4.0 Water Quality

4.1 Issue Statements

The lakes, ponds, streams, and wetlands of the Bassett Creek watershed are important community assets. These resources supply aesthetic and recreational benefits, in addition to providing wildlife and fisheries habitat and refuge. The BCWMC recognizes the need to ensure adequate water quality in the water bodies in its jurisdiction, and has taken steps to protect these resources. These steps include adopting a water quality management policy, classifying major water bodies, collecting water quality data (including biological data) for the major water bodies, preparing watershed and lake management plans for the major water bodies, developing an implementation program to meet water quality goals, and reviewing proposed projects for conformance with BCWMC policies.

Stormwater runoff carries with it a number of contaminants affecting water quality. The principal pollutants found in runoff include nutrients, sediments, organic materials, pathogens, hydrocarbons, metals, pesticides, chlorides, trash and debris. Table 4-1, from the *Minnesota Urban Small Sites BMP Manual* (Barr Engineering, 2001, for the Metropolitan Council), summarizes the source of these pollutants and their impacts. Of these pollutants, the BCWMC recognizes that phosphorus and suspended sediment are particularly detrimental to the health and recreational use of lakes and streams. As a result, the BCWMC requires measures to reduce the influx of these pollutants to its water bodies.

This section includes the water quality goals and polices followed by a detailed water quality background discussion. The background includes a review of the water quality planning approach, and the following water quality issues associated with streams and lakes:

Streams: the plan includes the BCWMC's involvement with the watershed outlet monitoring program (WOMP); its biological indicators monitoring and a review of the *Bassett Creek Main Stem Watershed Management Plan*. Recommendations provided in the Main Stem plan are summarized. However, not all recommendations are included in the capital improvement plan.

Lakes: the plan includes a summary of the historical lake monitoring and preparation of 12 watershed and lake management plans. Recommendations provided in each of the 12 plans are summarized. However, not all recommendations are included in the capital improvement plan.

These plans were prepared between 1993 and 2000. Several changes have occurred in the watershed since completion of some of the plans. The BCWMC has made an effort to address updated information at the end of the discussion for each plan. A summary of the watershed information for each of the primary water resources and copies of the most recent water quality monitoring data is included in Appendix E.

Some of these lake and streams plans will also need to be updated because the water bodies have been listed as "impaired" (not meeting water quality standards and not supporting assigned beneficial uses) by the MPCA. The federal Clean Water Act requires that the MPCA assess the quality of streams and lakes in Minnesota, determine if they are impaired and list and report the impaired waters to the EPA. Water bodies on the 303(d) list (Section of the Clean Water Act) are required to have an assessment completed that addresses the causes and sources of the impairment. This process is called a total maximum daily load (TMDL) analysis and its purpose is to bring the water body back into compliance with water quality standards. The State of Minnesota's Water Quality Standards, Minnesota Rules Chapter 7050, are the numeric and narrative conditions that are used to determine if the waters are impaired.

There are currently five lakes and Bassett Creek in the Bassett Creek watershed that are included on the MPCA's draft 2004 impaired waters 303(d) list:

- Parkers Lake (listed for mercury)
- Medicine Lake (listed for mercury and excess nutrients)
- Sweeney Lake (listed for excess nutrients)
- Wirth Lake (listed for mercury and excess nutrients)
- Northwood Lake (listed for excess nutrients)
- Bassett Creek (listed for biota/fish)

4.2 Goals and Policies

4.2.1. Water Quality Goals

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. Such uses may include aesthetic appreciation, wildlife observation, swimming, boating or others.

Improve the quality of stormwater runoff reaching the Mississippi River by reducing nonpoint source pollution (including sediment) carried as stormwater runoff.

Protect and enhance fish and wildlife habitat and maintain shoreland integrity.

The BCWMC's 30 µg/L phosphorus goal for Level I lakes is the same as the MPCA's earlier phosphorus criteria for "full support" of swimmable use in this ecoregion (*Minnesota Lake Water Quality Assessment Data: 1997*, MPCA, 1998). The document states that a 30 µg/L phosphorus concentration "ensures that conditions associated with impaired swimming would occur less than ten percent of the summer. Phosphorus concentrations above criteria levels would result in greater frequencies of nuisance algal blooms and increased frequencies of impaired swimming." The document further states that a 40 µg/L phosphorus concentration serves as the upper threshold for "support threatened" swimmable use.

The BCWMC will conduct a future review of the criteria included in the standards (Minnesota Rules 7050) and a comparison of the criteria and available water quality data, including bacteria. An evaluation will be completed to determine if additional data is needed.

4.2.2. Water Quality Policies

4.2.2.1 Policies Relating to Lake and Stream Management

A. The BCWMC will classify major water bodies into one of four management categories (Level I – IV) based on desired water quality goals and recreational uses of the water bodies. Table 4-2 lists the management classifications of the major BCWMC water bodies. Table 4-3 presents the desired, in-lake water quality goals for each of the management categories.

B. In their local water management plans, the member cities will classify water bodies into one of four management categories (Level I – IV) based on desired water quality goals and recreational uses of the water bodies (see Table 4-3).

C. The BCWMC will work with stakeholders to manage water bodies to attain the BCWMC water quality goals.

D. The BCWMC and the member cities will implement the improvement options listed in Table 12-2 to improve or maintain the water quality of the water bodies with regional significance, based on feasibility, prioritization, and available funding. Table 12-2 is the 10-year CIP for implementing the improvement options identified in the lake plans. The BCWMC will update its 10-year CIP annually. Table 12-3 lists potential future water quality improvement projects. All but one of these projects (PL-5) was recommended by the BCWMC's watershed and lake management plans to attain or maintain the BCWMC's water quality goals. The projects listed in Table 12-3 are not likely to be ready for implementation in the 10 years following adoption of the Plan. The BCWMC will move ahead with the alum treatment projects listed in Table 12-3 only after sufficient time has passed to evaluate the effectiveness of the less-costly water quality best management practices (BMPs) and other improvement projects. Figure 12 shows all of these proposed water quality improvement projects. The BCWMC will move ahead with the alum treatment projects listed in Table 12-3 only after it has been shown that the structural and nonstructural BMPs listed in Table 12-2 have been implemented and it is apparent that the BMPs have been unable to achieve the BCWMC water quality goals.

E. The BCWMC will give higher priority to water quality improvement projects including nonstructural measures and education that are the most effective at achieving water quality goals.

   A discussion of stormwater BMPs from Section 5 of the BCWMC's *Medicine Lake Watershed and Lake Management Plan* and a listing of BMPs from the *Requirements for Improvements and Development Proposals* are included in Appendices C and F, respectively.

F. The BCWMC will fund 100 percent of the water quality improvement project costs for those projects listed in the 10-year CIP (Table 12-2). The projects will be funded in accordance with the BCWMC joint powers agreement and (specifically) Minnesota Statutes 103B.251. This statute allows BCWMC to certify Hennepin County to levy an ad valorem tax over the

Bassett Creek watershed for the sole purpose of funding projects identified in the BCWMC Plan. The BCWMC will follow the process for ordering projects as outlined in its joint powers agreement and summarized in Section 12.2.

G. The BCWMC will cooperate with member cities, the MPCA and other stakeholders in the preparation of TMDL studies for water bodies on the MPCA's current or future impaired waters (303(d)) list (currently Parkers Lake, Medicine Lake, Sweeney Lake, Wirth Lake, Northwood Lake, and Bassett Creek). Since the MPCA's regional TMDL study for mercury will include Parkers Lake and Medicine Lake, the BCWMC and the cities will not likely be involved in those TMDL studies. However, since Medicine Lake is also listed as impaired for nutrients, a separate TMDL study for nutrients will need to be completed, which will involve the cities, lake associations, the BCWMC, and other stakeholders. The BCWMC will work with the cities to evaluate funding options for the TMDL studies. As part of the TMDL studies, responsibilities for implementation and funding sources will be identified. The BCWMC will adopt these TMDL studies, once they are approved by the MPCA.

H. The BCWMC will continue to identify opportunities to maintain or improve the excellent water quality in Twin Lake (in the city of Golden Valley).

I. The BCWMC will monitor, or coordinate with others to monitor, the water quality of the lakes and streams in the watershed on a regular basis. Monitoring will vary from BCWMC's participation in the Metropolitan Council's Citizen Assisted Monitoring Program (CAMP) to more in-depth monitoring performed by BCWMC, the Three Rivers Park District, or the Minneapolis Park and Recreation Board (MPRB). The BCWMC will determine the appropriate monitoring frequency of monitoring programs funded by the BCWMC. The objective of the monitoring is to detect changes or trends in the water quality over time, thereby determining the effect of changing land use patterns in the watershed and the effectiveness of the BCWMC's efforts to preserve/improve water quality.

J. The BCWMC will consider moving projects listed in Table 12-3 to the 10-year CIP (Table 12-2), using the minor plan amendment process, if water quality problems arise in water bodies that are monitored regularly (e.g., Parkers Lake). The BCWMC's 10-year CIP (see Table 12-2) includes one improvement project for Parkers Lake (PL-6). This project is one of the projects recommended in the city's plan. As long as the lake's water quality continues to meet the BCWMC goals, the BCWMC will not implement the structural BMPs

recommended in the BCWMC's Parkers Lake Plan. The BCWMC considers these projects to be "future projects" that are not yet included in the BCWMC's CIP (see Table 12-3). Table 12-3 also includes another project recommended in the city's plan.

K. The BCWMC will include chloride monitoring in its stream water quality testing programs, when appropriate.

L. The BCWMC will compile a water quality report for every year sampling is conducted for the BCWMC's lakes and/or streams. All of the water quality monitoring results for that year will be consolidated into a single report. The BCWMC will then post the report on the BCWMC website.

4.2.2.2 Policies Relating to Stormwater Runoff Management

A. The BCWMC will require all regulated stormwater to be treated to Level I standards throughout the watershed. See Policy A, under Section 4.2.2.4 "Policies Relating to Administration of BCWMC Water Quality Management Standards."

B. The BCWMC will continue to participate in the Metropolitan Council's Watershed Outlet Monitoring Program (WOMP) to monitor the water quality of Bassett Creek before it enters the Mississippi River.

C. Each city shall adopt an ordinance that enforces the Minnesota State Law limiting the use of lawn fertilizers containing phosphorus. The BCWMC shall develop, in conjunction with the cities, an education program that educates residents about the importance of soil testing to determine their lawns' nutrient needs. Education programs will include factual information regarding the affects of phosphorus and nitrogen on the water quality of lakes, wetlands, and streams. The effort expended in implementing these education programs will be consistent with available resources.

D. BCWMC requires developers to consider/evaluate the use of BMPs in the *Requirements for Improvements and Development Proposals* (1998) (Appendix F), and to submit with their application a report on the BMPs implemented on the proposed project and why the other suggested BMPs cannot be implemented on the project. Appendix B is a categorization of BMPs.

4.2.2.3 Policies Relating to Fish and Wildlife Habitat and Shoreland Management

A. The BCWMC requires that a buffer policy for land adjacent to water resources (including wetlands) be included in the member cities' revised local stormwater management plans.

B. When the BCWMC deems appropriate, the BCWMC will react to recommendations from other agencies regarding fish and wildlife issues.

C. The BCWMC will collect, or coordinate with others to collect, macroinvertebrate (insect) monitoring data at selected stream locations within BCWMC, preferably through continued support of Hennepin Conservation District's River Watch program.

D. The BCWMC will promote and encourage protection of non-disturbed shoreland areas and restoration of disturbed shorelines and streambanks to their natural state where feasible.

E. The BCWMC will encourage preservation of streambank and lakeshore vegetation during and after construction projects.

F. The BCWMC will encourage the creation of a buffer zone along shorelines where natural vegetation is maintained. These "lakescaping" techniques provide wildlife habitat and help improve water quality.

G. The cities are required to maintain control and responsibility for shoreland regulation. Cities are required to adopt DNR-approved shoreland ordinances, in accordance with the DNR's priority phasing list.

4.2.2.4 Policies Relating to Administration of BCWMC Water Quality Management Standards

A. The BCWMC will review projects and developments to evaluate compliance with BCWMC water quality management standards. The BCWMC water quality management standards will be revised to reflect treatment of all regulated stormwater from new development to Level I standards and non-degradation (no increase in phosphorus load) for redevelopment projects that result in increased impervious surface. The rationale behind this policy is that because there is very little undeveloped land in the watershed, the maximum amount of stormwater treatment should be obtained at the time of development, to avoid costly retrofitting in the future. The BCWMC also believes a uniform policy for stormwater treatment in the watershed is appropriate. The types of projects that must be submitted to the BCWMC for

review, the BCWMC's review procedure, submittal requirements, guidelines, design criteria, etc. are provided in the BCWMC's document *Requirements for Improvements and Development Proposals* (BCWMC, November 1998, as revised) (Appendix F).

A commercial, industrial, institutional, or public development is defined as a project involving a site of more than 0.5 acres of land where there is no existing commercial, industrial, institutional, or public development.

A residential development is defined as a project involving a site of more than 2 acres and which contains 4 or more proposed living units.

Commercial, industrial, institutional, or public redevelopment is defined as a project involving more than 5 acres of land where commercial, industrial, institutional, or public redevelopment currently exists and a more intense land use is proposed (increased impervious surface). A residential redevelopment project is defined as a site greater than 10 acres where there are more than 4 existing living units and where more intense land use is proposed (increased impervious surface).

B. The BCWMC will continue to work with other public agencies to gain their compliance with the BCWMC water quality management standards; such compliance will help maintain and possibly improve the quality of stormwater runoff. The Minnesota legislature requires watershed management organizations to adopt and implement water management policies and therefore, the BCWMC believes it is the responsibility of all public agencies to conform to the BCWMC's water management policies.

C. The BCWMC will review local watershed management plans for compliance with this Plan's goals and policies regarding water quality.

4.3 Background

Although originally formed to address flood control issues in the watershed, the BCWMC has become more involved in water quality monitoring, planning, and management. For example, in 1987 the DNR, the Hennepin County Public Works Department, the BCWMC, and the city of Plymouth cooperated to construct a rough fish barrier on Plymouth Creek. The 1982 Medicine Lake water quality management plan called for construction of a rough fish barrier as part of the implementation program. The fish barrier prevents the migration of rough fish from Medicine Lake to spawning areas

along Plymouth Creek, thus reducing the population of rough fish in Medicine Lake and eventually improving water clarity in the lake.

The BCWMC's involvement in water quality issues accelerated in 1991, when a workshop was held to discuss water quality issues within the Bassett Creek watershed. As a result of this workshop, the BCWMC developed its *Draft Water Quality Management Plan* (1993 Water Quality Plan (BCWMC, February 1993)), which identified water quality goals for the major water bodies in the Bassett Creek watershed. The 1993 Water Quality Plan proposed the BCWMC's initial water quality objectives for water bodies, wetlands and streams in the Bassett Creek watershed. Public participation was encouraged during the goal-setting process. Comments from citizens indicated a desire for the BCWMC to perform watershed and lake management plans for the entire watershed. Between 1993 and 2000, the BCWMC completed watershed and lake management plans for 14 lakes/ponds and the Main Stem of Bassett Creek. These individual plans set forth the improvements required to achieve or maintain the BCWMC's water quality goals. In addition to the proposed water quality improvements, numerous BMPs have been implemented since the BCWMC adopted its water quality plan. Figure 8 shows the location of these in-place BMPs.

During development of the 1993 Water Quality Plan, the BCWMC issued a recreational use survey to local, regional, and state water resources managers to determine the current and intended recreational uses for each water body and each stretch of Bassett Creek in the Bassett Creek watershed. The BCWMC used the survey results for the goal-setting process, which assigned each water body to a water quality category based on its intended recreational use.

The 1993 Water Quality Plan proposed rules regarding water quality. The BCWMC used these proposed rules to develop a water quality management policy, which they adopted in 1994. This water quality management policy is included in the BCWMC's *Requirements for Improvements and Development Proposals* (1995, revised 1998) (Appendix F). The BCWMC's 1993 Water Quality Plan and subsequent water quality management policy divided water bodies located in the Bassett Creek watershed into four management categories. The categories are based on desired water quality goals and recreational uses. These categories include:

Level I – These water bodies fully support all water-based recreational activities including swimming, scuba diving, and snorkeling.

Level II – These water bodies are appropriate for all recreational uses except full body contact activities. Recreational activities for these water bodies include: sail boating, water skiing, motor boating, canoeing, wind surfing, and jet skiing.

Level III – These water bodies will support fishing, aesthetic viewing activities, and observing wildlife.

Level IV – These water bodies are generally intended for runoff management (i.e., stormwater detention) and have no significant recreational use values.

The degree to which a water body can support a particular recreational use is primarily controlled by the quality of its water. In lakes, wetlands, and to a certain extent, streams, nutrients (primarily phosphorus) control what recreational activities can occur in the Bassett Creek watershed. Phosphorus controls the recreational uses of water bodies because it is the nutrient that limits the growth of algae. High algal growth is a major cause of poor water clarity, which is often the determining factor in the recreational use suitability of a water body. The BCWMC set goals for phosphorus and chlorophyll-a (a measure of algal abundance) concentrations and Secchi disc transparency (a measure of water clarity) for each water quality category. These water quality goals are shown in Table 4-3.

The BCWMC classified 18 water bodies and the Main Stem of Bassett Creek; these are shown in Table 4-2. After classifying the water bodies, the BCWMC set specific water quality goals for each lake, pond, or stream. These goals were compared to current and predicted future water quality to assess whether the water bodies required protection or restoration to maintain or achieve their goals. The BCWMC found that water quality goals could not be met without taking measures to assure adequate water quality in the subwatersheds draining to the water bodies. As a result, watershed management, including review of land development, forms a major component of the management program for the lakes and streams of the Bassett Creek watershed.

Water quality monitoring within the Bassett Creek watershed shows control of phosphorus levels to be the key to attaining the categorical goals for the water body. The BCWMC's watershed management and land development policies are therefore directed mainly at controlling the amount of phosphorus that is transported in the runoff from the watershed.

The BCWMC intends to use regional watershed treatment facilities wherever possible to attain the water quality goals for the watershed. In addition to regional treatment, implementation of BMPs is required on construction sites throughout the watershed. Such practices are seen as particularly important in areas of the watershed where regional detention facilities have not been established or are not feasible.

To encourage water quality protection and the use of BMPs, the BCWMC reviews plans for construction activities within the Bassett Creek watershed in accordance with this policy. Prior to implementation of this Plan, activities within the subwatershed were regulated according to the classification (Level I, II, III, etc.) of the receiving water body – less nutrient removal (treatment) was required in watersheds tributary to Level II water bodies than in watersheds tributary to Level I water bodies. Implementation of this Plan will require treatment of all regulated stormwater to Level I standards throughout the watershed, regardless of the classification of the receiving water. The rationale behind the policy is for the BCWMC and its member cities to obtain the highest level of stormwater runoff treatment at the time of development or redevelopment everywhere in the watershed.

Through its lake (stream) and watershed management plans, the BCWMC learned that many of the water bodies were not meeting the BCWMC's water quality goals. This means that the BCWMC and its member cities should be striving to achieve as much stormwater treatment as possible. Also, requiring Level I stormwater runoff treatment does not guarantee that the water quality of the water bodies classified as Level I will meet the BCWMC's Level I water quality goals (likewise for Level II and III treatment). The proposed policy to require Level I stormwater treatment throughout the watershed would "unlink" the water body classification from the required level of stormwater treatment. It would also help the BCMWC to classify water bodies realistically. For example, Turtle Lake and Lost Lake are currently both classified as Level II, but their current water quality and use are more closely aligned with a Level III water body (in fact, remedial measures would be needed for Turtle Lake to meet Level III water quality goals). The Turtle Lake and Lost Lake watershed and lake management plans did not recommend changing the water body classifications to Level III because to do so would have decreased the BCWMC's required water quality treatment requirements in the watershed (these lakes are also tributary to Medicine Lake). By requiring Level I treatment throughout the watershed, the BCWMC could then revise the management classifications for Turtle Lake and Lost Lake to Level III, without jeopardizing the level of treatment to be provided in those watersheds.

4.3.1. Stormwater Runoff

Closely related to the reduction of phosphorus loads to the water bodies is the control of suspended sediment inflows. Suspended sediment – fine particles of soil, dust, and dirt transported in moving water – results from stormwater runoff from streets and parking lots and abounds when erosion occurs. Sediment is also a major source of phosphorus, which is frequently bound to the fine

particles. As a result, many of the BCWMC's standards are aimed at preventing or slowing the transport of fine soil, dust, and dirt particles into the streams and lakes.

Managing stormwater runoff is a basic responsibility of local governments. The BCWMC looks to its member cities for primary management of local stormwater runoff issues. The Metropolitan Council requires cities to adopt stormwater management ordinances as part of their comprehensive plan updates. The Metropolitan Council's adopted "Interim Strategy to Reduce Nonpoint Source Pollution to All Metropolitan Water Bodies" includes three requirements: (1) local governments must adopt design standards (such as NURP) for new stormwater ponds that will reduce pollutant loadings from stormwater runoff; (2) local governments must follow the BMPs given in the MPCA's *Protecting Water Quality in Urban Areas* (2000), or an equivalent set of standards; and (3) local governments must adopt the DNR's shoreland regulations, as required by the DNR's priority phasing list. The Metropolitan Council developed a model stormwater ordinance that addresses the first two requirements. The MPCA developed a later model stormwater ordinance.

Under the U.S. Environmental Protection Agency's (EPA) Storm Water Phase II NPDES Rules, small municipal separate storm sewer systems ("MS4s") serving populations under 100,000 that are located in urbanized areas, are required to obtain a National Pollutant Discharge Elimination System (NPDES) Phase II Storm Water permit under the Clean Water Act. The Phase II rule takes a "best management practice" approach, providing MS4s with the flexibility to decide what practices to implement. MS4s must develop, implement, and enforce a Storm Water Pollution Prevention Plan (SWPPP) designed to minimize the discharge of pollutants from the MS4, to protect water quality, and to satisfy the appropriate water quality requirements of the Clean Water Act. The SWPPP must be designed and managed to minimize the discharge of pollutants from the MS4 to the maximum extent practicable (MEP). The SWPPP must include BMPs that control or reduce pollutants, as appropriate for the community. The Phase II rules also require owners and operators of construction sites disturbing one to five acres to obtain a NPDES stormwater permit for construction activity.

The MPCA may modify the NPDES permit or issue other permits that include more stringent effluent limitations, including permit requirements that are in addition to the minimum control measures. This is most likely to occur in watershed areas with an approved TMDL allocation. SWPPPs must meet the requirements of an approved TMDL implementation plan.

4.3.2. Streams

The BCWMC conducts water quality monitoring of streams in the watershed and analyzes the data to determine if the water quality is improving or degrading. The BCWMC collects biological data for its streams on a regular basis. The biological data are indicators (bioindicators) of water quality.

4.3.2.1 Watershed Outlet Monitoring Program (WOMP)

In 2000, the BCWMC, in cooperation with Metropolitan Council Environmental Services (MCES) and the Minneapolis Park and Recreation Board, began monitoring Bassett Creek as part of the Watershed Outlet Monitoring Program (WOMP). The WOMP program is coordinated by MCES and consists of a network of monitoring stations located throughout the Metro Area. The objective of this program is to collect water quality and quantity (stream flow) data needed to assess current conditions, develop target pollutant loads, and to provide continued monitoring after BMPs are implemented in the watersheds.

The Bassett Creek WOMP site is located at Irving Avenue, one-fourth mile upstream of the storm sewer tunnel that runs beneath downtown Minneapolis to the Mississippi River. Data collection consists of continuous measurements of stream flow, temperature and conductivity, as well as monthly base flow grab samples and storm event composite samples. The samples are analyzed in the MCES laboratory for many water quality parameters.

Prior to installation of the WOMP station, the BCWMC collected continuous water quality monitoring data for Bassett Creek in 1980 and 1992, at two different locations.

4.3.2.2 Biological Indicators

Temperature and flow data give only an indirect measure of a stream's suitability for fish and other aquatic species. A second approach to assessing the health of a stream is to sample the organisms that are living in the stream. Monitoring for the presence of biological indicator organisms provides indirect evidence of the water quality of Bassett Creek, including transitory changes in stream water quality related to stormwater runoff. Evaluating benthic macroinvertebrates (bottom-dwelling aquatic organisms, mainly insects) in a stream provides a long-term assessment of its water quality. The benthic invertebrates are exposed to all the temporal variations in stream water quality and 'integrate' the quality of passing water. Therefore the presence or absence of pollutant tolerant organisms demonstrates the water quality impacts of urban runoff better than do grab samples. The inventory of benthic organisms also indicates whether there is a suitable food supply for fish.

The types of organisms living on the stream bottom depend on the available habitat, and the habitat quality is affected by the water quality. Water quality is degraded when pollutants enter a stream. Organic pollutants and nutrients cause a loss of oxygen in the stream. Organisms sensitive to low oxygen concentrations in the water are only able to survive in the highest water quality. There are tolerant invertebrate species that can survive in low oxygen conditions, and their presence indicates low water quality (i.e., organic pollution). Other stressors, such as high suspended solids concentration or high metals concentrations, can also affect the macroinvertebrate community.

Historically, benthic organisms have been collected and inventoried from several Bassett Creek locations. During 1980, 1983, 1991, 1995, and 2000 benthic macroinvertebrates were collected from Plymouth Creek, the Sweeney Lake Branch, and from the North Branch and Main Stem of Bassett Creek to evaluate their water quality and to detect changes in water quality over time. The report *A Biotic Index Evaluation of Bassett Creek and Plymouth Creek: 2000* (Biotic Index Report, BCWMC, 2001) evaluates the existing water quality and assesses changes. The sampling locations are identified as follows:

- Main Stem of Bassett Creek at Rhode Island Avenue in Golden Valley.
- Main Stem of Bassett Creek south of Zane Avenue North in Crystal.
- Main Stem of Bassett Creek at Irving Avenue, upstream of the conduit, in Minneapolis.
- North Branch of Bassett Creek at 32nd Street and Adair in Crystal.
- Sweeney Lake Branch of Bassett Creek at Turner's Crossroad (Xenia Avenue) in Golden Valley.
- Plymouth Creek at Industrial Park Boulevard in Plymouth.

The locations were the same in all surveys, except for the North Branch location. Prior to 2000, the North Branch was sampled just north of Zane Avenue. In 1995, this location had silted in and was no longer a representative habitat for the stream. A short distance upstream, at 32nd and Adair, the habitat was characteristic of the stream and samples were collected at that site.

At each sample location, samples were collected from riffle areas where the flow was fairly rapid and the substrate was composed of gravel and small stones. Samples were collected by disturbing the creek bottom and allowing dislodged invertebrates to drift into a net downstream. Rocks and other substrate materials were also examined for invertebrates.

An average pollution tolerance was determined for all species collected from the stream. To determine the average water quality of each Bassett Creek monitoring location, the pollution tolerance level of invertebrates collected from the creek was determined. Two biotic indices were used to evaluate the water quality of Bassett Creek in 2000. The Hilsenhoff Biotic Index (HBI) is an indicator of organic pollution and the Invertebrate Community Index (ICI) is an indicator of a broader range of pollutants.

The HBI has been used in all of the surveys to assess water quality at the sample stations, based on the macroinvertebrate communities (Hilsenhoff, 1982 and 1987). The HBI uses tolerance values assigned to certain species. Tolerance values indicate the species' ability to survive in low-oxygen conditions and range from 0 to 10. The lower the value, the less tolerant the species to low dissolved oxygen. A tolerance value of 0 is assigned to species collected only in unaltered streams of very high water quality, and a 10 is assigned to species known to occur in severely polluted or significantly disturbed streams. Intermediate values have been assigned to species known to occur in streams with various degrees between good water quality and poor water quality. The following table shows how the biotic index values were used to determine water quality and the degree of organic pollution of the stream locations.

Tolerance Value	Water Quality	Degree of Organic Pollution
0.00-3.50	Excellent	No apparent organic pollution
3.51-4.50	Very Good	Possible slight organic pollution
4.51-5.50	Good	Some organic pollution
5.51-6.50	Fair	Fairly significant organic pollution
6.51-7.50	Fairly poor	Significant organic pollution
7.51-8.50	Poor	Very significant organic pollution
8.51-10.00	Very Poor	Severe organic pollution

Beginning in 1995, the HBI has been supplemented by the ICI, developed by the Ohio Environmental Protection Agency (DeShon, 1995). The ICI-based index uses the same data collected for the HBI, but includes a wider range of invertebrates. The ICI tolerance values were derived from the abundance of each organism and the quality of the streams in which they were found. The scale for the ICI varies from 0 to 60, with 60 being the highest quality. Like the HBI, the numeric scores are grouped according to water quality categories, ranging from poor to exceptional.

Figure 9 shows the location of the biotic index sampling stations. Figure 10 and Figure 11 summarize the biological monitoring results. Figure 10 compares the HBI and ICI indices for 1995 and 2000.

Figure 11 shows a graphical comparison of the HBI values at all stations since biomonitoring began in 1980. The 2000 evaluation of the HBI values indicated the following:

- Statistically significant water quality improvement occurred at the Sweeney Lake Branch location between 1995 and 2000; the water quality in 2000 was the best it has been since 1980.

- No statistically significant water quality changes occurred at the other five stations between 1995 and 2000. However, over the 20-year biomonitoring period, these stations have shown significant improvements in water quality.

Both the HBI and ICI generally gave similar water quality classifications, with the exception of the Sweeney Lake Branch station. Comparing the Sweeney Lake Branch results to the other six sampling stations, the HBI values indicated that it had the highest water quality, whereas the ICI values indicated it had the lowest water quality. This discrepancy between the two indices suggest the oxygen-demanding pollutants are low at the Sweeney Lake Branch, but other pollutants or stressors, as reflected in the ICI, may be affecting the macroinvertebrates.

Notable changes in water quality should prompt a look at stormwater flow patterns, land use changes, and watershed management practices. To identify the actual stressors, additional water quality monitoring would be needed. The monitoring would need to include collection of storm event runoff using automatic samplers and flow loggers. Water quality parameters could include total and dissolved phosphorus, total suspended solids, and metals.

Based on the results of the 2000 monitoring program, the Biotic Index Report recommends the following:

- The BCWMC's management efforts appear to be benefiting the water quality in Bassett Creek, given the improvements in water quality over the last 20 years and the stable water quality conditions of the last five years. The BCWMC should continue to pursue the installation of BMPs such as those that have been installed in the last decade.

- The biotic index results demonstrate that they are useful in the long-term of Bassett Creek water quality. The BCWMC should continue to use the two biotic indices (HBI and ICI).

- The BCWMC should continue to sample all stations again in five years to maintain the long-term monitoring record. (The BCWMC has recommended sampling on a three-year cycle.)

4.3.2.3 Bassett Creek Main Stem Watershed Management Plan

The following paragraphs summarize the watershed management plan that the BCWMC prepared for the Main Stem of Bassett Creek.

The *Bassett Creek Main Stem Watershed Management Plan* (Bassett Creek Main Stem Plan (BCWMC, June 2000)) establishes priorities and provides guidelines for the cities of Plymouth, Minnetonka, St. Louis Park, New Hope, Crystal, Golden Valley, Robbinsdale, and Minneapolis, the BCWMC, and citizens for meeting water quality goals set for the Main Stem of Bassett Creek. As shown in Table 4-2, the BCWMC goal for the Bassett Creek Main Stem is a management classification of Level III, meaning its water quality should support fishing, aesthetic viewing and wildlife observation activities.

Bassett Creek currently suffers from the problems that commonly occur when a creek's watershed becomes urbanized. The increased volume and pollutant levels of stormwater runoff from the watershed result in a deterioration of stream water quality. The focus of the Bassett Creek Main Stem Plan is the total water and phosphorus loading to Bassett Creek because these are the most likely to have adverse downstream effects.

The watershed of the Main Stem of Bassett Creek was adjusted to reflect changes resulting from the newly constructed Bassett Creek tunnel. The Bassett Creek Main Stem Plan divides the watershed into four drainage districts: Upper Main Stem – West, Upper Main Stem – East, Middle Main Stem, and Lower Main Stem. Each drainage district was evaluated for nutrient removal efficiency under existing land use conditions. These conditions were found to be consistent with final development conditions.

As part of the Bassett Creek Main Stem Plan, in-pond improvement options and site-specific structural best management practices for each drainage district were evaluated. The Bassett Creek Main Stem Plan also identifies general best management practices to be implemented throughout the watershed. The recommendations are discussed in the following paragraphs.

Site-Specific Structural Best Management Practices Recommendations

Site-specific recommendations for each of the drainage districts are described below.

1. <u>Upper Main Stem – West Drainage District</u>

This drainage district accounts for a relatively small proportion of the total phosphorus contributions to the Main Stem of Bassett Creek. The existing wetlands and detention basins have relatively high

removal efficiencies, so the Bassett Creek Main Stem Plan does not recommend any new structural best management practices. However, it does strongly recommend that the detention basins and wetlands in this district be inspected on a regular basis. Such inspections should occur during dry and wet periods to ensure that these systems continue to function efficiently.

2. Upper Main Stem – East Drainage District

This drainage district provides an excellent opportunity to reduce phosphorus loading to the Main Stem of Bassett Creek. Currently, it only provides approximately 34 percent removal of total phosphorus. Significant improvements in water quality could be made through the implementation of the following two best management practices recommended in the Bassett Creek Main Stem Plan:

- **Construction of BC-10-3 Detention Basin** – This basin would treat stormwater runoff from the largely commercial and industrial district neighboring Boone Avenue. The basin, as proposed, would remove nearly 37 pounds of phosphorus from stormwater running off to the Main Stem of Bassett Creek. This improvement option is shown as BC-1 (Option 4 in the Bassett Creek Main Stem Plan) on Figure 12.

- **Construction of BC-91-5 Detention Basin** – Located adjacent to the intersection of Winnetka Avenue and 10th Avenue North, this basin would treat 62 acres of residential land that currently discharges untreated to the Main Stem of Bassett Creek. In an average year, this basin would remove 34 percent, or 14 pounds, of the phosphorus from storm flows to the Main Stem. This improvement option is shown as BC-6 (Option 5 in the Bassett Creek Main Stem Plan) on Figure 12. The Bassett Creek Main Stem Plan notes that space limitations and access are obstacles to the construction of this best management practice.

3. Middle Main Stem Drainage District

This district was found to have the highest areal phosphorus loading (pounds of phosphorus per acre of land area in a watershed) in this study. It also accounts for a significant amount of the total phosphorus loading to the Main Stem. A large portion of the stormwater runoff from impervious surfaces in this district is currently untreated. Significant reductions in phosphorus loading to the Main Stem of Bassett Creek could result through the implementation of the following three best management practices recommended in the Bassett Creek Main Stem Plan:

- **Retrofit and Excavation of HH-11 Detention Basin** – This option requires the excavation of an existing stormwater detention basin located at the intersection of Hampshire Lane and Douglas Drive. It receives flows from a large upstream complex of basins and stormwater runoff from the

Honeywell complex. Design modifications to this basin could potentially increase the phosphorus removal efficiency from 17 to 20 percent (an additional 36 pounds of phosphorus). This improvement option is shown as BC-4 (Option 1 in the Bassett Creek Main Stem Plan) on Figure 12. The Bassett Creek Main Stem Plan recommends that this option be constructed along with the following two options since these basins operate in series. This will enhance the longevity and removal efficiency of each basin.

- **Construction of HH1111-1 Detention Basin** – This detention basin would be located south of the intersection of Sandburg Road and Louisiana Avenue in Golden Valley, and would treat stormwater runoff from the surrounding industrial area. This best management practice would enhance the phosphorus removal efficiency and increase the life expectancy of downstream basins. On average, this basin would remove 67 pounds of phosphorus annually. This improvement option is shown as BC-2 (Option 2 in the Bassett Creek Main Stem Plan) on Figure 12.

- **Construction of HH11-0 Detention Basin** – This detention basin would be located along the railroad corridor between Hampshire Lane and the Honeywell Complex located on Douglas Drive. The basin would provide additional treatment to stormwater runoff from the series of larger upstream basins, and remove 15 pounds of phosphorus annually. This improvement option is shown as BC-8 (Option 3 in the Bassett Creek Main Stem Plan) on Figure 12. The primary purpose of this basin is to enhance the life expectancy and removal efficiency of the proposed retrofit to basin HH-11.

4. <u>Lower Main Stem Drainage District</u>

This drainage district receives flow from the entire Bassett Creek watershed and terminates at the Bassett Creek Tunnel in Minneapolis. This district currently has good removal efficiency and the lowest areal phosphorus loading of the drainage districts in the study. However, residential areas in Golden Valley and Minneapolis contribute significant amounts of untreated flow to the Main Stem. The implementation of the following three best management practices recommended in the Bassett Creek Main Stem would address significant portions of these flows and significantly reduce the mean annual phosphorus loading to the Main Stem of Bassett Creek:

- **Construction of BC-72-2 Detention Basin** – The 63.5 acre watershed of this residential neighborhood contributes untreated stormwater runoff to the Main Stem of Bassett Creek. A detention basin located west of Scott Avenue North and south of Dawnview Terrace could reduce

the annual phosphorus loading from 34 pounds to 20 pounds, a removal efficiency of 41 percent. This improvement option is shown as BC-7 (Option 6 in the Bassett Creek Main Stem Plan) on Figure 12.

- **Construction of BC-11112-12 Detention Basin** – This basin would be located near Bassett Creek, just north of the park area in the Bryn Mawr neighborhood and treat stormwater runoff from 209 acres of land. Runoff from about 100 acres already receives treatment in the detention basin located near Penn Avenue. This basin would reduce the annual phosphorus loading to the Main Stem from 54 pounds to 32 pounds, a removal efficiency of 40 percent. This improvement option is shown as BC-5 (Option 7 in the Bassett Creek Main Stem Plan) on Figure 12.

- **Construction of BC-111152 Detention Basin** – This basin would be located just west of the intersection of Xerxes Avenue and 16th Street. Storm sewers draining 658 acres of mostly residential land located in the city of Minneapolis would contribute flow to this detention basin. Construction of a detention basin at Logan Avenue North, from 27th Avenue North to 29th Avenue North, will treat runoff from about 115 of these acres. Construction of this pond will be completed in the summer of 2003. The remaining 543 acres contribute runoff to the Main Stem of Bassett Creek without treatment. This drainage area is so large that to accomplish any significant reductions in phosphorus loading requires large detention volumes. The proposed basin would require about 4 acres of land, but could reduce the annual phosphorus loading by 131 pounds. This is equivalent to 15 percent of the total loading within the Lower Main Stem drainage district. This improvement option is shown as BC-3 (Option 8 in the Bassett Creek Main Stem Plan) on Figure 12.

In-Stream Improvement Recommendations

Inventory Channel Erosion Sites

The Bassett Creek Main Stem Plan recommends that an inventory of stream channel erosion sites be performed to minimize the damages posed to hydraulic structures, stream channels, private property, bridge footings, building foundations, natural stream aesthetics, and water quality by channel erosion. This inventory is also recommended in the *Bassett Creek Park Pond Watershed Management Plan*. The recommended inventory has two phases. Phase I is the acquisition of all existing sources of information regarding known stream channel erosion. Phase II is a field inventory of problematic stream sites along the entire length of the creek. The Bassett Creek Main Stem Plan recommends completion of a report summarizing the results of the Phase I and II inventories. The report would include:

1. Site recommendations for in-stream improvements.
2. An inventory of all in-stream problem areas.
3. A severity index denoting magnitude and impacts of erosion.
4. A photographic log of problem areas.
5. Location maps of problem areas.
6. Identification of the nature of the in-stream problem (erosion, deposition, etc.).
7. A list of resources impacted at each site (bridges, culverts, private property, etc.).

This inventory and report minimizes long term investment costs while focusing efforts where they may be most effective. In addition, this type of inventory prevents the risk of unknowingly exacerbating stream channel impacts in adjacent upstream and downstream problem areas.

General Best Management Practice Recommendations

The Bassett Creek Main Stem Plan recommends the same general best management practices recommended for the entire Bassett Creek watershed in the lake management plans.

Update: Activities Since Completion of Watershed Management Plan

The BCWMC's structural capital improvement program includes the BC-1 BMP recommended in the Bassett Creek Main Stem Plan (shown in Table 12-2). Since the member cities have already completed or will complete channel erosion inventories, the channel erosion inventory recommended in the Bassett Creek Main Stem Plan is not included in the BCWMC's BMP program. The BCWMC considers the other BMPs recommended in the Bassett Creek Main Stem Plan to be potential future water quality projects and are not yet included in the BCWMC's CIP (see Table 12-3).

Since completion of the Bassett Creek Main Stem Plan, the cities of Golden Valley, New Hope and Plymouth have completed channel erosion inventories for Bassett Creek. Figure 13 shows the erosion and sedimentation sites that have been identified in the BCWMC. These identified sites will be eligible for BCWMC funding for stream restoration (see the Stream Restoration section of this Plan for more information).

Since completion of the Bassett Creek Main Stem Plan, the BCWMC, in cooperation with the Metropolitan Council Environmental Services, began monitoring Bassett Creek as part of the Watershed Outlet Monitoring Program (WOMP). The BCMC also collected new biological data from

various stream locations in 2000. More information about Bassett Creek stream monitoring can be found in the preceding Streams subsection of this Plan.

4.3.3. Lakes

Several different organizations have monitored the water quality of lakes in the Bassett Creek watershed at various times. These organizations include BCWMC, the Metropolitan Council, Three Rivers Park District (TRPD) (formerly Hennepin Parks and Suburban Hennepin Regional Park District), the Minnesota Pollution Control Agency (Citizen Lake Monitoring Program), the Minnesota Department of Natural Resources, Minneapolis Park and Recreation Board (MPRB), municipalities, and others, including volunteers for the Metropolitan Council's Citizen Assisted Monitoring Program (CAMP). Water quality data, typically including Secchi disc transparency, total phosphorus concentration, and chlorophyll-a concentration, have been collected at the following lakes, in the following years:

- Medicine Lake:
  Secchi disc transparency, total phosphorus, and chlorophyll-a: 1972, 1974, 1977, 1981, 1982-1984, 1990-1995, 1997-2001 (BCWMC, TRPD)
  Secchi disc transparency only: 1980, 1985, 1988, 1989, 1996, 1980-2001 (MPCA)
  Total phosphorus and Secchi disc transparency: 1948, 1966, 1969
  Total phosphorus and chlorophyll-a: 1974
  Secchi disc transparency and chlorophyll-a: 1990

  Remote Underwater Sampling Station (RUSS) operated by Lake Access and TRPD, provides real-time data and monitoring of Medicine Lake. RUSS is funded through a grant from the Environmental Protection Agency's EMPACT program. (http://lakeaccess.org/): 2001-2003

- Parkers Lake:
  Secchi disc transparency, total phosphorus, and chlorophyll-a: 1972, 1977, 1980, 1982, 1992, 1995, 1996, 2000 (BCWMC); 1999-2002 (others); 2000, 2002, 2003 (CAMP)
  Secchi disc transparency and total phosphorus: 1990-2001 (TRPD)

- Wirth Lake:
  Secchi disc transparency, total phosphorus, and chlorophyll-a: 1972, 1977, 1982 (BCWMC); 1992-1995, 2001, 2002 (MPRB)
  Secchi disc transparency only: 1979 and 1986 (MPCA)
  Total phosphorus and Secchi disc transparency: 1975

- Sweeney Lake:
  Secchi disc transparency, total phosphorus, and chlorophyll-a: 1972, 1977, 1982, 1985, 1992, 1996, 2000 (BCWMC); 2000-2003 (CAMP)

- Twin Lake (June 2000):
  Secchi disc transparency, total phosphorus, and chlorophyll-a: 1972, 1977, 1982, 1992, 1996, 2000 (BCWMC)

- Westwood Lake:
  Secchi disc transparency, total phosphorus, and chlorophyll-a: 1982, 1993, 1997 (BCWMC); and 2000-2002 (CAMP)
  Total phosphorus and Secchi disc transparency: 1972
  Total phosphorus and chlorophyll-a: 1977 (BCWMC)

- Northwood Lake:
  Secchi disc transparency, total phosphorus, and chlorophyll-a: 1982, 1992, 1996, 2000 (BCWMC); 2000-2002 (CAMP)
  Total phosphorus only: 1972
  Total phosphorus and chlorophyll-a: 1977 (BCWMC)

- North Rice Pond:
  Secchi disc transparency, total phosphorus, and chlorophyll-a: 1994 and 1998 (BCWMC)

- South Rice Pond:
  Secchi disc transparency, total phosphorus, and chlorophyll-a: 1994, 1998 (BCWMC); 2000-2002 (CAMP)

- Grimes Pond:
  Secchi disc transparency, total phosphorus, and chlorophyll-a: 1996 (BCWMC)

- Crane Lake (Dayton Pond, Ridgedale Pond):
  Secchi disc transparency, total phosphorus, and chlorophyll-a: 1982, 1993, 1997, 2001 (BCWMC); 1977-1994 (others)
  Total phosphorus only: 1972
  Chlorophyll-a only: 1975

- Turtle Lake:
  Secchi disc transparency, total phosphorus, and chlorophyll-a: 1994 (BCWMC)

- Lost Lake:
  Secchi disc transparency, total phosphorus, and chlorophyll-a: 1982, 1993, 1997 (BCWMC)
  Total phosphorus and Secchi disc transparency: 1972
  Total phosphorus and chlorophyll-a: 1977 (BCWMC)

- Sunset Hill Pond (Cavanaugh Lake):
  Secchi disc transparency, total phosphorus, and chlorophyll-a: 1977, 1982, 1994, 1998 (BCWMC)
  Total phosphorus only: 1972

A summary of watershed data and most recent water quality monitoring results for the referenced water resources are included in Appendix E.

The BCWMC analyzed monitoring data to determine the condition (including improving or degrading trends) and use attainability of 18 lakes and the Main Stem of Bassett Creek within BCWMC. The BCWMC classified the water resources according to their current and attainable uses, based on the data collected, municipal water management plans, and regional goals. The BCWMC then developed lake and watershed management plans (lake plans) for these resources.

The purpose of each lake plan was to establish priorities and provide guidelines for meeting the water body's water quality goals. Each lake plan identifies improvement options and BMPs that may help to achieve the water body's water quality goals. Management activities include recommendations for land use controls, plans for integrated water resource management (parks/nature centers, etc.), and

passive or active water treatment projects or facilities. Estimated costs for the various management practices are also identified, along with recommendations for the most cost-effective improvements and practices. The recommended management activities for each lake are discussed on the following pages. Other BMPs not identified in the lake plans may become feasible with redevelopment; the BCWMC will consider the implementation of these BMPs at that time.

Each lake plan also provides information regarding existing lake and watershed conditions. Existing lake water quality data and watershed modeling results were used to evaluate the existing condition of the lake. This evaluation established a baseline to determine the effectiveness of various options to improve lake water quality. The lake plans estimate the amount of nutrient reduction necessary to meet the lake's water quality goals. Reductions in nutrient loading from watershed sources were studied. An urban runoff water quality model was used to evaluate the water quality of stormwater runoff into the lakes. Tables 12-2 and 12-3 and Figure 12 show all of the improvement options identified in the lake plans that are needed for the water bodies to meet the BCWMC goals. Table 12-2 shows the 10-year CIP for implementing the improvement options identified in the lake plans. Table 12-3 lists the potential future water quality capital improvement projects.

The lake and watershed plans concentrate on the total phosphorus loading to the water bodies because phosphorus is the nutrient that activates algal growth. A reduction in the phosphorus concentration in the water bodies is necessary to improve or maintain water transparency.

The lake plans recommend varying BMPs for the entire Bassett Creek watershed. The following list combines all of the recommended general best management practices; not all recommendations may be feasible or applicable for every area:

1. Require wet detention, or other techniques that provide equal degrees of treatment, for all new or redeveloped properties, where applicable.
2. Adopt and enforce a watershed-wide (or city-wide) ban or set limitations on the use of phosphorus fertilizers. Continue to educate watershed residents about soil testing and the importance of using phosphorus-free fertilizers. (In 2002, the Minnesota legislature passed a law banning phosphorus in metro-area lawn fertilizers.)
3. Implement a program to educate watershed residents and lake users on practices that would reduce pollutants entering the lake.
4. Enforce existing ordinances regarding eliminating litter and animal waste.

5. Encourage cities to implement a fall street sweeping program.
6. Require/encourage vegetated buffer strips between maintained lawns and water bodies.
7. Encourage cities to place additional garbage cans along trail systems around lakes and in parks to provide more convenience for disposal of garbage.
8. Promote stormwater retention through infiltration practices where soil types and groundwater levels permit infiltration.
9. Reduce stormwater runoff volumes by reducing the amount of impervious surfaces.

The following pages summarize the BCWMC's lake and watershed management plans and provide updated information for the following lakes/ponds (report year noted):

- Medicine Lake (March 2000)
- Parkers Lake (November 1993)
- Wirth Lake (May 1996)
- Sweeney Lake (January 1994)
- Twin Lake (June 2000)
- Westwood Lake (February 1995)
- Bassett Creek Park Pond (June 2000)
- Northwood Lake (June 1996)
- North Rice Pond, South Rice Pond and Grimes Pond (January 1997)
- Crane Lake (February 1995)
- Turtle Lake (April 1995)
- Lost Lake (May 1996)

4.3.3.1 Medicine Lake

The city of Plymouth provided the following information regarding plans for Medicine Lake water quality improvement.

Introduction

The BCWMC, the city of Plymouth, Three Rivers Park District, and the city of Medicine Lake have been partners in working to improve the water quality of Medicine Lake for many years. The BCWMC completed a draft *Medicine Lake Watershed and Lake Management Plan* in 1999. The city of Plymouth adopted a *Medicine Lake Watershed Implementation and Management Plan* in 2001.

The city's plan was the result of a committee process that involved citizens, businesses, and professionals in the water quality field.

Three Rivers Park District (formerly Hennepin Parks District) has been monitoring Medicine Lake for many years. The monitoring data indicates that the quality of Medicine Lake has remained relatively constant for the past 10 years, with a trend toward improving conditions. The lake quality in the past 3 years has been better than any previous 3-year period, and the quality in 2003 was the best observed in the past 13 years of monitoring. The slightly improved conditions occurred despite above average rainfall and runoff in 2002 and early 2003. This suggests that reductions in nutrient loading are occurring through implementation of BMPs such as the phosphorus fertilizer ordinance, construction of NURP ponds, and shoreline restoration.

The data also show that the phosphorus concentration increases significantly following the die-off of curly leaf pondweed in late June each year. The increase in phosphorus results in accelerated algae growth and poor water clarity conditions the remainder of the summer. Control of the curly leaf pondweed in the lake appears to be necessary to improve water quality conditions.

The following information briefly reviews the contents of the two Medicine Lake plans and recent actions taken by the BCWMC, the city of Plymouth, Three Rivers Park District, and the city of Medicine Lake to improve the water quality of Medicine Lake.

History

Commission Work

Medicine Lake, located in the city of Plymouth, is the second largest lake in Hennepin County and is considered the most important recreational water body in the watershed. Regional and local parks and trails are located on or near the lake. These amenities provide access to the lake and contribute to the intense uses of the lake during both summer and winter months. Fishing, boating, swimming, water-skiing and aesthetic viewing are some of the major recreational uses made of the lake.

As part of the BCWMC's work, classifications were set for each lake in the watershed. The classifications were set in 1994 after a public process that included a public hearing. The classification for Medicine Lake is Level I. This classification establishes a water quality for Medicine Lake that supports all recreational activities - boating, fishing and swimming - and reflects the current and expected future uses of the lake.

The BCWMC goal for Medicine Lake when the plans were written was 30 µg/l. On March 10, 2004, the BCWMC took action changing the goal to 38 µg/l. This is consistent with the goal identified in the Plymouth plan.

BCWMC's Medicine Lake Plan

As a result of setting that classification, the BCWMC, in the mid- to late 1990s, undertook a study of Medicine Lake and in 1999 issued the draft Medicine Lake plan (BC-MLP). The BC-MLP established priorities and provided guidelines for improving the water quality of the lake. The BC-MLP divided the Medicine lake watershed into five drainage districts: Plymouth Creek, Ridgedale Creek, Medicine Lake North, Boat Landing, and Medicine Lake Direct.

Each drainage district was evaluated for nutrient removal efficiency with the existing ponding available and ultimate land use conditions. That evaluation assigned a percentage for which each district was responsible for contributing phosphorous load to the lake. It also found that the lake typically falls below the water quality goals.

Trend analyses of historical water quality data for Medicine Lake indicate that, while brief periods of poor water quality occur annually during late summer, overall conditions remain steady. The leveling off of the decline in water quality is likely in part due to the city of Plymouth implementing a requirement that new developments meet certain criteria including a pond meeting guidelines developed by the Nationwide Urban Runoff Program (NURP). Since the Medicine Lake watershed is nearly fully developed and water quality ponds are required the impacts of new development are expected to be minimal.

By state law, cities are required to develop a water resources management plan that includes the requirement of the WMOs within their political boundaries. Medicine Lake falls within the boundaries of the city of Plymouth which updated its water resource management plan in the mid-2000. That plan is described below.

The city of Medicine Lake has not yet adopted a water resources management plan and is generally guided by the BCWMC's management plan.

Three Rivers Park District

Three Rivers Park District (TRPD) has been a driving force for improving water quality on Medicine Lake. The TRPD headquarters is within the Plymouth Creek sub-watershed and French Regional Park lies on the north end of Medicine Lake. French Regional Park offers Medicine Lake amenities

to the area that include a boat landing and beach. The TRPD has monitored the water quality conditions in the lake for over 12 years, and has been instrumental in monitoring the water quality of the creeks coming into the lake. The data collected has been used by the BCWMC and the city of Plymouth to develop their Medicine Lake plans.

Three Rivers Park District, using funds from the Environmental Protection Agency EMPACT Program, operated a Remote Underwater Sampling Station (RUSS Unit) on Medicine Lake from 2001 to 2003. The RUSS unit documented wind-driven de-stratification events on the lake, during which, phosphorus released from the bottom sediments is transported to the lake surface where it is used by algae. Approximately 70 percent of the internal loading of phosphorus in the lake appears to come from wind-driven mixing.

The TRPD is also continuing a monitoring program documenting the effectiveness of the phosphorus fertilizer ordinance adopted by the city of Plymouth. Preliminary data suggests that the ordinance is reducing phosphorus runoff from residential areas by approximately 20 percent. Funding for this effort was provided by the EPA EMPACT Program.

City of Medicine Lake's Activities

The city of Medicine Lake has been an active participant in Plymouth's Medicine Lake subcommittee and Aquatic Vegetation Management (AVM) Group. In addition, the city of Medicine Lake has dedicated a portion of the revenues raised from property tax to the activities identified by the AVM Group. The city of Medicine Lake also engages in street sweeping and educating its residents about activities they can engage in to improve the water quality of the lake.

City of Plymouth's Water Resources Management Plan

The city of Plymouth's Water Resources Management Plan (PWRMP) was adopted in February 2000, and was developed with active participation of its Environmental Quality Committee (EQC). The plan established ten citywide goals and one specific goal for Medicine Lake.

The citywide goals include general goals for flooding, water quality, erosion control, wetlands, public participation and education, monitoring, maintenance and inspection of water structures, recreation, ground water, and finance. The specific goal for Medicine Lake states, "Increase clarity and reduce total phosphorus and chlorophyll a concentrations, working toward the goal for total phosphorus established by the Bassett Creek Watershed Management Commission."

Citizens and staff identified the need to extend the 1995 Plymouth ordinance restricting the use of lawn fertilizers containing phosphorus by commercial applicators. The EQC recommended that the restriction be extended to residents applying fertilizers and in 1999, prior to the adoption of the PWRMP, the City Council enacted the recommendation.

In August 2000, the City Council adopted the PWRMP and it has been the guiding force in the city's activities since its adoption. The first activity undertaken was the evaluation of a funding mechanism (goal 10) for the capital projects and activities. The City Council began the evaluation of the use of property taxes or a Surface Water Management utility fee in July of 1999. It was determined that a fee best suited the city's needs and adopted a fee on June 12, 2001. This allowed the city to begin implementing the PWRMP.

The PWRMP recommended strengthening the city's ongoing education efforts. The adoption of the PWRMP and a funding mechanism allowed the city to expand an existing part-time position to a full-time position and incorporate water quality education into that position. This allowed the city to expand its educational efforts. Publication of the *Environmental Extra* insert to the city newsletter was expanded from two to three times a year, with the July issue dedicated to water quality information. Lake-specific newsletters, "landscaping for water quality" workshops, and shoreline and upland native plant gardens are among the many activities added to the city's water quality education program.

The Plymouth Water Resources Management Plan placed a high priority on citizen involvement in water resource planning and implementation. As a result, the Plymouth City Council directed its EQC to establish a sub-committee of residents and businesses whose purpose would be to develop a management plan for Medicine Lake.

City of Plymouth's Medicine Lake Plan

The Medicine Lake subcommittee first met on October 19, 2000, and met once a month until June 5, 2001. The subcommittee used the BC-MLP as well as a variety of information from published research and information provided to the committee by TRPD and outside lake consultants.

The subcommittee's Medicine Lake plan was presented to the EQC on June 13, 2001 and recommended to go to the Council in July. The Council and EQC held a joint meeting on July 17, 2001 to receive comments from the public on the Plymouth Medicine Lake Plan (P-MLP) and adopted the plan in August 2001.

The primary focus of the current P-MLP was external and internal BMPs for the Medicine Lake Direct Drainage District. However, recommendations were made regarding in-lake alum treatment and the construction of alum treatment facilities. These recommendations are discussed in the appropriate sections below.

Finally, recommendations for Plymouth Creek were not included in the P-MLP, as a monitoring plan had been developed for Plymouth Creek that was to be implemented in the summer of 2001. Although that monitoring is continuing, enough data has been collected so that the city's Medicine Lake subcommittee could be brought back together to evaluate the data. Therefore on September 23, 2003, the Plymouth City Council directed staff to bring the Medicine Lake subcommittee back together to develop a plan for Plymouth Creek.

In November 2003, the City Council expanded the scope of the committee to all remaining areas not addressed in the initial P-MLP. It is expected that that committee will meet for 6 – 9 months and forward recommendations to the EQC and City Council.

Medicine Lake Drainage Districts

The BC-MLP divides the Medicine Lake watershed into five major drainage districts: Medicine Lake Direct, Plymouth Creek, Ridgedale Creek, Medicine Lake North, and the Boat Landing. The BC-MLP evaluated each district for nutrient removal efficiency under existing conditions, i.e., full development. The specific BMPs recommend by the BC-MLP are discussed for each drainage district in the following paragraphs.

In addition, the P-MLP recommendations have been incorporated into the discussion since the most recent efforts to improve the water quality of Medicine Lake have been by the city of Plymouth.

1. Medicine Lake Direct District

The draft BC-MLP was completed in 1999 and recommended in-lake alum treatment to reduce the impact of in-lake phosphorus and the management of aquatic plants. The BC-MLP recommended management of purple loosestrife through the introduction of two beetle species that effectively prey on purple loosestrife.

The P-MLP, completed in 2001, relied heavily on the BC-MLP and expertise from TRPD staff and the Blue Water Science consulting firm. The recommendations from the subcommittee reordered the BMPs recommended in the BC-MLP. The subcommittee emphasized the prevention of pollutants from getting to the lake through the use of structural and nonstructural BMPs.

Further, the subcommittee recommended that the alum treatment recommended by the BC-MLP be delayed. The committee was not certain it would be needed if the other structural and nonstructural BMPs were effective in reaching the lake's goals. In addition, even if the alum treatment were still needed, the implementation of the other BMPs prior to treatment would likely enhance the effectiveness of the alum treatment. The P-MLP recommends that an evaluation of the effectiveness of the BMPs occur in 2006.

The P-MLP focuses on two primary areas: (1) external nutrient management, and (2) internal nutrient management. Details of the plan are given below.

External Lake Recommendations

Both MLPs set a goal of reducing the inflow of phosphorus and sediment into the lake. Recommendations for management include the construction of NURP ponds where feasible, street sweeping, lakescaping, rain gardens, education and management of geese.

As a result of the recommendations in both the BCWMC and the Plymouth Medicine Lake plans, the city of Plymouth started the planning process to construct stormwater ponds, BC98 and BC107. At its November 12, 2002 council meeting, the council approved a staff recommendation that the city hire an engineering firm to design and construct these two ponds. Two public meetings were held on January 6 and February 10, 2003, to present the conceptual designs to interested parties and gather their comments. Comments focused on expanding the ponds and relocating BC107 to minimize damage to East Medicine Lake Park.

The city presented the project to the BCWMC and requested financial assistance. The Commission agreed to assist the city and began the process of amending the previous plan to accommodate that request.

At the present time, discussions with Ryerson Steel are ongoing to see if an agreement can be reached to use a portion of the Ryerson property. This would reduce the impact on the Park and allow for the construction of the largest pond possible. At this time, the outcome of those discussions is unknown.

In addition, the city has begun a small grant program that assists residents in planting rain gardens and lakescaping within the Medicine Lake watershed. In 2003, city staff notified residents living on the lake of availability of a grant program to do lakescaping on their shoreline. Twenty-seven residents indicated an interest and city staff was able to combine some of the residential lots into one

site. As a result, the city will begin working with nine sites in the spring of 2004 and nine sites in the fall.

To supplement the Environmental Extra, the city has established a quarterly newsletter for Medicine Lake that is mailed to each resident within the watershed. The newsletter contains information on the condition of the lake and what residents can do in their homes to help the water quality of the lake.

Finally, the city has included additional funding in its annual budget for extra street sweeping and continues its goose round-up program.

In-lake Improvement Recommendations

The BCWMC and Plymouth Lake management plan recommended internal management strategies that included management of aquatic vegetation. The P-MLP recommended the establishment of an aquatic vegetation management group to develop a management plan for both exotic and native plant species. Lakescaping, aquascaping, and management of rough fish are also recommended.

Aquatic Vegetation Management Group

As a result of the recommendations from the P-MLP an Aquatic Vegetation Management Group (AVM) was established. Members of the AVM included the Mn/DNR, TRPD, Plymouth Parks and Engineering Departments, city of Medicine Lake, BCWMC, Association of Medicine Lake Area Citizens, and the Plymouth EQC.

Resources used to develop the AVM plan included a TRPD survey of the locations, type and extent of aquatic plant beds within the lake, citizen surveys of the Medicine Lake Skiing Group and Sailing Club, as well as the marina owner. Lake usage patterns were supplied by TRPD and the city of Plymouth's Parks Department.

Once the final plan was approved by the Plymouth City Council it was submitted to the Mn/DNR for approval. The Commissioner of the Mn/DNR approved the plan and Mn/DNR staff has been very active in the AVM committee. They are assisting the city in implementing a whole lake treatment for curly leaf pondweed in the spring of 2004.

Aquatic Vegetation Management Plan Content

The AVM developed a management plan that establishes three types of management areas:
(1) protection, (2) shoreline restoration, and (3) control.

Protection areas have significant populations of desirable native aquatic plants that the AVM plan seeks to protect and expand. Examples of these plants include: Flatstem, Sago, and Richard's pondweed, Northern milfoil, Coontail and many others.

The shoreland restoration areas were identified as areas that have significant numbers of undesirable plants, shoreline erosion, and lack of turf or other vegetative cover on upland areas. The AVM plan targets these areas for the shoreline restoration program and the city established the grant program described above to assist residents interested in lakescaping and rain gardens. In addition, city and TRPD staff provides assistance to residents in developing plans for lakescaping and rain gardens.

Control areas are those areas with excessive aquatic plant growth that have significantly diminished the lakes use and/or health. The purpose of controlling excessive plant growth would be to reestablish lake uses and promote health. The plant survey showed that in 2003, Medicine Lake was infested with 300 acres of Curly leaf Pondweed (CLP), virtually the entire littoral zone of the lake.

The Army Corp of Engineers, and other scientists, has identified CLP as a large contributor to increased phosphorus and blue green algae blooms. The AVM is working with the Mn/DNR to implement an aggressive total lake treatment for curly leaf pondweed. Public information meetings are scheduled for January 2004. It is projected that this BMP could reduce the amount of in-lake phosphorus loading by 15 percent. Implementation of the control plan is scheduled for May 2004.

The recommendations of the P-MLP and AVM plan have been incorporated into City and Parks staffs work plan and in the city's 5-year Capital Improvement Plan.

2. Plymouth Creek Drainage District

The Plymouth Creek sub-watershed contributes more than 30 percent of the total annual phosphorus load and 60 percent of the external phosphorus load to Medicine Lake. This makes Plymouth Creek the largest single contributor of phosphorus to Medicine Lake.

The BCWMC and the Plymouth's Medicine Lake Plans outline significantly different approaches to the issue of phosphorus entering Medicine Lake from Plymouth Creek. The BC-MLP analyzed several different options involving the construction of water quality ponds and two options for an alum treatment facility at the confluence of Medicine Lake and Plymouth Creek. The BCWMC's final recommendation was for the construction of an alum treatment facility with the implementation of some additional BMPs.

In contrast, while the city's Medicine Lake sub-committee made no specific recommendations for Plymouth Creek, there was a consensus that any type of alum treatment be delayed. There were two reasons for this recommendation: (1) a monitoring program for Plymouth Creek had been developed and would be implemented in the summer of 2001, and (2) BMPs that prevented pollution from reaching the lake should be implemented and monitored to determine their impact on the lake before alum is used.

Plymouth Creek Monitoring Plan

At the time the P-MLP was developed, the city and the TRPD had developed a monitoring program for the sub-watershed that would be implemented in the summer of 2001. Since the focus of the monitoring plan was to collect water monitoring data that would identify the origins of the phosphorus from this sub-watershed the subcommittee determined that it would be appropriate to wait for the data, then reconvene the subcommittee to develop a plan for Plymouth Creek.

The BC-MLP treats Plymouth Creek as a single sub-watershed. In contrast, the Plymouth WRMP breaks Plymouth Creek sub-watershed into four components, Upper, Middle and Lower Plymouth Creek and Turtle Lake. The monitoring program that the city and TRPD designed placed monitoring stations at the junction of Middle (receiving stormwater from Upper, Middle and Turtle Lake Districts) and Lower Plymouth Creek and at the confluence of Plymouth Creek with Medicine Lake.

In 2001, monitoring was conducted at these two sites. As a result of the initial monitoring, three sites, the two original and an additional site, were monitored in 2002, and three more sites, six total, were monitored in 2003. The results of that monitoring are currently being evaluated and the subcommittee will make recommendations that will move forward to the EQC and Plymouth City Council in mid-2004. The approved recommendations will be formally presented to the BCWMC.

As previously mentioned, the Plymouth City Council authorized the re-convening of the city's Medicine Lake subcommittee. At this time the committee has met three times and reaffirmed its approach of focusing on BMPs that promote pollution prevention strategies with the use of mechanical or structural BMPs as the monitoring data shows the need.

The subcommittee has requested that P-8 models be run using the current data and using a variety of external and internal nonstructural BMPs. The goal is to determine what the most effective combinations of BMPs may be to achieve the water quality goal of 30 µg/l. Experts attending the subcommittee meetings believe that some combination of these BMPs has a real chance of achieving the goal without the use of alum treatments.

The subcommittee is discussing the use of a combination of structural and nonstructural BMPs. Structural BMPs including the construction of a large NURP pond in a wetland area upstream of the confluence of Plymouth Creek and Medicine Lake and west of West Medicine Lake Drive. The added benefit to this particular BMP is that it will also treat water coming into Plymouth Creek via the Parkers Lake watershed outlet. As discussions progress, other structural BMPs may be identified by the subcommittee.

Nonstructural BMPs being discussed by the subcommittee include, street sweeping, programs to better manage yard waste (leaves and grass), rain gardens, lakescaping, and education. These are all critical elements of the original Medicine Lake plan and the committee's recommendations may expand these programs.

Metropolitan Council Grant

The city of Plymouth applied for and received a Metropolitan Council grant that is focusing on reducing runoff from impervious surfaces. The grant includes industrial and residential areas located in the Middle and Lower Plymouth Creek and West Medicine Lake sub watershed. The project is divided into four parts: data acquisition, identification of high priority areas, contacting possible participants in the sub-watershed, and implementation of BMPs.

Seventy percent of the total budget is allocated as financial incentives to implement BMPs that can include, but are not limited to rain gardens, native plantings or environmentally friendly materials applied to lawns. It is hoped that this project will be used as a model for other areas within the city.

At the present time, activities undertaken for the grant include the use of GIS to determine stormwater drainage and impervious areas, digitizing and overlaying that information on a year 2000 aerial photo and identifying high priority areas. Next, the ratio of impervious area to the total area within the 17 districts was calculated and known persistent problems identified by city staff. A list of candidate properties was generated and letters were sent to the owners and/or occupants of the identified properties on July 22, 2003. An engineering firm has recently been hired to design plans for participating properties.

3. Ridgedale Creek Drainage District

Medicine Lake receives about 6 percent of its annual phosphorus load from Ridgedale Creek. The Ridgedale Creek Drainage District represents about 12 percent of the total external phosphorus load from the Medicine Lake watershed. Also, Ridgedale Creek represents nearly 70 percent of the total phosphorus load to the eastern half of the Medicine Lake west bay.

The BC-MLP originally evaluated the construction of an alum treatment plant adjacent to the wetland on the south side of the Medicine Lake west bay. While this BMP would improve water quality especially in the west bay, the BC-MLP does not recommend that BMP, as it is not needed to meet the BCWMC's water quality goals for Medicine Lake.

Long-term goals for this sub-watershed may be to work with Ridgedale Center to replace impermeable pavement with permeable pavement, install rain gardens in the parking lot, and street sweeping. Focused public educations may also be an option for this sub-watershed.

Since this sub-watershed is located within both the cities of Minnetonka and Plymouth, coordination on many of these nonstructural options would be beneficial to both cities and the lake.

4. Medicine Lake North Drainage District

Medicine Lake receives more than 2 percent of its annual phosphorus load from this drainage district. This represents about 5 percent of the external phosphorus load from the Medicine Lake watershed. Since the completion of the BC-MLP significant development has occurred in this sub-watershed, including a large commercial complex and residential housing with the accompanying roads. In addition, there have been significant upgrades to Rockford Road (CR 9) and Northwest Boulevard (CR 61), which crosses this drainage district.

The Commission's plan does not recommend implementation of additional structural BMPs in this district. However, the TRPD has brought a severe erosion problem to the attention of the city of Plymouth and Hennepin County which will likely result in a project during the time period that this plan is in effect.

At the time that CR 9 was reconstructed, the TRPD constructed a pair of box culverts under CR 9 to provide a trail friendly crossing. The box culvert is now virtually impassable as a result of sediment and standing water filling the box culverts. The loss of the use of the box culverts to cross under CR 9 has resulted in trail users crossing CR 9 at grade, east of the controlled intersection of CR 9 and CR 61. This creates a significant safety hazard.

The sediment and water are diverted into the box culvert for two reasons: (1) The development in this drainage district in the late-eighty's and early ninety's has increased the volume of water in the small creek**,** and (2) the pipe constructed to convey the water under County Road 9 and into Medicine Lake was undersized for the volume of water it now receives. These two factors have resulted in the water being diverted into the box culverts rendering them unusable to trail users.

Erosion has become a significant factor in this small watershed. This small creek, which once meandered on the surface, has eroded a valley that is now over 10 feet deep in much of its length.

To address these issues and return the trail to a useable condition, Hennepin County began constructing a pond on the south side of CR 9 in the fall of 2003. In addition, a berm will be constructed on the north side of CR 9 to divert the water and sediment through the western box culvert.

This is considered a temporary fix to the problem and a solution needs to be found that will prevent the upstream erosion. Two possible solutions to this erosion issue have been discussed: (1) the construction of a series of ponds that will step the stormwater down the slope without erosion, and (2) a pipe that will convey the water to the pond constructed by Hennepin County or the wetland at the end of the north arm of Medicine Lake. Construction of the solution is estimated to be in the range of $400,000 to $600,000, the pipe option is estimated to approximately half that.

At this time the Medicine Lake subcommittee will be examining this situation and making recommendations for solutions.

5. Boat Landing District

This drainage district is identified as the NE Medicine Lake Drainage District in the city's WRMP. This district contributes less than 2 percent of the annual phosphorous load to Medicine Lake and represents about 3 percent of the external phosphorus load from the Medicine Lake watershed.

Both the BC-MLP and city's WRMP include no structural BMPs for this drainage district. The BC-MLP makes general recommendations that nonstructural BMPs be implemented. The subcommittee will be reviewing these recommendations and may make specific recommendations for the implementation of nonstructural BMPs.

4.3.3.2 Parkers Lake

The *Parkers Lake Watershed and Lake Management Plan* (Parkers Lake Plan (BCWMC, 1993)) establishes priorities and provides guidelines for the city of Plymouth, the BCWMC and citizens for meeting water quality goals set for Parkers Lake. As shown in Table 4-2, the BCWMC goal is a management classification of Level I for Parkers Lake, meaning its water quality should support all recreational activities, including swimming.

Parkers Lake, located in the city of Plymouth, currently suffers from the problems that commonly occur when a lake's watershed becomes urbanized. The increased volume and pollutant levels of stormwater runoff from the watershed result in a deterioration of lake water quality.

For the Parkers Lake Plan, the Parkers Lake watershed was divided into six drainage districts: South Niagara Lane, Fernbrook Lane, North Work House, South Work House, Parkers Lake North Addition, and Parkers Lake Direct. Each drainage district was evaluated for nutrient removal efficiency under existing conditions and under proposed improved conditions. The Parkers Lake Plan identifies specific drainage district recommendations and general recommended best management practices. The recommendations are discussed in the following paragraphs.

Site-Specific Structural Best Management Practices Recommendations

The specific recommendations for best management practices include:

1. South Niagara Lane Drainage District

The storm sewer system discharging from this drainage district should be routed to the existing South Work Farm pond. The pond would remove a significant percentage of total phosphorus from the stormwater before it enters the lake. This improvement option is shown as PL-3 (Option 1 in Parkers Lake Plan) on Figure 12.

2. Fernbrook Lane Drainage District

Two best management practices options are recommended to reduce the amount of phosphorus that enters the lake. The recommended best management practices include:

- Diversion of a portion of the flows from the 96-inch Fernbrook Lane storm sewer into an existing City stormwater pond (identified as Pond BC-P20 in the Plymouth drainage plan) adjacent to I-494. This improvement option is shown as PL-1 (Option 3 in Parkers Lake Plan) on Figure 12.

- Construction of an alum treatment plant to treat a portion of the stormwater in the Fernbrook Lane storm sewer at the Parkers Lake Baptist Church site. This option also includes the construction of a sedimentation pond. This improvement option is shown as PL-2 (Option 4 in Parkers Lake Plan) on Figure 12.

The Parkers Lake Plan also recommends that the remaining undeveloped land in this drainage district should be treated in wet detention ponds before entering the city's drainage system.

3. North Work House and South Work House Drainage Districts

The existing wet detention ponds in these drainage districts provide adequate treatment for their watersheds. The Parkers Lake Plan does not recommend implementation of additional structural best management practices in these drainage districts.

4. Parkers Lake North Addition Drainage District

The Parkers Lake Plan recommends the construction of a sedimentation/skimming device at the outflow point to the lake to remove larger sediment, floatable debris and garbage. This improvement option is shown as PL-4 (Option 6 in Parkers Lake Plan) on Figure 12.

5. Parkers Lake Direct Drainage District

Because this drainage district drains directly to Parkers Lake, mainly through overland flow, there is little opportunity available for treatment of stormwater runoff. However, source reduction measures, such as the general best management practices recommended for the entire Bassett Creek watershed, would improve the quality of water entering the lake.

Update: Activities Since Completion of Lake and Watershed Management Plan

Since completion of the Parkers Lake Plan, Parkers Lake water quality has improved and is now meeting the BCWMC's Level I water quality goals. At the time of the study for the Parkers Lake Plan, Parkers Lake water quality was not meeting the BCWMC's goals, so the Parkers Lake Plan recommended the implementation of water quality improvement projects. The city of Plymouth has implemented the following best management practices (BMPs) identified in the Parkers Lake Plan:

- Construction of at least 12 wet detention ponds in the Parkers Lake watershed.
- Adoption of citywide ban on the use of phosphorus fertilizers.
- Implementation of an education program to educate watershed residents.
- Fall street sweeping (continuation).

Additional BMPs implemented by the city of Plymouth include treatment of the lake with Sonar herbicide to eradicate Eurasian watermilfoil, adoption and implementation of a wetland buffer ordinance, and implementation of a goose relocation program.

In 2002, the city of Plymouth prepared the *Parkers Lake Implementation Plan, Plymouth, Minnesota* (Bonestroo, Rosene, Anderlik & Associates, and Blue Water Science). The city's plan includes a set of recommendations for improving the water quality of Parkers Lake. The recommendations do not

include any of the structural best management practices (BMPs) recommended in the BCWMC Parkers Lake Plan. The BMPs in the city's plan include aquatic plant management, stabilization of eroded areas, runoff monitoring, goose control, public education, improvements to a stormwater basin and possible future improvements to the Workhouse Pond. The BCWMC's 10-year CIP (see Table 12-2) includes one improvement project for Parkers Lake (PL-6). This project is one of the projects recommended in the city's plan. As long as the lake's water quality continues to meet the BCWMC goals, the BCWMC will not implement the structural BMPs recommended in the BCWMC's Parkers Lake Plan. The BCWMC considers these projects to be "future projects" that are not yet included in the BCWMC's CIP (see Table 12-3). Table 12-3 also includes another project recommended in the city's plan.

As part of the Citizen Assisted Monitoring Program (CAMP), water quality samples were collected from Parkers Lake in 2000 and 2002, and by Three Rivers Park District in 2001. The summer averages of water quality parameters for Parkers Lake have been improving since the mid-1990s.

4.3.3.3 Wirth Lake

The *Wirth Lake Watershed and Lake Management Plan* (Wirth Lake Plan (BCWMC, 1996)) establishes priorities and provides guidelines for the Cities of Minneapolis and Golden Valley, the BCWMC, and citizens for meeting water quality goals set for Wirth Lake. As shown in Table 4-2, the BCWMC goal is a management classification of Level I for Wirth Lake, meaning its water quality should support all recreational activities, including swimming.

Wirth Lake, located in the city of Golden Valley, has typically fallen below the BCWMC's water quality goals. Wirth Lake will continue to be affected by the problems that occur when a lake's watershed has become urbanized. The increased volume and pollutant levels of stormwater runoff from the watershed result in a deterioration of lake water quality.

The Wirth Lake Plan divides the watershed into five drainage districts: Highway 55, France Avenue, Southeast Wirth Park, Wirth Lake Direct, and South Wirth Park. Each drainage district was evaluated for nutrient removal efficiency under existing conditions, which was determined to be the same as the proposed full-development conditions.

As part of the Wirth Lake Plan, an in-lake improvement option and site-specific structural best management practices for each drainage district were evaluated. The Wirth Lake Plan also identifies general best management practices to be implemented throughout the watershed. The

recommendations are discussed in the following paragraphs. Implementing these recommended best management practices will help ensure that Wirth Lake water quality meets the BCWMC's Level I goals on a more frequent basis during varying climatic conditions.

In-Lake Improvement Recommendations

Wirth Lake receives approximately half of its annual phosphorus load from release of phosphorus from the lake's bottom sediments. Areal application of aluminum sulfate (alum) to the lake water can be used as a long-term control of phosphorus release from the lake sediments. This in-lake treatment technique will likely be effective for five to ten years, depending upon how well watershed nutrient sources have been reduced through implementation of watershed best management practices. This improvement option is shown as WTH-3 (Option 1 in Wirth Lake Plan) on Figure 12.

The Wirth Lake Plan also recommends completion of a fishery survey, in cooperation with the DNR, to determine the type and numbers of fish present in Wirth Lake. Based on the survey results, removal of the bottom dwelling fish (e.g., carp and bullheads) should be considered as another improvement option.

Site-Specific Structural Best Management Practices Recommendations

The specific recommendations for best management practices include:

1. Highway 55 Drainage District

The Wirth Lake Plan identifies one best management practice option to reduce the amount of phosphorus that enters the lake from this drainage district. This option involves construction of a wet detention area adjacent to the northwest corner of Wirth Lake to provide treatment of most of the stormwater runoff from the Highway 55 Drainage District. This best management practice is the most cost-effective watershed best management practice proposed as part of the study. This improvement option is shown as WTH-2 (Option 3 in Wirth Lake Plan) on Figure 12.

2. France Avenue Drainage District

The Wirth Lake Plan identifies one best management practice option to reduce the amount of phosphorus that enters the lake from this drainage district. This option involves dredging the wetland area (Pond FR-5) adjacent to the west side of Wirth Lake to provide additional detention for stormwater runoff from the France Avenue Drainage District. Implementation of this best management practice would improve Wirth Lake water quality, if additional detention were provided that eliminates the existing channelized flow. This improvement option is shown as WTH-1 (Option 2 in the Wirth Lake Plan) on Figure 12.

3. Southeast Wirth Park and South Wirth Park Drainage Districts

The existing wet detention ponds in these drainage districts provide adequate treatment for their watersheds. The Wirth Lake Plan does not recommend implementation of additional structural best management practices.

4. Wirth Lake Direct Drainage District

This drainage district drains directly to Wirth Lake, primarily through overland flow. Therefore, little opportunity for treatment of runoff is available. The Wirth Lake Plan does not recommend implementation of additional structural best management practices.

Update: Activities Since Completion of Lake and Watershed Management Plan

Since completion of the Wirth Lake Plan, the BCWMC has applied for grants from the Legislative Commission on Minnesota Resources (LCMR) and was successful in being recommended for a grant to implement the BMPs identified in the Wirth Lake Plan. However, state budget issues may result in reduced funding from the LCMR and other project partners.

The BCWMC's capital improvement program (CIP) includes all of the BMPs recommended in the Wirth Lake Plan (see Table 12-2).

The Minneapolis Parks and Recreation Board (MPRB) has collected water quality data for Wirth Lake since 1992. The *2001 Water Resources Report* (MPRB Environmental Operations, 2002) includes 1992-2001 Wirth Lake data. According to the MPRB report, Wirth Lake has shown a strong water quality improvement trend over the 1992-2001 period. The BCWMC's *2000 and 2001 Water Quality Study* also includes the 2000 and 2001 MPRB data. The summer averages for Secchi depth, total phosphorus and chlorophyll a were nearly identical for 2000 and 2001 and did not meet BCWMC's Level I water quality goals. The MPRB also sampled Wirth Lake during 2002 and 2003.

4.3.3.4 Sweeney Lake

The *Sweeney Lake Watershed and Lake Management Plan* (Sweeney Lake Plan (BCWMC, 1994)) establishes priorities and provides guidelines for the cities of St. Louis Park and Golden Valley, the BCWMC, and citizens for meeting water quality goals set for Sweeney Lake. As shown in Table 4-2, the BCWMC goal is a management classification of Level I for Sweeney Lake, meaning its water quality should support all recreational activities, including swimming.

Sweeney Lake, located in the city of Golden Valley, currently suffers from the problems that commonly occur when a lake's watershed becomes urbanized. The increased volume and pollutant levels of stormwater runoff from the watershed result in a deterioration of lake water quality. It is usually necessary to reduce the phosphorus concentration in a lake to improve water transparency. Monitoring indicates that there is currently a significant contribution of phosphorus from the sediments at the bottom of the lake. Because of this, light may be the only factor that limits the growth of algae. If this is the case, a reduction in phosphorus from watershed sources may not noticeably improve the clarity of Sweeney Lake.

The recommendations in the Sweeney Lake Plan are split into two phases. The Phase I recommendations include shutting down the aeration system and monitoring the lake. The monitoring results will then be used to determine if the aeration system was causing phosphorus to be released from the sediments and also if it was causing Sweeney Lake to be light-limited. The Phase I recommendations include the general best management practices recommended for the entire Bassett Creek watershed.

The Sweeney Lake Plan recommends maintenance of several existing ponding areas, including dredging. Most of these ponding areas are tributary to the Interstate 394 and Trunk Highway 55 stormwater systems. The Sweeney Lake Plan recommends that four of these ponds – Duck, Glen 1, Glen 2, and Breck (Option 1 in Sweeney Lake Plan) – be dredged and/or excavated to provide additional storage for water quality treatment, if alum treatment is not implemented. The Sweeney Lake Plan's last Phase I recommendation involves constructing a wet detention pond at the outlet of the storm sewer system draining from the west into the DNR-protected wetland south of Sweeney Lake. This pond was constructed as part of the Schaper Park project during 1998. The pond has effectively reduced the amount of sediment and other pollutants that enter the wetland and Sweeney Lake from this system. This completed improvement option is shown as SL-1 (Option 4 in Sweeney Lake Plan) on Figure 12.

In Phase II, the lake water quality monitoring results would be used to decide if the aeration system provides a benefit to the lake or if it is causing the lake's water quality to degrade. If monitoring indicates the lake remains stratified in the summer without aeration, then the internal loading of phosphorus would be reduced or prevented by not operating the aeration system during the summer. This would essentially be a "no-cost" method of reducing nutrient loadings to the lake. If the findings indicate that aeration may be beneficial to the lake, the oxygen depletion rates from the monitoring data would aid in properly sizing the aeration system to provide the best treatment.

The monitoring data would also be used to re-evaluate the predicted in-lake water quality improvements resulting from the recommended alum treatment facility north of T.H. 55 and the recommended diversion of outflow from Breck Pond into Spring Pond (Option 2 in Sweeney Lake Plan). If an alum treatment facility is constructed as part of Phase II, it becomes unnecessary to dredge the Duck, Glen 1, Glen 2, and Breck Ponds, and unnecessary to divert Breck Pond outflows into Spring Pond. The alum treatment facility is shown as SL-2 (Option 3 in Sweeney Lake Plan) on Figure 12.

The combination of the alum treatment facility and the new wet detention pond constructed in Schaper Park adjacent to the DNR wetland during 1998 would provide the greatest amount of water quality improvement in the lake, bringing the lake closest to its water quality goals. Even with implementation of these water quality improvements, Sweeney Lake is not predicted to meet the BCWMC's Level I goals for the lake.

Update: Activities Since Completion of Lake and Watershed Management Plan

Since completion of the Sweeney Lake Plan, water quality data has been collected in 1996, and 2000–2002 for Sweeney Lake. The monitoring results for 2000 – 2002 show similar water quality between the three years, but poorer water quality than in 1996. A major reconstruction of Highway 100 was underway and the monitoring results reflect the impacts of this project on Sweeney Lake. The 2002 monitoring results were slightly better than those of 2000 and 2001, which may be due to some stabilization of the Highway 100 reconstruction area.

The BCWMC decided not to implement the structural and in-lake BMPs recommended in the BCWMC's Sweeney Lake Plan. These BMPs are considered "future projects" that are not yet included in the BCWMC's 10-year CIP (see Table 12-3).

4.3.3.5 Twin Lake

The *Twin Lake Watershed and Lake Management Plan* (Twin Lake Plan (BCWMC, 2000)) establishes priorities and provides guidelines for the city of Golden Valley, the BCWMC, and citizens for meeting water quality goals set for Twin Lake. As shown in Table 4-2, the BCWMC goal is a management classification of Level I for Twin Lake, meaning its water quality should support all recreational activities, including swimming.

Twin Lake, located in the city of Golden Valley, currently meets the BCWMC's water quality goals for Level I water bodies. Twin Lake has excellent water quality, possibly the highest water quality in

the metropolitan area. Twin Lake has avoided conditions that typically occur when a lake's watershed becomes urbanized. Twin Lake has not been subjected to the increased volume and pollutant levels of stormwater runoff from the watersheds that result in a deterioration of lake water quality. The focus of the Twin Lake Plan is the total watershed and phosphorus loading into Twin Lake.

Total phosphorus concentrations in the lake are currently below the maximum allowable concentrations for Level I water bodies. The Twin Lake Plan identifies one site-specific structural best management practice: the expansion of a pond in a low area on the south side of the railroad within the railroad right-of-way. A storm sewer flowing from Ottawa Avenue discharges into this low area, within approximately 20 feet of the outlet pipe under the railroad embankment. The pond expansion would provide additional storage for water quality treatment. This improvement option is shown as TW-1 (Option 1) on Figure 12. Analysis has shown that implementation of structural best management practices, such as wet-detention ponds for stormwater runoff, will yield only a slight reduction in total phosphorus concentrations.

Update: Activities Since Completion of Lake and Watershed Management Plan

The Union Pacific Railroad replaced a culvert through the embankment at the proposed water quality treatment area adjacent to Ottawa Avenue. The BCWMC's 10-year capital improvement program (CIP) includes the one BMP recommended in the Twin Lake Plan (see Table 12-2).

No additional water quality data has been collected for Twin Lake since completion of the Twin Lake Plan.

4.3.3.6 Westwood Lake

The *Westwood Lake Watershed and Lake Management Plan* (Westwood Lake Plan (BCWMC, 1995)) establishes priorities and provides guidelines for the cities of St. Louis Park, Golden Valley, and Minnetonka, the BCWMC, and citizens for meeting water quality goals set for Westwood Lake. As shown in Table 4-2, the BCWMC goal is a management classification of Level II for Westwood Lake, meaning its water quality should support all recreational activities, except full body contact activities. Recreational activities for these water bodies include: sail boating, water skiing, motor boating, canoeing, wind surfing and jet skiing.

Westwood Lake did not meet the BCWMC's water quality goals during 1972, 1977, and 1982. However, during 1993 the lake met the goals for both phosphorus and chlorophyll a; the Secchi disc transparency was only slightly below the BCWMC's goal.

The Westwood Lake Plan divides the Westwood Lake watershed into three drainage districts: Flag Avenue, Westwood Lake Direct and Westmoreland Lane. Each drainage district was evaluated for nutrient removal efficiency under existing conditions and under proposed improved conditions.

As part of the Westwood Lake Plan, site-specific structural best management practices for each drainage district were evaluated. The Westwood Lake Plan also identifies general best management practices to be implemented throughout the watershed. The recommendations are discussed in the following paragraphs.

Site-Specific Structural Best Management Practices Recommendations

The specific recommendations for best management practices include:

1. Flag Avenue Drainage District

This drainage district contributes 48 percent of the stormwater phosphorus load to the lake. Kilmer Pond treats stormwater runoff from the 92 acres west of Highway 169. The discharge from Kilmer Pond joins the storm sewer system draining the 52 acres of single-family residences directly west of the lake. This runoff enters the lake untreated, and has been observed to carry much debris and litter to the lake.

Results of intensive monitoring conducted during 1993 showed that Westwood Lake met the BCWMC's Level II goals. If future monitoring shows that these results were truly representative of the lake's permanent water quality, the Westwood Lake Plan recommends that a skimmer be installed at the storm sewer outlet to collect litter and debris. In this case, construction of a wet-detention pond is not recommended.

Future monitoring may show that Westwood Lake's water quality measured during 1993 was unusually high due to favorable climatic conditions, and that typically the lake does not meet the BCWMC's goals. If this is the case, the Westwood Lake Plan recommends that a wet detention pond with skimmer be constructed at the outlet of the Flag Avenue storm sewer system. Construction of a wet detention pond with a skimming device would reduce the amount of phosphorus, suspended sediments, and litter entering the lake. This improvement option is shown as WST-1 on Figure 12 (this option was not numbered in the Westwood Lake Plan).

2. Westwood Lake Direct Drainage District

This drainage district contributes 34 percent of the stormwater phosphorus load to the lake. Stormwater runoff drains directly to Westwood Lake, primarily by overland flow. Since there is little opportunity available for treatment of stormwater flows, construction of wet detention basins is not recommended. Severe bank erosion has been observed at the outfall draining the commercial area east of Vermont Avenue South (Thorpe Brothers Real Estate Inc.). Although not needed for Westwood Lake to reach its water quality goals, the Westwood Lake Plan recommends diversion of this runoff away from the lake to decrease the suspended solids and phosphorus load to the lake, and eliminate further bank erosion. In particular, the Westwood Lake Plan recommends that the runoff be diverted to the Mn/DOT storm sewer system directly north of the property, and that the bank be stabilized with riprap to prevent further erosion. A sanitary sewer line crosses under the southwest corner of the lake. The Westwood Lake Plan recommends regular inspection and maintenance of this line to prevent accidental spills. If upgrades or changes are planned for the sanitary sewer system, the Westwood Lake Plan recommends that this line be moved away from the lake.

3. Westmoreland Lane Drainage District

This drainage district contributes 18 percent of the stormwater phosphorus load to the lake. Three storm sewer outfalls drain this area into Westwood Lake. Construction of structural best management practices in this drainage district would not be cost effective, and are therefore not recommended.

Update: Activities Since Completion of Lake and Watershed Management Plan

The BCWMC's 10-year capital improvement program includes a scaled-down version of the one BMP recommended in the Westwood Lake Plan (see Table 12-2). The city of St. Louis Park completed the project to divert the runoff from the commercial area north of the lake during 1997 or 1998. The project in the BCWMC 10-year CIP does not include bank stabilization.

The BCWMC monitored the water quality of Westwood Lake in 1997 and sponsored the volunteer water quality sampling in 2000 – 2002 (for the Citizen Assisted Monitoring Program (CAMP)). The data show that the water quality of Westwood Lake has improved since 1997, with the exception of chlorophyll a. In 2001, Westwood Lake water quality parameters met the BCWMC's Level II water quality goals, except for chlorophyll a. In 2002, Westwood Lake water quality parameters met the BCWMC's Level II water quality goals, except for Secchi disc transparency.

4.3.3.7 Bassett Creek Park Pond

The *Bassett Creek Park Pond Watershed Management Plan* (Bassett Creek Park Pond Plan (BCWMC, 2000)) establishes priorities and provides guidelines for the cities of New Hope, Crystal, and Golden Valley, the BCWMC, and citizens for meeting water quality goals set for Bassett Creek Park Pond. As shown in Table 4-2, the BCWMC goal is a management classification of Level III for Bassett Creek Park Pond, meaning its water quality should support fishing, aesthetic viewing and wildlife observation activities.

Bassett Creek Park Pond currently suffers from the problems that commonly occur when a lake's watershed becomes urbanized. The increased volume and pollutant levels of stormwater runoff from the watershed result in a deterioration of stream water quality. Existing water quality in Bassett Creek Park Pond is far below the BCWMC's goals. The Bassett Creek Park Pond Plan identifies several best management practices that may improve the water quality. Even with the implementation of eight additional wet detention ponds throughout the watershed, the water quality of Bassett Creek Park Pond would still not meet the BCWMC's water quality goals. Only the implementation of a flow diverted alum treatment facility is likely to lower phosphorus levels to approach the BCWMC's water quality goals for the pond. This improvement option is shown as BCP-1 (Option 9 in the Bassett Creek Park Pond Plan) on Figure 12.

Since there is no known water quality data for Bassett Creek Park Pond, the Bassett Creek Park Pond Plan recommends the establishment of a monitoring program to both verify the existing water quality conditions and to monitor the impact of best management practices on the water quality. The Bassett Creek Park Pond Plan recommends that structural best management practices (this includes the alum treatment facility) not be implemented until a monitoring program is established and the general best management practices are implemented. After that time, the structural best management practices may be re-examined.

In-Stream Improvement Recommendations

Inventory Channel Erosion Sites

The Bassett Creek Park Pond Plan strongly urges that an inventory of stream channel erosion sites be performed to minimize the damages posed to hydraulic structures, stream channels, private property, bridge footings, building foundations, and natural stream aesthetics by channel erosion. This inventory is also recommended in the *Bassett Creek Main Stem Watershed Management Plan*. The recommended inventory has two phases. Phase I is the acquisition of all existing sources of information regarding known stream channel erosion. Phase II is a field inventory of problematic

stream sites along the entire length of the creek. The Bassett Creek Park Pond Plan recommends that a report be completed summarizing the results of the Phase I and II inventories. The report would include:

1. Site recommendations for in-stream improvements.
2. An inventory of all in-stream problem areas.
3. A severity index denoting magnitude and impacts of erosion.
4. A photographic log of problem areas.
5. Location maps of problem areas.
6. Identification of the nature of the in-stream problem (erosion, deposition, etc.).
7. A list of resources impacted at each site (bridges, culverts, private property, etc.).

Update: Activities Since Completion of Watershed Management Plan

Since completion of the Bassett Creek Park Pond Plan, the city of New Hope has completed a channel erosion inventory for Bassett Creek within the Bassett Creek Park Pond watershed. Figure 13 shows the stream erosion and sedimentation sites that have been identified in the BCWMC, including those identified by the city of New Hope. These identified sites will be eligible for BCWMC funding for stream restoration (see the Stream Restoration section of this plan for more information). No water quality data has been collected for Bassett Creek Park Pond since completion of the Bassett Creek Park Pond Plan.

Because of the high cost, the BCWMC decided not to implement the structural BMP recommended in the BCWMC's Bassett Creek Park Pond Plan. This BMP is considered a "future project" that is not yet included in the BCWMC's 10-year CIP (see Table 12-3). Since the member cities have already completed or will complete channel erosion inventories, the channel erosion inventory recommended in the Bassett Creek Park Pond Plan is not included in the BCWMC's BMP program (see the Bassett Creek Main Stem section of this Plan).

4.3.3.8 Northwood Lake

The *Northwood Lake Watershed and Lake Management Plan* (Northwood Lake Plan (BCWMC, 1996)) establishes priorities and provides guidelines for the cities of New Hope and Plymouth, the BCWMC, and citizens for meeting water quality goals set for Northwood Lake. As shown in Table 4-2, the BCWMC goal is a management classification of Level II for Northwood Lake,

meaning its water quality should support all recreational activities, except full body contact activities. Recreational activities for these water bodies include: sail boating, water skiing, motor boating, canoeing, wind surfing and jet skiing.

The water quality in Northwood Lake, located in the city of New Hope, has typically fallen below the BCWMC's water quality goals. The results of this study indicate that it may not be possible to meet Level II goals in Northwood Lake. Since the lake is classified by the DNR as a Class V wetland, it may be appropriate to change the management level of the lake to Level III.

As part of the Northwood Lake Plan's evaluation of water quality management alternatives, the Northwood Lake watershed was divided into four drainage districts: Pond 7, Northeast, Southeast, and Northwood Lake Direct. Each drainage district was evaluated to estimate annual runoff volumes and pollutant loadings to Northwood Lake, assuming ultimate watershed land use conditions, both with and without implementation of runoff best management practices.

As part of the Northwood Lake Plan, site-specific structural best management practices for each drainage district were evaluated. The Northwood Lake Plan also identifies general best management practices to be implemented throughout the watershed. The recommendations are discussed in the following paragraphs.

Site-Specific Structural Best Management Practices Recommendations

The specific recommendations for best management practices include:

1. <u>Pond 7 Drainage District</u>

This 824-acre drainage district encompasses the portion of the watershed west of Highway 169 in the city of Plymouth. The entire drainage district flows to Northwood Lake through the outlet of pond NB-07 ("Pond 7"), and contributes 55 percent of the total phosphorus load to the lake. Although numerous ponds and wetlands treat much of the stormwater runoff from this district, the Northwood Lake Plan recommends a few additional best management practices. One option is to divert a portion of the Lancaster Lane storm sewer (which drains 38 acres of high density residential development) from pond NB-07 to NB-10. Detention in pond NB-10 would provide additional removal of suspended solids and phosphorus from stormwater runoff before it flows to pond NB-07 and Northwood Lake. This improvement option is shown as NL-3 (Option 3 in the Northwood Lake Plan) on Figure 12. Another option is to dredge and enlarge pond NB-07 to provide additional treatment of stormwater runoff from the entire district. This improvement option is shown as NL-2 (Option 1 in the Northwood Lake Plan) on Figure 12. Water quality simulations indicate that implementing these

two best management practices would result in a 14 percent reduction in phosphorus discharged to Northwood Lake.

The Northwood Lake Plan also recommends dredging ponds NB-19 and NB-21, located at the intersection of Rockford Road and Highway 169. These ponds, along with pond NB-23 (located in the Northeast Drainage District), are part of the Mn/DOT drainage system and are important in removing suspended solids and floatable pollutants from the Highway 169 runoff. This improvement option is shown as NL-5 (Option 6 in the Northwood Lake Plan) on Figure 12.

The Northwood Lake Plan also considered the construction of a runoff alum treatment plant at pond NB-07. This facility would inject alum into the stormwater flow and settle out the resulting floc particles upstream of Northwood Lake. This improvement option is shown as NL-6 (Option 10 in the Northwood Lake Plan) on Figure 12. Assuming that this option results in a 90 percent reduction in phosphorus from the Pond 7 Drainage District, implementation of these constructed best management practices would achieve a 49 percent reduction in the phosphorus loading to Northwood Lake.

2. Northeast Drainage District

This 227-acre drainage district includes the portion of the Northwood Lake watershed north of the lake, as well as the section of Highway 169 immediately west of the lake. Stormwater runoff from this district enters the lake through five storm sewer outfalls. The district contributes 18 percent of the annual total phosphorus load entering Northwood Lake. The Northwood Lake Plan recommends several best management practices for this drainage district. One option is to construct a two-cell detention pond in NB-28 to provide treatment of runoff from the residential area north of Rockford Road. This improvement option is shown as NL-4 (part of Option 5 in Northwood Lake Plan) on Figure 12. A second option involves construction of a two-cell detention pond in NB-29, immediately north of the lake (located in the Northwood Lake Direct Drainage District). This improvement option is shown as NL-1 (part of Option 4 in Northwood Lake Plan) on Figure 12. The Northwood Lake Plan also recommends dredging pond NB-23, located at the intersection of Rockford Road and Highway 169. This improvement option is shown as one of the NL-5 options on Figure 12. This pond, along with ponds NB-19 and NB-21, is part of the Mn/DOT drainage system and is important in removing suspended solids and floatable pollutants from the Highway 169 runoff. Water quality modeling simulations indicate that implementing these options would result in a 10 percent reduction in phosphorus loading to Northwood Lake.

3. Southeast Drainage District

This 263-acre district drains the portion of the Northwood Lake watershed immediately south of the lake. Stormwater runoff from this district enters the lake at three stormwater outfalls. The district contributes 25 percent of the annual total phosphorus load to Northwood Lake. In addition to Northwood Lake, the city of New Hope would like to improve the water quality in Hidden Valley Park Pond, located at the south edge of the district. The Northwood Lake Plan recommends several structural best management practices for this drainage district. One option involves construction of two detention ponds adjacent to Hidden Valley Park Pond (NB-38 and NB-37) to treat the runoff entering the pond from the residential areas surrounding the park. This improvement option is shown as one of the NL-4 options (part of Option 5 in Northwood Lake Plan) on Figure 12. Another option involves construction of a detention pond just east of 35th Avenue North (NB-36) and diverting a portion of the storm sewer draining the residential area south of 35th Avenue North to this pond. This improvement option is another one of the NL-4 options (Option 5 in the Northwood Lake Plan) shown on Figure 12. A third option in this drainage district involves construction of a three-cell detention pond in the parkland just south of Northwood Lake (in the Northwood Lake Direct Drainage District) to treat all stormwater entering the lake from NB-35, as well as NB-34. This improvement option is shown as NL-1 (Option 4 in the Northwood Lake Plan) on Figure 12. Water quality modeling simulations indicate that implementing these best management practices could achieve a 12 percent reduction in phosphorus loading to Northwood Lake.

4. Northwood Lake Direct Drainage District

This 41-acre drainage district drains the area directly adjacent to Northwood Lake. Since stormwater runoff from this area enters the lake via overland flow, structural best management practices are not practical, and the Northwood Lake Plan recommends implementation of nonstructural best management practices (discussed later).

In-Lake Improvement Recommendations

To identify the source of excess dissolved phosphorus in Northwood Lake, the Northwood Lake Plan recommends that additional monitoring be performed (the BCWMC monitored the lake in 1996 and 2000). In addition to collecting lake water samples, the Northwood Lake Plan also recommends collection of a few stormwater inflow grab samples and flow velocity measurements, both during dry weather flows and during precipitation events at the NB-07 outlet, and at the NB-35 and NB-29 storm sewer outfalls.

The Northwood Lake Plan also recommends that the DNR be encouraged to perform a fishery survey to determine the type and numbers of fish present in Northwood Lake. If the survey shows that bottom dwelling fish (e.g., carp and bullheads) are overabundant in the lake, the Northwood Lake Plan recommends that these fish be removed to prevent resuspension of lake sediments and prevent dissolved phosphorus release to the lake water from the feeding activities of the fish.

The Northwood Lake Plan also recommends that the DNR be encouraged to perform a survey of the numbers and species of waterfowl residing in Northwood Lake during the summer months. This information will be used to calculate the dissolved phosphorus load entering the lake from waterfowl. The DNR may also be able to suggest alternative means of deterring waterfowl from nesting and feeding on the lake.

If the additional monitoring data collected in 1996 indicate that internal phosphorus load is being released from the sediments of Northwood Lake, the Northwood Lake Plan recommends that the effectiveness of alum application to the lake's sediments be evaluated.

General Best Management Practice Recommendations

In addition to the general best management practices recommended for the entire Bassett Creek watershed, the Northwood Lake Plan recommends the following best management practice specifically for Northwood Lake:

1. Discourage the presence of waterfowl on Northwood Lake by constructing vegetated buffer strips between maintained lawns and the lake, and by prohibiting the feeding of waterfowl on public lands.

Update: Activities Since Completion of Watershed and Lake Management Plan

Since completion of the Northwood Lake Plan, the city of New Hope has implemented a number of the BMPs recommended in the Northwood Lake Plan. These projects include:

- Construction of ponds NB-35A, B, and C (part of NL-1), but not to the same degree as proposed in the Northwood Lake Plan. These improvements will need to be re-evaluated as part of the feasibility study. Costs will be added to the CIP to upgrade these ponds if the feasibility study indicates that they should be upgraded.

- Construction of ponds NB-28A and B (part of NL-4).

- Construction of ponds NB-37A and NB-38A were completed in 2003 (part of NL-4).

In addition, Pond NB-36A may be constructed in conjunction with a church expansion project.

The BCWMC's 10-year CIP includes the NL-1, NL-2, NL-3 and NL-4 BMPs recommended in the Northwood Lake Plan (shown in Table 12-2). The BCWMC considers the other BMPs recommended in the Northwood Lake Plan (NL-5 and NL-6) to be potential future water quality projects and are not yet included in the BCWMC's 10-year CIP (see Table 12-3).

The BCWMC monitored the water quality of Northwood Lake in 1996 and sponsored the volunteer water quality sampling in 2000 – 2002(for the Citizen Assisted Monitoring Program (CAMP)). The data show an improvement in the water quality of Northwood Lake since 1996. The lake received barley straw treatment in 2000, 2001, and 2002. In 2000 and 2002, the barley straw appeared to significantly reduce the chlorophyll a concentration, with a corresponding increase in Secchi disc transparency. Although the chlorophyll a concentration was higher in 2001 than in 2000 and 2002, it was lower than in 1996. Even with the improvements in the water quality, Northwood Lake did not meet the BCWMC's Level II water quality goals in 2001 and 2000 (except for chlorophyll a).

4.3.3.9 North Rice Pond, South Rice Pond and Grimes Pond

The *North Rice, South Rice, and Grimes Ponds Watershed and Lake Management Plan* (Rice and Grimes Ponds Plan (BCWMC, 1997)) establishes priorities and provides guidelines for the cities of Robbinsdale, Golden Valley, and Crystal, the BCWMC, and citizens for meeting water quality goals set for North Rice, South Rice and Grimes Ponds. As shown in Table 4-2, the BCWMC goal for these three water bodies is a management classification of Level III, meaning their water quality should support fishing, aesthetic viewing and wildlife observation activities.

North Rice and Grimes Ponds, located in the city of Robbinsdale, and South Rice Pond, located in the Cities of Golden Valley and Robbinsdale, currently suffer from the problems that commonly occur when a lake or pond's watershed becomes urbanized. The increased volume and pollutant levels of stormwater runoff from the watershed result in a deterioration of pond water quality.

The Rice and Grimes Ponds Plan divides the North Rice, South Rice, and Grimes Ponds watershed into four drainage districts: Sunset Hill, Grimes Pond, North Rice Pond and South Rice Pond. Each drainage district was evaluated for nutrient removal efficiency under existing conditions, which was determined to be the same as the proposed full-development conditions.

As part of the Rice and Grimes Ponds Plan, in-pond improvement options and site-specific structural best management practices for each drainage district were evaluated. The Rice and Grimes Ponds Plan also identifies general best management practices to be implemented throughout the watershed. Implementing these recommended best management practices will help ensure that the water quality of North Rice Pond, South Rice Pond, and Grimes Pond meet the BCWMC's Level III goals. The recommendations are discussed in the following paragraphs. Discussions with the DNR indicated that a permit to work in protected waters would be required from the DNR for all improvement options.

In-Pond Improvement Recommendations

The Rice and Grimes Ponds Plan recommends the following in-pond improvements:

1. Macrophyte Harvesting and Removal

Grimes, North Rice, and South Rice Ponds receive a portion of their annual phosphorus loads due to release of phosphorus from decaying aquatic plants. This option consists of removing the aquatic plants from the open water portions of each pond using either harvesting methods or aquatic herbicides. Aquatic plant removal will also likely be necessary to ensure the effectiveness of the areal alum application for each pond. This improvement option is shown as GR-1 (Option 2 in the Rice and Grimes Ponds Plan) on Figure 12.

2. In-Pond Alum Treatment

North Rice and South Rice Ponds receive a majority of their annual phosphorus loads due to release of phosphorus from bottom sediments. Grimes Pond also receives a significant loading of phosphorus due to release from bottom sediments. Areal application of aluminum sulfate (alum) to the pond water can be used as a long-term control of phosphorus release from the bottom sediments. This in-lake treatment technique will likely be effective for five to ten years, depending upon how well watershed nutrient sources have been reduced. Alum treatment provides greater nutrient removal than dredging at a fraction of the cost. This improvement option is shown as GR-3 (Option 3 in the Rice and Grimes Ponds Plan) on Figure 12.

Site-Specific Structural Best Management Practices Recommendations

Site-specific recommendations for each of the ponds' drainage districts are described below.

1. Sunset Hill Drainage District

This watershed contributes a relatively small proportion of total phosphorus to North Rice, South Rice, and Grimes Ponds. A wetland (Basin K) with significant infiltration capacity receives all of the stormwater runoff from this drainage district. Because of this infiltration capacity, Basin K currently

removes about 86 percent of the total phosphorus. The Rice and Grimes Ponds Plan recommends inspection of this wetland on a regular basis, during both dry- and wet-weather periods, to ensure that it continues to function as an infiltration/wet detention basin. Implementation of additional structural best management practices is not recommended.

2. Grimes Pond Drainage District

This drainage district currently provides about 27 percent removal of total phosphorus from stormwater runoff. The Rice and Grimes Ponds Plan recommends construction of a wet detention pond within the northern boundary of Grimes Pond to reduce the amount of phosphorus entering the pond. This improvement option is shown as GR-2 (Option 4 in the Rice and Grimes Ponds Plan) on Figure 12. The DNR indicated that conditions for DNR permit approval of this project most likely would include demonstrating a significant water quality improvement for the pond or wetland and limiting the dredging to a maximum depth of 2 meters (6.6 feet).

3. North Rice Pond Drainage District

The existing wet detention basins in this drainage district provide adequate treatment of the watershed's stormwater runoff. Implementation of additional structural best management practices is not recommended.

4. South Rice Pond Drainage District

This drainage district drains directly to South Rice Pond, primarily through overland flow, and there is little opportunity available for providing treatment of stormwater flows. The Rice and Grimes Ponds Plan does not recommend implementation of additional structural best management practices. Because of the limited opportunity for structural best management practices in this drainage district, implementation of the recommended general best management practices is important.

Update: Activities Since Completion of Watershed and Lake Management Plan

The BCWMC's 10-year CIP includes one BMP (GR-2) recommended in the Rice and Grimes Ponds Plan (shown in Table 12-2). This BMP (the Grimes Pond wet detention pond) should be feasible as part of the city of Robbinsdale's street reconstruction project, taking place in the near future. The BCWMC considers the in-lake alum treatment recommended in the Rice and Grimes Ponds Plan (GR-3) to be a potential future water quality project and is not yet included in the BCWMC's 10-year CIP (see Table 12-3). It is possible that local residents already implemented an in-lake alum treatment of North and South Rice Ponds. The macrophyte removal BMP (GR-2) is not included in either Table 12-2 or Table 12-3 since the BCWMC is not usually involved in such programs.

No additional water quality data has been collected for Grimes Pond since completion of the Rice and Grimes Ponds Plan. The BCWMC monitored the water quality of North Rice Pond and South Rice Pond in 1998 and sponsored the volunteer water quality sampling of South Rice Pond (Lake) in 2000 – 2002 (for the Citizen Assisted Monitoring Program (CAMP)). For South Rice Pond, the chlorophyll a and total phosphorus summer average concentrations were extremely high in 2000, higher than in 1998, 2001, or 2002. Assuming the results from 2000 are either incorrect or an anomaly, the water quality of South Rice Pond appears to have improved from 1998 to 2002, although it does not meet the BCWMC's Level III water quality goals (except for chlorophyll-a). The 1998 data for North Rice Pond show that the water quality of North Rice Pond is better than South Rice Pond, although the pond did not meet the BCWMC's Level III water quality goals.

As part of the 1998 BCWMC water quality study, aquatic macrophytes were surveyed in North Rice Pond and South Rice Pond. The North Rice Pond survey results show that, with the exception of a 400-foot section of the shore, the entire pond is surrounded by cattails and purple loosestrife. The South Rice Pond survey results show that the entire pond is surrounded by cattails and purple loosestrife.

4.3.3.10 Crane Lake

The *Crane Lake Watershed and Lake Management Plan* (Crane Lake Plan (BCWMC, 1995)) establishes priorities and provides guidelines for the city of Minnetonka, the BCWMC, and citizens for meeting water quality goals set for Crane Lake. As shown in Table 4-2, the BCWMC goal for Crane Lake is a management classification of Level III, meaning its water quality should support fishing, aesthetic viewing and wildlife observation activities.

Crane Lake, located in the city of Minnetonka, has typically met the BCWMC's water quality goals. However, Crane Lake will continue to be affected by the problems that occur when a lake's watershed becomes urbanized. The increased volume and pollutant levels of stormwater runoff from the watershed result in a deterioration of lake water quality.

The Crane Lake Plan divides the Crane Lake watershed into seven drainage districts: Ramada Inn Ridgedale South Pond, Ridgedale Northeast Pond, Crane Lake Direct, West Frontage Road, East Frontage Road and Joy Lane. Each drainage district was evaluated for nutrient removal efficiency under existing conditions and under proposed improved conditions. As part of the Crane Lake Plan, site-specific structural best management practices for each drainage district were evaluated. The Crane Lake Plan also identifies general best management practices to be implemented throughout the

watershed. Implementing either of the recommended best management practices would result in Crane Lake meeting the BCWMC's Level III water quality goals. Implementing both options would help ensure that Crane Lake meets the goals more consistently, under a variety of climatic conditions. The recommendations are discussed in the following paragraphs.

Site-Specific Structural Best Management Practices Recommendations

Site-specific recommendations for each of the lake's drainage districts are described below.

1. Ramada Inn Drainage District

The Crane Lake Plan identifies one best management practice option to reduce the amount of phosphorus that enters the lake. This option includes excavation of an existing dry detention area located east of the Ramada Inn parking lot to provide wet detention ponding. This would provide the greatest improvement in lake water quality at a cost that is comparable with construction of the Joy Lane wet detention pond. Another benefit of this option is that there would likely be less permitting requirements and land acquisition costs. For these reasons the Crane Lake Plan recommends implementation of this best management practice option. This improvement option is shown as CL-1 (Option 1 in the Crane Lake Plan) on Figure 12.

2. Ridgedale South Pond, Ridgedale Northeast Pond, West Frontage Road, and East Frontage Road Drainage Districts

The existing wet detention ponds in these drainage districts provide adequate treatment for their watersheds; the Crane Lake Plan does not recommend implementation of additional structural best management practices.

3. Crane Lake Direct Drainage District

This drainage district drains directly to Crane Lake, primarily through overland flow, so there is little opportunity available for treatment of stormwater runoff. The Crane Lake Plan does not recommend implementation of additional structural best management practices.

4. Joy Lane Drainage District

The Crane Lake Plan identifies one best management practice option to reduce the amount of phosphorus that enters the lake. This option includes construction of a wet detention pond within the eastern portion of Crane Lake. This pond would treat stormwater runoff entering the lake from two separate inlets located along County Road 73. This improvement option is shown as CL-2 (Option 2 in the Crane Lake Plan) on Figure 12. The Crane Lake Plan notes that discussions with the DNR

indicated it might not be feasible to obtain a DNR permit for this project, so the Crane Lake Plan recommends construction of the Ramada Inn wet detention pond instead.

Update: Activities Since Completion of Watershed and Lake Management Plan

The BCWMC's 10-year CIP includes the BMPs recommended in the Crane Lake Plan (CL-1 and CL-2 – shown in Table 12-2).

The BCWMC monitored the water quality of Crane Lake in 1997 and 2001. The historical record indicates that the water quality of Crane Lake has improved since 1989. Since 1989, Crane Lake has met the BCWMC's Level III water quality goal for chlorophyll a every year, and met the phosphorus goal a majority of the years. The 2001 macrophyte survey found cattails and purple loosestrife present along the entire shore of Crane Lake.

4.3.3.11 Turtle Lake

The *Turtle Lake Watershed and Lake Management Plan* (Turtle Lake Plan (BCWMC, 1995)) establishes priorities and provides guidelines for the city of Plymouth, the BCWMC, and citizens for meeting water quality goals set for Turtle Lake. As shown in Table 4-2, the BCWMC goal for Turtle Lake is a management classification of Level II, meaning its water quality should support all recreational activities, except full body contact activities. Recreational activities for these water bodies include: sail boating, water skiing, motor boating, canoeing, wind surfing and jet skiing.

Turtle Lake, located in the city of Plymouth, currently suffers from the problems that commonly occur when a lake's watershed becomes urbanized. The increased volume and pollutant levels of stormwater runoff from the watershed result in a deterioration of lake water quality.

The Turtle Lake Plan divides the Turtle Lake watershed into four drainage districts: North Wetland, Polaris Lane, Southeast Wetland, and Turtle Lake Direct. Each drainage district was evaluated for nutrient removal efficiency under existing conditions and under proposed improved conditions. As part of the Turtle Lake Plan, site-specific structural best management practices (BMPs) for each drainage district were evaluated. The Turtle Lake Plan also identifies general best management practices to be implemented throughout the watershed. Implementation of the recommended structural BMPs is required for significant water quality enhancement and to bring the lake closest to the BCWMC's Level II water quality goals. Discussions with the DNR indicated that a DNR permit to work in protected waters would be required for any of these BMPs, since they involve dredging. Conditions for DNR permit approval most likely would include demonstrating a significant water

quality improvement for the lake or wetland and limiting the dredging to a maximum depth of 2 meters (6.6 feet).

Extensive dredging of Turtle Lake in conjunction with dredging of the north wetland could improve the lake's water quality enough to meet the BCWMC's goals for Level III water bodies, which may be an appropriate management goal for the lake. The Turtle Lake Plan did not recommend changing the management level of Turtle Lake because it would decrease the BCWMC water quality treatment requirements in the watershed.

The recommendations are discussed in the following paragraphs.

Site-Specific Structural Best Management Practices Recommendations

Site-specific recommendations for each of the ponds' drainage districts are described below.

1. North Wetland Drainage District

The Turtle Lake Plan recommends one option to reduce the amount of phosphorus that enters the lake. The recommended option involves dredging the open water portion of the north wetland to provide increased detention time and additional treatment of untreated runoff entering from the drainage district. This improvement option is shown as TU-1 (Option 4 in the Turtle Lake Plan) on Figure 12.

2. Polaris Lane and Southeast Wetland Drainage Districts

Since the existing wet detention ponds in these drainage districts provide adequate treatment for their watersheds, the Turtle Lake Plan does not recommend implementation of additional structural best management practices.

3. Turtle Lake Direct Drainage District

This drainage district drains directly to Turtle Lake, mainly through overland flow, so there is little opportunity available for treatment of stormwater runoff. However, due to the shallowness of the lake, resuspension of particulate phosphorus may be a factor in keeping the lake concentrations relatively high. Therefore, the Turtle Lake Plan recommends dredging Turtle Lake to provide increased detention time and additional treatment of stormwater runoff. The Turtle Lake Plan identifies two dredging options: dredging the open water portion of the lake, and extensive dredging of the entire lake area. To bring the lake's water quality closest to the BCWMC's Level II goals, the Turtle Lake Plan recommends the extensive dredging option. This improvement option is shown as TU-2 (Option 6 in the Turtle Lake Plan) on Figure 12.

Update: Activities Since Completion of Watershed and Lake Management Plan

With input from the city of Plymouth, the BCWMC determined that improvement of Turtle Lake is not a high enough priority (and too costly) to warrant BCWMC involvement. As a result, the BCWMC considers the water quality improvement BMPs recommended in the Turtle Lake Plan to be potential future water quality projects and are not yet included in the BCWMC's 10-year CIP (see Table 12-3).

4.3.3.12 Lost Lake

The *Lost Lake Watershed and Lake Management Plan* (Lost Lake Plan (BCWMC, 1996)) establishes priorities and provides guidelines for the city of Plymouth, the BCWMC, and citizens for meeting water quality goals set for Lost Lake. As shown in Table 4-2, the BCWMC goal for Lost Lake is a management classification of Level II, meaning its water quality should support all recreational activities, except full body contact activities. Recreational activities for these water bodies include: sail boating, water skiing, motor boating, canoeing, wind surfing and jet skiing.

The water quality in Lost Lake has typically fallen below the BCWMC's water quality goals for a Level II water body. The results of the Lost Lake study indicate that it may not be possible to meet Level II goals in Lost Lake. Since the lake is classified by the DNR as a class V wetland, it may be appropriate to change the management level of the lake to Level III.

The Lost Lake watershed is quite small (39 acres) and contains no stormwater detention ponds; therefore it was not divided into subwatersheds as part of the Lost Lake evaluation.

Site-Specific Structural Best Management Practices Recommendations

Due to the small size of the Lost Lake watershed, the density of development (which limits space available for best management practices), and the number of storm sewer outfalls entering the lake, structural best management practices are not practical or cost-effective.

In-Lake Improvement Recommendations

1. <u>Re-evaluate the application of herbicides to the lake to control aquatic plants</u>

Currently, few rooted aquatic plants grow in Lost Lake. While it is not desirable to have too many aquatic plants, some are necessary for the health of the ecosystem. The aquatic plant growth may be impeded by the low water clarity in the lake, as well as by the amount and types of chemicals currently applied each summer. In addition, an in-lake alum treatment may result in much higher

water clarity in Lost Lake and subsequent prolific aquatic plant growth may occur. Management of the plants may need to be modified accordingly.

2. DNR Fishery Survey

The Lost Lake Plan encourages the DNR to perform a fishery survey to determine the type and numbers of fish present in Lost Lake. If the survey shows that bottom dwelling fish (e.g., carp and bullheads) are overabundant in the lake, the Lost Lake Plan recommends that these fish be removed to prevent resuspension of lake sediments and prevent dissolved phosphorus release to the lake water from the feeding activities of the fish.

3. DNR Waterfowl Survey

The Lost Lake Plan encourages the DNR to perform a survey of the numbers and species of waterfowl residing in Lost Lake during the summer months. This information will be used to calculate the dissolved phosphorus load entering the lake from waterfowl. The DNR may also be able to suggest alternative means of deterring waterfowl from nesting and feeding on the lake.

4. Evaluate the effectiveness of in-lake alum treatment

Lost Lake receives approximately 68 percent of its annual phosphorus load due to phosphorus release from the bottom sediments. Areal application of aluminum sulfate (alum) to the lake can be used as a long-term control of phosphorus release from the sediments. This in-lake treatment will likely be effective for 5 to 10 years, depending on how well watershed nutrient sources have been reduced. This improvement option is shown as LL-1 on Figure 12.

The Lost Lake Plan notes that alum treatment of shallow lakes, such as Lost Lake, may be ineffective because of the disruption of the alum floc by wind mixing. There is a possibility this treatment may not work in Lost Lake.

General Best Management Practice Recommendations

In addition to the general best management practices recommended for the entire Bassett Creek watershed, the Lost Lake Plan recommends the following best management practice specifically for Lost Lake:

1. Discourage waterfowl from feeding and nesting on Lost Lake and adjacent shoreland.

Update: Activities Since Completion of Watershed and Lake Management Plan

With input from the city of Plymouth, the BCWMC determined that improvement of Lost Lake is not a high enough priority to warrant BCWMC involvement. As a result, the BCWMC considers the water quality improvement BMP recommended in the Lost Lake Plan to be a potential future water quality projects and is not yet included in the BCWMC's 10-year CIP (see Table 12-3).

The BCWMC monitored the water quality of Lost Lake in 1997. The historical data indicate that Lost Lake is hypereutrophic and has not met the BCWMC's Level II water quality goals. The data also show that the water quality of Lost Lake has not changed significantly in recent years.

Table 4-1. Principal Pollutants in Stormwater Runoff

Stormwater Pollutant	Examples of Sources	Related Impacts
Nutrients: Nitrogen, Phosphorus	Animal waste, fertilizers, failing septic systems	Algal growth, reduced clarity, other problems associated with eutrophication (oxygen deficit, release of nutrients and metals from sediments)
Sediments: Suspended and Deposited	Construction sites, other disturbed and/or non-vegetated lands, eroding banks, road sanding	Increased turbidity, reduced clarity, lower dissolved oxygen, deposition of sediments, smothering of aquatic habitat including spawning sites, sediment and benthic toxicity
Organic Materials	Leaves, grass clippings	Oxygen deficit in receiving water body, fish kill.
Pathogens: Bacteria, Viruses	Animal waste, failing septic systems	Human health risks via drinking water supplies, contaminated swimming beaches
Hydrocarbons: Oil and Grease, PAHs (Napthalenes, Pyrenes)	Industrial processes; automobile wear, emissions & fluid leaks; waste oil.	Toxicity of water column and sediment, bioaccumulation in aquatic species and through food chain
Metals: Lead, Copper, Cadmium, Zinc, Mercury, Chromium, Aluminum, others	Industrial processes, normal wear of auto brake linings and tires, automobile emissions & fluid leaks, metal roofs	Toxicity of water column and sediment, bioaccumulation in aquatic species and through the food chain, fish kill
Pesticides: PCBs, Synthetic Chemicals	Pesticides (herbicides, insecticides, fungicides, rodenticides, etc.), industrial processes	Toxicity of water column and sediment, bioaccumulation in aquatic species and through the food chain, fish kill
Chlorides	Road salting and uncovered salt storage	Toxicity of water column and sediment
Trash and Debris	Litter washed through storm drain networks	Degradation of the beauty of surface waters, threat to wildlife

Source: *Minnesota Urban Small Sites BMP Manual* (Barr Engineering Company, 2001c).

Table 4-2. Management Classifications of Major BCWMC Water Bodies

Watershed Description	Water Body	Management Classification
Main Stem	Grimes Pond	Level III
	North Rice Pond	Level III
	South Rice Pond	Level III
	Birch Pond	Level III
	Wirth Lake	Level I
	Westwood Lake	Level II
	Bassett Creek (Mississippi River to Medicine Lake)	Level III
North Branch	Lost Lake	Level II
	Northwood Lake	Level II
	Bassett Creek Park Pond	Level III
Medicine Lake Branch	Parkers Lake	Level I
	Turtle Lake	Level II
	Crane Lake	Level III
	Medicine Lake	Level I
Sweeney Branch	W. Ring Pond	Level III
	E. Ring Pond	Level III
	Courtlawn Pond	Level III
	Twin Lake	Level I
	Sweeney Lake	Level I

Level I Recreational (all activities)

Level II Recreational (non-body contact activities)

Level III Aesthetic Viewing

Level IV Runoff Management

Table 4-3. BCWMC Water Quality Goals for Water Body Classifications

Water Quality Category	Desired Total Phosphorus Concentration (µg/L)	Desired Chlorophyll-a Concentration (µg/L)	Desired Secchi Disc Depth (meters)
Level I	30*	10	2.2
Level II	45	20	1.4
Level III	75	40	0.9
Level IV	105	60	0.7

* The BCWMC's 30 µg/L phosphorus goal for Level I lakes is the same as the Minnesota Pollution Control Agency's (MPCA) phosphorus criteria for "full support" of swimmable use in this ecoregion (*Minnesota Lake Water Quality Assessment Data: 1997,* MPCA, 1998). However, due to implementation costs of water quality improvements to Medicine Lake and in support of recent MPCA data concerning Medicine Lake, the goal for Medicine Lake is changed to 38 µg/L.