Drainage Areas	13	Figure 30
Drainage Area	784.4 acres	
Impervious Acreage	344.1 acres	Table 79
Impervious percentage	43.9%	

Location

The North Branch subwatershed is located in east-central Plymouth, between Zachary Lane and Highway 169, north of 35th Avenue and centered about County Road 9. The subwatershed discharges east toward New Hope.

Background

The North Branch Subwatershed is named after the North Branch of Bassett

Creek. The existing system south of County Road 9 was in place when the 1980 Storm Drainage Plan was prepared. North of County Road 9, the in-place system generally conforms to the 1980 Storm Drainage Plan, substituting ditch/culvert systems for the trunk storm sewers shown in the 1980 Storm Drainage Plan. A small pond and skimmer structure were installed near the corner of Larch Lane and 45th No specific studies were identified during the preparation of this plan nor were any specific problem areas noted.

Significant resources within the North Branch Subwatershed include 24 acres of exceptional and high quality wetland, as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). The exceptional quality wetland is located in NB3.

<u>Surface water treatment</u>

Surface water treatment potential was analyzed for the North Branch Subwatershed and associated drainage areas (Table 79 and Figure 30). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type. Currently, the City of Plymouth requires pre-treatment of surface water prior to discharge into any wetlands, which is intended to further protect water quality.

Table 79. North Branch Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
NB1	16.7	1.1	1.1	-	-	1.1	-	-	1.1	0.5	49.6	0.5	HIGH
NB2	18.3	1.2	1.7	-	-	0.7	0.5	-	1.2	0.5	28.6	1.2	HIGH
NB4	38.2	2.4	2.4	-	-	0.2	-	-	0.2	0.1	3.5	2.3	HIGH
NB3	41.1	2.6	6.1	-	-	-	-	21.1	21.1	0.0	0.0	6.1	HIGH
NB5	10.3	0.7	6.8	-	-	5.7	-	-	5.7	2.8	41.8	4.0	HIGH
NB6	22.5	1.4	1.4	-	-	0.4	-	-	0.4	0.2	13.0	1.2	HIGH
NB8	4.7	0.3	5.5	-	-	0.8	-	-	0.8	0.4	7.6	5.1	HIGH
NB15	10.3	0.7	0.7	-	-	-	-	-	0.0	0.0	0.0	0.7	HIGH
NB14	16.4	1.0	1.7	-	-	-	-	-	0.0	0.0	0.0	1.7	HIGH
NB13	40.8	2.6	2.6	-	-	-	-	-	0.0	0.0	0.0	2.6	HIGH
NB10	20.3	1.3	1.3	-	-	0.4	-	-	0.4	0.2	14.0	1.1	HIGH
NB12	42.3	2.7	2.7	-	-	0.2	2.4	-	2.6	0.7	26.5	2.0	HIGH
NB7	**62.2**	**3.9**	**16.4**	**-**	**1.8**	**8.6**	**-**	**-**	**10.3**	**5.6**	**34.3**	**10.7**	**HIGH**

Figure 30. North Branch Subwatershed

Back of Figure 30

In conclusion, the North Branch Subwatershed is considered to be a medium-priority for implementation of projects based on a low receiving water ranking, high treatment deficiency and low land use change. Additional treatment should focus up stream of NB3 where the exceptional quality wetland exists. The City of Plymouth's most recent Capital Improvements Program (2009-2013) lists a surface water drainage improvement project for the 45th Avenue/Nathan Lane. Improvements should be closely coordinated with the BCWMC.

C ELM CREEK WATERSHED

Elm Creek drains the mostly undeveloped northwestern part of the City. Approximately 4,000 acres from Medina contribute runoff to Elm Creek before it enters Plymouth. The Elm Creek Watershed covers over 109 square miles in northwestern Hennepin County. As this area begins to develop, the drainage plans for the two cities will have to be coordinated to adequately provide for conveyance of the projected large amount of runoff.

Elm Creek flows northeasterly into Plymouth, from Medina under Highway 55 just east of County Road 101. Elm Creek continues in a northeasterly direction, crossing under Peony Lane/Troy Lane before turning north through a wide (2 mile) flood plain and crossing under County Road 47 into Maple Grove. Lake Camelot, located in the extreme southeast corner of the watershed, south of County Road 47 and just west of Interstate 494, is the most significant water body in that portion of the watershed within Plymouth.

1. ELM CREEK WATERSHED MANAGEMENT ORGANIZATION

The Elm Creek Watershed Management Commission (ECWMC) is made up of the Cities of Champlin, Corcoran, Dayton, Maple Grove, Medina, Plymouth, Rogers, and Hassan through a “Joint Powers Agreement” most recently amended and adopted in 2004. The purpose of the ECWMO is to:

- Protect, preserve, and use the natural surface and groundwater storage and retention systems;
- Minimize public capital expenditures needed to correct flooding and water quality problems;
- Identify and plan for means to effectively protect and improve surface and groundwater quality;
- Establish more uniform local policies and official controls for surface and groundwater management:
- Prevent erosion of soil into surface water systems;
- Promote groundwater recharge;

- Protect and enhance fish and wildlife habitat and water recreational facilities;
- Secure the other benefits associated with the proper management of surface and groundwater, as identified in Minn. Stat. 103B.201.

2. SUBWATERSHEDS

The Plymouth portion of the Elm Creek Watershed includes two subwatersheds (Figure 31):

- Elm Creek
- Lake Camelot

The subwatersheds are based on receiving waters or on the amount of anticipated land use change to occur in the future. Each subwatershed has been further divided into numerous drainage areas that generally correspond to the 1980 drainage plan. Each identified drainage area includes at least one pond, wetland or water body that receives storm water. When more than one water body is identified within a drainage area, it is probable that there are no City records available that indicate the contributing area to each water body.

For each subwatershed, a corresponding table and figure describes the drainage, wetland classes, and the treatment potential based on the amount of ponding available. Within the table, the drainage area treatment status column is the ratio of effective treatment to the required ponding for the direct tributary drainage area. The treatment deficiency column illustrates when the required ponding exceeds the effective acreage, indicating the need for additional treatment. Additionally, the treatment deficiency column carries downstream into the next drainage area by adding to the required ponding in the downstream drainage area. The total required ponding is the sum of the required drainage area ponding and upstream ponding deficiencies.

Because treatment deficiency within each subwatersehd only accounts for ponding, consideration will need to be given to "pre-treatment", Wetland Conservation Act, and other best management practice requirements which are current policies or regulations when assessing the actual treatment deficiency of a drainage area. Currently, the City of Plymouth requires pre-treatment of surface water prior to discharge into any wetlands, which is intended to further protect water quality.

Historic floods in the watershed occurred in April of 1965 and June of 1974. The WMO completed hydrologic modeling of the watershed with the Soil Conservation Service TR-20 model and analyzed flood profiles using HEC-2. Model results yielded peak flow rates for Elm Creek in Plymouth (Table 80). In 2001, a large portion of the Lake Camelot Subwatershed was included in a Hydrologic and Hydraulic Study by the City of Plymouth in 2001. Additionally, in 2007 the Elm Creek Watershed Management Commission (ECWMC) completed a channel study which has led to more restrictive volume regulations for development and re-development.

Table 80. Elm Creek Flows in Plymouth (HSWCD, 1988)

Location	Tributary Area	Peak Flow Rate
STH-55 – Medina	6.83 sq. mi.	365 cfs
Above Co. Rd. 47 – Plymouth	11.17 sq. mi.	535 cfs

Figure 31. Elm Creek Subwatersheds in Plymouth

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a. Elm Creek Subwatershed

Table 81. Elm Creek Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Elm Creek	
Receiving Water Ranking	Low	
Treatment Deficiency	Low	
Land Use Change	Medium	
Priority Status	**Low**	
Receives runoff from:	Medina	Figure 32
Downstream-most water body:	EC21	Figure 32
Discharges to:	Maple Grove	Figure 32
Exceptional Quality Wetlands	16.1 acres	Table 82
High Quality Wetlands	315.9 acres	Table 82
Medium Quality Wetlands	141.7 acres	Table 82
Low Quality Wetlands	31.9 acres	Table 82
Storm Water Ponds	13.1 acres	Table 82
Effective Treatment (Cuml. Area)	24.5 acres	Table 82
General Hydrologic Soil Group	B	
Total # of Drainage Areas	21	Figure 32
Drainage Area	2597.6	
Impervious Acreage	422.8 acres	Table 82
Impervious percentage	16.3%	

Location

The Elm Creek Subwatershed is located in northwestern Plymouth. It is generally bounded by the City limits to the north and west, and in a diagonal line from where Highway 55 enters Medina and Interstate 494 enters Maple Grove.

Background

Little of the 1980 Storm Drainage Plan has been implemented due to minimal development. The major features of the 1980 Storm Drainage Plan in this subwatershed are the water level control dikes for EC10, EC16, EC18, EC23, and EC24. The flood control concept behind the 1980 Storm Drainage Plan is still valid; however, the current wetland regulations likely prohibit implementation of the 1980 Storm Drainage Plan. Therefore, controls on land development density and on-site detention are necessary to limit runoff to existing levels. The City of Plymouth continues to pursue land acquisition for the Northwest Greenway when properties become available. Recently, land was purchased in area EC16. More restrictive volume controls were adopted upon the completion of the Elm Creek Channel Study in 2007.

Surface Water Treatment

Surface water treatment potential was analyzed for the Elm Creek Subwatershed and associated drainage areas (Table 82 and Figure 32). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Significant resources within the Elm Creek Subwatershed include approximately 16 acres of wetland classified as exceptional (EC15, EC16, and EC23) and adjacent natural areas as identified in the Natural Resources Inventory (Appendix F).

Table 82. Elm Creek Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status	Treat. Defic. (Ac)	Treat. Defic. Value
EC1	42.0	2.7	2.7	-	1.5	43.7	-	-	45.2	23.0	852.0	0.0	LOW
EC2	29.9	1.9	1.9	-	27.9	3.5	-	-	31.4	22.7	1197.2	0.0	LOW
EC3	19.3	1.2	1.2	0.8	-	0.4	6.4	-	7.5	2.5	207.9	0.0	LOW
EC7	6.8	0.4	0.4	0.5	-	9.3	2.5	-	12.4	5.8	1450.0	0.0	LOW
EC9	6.6	0.4	0.4	0.7	-	0.5	6.3	-	7.4	2.5	599.4	0.0	LOW
EC11	22.3	1.4	1.4	-	-	-	3.7	-	3.7	0.9	65.2	0.5	MED
EC10	54.9	3.5	4.0	1.4	-	0.5	0.5	-	2.4	1.8	44.4	2.2	HIGH
EC8	5.7	0.4	0.4	6.9	0.0	1.6	5.1	-	13.6	9.0	2250.6	0.0	LOW
EC12	12.2	0.8	0.8	-	-	3.6	188.5	-	192.1	48.9	6342.4	0.0	LOW
EC13	12.6	0.8	0.8	1.0	-	0.2	11.7	-	12.9	4.0	500.9	0.0	LOW
EC14	15.3	1.0	1.0	-	-	7.2	-	-	7.2	3.6	371.0	0.0	LOW
EC15	20.2	1.3	1.3	0.5	-	1.9	-	1.5	4.0	1.5	114.2	0.0	LOW
EC17	20.9	1.3	1.3	-	0.6	12.4	2.5	-	15.5	7.3	561.2	0.0	LOW
EC18	40.5	2.6	2.6	-	-	4.7	51.6	-	56.2	15.2	593.7	0.0	LOW
EC22	7.7	0.5	0.5	-	0.2	1.2	6.1	-	7.4	2.3	452.5	0.0	LOW
EC16	61.1	3.9	6.1	1.3	0.6	9.5	28.9	1.4	41.8	13.7	226.1	0.0	LOW
EC21	**5.9**	**0.4**	**0.4**	**-**	**-**	**14.3**	**-**	**-**	**14.3**	**7.2**	**1918.8**	**0.0**	**LOW**
EC23	18.4	1.2	1.2	-	-	6.4	-	13.1	19.5	3.2	265.8	0.0	LOW
EC24	**5.1**	**0.3**	**0.3**	**-**	**-**	**0.6**	**0.8**	**-**	**1.3**	**0.5**	**143.7**	**0.0**	**LOW**
EC20	**9.1**	**0.6**	**0.6**	**-**	**-**	**17.0**	**-**	**-**	**17.0**	**8.5**	**1416.7**	**0.0**	**LOW**
EC25	**6.3**	**0.4**	**0.4**	**-**	**1.1**	**3.4**	**1.5**	**-**	**5.9**	**2.8**	**706.3**	**0.0**	**LOW**

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Figure 32. Elm Creek Subwatersheds in Plymouth

Back of Figure 32

In conclusion, the Elm Creek Subwatershed is considered to be a low-priority for implementation of projects to treat surface water based a low receiving water ranking, low treatment deficiency, and medium land use change. Currently, the only drainage areas deficient in surface water treatment are EC10 and EC11. Best management practices could be incorporated into these areas to aid in treatment. The City's most recent Capital Improvements Program (2009-2013) lists an erosion repair project for the Conor Meadows development in 2011. Implementation of best management practices should be closely coordinated with the ECWMC.

Table 83. Elm Creek Management Plan

Subject:	Elm Creek Watershed within Plymouth city limits
Purpose:	To control runoff impacts to Elm Creek
Goal:	The flow rate in Elm Creek shall be maintained at pre-development flow rates for the 2, 10, and 100 year rainfall events. The City will work toward the in-stream goals established by the ELWMC: TP – 250 mg/l; TSS – 25 mg/l; TN – 3 mg/l; COD – 100 mg/l. Incorporate the recommendations of the Elm Creek Channel Study (2007)

Problems:

1. Differences exist between the 1980 Storm Drainage Plan proposed ponding, flood plain or ordinance, the Wetland Conservation Act, and the 1983 flood insurance study for Elm Creek.
2. Insufficient monitoring data exists for Elm Creek within the City of Plymouth.
3. Future development may increase the pollutant loading risk to Elm Creek.
4. Treatment deficiencies in some drainage areas could result in excessive pollutant loadings to wetlands.
5. Peak flow rates and volumes continue to threaten the creek, causing excessive stream bank erosion and bottom scour.

Solutions:

1. Update the 1980 Storm Drainage Plan as necessary to meet the City's needs and to comply with current laws, rules, ordinances, and goals.
2. Continue a joint-monitoring program with the ECWMO to establish baseline conditions and total annual pollutant loading guidelines.
3. In addition to incorporation of BMPs, consider regional ponding, where feasible, to offset the impacts from future development and reduce future maintenance costs to the City.
4. Assess treatment deficiencies and analyze the potential and necessity for providing treatment where deficiencies exist.

5. Implement requirements of the Elm Creek Channel Study (2007) including extended detention requirements and pursue an average buffer width of 100 feet from the Elm Creek Channel.

Table 84. Elm Creek Implementation Plan

Implementation Item	Resources	Measurement	Target Date	Est. Cost
1. Update the 1980 Storm Drainage Plan as necessary	• 1980 Storm Drainage Plan • Development Reviews	• Updated plan	2009-2019 (@$1000/yr)	$10,000
2. Monitoring of Elm Creek	• Three Rivers Park District	• Monitoring Reports	SEE TABLE 16	SEE TABLE 16
3. Reduce pollutant loading	• Non-degradation report • ECWMC Channel Study (2007)	• No increase in TSS, P, and water volume • Protection of channel • Regional ponding • 100 foot creek buffer	2016	$0
4. Pursue grant funds	• Various regulatory agencies including MPCA, MN DNR, BWSR, etc…	• Use of porous pavement and/or other BMPs within the watershed	2016	$0

a. Lake Camelot Subwatershed

Table 85. Lake Camelot Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Elm Creek	
Receiving Water Ranking	Low	
Treatment Deficiency	Low	
Land Use Change	High	
Priority Status	**Medium**	
Receives runoff from:	LC-1	Figure 33
Downstream-most water body:	LC-3, LC-4, LC-5	Figure 33
Discharges to:	Maple Grove	Figure 33
Exceptional Quality Wetlands	33.6 acres	Table 86
High Quality Wetlands	4.6 acres	Table 86
Medium Quality Wetlands	1.3 acres	Table 86
Low Quality Wetlands	2.9 acres	Table 86
Storm Water Ponds	1.5 acres	Table 86
Effective Treatment (Cuml. Area)	2.9 acres	Table 86
General Hydrologic Soil Group	B	
Total # of Drainage Areas	5	Figure 33
Drainage Area	287.5	
Impervious Acreage	52.1 acres	Table 86
Impervious percentage	18.1%	

Location

The Lake Camelot Subwatershed is located in north central Plymouth, west of and adjacent to I-494.

Background

A large portion of the Lake Camelot Subwatershed was included in the Hydrologic and Hydraulic Study by the City of Plymouth in 2001. Water quality data (1986) from the ECWMO for Lake Camelot is as follows:

transparency was at 2.1 feet; chlorophyll a – 181 mg/l; total phosphorus – 166 mg/l; NO_3 – 230 mg/l; and NO_2 – 5 mg/l. Additionally, water quality monitoring was coordinated by the City of Plymouth and Three Rivers Park District.

Surface Water Treatment

Surface water treatment potential was analyzed for the Lake Camelot Subwatershed and associated drainage areas (Table 86 and Figure 33). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Significant resources within the Lake Camelot Subwatershed include a large, 7.8 acre exceptional wetland and adjacent natural areas as identified in the Natural Resources Inventory (Appendix F).

Table 86. Lake Camelot Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status	Treat. Defic. (Ac)	Treat. Defic. Value
LC1	9.61	0.6	0.6	0.06	-	0.3	-	25.8	26.2	0.2	35.8	0.4	HIGH
LC2	4.1	0.3	0.7	-	0.5	1.4	-	7.8	9.8	1.1	166.2	0.0	LOW
LC3	**7.3**	**0.5**	**0.5**	**-**	**-**	**21.4**	**0.1**	**-**	**21.5**	**10.7**	**2326.5**	**0.0**	**LOW**
LC4	**12.7**	**0.8**	**0.6**	**0.7**	**0.8**	**0.3**	**4.5**	**-**	**6.2**	**2.5**	**414.2**	**0.0**	**LOW**
LC5	**18.4**	**1.2**	**0.4**	**0.7**	**-**	**5.0**	**-**	**-**	**5.7**	**3.2**	**810**	**0.0**	**LOW**

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Figure 33. Lake Camelot Subwatershed.

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In conclusion, the Lake Camelot Subwatershed is considered to be a medium-priority for implementation of projects to treat surface water based on a low receiving water ranking, low treatment deficiency, and high land use change. Currently, the only drainage area deficient in surface water treatment is LC1. Best management practices could be incorporated into these areas to aid in treatment. Implementation of best management practices should be closely coordinated with the ECWMC.

Table 87. Lake Camelot Management Plan

Subject:	Lake Camelot Management Plan
Purpose:	Protect and preserve Lake Camelot consistent with its water quality goals.
Goal:	1. Reduce phosphorus loadings at storm water inlet points, increase clarity and work toward an in-lake average total phosphorus concentration of 38-60 μg/l , secchi depths 2.4-4.6 feet, and chlorophyll-a concentrations within 10-30 μg/l. 2. Work toward reaching goals as set forth in an future EPA approved TMDL Implementation Plan.

Problems:

1. Lake Camelot lacks historical water quality monitoring.
2. Lake Camelot may not meet water quality goals.

Solutions:

1. Operate an enhanced street sweeping program.
2. Incorporate structural BMPs where feasible.
3. Study opportunities for wetland enhancements within the watershed.
4. Require surface water treatment for development and redevelopment projects which exceed 0.5 acres.
5. Discuss opportunities for aquatic vegetation management.
6. Implement any EPA approved TMDL Plan.
7. Implementing surface water quality monitoring.
8. Provide education to City residents on water quality.

Table 88. Lake Camelot Implementation Plan

Implementation Item	Resources	Measurement	Target Date	Est. Cost
1. Operate an enhanced street sweeping program	• City staff	• Lbs. of material removed from the streets	SEE TABLE 18	SEE TABLE 18
2. Incorporate structural BMPs where feasible.	• City staff • BCWMC • Feasability study	• Number of BMPs and their modeled efficiency	SEE TABLE 5	SEE TABLE 5
3. Study opportunities for wetland enhancements within the Parkers Lake watershed	• City staff • BWSR • MN DNR • BCWMC • Feasibility Study	• Acreage of wetland enhancements	SEE TABLE 12	SEE TABLE 12
4. Require surface water treatment to NURP standards for development or redevelopment projects that exceed 0.5 acres	• City staff • Surface Water Management Plan	• Improved quality of surface water runoff	2009-2016	$0
5. Discuss opportunities for aquatic vegetation management	• City Staff • EQC • Residents	• Number of meetings	2009	$0
6. Implement any EPA approved TMDL implementation plan	• City staff • MPCA • EPA • BCWMC	• EPA approved TMDL • Implementation of items		
7. Implementing surface water quality monitoring	• City staff • Three Rivers Park Dist.	• Annual Water Quality Monitoring Report	SEE TABLE 16	SEE TABLE 16
8. Education	• City staff • BCWMC • Three Rivers Park Dist.	• Number of promotions and mailers	SEE TABLE 14	SEE TABLE 14

D MINNEHAHA CREEK WATERSHED

The Minnehaha Creek Watershed covers approximately 181 square miles in Hennepin and Carver Counties. The Plymouth portion of the Minnehaha Creek Watershed has been divided into eight subwatersheds.

The Minnehaha Creek basin is located in the southwestern portion of the City. The major lakes in this basin are Gleason Lake and Mooney Lake. This part of Plymouth drains south into Minnetonka and west into Medina.

Although Lake Minnetonka is a focal point, Gleason Lake and Mooney Lake are the most significant water bodies in the Plymouth portion of the Minnehaha Creek Watershed. Specific lake management plans have been prepared for both Gleason and Mooney Lakes. Pertinent data for these lakes and other major water bodies is included in the subwatershed descriptions.

1. MINNEHAHA CREEK WATERSHED DISTRICT

Since its formation on March 9, 1967, the Minnehaha Creek Watershed District (MCWD) has managed water quality and quantity along Minnehaha Creek. The MCWD interests have broadened from it original flooding and drainage focus to address water quality with an increasing emphasis. The District overlies all or parts of 27 cities and two counties. The MCWD has most recently revised its Watershed Management Plan on July 5, 2007 and will review land development proposals for compliance with MCWD rules.

Local planning must demonstrate conformance with MCWD plans as well as the existence of official controls. Once the City has an approved plan, individual developments will satisfy the requirements of the Districts' rules by complying with the City's plan. The MCWD, however, still maintains permitting authority over development proposals consistent with their rules and regulations.

The MCWD Watershed Management Plan included several specific local plan requirements for Plymouth including phosphorus load reductions, landlocked basin identification, flooding or modeled high water locations, flow velocity and erosion identification, and land conservation. Additionally, City of Plymouth and MCWD staff should meet annually to review cooperative opportunities for projects in the watershed.

a. Phosphorus Load Reduction

Two subwatersheds in Plymouth encompassing four annual load reductions are identified by the MCWD. The MCWD identifies Plymouth for a load reduction of 10 lbs in the MCWD Minnehaha Creek subwatershed and a load reduction of 146 lbs in the MCWD Gleason Lake subwatershed. The Minnehaha Creek subwatershed corresponds to the City of Plymouth's Minnetonka subwatershed and the Gleason Lake Subwatershed corresponds to the City of Plymouth's Gleason Lake, Dunkirk Lane, 19th Avenue, Hadley Lake, and Kreatz Lake/Snyder Lake subwatersheds. In addition to a 60% reduction in phosphorus for any new or redevelopment project greater than 0.5 acres the City has operated an enhanced street sweeping program since 2005.

Samples from street sweepings were tested by the University of Minnesota and found to contain 1.0 pounds of phosphorous per street mile per sweep. These findings are more conservative than the report "Deriving Reliable Pollutant Removal Rates for Municipal Street Sweeping and Storm Drain Cleanout Programs in the Chesapeake Bay Basin" prepared by the Center for Watershed Protection. The City of Plymouth sweeps all City streets three times each year yielding a removal of approximately 3.0 pounds of phosphorus per street mile annually. Based on the testing by the University of Minnesota, the City of Plymouth is consistent in meeting the load reduction requirements of the MCWD (Table 89).

Table 89. Enhanced street sweeping phosphorus removals within the Minnehaha Creek Watershed.

MCWD Subwatershed	Phosphorus removals
Minnehaha Creek – Lake Hiawatha	9.6 pounds
Gleason Lake – Upstram of Gleason Lake	139.5 pounds
Gleason Lake – Upstream of Hadley Lake	26.4 pounds
Gleason Lake – Downstream of Gleason/Hadley Lakes	17.4 pounds

Additionally, since 2000, the City of Plymouth has reduced impervious surface by narrowing streets in street reconstruction areas, constructed two water quality ponds, repaired erosion on County Ditch 15, completed a wetland enhancement project, constructed four rain gardens to capture street surface water runoff from area streets, worked in cooperation with the MCWD on the Gleason Lake Inlet Pond project, and offers Water Resources Grants to residents or businesses who incorporate native plants into their landscape.

The Gleason Lake Implementation Plan (Table 100) outlines future efforts, including structural best management practices, to improve the water quality of Gleason Lake and to further reduce phosphorus loading consistent with MCWD goals. Lastly, "Housekeeping requirements" of the MCWD are described in the City's SWPPP under minimum control measure #6 (see Appendix D)

b. Landlocked Basin Identification

The MCWD Watershed Management Plan mentions two landlocked subwatershed basins that ultimately drain to Mooney Lake, along the west boundary of the City; however, the MCWD Watershed Management Plan is not more specific as to the location of these basins. City records do not indicate any landlocked basins in the area that drains to Mooney Lake.

c. Flooding or Modeled High Water Locations

The MCWD Watershed Management Plan identified five specific locations in

Plymouth where there are known or modeled flooding issues. These areas include 23rd Avenue North, County Road 6, 5th Avenue North, the trail at 27th Avenue North, and Black Oaks Lane. The City of Plymouth adopted a Pond Maintenance Policy in 2005 to address flooding issues in the City. Additionally, the City inspects the entire drainage system on a five-year cycle per NPDES MS4 permitting requirements. Flooding issues are reviewed annually and specific projects are included in the City's Capital Improvement Program where appropriate.

c. Flow Velocity and Erosion Identification

The MCWD Watershed Management Plan identified three specific locations in Plymouth where there are known or modeled flow velocity or erosion issues. These areas include the Snyder Lake Outlet, Dunkirk Lane Culvert, and County Road 6 RCP arch. Incidentally, the City plan calls out the basin on the west side of County Road 101 as Snyder Lake, and the basin on the east side of County Road 101 as Kreatz Lake. The MCWD has completed a detention pond and stream restoration just south of the County Road 6 RCP arch. As stated above, the City inspects the entire drainage system on a five-year cycle per NPDES MS4 permitting requirements. This includes erosion issues and areas in need of energy dissipaters. Issues are reviewed annually and included in the City's Capital Improvement Program where appropriate.

d. Land Conservation

The MCWD Watershed Management Plan identifies several key conservation areas in Plymouth. Most of the conservation areas are adjacent to Gleason Lake, Hadley Lake, Snyder Lake, and Kreatz Lake. In addition to acting as the local government unit (LGU) for the Wetland Conservation Act and requiring mitigation for impacts to wetlands, the City has adopted a Shoreland Management Overlay District which encompasses each of these four lakes and thus, much of the key conservation areas identified by the MCWD. The intent of the Shoreland Management Overlay District is to "guide and govern the wise development of shoreland of public waters, thus preserving and enhancing the quality of surface waters, preserving the economic and natural environmental values of shorelands, and providing for the wise utilization of water and related land resources in the City." The Shoreland Management Overlay District is consistent with the goals of the MCWD.

e. Wetlands

The MCWD completed a Functional Assessment of Wetlands in 2007. The functions of each wetland in the District were assessed using the *Minnehaha Creek Routine Assessment Method for Evaluating Wetland Functions*. The City of Plymouth had previously completed a similar functions and values assessment of wetlands within the City in 1994. The functions of each wetland in the City were assessed using the Wisconsin Rapid Assessment Method (WiRAM). Both evaluation methods consider the vegetative community, hydrologic regime, wildlife habitat, shoreline protection, aesthetics, recreation, and other wetland characteristics and both the MCWD and the City of Plymouth apply stricter protections for wetlands of a higher classification (Table 90).

Table 90. MCWD Functional Assessment of Wetlands compared to the City of Plymouth Functions and Values Assessment.

MCWD Functional Assessment of Wetlands		City of Plymouth Functions and Values Assessment
Preserve	→	Exceptional
Manage 1	→	High
Manage 2	→	Medium
Manage 3	→	Low

Generally, the classifications of the MCWD Functional Assessment of Wetlands and the City of Plymouth Functions and Values Assessment correlate well.

2. SUBWATERSHEDS

The Plymouth portion of the Minnehaha Creek Watershed includes eight subwatersheds (Figure 34):

- Kreatz Lake/Snyder Lake

- 19th Avenue
- Dunkirk Lane
- Gleason Lake
- Hadley Lake
- Medina
- Minnetonka
- Mooney Lake

The subwatersheds are based on receiving waters or on the amount of anticipated land use change to occur in the future. Each subwatershed has been further divided into numerous drainage areas that generally correspond to the 1980 drainage plan. Each identified drainage area includes at least one pond, wetland or water body that receives storm water. When more than one water body is identified within a drainage area, it is probable that there are no City records available that indicate the contributing area to each water body.

For each subwatershed, a corresponding table and figure describes the drainage, wetland classes, and the treatment potential based on the amount of ponding available. Within the table, the drainage area treatment status column is the ratio of effective treatment to the required ponding for the direct tributary drainage area. The treatment deficiency column illustrates when the required ponding exceeds the effective acreage, indicating the need for additional treatment. Additionally, the treatment deficiency column carries downstream into the next drainage area by adding to the required ponding in the downstream drainage area. The total required ponding is the sum of the required drainage area ponding and upstream ponding deficiencies.

Because treatment deficiency within each subwatersehd only accounts for ponding, consideration will need to be given to "pre-treatment", Wetland Conservation Act, and other best management practice requirements which are current policies or regulations when assessing the actual treatment deficiency of a drainage area. Currently, the City of Plymouth requires pre-treatment of surface water prior to discharge into any wetlands, which is intended to further protect water quality.

Figure 34. Minnehaha Creek Subwatersheds

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a. Kreatz Lake/Snyder Lake Subwatershed

Table 91. Kreatz Lake/Snyder Lake Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Minnehaha Creek	
Receiving Water Ranking	Gleason/Low	
Treatment Deficiency	Low	
Land Use Change	Low	
Priority Status	**Low**	
Receives runoff from:	NA	Figure 35
Downstream-most water body:	GL17	Figure 35
Discharges to:	GL-10A	Figure 35
Exceptional Quality Wetlands	3.6 acres	Table 92
High Quality Wetlands	10.8 acres	Table 92
Medium Quality Wetlands	34.8 acres	Table 92
Low Quality Wetlands	0 acres	Table 92
Storm Water Ponds	0 acres	Table 92
Effective Treatment (Cuml. Area)	7.5 acres	Table 92
General Hydrologic Soil Group	B & C/D	
Total # of Drainage Areas	6	Figure 35
Drainage Area	385.2 acres	
Impervious Acreage	108.7 acres	Table 92
Impervious percentage	28.2%	

Location

The Kreatz Lake/Snyder Lake subwatershed is located in southwestern Plymouth. The subwatershed lies generally north of 19th Avenue, south of County Road 24 and is split by State Highway 101. Snyder Lake lies on the west side of State Highway 101, while Kreatz Lake lies directly to the east.

Background

The existing drainage system for this subwatershed closely conforms to the 1980 Drainage Plan. One specific drainage problem was noted during the preparation of this plan. A drainage swale from south of 28th Avenue North and west of County Road 101 is highly eroded. The City proposes to repair this drainage swale and reduce erosion in cooperation with the construction of County Road 101 by Hennepin County.

Kreatz Lake is a DNR protected water (108P) with an established ordinary high water (OHW) elevation of 972.3. Snyder Lake is also a DNR protected water (468W) with an established OHW of 972.3.

Significant resources within the Kreatz Lake/Snyder Lake Subwatershed include approximately four acres of wetland classified as exceptional (GL 17) and adjacent natural areas as identified in the Natural Resources Inventory (Appendix F).

Surface Water Treatment

Surface water treatment potential was analyzed for the Kraetz Lake/Snyder Lake Subwatershed and associated drainage areas (Table 92 and Figure 35). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 92. Kreatz Lake/Snyder Lake Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status	Treat. Defic. (Ac)	Treat. Defic. Value
GL15	25.6	1.6	1.6	-	-	7.6	1.0	-	8.6	4.1	250.7	0.0	LOW
GL14	16.1	1.0	1.0	-	-	1.2	-	-	1.2	0.6	57.4	0.4	MED
GL13	5.3	0.3	0.3	-	-	2.6	-	-	2.6	1.3	389.8	0.0	LOW
GL12	22.9	1.4	1.9	-	-	4.0	-	-	4.0	2.0	105.1	0.0	LOW
GL16	26.9	1.7	1.7	-	-	-	9.8	-	9.8	2.4	143.5	0.0	LOW
GL17	**28.0**	**1.8**	**1.8**	**-**	**-**	**19.4**	**-**	**3.7**	**23.1**	**9.7**	**548.0**	**0.0**	**LOW**

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Figure 35. Kreatz Lake/Snyder Lake Subwatershed

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In conclusion, the Kreatz Lake/Snyder Lake Subwatershed is considered to be a low-priority for implementation of projects to treat surface water based a low receiving water ranking, low treatment deficiency, and low land use change. Currently, the only drainage area deficient in surface water treatment is GL 14. Best management practices could be incorporated into this area to aid in treatment. Improvements to County Road 101 in 2008-2009 by Hennepin County will include surface water treatment. Additionally the City is conducting drainage way improvements just north of Snyder Lake. Implementation of best management practices should be closely coordinated with the MCWD.

b. 19th Avenue Subwatershed

Table 93. 19th Avenue Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Minnehaha Creek	
Receiving Water Ranking	Gleason/Low	
Treatment Deficiency	Medium	
Land Use Change	Low	
Priority Status	**Low**	
Receives runoff from:	Kreatz/Snyder	Figure 36
Downstream-most water body:	GL-10	Figure 36
Discharges to:	Dunkirk Lane	Figure 36
Exceptional Quality Wetlands	3.8 acres	Table 94
High Quality Wetlands	6.2 acres	Table 94
Medium Quality Wetlands	15.1 acres	Table 94
Low Quality Wetlands	0 acres	Table 94
Storm Water Ponds	0 acres	Table 94
Effective Treatment (Cuml. Area)	4.9 acres	Table 94
General Hydrologic Soil Group	B & C/D	
Total # of Drainage Areas	7	Figure 36
Drainage Area	341.9 acres	
Impervious Acreage	102.3 acres	Table 94

Impervious percentage 29.9%

Location

The 19th Avenue subwatershed extends in a north/south fashion and is bounded generally on the east by Dunkirk Lake, on the north by County Road 24 and an the south by 19th Avenue. The downstream-most drainage area (GL-10) had a pond excavated as part of the Dunkirk Lane improvements in 1984.

Background

The existing 19th Avenue subwatershed drainage system generally conforms to the 1980 Storm Drainage Plan. However, as part of the 1984 Dunkirk Lane Improvements, the contributing drainage areas were modeled using the SCS-TR20 program. The modeling resulted in different flow rates and high water elevations. In 2007 the MCWD and City of Plymouth collaborated on an erosion repair project in drainage area GL-10 from 24th Avenue south to pond GLP-13. This project included several hundred feet of storm sewer pipe south from 24th avenue, several hundred feet of open channel south of the pipe, and dredging of a sediment delta from GLP-13. Other issues in the area include low home elevations in the area of 26th Avenue east of Dunkirk Lane.

Significant resources within the 19th Avenue Subwatershed include approximately 10 acres of high and exceptional quality wetlands as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F).

Surface Water Treatment

Surface water treatment potential was analyzed for the 19th Avenue Subwatershed and associated drainage areas (Table 94 and Figure 36). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 94. 19th Avenue Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status	Treat. Defic. (Ac)	Treat. Defic. Value
GL11	6.8	0.4	0.4	-	-	2.8	-	-	2.8	1.4	326.1	0.0	LOW
GL8	26.2	1.7	1.7	-	-	-	3.3	-	3.3	0.8	50.1	0.8	MED
GL9	10.0	0.6	1.5	-	-	3.7	0.8	-	4.5	2.0	140.3	0.0	LOW
GL7	23.8	1.5	0.4	-	-	6.0	-	-	6.0	3.0	696.5	0.0	LOW
GL6	7.5	0.5	0.5	-	-	-	-	3.8	3.8	0.0	0.0	0.5	HIGH
GL10A	3.48	0.2	0.2	-	-	-	-	-	0.0	0.0	0.0	0.2	HIGH
GL10	**24.5**	**1.6**	**2.2**	**-**	**-**	**2.7**	**2.1**	**-**	**4.8**	**1.9**	**82.4**	**0.4**	**MED**

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Figure 36. 19th Avenue Subwatershed.

Back of Figure 36

In conclusion, the 19th Avenue Subwatershed is considered to be a low-priority for implementation of projects to treat surface water based on a low receiving water ranking, medium treatment deficiency, and low land use change. Additional treatment opportunities, however, should be pursued in GL6 and GL10A when opportunities arise. Implementation of best management practices should be closely coordinated with the MCWD.

c. Dunkirk Lane Subwatershed

Table 95. Dunkirk Lane Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Minnehaha Creek	
Receiving Water Ranking	Gleason/Low	
Treatment Deficiency	High	
Land Use Change	Low	
Priority Status	**Medium**	
Receives runoff from:	19th Avenue	Figure 37
Downstream-most water body:	GL 34	Figure 37
Discharges to:	GL 40	Figure 37
Exceptional Quality Wetlands	6.8 acres	Table 96
High Quality Wetlands	74.7 acres	Table 96
Medium Quality Wetlands	31.3 acres	Table 96
Low Quality Wetlands	0 acres	Table 96
Storm Water Ponds	1.5 acres	Table 96
Effective Treatment (Cuml. Area)	13.7 acres	Table 96
General Hydrologic Soil Group	B & B/D	
Total # of Drainage Areas	24	Figure 37
Drainage Area	924.6 acres	
Impervious Acreage	307.2 acres	Table 96
Impervious percentage	33.2%	

Location

The Dunkirk Lane subwatershed lies in southwestern Plymouth. The subwatershed is generally bounded on the north by State Highway 55, on the east by Vicksburg Lane and on the west by Dunkirk Lane. The subwatershed extends south of County Road 6 to just north of Gleason Lake's upper basin.

Background

The existing Dunkirk Lane subwatershed drainage system generally conforms to the 1980 Storm Drainage Plan. However, as part of the 1984 Dunkirk Lane Improvements, the contributing drainage areas were modeled using the SCS-TR20 program. The modeling resulted in different flow rates and high water elevations. Additionally, in 2007 the City of Plymouth included a water quality pond (expansion of pond GLP 22A) and two rain gardens within drainage area GL 34 and the pond is accounted for in the surface water treatment potential analysis that follows. Additionally, the MCWD completed a stream restoration and water quality pond (GLP 22C), which treats surface water from the entire subwatershed prior to discharge into Gleason Lake.

Significant resources within the Dunkirk Lane Subwatershed include approximately 81.5 acres of high and exceptional quality wetlands as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). High quality wetlands in GL1, GL2, and GL3 are also in a headwater position.

Surface Water Treatment

Surface water treatment potential was analyzed for the Dunkirk Lane Subwatershed and associated drainage areas (Table 96 and Figure 37). Although no specific problems were noted during the preparation of this plan, several specific drainage areas and their upstream contributing areas could be considered for future treatment including GL-4, GL-28, GL-31, GL-32, and GL-34. The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 96. Dunkirk Lane Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
GL2	5.4	0.3	0.3	-	-	1.1	2.8	-	3.9	1.2	364.3	0.0	LOW
GL4	12.7	0.8	0.8	-	-	-	-	-	0.0	0.0	0.0	0.8	HIGH
GL1	8.7	0.5	0.5	0.13	-	0.45	11.8	-	12.4	3.3	603.2	0.0	LOW
GL3	59.7	3.8	4.6	-	-	2.2	53.0	-	55.2	14.4	313.4	0.0	LOW
GL3A	19.1	1.2	1.2	-	-	-	4.4	-	4.4	1.1	91.0	0.1	LOW
GL5	11.1	0.7	0.8	-	-	-	2.7	3.0	5.8	0.7	84.4	0.1	MED
GL19	11.2	0.7	0.8	-	-	3.42	-	-	3.4	1.7	205.0	0.0	LOW
GL20	11.2	0.7	0.7	-	-	2.7	-	-	2.7	1.3	189.7	0.0	LOW
GL21	0.8	0.0	0.0	-	-	2.7	-	-	2.7	1.4	2837.8	0.0	LOW
GL23	16.3	1.0	1.0	-	-	3.9	-	-	3.9	1.9	188.5	0.0	LOW
GL22	12.0	0.8	0.8	-	-	3.5	-	-	3.5	1.7	230.1	0.0	LOW
GL33	4.3	0.3	0.3	-	-	-	-	-	0.0	0.0	0.0	0.3	HIGH
GL24	16.9	1.1	1.3	1.37	-	0.9	-	-	2.3	1.8	136.1	0.0	LOW
GL25	4.0	0.3	0.3	-	-	-	-	1.4	1.4	0.0	0.0	0.3	HIGH
GL26	14.8	0.9	1.2	-	-	5.1	-	-	5.1	2.6	214.1	0.0	LOW
GL28	22.2	1.4	1.4	-	-	0.25	-	-	0.3	0.1	8.9	1.3	HIGH
GL18	5.32	0.3	0.3	-	-	0.6	-	-	0.6	0.3	90.6	0.0	LOW
GL27	3.9	0.2	1.6	-	-	-	-	-	0.0	0.0	0.0	1.6	HIGH
GL31	2.2	0.1	1.7	-	-	0.5	-	-	0.5	0.2	14.4	1.5	HIGH
GL30	5.6	0.4	0.4	-	-	-	-	-	0.0	0.0	0.0	0.4	HIGH
GL32	1.9	0.1	1.9	-	-	0.4	-	-	0.4	0.2	11.4	1.7	HIGH

GL29	20.3	1.3	1.3	-	-	-	-	-	0.0	0.0	0.0	1.3	HIGH
GL35	18.5	1.2	2.5	-	-	3.2	-	-	3.2	1.6	65.8	0.8	MED
GL34	**19.2**	**1.2**	**3.8**	**-**	**-**	**0.3**	**-**	**2.3**	**2.7**	**0.2**	**4.2**	**3.6**	**HIGH**

Figure 37. Dunkirk Lane Subwatershed.

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In conclusion, the Dunkirk Lane Subwatershed is considered to be a medium-priority for implementation of projects to treat surface water based on a low receiving water ranking, high treatment deficiency, and low land use change. The high quality headwater wetlands of GL1, GL2, and GL3 may have been impacted by recent commercial development in the area. Several drainage districts would benefit from best management practices including GL4, GL33, GL25, GL28, GL27, GL30, GL31, and GL32. Implementation of best management practices should be closely coordinated with the MCWD.

d. Gleason Lake Subwatershed

Table 97. Gleason Lake Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Minnehaha Creek	
Receiving Water Ranking	Gleason/Low	
Treatment Deficiency	High	
Land Use Change	Low	
Priority Status	**Medium**	
Receives runoff from:	GL40	Figure 38
Downstream-most water body:	Gleason Lake	Figure 38
Discharges to:	Minnetonka	Figure 38
Exceptional Quality Wetlands	6.4 acres	Table 99
High Quality Wetlands	28.2 acres	Table 99
Medium Quality Wetlands	8.0 acres	Table 99
Low Quality Wetlands	0 acres	Table 99
Storm Water Ponds	1.5 acres	Table 99
Effective Treatment (Cuml. Area)	8.6 acres	Table 99
General Hydrologic Soil Group	B & B/D	
Total # of Drainage Areas	13	Figure 38
Drainage Area	798.7 acres	
Impervious Acreage	262.9 acres	Table 99
Impervious percentage	32.9%	

Location

The Gleason Lake Subwatershed is located in southwestern Plymouth, just east of County Road 101 and extending into Minnetonka. The Luce Line Trail splits Gleason Lake into two basins.

Background

The existing Gleason Lake subwatershed drainage system generally conforms to the 1980 Storm Drainage Plan due to the fact that the existing infrastructure was already in place when the 1980 Storm Drainage Plan was developed. Gleason Lake is the most significant resource within this subwatershed (Table 98). In the early 1990s, the MCWD initiated a project to control the peak discharge and increase the storage volume of Gleason Lake. The project resulted in a peak discharge reduction from 134 cfs to 24 cfs and an increase in storage volume from 338 acre feet to 562 acre feet. In 2007, the MCWD, with assistance from the City of Plymouth, completed a stream restoration and water quality pond (GLP22C) to address water quality concerns in Gleason Lake. This particular project now treats surface water from the entire subwatershed prior to discharge into Gleason Lake.

Significant resources within the Gleason Lake Subwatershed include Gleason Lake itself, a small amount of exceptional quality wetlands along the fringe of Gleason Lake, a large high quality wetland within GL46, and adjacent natural areas as identified in the Natural Resources Inventory (Appendix F).

Table 98. Gleason Lake data.

Lake Data	
DNR ID:	27-0095
Public Water #:	95P
Drainage Basin Area:	2434 Acres
Lake Area	142 Acres
Drainage Basin Area to Lake Area Ratio:	17:1
Maximum Depth:	16 feet
Water Clarity:	2.5 feet
Phosphorus:	205 ppb
Chlorophyll a:	90 ppb

Winter Kill Status:	Occasional
Park Information:	None

Abundant Aquatic Plants
Cattails
Canada Waterweed
Narrowleaf Pondweed

Exotic Aquatic Plants
Purple Loosestrife
Curlyleaf pondweed

DNR Fish Management Plan
Largemouth Bass (primary)
Bluegill Sunfish (secondary)

Source: City of Plymouth Water Resources Management Plan (2000). Additional information can be found at: http://www.minnehahacreek.org/wq.php#annual.

Surface Water Treatment

Surface water treatment potential was analyzed for the Gleason Lake Subwatershed and associated drainage areas (Table 99 and Figure 38). Although no specific problems were noted during the preparation of this plan, several specific drainage areas and their upstream contributing areas could be considered for future treatment including GL-4, GL-28, GL-31, GL-32, and GL-34. The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 99. Gleason Lake Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
GL42	12.5	0.8	0.8	-	-	1.4	-	-	1.4	0.7	85.4	0.1	MED
GL43	7.3	0.5	0.5	-	-	-	-	-	0.0	0.0	0.0	0.5	HIGH
GL36	34.0	2.2	2.2	-	-	2.9	-	-	2.9	1.5	68.1	0.7	MED
GL37	24.0	1.5	1.5	-	-	-	-	-	0.0	0.0	0.0	1.5	HIGH
GL38	9.3	0.6	0.6	-	-	2.1	-	-	2.1	1.1	181.2	0.0	LOW
GL39	3.1	0.2	1.7	-	-	-	-	-	0.0	0.0	0.0	1.7	HIGH
GL40	8.4	0.5	3.5	-	-	0.9	0.4	4.5	5.7	0.5	14.8	3.0	HIGH
GL44	17.9	1.1	1.1	-	-	-	-	-	0.0	0.0	0.0	1.1	HIGH
GL45	6.31	0.4	0.4	-	-	-	-	-	0.0	0.0	0.0	0.4	HIGH
GL41A	20.4	1.3	1.7	-	-	0.4	-	-	0.4	0.2	10.4	1.5	HIGH
GL48	6.6	0.4	0.4	-	-	0.3	-	-	0.3	0.2	38.4	0.3	HIGH
GL46	70.0	4.4	4.7	-	-	-	25.6	-	25.6	6.4	136.6	0.0	LOW
GL41	**43.1**	**2.7**	**8.4**	**-**	**-**	**-**	**2.2**	**1.9**	**4.1**	**0.6**	**6.6**	**7.8**	**HIGH**

Figure 38. Gleason Lake Subwatershed

Back of Figure 38

In conclusion, the Gleason Lake Subwatershed is considered to be a medium-priority for implementation of projects to treat surface water based on a low receiving water ranking, high treatment deficiency, and low land use change. The quality of the receiving water is the biggest influence on the ranking. Even if the existing water quality was better, lake morphology and the question of how good (quality) was this lake prior to development would limit the prioritization of improvement within this subwatershed. Additionally, significant resources would be required to create adequate ponding within this subwatershed. Projects within GL40, GL46, and/or GL41, however, would benefit Gleason Lake. Implementation of best management practices should be closely coordinated with the MCWD.

Table 100. Gleason Lake Management Plan

Subject: Gleason Lake Management Plan

Purpose: Protect and preserve Gleason Lake consistent with its City ranking and water quality goals.

Goal:
1. Work toward an in-lake average total phosphorus concentration of near 60 µg/l, secchi depths greater than 2.4 feet, and chlorophyll-a concentrations below 30 µg/l.

Problems:

1. Gleason Lake does not meet all lake water quality goals.
2. Gleason Lake has a substantial amount of aquatic invasive species.
3. The Gleason Lake watershed lacks surface water treatment.
4. Due to the developed nature of the Gleason Lake subwatershed, few options exist for structural BMPs.

Solutions:

1. Operate an enhanced street sweeping program.
2. Offer grant funds for water quality BMPs.
3. Incorporate structural BMPs where feasible.
4. Study opportunities for wetland enhancements within the watershed.
5. Require surface water treatment for development and redevelopment projects which exceed 0.5 acre.
6. Discuss opportunities for aquatic vegetation management.
7. Continue implementing surface water quality monitoring.
8. Provide education to City residents on water quality.
9. Discuss the impact of sediment deltas on lake water quality.
10. Work cooperatively with the MCWD to implement items in the MCWD CIP.
11. Evaluate the effect of rough fish on Gleason Lake.

Table 101. Gleason Lake Implementation Plan

Implementation Item	Resources	Measurement	Target Date	Est. Cost
1. Operate an enhanced street sweeping program	• City staff	• Lbs. of material removed from the street	SEE TABLE 18	SEE TABLE 18
2. Grant Funds for water quality BMPs	• City staff • MN DNR • MCWD	• Acreage of restored shoreline or other BMP projects.	SEE TABLE 7	SEE TABLE 7
3. Incorporate structural BMPs where feasible.	• City staff • MCWD • Feasability study	• Number of BMPs and their modeled efficiency	SEE TABLE 5	SEE TABLE 5
4. Study opportunities for wetland enhancements within the Gleason Lake watershed	• City staff • BWSR • MN DNR • MCWD • Feasibility Study	• Acreage of wetland enhancements	SEE TABLE 12	SEE TABLE 12
5. Require surface water treatment to NURP standards for development or redevelopment projects that exceed 0.5 acres	• City staff • Surface Water Management Plan	• Improved quality of surface water runoff	2009-2016	$0
6. Discuss opportunities for aquatic vegetation management	• City Staff • EQC • Residents	• Number of meetings	2009	$0
7. Continue implementing surface water quality monitoring	• City staff • Three Rivers Park Dist.	• Annual Water Quality Monitoring Report	SEE TABLE 16	SEE TABLE 16
8. Education	• City staff • MCWD • Three Rivers Park Dist.	• Number of promotions and mailers	SEE TABLE 14	SEE TABLE 14
9. Discuss the impact of sediment	• City staff	• Number of meetings	2009	$0

deltas on lake water quality	• EQC • Residents			
10. Work cooperatively with the MCWD to implement items in their CIP.	• City staff • MCWD	• Completed projects	2009-2016	$
11. Fish survey	• MN DNR	• Fish survey	2009	SEE TABLE 22

e. Hadley Lake Subwatershed

Table 102. Hadley Lake Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Minnehaha Creek	
Receiving Water Ranking	Low	
Treatment Deficiency	Low	
Land Use Change	Low	
Priority Status	**Low**	
Receives runoff from:		Figure 39
Downstream-most water body:	HL 11	Figure 39
Discharges to:	Minnetonka	Figure 39
Exceptional Quality Wetlands	5.9 acres	Table 103
High Quality Wetlands	35.0 acres	Table 103
Medium Quality Wetlands	20.7 acres	Table 103
Low Quality Wetlands	0.6 acres	Table 103
Storm Water Ponds	0.11 acres	Table 103
Effective Treatment (Cuml. Area)	7.6 acres	Table 103
General Hydrologic Soil Group	B & C/D	
Total # of Drainage Areas	26	Figure 39
Drainage Area	689.1 acres	
Impervious Acreage	217.4 acres	Table 103
Impervious percentage	31.6%	

Location

The Hadley lake subwatershed is located in extreme southwestern Plymouth. The subwatershed is roughly bounded to the north by County Road 6 and to the south by the Luce Line Trail.

Background

The existing Hadley Lake subwatershed drainage system generally conforms to the 1980 Storm Drainage Plan as most of the existing infrastructure was in place when the 1980 plan was prepared. No specific studies or problems were noted in this subwatershed during preparation of this plan, however, a water quality pond was constructed in area HL12 with a street reconstruction project in 2007.

Significant resources within the Hadley Lake Subwatershed include Hadley Lake itself, approximately 41 acres of high and exceptional quality wetlands as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). Exceptional quality wetlands are present in HL5 and HL8.

Surface water treatment

Surface water treatment potential was analyzed for the Hadley Lake Subwatershed and associated drainage areas (Table 103 and Figure 39). Although no specific problems were noted during the preparation of this plan, several specific drainage areas and their upstream contributing areas could be considered for future treatment including HL-1, HL-6, HL-8, HL-9, and HL-12. The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 103. Hadley Lake Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
HL1	20.6	1.3	1.3	-	-	-	-	-	0.0	0.0	0.0	1.3	HIGH
HL2	18.6	1.2	1.2	-	-	1.4	-	-	1.4	0.7	58.3	0.5	MED
HL6	41.3	2.6	2.6	-	-	-	-	-	0.0	0.0	0.0	2.6	HIGH
HL3	7.3	0.5	0.5	-	0.6	-	-	-	0.6	0.4	91.5	0.0	LOW
HL5	31.9	2.0	6.5	-	-	8.7	10.7	1.8	21.3	7.0	108.9	0.0	LOW
HL8	8.4	0.5	0.5	-	-	0.3	-	4.1	4.4	0.2	28.2	0.4	HIGH
HL7	3.3	0.2	0.2	-	-	-	0.6	-	0.6	0.1	70.6	0.1	MED
HL4	8.4	0.5	0.5	0.1	-	2.8	-	-	2.9	1.5	287.9	0.0	LOW
HL4a	4.0	0.3	0.3	-	-	2.9	-	-	2.9	1.4	560.6	0.0	LOW
HL9	31.5	2.0	2.4	-	-	2.4	-	-	2.4	1.2	49.2	1.2	HIGH
HL11a	3.7	0.2	0.2	-	-	0.9	-	-	0.9	0.5	196.4	0.0	LOW
HL11b	2.5	0.2	0.2	-	-	-	1.2	-	1.2	0.3	198.3	0.0	LOW
HL11c	7.9	0.5	0.5	-	-	1.4	-	-	1.4	0.7	135.5	0.0	LOW
HL11	**10.7**	**0.7**	**1.9**	**-**	**-**	**-**	**16.7**	**-**	**16.7**	**4.2**	**217.1**	**0.0**	**LOW**
HL10	**9.9**	**0.6**	**0.6**	**-**	**-**	**-**	**5.8**	**-**	**5.8**	**1.5**	**230.9**	**0.0**	**LOW**
HL12	**7.5**	**0.5**	**0.5**	**-**	**-**	**-**	**-**	**-**	**0.0**	**0.0**	**0.0**	**0.5**	**HIGH**

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Figure 39. Hadley Lake Subwatershed

Back of Figure 39

In conclusion, the Hadley Lake Subwatershed is considered to be a low-priority for implementation of projects based on a low receiving water ranking, low treatment deficiency, and low land use change. Drainage areas HL1, HL3, HL8, HL9, and HL12 would benefit from incorporation of best management practices. Implementation of best management practices should be closely coordinated with the MCWD.

f. Medina Subwatershed

Table 104. Medina Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Minnehaha Creek	
Receiving Water Ranking	Low	
Treatment Deficiency	Low	
Land Use Change	Low	
Priority Status	**Low**	
Receives runoff from:		Figure 40
Downstream-most water body:	M4	Figure 40
Discharges to:	Medina	Figure 40
Exceptional Quality Wetlands	0 acres	Table 105
High Quality Wetlands	0 acres	Table 105
Medium Quality Wetlands	1.3 acres	Table 105
Low Quality Wetlands	0 acres	Table 105
Storm Water Ponds	0 acres	Table 105
Effective Treatment (Cuml. Area)	0.3 acres	Table 105
General Hydrologic Soil Group	B	
Total # of Drainage Areas	1	Figure 40
Drainage Area	18.5 acres	
Impervious Acreage	5.3 acres	Table 105
Impervious percentage	28.7%	

Location

The Medina subwatershed is located on Plymouth's west side between Medina Road and 35th Avenue North. The subwatershed covers only about 18 acres, and discharges to Medina.

Background

The existing Medina subwatershed drainage system generally conforms to the 1980 Storm Drainage Plan as no infrastructure was proposed in this area, however, the size of the subwatershed is considerably smaller that shown on the 1980 plan. The north half and east one-quarter of the old M4 subwatershed, per the 1980 plan, have been diverted into the Bassett Creek watershed by construction of the local storm drainage system.   No specific studies or problems were noted in this subwatershed during preparation of this plan.

Within the City of Plymouth there are no known significant resources in the Medina Subwatershed.

Surface water treatment

Surface water treatment potential was analyzed for the Medina Subwatershed and associated drainage area (Table 105 and Figure 40). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 105. Medina Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
M4	**5.3**	**0.3**	**0.3**	**-**	**-**	**1.3**	**-**	**-**	**1.3**	**0.7**	**195.2**	**0.0**	**LOW**

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Figure 40. Medina Subwatershed.

Back of Figure 40

In conclusion, the Medina Subwatershed is considered to be a low-priority for implementation of projects based on a low receiving water ranking, low treatment deficiency, and low land use change.

g. MInnetonka Outlet Subwatershed

Table 106. Minnetonka Outlet Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Minnehaha Creek	
Receiving Water Ranking	Low	
Treatment Deficiency	Medium	
Land Use Change	High	
Priority Status	**Medium**	
Receives runoff from:		Figure 41
Downstream-most water body:		Figure 41
Discharges to:	Minnetonka	Figure 41
Exceptional Quality Wetlands	0.0 acres	Table 107
High Quality Wetlands	1.1 acres	Table 107
Medium Quality Wetlands	11.5 acres	Table 107
Low Quality Wetlands	2.6 acres	Table 107
Storm Water Ponds	0.0 acres	Table 107
Effective Treatment (Cuml. Area)	4.1 acres	Table 107
General Hydrologic Soil Group	B & B/D	
Total # of Drainage Areas	5	Figure 41
Drainage Area	179.9 acres	
Impervious Acreage	75.0 acres	Table 107
Impervious percentage	41.7%	

Location

The Minnetonka Outlet subwatershed is comprised of several separate drainage areas that all discharge directly into the City of Minnetonka. The subwatershed is located between Niagara Lane and Teakwood Lane, south of

Gleason Lake Drive and Sunset Trail. Interstate 494 splits the subwatershed into two parts.

Background

The existing Minnetonka Outlet subwatershed drainage system generally conforms to the 1980 Storm Drainage Plan. The MCWD has identified this subwatershed for an annual phosphorus load reduction of 10 lbs. No other specific studies or problems were noted in this subwatershed during preparation of this plan.

Significant resources within the Minnetonka subwatershed include 1.1 acres of high quality wetland in MC4 as wll as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F).

Surface water treatment

Surface water treatment potential was analyzed for the Minnetonka Outlet subwatershed and associated drainage areas (Table 107 and Figure 41). Although no specific problems were noted during the preparation of this plan, the MC4 drainage area could be considered for future treatment. The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 107. Minnetonka Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
MC1	**36.3**	**2.3**	**2.3**	**-**	**-**	**9.1**	**-**	**-**	**9.1**	**4.6**	**198.8**	**0.0**	**LOW**
MC2	**7.2**	**0.5**	**0.5**	**-**	**2.6**	**-**	**-**	**-**	**2.6**	**2.0**	**430.8**	**0.0**	**LOW**
MC3	**12.7**	**0.8**	**0.8**	**-**	**-**	**1.2**	**-**	**-**	**1.2**	**0.6**	**72.0**	**0.2**	**MED**
MC4	**12.4**	**0.8**	**0.8**	**-**	**-**	**-**	**1.1**	**-**	**1.1**	**0.3**	**34.1**	**0.5**	**HIGH**
GL47	**6.3**	**0.4**	**0.4**	**-**	**-**	**1.2**	**-**	**-**	**1.2**	**0.6**	**151.0**	**0.0**	**LOW**

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Figure 41. Minnetonka Outlet Subwatershed.

Back of Figure 41

In conclusion, the Minnetonka Subwatershed is considered to be a medium-priority for implementation of projects based on a low receiving water ranking, medium treatment deficiency, and high land use change. Drainage area MC4 would benefit most from incorporation of best management practices. Implementation of best management practices should be closely coordinated with the MCWD.

h. Mooney Lake Subwatershed

Table 108. Mooney Lake Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Minnehaha Creek	
Receiving Water Ranking	Mooney/Low	
Treatment Deficiency	Low	
Land Use Change	Low	
Priority Status	**Low**	
Receives runoff from:		Figure 42
Downstream-most water body:	M2	Figure 42
Discharges to:	Medina	Figure 42
Exceptional Quality Wetlands	0.0 acres	Table 110
High Quality Wetlands	6.2 acres	Table 110
Medium Quality Wetlands	13.2 acres	Table 110
Low Quality Wetlands	0.4 acres	Table 110
Storm Water Ponds	0.1 acres	Table 110
Effective Treatment (Cuml. Area)	6.2 acres	Table 110
General Hydrologic Soil Group	B & C/D	
Total # of Drainage Areas	2	Figure 42
Drainage Area	395.5 acres	
Impervious Acreage	164.5 acres	Table 110
Impervious percentage	41.6%	

Location

The Mooney Lake subwatershed is located on Plymouth's west side, between County Road 6 and 25th Avenue North, west of County Road 101.

Background

The existing Mooney Lake subwatershed drainage system generally conforms to the 1980 Storm Drainage Plan. Mooney Lake is the most significant resource within this subwatershed (Table 109). An open channel rather than pipe conveys surface water and discharges into the north end of Mooney Lake. Mooney Lake was historically a land-locked basin and residents had concerns regarding the flooding potential of the lake. To remedy this situation, the City of Plymouth and the MCWD constructed an emergency outlet on the south end of the lake in 2008. The outlet is a lift station that operates only when the lake level exceeds a MN DNR regulated threshold.

Significant resources within the Mooney Lake Subwatershed include Mooney Lake itself, approximately 6.2 acres of high quality wetlands as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F).

Table 109. Mooney Lake data.

Lake Data	
DNR ID:	27-0134
Public Water #:	134P
Drainage Basin Area:	426 Acres
Lake Area	118 Acres
Drainage Basin Area to Lake Area Ratio:	4:1
Maximum Depth:	10 feet
Water Clarity:	1.6 feet
Phosphorus:	171 ppb
Chlorophyll a:	57 ppb
Winter Kill Status:	Occasional
Park Information:	None

Abundant Aquatic Plants

Cattails
Softstem Bulrush
Canada Waterweed

Exotic Aquatic Plants
None

DNR Fish Management Plan
Northern Pike (primary)
Bluegill Sunfish (secondary)

Source: City of Plymouth Water Resources Management Plan (2000). Additional information can be found at: http://www.minnehahacreek.org/wq.php#annual.

Surface water treatment

Surface water treatment potential was analyzed for the Hadley Lake Subwatershed and associated drainage areas (Table 110 and Figure 42). Although no specific problems other than high water levels were noted during the preparation of this plan, the possible presence and condition of on-site sanitary systems may be a concern. The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 110. Mooney Lake Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
M1	35.6	2.3	2.3	-	0.2	5.7	6.2	-	12.1	4.6	203.3	0.0	LOW
M2	**60.1**	**3.8**	**3.8**	**0.1**	**0.2**	**7.5**	**-**	**-**	**7.7**	**3.9**	**103.7**	**0.0**	**LOW**

Figure 42. Mooney Lake Subwatershed.

Back of Figure 42

In conclusion, the Mooney Lake Subwatershed is considered to be a low-priority for implementation of projects based on a low receiving water ranking, low treatment deficiency, and low land use change.

Table 111. Mooney Lake Management Plan

Subject:	Mooney Lake Management Plan
Purpose:	Protect and preserve Mooney Lake consistent with its City ranking and water quality goals.
Goal:	1. Work toward an in-lake average total phosphorus concentration of 60 µg/l, secchi depths greater than 2.4 feet, and chlorophyll-a concentrations below 30 µg/l.

Problems:

1. Mooney Lake does not meet all lake water quality goals.
2. The Mooney Lake watershed lacks surface water treatment.
3. Due to the developed nature of the Mooney Lake subwatershed, few options exist for structural BMPs.

Solutions:

1. Operate an enhanced street sweeping program.
2. Offer grant funds for water quality BMPs.
3. Incorporate structural BMPs where feasible.
4. Study opportunities for wetland enhancements within the watershed.
5. Require surface water treatment for development and redevelopment projects which exceed 0.5 acres.
6. Discuss opportunities for aquatic vegetation management.
7. Implement surface water quality monitoring.
8. Provide education to City residents on water quality.
9. Discuss the impact of sediment deltas on lake water quality.
10. Work cooperatively with the MCWD to implement items in the MCWD CIP.
11. Evaluate the effects of rough fish on Mooney Lake.

Table 112. Mooney Lake Implementation Plan

Implementation Item	Resources	Measurement	Target Date	Est. Cost
1. Operate an enhanced street sweeping program	• City staff	• Lbs. of material removed from the street	SEE TABLE 18	SEE TABLE 18
2. Grant Funds for water quality BMPs	• City staff • MN DNR • MCWD	• Acreage of restored shoreline or other BMP projects.	SEE TABLE 7	SEE TABLE 7
3. Incorporate structural BMPs where feasible.	• City staff • MCWD • Feasability study	• Number of BMPs and their modeled efficiency	SEE TABLE 5	SEE TABLE 5
4. Study opportunities for wetland enhancements within the Mooney Lake watershed	• City staff • BWSR • MN DNR • MCWD • Feasibility Study	• Acreage of wetland enhancements	SEE TABLE 12	SEE TABLE 12
5. Require surface water treatment to NURP standards for development or redevelopment projects that exceed 0.5 acres	• City staff • Surface Water Management Plan	• Improved quality of surface water runoff	2009-2016	$0
6. Discuss opportunities for aquatic vegetation management	• City Staff • EQC • Residents	• Number of meetings	2009	$0
7. Implementing surface water quality monitoring	• City staff • Three Rivers Park Dist.	• Annual Water Quality Monitoring Report	SEE TABLE 16	SEE TABLE 16
8. Education	• City staff • MCWD • Three Rivers Park Dist.	• Number of promotions and mailers	SEE TABLE 14	SEE TABLE 14
9. Discuss the impact of sediment	• City staff	• Number of meetings	2009	$0

deltas on lake water quality	• EQC • Residents			
11. Work cooperatively with the MCWD to implement items in their CIP.	• City staff • MCWD	• Completed projects	NA	NA

D SHINGLE CREEK WATERSHED

Shingle Creek drains the urbanized north central and northeastern part of Plymouth. Water from this watershed enters New Hope under Highway 169 and Maple Grove through Pike Lake and Eagle Lake. The major lakes in the watershed are in the northeast part of the City and include Bass Lake, Pomerleau Lake, Schmidt Lake and Pike Lake.

The Shingle Creek Watershed covers 43.5 square miles in east central Hennepin County. It extends approximately 10 miles from Plymouth and Maple Grove to Minneapolis. Shingle Creek begins at the junction of Bass Creek and Eagle Creek in Brooklyn Park.

The watershed is mostly covered by loamy soils with moderate infiltration (hydrologic group B). Pre-settlement vegetation varied from oak openings and barrens in the east to big woods in the west.

1. SHINGLE CREEK WATERSHED MANAGEMENT ORGANIZATION

The Shingle Creek Watershed Management Commission (SCWMC) formed in 1984 using a Joint Powers Agreement developed under authority conferred to the member communities by Minnesota Statutes 471.59 and 103B.201 through 103B.251. The watershed is located in the northwest portion of the seven county metropolitan area and are comprised of all or part of the following ten cities in Hennepin County:

- Brooklyn Center
- Brooklyn Park
- Champlin
- Crystal
- Maple Grove
- Minneapolis
- New Hope

- Osseo
- Plymouth
- Robbinsdale

The Commission is governed by a Board of Commissioners that is comprised of one member and one alternate appointed from each community by their respective City Councils. The Commissions' purpose is to preserve and use natural water storage and retention in the Shingle Creek watershed to meet Surface Water Management Act goals. Because many of the communities that are members of the Shingle Creek WMO are also members of the West Mississippi WMO, the Commissions often work jointly on issues of interest to both, including their Second Generation Plan.

The SCWMC Second Generation Plan was developed between March 2001 and May 2003. The SCWMC held several citizen, agency, and Commission meetings throughout the planning process where input was actively solicited from those with an interest in the watershed. The Plan includes information required in Minnesota Administrative Rules Chapter 8410, Local Water Management; an updated land and water resources inventory, goals and policies in eight specific areas; an assessment of problems and identification of corrective actions; an implementation program; and a process for amending the Plan.

Issues identified by the public and the Commission during the planning process are as follows:

1. Increases in impervious surface as the watershed becomes fully developed will increase the duration and frequency of bank full conditions and should be addressed and monitored.
2. Standards that have prevented flooding potential as the watershed developed should be continued or enhanced as development is completed.
3. Water quality in the Twin Lakes, especially Upper Twin, should be improved.

4. Phosphorus loading is degrading lake water quality. Nutrient loading has resulted in an Impaired Waters listing for ten lakes in the watershed.
4. Excessive chloride in Shingle Creek has resulted in an Impaired Waters listing.
5. Water quality should be maintained or improved to assure safe swimming.
6. Redevelopment should have an environmental focus.
7. Polluted water should be cleaned up and further pollution should be prevented.
8. Recent water quality testing indicates some bacterial levels of concern that should be monitored.
9. Water quality in Shingle Creek should be improved.
10. The natural beauty and recreational opportunities of the creek should be capitalized upon with expanded trails, parks, and access.
11. Commission should implement an active program to increase buffers, native plants, rain gardens, and native landscaping.
12. Native habitat should be evaluated and protected.
13. The Commission should become more accessible to citizens.
14. Citizens should be educated more on what they can do to improve water quality and protect water resources, and to be more involved.
15. Existing wetlands should be protected from encroachment by development.
16. Wetlands should be restored and cleaned up.
17. Runoff volumes and lack of vegetative border has led to stream degradation and erosion that should be evaluated and improved.

Through the identification of issues in the watersheds, the SCWMC developed eight goals to guide their water resources planning and management functions:

1. Maintain the existing 100-year flood profile throughout the watershed.
2. Protect and improve water quality based on practical use.

3. Strive to provide water quality that supports recreation, fish and wildlife based on practical use.
4. Establish an education and public outreach program.
5. Develop an appropriate management strategy for Hennepin County Ditch #13.
6. Protect and improve groundwater quality and promote groundwater recharge.
7. Protect and improve wetlands.
8. Reduce erosion and sedimentation.

Strategies to be implemented by the SCWMC to reach the desired goals include:

1. The Commission will continue to control peak runoff rates at management sector boundaries and city boundaries, requiring development and redevelopment of certain sizes to adhere to a stormwater management plan that provides rate control and water quality improvements and adding an infiltration requirement. The watershed model will be maintained and the creek's 100 year profile will be reevaluated.
2. The Commission's more active education and public outreach program will provide regular information to cities and local media for distribution, useful information on the Commissions' web site, opportunities for participation, and more interaction with schools.
3. The Commission's education and public outreach program will meet minimum requirements for NPDES Phase II and the Commission will help facilitate other NPDES activities, such as facilitating training in good housekeeping methods for city staff, as requested.
4. Over the first five years of the Second Generation Plan the Commission will prioritize water resources and develop management plans for those resources by priority or as opportunity provides. These plans will include goals for maintaining or improving water quality based on practical use and implementation strategies that may include maintenance or capital improvements.

5. The Commission will promote Shingle Creek and other streams and rivers as greenways, emphasizing streambank improvements and habitat restoration where possible.
6. The Commission will prioritize wetlands for preservation and wetlands for potential restoration. Buffers will be required adjacent to wetlands and watercourses as development or redevelopment occurs. Cities that are the LGUs for WCA will perform functions and values analyses on their wetlands in accordance with Commission standards. For those cities where the Commission is the LGU, the Commission's engineer will perform those analyses at the city's cost.
7. The Commission will create a Construction/Matching Grant Fund that will be used to: match grants for resources management projects or capital improvements; construct capital improvements that are of high watershed priority, are demonstration projects, or have otherwise been designated by the Commission for construction by the Commissions; and as match or "seed money" to encourage local improvements.

2. SUBWATERSHEDS

The Plymouth portion of the Shingle Creek Watershed includes 11 subwatersheds (Figure 43):

- Pomerleau Lake
- Curtis Lake
- Upper Shingle Creek
- Schmidt Lake
- Bass Lake South
- Bass Lake Northwest
- Bass Lake
- Lower Shingle Creek
- Shingle Creek Outlet
- Pike Lake
- New Hope

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Figure 43. Shingle Creek Subwatersheds in Plymouth

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Each subwatershed has been further divided into numerous drainage areas that generally correspond to the 1980 drainage plan. Each identified drainage area includes at least one pond, wetland or water body that receives storm water. When more than one water body is identified within a drainage area, it is probable that there is no information available in City files that indicate the contributing area to each water body.

There are several impairments in the Shingle Creek Watershed including mercury, fish index of biological indicators (IBI), invertebrate IBI, low oxygen, and excess nutrients. Additionally, the Environmental Protection Agency (EPA) has approved the Shingle Creek Chloride TMDL (Appendix N) and Implementation Plan.

a. Pomerleau Lake Subwatershed

Table 113. Pomerleau Lake Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Shingle Creek	
Receiving Water Ranking	Pomerleau/Medium	
Treatment Deficiency	Medium	
Land Use Change	Low	
Priority Status	**Medium**	
Receives runoff from:	SC10 & SC11	Figure 44
Downstream-most water body:	Pomerleau Lake	Figure 44
Discharges to:	Upper Shingle Crk.	Figure 44
Exceptional Quality Wetlands	51.2 acres	Table 115
High Quality Wetlands	0.0 acres	Table 115
Medium Quality Wetlands	2.3 acres	Table 115
Low Quality Wetlands	1.0 acres	Table 115
Storm Water Ponds	0.0 acres	Table 115
Effective Treatment (Cuml. Area)	1.4 acres	Table 115
General Hydrologic Soil Group	B & C/D	
Total # of Drainage Areas	2	Figure 44

Drainage Area	271.0 acres	
Impervious Acreage	54.1 acres	Table 115
Impervious percentage	20.0%	
Impaired Water	Bass Creek Shingle Creek Bass Lake Pomerleau Lake	
Impairments	Fish IBI, Chloride, Invertebrate IBI, Low Oxygen Excess Nutrients	
EPA Approved TMDL	Shingle Creek Chloride	Appendix N

Location

The Pomerleau Lake Subwatershed is located in north central Plymouth, situated near the headwaters of the Shingle Creek watershed. The subwatershed is generally bounded by I-494 on the east, 43rd Avenue to the sourth, Vicksburg Lane to the west and County Road 47 to the north.

Background

The existing Pomerleau Lake Subwatershed drainage system generally conforms to the 1980 Storm Drainage Plan. Pomerleau Lake is the most significant resource in this subwatershed (Table 114). The 1980 Storm Drainage Plan identifies 45.0-acre feet of storage available between 935.5 and 937.0, with a 5 cfs peak discharge. Currently, Pomerleau Lake encompasses approximately 30 acres at its normal water level. As this area continues to develop, the existing rate control and water quality treatment policies will ensure that downstream areas are protected, even if the previously planned flood storage on Pomerleau Lake cannot be completed as originally planned.

Table 114. Pomerleau Lake data.

Lake Data	
DNR ID:	27-0100
Public Water #:	100P

Drainage Basin Area:	271 Acres
Lake Area	30 Acres
Drainage Basin Area to Lake Area Ratio:	9:1
Maximum Depth:	26 feet
Water Clarity:	5.0 feet
Phosphorus:	NA
Chlorophyll a:	NA
Shoreland Class:	Natural Environment
Winter Kill Status:	Occasional
Park Information:	None

Abundant Aquatic Plants
Cattails
Little White Waterlily
Coontail

Exotic Aquatic Plants
None

DNR Fish Management Plan
Bluegill Sunfish (primary)
Largemouth Bass (secondary)

Currently, a TMDL plan to address an excess nutrient impairment is being developed through the Shingle Creek Watershed Management Commission. No other problems relating to Pomerleau Lake were identified during the preparation of this plan.

Significant resources within the Pomerleau Lake Subwatershed include Pomerleau Lake itself, approximately 51.2 acres of high and exceptional quality wetlands as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). Exceptional quality wetlands are present in SC10 and SC11.

Surface water treatment

Surface water treatment potential was analyzed for the Pomerleau Lake Subwatershed and associated drainage areas (Table 115 and Figure 44). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 115. Pomerleau Lake Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
SC10	32.7	2.1	2.1	-	0.2	-	-	33.5	33.7	0.1	6.8	2.0	HIGH
SC11	21.4	1.4	3.3	-	0.8	2.3	-	17.7	20.8	1.7	52.0	1.6	MED

Figure 44. Pomerleau Lake Subwatershed

Back of Figure 44

In conclusion, the Pomerleau Lake Subwatershed is considered to be a medium-priority for implementation of projects based on a medium receiving water ranking, medium treatment deficiency, and low land use change. Drainage area SC10 would benefit from incorporation of best management practices. The EPA has approved the Shingle Creek Chloride TMDL and Implementation Plan. Best management practices associated with the approved Shingle Creek Chloride TMDL and Implementation Plan and other projects should be closely coordinated with the SCWMC.

Table 116. Pomerleau Lake Management Plan

Subject:	Pomerleau Lake Management Plan
Purpose:	Protect and preserve Pomerleau Lake consistent with its City ranking and water quality goals.
Goal:	1. Work toward and in-lake average total phosphorus concentration of 38-60 µg/l, secchi depths greater than 2.4-4.6 feet, and chlorophyll-a concentrations below 10-30 µg/l. 2. Work toward reaching goals as set forth in any future EPA approved TMDL Implementation Plan.

Problems:

1. Pomerleau Lake does not meet all lake water quality goals.
2. Pomerleau Lake has aquatic invasive species.
3. The Pomerleau Lake watershed lacks surface water treatment.

Solutions:

1. Operate an enhanced street sweeping program.
2. Offer grant funds for shoreline restorations and other water quality BMPs.
3. Incorporate structural BMPs where feasible.
4. Study opportunities for wetland enhancements within the watershed.
5. Require surface water treatment for development and redevelopment projects which exceed 0.5 acres.
6. Discuss opportunities for aquatic vegetation management.
7. Implement any EPA approved TMDL Plan.
8. Continue implementing surface water quality monitoring.
9. Provide education to City residents on water quality.
10. Discuss the impact of sediment deltas on lake water quality.
11. Work cooperatively with the SCWMC to implement items in the SCWMC CIP.
12. Construct public access
13. Evaluate effect of rough fish on Pomerleau Lake.

Table 117. Pomerleau Lake Implementation Plan

Implementation Item	Resources	Measurement	Target Date	Est. Cost
1. Operate and enhanced street sweeping program	• City staff	• Lbs. of material removed from the street	SEE TABLE 18	SEE TABLE 18
2. Grant Funds for shoreline restorations and other water quality BMPs	• City staff • MN DNR • SCWMC	• Acreage of restored shoreline or other BMP projects.	SEE TABLE 7	SEE TABLE 7
3. Incorporate structural BMPs where feasible.	• City staff • SCWMC • Feasability study	• Number of BMPs and their modeled efficiency	SEE TABLE 5	SEE TABLE 5
4. Study opportunities for wetland enhancements within the Pomerleau Lake watershed	• City staff • BWSR • MN DNR • SCWMC • Feasibility Study	• Acreage of wetland enhancements	SEE TABLE 12	SEE TABLE 12
5. Require surface water treatment to NURP standards for development or redevelopment projects that exceed 0.5 acres	• City staff • Surface Water Management Plan	• Improved quality of surface water runoff	2009-2016	$0
6. Discuss opportunities for aquatic vegetation management	• City Staff • EQC • Residents	• Number of meetings	2009	$0
7. Implement any EPA approved TMDL implementation plan	• City staff • MPCA • EPA • SCWMC	• EPA approved TMDL • Implementation of items		
8. Continue implementing surface water quality monitoring	• City staff • Three Rivers Park Dist.	• Annual Water Quality Monitoring Report	SEE TABLE 16	SEE TABLE 16

9. Education	• City staff • BCWMC • Three Rivers Park Dist.	• Number of promotions and mailers	SEE TABLE 14	SEE TABLE 14
10. Discuss the impact of sediment deltas on lake water quality	• City staff • EQC • Residents	• Number of meetings	2009	$0
11. Work cooperatively with the SCWMC to implement items in their CIP.	• City staff • SCWMC	• Completed projects	2009-2016	NA
12. Investigate and evaluate appropriate public uses and public access.	• City staff (planning) • MN DNR • Feasibility Study	• Feasibility study • Completed public use plan	SEE TABLE 22	SEE TABLE 22
13. Fish survey	• MN DNR	• Fish survey	2009	SEE TABLE 22

b. Curtis Lake Subwatershed

Table 118. Curtis Lake Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Shingle Creek	
Receiving Water Ranking	Bass Lake/Medium	
Treatment Deficiency	Low	
Land Use Change	Medium	
Priority Status	**Medium**	
Receives runoff from:	SC16, SC16A, & SC18	Figure 45
Downstream-most water body:	Curtis Lake	Figure 45
Discharges to:	Upper Shingle Crk.	Figure 45
Exceptional Quality Wetlands	19.8 acres	Table 119
High Quality Wetlands	34.7 acres	Table 119
Medium Quality Wetlands	9.5 acres	Table 119
Low Quality Wetlands	0.0 acres	Table 119
Storm Water Ponds	2.8 acres	Table 119
Effective Treatment (Cuml. Area)	66.8 acres	Table 119
General Hydrologic Soil Group	B & NA	
Total # of Drainage Areas	3	Figure 45
Drainage Area	294.0 acres	
Impervious Acreage	61.5 acres	Table 119
Impervious percentage	20.9%	
Impaired Water	Bass Creek Shingle Creek Bass Lake	
Impairments	Fish IBI, Chloride, Invertebrate IBI, Low Oxygen, Excess Nutrients	
EPA Approved TMDL	Shingle Creek Chloride	Appendix N

Location

The Curtis Lake Subwatershed is located in the center of Plymouth, straddling I-494 and lying south of Schmidt Lake Road. Curtis Lake is the large wetland lying east of and adjacent to I-494.

Background

The existing Curtis Lake Subwatershed drainage system generally conforms to the 1980 Storm Drainage Plan. Although no specific studies or reports were identified during the preparation of this plan, new pipes under Schmidt Lake Road east of I-494 have made the values in the 1980 Storm Drainage Plan obsolete.

Significant resources within the Curtis Lake Subwatershed include approximately 54.5 acres of exceptional and high quality wetlands as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). Exceptional quality wetlands are present in SC16 and SC18.

Surface water treatment

Surface water treatment potential was analyzed for the Curtis Lake Subwatershed and associated drainage areas (Table 119 and Figure 45). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 119. Curtis Lake Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
SC16A	8.9	0.6	0.6	0.1	-	3.7	-	-	3.8	1.9	320.8	0.0	LOW
SC16	20.0	1.3	1.3	0.5	-	5.7	-	19.8	25.9	3.3	261.1	0.0	LOW
SC18	32.63	2.1	2.1	2.3	-	0.1	34.7	-	37.1	11.0	533.0	0.0	LOW

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Figure 45. Curtis Lake Subwatershed

Back of Figure 45

In conclusion, the Curtis Lake Subwatershed is considered to be a medium-priority for implementation of projects based on a medium receiving water ranking, low treatment deficiency, and medium land use change. The exceptional wetland in drainage area SC16 would benefit from incorporation of best management practices. Best management practices associated with the approved Shingle Creek Chloride TMDL and Implementation Plan and other projects should be closely coordinated with the SCWMC.

c. Upper Shingle Creek Subwatershed

Table 120. Upper Shingle Creek Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Shingle Creek	
Receiving Water Ranking	Bass Lake/Medium	
Treatment Deficiency	Low	
Land Use Change	Low	
Priority Status	**Low**	
Receives runoff from:	SC18 & SC11	Figure 46
Downstream-most water body:	Bass Lake	Figure 46
Discharges to:	Bass Lake South	Figure 46
Exceptional Quality Wetlands	0.0 acres	Table 121
High Quality Wetlands	92.8 acres	Table 121
Medium Quality Wetlands	57.6 acres	Table 121
Low Quality Wetlands	2.7 acres	Table 121
Storm Water Ponds	2.1 acres	Table 121
Effective Treatment (Cuml. Area)	13.9 acres	Table 121
General Hydrologic Soil Group	B & NA	
Total # of Drainage Areas	16	Figure 46
Drainage Area	1135.4 acres	
Impervious Acreage	233.6 acres	Table 121
Impervious percentage	19.7%	
Impaired Water	Bass Creek Shingle Creek Bass Lake	

Impairments	Fish IBI, Chloride, Invertebrate IBI, Low Oxygen, Excess Nutrients	
EPA Approved TMDL	Shingle Creek Chloride	Appendix N

Location

The Upper Shingle Creek Subwatershed is located in northeast Plymouth. With 43rd Avenue North and the railroad grade as its east/west axis, the subwatershed stretches from Vicksburg Lane in the west to Pineview lane in the east.

Background

The 1980 Storm Drainage Plan anticipated water level control dikes for areas SC2, SC5, and SC7. Based on review of the storm sewer map, it would appear that none of these structures nor the connecting storm sewers has been built. Ultimate development of the storage capacity anticipated in the 1980 Storm Drainage Plan will depend upon the regulatory climate. Water quantity polices will require ponding to provide adequate storage. No specific studies or problems were identified during the preparation of this plan.

Significant resources within the Upper Shingle Creek Subwatershed include approximately 100.0 acres of high quality wetlands as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). High quality wetlands are present in SC1, SC8, SC12, SC20, and SC21.

Surface water treatment

Surface water treatment potential was analyzed for the Upper Shingle Creek Subwatershed and associated drainage areas (Table 121 and Figure 46). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 121. Upper Shingle Creek Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
SC1	12.2	0.8	0.8	-	0.2	3.5	15.2	-	19.0	5.7	715.3	0.0	LOW
SC2	6.4	0.4	0.4	-	-	8.2	-	-	8.2	4.1	1011.8	0.0	LOW
SC3	4.9	0.3	0.3	-	-	2.7	-	-	2.7	1.3	433.7	0.0	LOW
SC4	2.3	0.1	0.1	-	-	-	-	-	0.0	0.0	0.0	0.1	HIGH
SC5	10.6	0.7	0.8	-	0.1	4.8	-	-	4.9	2.5	319.9	0.0	LOW
SC6	5.9	0.4	0.4	-	-	0.5	-	-	0.5	0.3	67.5	0.1	MED
SC7	26.2	1.7	1.7	-	0.4	5.4	-	-	5.8	3.0	175.4	0.0	LOW
SC9	55.0	3.5	3.6	-	0.8	9.6	-	-	10.3	5.4	148.3	0.0	LOW
SC8	19.5	1.2	1.2	0.8	-	0.1	24.2	-	25.1	6.9	560.8	0.0	LOW
SC12	15.5	1.0	1.0	-	-	8.0	13.9	-	21.9	7.5	760.8	0.0	LOW
SC13	2.8	0.2	0.2	-	-	0.6	-	-	0.6	0.3	160.3	0.0	LOW
SC14	1.7	0.1	0.1	-	-	0.9	-	-	0.9	0.4	395.0	0.0	LOW
SC15	3.4	0.2	0.2	-	0.4	4.7	-	-	5.1	2.6	1315.0	0.0	LOW
SC17	10.5	0.7	0.7	-	0.8	6.3	-	-	7.2	3.8	542.9	0.0	LOW
SC20	8.2	0.5	0.5	-	-	0.5	15.5	-	16.0	4.1	797.3	0.0	LOW
SC21	38.6	2.4	2.4	1.3	-	1.6	24.1	-	27.0	8.1	333.1	0.0	LOW

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Figure 46. Upper Shingle Creek Subwatershed.

Back of Figure 46

In conclusion, the Upper Shingle Creek Subwatershed is considered to be a low-priority for implementation of projects based on a medium receiving water ranking, low treatment deficiency, and low land use change. Drainage areas SC4 and SC6 would benefit from incorporation of best management practices. Best management practices associated with the approved Shingle Creek Chloride TMDL and Implementation Plan and other projects should be closely coordinated with the Shingle Creek Watershed Management Commission.

d. Schmidt Lake Subwatershed

Table 122. Schmidt Lake Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Shingle Creek	
Receiving Water Ranking	Schmidt Lake/MED	
Treatment Deficiency	High	
Land Use Change	Low	
Priority Status	**Medium**	
Receives runoff from:	SC32	Figure 47
Downstream-most water body:	SC31	Figure 47
Discharges to:	Bass Lake South	Figure 47
Exceptional Quality Wetlands	0.0 acres	Table 124
High Quality Wetlands	0.0 acres	Table 124
Medium Quality Wetlands	1.36 acres	Table 124
Low Quality Wetlands	0.0 acres	Table 124
Storm Water Ponds	0.4 acres	Table 124
Effective Treatment (Cuml. Area)	1.1 acres	Table 124
General Hydrologic Soil Group	B	
Total # of Drainage Areas	1	Figure 47
Drainage Area	203.6 acres	
Impervious Acreage	53.5 acres	Table 124
Impervious percentage	26.3%	
Impaired Waters	Bass Creek	

	Shingle Creek Bass Lake Schmidt Lake	
Impairments	Fish IBI, Chloride, Invertebrate IBI, Low Oxygen, Excess Nutrients	
EPA Approved TMDL	Shingle Creek Chloride	Appendix N

Location

The Schmidt Lake Subwatershed is located in northeastern Plymouth, directly south of Bass Lake. The contributing subwatershed is fully developed, primarily with residential land use.

Background

Schmidt Lake is the seventh largest lake basin in the Shingle Creek Watershed and is the most significant resource in this subwatershed (Table 123). The lake surface area is 47 acres with a fully developed tributary area of 190 acres. Land use is 77 percent residential. Some water quality monitoring data is available, however, information regarding dissolved oxygen is limited. Given lake stratification characteristics, dissolved oxygen conditions will be low and could become anoxic, favoring a fishery that is tolerant of low DO conditions. Release of nutrients from bottom sediments under these conditions may be significant.

Significant resources within the Schmidt Lake Subwatershed include Schmidt Lake itself as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F).

Table 123. Schmidt Lake data.

Lake Data	
DNR ID:	27-0102
Public Water #:	102P

Drainage Basin Area:	204 Acres
Lake Area	37 Acres
Drainage Basin Area to Lake Area Ratio:	5:1
Maximum Depth:	25 feet
Water Clarity:	5.4 feet
Phosphorus:	43 ppb
Chlorophyll a:	10 ppb
Winter Kill Status:	None
Park Information:	Schmidt Lake Park

Abundant Aquatic Plants
Arrowhead
Northern Watermilfoil
White Waterlily
Wild Celery
Bushy Pondweed

Exotic Aquatic Plants
Purple Loosestrife
Eurasian Watermilfoil
Curlyleaf Pondweed

DNR Fish Management Plan
Largemouth Bass (primary)
Bluegill sunfish (secondary)
Black Crappie (secondary)

In 2004, three rain gardens were installed within the watershed to help filter pollutants from previously untreated storm water. In 2005, the City began an enhanced street sweeping program to collect fine sediments and improved the public access to Schmidt Lake in conjunction with road improvements of Larch Lane. The improved public access has resulted in a high priority for Schmidt Lake.

The existing Schmidt Lake Subwatershed drainage system generally conforms to the 1980 Storm Drainage Plan. Specific problems in this subwatershed relate to water quality. Existing studies of Schmidt Lake include aquatic vegetation management surveys, and water quality monitoring data.

Surface water treatment

Surface water treatment potential was analyzed for the Schmidt Lake

Subwatershed and associated drainage areas (Table 124 and Figure 47). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type. Additionally, TMDL studies are underway to address the various impairments associated with this subwatershed.

Table 124. Schmidt Lake Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
SC31	53.5	3.4	3.4	0.4	-	1.5	-	-	1.8	1.1	32.4	2.3	HIGH

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Figure 47. Schmidt Lake Subwatershed.

Back of Figure 47

In conclusion, the Schmidt Lake Subwatershed is considered to be a medium-priority for implementation of projects based on a medium receiving water ranking, high treatment deficiency, and low land use change. Schmidt Lake would benefit from incorporation of best management practices. Best management practices associated with the approved Shingle Creek Chloride TMDL and Implementation Plan and other projects should be closely coordinated with the SCWMC.

Table 125. Schmidt Lake Management Plan

Subject:	Schmidt Lake Management Plan
Purpose:	Protect and preserve Schmidt Lake consistent with its City ranking and water quality goals.
Goal:	1. Work toward an in-lake average total phosphorus concentration of 38-60 µg/l, secchi depths greater than 2.4-4.6 feet, and chlorophyll-a concentrations below 10-30 µg/l. 2. Work toward reaching goals as set forth in any future EPA approved TMDL Implementation Plan.

Problems:

1. Schmidt Lake does not meet all lake water quality goals.
2. Schmidt Lake has aquatic invasive species.
3. The Schmidt Lake watershed lacks surface water treatment.
4. Due to the developed nature of the Schmidt Lake subwatershed, few options exist for structural BMPs.
5. Public access to Schmidt Lake is gravel and likely contributes to poor water quality.

Solutions:

1. Operate an enhanced street sweeping program.
2. Offer grant funds for shoreline restorations and other water quality BMPs.
3. Incorporate structural BMPs where feasible.
4. Study opportunities for wetland enhancements within the watershed.
5. Require surface water treatment for development and redevelopment projects which exceed 0.5 acres.
6. Discuss opportunities for aquatic vegetation management.
7. Implement any EPA approved TMDL Plan.
8. Continue implementing surface water quality monitoring.
9. Provide education to City residents on water quality.
10. Discuss the impact of sediment deltas on lake water quality.
11. Work cooperatively with the SCWMC to implement items in the SCWMC CIP.
12. Replace gravel public access with possible porous pavement.
13. Evaluate effect of rough fish on Schmidt Lake.

Table 126. Schmidt Lake Implementation Plan

Implementation Item	Resources	Measurement	Target Date	Est. Cost
1. Operate an enhanced street sweeping program	• City staff	• Lbs. of material removed from the street	SEE TABLE 18	SEE TABLE 18
2. Grant Funds for shoreline restorations and other water quality BMPs	• City staff • MN DNR • SCWMC	• Acreage of restored shoreline or other BMP projects.	SEE TABLE 7	SEE TABLE 7
3. Incorporate structural BMPs where feasible.	• City staff • BCWMC • Feasability study	• Number of BMPs and their modeled efficiency	SEE TABLE 5	SEE TABLE 5
4. Study opportunities for wetland enhancements within the Schmidt Lake watershed	• City staff • BWSR • MN DNR • SCWMC • Feasibility Study	• Acreage of wetland enhancements	SEE TABLE 12	SEE TABLE 12
5. Require surface water treatment to NURP standards for development or redevelopment projects that exceed 0.5 acres	• City staff • Surface Water Management Plan	• Improved quality of surface water runoff	2009-2016	$0
6. Discuss opportunities for aquatic vegetation management	• City Staff • EQC • Residents	• Number of meetings	2009	$0
7. Implement any EPA approved TMDL implementation plan	• City staff • MPCA • EPA • SCWMC	• EPA approved TMDL • Implementation of items		
8. Continue implementing surface water quality monitoring	• City staff • Three Rivers Park Dist.	• Annual Water Quality Monitoring Report	SEE TABLE 16	SEE TABLE 16

9. Education	• City staff • SCWMC • Three Rivers Park Dist.	• Number of promotions and mailers	SEE TABLE 14	SEE TABLE 14
10. Discuss the impact of sediment deltas on lake water quality	• City staff • EQC • Residents	• Number of meetings	2009	$0
11. Work cooperatively with the SCWMC to implement items in their CIP.	• City staff • SCWMC	• Completed projects	2009-2016	NA
12. Replace gravel public access	• City staff • MN DNR • SCWMC	• New access	2010	$20,000
13. Fish survey	• MN DNR	• Fish survey	2009	SEE TABLE 22

e. Bass Lake South Subwatershed

Table 127. Bass Lake South Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Shingle Creek	
Receiving Water Ranking	Bass Lake/Medium	
Treatment Deficiency	Medium	
Land Use Change	Low	
Priority Status	**Medium**	
Receives runoff from:	Upper Shingle Crk. Schmidt Lake	 Figure 48
Downstream-most water body:	SC30	Figure 48
Discharges to:	Bass Lake	Figure 48
Exceptional Quality Wetlands	0.0 acres	Table 128
High Quality Wetlands	3.4 acres	Table 128
Medium Quality Wetlands	13.7 acres	Table 128
Low Quality Wetlands	0.3 acres	Table 128
Storm Water Ponds	0.4 acres	Table 128
Effective Treatment (Cuml. Area)	4.8 acres	Table 128
General Hydrologic Soil Group	B	
Total # of Drainage Areas	2	Figure 48
Drainage Area	245.9 acres	
Impervious Acreage	92.0 acres	Table 128
Impervious percentage	37.4%	
Impaired Water	Bass Creek Shingle Creek Bass Lake	
Impairments	Fish IBI, Chloride, Invertebrate IBI, Low Oxygen Excess Nutrients	
EPA Approved TMDL	Shingle Creek Chloride	 Appendix N

Location

The Bass Lake South Subwatershed lies northwest of Schmidt Lake and directly south of Bass Lake. The subwatershed receives runoff from both the Schmidt Lake and Upper Shingle Creek subwatershed before discharging toward Bass Lake.

Background

The Bass Lake South Subwatershed generally conforms to the 1980 Storm Drainage Plan. A cross-connection to SC29A provides a second discharge point towards Bass Lake. No specific studies were identified during the preparation of this plan. One problem area was identified, however, in SC30 between Jonquil and Ives Lane. The open channel between these two streets and just north of Schmidt Lake Road was highly eroded and causing a flooding problem. The City of Plymouth corrected this problem in 2003.

Significant resources within the Bass Lake South Subwatershed include approximately 3.4 acres of high quality wetlands as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). High quality wetlands are present in SC19 and SC30.

Surface water treatment

Surface water treatment potential was analyzed for the Bass Lake South Subwatershed and associated drainage areas (Table 128 and Figure 48). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 128. Bass Lake South Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
SC19	31.9	2.0	2.0	0.4	0.3	9.4	0.8	-	10.9	5.5	276.8	0.0	LOW
SC30	60.1	3.8	3.8	-	-	4.3	2.6	-	7.0	2.8	74.2	1.0	MED

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Figure 48. Bass Lake South Subwatershed.

Back of Figure 48

In conclusion, the Bass Lake South Subwatershed is considered to be a medium-priority for implementation of projects based on a medium receiving water ranking, medium treatment deficiency, and low land use change. Drainage area SC30 would benefit from incorporation of best management practices. Best management practices associated with the approved Shingle Creek Chloride TMDL and Implementation Plan and other projects should be closely coordinated with the SCWMC.

f. Bass Lake Northwest Subwatershed

Table 129. Bass Lake Northwest Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Shingle Creek	
Receiving Water Ranking	Bass Lake/Medium	
Treatment Deficiency	Medium	
Land Use Change	High	
Priority Status	**Medium**	
Receives runoff from:		
Downstream-most water body:	SC26A/SC27	Figure 49
Discharges to:	Bass Lake	Figure 49
Exceptional Quality Wetlands	0.0 acres	Table 130
High Quality Wetlands	5.2 acres	Table 130
Medium Quality Wetlands	8.8 acres	Table 130
Low Quality Wetlands	0.0 acres	Table 130
Storm Water Ponds	2.2 acres	Table 130
Effective Treatment (Cuml. Area)	5.8 acres	Table 130
General Hydrologic Soil Group	B	
Total # of Drainage Areas	6	Figure 49
Drainage Area	279.9 acres	
Impervious Acreage	118.4 acres	Table 130
Impervious percentage	42.4%	
Impaired Water	Bass Creek Shingle Creek Bass Lake	

Impairments	Fish IBI, Chloride, Invertebrate IBI, Low Oxygen Excess Nutrients	
EPA Approved TMDL	Shingle Creek Chloride	Appendix N

Location

The Bass Lake Northwest Subwatershed is located in northeastern Plymouth, lying north of 55th Avenue between Bass Lake and I-494.

Background

The Bass Lake Northwest Subwatershed conforms to the 1980 Storm Drainage Plan. No specific studies or problems were identified during the preparation of this plan.

Significant resources within the Bass Lake Northwest Subwatershed include approximately 5.2 acres of high quality wetlands as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). High quality wetlands are present in SC26A, SC25, and SC27A.

Surface water treatment

Surface water treatment potential was analyzed for the Bass Lake Northwest Subwatershed and associated drainage areas (Table 130 and Figure 49). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 130. Bass Lake Northwest Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
SC24	22.4	1.4	1.4	-	-	1.3	-	-	1.3	0.6	45.0	0.8	HIGH
SC26A	**32.8**	**2.1**	**2.8**	**0.5**	-	**1.5**	**0.9**	-	**2.8**	**1.4**	**50.3**	**1.4**	**MED**
SC26B	3.2	0.2	0.2	0.9	-	-	-	-	0.9	0.9	447.2	0.0	LOW
SC25	27.0	1.7	1.7	0.8	-	2.6	2.2	-	5.6	2.7	155.0	0.0	LOW
SC26C	**31.5**	**2.0**	**2.0**	-	-	**3.5**	-	-	**3.5**	**1.8**	**87.8**	**0.2**	**MED**
SC27A	**1.6**	**0.1**	**0.1**	-	-	-	**2.1**	-	**2.1**	**0.5**	**520.0**	**0.0**	**LOW**

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Figure 49. Bass Lake Northwest Subwatershed.

Back of Figure 49

In conclusion, the Bass Lake Northwest Subwatershed is considered to be a medium-priority for implementation of projects based on a medium receiving water ranking, medium treatment deficiency, and high land use change. Drainage area SC24 would benefit from incorporation of best management practices. Best management practices associated with the approved Shingle Creek Chloride TMDL and Implementation Plan and other projects should be closely coordinated with the Shingle Creek Watershed Management Commission.

g. Bass Lake Subwatershed

Table 131. Bass Lake Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Shingle Creek	
Receiving Water Ranking	Bass Lake/Medium	
Treatment Deficiency	High	
Land Use Change	Low	
Priority Status	**Medium**	
Receives runoff from:	Bass Lake NW Bass Lake South	Figure 50
Downstream-most water body:	Bass Lake	Figure 50
Discharges to:	Lower Shingle Crk.	Figure 50
Exceptional Quality Wetlands	26.5 acres	Table 133
High Quality Wetlands	16.5 acres	Table 133
Medium Quality Wetlands	20.4 acres	Table 133
Low Quality Wetlands	0.0 acres	Table 133
Storm Water Ponds	0.4 acres	Table 133
Effective Treatment (Cuml. Area)	10.9 acres	Table 133
General Hydrologic Soil Group	B	
Total # of Drainage Areas	9	Figure 50
Drainage Area	196.4 acres	
Impervious Acreage	49.1 acres	Table 133
Impervious percentage	25.0%	

Impaired Water	Bass Creek Shingle Creek Bass Lake	
Impairments	Fish IBI, Chloride, Invertebrate IBI, Low Oxygen Excess Nutrients	
EPA Approved TMDL	Shingle Creek Chloride	Appendix N

Location

The Bass Lake Subwatershed is located in northeastern Plymouth, receiving water from the Bass Lake Northwest and Bass Lake South Subwatersheds and discharging to Lower Shingle Creek and into Maple Grove.

Background

The Bass Lake Subwatershed generally conforms to the 1980 Storm Drainage Plan. Bass Lake is the most significant resource within this subwatershed (Table 132). A street reconstruction was completed in drainage area SC28 in 2006. The City constructed 5 rain gardens with the street reconstruction project. Additionally, the City completed a drainage project for flood protection and water flow south of Schmidt Lake Road and east of Zachary Lane.

The most recent studies on Bass Lake include an aquatic vegetation survey and water quality monitoring data all collected in 2007. Additionally, the Shingle Creek Watershed Management Commission received the report entitled “Report on Existing Water Quality Data for Bass Lake – Plymouth, Minnesota” in 1995. The report identifies Bass Lake as providing important wildlife habitat as well as numerous recreational opportunities including fishing, swimming, and boating. Bass Lake is the second largest lake in Plymouth and the Shingle Creek Watershed.

Table 132. Bass Lake data.

Lake Data	
DNR ID:	27-0098
Public Water #:	98P
Drainage Basin Area:	3111 Acres
Lake Area	174 Acres
Drainage Basin Area to Lake Area Ratio:	18:1
Maximum Depth:	31 feet
Water Clarity:	5.0 feet
Phosphorus:	67 ppb
Chlorophyll a:	35 ppb
Winter Kill Status:	Occasional
Park Information:	Timber Shores Park
Abundant Aquatic Plants	
Cattails	
Canada Waterweed	
Bushy Pondweed	
White Waterlily	
Yellow Waterlily	
Lesser Duckweed	
Exotic Aquatic Plants	
None	
DNR Fish Management Plan	
Largemouth Bass (primary)	
Bluegill Sunfish (secondary)	
Northern Pike (secondary)	

According to the report, the Bass Lake Watershed has experienced significant development since 1990. The lake has a history of winter kill, when dissolved oxygen (DO) levels become depleted to the point where most fish species can no longer survive. The report concluded the lake is partially supportive of swimming, which is considered to be the most sensitive use of the lake. Other than water quality, no specific problems were identified as part of the plan.

Significant resources within the Bass Lake Subwatershed include approximately 43.0 acres of exceptional and high quality wetlands as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). Exceptional and high quality wetlands are present in SC23, SC35, and SC32.

Surface water treatment

Surface water treatment potential was analyzed for the Bass Lake Subwatershed and associated drainage areas (Table 133 and Figure 50). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 133. Bass Lake Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
SC29	2.9	0.2	0.2	-	-	3.4	-	-	3.4	1.7	840.0	0.0	LOW
SC29A	7.0	0.4	0.4	0.2	-	9.9	-	-	10.1	5.2	1169.2	0.0	LOW
SC27	11.9	0.8	0.8	-	-	0.4	-	-	0.4	0.2	26.3	0.6	HIGH
SC23	14.2	0.9	0.9	-	-	-	13.6	-	13.6	3.4	377.8	0.0	LOW
SC22	15.7	1.0	1.0	-	-	-	-	-	0.0	0.0	0.0	1.0	HIGH
SC32A	2.3	0.1	0.1	-	-	0.2	-	-	0.2	0.1	54.5	0.1	MED
SC32B	1.5	0.1	0.2	-	-	0.4	-	-	0.4	0.2	128.3	0.0	LOW
SC35	28.6	1.8	1.8	0.2	-	1.2	-	26.5	27.9	0.8	42.3	1.0	HIGH
SC36	28.6	1.8	2.9	-	-	2.7	-	-	2.7	1.4	47.3	1.5	HIGH
SC32	8.0	0.5	0.5	-	-	-	2.9	-	2.9	0.7	143.1	0.0	LOW
SC28	**49.1**	**3.1**	**6.2**	**-**	**-**	**0.4**	**-**	**-**	**0.4**	**0.2**	**3.4**	**6.0**	**HIGH**

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Figure 50. Bass Lake Subwatershed.

Back of Figure 50

In conclusion, the Bass Lake Subwatershed is considered to be a medium-priority for implementation of projects based on a medium receiving water ranking, high treatment deficiency, and low land use change. Drainage areas SC27, SC22, SC35, SC36, SC28 would benefit from incorporation of best management practices. The City of Plymouth's most recent Capital Improvements Program (2009-2013) lists a surface water drainage improvement project for the Wild Wings development and an improvement to the Bass Lake outlet. Best management practices associated with the approved Shingle Creek Chloride TMDL and Implementation Plan and other projects should be closely coordinated with the SCWMC.

Table 134. Bass Lake Management Plan

Subject:	Bass Lake Management Plan
Purpose:	Protect and preserve Bass Lake consistent with its City ranking and water quality goals.
Goal:	1. Work toward an in-lake average phosphorus concentration of 38-60 µg/l, secchi depths greater than 2.4-4.6 feet, and chlorophyll-a concentrations below 10-30 µg/l. 2. Work toward reaching goals as set forth in any future EPA approved TMDL Implementation Plan.

Problems:

1. Bass Lake does not meet all lake water quality goals.
2. Bass Lake has a substantial amount of aquatic invasive species.
3. The Bass Lake watershed lacks surface water treatment.
4. Due to the developed nature of the Bass Lake subwatershed, few options exist for structural BMPs.

Solutions:

1. Operate an enhanced street sweeping program.
2. Offer grant funds for water quality BMPs.
3. Incorporate structural BMPs where feasible.
4. Study opportunities for wetland enhancements within the watershed.
5. Require surface water treatment for development and redevelopment projects which exceed 0.5 acres.
6. Discuss opportunities for aquatic vegetation management.
7. Implement any EPA approved TMDL Plan.
8. Continue implementing surface water quality monitoring.
9. Provide education to City residents on water quality.
10. Discuss the impact of sediment deltas on lake water quality.
11. Work cooperatively with the SCWMC to implement items in the SCWMC CIP.
12. Evaluate the effect of rough fish on Bass Lake.

Table 135. Bass Lake Implementation Plan

Implementation Item	Resources	Measurement	Target Date	Est. Cost
1. Operate an enhanced street sweeping program	• City staff	• Lbs. of material removed from the street	SEE TABLE 18	SEE TABLE 18
2. Grant Funds for water quality BMPs	• City staff • MN DNR • SCWMC	• Acreage of restored shoreline or other BMP projects.	SEE TABLE 7	SEE TABLE 7
3. Incorporate structural BMPs where feasible.	• City staff • SCWMC • Feasibility study	• Number of BMPs and their modeled efficiency	SEE TABLE 5	SEE TABLE 5
4. Study opportunities for wetland enhancements within the Bass Lake watershed	• City staff • BWSR • MN DNR • SCWMC • Feasibility Study	• Acreage of wetland enhancements	SEE TABLE 12	SEE TABLE 12
5. Require surface water treatment to NURP standards for development or redevelopment projects that exceed 0.5 acres	• City staff • Surface Water Management Plan	• Improved quality of surface water runoff	2009-2016	$0
6. Discuss opportunities for aquatic vegetation management	• City Staff • EQC • Residents	• Number of meetings	2009	$0
7. Implement any EPA approved TMDL implementation plan	• City staff • MPCA • EPA • SCWMC	• EPA approved TMDL • Implementation of items		
8. Continue implementing surface water quality monitoring	• City staff • Three Rivers Park Dist.	• Annual Water Quality Monitoring Report	SEE TABLE 16	SEE TABLE 16

	• SCWMC			
9. Education	• City staff • SCWMC	• Number of promotions and mailers	SEE TABLE 14	SEE TABLE 14
10. Discuss the impact of sediment deltas on lake water quality	• City staff • EQC • Residents	• Number of meetings	2009	$0
11. Work cooperatively with the SCWMC to implement items in their CIP.	• City staff • SCWMC	• Completed projects	2009-2016	NA
12. Fish survey	• MN DNR	• Fish Survey	2010	SEE TABLE 22

h. Lower Shingle Creek Subwatershed

Table 136. Lower Shingle Creek Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Shingle Creek	
Receiving Water Ranking	Low	
Treatment Deficiency	Medium	
Land Use Change	High	
Priority Status	**Medium**	
Receives runoff from:	Bass Lake	Figure 51
Downstream-most water body:	SC37/SC34	Figure 51
Discharges to:	SC38	Figure 51
Exceptional Quality Wetlands	51.0 acres	Table 137
High Quality Wetlands	50.9 acres	Table 137
Medium Quality Wetlands	17.3 acres	Table 137
Low Quality Wetlands	0.9 acres	Table 137
Storm Water Ponds	2.2 acres	Table 137
Effective Treatment (Cuml. Area)	26.0 acres	Table 137
General Hydrologic Soil Group	NA	
Total # of Drainage Areas	8	Figure 51
Drainage Area	458.9 acres	
Impervious Acreage	128.2 acres	Table 137
Impervious percentage	28.0%	
Impaired Water	Bass Creek Shingle Creek	
Impairments	Fish IBI, Chloride, Invertebrate IBI, Low Oxygen	
EPA Approved TMDL	Shingle Creek Chloride	Appendix N

Location

The Lower Shingle Creek Subwatershed is directly downstream from Bass Lake in northeastern Plymouth. Bass Creek flows from Bass Lake through this subwatershed and ultimately flows into Brooklyn Park where it combines with Eagle Creek to form Shingle Creek.

Background

The Lower Shingle Creek Subwatershed conforms to the 1980 Storm Drainage Plan. However, a formal storm sewer system along the south side of County Road 10 (SC33 and SC37) is not in place according to the City's storm sewer base map. Also, a formal outlet from SC33A has not been constructed as planned. Several large wetland complexes dominate this subwatershed. No specific studies were identified during the preparation of this plan. In 1996, residents of the Cardinal Ridge Development brought forward a request to re-route storm sewer discharges from 55th Avenue North and Nathan Lane to discharge east under 54th Avenue North and avoid the high quality wetland where discharges are currently going.

Significant resources within the Lower Shingle Creek Subwatershed include approximately 107.0 acres of exceptional and high quality wetlands as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). Exceptional and high quality wetlands are present in SC33A, SC33D, and SC33C.

Surface water treatment

Surface water treatment potential was analyzed for the Lower Shingle Creek Subwatershed and associated drainage areas (Table 137 and Figure 51). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 137. Lower Shingle Creek Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
SC33B	1.7	0.1	0.1	0.1	-	3.3	-	-	3.5	1.8	1795.0	0.0	LOW
SC33A	27.3	1.7	1.7	0.6	-	0.2	27.9	6.6	35.3	7.7	443.1	0.0	LOW
SC33D	15.3	1.0	1.0	-	-	-	-	44.5	44.5	0.0	0.0	1.0	HIGH
SC33C	18.9	1.2	2.2	0.5	0.9	-	23.0	-	24.3	6.9	314.0	0.0	LOW
SC33	10.3	0.7	0.7	0.3	-	9.6	-	-	9.9	5.1	772.4	0.0	LOW
SC37	**14.0**	**0.9**	**0.9**	**0.7**	**-**	**0.7**	**-**	**-**	**1.4**	**1.1**	**121.7**	**0.0**	**LOW**
SC34	**40.8**	**2.6**	**2.6**	**-**	**-**	**3.5**	**-**	**-**	**3.5**	**1.7**	**67.1**	**0.8**	**MED**

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Figure 51. Lower Shingle Creek Subwatershed

Back of Figure 51

In conclusion, the Lower Shingle Creek Subwatershed is considered to be a medium-priority for implementation of projects based on a low receiving water ranking, medium treatment deficiency, and high land use change. Drainage area SC33D would benefit from incorporation of best management practices. Best management practices associated with the approved Shingle Creek Chloride TMDL and Implementation Plan and other projects should be closely coordinated with the SCWMC.

i. Shingle Creek Outlet Subwatershed

Table 138. Shingle Creek Outlet Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Shingle Creek	
Receiving Water Ranking	Low	
Treatment Deficiency	Low	
Land Use Change	High	
Priority Status	**Medium**	
Receives runoff from:	Lower Shingle Crk.	Figure 52
Downstream-most water body:	SC38	Figure 52
Discharges to:	Maple Grove	Figure 52
Exceptional Quality Wetlands	0.0 acres	Table 139
High Quality Wetlands	37.2 acres	Table 139
Medium Quality Wetlands	3.8 acres	Table 139
Low Quality Wetlands	0.2 acres	Table 139
Storm Water Ponds	0.0 acres	Table 139
Effective Treatment (Cuml. Area)	4.0 acres	Table 139
General Hydrologic Soil Group	B & C	
Total # of Drainage Areas	1	Figure 52
Drainage Area	159.7 acres	
Impervious Acreage	63.7 acres	Table 139
Impervious percentage	39.9%	
Impaired Water	Bass Creek Shingle Creek	

Impairments	Fish IBI, Chloride, Invertebrate IBI, Low Oxygen
EPA Approved TMDL	Shingle Creek Chloride

Location

The Shingle Creek Outlet Subwatershed is located in extreme northeastern Plymouth. This subwatershed receives runoff from Lower Shingle Creek before ultimately discharging to Maple Grove.

Background

The Shingle Creek Outlet Subwatershed conforms to the 1980 Storm Drainage Plan. However, the SC38 drainage area is considerably larger than indicated in the 1980 Storm Drainage Plan. The storm sewer on the north side of County Road 10/Bass Lake Road was modified between Trenton Lane and Nathan Lane to accommodate this difference. No specific studies or problems were identified during the preparation of this plan.

Significant resources within the Shingle Creek Outlet Subwatershed include approximately 37.2 acres of high quality wetlands as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). High quality wetlands are present in SC38.

Surface water treatment

Surface water treatment potential was analyzed for the Shingle Creek Outlet Subwatershed and associated drainage areas (Table 139 and Figure 52). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 139. Shingle Creek Outlet Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
SC38	**63.7**	**4.0**	**4.0**	**-**	**0.2**	**3.8**	**37.2**	**-**	**41.2**	**11.3**	**283.7**	**0.0**	**LOW**

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Figure 52. Shingle Creek Outlet Subwatershed.

Back of Figure 52

In conclusion, the Shingle Creek Outlet Subwatershed is considered to be a medium-priority for implementation of projects based on a low receiving water ranking, low treatment deficiency, and high land use change. Drainage area SC38 would benefit from incorporation of best management practices. Best management practices associated with the approved Shingle Creek Chloride TMDL and Implementation Plan and other projects should be closely coordinated with the SCWMC.

j. Pike Lake Subwatershed

Table 140. Pike Lake Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Shingle Creek	
Receiving Water Ranking	Medium/Pike	
Treatment Deficiency	Low	
Land Use Change	Medium	
Priority Status	**Medium**	
Receives runoff from:	SC39 and SC40	Figure 53
Downstream-most water body:	Pike Lake	Figure 53
Discharges to:	Maple Grove	Figure 53
Exceptional Quality Wetlands	36.7 acres	Table 142
High Quality Wetlands	0.0 acres	Table 142
Medium Quality Wetlands	13.6 acres	Table 142
Low Quality Wetlands	0.5 acres	Table 142
Storm Water Ponds	0.2 acres	Table 142
Effective Treatment (Cuml. Area)	7.9 acres	Table 142
General Hydrologic Soil Group	B	
Total # of Drainage Areas	2	Figure 53
Drainage Area	368.2 acres	
Impervious Acreage	77.8 acres	Table 142
Impervious percentage	21.1%	
Impaired Water	Pike Lake Eagle Lake Shingle Creek	

Impairments	Excess Nutrients Mercury FCA Chloride	
EPA Approved TMDL	Shingle Creek Chloride	Appendix N

Location

The Pike Lake Subwatershed is located in the northeastern part of Plymouth, north of Bass Lake and bounded to the north by the Plymouth/Maple Grove City limits. The City limits effectively split Pike Lake into two parts.

Background

The Pike Lake Subwatershed conforms to the 1980 Storm Drainage Plan, however, the 1980 Storm Drainage Plan shows a channel sweeping north into Maple Grove and then to Pike Lake. Currently, Pike Creek follows the city limits north of 62^{nd} Avenue, discharging through a sediment trap before continuing on to Pike Lake. This channel underwent a stabilization project in 2003. Pike Lake is the most significant resource within this subwatershed (Table 141). No specific studies were identified regarding this subwatershed during the process of preparing this plan. No problems were identified during the process of preparing this plan.

Table 141. Pike Lake data.

Lake Data	
DNR ID:	27-0111-02
Public Water #:	111P
Drainage Basin Area:	932 Acres
Lake Area	48 Acres
Drainage Basin Area to Lake Area Ratio:	19:1
Maximum Depth:	15 feet
Water Clarity:	4.6 feet
Phosphorus:	78 ppb
Chlorophyll a:	20 ppb
Winter Kill Status:	Occasional
Park Information:	Hennepin Parks

Abundant Aquatic Plants
Cattails
Muskgrass
Coontail
Greater Bladderwort
Northern Watermilfoil
Flatstem Pondweed
Bushy Pondweed
White Waterlily
Yellow Waterlily

Exotic Aquatic Plants
Purple Loosestrife

DNR Fish Management Plan
Walleye (primary)
Largemouth Bass (secondary)

Significant resources within the Pike Lake Subwatershed include Pike Lake itself as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F).

Surface water treatment

Surface water treatment potential was analyzed for the Pike Lake Subwatershed and associated drainage areas (Table 142 and Figure 53). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 142. Pike Lake Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
SC39	38.1	2.4	2.4	-	-	3.4	-	-	3.4	1.7	70.0	0.7	MED
SC40	**60.6**	**3.8**	**4.6**	**0.2**	**-**	**9.9**	**-**	**-**	**10.1**	**5.2**	**113.7**	**0.0**	**LOW**

__Figure 53. Pike Lake Subwatershed.__

Back of Figure 53

In conclusion, the Pike Lake Subwatershed is considered to be a medium-priority for implementation of projects based on a medium receiving water ranking, low treatment deficiency, and medium land use change. Drainage area SC39 would benefit from incorporation of best management practices. Best management practices associated with the approved Shingle Creek Chloride TMDL and Implementation Plan and other projects should be closely coordinated with the SCWMC.

Table 143. Pike Lake Management Plan

Subject:	Pike Lake Management Plan
Purpose:	Protect and preserve PIke Lake consistent with its City ranking and water quality goals.
Goal:	1. Work toward an in-lake average total phosphorus concentration of 38-60 µg/l, secchi depths greater than 2.4-4.6 feet, and chlorophyll-a concentrations below 10-30 µg/l. 2. Work toward reaching goals as set forth in any future EPA approved TMDL Implementation Plan.

Problems:

1. Pike Lake does not meet all lake water quality goals.
2. Pike Lake may have aquatic invasive species.
3. The Pike Lake watershed lacks surface water treatment.
4. Due to the developed nature of the Pike Lake subwatershed, few options exist for structural BMPs.

Solutions:

1. Operate an enhanced street sweeping program.
2. Offer grant funds for water quality BMPs.
3. Incorporate structural BMPs where feasible.
4. Study opportunities for wetland enhancements within the watershed.
5. Require surface water treatment for development and redevelopment projects which exceed 0.5 acres.
6. Discuss opportunities for aquatic vegetation management.
7. Implement any EPA approved TMDL Plan.
8. Implement surface water quality monitoring.
9. Provide education to City residents on water quality.
10. Discuss the impact of sediment deltas on lake water quality.
11. Work cooperatively with the SCWMC to implement items in the SCWMC CIP.
12. Evaluate the effect of rough fish on Pike Lake.

Table 144. Pike Lake Implementation Plan

Implementation Item	Resources	Measurement	Target Date	Est. Cost
1. Operate an enhanced street sweeping program	• City staff	• Lbs. of material removed from the street	SEE TABLE 18	SEE TABLE 18
2. Grant Funds for water quality BMPs	• City staff • MN DNR • SCWMC	• Acreage of restored shoreline or other BMP projects.	SEE TABLE 7	SEE TABLE 7
3. Incorporate structural BMPs where feasible.	• City staff • SCWMC • Feasibility study	• Number of BMPs and their modeled efficiency	SEE TABLE 5	SEE TABLE 5
4. Study opportunities for wetland enhancements within the Pike Lake watershed	• City staff • BWSR • MN DNR • SCWMC • Feasibility Study	• Acreage of wetland enhancements	SEE TABLE 12	SEE TABLE 12
5. Require surface water treatment to NURP standards for development or redevelopment projects that exceed 0.5 acres	• City staff • Surface Water Management Plan	• Improved quality of surface water runoff	2009-2016	$0
6. Discuss opportunities for aquatic vegetation management	• City Staff • EQC • Residents	• Number of meetings	2009	$0
7. Implement any EPA approved TMDL implementation plan	• City staff • MPCA • EPA • SCWMC	• EPA approved TMDL • Implementation of items		
8. Implement surface water quality monitoring	• City staff • Three Rivers Park Dist.	• Annual Water Quality Monitoring Report	SEE TABLE 16	SEE TABLE 16

9. Education	• City staff • BCWMC • Three Rivers Park Dist.	• Number of promotions and mailers	SEE TABLE 14	SEE TABLE 14
10. Discuss the impact of sediment deltas on lake water quality	• City staff • EQC • Residents	• Number of meetings	2009	$0
11. Work cooperatively with the SCWMC to implement items in their CIP.	• City staff • SCWMC	• Completed projects	2009-2016	NA
12. Fish study	• MN DNR	• Fish survey	2009	SEE TABLE 22

k. New Hope Subwatershed

Table 145. New Hope Subwatershed Characteristics

	Characteristic	Plan Reference
Watershed	Shingle Creek	
Receiving Water Ranking	Low	
Treatment Deficiency	High	
Land Use Change	Medium	
Priority Status	**Medium**	
Receives runoff from:		Figure 54
Downstream-most water body:	NH3B/NH5	Figure 54
Discharges to:	New Hope	Figure 54
Exceptional Quality Wetlands	18.6 acres	Table 146
High Quality Wetlands	13.4 acres	Table 146
Medium Quality Wetlands	12.7 acres	Table 146
Low Quality Wetlands	0.2 acres	Table 146
Storm Water Ponds	0.5 acres	Table 146
Effective Treatment (Cuml. Area)	4.5 acres	Table 146
General Hydrologic Soil Group	NA	
Total # of Drainage Areas	8	Figure 54
Drainage Area	276.4 acres	
Impervious Acreage	136.9 acres	Table 146
Impervious percentage	46.7%	
Impaired Water	Shingle Creek	
Impairments	Chloride	
EPA Approved TMDL	Shingle Creek Chloride	Appendix N

<u>Location</u>

The New Hope Subwatershed is located in eastern Plymouth, between Bass Lake and Highway 169. The subwatershed is fully developed and ultimately discharges west into New Hope. The overflow is limited by an agreement with New Hope to 40 cfs at the 36-inch culvert crossing north of 49th Avenue and to 10 cfs at the 24-inch crossing at 49th Avenue.

Background

The New Hope Subwatershed conforms to the 1980 Storm Drainage Plan, with a trunk storm sewer following Schmidt Lake Road. No specific studies or were identified during the preparation of this plan, however, sedimentation is occurring at discharge points into New Hope.

Significant resources within the New Hope Subwatershed include approximately 32.0 acres of exceptional and high quality wetlands as well as adjacent natural areas as identified in the Natural Resources Inventory (Appendix F). Exceptional and high quality wetlands are present in NH2B, NH2C, and NH4.

Surface water treatment

Surface water treatment potential was analyzed for the New Hope Subwatershed and associated drainage areas (Table 146 and Figure 54). The analysis consisted of a comparison between the required ponding based on impervious area and the existing storm water pond and wetland acreage/type.

Table 146. New Hope Subwatershed Treatment Potential.

Drainage Area ID	Existing Imperv Area (Ac)	D.A. Req. Pond (Ac)	Total Req. Pond (Ac)	Storm Class (Ac)	Low Class (Ac)	Med Class (Ac)	High Class (Ac)	Excpt. Class (Ac)	Total	Effec Acres	Drainage Area Treat. Status (%)	Treat. Defic. (Ac)	Treat. Defic. Value
NH2B	19.2	1.2	1.2	-	-	4.4	5.6	-	10.0	3.6	299.6	0.0	LOW
NH2A	10.7	0.7	0.7	-	-	-	-	-	0.0	0.0	0.0	0.7	HIGH
NH2D	8.4	0.5	0.5	-	-	-	-	-	0.0	0.0	0.0	0.5	HIGH
NH2C	15.2	1.0	1.0	-	-	-	7.8	-	7.8	1.9	194.0	0.0	LOW
NH4	31.4	2.0	2.0	0.5	0.2	7.6	-	18.6	27.0	4.5	224.9	0.0	LOW
NH3A	12.8	0.8	0.8	-	-	-	-	-	0.0	0.0	0.0	0.8	HIGH
NH3B	31.4	2.0	4.0	-	-	0.7	-	-	0.7	0.3	8.3	3.6	HIGH
NH5	**7.9**	**0.5**	**0.5**	**-**	**-**	**-**	**-**	**-**	**0.0**	**0.0**	**0.0**	**0.5**	**HIGH**

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Figure 54. New Hope Subwatershed.

Back of Figure 54

In conclusion, the New Hope Subwatershed is considered to be a medium-priority for implementation of projects based on a low receiving water ranking, high treatment deficiency, and medium land use change. Drainage areas NH2A, NH2D, NH3A, NH3B, and NH5 would benefit from incorporation of best management practices. The City of Plymouth's most recent Capital Improvements Program (2009-2013) lists a surface water drainage improvement project for the Wild Wings development in 2009. Best management practices associated with the approved Shingle Creek Chloride TMDL and Implementation Plan and other projects should be closely coordinated with the SCWMC.

END OF SURFACE WATER MANAGEMENT PLAN