Loeb Lake and Willow Reserve Management Plan

Wenck

Prepared for

Capitol Region Watershed District

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Executive Summary

The purpose of the Loeb Lake and Willow Reserve Management Plan (LLWRMP) is to provide a framework for the protection and potential improvement of Loeb Lake and nearby Willow Reserve. The management plan is intended to assess the current condition of the two areas and identify opportunities for improving the ecological, aesthetic, and recreational opportunities for each.

Loeb Lake and Willow Reserve are located within the northwest part of the City of Saint Paul, Minnesota. Loeb Lake receives drainage from approximately 44 acres and does not have an outlet. Willow Reserve is located approximately two blocks east of Loeb Lake, has a drainage area of approximately 30 acres, and has a "high flow" connection to the adjacent Trout Brook storm sewer. Loeb Lake and Willow Reserve are not hydrologically connected, but due to their proximity in the Capitol Region Watershed District (CRWD), they are both included in the LLWRMP.

ISSUES AND CONCERNS

CRWD identified several issues and areas of concern for Loeb Lake with respect to the water quality, fish health, aquatic plant diversity, shoreline environment, and educating users and residents of the lake and its watershed.

The major source of nutrient loading to the lake is from the watershed. The small pond at the southeast corner of Loeb Lake serves an important role in the lake's nutrient budget by removing approximately 25% of the watershed load. Internal nutrient loading is minor compared to the watershed load. However, based on observations made by CRWD during 2008, there appears to be a filamentous green algae population that is likely driven by the internal nutrient loading.

Loeb Lake is designated as a "Fishing in the Neighborhood" lake by the Minnesota Department of Natural Resources (DNR). It is a highly managed and stocked system. Lake management files from the DNR indicate that stocking efforts began in 1974 and have continued on an annual basis since that time. It appears that stocking efforts have focused on a "put and take" fishery where adult, catchable size fish are stocked. In general, panfish and rough fish groups have dominated the eight fish surveys conducted since 1974. Black bullhead and bluegill have been the most numerous species collected. No carp have been identified in Loeb Lake.

Aquatic plant community data for Loeb Lake was collected by the DNR during their 1981 and 2000 fish surveys and by Ramsey County in 2005. From 1981 to 2000, the abundance of desirable native submerged species appears to have declined. This could indicate a decline in water quality and fish habitat as species such as sago pondweed are known to be important components of fish and waterfowl habitats as well as sensitive to degraded water quality. Another significant observation is the presence of curly leaf pondweed in the 2000 survey. Curly leaf pond weed is an exotic species that begins growing under the ice and reaches peak growth, often in dense mats, prior to senescence (i.e., die-back) in mid to late June. When the thick mats of curly leaf pondweed die-back in the early summer, lake water clarity is reduced and nutrients are released into the water column which can spur algal growth. The DNR noted that the exotic submerged plant species Eurasian water milfoil was found in Loeb Lake in 2003. Ramsey County Public Works collected aquatic vegetation survey data in 2005 that supports the observations of the 1981 and 2000 data.

Similar to Loeb Lake, CRWD identified issues and areas of concern for Willow Reserve. CRWD identified concerns related to the degree of desired restoration for Willow Reserve, vegetative and wildlife diversity, the hydrologic regime, and water quality.

The CRWD Watershed Management Plan (2000) identified Willow Reserve as an opportunity to restore native vegetation and wildlife in an urban setting. The plan, however, did not identify a specific restoration goal or plan for Willow Reserve. The area was originally established as a wildlife preserve and bird sanctuary. However, today it is somewhat neglected because it is concealed by overgrown, invasive vegetation.

If restoration is desirable, it must be determined to what condition should the area be restored. A review of historic aerial photographs indicates that all or a portion of Willow Reserve was actively managed for agricultural production from before 1940 though the late 1980s. The current wetland types and vegetative communities are the result of a change in land use and do not represent pre-settlement conditions. After the change in land use, the wetlands were left to go fallow and became vegetated with mainly invasive species (reed canary grass, stinging nettle, and buckthorn) along with fast growing woody species (box elder, dogwood, cottonwood, and willow). Restoration of the area to “pre-settlement” conditions may prove very difficult and expensive.

The hydrologic regime and water budget of Willow Reserved has changed dramatically since pre-settlement conditions. The area was historically used for agriculture, and in the late 1980s, the area was designated to serve as a “pressure relief valve” for the Trout Brook storm sewer interceptor system (TBI). If the area is to be restored, additional hydrologic and hydraulic information must be obtained to know how stormwater runoff may impact the restored areas.

The function and value assessment for Willow Reserve identified stormwater attenuation as high for function because of the stormwater diverted into Willow Reserve from TBI. In a sense, the functional assessment indicates that this portion of the wetland is acting as a stormwater sediment pond. While good for sedimentation, the NRIHA also concluded that this connection of untreated stormwater to the wetland has significantly changed the hydrology and degraded the plant community type and vegetative diversity. In this case, a high function for stormwater treatment downstream directly impacts the value of the wetland negatively for vegetative diversity.

MANAGEMENT GOALS

Management goals were developed by CRWD to guide the management of Loeb Lake and Willow Reserve. The goals were developed to address the issues and concerns listed above. The goals provide a structure so the outcome of the management actions presented below can be objectively evaluated.

Goals for Loeb Lake

GOAL #1 Maintain water quality at current conditions (nondegradation).

GOAL #2 Provide a natural land/water interface that reduces runoff and enhances pollutant filtration while providing access for recreational use of the lake.

GOAL #3 Raise awareness of nonpoint source pollution and its effects on lake water quality.

GOAL #4 Promote a healthy and balanced fish community.

GOAL #5 Achieve a healthy and diverse community of native plants and animals.

Goals for Willow Reserve

GOAL #1 Restore the area to maximize urban wildlife and native, non-invasive vegetative species diversity.

GOAL #2 Raise the awareness of Willow Reserve, its purpose, and its potential.

GOAL #3 Assess and improve, if necessary, the quality of water discharging from Willow Reserve to Trout Brook.

MANAGEMENT ACTIONS

Fourteen management actions were developed to help achieve the management goals stated above. The actions were selected based on their potential success in addressing the issues and goals identified for Loeb Lake and Willow Reserve. The LLWRMP assumes that periodic evaluation of progress towards the goals will lead to periodic adjustment to the LLWRMP.

The implementation of the management actions shall occur on a 10-year schedule, beginning in 2009 and ending in 2018. This timeframe corresponds with the CRWD 2nd Generation Management Plan. Some of the management activities may be undertaken immediately, while others should be implemented as opportunities arise.

Actions for Loeb Lake

ACTION #1 CRWD, in cooperation with Saint Paul Parks and Recreation Department, will investigate the performance of the southeast pond.

ACTION #2 Saint Paul Parks and Recreation Department, in cooperation with CRWD, will install a skimmer structure on the pipe connecting the southeast pond to Loeb Lake to retain floatable debris.

ACTION #3 CRWD, in cooperation with the Saint Paul Public Works Department, will assess the current municipal good housekeeping practices and determine the need for increased level of practices in the watershed.

ACTION #4 Ramsey County Public Works and the Minnesota Department of Natural Resources, in cooperation with CRWD, will continue to monitor the current suite of water quality and biological parameters, including zooplankton, and add monitoring of the spatial presence of filamentous algae by visual observation.

ACTION #5 CRWD, in cooperation with the District 6 Council and Saint Paul Parks and Recreation Department, will tailor and implement an education program for Loeb Lake based on an assessment of current residential practices.

ACTION #6 Saint Paul Parks and Recreation Department, in cooperation with CRWD, will conduct an assessment to evaluate the condition of the shoreline and implement shoreline restoration and stabilization as identified in the assessment. CRWD will work with Saint Paul Park and Recreation Department to determine and possibly improve on current turf management practices in Marydale Park.

ACTION #7 Ramsey County Public Works and the Department of Natural Resources, in cooperation with CRWD, will monitor the presence of invasive plant species. Specifically, they will record the spatial presence of curly leaf pondweed and Eurasian water milfoil by visual observation.

ACTION #8 The Minnesota Department of Natural Resources, in cooperation with CRWD and the Saint Paul Parks and Recreation Department, will develop an aquatic plant management plan.

ACTION #9 CRWD will work with the Minnesota Department of Natural Resources to develop a fish stocking plan that maintains top predators in an effort to maintain good water quality.

ACTION #10 CRWD, City of Saint Paul, residents, and private businesses/groups will install stormwater treatment practices in the Loeb Lake South subwatershed as opportunities arise.

Actions for Willow Reserve

ACTION #11 CRWD, in cooperation with the District 6 Council and Saint Paul Parks and Recreation Department, will form a stakeholder group to define the desired ultimate condition of Willow Reserve.

ACTION #12 CRWD, in cooperation with the City of Saint Paul and the District 6 Council, will develop and implement the restoration plan recommended by the stakeholder group.

ACTION #13 CRWD, in cooperation with the City of Saint Paul and the District 6 Council, will tailor and implement educational outreach activities for Willow Reserve and its watershed.

ACTION #14 CRWD will monitor the water quality entering and discharging from Willow Reserve.

Table 1. LLWRMP 10-year implementation plan summary.

Management Action	Estimated Total Cost	Responsible Agency	Partners / Cooperators	Proposed Implementation Years									
				2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Loeb Lake													
1. Investigate the performance of the southeast pond.	$25,000	CRWD	SPPR										
2. Install a skimmer structure on the pipe connecting the southeast pond to Loeb Lake to retain floatable debris.	$10,000	SPPR	CRWD										
3. Assess the current municipal good housekeeping practices and determine the need for increased level of practices in the watershed.	To Be Determined	CRWD	SPPW										
4. Continue to monitor the current suite of water quality parameters (including zooplankton), while adding the recording of the spatial presence of filamentous algae by visual observation.	$5,000/year	RCPW, DNR	CRWD										
5. Tailor and implement an education program for Loeb Lake based on an assessment of current residential practices.	$15,000 one-time; $5,000/yr	CRWD	District 6, DNR, SPPR										
6. Restore the shoreline of Loeb Lake.	To Be Determined	SPPR	CRWD										
7. Monitor the presence of invasive plant species. Specifically, record the spatial presence of curly leaf pondweed and Eurasian water milfoil by visual observation.	To Be Determined	RCPW, DNR	CRWD										
8. Work with SPPR and the DNR to develop an aquatic plant management plan.	To Be Determined	DNR	CRWD, SPPR										
9. Work with the DNR to develop a fish stocking plan that maintains top predators in an effort to maintain good water quality.	To Be Determined	DNR	CRWD										
10. Install stormwater treatment practices in the Loeb Lake South subwatershed as opportunities arise.	Variable	CRWD, SP	Residents, Businesses										
Willow Reserve													
11. Form a stakeholder group to define the desired ultimate condition of Willow Reserve.	To Be Determined	CRWD	SPPR, SPPW, District 6, Residents										
12. Develop and implement the restoration plan recommended by the stakeholder group.	Variable	CRWD	SP, District 6, Residents										
13. Tailor and implement educational outreach activities for Willow Reserve and its watershed.	$15,000 or more	CRWD	SP, District 6										
14. Monitor the water quality entering and discharging from Willow Reserve.	$16,000 one-time; $10,000/yr	CRWD	SP										

1.0 Introduction

The purpose of the Loeb Lake and Willow Reserve Management Plan (LLWRMP) is to provide a framework for the protection and improvement of Loeb Lake and Willow Reserve located in the Capitol Region Watershed District (CRWD). The plan is intended to assess the current conditions of each and identify opportunities for improving the ecological, aesthetic, and recreational opportunities of Loeb Lake and Willow Reserve.

CRWD covers 40 square miles and includes portions of Falcon Heights, Lauderdale, Maplewood, Roseville, and St. Paul (Figure 1). CRWD is located within Ramsey County and has a population of approximately 245,000 people. The Mississippi River is the predominant water resource to which the entire district drains. Como Lake, Crosby Lake, and Lake McCarrons are also located within the District.

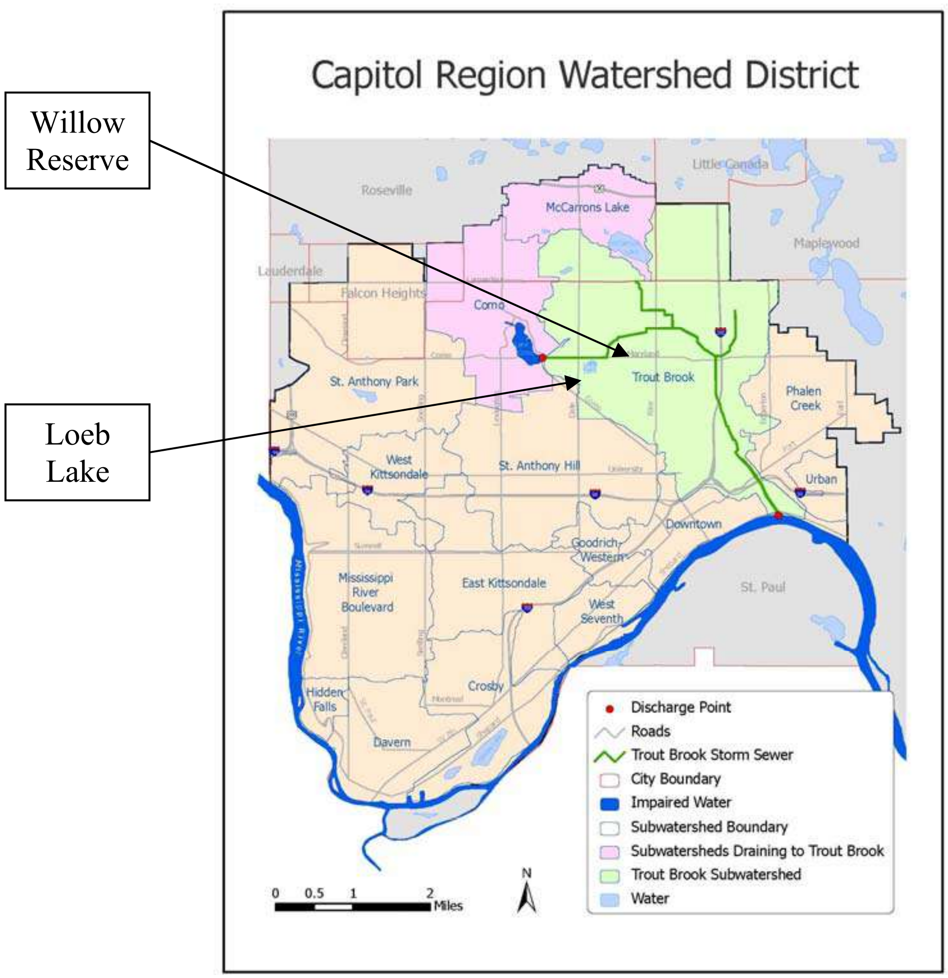

Figure 1. Capitol Region Watershed District Location Map

Established in 1998, CRWD is guided by five managers who are appointed by Ramsey County. The Board of Managers works with other governmental bodies, such as the Ramsey Soil and Water Conservation District, Ramsey County, state agencies and cities within its jurisdiction, to protect, manage, and improve surface water and groundwater. It initiates major water quality, lake management, and flood control studies and projects and provides public education on water resources protection.

CRWD has accepted responsibility for the administration, coordination and oversight of the LLWRMP. To this end, CRWD will assist partners and cooperators as necessary; monitor their performance; and ensure that the management actions set forth here are implemented as scheduled.

Loeb Lake

Loeb Lake is a small, urban lake located within the northwestern portion of the City of Saint Paul (Figure 2). It is surrounded by Marydale Park and is generally considered to have good water quality. The primary recreational use of the lake is for fishing because it is designated as a "Fishing in the Neighborhood" (FiN) lake by the Minnesota Department of Natural Resources (DNR).

Figure 2. Location map of Loeb Lake and Willow Reserve in Saint Paul, MN.

Despite the good water quality of Loeb Lake, there are concerns related to the future health of Loeb Lake. Issues such as filamentous algae, shoreline erosion, invasive aquatic plants, and an imbalanced fishery all create concerns that motivate someone to further protect Loeb Lake.

Willow Reserve

Willow Reserve is a 23-acre open space owned by the City of St. Paul. Located two blocks to the northeast of Loeb Lake (Figure 2), a neighborhood group worked with the City to acquire the site for a bird and wildlife sanctuary in the mid 1960's. The property consists of wetland and upland areas and is currently owned and managed by the Saint Paul Parks & Recreation Department as a Park Preserve. Prior to City ownership, the land was actively managed for agricultural production from before 1940 through the late 1980s. Willow Reserve takes its name from the local florists that grew Pussy Willow stems at the Willow Reserve site for sale in their shops.

Willow Reserve was created as a wildlife preserve because it is a unique natural resource in the midst of an urban setting that provides rare wildlife habitat. The 2007 Natural Resource Inventory and Habitat Assessment (NRIHA) identified a variety of wildlife species including deer and 36 bird species. Willow Reserve is a stopping point for birds including those following the Mississippi River Flyway, a recognized migration path for bird species. Because of the relative scarcity of greenspace in the city, its large size, regional setting and the various ecotypes, Willow Reserve is highly valued as wildlife habitat.

There are currently few to no recreational opportunities associated with Willow Reserve. This is both a benefit and a detriment to the area. Wildlife and habitat are isolated from human interaction, but the area is concealed by overgrown, invasive vegetation so that dumping of trash and debris has become a significant problem.

In the early 1990s, the combined Trout Brook sewer interceptor system, which carried both sanitary waste and stormwater, was separated to convey stormwater flows only. Because of the lack of hydraulic capacity in the Trout Brook storm sewer interceptor system (TBI), a connection was created between TBI and Willow Reserve to allow high flows into the Reserve, which in essence functions as a "pressure relief valve" for TBI. The favorable wetland conditions and its proximity to TBI made Willow Reserve ideal for conversion into a stormwater rate control and sedimentation basin. Prior to sewer separation, the wetland community consisted of those saturated to the surface but did not typically have standing water throughout the year. It was only after excavation for these ponding areas did standing water exist in Willow Reserve year-round.

The NRIHA functions and values assessment identified stormwater attenuation as high for function because stormwater is diverted into Willow Reserve from TBI. In a sense, the functional assessment indicates that this portion of the wetland is acting as a stormwater sediment pond. While good for sedimentation, the NRIHA also concluded that this connection of untreated stormwater to the wetland has significantly changed the hydrology and degraded the plant community type and vegetative diversity. In this case, a high function for stormwater treatment downstream directly impacts the value of the wetland negatively for vegetative diversity.

The designation of Willow Reserve as a preserve does not exempt it from having its own set of issues and concerns. A primary concern is the unknown vision or desired ultimate condition of Willow Reserve by the various stakeholders including local residents, environmentalists, and the City of Saint Paul. Restoring Willow Reserve to increase vegetative and wildlife diversity has been discussed by interested parties, but a vision or goal has not been established because there is currently not enough information gathered about the area to begin restoration planning.

2.0 Context for This Plan

2.1 MANAGEMENT PLANNING PROCESS

The development of the LLWRMP by CRWD relies on input from a broad-based Advisory Group. Existing District groups including the Board of Managers, Citizen Advisory Committee and Technical Advisory Committee are a part of the Advisory Group membership. Involvement by citizens or non-profit organizations, such as Friends of the Parks, is also important. Local political groups, including St. Paul Community Council District 6 (North End), Ramsey County and the various departments of the City of St. Paul, are essential to development of the LLWRMP.

2.2 PREVIOUS STUDIES

Several studies have been completed that are relevant to this management plan. Following is a brief description of the studies completed prior to this management plan.

2.2.1 CRWD Watershed Management Plan

CRWD's Watershed Management Plan (2000) identifies both Loeb Lake and Willow Reserve as wetlands. The implementation section of the Watershed Management Plan lists the completion of a strategic lake management plan for Loeb Lake (Action Policies WQUAL1, WTMGT2c). Additionally, the Watershed Management Plan lists developing specific wetland restoration plans for multiple wetlands in the District including Willow Reserve (Action policy WTMGT2c). The next generation of the District's Watershed Management Plan will be completed in 2010 and will incorporate the management goals, objectives and actions of this subwatershed management plan.

2.2.2 Loeb Lake Small Area Plan

The City of Saint Paul Planning Commission initiated the "Loeb Lake Small Area Plan" in February 2005 and appointed a task force to develop the plan consisting of representatives from community organizations, a school, a religious institution, CRWD, area businesses, residents, and developers. The plan resulted in renewed interest in Loeb Lake and Marydale Park.

The plan established a wide vision, including "Loeb Lake will be a safe, attractive and vibrant community that retains its distinctive character with a focus on preservation and enhancement of the area's existing natural amenities…Natural amenities such as Loeb

Lake and Willow Reserve will be enhanced to provide more recreational and bird and wildlife observation opportunities." The plan also recommended that all new development closely observe CRWD's regulations and storm water management requirements. Finally, the plan identified action programs related to residential housing, commercial development, public areas, zoning recommendations, and City responsibilities.

2.2.3 Willow Reserve Wetland Delineation

CRWD delineated the wetland boundaries and identified wetland plant types in Willow Reserve in 2005 (Appendix A). Approximately 16.3 acres of wetland was delineated. Appendix A contains a map showing the wetland boundaries and types that were delineated.

2.2.4 Willow Reserve Natural Resources Inventory and Habitat Assessment

CRWD completed the "Willow Reserve Natural Resources Inventory and Habitat Assessment" (NRIHA) in December 2007 (Emmons & Oliver Resources). The NRIHA identified the ecological character of ten plant communities and habitats that occur within or immediately adjacent to Willow Reserve. The NRIHA also assessed the hydrology and soils/topography within the site and their role in potential restoration opportunities.

2.3 OTHER JURISDICTIONS AND AUTHORITIES

Numerous current regulations impact management activities for the protection of water quality in the City of Saint Paul's surface waters. Following is a brief discussion of the relevant regulations for this management plan.

2.3.1 MS4 Stormwater Permits

Stormwater discharges associated with municipal separate storm sewer systems (MS4s) are regulated through the use of National Pollutant Discharge Elimination System (NPDES) permits. NPDES permits are legal documents. Through this permit, the owner or operator is required to develop a stormwater pollution prevention program (SWPPP) that incorporates best management practices (BMPs) applicable to their MS4.

The City of Saint Paul and CRWD are MS4s. The City of Saint Paul operates and maintains the storm drains and lateral storm sewer pipes in the watershed, while CRWD assumed ownership and maintenance responsibilities of a trunk line storm sewer, Trout Brook Storm Sewer Interceptor, in 2006.

MS4s are required to develop and implement a stormwater pollution prevention program (SWPPP) to reduce the discharge of pollutants from their storm sewer system to the maximum extent practicable. The SWPPP must cover six minimum control measures:

- Public education and outreach;
- Public participation/involvement;
- Illicit discharge, detection and elimination;
- Construction site runoff control;
- Post-construction site runoff control; and
- Pollution prevention/good housekeeping.

The MS4 must identify best management practices (BMPs) and measurable goals associated with each minimum control measure. An annual report on the implementation of the SWPPP must be submitted each year. Additionally, if the MS4 discharges to an impaired water, the permit holder must address the TMDL load allocations once the TMDL is in place.

2.3.2 City of Saint Paul Site Plan Review

The City of Saint Paul requires a stormwater management plan as part of its development and redevelopment site plan review. The purpose of the plan is to show how stormwater will be managed on the site: where it will drain to, at what rate, and steps that will be taken to protect water quality. For sites smaller than one-quarter acre, the City recommends grading the site so that stormwater flows to a street or a public alley.

For sites larger than one-quarter acre, the City requires that the rate of stormwater runoff for the site may not exceed 1.64 cubic feet per second per acre. Stormwater must normally be directed to on-site stormwater detention ponds and catch basins connected to the City storm sewer system in order to control the rate of stormwater runoff from the site.

2.3.3 Capitol Region Watershed District Development Rules

CRWD adopted watershed rules in 2006 to address both short and long term stormwater management needs as part of its ongoing effort to improve water quality. The stormwater management rule requires land developers to control runoff from construction or redevelopment sites greater than one acre. Specifically, a stormwater management plan must be submitted that retains all runoff from the 1-inch storm; reduces proposed discharge rates to the existing values; and reduces the proposed total suspended solids loading by 90%. Additional rules are in place related to wetlands, erosion control, illicit discharges, and flooding.

2.3.4 Clean Water Act and Total Maximum Daily Loads

The federal Clean Water Act (CWA) requires states to adopt water-quality standards to protect waters from pollution. These standards define how much of a pollutant can be in the water and still allow it to meet designated uses, such as drinking water, fishing and swimming. If pollutant levels exceed these standards, they are considered to be "impaired." Neither Willow Reserve nor Loeb Lake has been designated as impaired.

Lake water quality is typically evaluated based on the concentration of total phosphorus in the water, because phosphorus is usually the limiting nutrient driving algal growth. However, two other lake response parameters are also considered: chlorophyll-a concentration and Secchi depth. As shown in Table 2, the water quality standards differ for deep and shallow lakes, which take into account nutrient cycling differences between these types of lakes. Loeb Lake is considered a shallow lake for regulatory purposes.

Table 2. Minnesota water quality standards for lakes in the North Central Hardwood Forest ecoregion.

Parameter	North Central Hardwood Forest	
	Shallow[1]	Deep
Phosphorus concentration (μg/L)	60	40
Chlorophyll-a concentration (μg/L)	20	14
Secchi disk transparency (meters)	>1	>1.4

[1] Shallow lakes are defined as lakes with a maximum depth of 15 feet or less, or with 80% or more of the lake area shallow enough to support emergent and submerged rooted aquatic plants (littoral zone).

2.3.5 DNR Public Waters Inventory

Loeb Lake is designated as public water wetland 231W on the Minnesota Department of Natural Resources (DNR) Public Water Inventory (Map 2). Willow Reserve is not designated as a public water. Designation as a public water indicates that the waterbody is subject to the regulatory jurisdiction of the DNR.

Public waters are all basins and watercourses that meet the criteria set forth in Minnesota Statutes (Section 103G.005, subd. 15). Public waters are identified with a number followed by a "P" (e.g., 85P) and public water wetlands are identified with a number followed by a "W" (e.g., 30W). Public water wetlands include all type 3, type 4, and type 5 wetlands (as defined in U.S. Fish and Wildlife Service Circular No. 39, 1971 edition) that are 2 acres or more in size in incorporated areas. The regulatory "boundary" of these waters and wetlands is called the ordinary high water level (OHW). The DNR has not established an ordinary high water (OHW) level for Loeb Lake.

3.0 Loeb Lake and its Watershed

Successful lake management requires an understanding of not only nutrient cycling in the lake and its watershed, but also an understanding of in-lake processes that may be affecting water quality and lake value. To successfully protect lake quality, managers must address both the phosphorus loads to the lake as well as degraded biological conditions including an imbalanced fishery, lack of appropriate aquatic vegetation, and degraded habitats and shorelines. Biological conditions are addressed in this section, while subsequent sections assess phosphorus loading to the lake.

3.1 LAKE CHARACTERISTICS

Loeb Lake is located within the northwestern portion of the City of Saint Paul and is generally considered to have good water clarity. It has a surface area of 9.7 acres and an average depth of 9 feet (Table 3). It is considered a shallow lake despite a maximum depth of 28 feet. The amount of littoral area (less than 15 feet in depth and where the majority of the aquatic plants grow) defines whether a lake is considered deep or shallow. Shallow lakes have more than 80% littoral area, while deep lakes have a littoral area less than 80%.

Table 3. Characteristics of Loeb Lake.

Parameter	Loeb Lake
Surface Area (ac)	9.7
Average Depth (ft)	8.7
Maximum Depth (ft)	28
Volume (ac-ft)	84
Littoral Area (ac)	7.9
Littoral Area (%)	81
Watershed (ac)	44

3.2 WATERSHED CHARACTERISTICS

Loeb Lake receives stormwater runoff from a 44-acre, fully developed urban watershed, including approximately 9 acres of impervious cover, and it does not have an outlet. Runoff from the north half of the watershed (Loeb Lake North) enters the lake primarily by sheet flow through Marydale Park, which surrounds the lake (Map 3). A storm sewer that collects runoff from Mackubin Street between Maryland and Jessamine Avenues discharges into the Loeb Lake

North subwatershed. Approximately 61% of the north subwatershed consists of Marydale Park, 28% the lake surface, 9% single and multi-family residential, and 2% railroad (Map 4).

Runoff from the Loeb Lake South subwatershed (Map 3) is conveyed to Loeb Lake through two storm sewers. The storm sewers drain Jessamine Avenue, a portion of Mackubin Street south of Jessamine Avenue, and Jessamine Court and discharge to the stormwater pond at the southeast corner of Loeb Lake. The pond is connected to Loeb Lake by a 36-inch reinforced concrete pipe (RCP; estimated diameter). Approximately 74% of the south subwatershed is developed as residential, commercial or industrial land use (Map 4). The area was developed prior to implementation of CRWD rules requiring stormwater treatment, so there is minimal treatment of runoff prior to entering the southeast stormwater pond. Specific land use classifications and areas are listed in Table 4.

Table 4. 2005 land use for the Loeb Lake drainage area.

Loeb Lake North Subwatershed	
Land Use	**Area (ac)**
Single Family Residential	0.9
Multi-Family Residential	1.5
Commercial	0.2
Park and Recreation	16.0
Railway	0.8
Water	7.4
Total	26.8
Loeb Lake South Subwatershed	
Land Use	**Area (ac)**
Single Family Residential	6.7
Commercial	0.3
Industrial	5.3
Park and Recreation	2.2
Undeveloped	2.2
Total	16.8
Total Drainage Area to Loeb Lake	**43.6**

Map 5 depicts the Ramsey County Soil Survey data in the north and south subwatersheds. Since much of the subwatersheds were developed prior to the creation of the soil survey, the majority of the landscape is mapped as urban land. Urban land nomenclature indicates the soil survey did not include an analysis of these areas.

The south end of Loeb Lake is mapped as a Seelyeville Soil Series, a hydric soil series, consisting of deep muck and peat soils. Loeb Lake is surrounded by the Udorthents Soil Series which does not have an official soil description but is an indication of past excavation for mineral aggregate or some other type of past disturbance.

The best indication of soil type and geology of the area that can be obtained from the soil survey is in the areas never developed or disturbed. Two soil series, Chetek and Mahtomedi, are shown on Map 5 north of Loeb Lake on relatively undisturbed land. These soil series are indications of the deposition of the area consisting of alluvium and sandy outwash. The subwatershed is likely underlain by the remnants of a glacial outwash deposit with coarse textured sandy soils, including gravel and boulders.

Shoreline conditions on Loeb Lake have not been surveyed. The entire shoreline is within Saint Paul's Marydale Park. A shoreline assessment would be useful for better quantifying shoreline conditions and for determining shoreline restoration and management needs.

3.3 WATER BUDGET

A water budget refers to the relationship between input and output of water through a system. The system can represent a lake, basin, stream, or groundwater reservoir. When the input and output from the system do not equal one another, there is a change in storage and resulting change in stage of the system.

For a lake water budget, input terms can include precipitation, runoff, surface flow to the lake (through a creek, stream or pipe), and groundwater. Output terms can include evapotranspiration, surface flow from the lake (through a creek, stream, or pipe), and groundwater. The general formula for a water budget is

$$P + I - O - E \pm G = \Delta S$$

Where P = precipitation
I = runoff and surface inflow
O = surface outflow
E = evapotranspiration
G = groundwater inflow and outflow
ΔS = change in storage of the lake

CRWD determined a water budget for Loeb Lake based upon measured lake levels, measured precipitation, estimated evaporation rates, and modeled runoff volumes. Lake level data was obtained from the DNR website for the years 2003-2007. CRWD obtained daily precipitation data for the area from the Minnesota Climatology Working Group website. Monthly evaporation rates were obtained from the *Minnesota Hydrology Guide*. Runoff volumes to Loeb Lake were obtained from the Loeb Lake P8 model.

Although lake level data was available for the years 2003 to 2007, water budgets were only determined using data from 2003 and 2006. (Water budget data is provided in Appendix B.) Years 2004, 2005, and 2007 were not used because of the lack of lake level measurements.

- 2003: Level measured 14 days from May 15 through December 10.

- 2004: Level measured four days from February 26 through April 22.
- 2005: No level measurements available.
- 2006: Level measured 18 days from March 9 through November 30.
- 2007: Level measured six days from January 1 through June 14.

The bathymetric map for Loeb Lake created by the DNR was used to determine the lake area, elevations, and storage relationships. Loeb Lake is considered a "seepage lake" because there is no surface outflow from the lake. Only three storm sewers located on Mackubin Street, Jessamine Avenue and Jessamine Court discharge into Loeb Lake. Therefore, the water budget was solved for the groundwater term. Table 5 lists the water budget for years 2003 and 2006.

Table 5. 2003 and 2006 water budgets for Loeb Lake.

	Inflow			Outflow		Days of Record
	Watershed (ac-ft)	Precipitation (ac-ft)	Groundwater (ac-ft)	Evaporation (ac-ft)	Groundwater (ac-ft)	
2003	11.5	13.2	8.2	20.1	14.3	209
2006	32.3	23.0	0.4	23.1	37.5	267

The Minnesota Climatology Working Group website reports approximately 30 inches of precipitation for Ramsey County in 2006 and 26 inches for 2003. The long term annual precipitation in the county is approximately 29 inches; therefore, the 2006 water budget is the most representative for Loeb Lake. Figures 3 and 4 show the annual water budget in percent for year 2006. Figure 3 displays the average inflow to the lake, while Figure 2 displays the average outflow.

From Figures 3 and 4, it is evident that Loeb Lake is a groundwater recharge lake. The majority of water leaves the lake through the groundwater. This is significantly greater than the amount of water that discharges to the lake from groundwater.

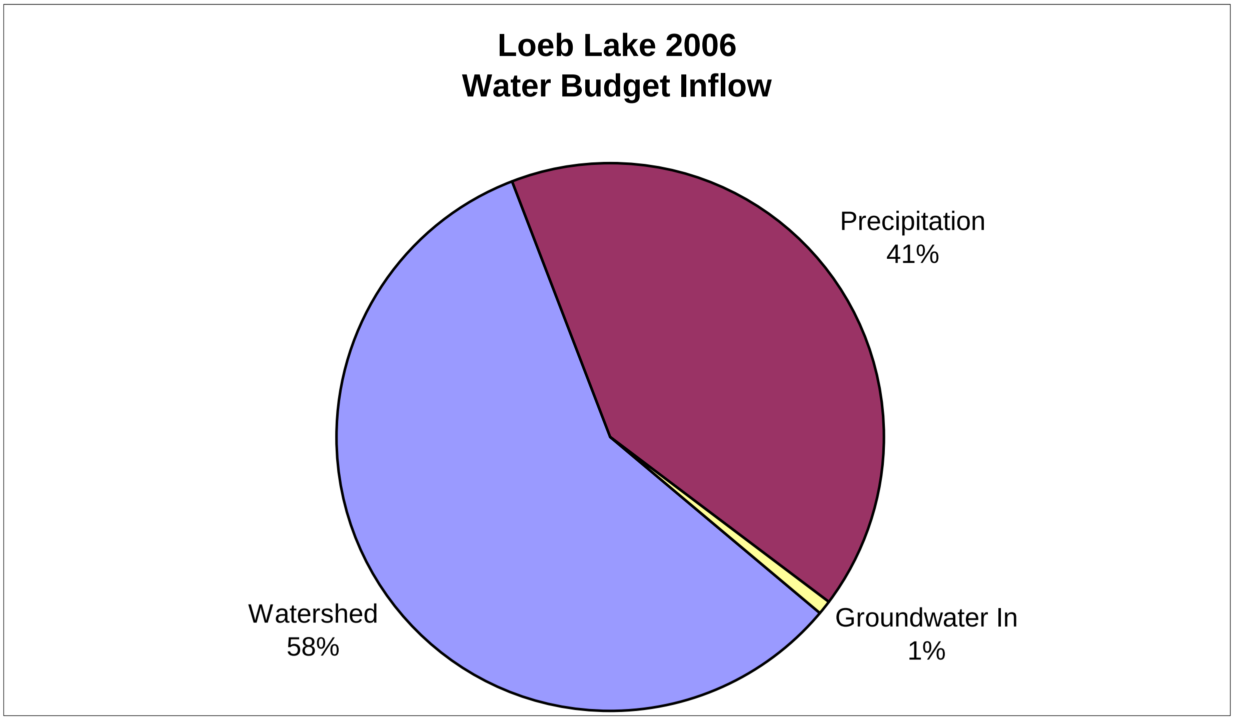

Figure 3. Loeb Lake inflow water budget for the 2006 monitoring season.

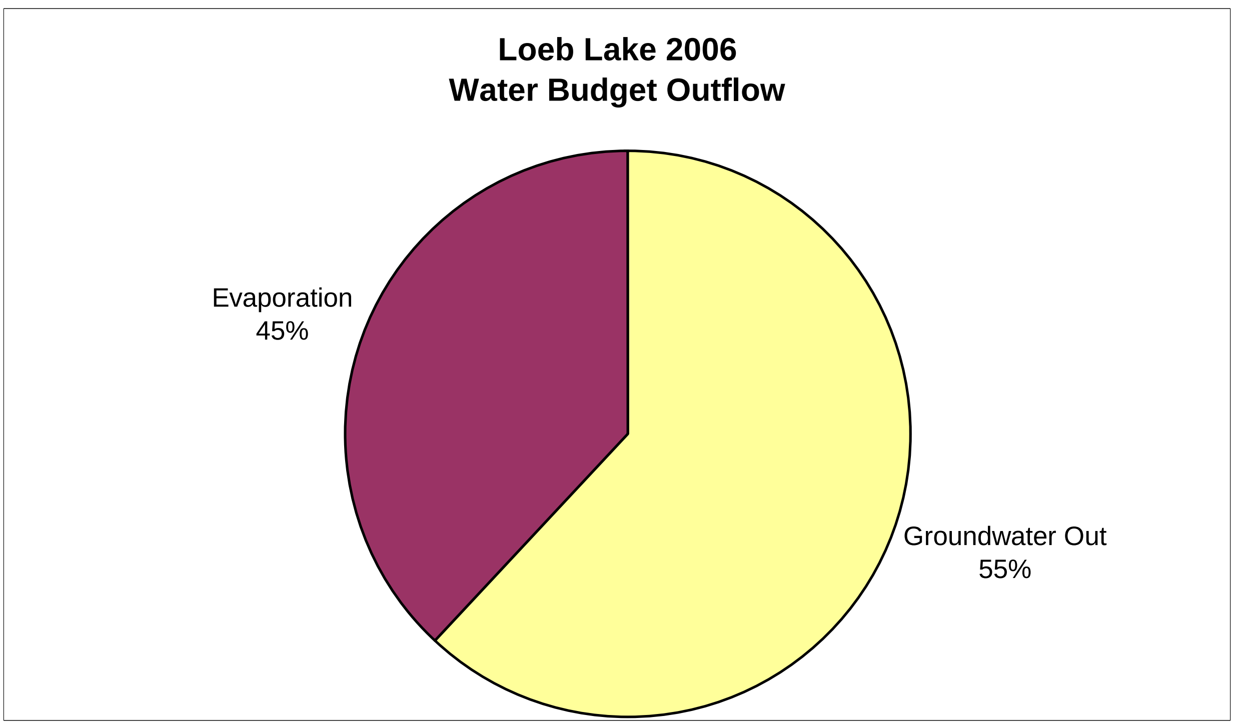

Figure 4. Loeb Lake outflow water budget for the 2006 monitoring season.

3.4 FISH POPULATION AND HEALTH

3.4.1 Fishing in the Neighborhood

Loeb Lake is a recreational lake that supports fishing and is a designated "Fishing in the Neighborhood" (FiN) lake by the DNR. The City maintains a public dock on the eastern side of the lake.

The FiN program provides fishing opportunities for residents and visitors in the Minneapolis-Saint Paul metropolitan area. This urban fishing program was established in 2001 to expand Twin Cities fishing opportunities. FiN works with local partners to make safe, family settings situated in residential areas. Together with the local partners including CRWD, FiN stocks fish, installs fishing piers and platforms, restores shoreline habitat, and sponsors aquatic education to create quality fishing opportunities.

3.4.2 DNR Fish Community Data

CRWD obtained fish community data from the DNR lake management plan and fish survey reports maintained in the DNR central office. There have been eight fish surveys conducted from 1974 through 2006. CRWD reviewed the historical fish community data in terms of species abundance and biomass.

DNR standard lake fish surveys are conducted using two sampling methods: gill nets and trap nets. Fish sampling methods contain inherent sampling bias – they successfully collect some species while rarely capturing others. Gill nets are used to sample game species such as northern pike and walleye, while trap nets are used to sample panfish, including bluegills, crappies and bullhead. Both gill nets and trap nets under-represent the presence/abundance of small minnow and darter species. Additionally, neither method is successful at collecting largemouth bass.

Fish community data was summarized by trophic groups for Loeb Lake. Species within a trophic group serve the same ecological process in the lake (i.e., panfish species feed on zooplankton and invertebrates, and may serve as prey for predators). Analyzing all the species as a group is often a more accurate summary of the fish community.

The trophic group summary for species collected during DNR surveys in Loeb Lake includes the following species in each group:

- Forage Species: Golden Shiner, White Sucker, Yellow Perch
- Panfish: Black Crappie, Bluegill, Hybrid Sunfish, Green Sunfish, Pumpkinseed Sunfish
- Top Predator: Channel Catfish, Largemouth Bass, Northern Pike, Walleye
- Rough Fish: Black Bullheads, Brown Bullheads

Figures 5, 6 and 7 summarize the trophic group abundance and biomass data for Loeb Lake. The amount of panfish caught in 2000 was extremely high (Figure 5; possibly due to recent fish stocking), so the 2000 year was removed and re-graphed in Figure 6.

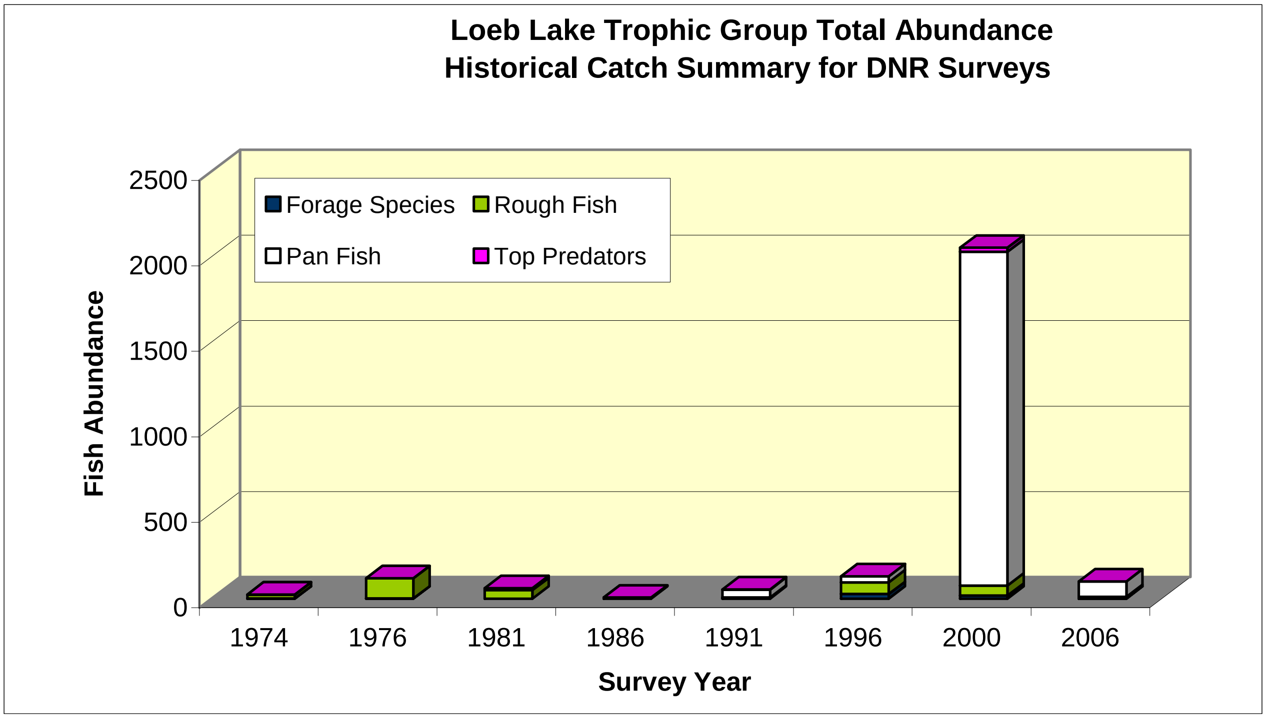

Figure 5. Historic fish survey data (all years).

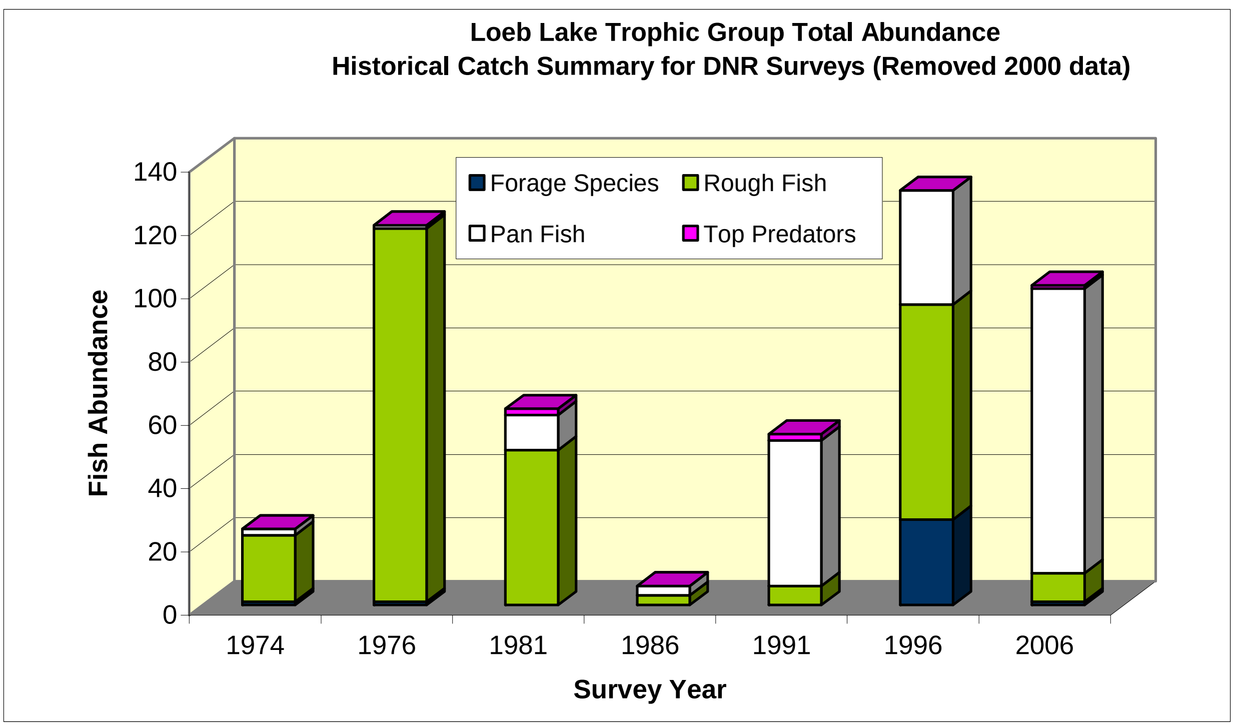

Figure 6 Historic fish survey data (2000 data removed).

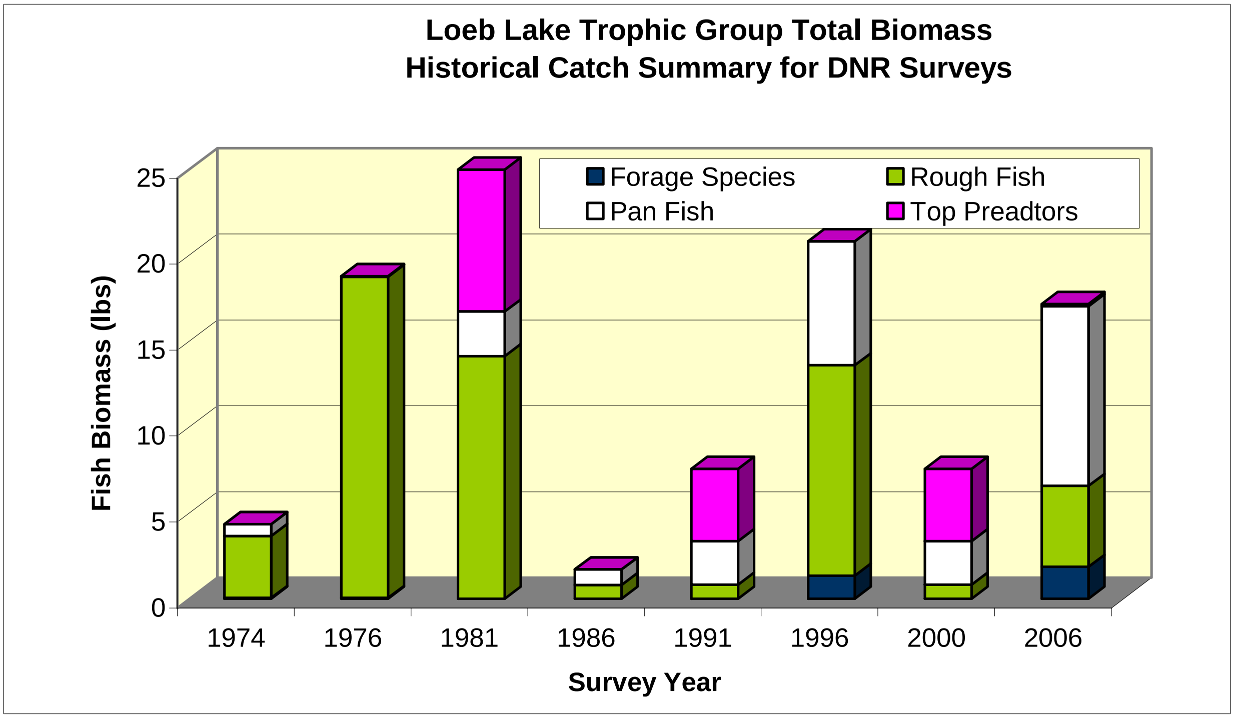

Figure 7. Historic fish survey biomass data.

3.4.3 Analysis of DNR Fish Community Data

Review of the historical fish data reveals that species in the panfish and rough fish groups comprise the majority of the catch during most surveys. Overall, black bullhead and bluegill have been the most numerous species collected. Rough fish and panfish groups also contain the majority of fish biomass during many surveys.

An interesting point is the high percentage of top predator biomass in the 1981, 1991 and 2000 surveys. This is due to the use of gill nets in conjunction with trap nets during these survey years. Gill nets collect more top predator species such as walleye and northern pike. The lack of top predator abundance and biomass during the 1976, 1986 and 1996 surveys is likely an artifact of gill nets not being used during the sampling.

DNR records indicate that Loeb Lake has experienced winter kill – as recently as the winter of 2006/2007. Winter kills are normally a result of thick ice cover and low oxygen levels in lakes. Winter kills rarely kill all fish present in a lake but often kill the majority of the game and panfish. Depending on the severity of the oxygen depletion, it is possible that only tolerant species such as black bullhead and golden shiner may survive.

Winter kills have a negative view by many park users and anglers but can provide some benefit in certain systems. Winter kills can provide a top down control in a system by helping to keep panfish populations in check, which in turn can lead to a larger or more abundant zooplankton community. A healthy and abundant zooplankton community in a lake is an important factor in limiting growth of algae . From a fish community standpoint, winter kill is likely not a concern in Loeb Lake due to the stocking program employed by the DNR. This ensures that a large number of desirable species continue to be present in the lake. The addition of a lake aerator (added in 2000) will also help to prevent winter kills during some years.

Lake management files for Loeb Lake indicate that stocking efforts began in 1974 and have continued on an annual basis since that time. Many stocking plans employ a “put, grow, take” strategy where small fry or fingerling fish are stocked and then spend several years in the lake to grow to a catchable size before they are harvested by anglers. Loeb Lake stocking efforts have recently employed “put, grow, take” for species such as walleye and channel catfish.

However, the majority of stocking efforts in Loeb Lake have focused more on a “put and take” fishery where adult, catchable size fish are stocked. Adult species that have been stocked in Loeb Lake include bluegill, walleye, channel catfish, black crappie, northern pike and largemouth bass. An interesting note in regards to the adult stocked fish is that very few have been captured in many of the DNR fish surveys. The reasons for this may include the absence of gill nets in some survey years or that the majority of adult size stocked fish are harvested by anglers before the end of the fishing season and are not present in the lake during the sampling the following year.

A recent fish survey conducted by the DNR (2000) indicates that Loeb Lake had a strong year class of bluegills and sunfish, which can exhibit heavy predation pressure on zooplankton. While the adult panfish stocked by the DNR are an important component of the DNR “Fishing in the Neighborhood Program,” the small panfish present in the 2000 survey are likely due to natural reproduction in the lake. The submerged vegetation in Loeb Lake provides refugia for small panfish, which may hinder top predator control. The DNR has been stocking top predators which may or may not help control panfish populations because of the intense fishing pressure this lake experiences. More recent zooplankton data suggests that the panfish population is not having a negative effect on large cladocera abundance (see Section 3.6).

3.5 AQUATIC VEGETATION

In shallow lakes, water quality is sensitive to changes in the biotic community. The fish community and aquatic vegetation play an important role in maintaining water quality and clarity. Shallow lakes usually exist in one of two states: clear water or turbid water. Changes in nutrient load, a fishery imbalance, or introduction of a nuisance or invasive species can cause a cascade of effects that will result in a rapid switch from clear water to turbid water. Therefore, it is important to monitor and manage the biotic community of a shallow lake as it is to control the nutrient load.

3.5.1 Aquatic Plant Community Data

Aquatic plant community data for Loeb Lake was collected by the DNR during its 1981 and 2000 fish surveys. Both DNR surveys were conducted during the summer. Ramsey County Public Works collected aquatic plant community data in the fall of 2005. The DNR collected the data using a transect method that included a relative abundance rating for each observed species. Ten transects were surveyed around the lake. Ramsey County

Public Works sampled a single transect through a large littoral portion of the west side of the lake.

The DNR relative abundance rating includes the following categories: abundant, common, occasional, rare, and present. In order to graphically display the survey data, a percent occurrence value was assigned to each DNR category in the following manner:

Abundant = 80%
Common = 50%
Occasional = 25%
Rare = 10%
Present = 5%
Not Observed = 0%

The results of the aquatic vegetation surveys are listed in groups of emergent, floating leaf and submergent species in Table 6 and displayed with the occurrence rating in Figure 8.

Table 6. Aquatic vegetation survey results for Loeb Lake.

Common Name	Scientific Name	Plant Type	1981 - Summer DNR	2000 - Summer DNR	2005 - Fall Ramsey Co. PW
Arrowhead	*Sagittaria latifolia*	Emergent	Occasional	Not Observed	Not Observed
Common Cattail*	*Typha latifolia*	Emergent	Abundant	Rare	Not Observed
Purple Loosestrife**	*Lythrum Sali*	Emergent	Not Observed	Rare	Not Observed
Smartweed	*Polygonum amphibium*	Emergent	Not Observed	Rare	Not Observed
Greater Duckweed	*Spirodela polyrhiza*	Floating Leaf	Not Observed	Abundant	Not Observed
Lesser Duckweed	*Lemna minor*	Floating Leaf	Common	Common	Rare
White Water Lily	*Nymphaea odorata*	Floating Leaf	Not Observed	Present	Not Observed
Curly Leaf Pondweed**	*Potamogeton crispus*	Submerged	Not Observed	Common	Occasional
Coontail	*Ceratophyllum demersum*	Submerged	Abundant	Common	Common
Eurasian Water Milfoil**	*Myriophyllum spicatum*	Submerged	Not Observed	Not Observed	Occasional
Filamentous Algae	Multiple species	Submerged	Not Observed	Rare	Present
Flatstem Pondweed	*Potamogeton zosteriformis*	Submerged	Abundant	Not Observed	Not Observed
Narrowleaf pondweed	*Potamogeton strictifolius*	Submerged	Common	Rare	Not Observed
Sago Pondweed	*Stuckenia pectinata*	Submerged	Common	Not Observed	Not Observed
Watermeal	*Wolffia*	Submerged	Not Observed	Common	Not Observed

* Narrow-leaf is considered non-native. Broad-leaf is native.
** Non-native

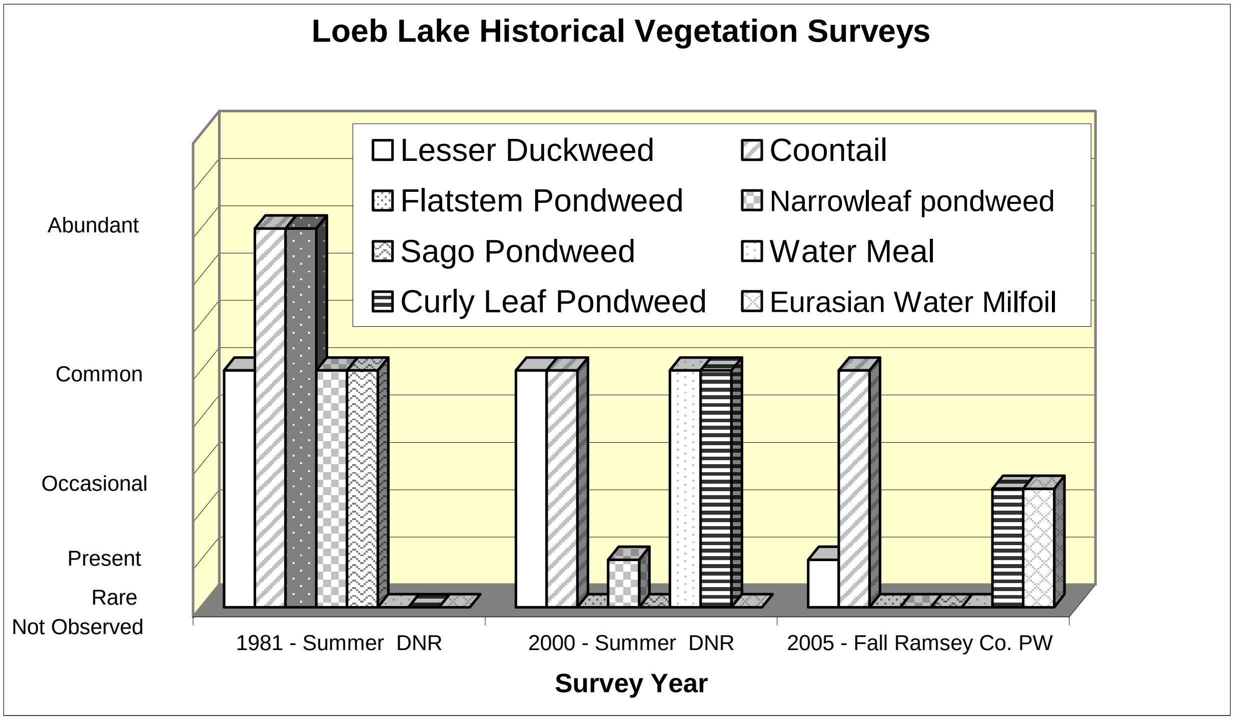

Figure 8. Loeb Lake historic aquatic vegetation survey data.

3.5.2 Analysis of Aquatic Plant Community Data

There were two emergent, one floating leaf and four submerged species observed during the 1981 survey. During the 2000 survey, there were three emergent, three floating leaf and five submerged species observed. No emergent, one floating leaf, and four submerged species were observed during the 2005 survey.

Between 1981 and 2000, there was a decline in the number of desirable native submerged species (sago pondweed, narrowleaf pondweed and flatstem pondweed). This could indicate a decline in water quality and fish habitat as species such as sago pondweed are known to be important components of fish and waterfowl habitats as well as sensitive to degraded water quality.

Another significant observation is the presence of curly leaf pondweed in the 2000 survey. Curly leaf pondweed is an exotic species that begins growing under the ice and reaches peak growth, often in dense mats, prior to senescence (i.e. die-back) in mid to late June. When the thick mats of curly leaf pondweed die-back in the early summer, lake water clarity is reduced and nutrients are released into the water column which can spur algal growth. Conversely, the native submerged species coontail and watermeal were still present during the 2000 survey which indicates that curly leaf pondweed densities have not completely eradicated native submergent species. The DNR lake management files indicate that the exotic submerged plant species Eurasian water milfoil was found in Loeb Lake in 2003.

The 2005 data is not directly comparable to the 1981 and 2000 data because they were collected during different times of the year (fall vs. summer). The 2005 method of data collection was also not as extensive as that used for the 1981 and 2000 DNR surveys.

The 2005 data, however, is still useful to validate the three trends observed between the 1981 and 2000 data.

- Curly leaf pondweed continues to be observed in the lake. The 2005 abundance is lower than 2000 because this species dies out at the end of summer. It likely has a strong presence in the lake and may have been re-growing at the time of the 2005 sampling.
- Narrow leaf pondweed was not observed in 2005. This is a native species that was "common" in 1981 and reduced to "present" in 2000.
- The native coontail continues to be "common" (the same as in 2000). However, this species is known to be the last native to survive in vulnerable ecosystems. Even though it is native, it can form dense, unappealing mats.

3.6 ZOOPLANKTON

Zooplankton data were collected from Loeb Lake from 2003 through 2007 (Figure 9). In each of the years, the zooplankton community had a relatively large proportion of large cladocera. The relative abundance of large cladocera is important because these planktivores tend to be very efficient grazers on algae. However, these organisms are also quite susceptible to fish predation because of their large size. The sizeable aquatic vegetation community in Lobe Lake provides refugia from predation for the zooplankton and likely contributes to the large coladoceran population. The prevalence of large cladocera in Loeb Lake helps maintain good water clarity and indicates a relatively balanced fishery.

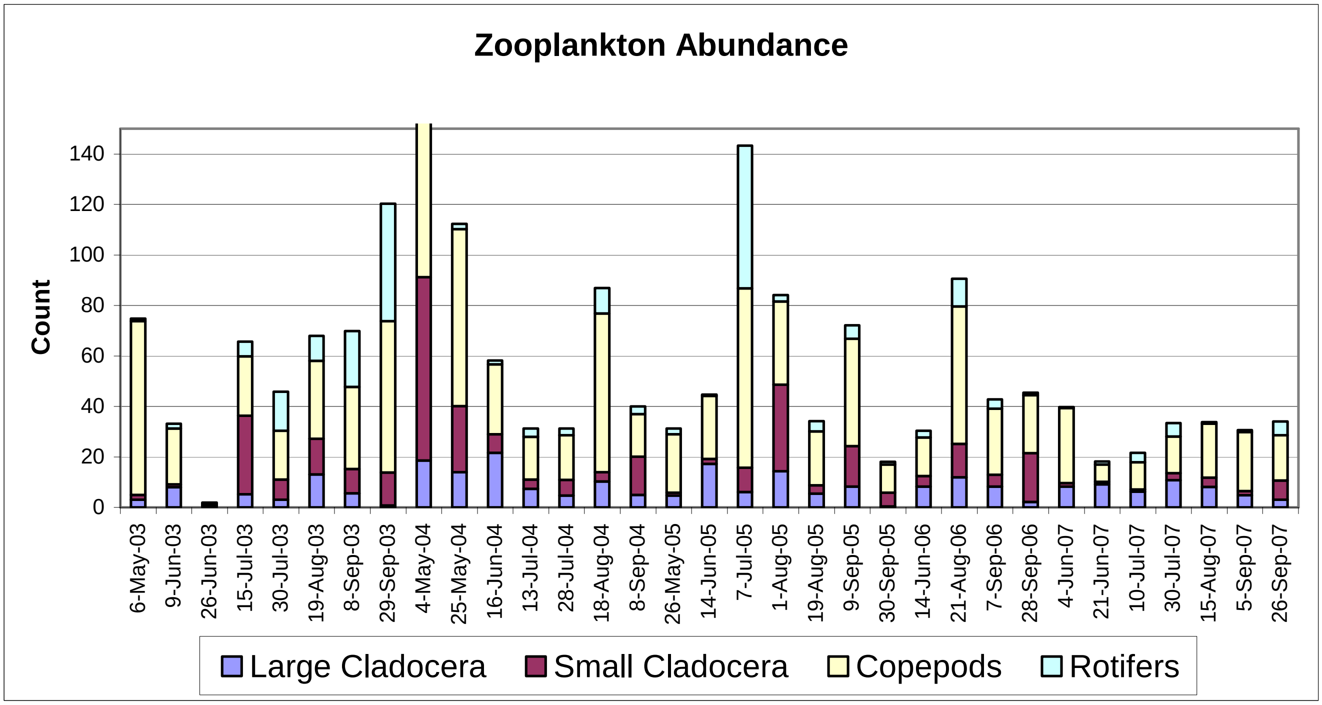

Figure 9. Zooplankton relative abundance for Loeb Lake.

4.0 Loeb Lake Water Quality

4.1 LAKE MONITORING PARAMETERS

The MPCA and Ramsey County collected a large amount of water quality data from 2004 to 2007. The measured parameters included water level, temperature, dissolved oxygen, total and dissolved phosphorus at a range of depths, ammonia, nitrate, total Kjeldahl nitrogen, chlorophyll-a, Secchi depth, pH, turbidity, chloride, alkalinity, hardness, and conductivity. The DNR also collected water level data during that time.

Temperature, dissolved oxygen, surface total phosphorus, chlorophyll-a, and Secchi depth data are provided in Appendix C.

4.2 TEMPERATURE AND DISSOLVED OXYGEN

Understanding lake stratification is important to the development of both the nutrient budget for a lake as well as ecosystem management strategies. Lakes that are dimictic (mix from top to bottom in the spring and fall) can have very different nutrient budgets than lakes that are completely mixed multiple times throughout the year.

Temperature difference typically causes stratification in a lake because water density changes with water temperature. Dissolved oxygen is a measure of the amount of oxygen dissolved in water that is available for aquatic organisms such as fish and macroinvertebrates. Dissolved oxygen can also have significant implications as a result of stratification. As cooler, denser water is trapped at the bottom of a lake, it can become devoid of oxygen affecting both aquatic organisms and sediment chemistry.

Loeb Lake temperature and dissolved oxygen profiles for 2006 are shown in Figures 9 and 10. Temperature and dissolved oxygen data were recorded from 2004 to 2007. However, only 2006 data is presented here because of approximately average precipitation during that year. Data from 2004, 2005, and 2007 exhibit similar trends as displayed for 2006.

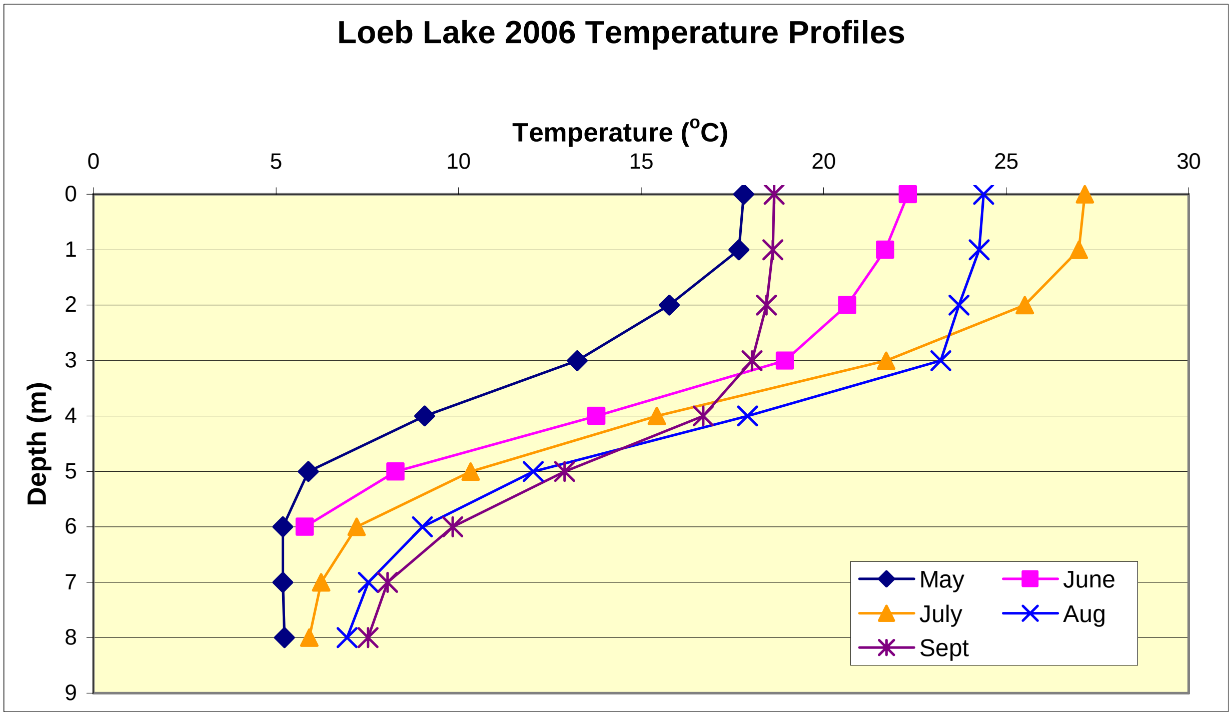

Figure 10. Temperature profile for Loeb Lake, 2006.

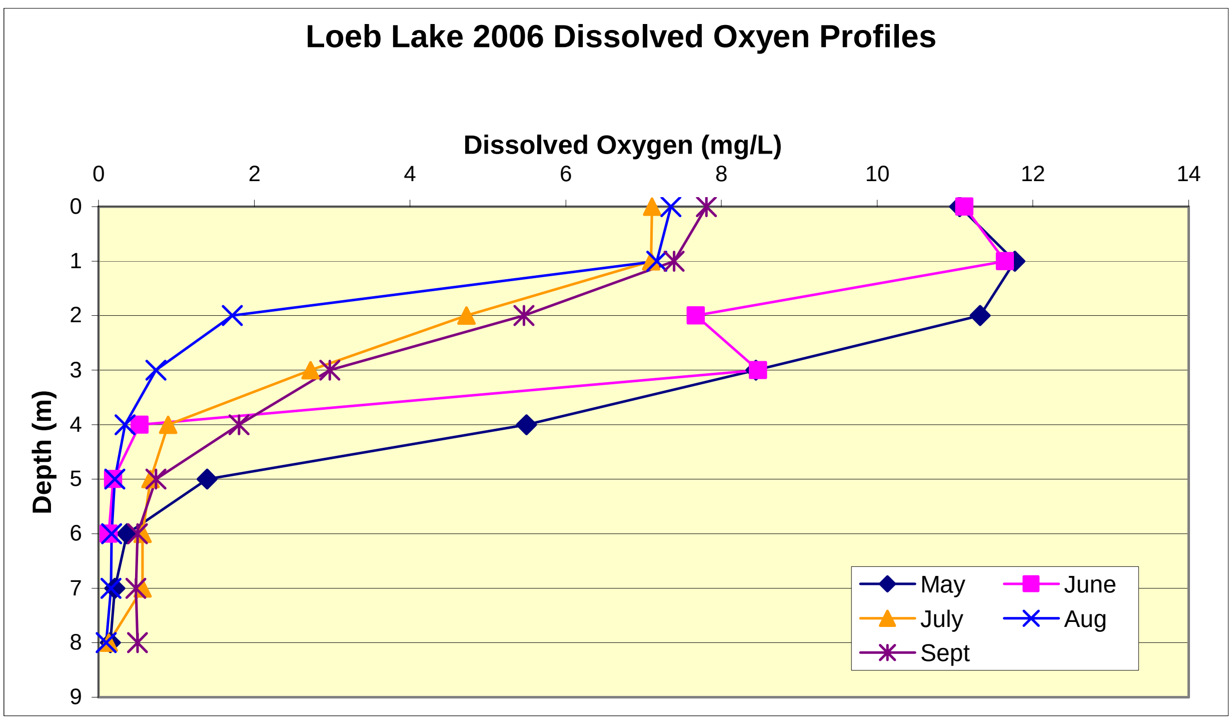

Figure 11. Dissolved oxygen profile for Loeb Lake, 2006.

Loeb Lake demonstrates stratification with the thermocline (define) typically between 2 and 4 meters (6.5 and 13 feet respectively). However, dissolved oxygen profiles demonstrate anoxia (<2 mg/L DO) as shallow as 2 meters in depth. This shallow anoxic zone can result in significant release rates of phosphorus from the sediments by activating sediment release from a larger area. The shallow anoxic area can also stress fish by providing few refugia with adequate dissolved oxygen concentrations (>5 mg/L). The shallow anoxic area in Loeb Lake is not uncommon in urban lakes that have received decades of nutrient additions from anthropogenic sources.

4.3 PHOSPHORUS AND NITROGEN

Lake algal production is typically limited by the availability of nutrients, specifically phosphorus and nitrogen. Minnesota lakes are almost exclusively limited by phosphorus but excessive phosphorus concentration can lead to nitrogen-limited conditions. Phosphorus and nitrogen are measured to determine the availability of the nutrients for algal production.

Dissolved and orthophosphorus are the most biologically available forms of phosphorus and total phosphorus is a measure of all forms of phosphorus including dissolved and particulate. Nitrate is the most biologically available form of nitrogen for algal production and total Kjeldahl nitrogen (TKN) is a measure of all forms of nitrogen in the water column.

Total phosphorus (TP) summer average surface concentrations for Loeb Lake are shown in Figure 11. Between 2004 and 2007, total phosphorus concentration ranged from 17 to 93 µg/L. All measurements were at or below the standard shallow lake concentration of 60 µg/L, except for one measurement of 93 µg/L in 2005. This value is excluded from the annual average calculation of 21 µg/L depicted for 2005.

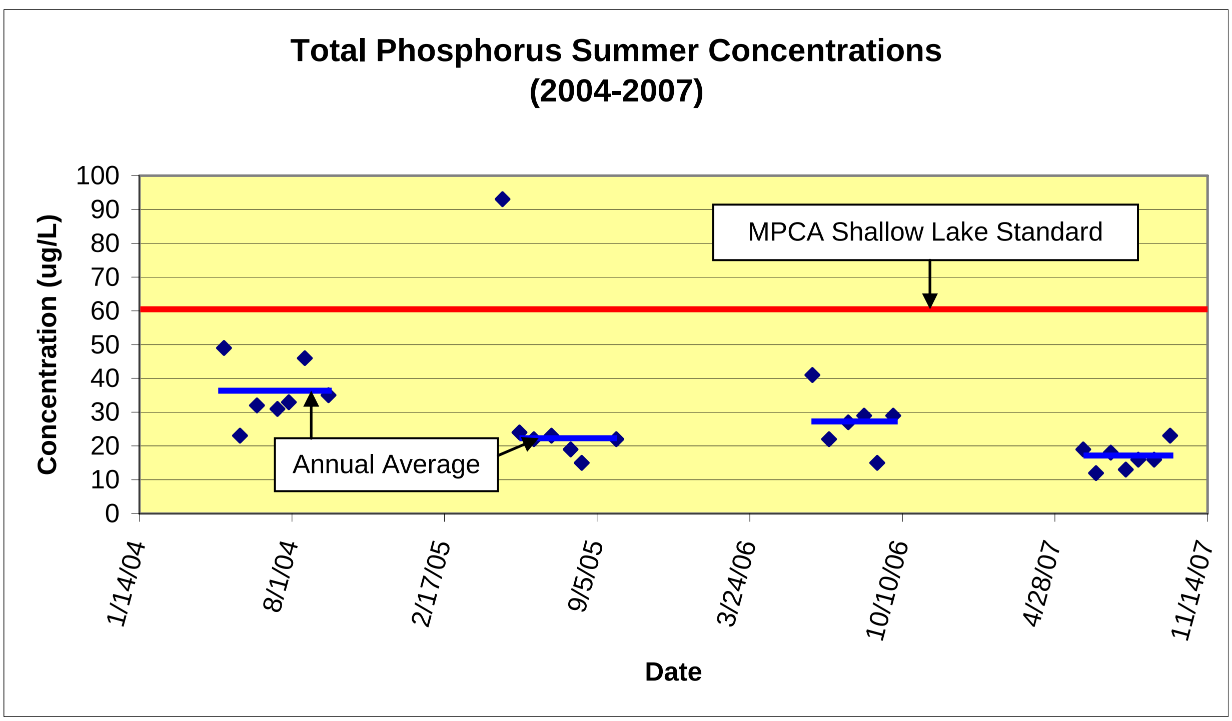

Figure 12. Summer average surface total phosphorus concentration for Loeb Lake, 2004-2007.

4.4 CHLOROPHYLL-A

Algal biomass can be measured directly by developing cell-by-cell counts and volumes. This process, however, is time intensive and often expensive. All types of algae contain chlorophyll-a, the primary pigment that algal cells use for photosynthesis. Consequently, chlorophyll-a has been shown to be a good surrogate for algal biomass and is inexpensive and easy to analyze.

Similar to TP concentrations, all chlorophyll-a concentrations except one are below the state shallow lake standard of 20 µg/L during the four years of monitoring (Figure 12).

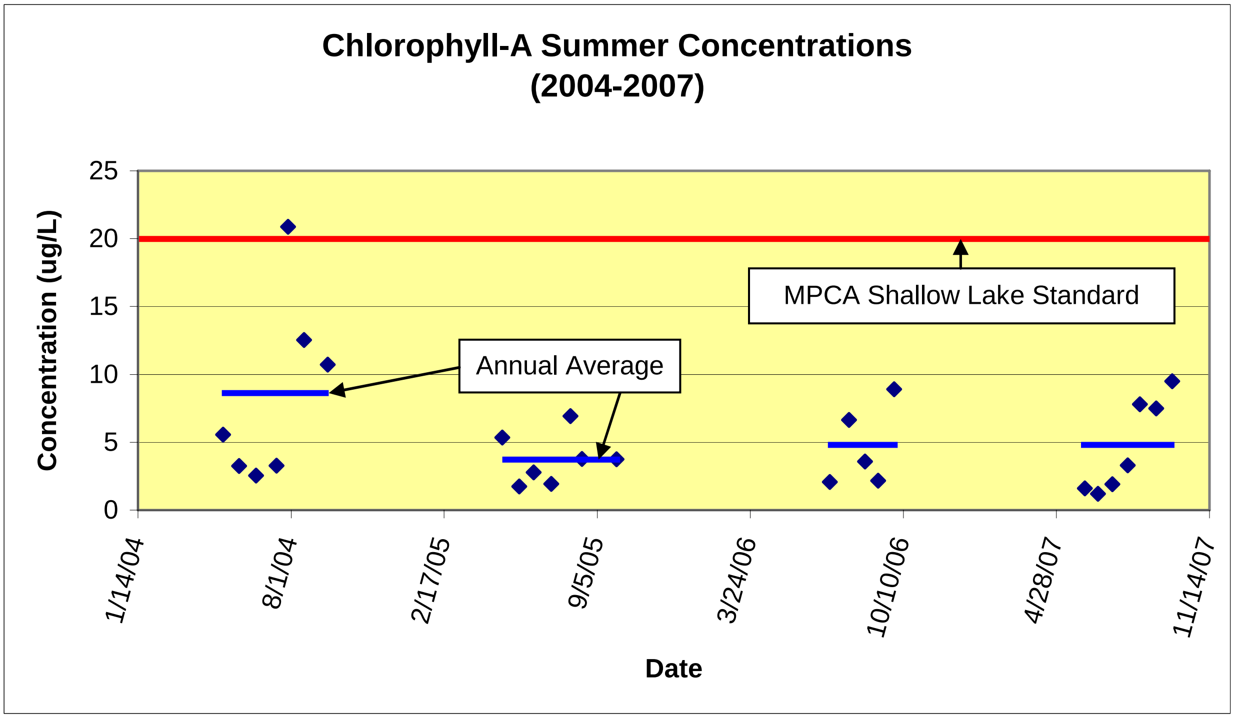

Figure 13. Summer average chlorophyll-a concentration for Loeb Lake, 2004-2007.

4.5 SECCHI DEPTH

Secchi depth is a measure of water clarity and can also be a surrogate for algal production. Secchi depth measurements involve lowering a round disc shaded black and white over the shady side of the boat and recording the depth at which the disc is no longer visible.

Summer average Secchi depth measurements are shown in Figure 13. Similar to TP and chlorophyll-a concentrations, Secchi depths are below the state shallow lake standard of 1.0 meters during the four years of monitoring.

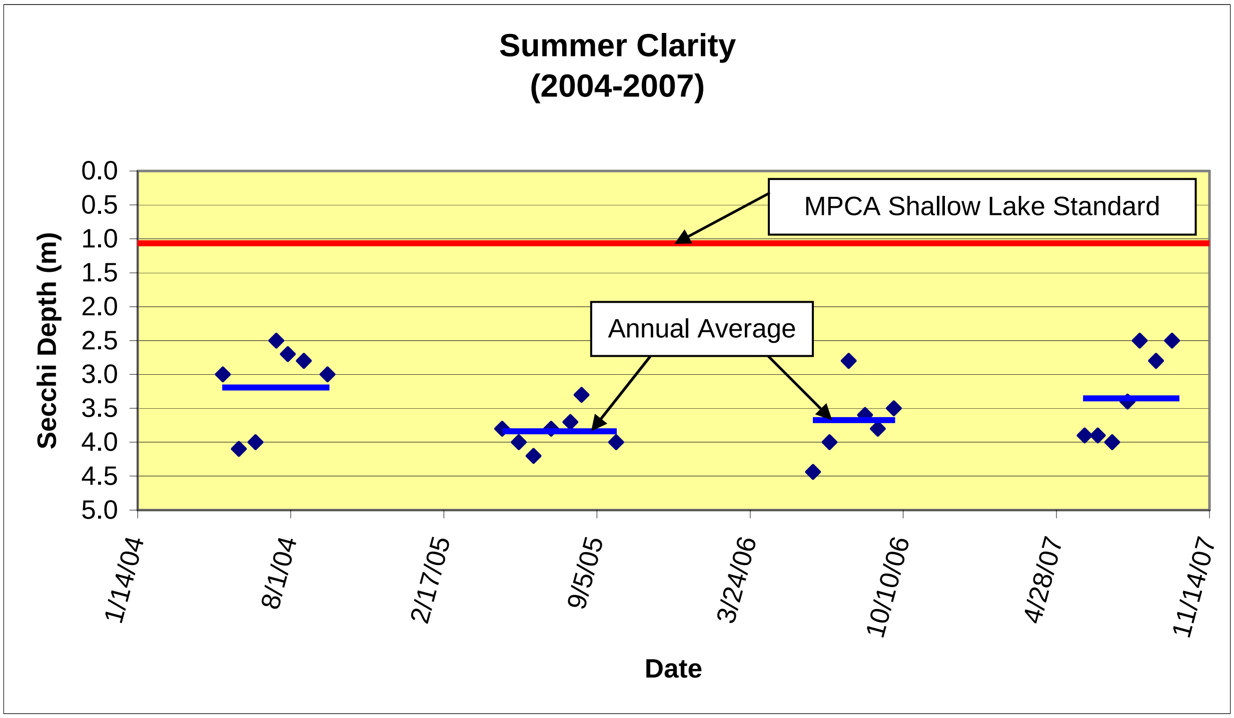

Figure 14. Summer average Secchi depth for Loeb Lake, 2004-2007.

4.6 OTHER PARAMETERS

As mentioned earlier, the PCA and Ramsey County collected pH, turbidity, chloride, alkalinity, hardness, and conductivity data from 2004 through 2007. (Alkalinity and hardness data were not collected during 2006 and 2007.) These parameters are typically useful for diagnosing specific issues and more in-depth studies. Since the primary water quality data (summarized above) indicates generally good water quality, these data have not been summarized. These data may be advantageous in the future if more study is desired.

4.7 CONCLUSIONS

Loeb Lake is currently demonstrating good water quality with one exceedance for total phosphorus and no exceedances for chlorophyll-a and Secchi depth. Lake conditions appear to have remained the same over the past four years.

Historic summer average concentrations for chlorophyll-a, total phosphorus, and Secchi depth for Loeb Lake are given in Table 7. Each average concentration is historically below the MPCA shallow lake standards of 20 µg/L (chlorophyll-a) and 60 µg/L (total phosphorus). Similarly, the Secchi depth is consistently greater than the MPCA standard of 1.0 m.

Table 7. Historic water quality data for Loeb Lake.

	Chlorophyll-a		Total Phosphorus		Secchi Depth	
Year	**N**	**Summer Average [µg/L]**	**N**	**Summer Average [µg/L]**	**N**	**Summer Average [m]**
Standard	--	< 20	--	< 60	--	> 1.0
2004	7	8.4	7	35.6	7	3.2
2005	7	3.7	7	20.8	7	3.8
2006	6	4.7	6	27.2	6	3.7
2007	7	4.2	7	16.7	7	3.3

5.0 Loeb Lake Nutrient Source Assessment

5.1 NUTRIENT SOURCES IN URBAN WATERSHEDS

Understanding the sources of nutrients to Loeb Lake is a key component in identifying appropriate lake management techniques. In this section, a brief description of the potential sources of phosphorus to the lake is provided.

It is important to note, however, that nutrients (nitrogen and phosphorus) are not bad in and of themselves. Rather they are important elements that are needed by all biological organisms. Phosphorus is important for cell energy and the formation of adenosine triphosphate (ATP) and nitrogen is an important component of amino acids, the building blocks of proteins. It is when these nutrients are in excess that they become a problem.

Nitrogen and especially phosphorus are typically limiting nutrients in aquatic systems meaning the abundance of these nutrients control the amount of plant growth. Excess nutrients can result in nuisance levels of algae and plant growth. These nuisance levels can lead to numerous problems such as low dissolved oxygen, pH shifts, and loss of diversity in the plant community. Ultimately, it is critical to manage nutrients in aquatic systems to maintain a healthy, diverse biological community.

5.1.1 Stormwater

Phosphorus transported by stormwater represents one of the largest contributors of phosphorus to lakes in Minnesota. Impervious surfaces and storm sewer systems in the watershed improve the efficiency of water moving to streams and lakes resulting in increased transport of phosphorus into local waterbodies. Phosphorus in stormwater is a result of illicit sanitary sewer connections, automobiles, leaves and grass clippings, fertilizers, and sediments. Consequently, stormwater is a high priority pollution concern in urban watersheds.

The sources mentioned above may lead to increased internal loading through the breakdown of organics and subsequent release from the sediments. Additionally, organic material increases the sediment oxygen demand by further exacerbating the duration and intensity of sediment phosphorus release from lake sediments.

Excess fertilizer applied to lawns is readily transported to local streams and lakes during runoff events and is immediately available for algal growth. Consequently, excess fertilizer represents a significant threat to lake water quality in urban watersheds. As of January 1, 2005, fertilizers containing phosphorus can no longer be used on residential lawns in Minnesota. Lawn fertilizer containing phosphorus can still be used by

Minnesota residents whenever new lawns are established by seeding or laying sod and soil testing shows a need for additional phosphorus.

5.1.2 Atmospheric Deposition

Precipitation contains phosphorus that can ultimately end up in the lakes as a result of direct input on the lake surface or as a part of stormwater runoff from impervious surfaces in the watershed. Although, atmospheric inputs must be accounted for in development of a nutrient budget, these inputs are impossible to control.

5.1.3 Internal Phosphorus Release

Internal phosphorus loading from sources already in lakes has been demonstrated to be an important aspect of the phosphorus budgets of lakes. Over time, lakes tend to accumulate phosphorus in their bottom sediments. This phosphorus is bound in many forms, some weak bonds and other stronger bonds. One of the primary bonds for phosphorus is with iron. This is a relatively weak bond that breaks under anoxic (devoid of oxygen) conditions and releases phosphorus into the water column. This phosphorus is in a dissolved form that is readily available to algae.

Phosphorus in the sediments can also be stirred up through bioturbation where biological organisms such as rough fish stir up the sediments releasing readily available phosphorus in the sediment's pore water.

Measuring or estimating internal loads can be a difficult process which is exacerbated by complex systems such as shallow lakes that may mix many times throughout the year. Understanding the quantity and rate of internal loading is an important component to any lake nutrient budget.

5.1.4 Lake Exchange

Lakes and bays can exchange nutrients through advection (movement of water carrying nutrients) or diffusion (nutrients moving from high concentration to low concentration). Since Loeb Lake is a relatively small, round lake, the exchange of phosphorus caused by advection and diffusive exchange of nutrients was assumed to be negligible.

5.2 LOEB LAKE PHOSPHORUS BUDGET

A detailed nutrient budget for Loeb Lake is useful for identifying management options and their potential effects on water quality. Additionally, models can be developed to understand the response of other variables such as chlorophyll-a and Secchi depth. Through this knowledge, managers can make educated decisions about how to allocate restoration dollars and efforts as well as the effectiveness of such activities.

5.2.1 Components

The phosphorus budget for Loeb Lake includes watershed loads through stormwater runoff, atmospheric load, and internal load from lake sediments. These components are described in detail in the sections below. There are no upstream loads (from other lakes or wetlands) to Loeb Lake.

Watershed Load

Watershed phosphorus loads were estimated using the P8 computer model. CRWD separated the Loeb Lake drainage area into north and south subwatersheds. Runoff from the north subwatershed enters Loeb Lake directly by sheet flow. Runoff from the south subwatershed is routed through storm sewer to a stormwater pond at the southeast corner of the lake. The pond was included in the P8 model to reflect phosphorus removal by sedimentation. The importance of this stormwater pond will be discussed further as it relates to internal loading in Section 5.4. The Loeb Lake P8 Model was not calibrated because monitoring data was not available.

Atmospheric Load

Atmospheric loads were estimated using published literature values for aereal loading rates (14.91 kg/km^2-yr for an average precipitation year) in Minnesota (Barr Engineering 2004). Aereal loading rates were multiplied by lake surface area to determine the annual loading rate (kg/yr) due to atmospheric deposition.

Internal Load

Internal phosphorus loading from sources already in lakes has been demonstrated to be an important aspect of the phosphorus budgets of lakes. Measuring or estimating internal loads, however, can be a difficult process, exacerbated by complex systems such as shallow lakes that may mix many times throughout the year.

Internal loading for Loeb Lake was estimated using an anoxic factor (days) and phosphorus release rate (mg/m^2-day) (Nürnberg 1988). The anoxic factor was estimated using the depth of anoxia from dissolved oxygen profiles and the surface area of the anoxic zone. Based on the hypolimnetic orthophosphorus samples, the phosphorus release rate in Loeb Lake is essentially zero because the sample concentrations changed very little during the growing season. However, most lakes exhibit some level of internal loading, and the presence of filamentous algae indicates there is a small internal load in Loeb Lake. Therefore, CRWD assumed an internal release rate of 0.5 mg/m^2-day. Refer to Appendix D for internal load and lake response model calculations.

5.2.2 Selection of Models

Modeling of the Loeb Lake system included use of P8 (Walker 2007) and model equations extracted from BATHTUB (Walker 1996). Output from P8 was used as input into the BATHTUB model equations in spreadsheet format to predict lake response to hydraulic and pollutant loading.

5.3 2004-2007 ANNUAL PHOSPHORUS BUDGETS

Modeled data from 2004 to 2007 was used to estimate the current sources of phosphorus to Loeb Lake. Table 8 lists the inflow volume and phosphorus load for Loeb Lake during this time. Figure 14 displays the magnitude of the phosphorus budget for each of the four monitoring years.

Direct precipitation and the watershed contribute 100% of the inflow volume to Loeb Lake. As mentioned earlier, groundwater flows out of Loeb Lake on an annual basis. Since the inflow volume is calculated on an annual time step here, there is no groundwater inflow. The watershed contributes approximately 83% of the phosphorus load while atmospheric deposition and internal load contribute the remaining 17% phosphorus load.

Table 8. Modeled inflow volume and total phosphorus load for Loeb Lake, 2004 - 2007.

	Source	*2004*	*2005*	*2006*	*2007*
Precipitation Depth [in]		32.8	36.7	31.9	36.0
	Residence Time [yr]	2.7	2.6	2.5	2.2
Inflow Volume [ac-ft / yr]	Direct Precipitation & Watershed	31	33	33	39
	Upstream Lakes	0	0	0	0
	TOTAL =	**31**	**33**	**33**	**39**
Total Phosphorus Load [lb / yr]	Watershed	17	18	17	20
	Septic Systems	0	0	0	0
	Upstream Lakes	0	0	0	0
	Atmosphere	2	2	2	2
	Internal Load	2	2	2	1
	TOTAL =	**21**	**22**	**21**	**23**

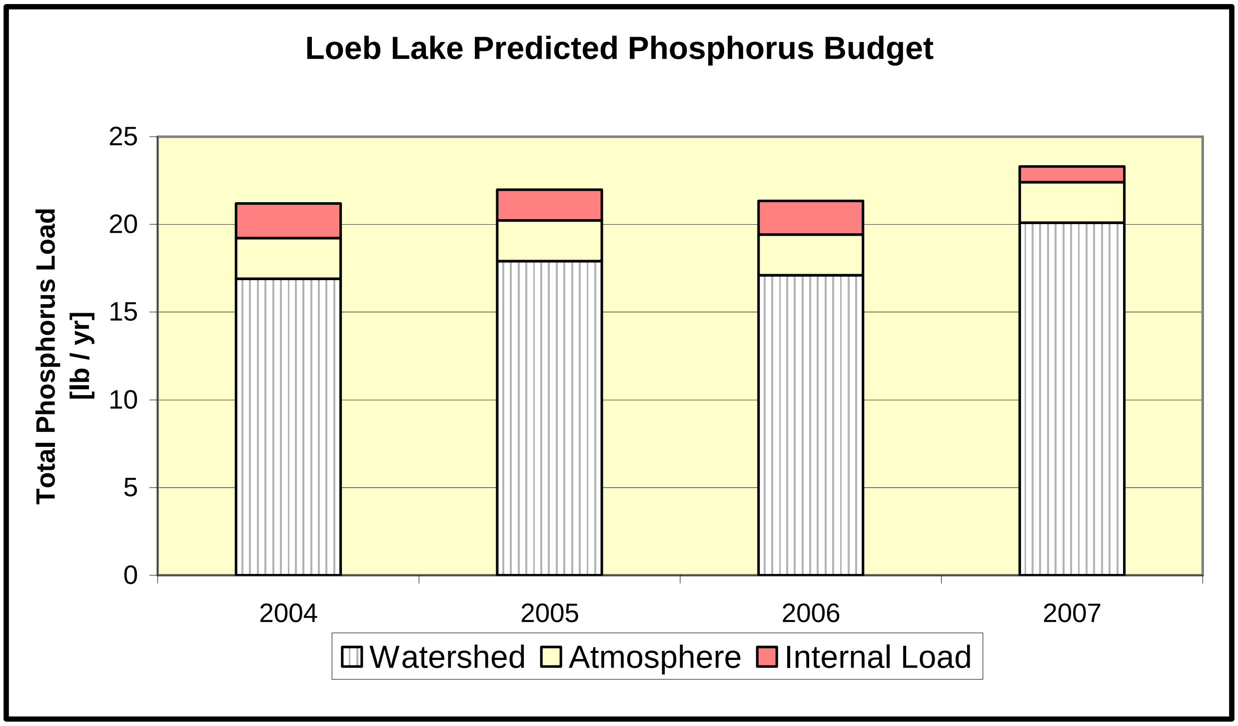

Figure 15. Predicted phosphorus budget for Loeb Lake, 2004 – 2007.

5.4 WATER QUALITY RESPONSE MODELING

BATHTUB is a publically available lake response modeling software package that includes several modeling equations to estimate in-lake phosphorus concentrations based on phosphorus loading. Because it is a suite of models, it is up to the modeler to select the appropriate model equation based on the characteristics of the system that is to be modeled.

5.4.1 Equation Selection

Model equations from BATHTUB were used to estimate the in-lake response to hydraulic and pollutant loads from 2004 to 2007 in Loeb Lake (Appendix D). Initially, Wenck selected the Canfield-Bachmann model for natural lakes to estimate lake response for phosphorus. However, because of the low phosphorus concentrations in the lake and poor performance of the model equation, it was determined that a second order fixed equation would perform better for Loeb Lake. Upon further review, the second order fixed model equation was selected as the most appropriate representation of Loeb Lake.

5.4.2 Validation

The lake response model for in-lake total phosphorus predicted larger in-lake phosphorus concentrations than were observed in all years (2004 – 2007) for Loeb Lake. To compensate for the difference, the Loeb Lake watershed was split into north and south subwatersheds so the stormwater pond at the southeast corner of Loeb Lake could be included in the P8 model. P8 predicts that this pond removes approximately 25% of the watershed load to Loeb Lake. This removal has a significant effect on the phosphorus budget and the internal loading within the lake.

As stated earlier, CRWD selected an internal loading rate of 0.5 mg/m^2-day. This is the lowest reasonable release rate to use in the absence of measured sediment release rates. This value corresponds to that reported by Nürnberg for oligotrophic lakes in Figure 15. Hypolimnetic samples or measured sediment release rates would further clarify the role of internal loading, but since internal loading is a minor portion of the phosphorus budget this additional information would likely not increase the understanding of the Loeb Lake phosphorus budget.

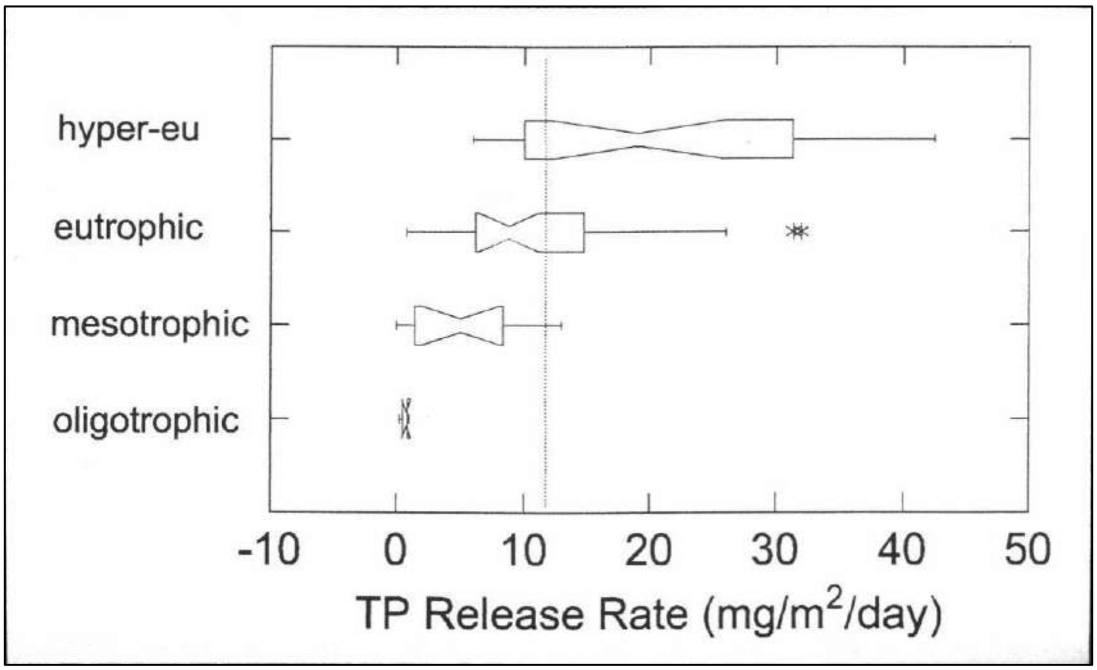

Figure 16. Sediment phosphorus release rates by trophic condition. (Nürnberg 1988)

Annual hydraulic and phosphorus loads were used to estimate the in-lake total phosphorus response in Loeb Lake. The results from the in-lake phosphorus response model are compared to measured in-lake phosphorus concentrations as shown in Figure 16.

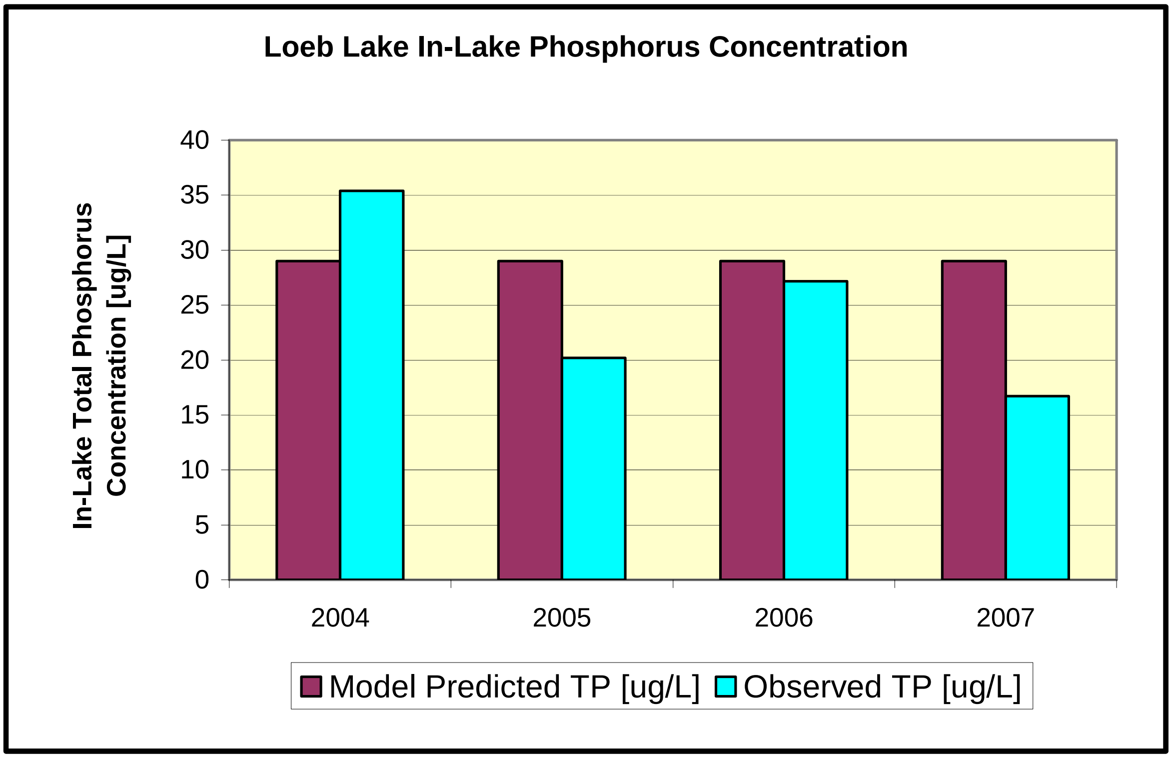

Figure 17. In-lake phosphorus model comparison to measured in-lake total phosphorus for Loeb Lake, 2004 – 2007.

5.4.3 Analysis

The in-lake phosphorus response model predicts a larger phosphorus concentration than measured values in most years. There are two possible explanations for this difference. Loeb Lake exhibits a filamentous algae bloom that is typically not sampled as a part of routine water quality monitoring. Much of the TP load to the lake may be tied up in the filamentous algal mass and therefore not accounted for in the monitoring data. However, anecdotal data on filamentous algae in the lake suggests that this is not a significant sink for phosphorus in Loeb Lake.

A second possible explanation is that shallow lakes typically demonstrate higher algal (and associated phosphorus) loss rates due to high levels of zooplankton grazing. This effect is not accounted for in the Canfield-Bachmann and second order fixed equations, and therefore over-predicts in lake concentrations. Loeb Lake does demonstrate a significant proportion of large bodied cladocerans that may account for some of the differences.

5.5 CONCLUSIONS

Successful lake management requires an understanding of not only nutrient cycling in the lake and its watershed, but also an understanding of in-lake processes that may be affecting water quality and lake value. To successfully protect lake quality, managers must address both the phosphorus loads to the lake as well as any potential degraded biological conditions such as an imbalanced fishery, lack of appropriate aquatic vegetation, and degraded habitats and shorelines.

The phosphorus budget of Loeb Lake appears to be driven by watershed loading. Watershed loading concentrations in the model were matched to typical concentrations monitored in the Trout Brook subwatershed. Even at these concentrations, the model tended to over predict in lake concentrations without any internal loading. Furthermore, the internal load analysis identified very little phosphorus in the form typically related to sediment phosphorus release. However, total phosphorus concentrations were consistently high in late summer. The source of the high total phosphorus in the hypolimnion is unclear and may warrant future consideration. Because current water quality conditions in the lake are good, further action on internal loading is not warranted at this time. If filamentous algae become a problem for Loeb Lake in the future, further investigation of internal loading would be necessary.

Based on the nutrient budget analysis, it appears that management should focus first on watershed loads and naturalized shorelines. These two areas will provide the most benefit to protecting water quality in Loeb Lake. The biological conditions in Loeb Lake appear to be relatively healthy with a high abundance of beneficial zooplankton and a robust submerged aquatic vegetation community to provide refuge from predation. Although the aquatic plant community is relatively abundant, it lacks diversity and includes invasive species such as curlyleaf pondweed. Future fish stocking efforts should be managed to maintain the balance fishery.

6.0 Willow Reserve and its Watershed

Willow Reserve is a 23-acre parcel of land owned by the City of St. Paul. Located within the northwestern portion of the City, a neighborhood group worked with the City to acquire the site for a bird and wildlife sanctuary in the mid 1960's. The property is currently owned and managed by the Saint Paul Parks & Recreation Department as a Park Preserve.

6.1 WATERSHED CHARACTERISTICS

Willow Reserve receives runoff from two sources: its direct watershed and the Trout Brook storm sewer system. The direct drainage area is approximately 29.6 acres (Map 6), and approximately 76% of the direct drainage area is the undeveloped Willow Reserve parcel (Map 7). The remaining 24% is comprised of single-family residential, mixed use, and railroad land uses. In total, there are approximately 2.5 acres of impervious surface in the Willow Reserve watershed. Table 9 lists the watershed characteristics of Willow Reserve and Table 10 lists specific land use classifications within the Willow Reserve watershed.

Willow Reserve was designated to serve as a "pressure relief valve" in the late 1980s for the Trout Brook storm sewer system. This will be discussed in more detail in Section 6.3.

Table 9. Watershed characteristics of Willow Reserve.

Parameter	Willow Reserve
Parcel Area (ac)	23.0
Drainage Area (ac)	29.6
Maximum Depth of Open Water Wetland (ft)	Approximately 4
Wetland Area (ac)	16.3
Type 4 Wetland Area (ac)	4.7
Type 3 Wetland Area (ac)	0.8
Type 2/6/7 Wetland Area (ac)	10.8

Table 10. Watershed land-use classification of Willow Reserve.

Land Use	Area (ac)
Single family residential	2.2
Mixed use	1.7
Railway	3.1
Undeveloped	22.6
Total	**29.6**

6.2 WILLOW RESERVE CHARACTERISTICS

CRWD evaluated the parcel for wetlands in 2005 and delineated approximately 16.3 acres of jurisdictional wetland (Appendix A). The wetland delineation identified the wetlands in Willow Reserve using the U.S. Fish and Wildlife Service *Circular 39 – Wetlands of the United States*. This publication uses a numbering system of wetland type from Type 1 – Type 8. Existing wetlands identified in the 2005 Wetland Delineation Report in Willow Reserve include Type 3, Type 4, and a mosaic area of Type 2, Type 6, and Type 7 wetlands. (Wetland Types 2, 6, and 7 are often grouped together in wetland delineations because of similar hydrology and soils.)

Subsequent to the wetland delineation, CRWD completed the "Natural Resource Inventory and Habitat Assessment (NRIHA)" (EOR, 2007) for Willow Reserve. The NRIHA identified wetlands using a method published by the MN DNR Natural Heritage Program. This method allows for differentiating vegetation communities within the same or similar wetland type.

A review of historic aerial photographs (1940, 1953, 1974, 1985 and 1999 found in Appendix E) indicates that all or a portion of Willow Reserve was actively managed for agricultural production from before 1940 though the late 1980s. The wetland types in the 2005 wetland delineation and the vegetative communities in the NRIHA are the result of a change in land use and do not represent pre-settlement conditions.

Currently, Type 3 and Type 4 wetlands are concentrated in the central part of the reserve and are typically inundated with shallow water. The mosaic wetland (the three combined wetland types) is the result of past land use. These areas were once actively farmed with crops or cut for hay and grass. After a change in land use and left to go fallow, the wetlands vegetated mainly with invasive species (reed canary grass, stinging nettle, and buckthorn) along with fast growing woody species (box elder, dogwood, cottonwood, and willow).

Map 9 shows the hydrologic regimes identified in the NRIHA for Willow Reserve. The area can generally be divided into three hydrologic regimes with the deepest in the center rising to upland along the edges. The deepest part of the wetland contains open and shallow water (1-4 feet deep) with emergent vegetation. Adjacent to the open/shallow water are soils that are generally saturated to the surface throughout the growing season with some flooding during wet periods. Upland soils saturated at greater than one foot below the surface surround the wetland.

The open/shallow water regime is currently acting as a stormwater retention basin with fringes of emergent vegetation. As long as stormwater is continued to be directed to this area, emergent vegetation restoration may prove difficult. Drawdown of the permanent water pool could be used to re-establish native submergent and emergent vegetation. However, the NRIHA identified the open/shallow open water regime area as having the greatest vegetative value and diversity.

6.3 WATER BUDGET

Sufficient monitoring data has not been collected to establish a water budget for Willow Reserve. However, CRWD has collected water level data for Willow Reserve during 2006 and 2007. Figure 17 shows the recorded water levels during 2006 and 2007. By observation, it appears that the TBI may surcharge to Willow Reserve for rainfall events greater than 0.5 to 0.75 inches and greater. Precipitation data was obtained from the Minnesota Climatology Working Group Website (http://climate.umn.edu/).

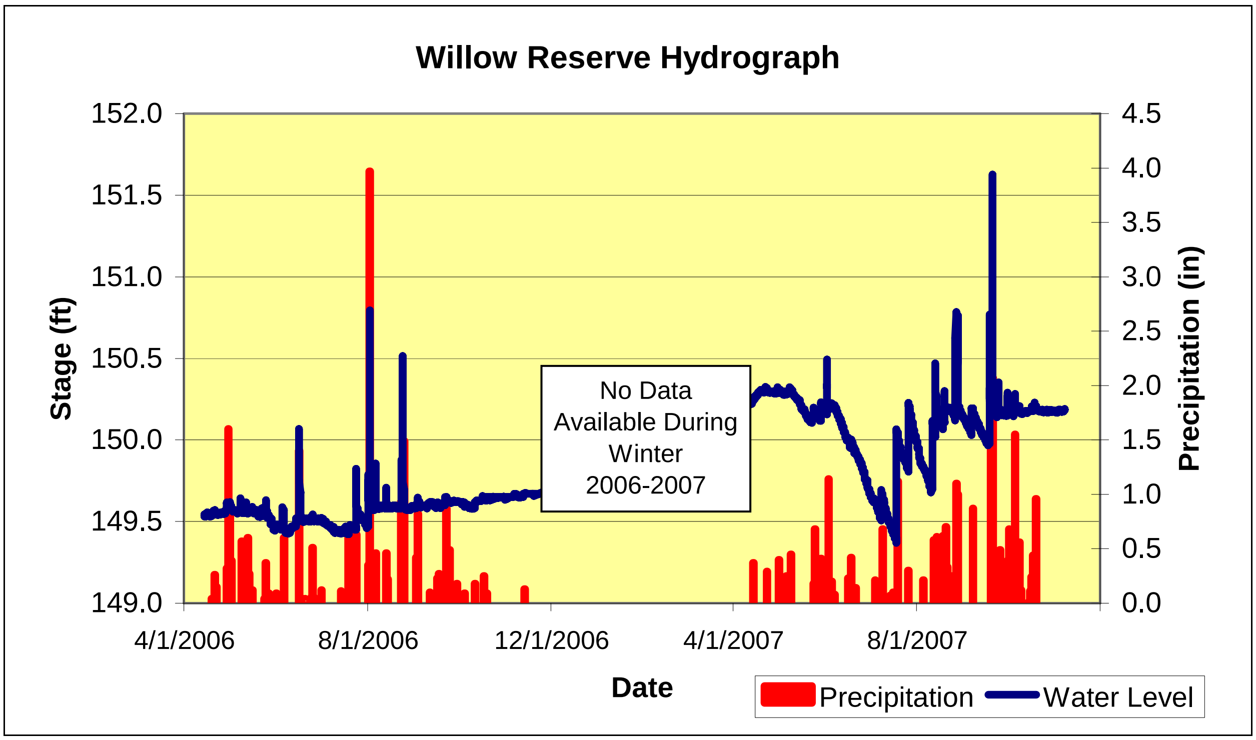

Figure 18. 2006 and 2007 water level and precipitation at Willow Reserve.

During heavy rainfall, street flooding in Virginia Street and the Trout Brook Interceptor (TBI) contribute runoff to Willow Reserve. Virginia Street is located east of Willow Reserve and is reported to overtop the curb and flow into Willow Reserve. Similarly, Willow Reserve functions as a "pressure relief valve" for the TBI during high flows. The elevation in TBI or the rainfall event which causes the TBI to surcharge is not known.

The NRIHA functions and values assessment identified stormwater attenuation as high for function because of the stormwater diverted into Willow Reserve from TBI. In a sense, the functional assessment indicates that this portion of the wetland is acting as a stormwater sediment pond. While good for sedimentation, the NRIHA also concluded that this connection of untreated stormwater to the wetland has significantly changed the hydrology and degraded the plant community type and vegetative diversity. In this case, a high function for stormwater treatment downstream directly impacts the value of the wetland negatively for vegetative diversity.

6.4 WILDLIFE HABITAT AND OTHER USES

Willow Reserve was created in the 1960s as a wildlife preserve. It is a unique resource in the midst of an urban setting and provides a rare wildlife habitat. The NRIHA identified a variety of wildlife species including deer and 36 bird species. Willow Reserve is a stopping point for birds including those following the Mississippi River Flyway, a recognized migration path for bird species. Because of the relative scarcity of greenspace in the city, its large size, regional setting and the variety ecotypes, Willow Reserve is highly valued as wildlife habitat.

There are currently few to no recreational opportunities associated with Willow Reserve. This is both a benefit and a detriment to the area. Wildlife and habitat are isolated from human interaction, but the area is concealed by overgrown, invasive vegetation so that dumping of trash and debris has become a significant problem.

7.0 Issues and Concerns

7.1 ISSUES AND CONCERNS FOR LOEB LAKE

CRWD identified several issues and areas of concern with respect to the water quality and conditions of Loeb Lake. These issues and concerns form the basis for the management goals in Section 8.0, which in turn form the basis for the management actions in Section 9.0.

CRWD did not limit their considerations to strictly water quality concerns, but rather they identified any concern they had relative to appearance, aesthetic enjoyment, environmental quality, and overall condition of the lake and its watershed.

The concerns listed below have not been assigned any priority rankings.

Water Quality

Loeb Lake is currently demonstrating good water quality with no exceedances for total phosphorus, chlorophyll-a, and Secchi depth. Lake conditions appear to have remained the same over the past four years.

The phosphorus budget of Loeb Lake is driven by watershed loading. Therefore, small reductions in the watershed load will have a greater benefit to water quality than in-lake reductions. Similarly, internal loading is not a major concern for Loeb Lake. However, it is potentially the driving force for the filamentous algae blooms that have recently been observed.

Fish

Recent fish surveys conducted by the DNR indicate that Loeb Lake has a dominant panfish population which can exhibit heavy predation pressure on zooplankton. While the adult panfish stocked by the DNR are an important component of the DNR "Fishing in the Neighborhood Program," the abundant, small panfish present in the surveys are mainly due to natural reproduction in the lake. The submerged vegetation in Loeb Lake provides refugia for small panfish, which may hinder top predator control. The DNR has been stocking top predators which may or may not help control panfish populations because of the fishing pressure this lake experiences.

Aquatic Plant Diversity

Between 1981 and 2000, there was a decline in the number of desirable native submerged species (sago pondweed, narrowleaf pondweed and flatstem pondweed). This could indicate a decline in water quality and fish habitat as species such as sago pondweed are known to be important components of fish and waterfowl habitats as well as sensitive to degraded water quality.

The native coontail remained constant between the 2000 and 2005 vegetation surveys. This species, however, is known to be the last native to survive in vulnerable ecosystems.

Another significant observation is the presence of curly leaf pondweed in the 2000 survey. When the thick mats of curly leaf pondweed die-back in the early summer, lake water clarity is reduced and nutrients are released into the water column which can spur algal growth. The DNR lake management files indicate that the exotic submerged plant species Eurasian water milfoil was found in Loeb Lake in 2003.

Shoreline Environment

The shoreline conditions of Loeb Lake have not been surveyed. The entire shoreline is within Saint Paul's Marydale Park. A shoreline assessment would be useful for better quantifying shoreline conditions and for determining shoreline restoration and management needs.

Lake and Watershed Education

CRWD maintains a robust Education and Outreach Program. However, much of the effort has been dedicated to Lake McCarrons, Como Lake, and general homeowner best management practices throughout the watershed. Specific education and outreach events have not been intended for Loeb Lake users and area residents. Watershed and lake education may inspire residents and users to protect and perhaps improve the water quality of Loeb Lake.

7.2 ISSUES AND CONCERNS FOR WILLOW RESERVE

Similar to Loeb Lake, CRWD identified issues and areas of concern for Willow Reserve. These issues and concerns form the basis for the management goals in Section 8.0, which in turn form the basis for the management actions in Section 9.0. CRWD identified concerns relative to function, aesthetic and recreational enjoyment, environmental quality, and overall condition of the wetland and its watershed.

The concerns listed below have not been assigned any priority rankings.

Degree of Desired Restoration

The CRWD Watershed Management Plan (2000) identified Willow Reserve as an opportunity to restore native vegetation and wildlife in an urban setting. The plan, however, did not identify a specific restoration goal or plan for Willow Reserve. The area was originally established as a wildlife preserve and bird sanctuary. However, today it is somewhat neglected because it is concealed by overgrown, invasive vegetation.

Vegetative Diversity

If restoration is desirable, it must be determined to what condition should the area be restored. A review of historic aerial photographs indicates that all or a portion of Willow Reserve was actively managed for agricultural production from before 1940 through the late 1980s. The current wetland types and vegetative communities are the result of a change in land use and do not represent pre-settlement conditions. After the change in land use and left to go fallow, the wetlands vegetated mainly with invasive species (reed canary grass, stinging nettle, and buckthorn) along with fast growing woody species (box elder, dogwood, cottonwood, and willow). Restoration planning for Willow Reserve requires consideration of the following factors: improving bird and wildlife habitat, community input/opinion, TBI hydrologic connection, current site conditions, and appropriate uses and access of Willow Reserve.

Hydrologic Regime and Water Budget

The hydrologic regime and water budget of Willow Reserve has changed dramatically since pre-settlement conditions. The area was historically used for agriculture, and in the late 1980's, the area was designated to serve as a "pressure relief valve" for the Trout Brook storm sewer system. If the area is to be restored, additional hydrologic and hydraulic information must be obtained to know how stormwater runoff may impact the restored areas.

Water Quality

The function and value assessment for Willow Reserve identified stormwater attenuation as high for function because of the stormwater diverted into Willow Reserve from TBI. In a sense, the functional assessment indicates that this portion of the wetland is acting as a stormwater sediment pond. While good for sedimentation, the NRIHA also concluded that this connection of untreated stormwater to the wetland has significantly changed the hydrology and degraded the plant community type and vegetative diversity. In this case, a high function for stormwater treatment downstream directly impacts the value of the wetland negatively for vegetative diversity.

8.0 Management Goals and Objectives

8.1 MANAGEMENT GOALS AND OBJECTIVES FOR LOEB LAKE

Management goals were developed by CRWD to guide the management of Loeb Lake and its watershed. The goals were developed to address the issues and concerns listed in Section 7.1. The goals provide a structure so the outcome of the management actions presented in Section 9.1 can be objectively evaluated.

The goals are listed below in priority order.

GOAL #1 Maintain water quality at current conditions (nondegradation).

Ramsey County, the MPCA, and CRWD collected a significant amount of water quality data for Loeb Lake since 2004. The data indicate that Loeb Lake has relatively good water quality and satisfies the MPCA shallow lake standards for phosphorus, chlorophyll-a, and Secchi depth. However, comparison of vegetation data from years 1981, 2000, and 2005 indicates that a decrease in water quality has occurred.

Loading from the watershed is the major source of phosphorus to Loeb Lake. Therefore, practices in the watershed (water quality ponds, biofiltration practices, infiltration basins, and other low impact development practices) to reduce loading to the lake can have significant, positive impacts on water quality. Continued and expanded monitoring data enables planners and stakeholders to make educated decisions regarding the health and quality of Loeb Lake.

Objectives:

a. Investigate the performance of the stormwater pond at the southeast corner of Loeb Lake. It may be necessary to remove sediment and further maintain the stormwater pond to maximize existing pollutant removal upstream of Loeb Lake.
b. Install a skimmer structure on the pipe connecting the southeast stormwater pond to Loeb Lake to retain floatable debris.
c. Assess the current level and need for increased good housekeeping practices (street sweeping) in the watershed.
d. Continue to monitor the current suite of water quality parameters (including zooplankton), while adding the recording of the spatial presence of filamentous algae by visual observation.
e. Install stormwater treatment practices in the Loeb Lake South subwatershed as opportunities arise.

GOAL #2 Provide a natural land/water interface that reduces runoff and enhances pollutant filtration while providing access for recreational use of the lake.

Shoreline conditions on Loeb Lake have not been surveyed. The entire shoreline is within Saint Paul's Marydale Park. A shoreline assessment would be useful for better quantifying shoreline conditions and for determining shoreline restoration and management needs. A natural transition from the water to upland areas provides habitat, filters runoff, and protects shorelines from erosion.

Objectives:

a. Conduct a shoreline assessment to evaluate the condition of the shoreline.
b. Implement shoreline restoration/stabilization as identified in the assessment.
c. Work with Saint Paul Park and Recreation Department to determine current turf management practices in Marydale Park.

GOAL #3 Raise awareness of nonpoint source pollution and its effects on lake water quality.

Homeowner education and voluntary implementation of housekeeping practices can result in noticeable phosphorus reductions to waterbodies. Given Loeb Lake's relatively good water quality, it is possible that area residents already protect the lake water quality as much as possible. Since the phosphorus budget for Loeb Lake is dominated by watershed loading, it may be possible to improve and expand existing housekeeping practices within the watershed.

Objective:

a. Assess best practices currently being carried out by property owners in the Loeb Lake watershed.
b. Determine feasibility of promoting new practices among property owners in the Loeb Lake watershed.
c. Tailor and implement educational outreach activities for Loeb Lake and its watershed.

GOAL #4 Promote a healthy and balanced fish community.

Recent fish surveys conducted by the DNR indicate that Loeb Lake has a dominant panfish population, which can exhibit heavy predation pressure on zooplankton. Zooplankton feed on filamentous algae within the lake, so if the panfish prey heavily on zooplankton, there is a smaller zooplankton population to control filamentous algae.

Habitat preservation is key to maintaining a healthy aquatic ecosystem, particularly a healthy fishery. Similarly, the submerged vegetation in Loeb Lake provides refugia for small panfish, which may hinder desirable top predator control. Because of fishing pressure this lake experiences, stocking of top predators by the DNR may or may not help to control panfish populations.

CRWD should work closely with the DNR to develop a stocking program that strives to meet the goals of both maintaining relatively good water quality, with balanced top predator/panfish ratio, and meeting the recreational fish needs of the lake users.

Objective:

a. Work with the DNR to develop a stocking plan that maintains top predators in an effort to maintain relatively good water quality.

GOAL #5 Achieve a healthy and diverse community of native plants and animals.

Between 1981 and 2000, there was a decline in the number of desirable native submerged species (sago pondweed, narrowleaf pondweed and flatstem pondweed). This could indicate a decline in water quality and fish habitat as species such as sago pondweed are known to be important components of fish and waterfowl habitats as well as sensitive to degraded water quality. The native coontail remained constant between the 2000 and 2005 vegetation surveys. This species, however, is known to be the last native to survive in vulnerable ecosystems.

Another significant observation is the presence of curly leaf pondweed in the 2000 survey. When the thick mats of curly leaf pondweed die-back in the early summer, lake water clarity is reduced and nutrients are released into the water column which can spur algal growth. The DNR lake management files indicate that the exotic submerged plant species Eurasian water milfoil was found in Loeb Lake in 2003.

Objectives:

a. Monitor the presence of invasive plant species. Specifically, record the spatial presence of curly leaf pondweed and Eurasian water milfoil by visual observation.
b. Prevent the introduction of additional invasive plant species in the lake.
c. Work with Saint Paul Parks and Recreation Department and the DNR to develop a lake aquatic plant management plan.

8.2 RESTORATION AND MANAGEMENT GOALS AND OBJECTIVES FOR WILLOW RESERVE

Goals were developed by CRWD to guide the restoration of Willow Reserve and management of its watershed. The goals were developed to address the issues and concerns listed in Section 7.2. The goals provide a structure so the outcome of the actions presented in Section 9.2 can be objectively evaluated.

The goals are listed below in priority order.

GOAL #1 Restore the area to maximize urban wildlife and native, non-invasive vegetative species diversity.

With the help of a neighborhood group, the City of Saint Paul acquired the Willow Reserve parcel in the mid 1960's to dedicate as a bird and wildlife sanctuary. Since that time, however, the wetland and upland areas have become vegetated with primarily invasive species (reed canary grass, stinging nettle, and buckthorn) along with fast-growing woody species (box elder, dogwood, cottonwood, and willow).

Historic aerial photographs indicate that all or a portion of Willow Reserve was actively managed for agricultural production from before 1940 though the late 1980s. The area was once actively farmed with crops or cut for hay and grass. Therefore, the current wetland types and vegetative communities are the result of a change in land use and do not represent pre-settlement conditions.

The CRWD Watershed Management Plan (2000) does not contain any specific direction for restoring Willow Reserve, but rather includes it with other water bodies to be evaluated for restoration. Therefore, the primary objective for this goal is to determine the best method to maximize urban wildlife and native, non-invasive vegetative species diversity. The extent of "restoration" will depend on the diversity of wildlife and vegetation desired within Willow Reserve.

<u>Objective:</u>

a. Form a stakeholder group to define the desired ultimate condition of Willow Reserve.

GOAL #2 Raise the awareness of Willow Reserve, its purpose, and its potential.

Currently, wildlife and habitat are isolated from human interaction, and the area is concealed by overgrown, invasive vegetation. Therefore, area residents may not be aware of the purpose and ultimate potential of Willow Reserve. Dumping of trash and debris has been a problem.

<u>Objective:</u>

a. Tailor and implement educational outreach activities for Willow Reserve and its watershed.

GOAL #3 Assess and improve, if necessary, the quality of water discharging from Willow Reserve to Trout Brook.

The NRIHA functions and values assessment identified stormwater attenuation as high for function because of the stormwater diverted into Willow Reserve from TBI. In a sense, the functional assessment indicates that this portion of the wetland is acting as a stormwater sediment pond. During heavy rainfall, Willow Reserve functions as a "pressure relief valve" for the TBI during high flows. The elevation in TBI or the rainfall event which causes the TBI to surcharge is not known. Similarly, it is not known what amount and quality of water is released back into TBI after it has surcharged.

<u>Objectives:</u>

a. Monitor water quality entering and discharging from Willow Reserve.
b. Investigate methods to improve water quality discharging from Willow Reserve back into TBI.

9.0 Management Actions

9.1 PLAN ADMINISTRATION

The management actions set forth here are an integrated set of ongoing management and operations activities that help achieve the management goals in Section 8.0. The actions were selected based on their potential success in addressing the issues and goals presented in Section 7.0 for Loeb Lake and Willow Reserve. The action priority, responsible agency, partners and cooperators, schedule, and estimated cost for each project or program are listed. This plan assumes that periodic evaluation of progress towards the goals established in Section 8.0 will lead to periodic adjustment to the LLWRMP.

CRWD has accepted responsibility for the administration, coordination and oversight of the LLWRMP. To this end, CRWD will assist partners and cooperators as necessary; monitor their performance; and ensure that the management actions set forth here are implemented as scheduled.

9.2 PLAN IMPLEMENTATION

The implementation of the management plan shall occur on a 10-year schedule, beginning in 2009 and ending in 2018. This timeframe corresponds with the CRWD 2010 (2^{nd} Generation) Management Plan. Some of the management activities may be undertaken immediately, while others should be implemented as opportunities, partnerships and resources arise. A summary of the management actions, responsible party, partner(s) and implementation schedule is presented in Table 11.

9.3 LOEB LAKE MANAGEMENT ACTIONS

The following actions are arranged in priority order, but it is expected that implementation will proceed as opportunities, partnerships, and resources arise.

ACTION #1 – Investigate the performance of the southeast stormwater pond.

> Drainage from the South Loeb Lake subwatershed is routed to a stormwater pond at the southeast corner of the lake. The City of Saint Paul reports that this stormwater pond was constructed in 1974. The stormwater pond serves a significant function (approximately 25% total phosphorus removal) by removing sediment and phosphorus from runoff to the lake.

It may be necessary to remove accumulated sediment and further maintain this stormwater pond to maximize pollutant removal upstream of Loeb Lake. The maintenance interval length is dependent on the specific subwatershed and pond characteristics, but usually varies between 10 and 15 years.

DNR, Wetland Conservation Act, and CRWD permits may be required to remove the accumulated sediment.

Goal Addressed: Loeb Lake 1
Responsible Agency: CRWD
Partners/Cooperators: Saint Paul Parks and Recreation Department
Estimated Cost: $25,000
Schedule: 2010 and 2019

ACTION #2 – Install a skimmer structure on the pipe connecting the southeast stormwater pond to Loeb Lake to retain floatable debris.

Currently, a 36-inch diameter RCP connects the stormwater pond to Loeb Lake. The pipe allows trash and floatable material to move freely into Loeb Lake. A skimmer structure should be installed to retain trash and debris in the stormwater pond for easy removal and disposal.

Goal Addressed: Loeb Lake 1
Responsible Agency: Saint Paul Parks and Recreation Department
Partners/Cooperators: CRWD
Estimated Cost: $10,000
Schedule: 2010

ACTION #3 – Assess the current municipal good housekeeping practices and determine the need for increased level of practices in the watershed.

Street sweeping aims to control urban runoff pollution at one of the major source areas – streets. Soil erosion, leaf litter, grass clippings, particulates from automobiles, and pet waste accumulate on streets and can therefore be controlled to some degree. Street sweeping to remove pollutants from the road surface and sump catchbasins to collect pollutants and prevent them from entering local surface waters comprise a significant investment for cities to reduce pollutant build-up and wash off from roads.

The frequency of street sweeping and sump catchbasin cleaning should be assessed in the Loeb Lake subwatershed. At a minimum, each should occur twice per year. Depending on the amount of material swept or removed, frequency may need to be increased.

Goal Addressed: Loeb Lake 1
Responsible Agency: CRWD
Partners/Cooperators: Saint Paul Public Works Department
Estimated Cost: Determine after assessing current level of practices
Schedule: 2010

ACTION #4 – Continue to monitor the current suite of water quality parameters (including zooplankton), while adding the recording of the spatial presence of filamentous algae by visual observation.

The current suite of water quality monitoring parameters should be continued and expanded to include measurement of the zooplankton population. Additionally, monitoring staff should begin to record the spatial presence of filamentous algae by visual observation. There are two possible sources of nutrients for the filamentous algae: the water column and internal loading. Because filamentous algae begin their life cycle as a benthic organism, it can often be associated with lakes that have a high internal loading rate. The lake response model over-predicted in-lake nutrient concentrations suggesting that the nutrients were tied up in the filamentous algae mat that is not sampled as a part of routine monitoring. Consequently, if nuisance blooms occur, measuring internal loading rates would help identify the source of load causing the filamentous algae problem.

Goals Addressed: Loeb Lake 1, 5
Responsible Agency: RCPW and DNR
Partners/Cooperators: CRWD
Estimated Cost: $5,000/year
Schedule: Ongoing

ACTION #5 – Tailor and implement an education program for Loeb Lake based on an assessment of current residential practices.

Given its relatively good water quality, the focus for management of Loeb Lake should be on education and stakeholder watershed management. One of the key factors in Loeb Lake is the issue of sustainable use. Education of local stakeholders regarding the sustainable uses of a shallow lake can help set the scientific basis for the recommended management actions.

Education and outreach activities should be implemented to raise awareness of the Loeb Lake watershed and the impact of nonpoint source pollution and its effects on lake water quality. Prior to development and implementation of the education and outreach activities in the Loeb Lake watershed, an assessment of stormwater management practices currently being carried out by property owners and the feasibility of promoting new practices among them will be conducted. Possible education and outreach activities include the installation of interpretive signs or kiosks, or by establishing a lake clean-up day. Establishing a visual connection and/or walking route between Loeb Lake and Willow Reserve should also be investigated.

Information about the types and effects of invasive species present in and around Loeb Lake can be made available to watershed residents. Regularly scheduled removal events and/or a stewardship program could be used to limit the spread of invasive species. Educational signage on invasive species could be located by the fishing pier to prevent introduction of invasive species through physical transport on items such as bait buckets. Materials and information are available from the DNR.

<u>Goals Addressed:</u>	Loeb Lake 1, 3, 5
<u>Responsible Agency:</u>	CRWD
<u>Partners/Cooperators:</u>	District 6 Council, DNR, and Saint Paul Parks and Recreation Department
<u>Estimated Cost:</u>	\$15,000 one-time cost; \$5,000/year
<u>Schedule:</u>	Ongoing

ACTION #6 – Restore the shoreline of Loeb Lake

a. Conduct an assessment to evaluate the condition of the shoreline.
b. Implement shoreline restoration and stabilization as identified in the assessment.
c. Work with Saint Paul Park and Recreation Department to determine current turf management practices in Marydale Park.

Natural shorelines provide filtration of direct runoff, provide fish refugia and habitat, and provide protection from erosion associated with wind and wave action. Natural shorelines can be maintained while still providing recreation access to the lake for shoreline owners. Native vegetation should be established around 75 to 100% of the shoreline. A shoreline assessment should be conducted for Loeb Lake. Shoreline restoration/stabilization projects should be implemented based on the results of the assessment. Demonstration projects may provide an opportunity for public education and outreach. Additionally, CRWD should work with Saint Paul Parks and Recreation Department to determine current turf management practices within Marydale Park and identify possible refinements to improve Loeb Lake.

<u>Goal Addressed:</u>	Loeb Lake 1, 2, 4
<u>Responsible Agency:</u>	Saint Paul Parks and Recreation Department
<u>Partners/Cooperators:</u>	CRWD
<u>Estimated Cost:</u>	To be determined
<u>Schedule:</u>	2011

ACTION #7 – Monitor the presence of invasive plant species. Specifically, record the spatial presence of curly leaf pondweed and Eurasian water milfoil by visual observation.

Between 1981 and 2000, there was a decline in the number of desirable native submerged species; this could indicate a decline in water quality and fish habitat. Preventing the spread of species such as curly-leaf pondweed and Eurasian water milfoil should be a priority to protect the lake. Monitoring staff should begin to record the spatial presence of curly leaf pondweed and Eurasian water milfoil by visual observation. Qualitative measurements by rake could also be obtained. If nuisance blooms occur, stem densities should be measured. If nuisance blooms persist, consider chemical treatment.

<u>Goal(s) Addressed:</u> Loeb Lake 5
<u>Responsible Agency:</u> RCPW and DNR
<u>Partners/Cooperators:</u> CRWD
<u>Estimated Cost:</u> To be determined
<u>Schedule:</u> Ongoing

ACTION #8 – Work with Saint Paul Parks and Recreation Department and the DNR to develop an aquatic plant management plan.

An aquatic plant management plan attempts to minimize the impacts of invasive species and retain native aquatic species. Aquatic invasive vegetation can have adverse effects on a lake ecosystem including loss of critical habitat, eutrophication, and loss of native species. Their populations can often rapidly increase allowing them to disrupt native plant communities, crowd out native species, and affect species beyond those they may directly displace. They can cause problems for those who use natural resources, and once established, invasive species rarely can be eliminated.

At least two options exist to reinvigorate the growth of native species in a shallow lake like Loeb. The first is a winter and summer drawdown that will reconsolidate the sediments and bring back the native aquatic vegetation in the lake. This action should be evaluated as there are remnants of a healthy aquatic vegetation community in Loeb Lake. Since Loeb Lake is landlocked, the time to refill the lake must also be investigated. The second option is the use of submergent plantings (perhaps even during the drawdown) to restore native vegetation.

<u>Goal Addressed:</u> Loeb Lake 5
<u>Responsible Agency:</u> DNR
<u>Partners/Cooperators:</u> CRWD and Saint Paul Parks and Recreation Department
<u>Estimated Cost:</u> To be determined
<u>Schedule:</u> 2013

ACTION #9 – Work with the DNR to develop a fish stocking plan that maintains top predators in an effort to maintain good water quality.

CRWD should work with the DNR to develop a stocking plan that maintains top predators. Because Loeb Lake is a panfish-dominated lake, there is the potential for the lake to develop a stunted panfish population which would result in decreased water quality.

<u>Goal Addressed:</u> Loeb Lake 4
<u>Responsible Agency:</u> DNR
<u>Partners/Cooperators:</u> CRWD
<u>Estimated Cost:</u> To be determined
<u>Schedule:</u> 2011

ACTION #10 – Install stormwater treatment practices in the Loeb Lake South subwatershed as opportunities arise.

Approximately 83% of the Loeb Lake phosphorus budget is delivered by watershed runoff. Therefore, both large and small reductions in phosphorus through the installation of stormwater treatment practices will improve the water quality of Loeb Lake. Rain gardens and infiltration basins reduce the volume of runoff that is delivered to downstream waterbodies by infiltrating stormwater and improve water quality by allowing pollutants to settle out or be used by vegetation. Opportunities for these practices should be investigated. These practices require maintenance and removal of accumulated sediments at regular intervals. The interval length is dependent on the specific subwatershed and basin characteristics, but usually varies between 5 and 10 years.

<u>Goal Addressed:</u> Loeb Lake 1
<u>Responsible Agencies:</u> CRWD and City of Saint Paul
<u>Partners/Cooperators:</u> Residents and businesses
<u>Estimated Cost:</u> Variable depending upon practice and ownership.
<u>Schedule:</u> Ongoing as opportunities arise

9.4 WILLOW RESERVE MANAGEMENT ACTIONS

The following actions are arranged in priority order, but it is expected that implementation will proceed as opportunities, partnerships, and resources arise. Action numbering is continued from Section 9.3 for easier implementation .

ACTION #11 – Form a stakeholder group to define the desired ultimate condition of Willow Reserve.

The stakeholder group should consider the ultimate condition of Willow Reserve based upon the desired amount of wildlife diversity; native vegetative species; invasive vegetative species; and human influence (i.e., recreational opportunities, interpretive signs, and trails). Potential stakeholders include CRWD, City of Saint Paul, area residents, and the neighborhood group initially responsible for its creation.

One to three public information or discussion sessions should be held to gather opinion and determine course for Willow Reserve. If the stakeholders are strongly opposed to any sort of restoration, any potential project will not be viewed as a success. Conversely, if the stakeholders see the effort as an opportunity to improve the wildlife and vegetative community within Willow Reserve, project partnerships can be cultivated to achieve a successful project that has strong stakeholder interest. During this phase, a pre-restoration biotic assessment of the vegetative and macroinvertebrate community should be performed to help document future improvement.

Initial planning will include the determination of what plant communities are desired and where to locate these communities. Several factors will go in to the decisions of creating the restoration plan:

- Resident's perception of the reserve as a wetland, forest, or meadow
- Maintenance costs of different native vegetation communities
- Habitat created to attract what type of wildlife
- Importance of stormwater treatment
- Height of canopy desired

CRWD suggests three options for the stakeholders to consider in defining the "ultimate condition:"

1. **Do nothing** – allow the area to remain as it exists today. This is the least expensive of the three options since there will be no additional management of the area than what currently exists.

2. Restore the area to its **pre-settlement** condition.

   Restoration would likely consist of a wooded and shrub swamp ecosystem since Willow Reserve is in the North Central Hardwood Ecoregion. Wooded swamps are important for stormwater and floodwater retention. They also provide habitat for wildlife including white-tailed deer, furbearers, songbirds, ruffed grouse, barred owl and amphibians. Shrub swamps provide high value habitat for songbirds, ruffed grouse, American woodcock and small mammals, and may be particularly important winter habitat for ring-necked pheasant, eastern cottontail, and white-tailed deer.

Unfortunately, it is likely impossible to restore the area to its exact pre-settlement condition because of human actions over the last 70-100 years and the increased role of stormwater in the hydrologic budget. Therefore, it may be beneficial to identify a reference wetland in Saint Paul or Roseville to use during the restoration planning process.

The stakeholder group shall also consider the amount of human activity (i.e., interpretive signs, benches, and trails), if any, is desired in the restored area.

This is likely the most expensive option and, in the short term, will dramatically change the landscape of Willow Reserve.

3. Restore the area to **maximize** native wildlife and vegetative diversity within each ecotype identified in the NRIHA.

   This option maximizes the potential of each ecotype using the existing landscape and stormwater influence. Along with wooded and shrub swamps discussed above, inland fresh meadows could be incorporated into the restoration; these are particularly important for their water quality protection functions. Inland fresh meadows provide wildlife habitat for many species including sandhill crane, ring-necked pheasant, common snipe, sedge wren, small mammals, and white-tailed deer. The abundance of small mammals supports mink, fox, and raptors such as the northern harrier. The vegetative diversity found in these meadows is an important fall and winter food source for songbirds.

   The stakeholder group shall also consider the amount of human influence (i.e., interpretive signs, benches, and trails), if any, in the restored area.

   The cost to complete this option is greater than the "do nothing" option and less than the "pre-settlement" option. The budget will vary depending on the amount and extent of restoration desired. A low to medium amount of landscape change should be expected in the short term.

If the "maximize" option is selected, it will be necessary to determine which ecotypes have the greatest potential for restoration. For example, the open/shallow water regime is currently acting as a stormwater retention basin with fringes of emergent vegetation. As long as stormwater is continued to be directed to this area, emergent vegetation restoration may prove difficult. Drawdown of the permanent water pool could be used to re-establish native submergent and emergent vegetation. However, the NRIHA identified the open/shallow open water regime area as having the greatest vegetative value and diversity.

In contrast, the saturated soils that surround the open/shallow water area offer an excellent substrate for the re-establishment of different vegetation communities including wooded swamp, shrub swamp, and fresh meadow. Saturated soils and a relatively static water level are preferred for vegetative restoration.

Removal of existing vegetation in the upland areas will provide opportunity to restore the vegetation to a native prairie or forest. Native short or long grass prairies provide habitat for ring-necked pheasant, common snipe, sedge wren, small mammals, and white-tailed deer. These species support an abundance of small mammals like mink, fox, and raptors.

Forested communities to be considered include oak-aspen and maple-basswood. Species present in these forests include: white oak, red oak, trembling aspen, paper birch, sugar maple, red maple, American basswood, green ash, and American elm. The forests provide habitat for wildlife including white-tailed deer, furbearers, songbirds, ruffed grouse, barred owl and amphibians.

Goal Addressed:	Willow Reserve 1
Responsible Agency:	CRWD
Partners/Cooperators:	SPPR, SPPW, District 6 Council, residents
Estimated Costs:	To be determined
Schedule:	2009 to 2010

ACTION #12 – Develop and implement the restoration plan recommended by the stakeholder group.

Restoring Willow Reserve to native plant communities will be an effort that will require a long term commitment to ensure success. The removal of the existing invasive vegetation, specifically buckthorn and reed canary grass, requires intensive site maintenance to ensure its removal and prevent re-establishment. The landscape will look dramatically different from the current condition and education of local residents should be conducted prior to implementing.

It is estimated that eight years will be needed from the time of initial planning through annual maintenance activities to ensure vegetation re-establishment. Below is a timeline that could be considered when planning for restoration:

Pre-restoration	– Begin gathering data mentioned in items a though h below
Year 1	– Create Vegetation Restoration Plan
Years 1-2	– Invasive Plant Removal
Year 2	– Soil Preparation
Years 2-3	– Seeding and Planting Communities
Years 3-8	– Plant Community Monitoring and Maintenance

Pre-restoration

A significant amount of communication, data and professional expertise may be necessary. A potential list includes:

a. One-foot topographic survey of the parcel.
b. Utility survey of the parcel, including mean sea level elevations of the TBI storm sewer system.
c. Soil borings, as necessary based on the selected restoration plan.
d. Monitoring wells in each hydrologic regime identified in the NRIHA and monitoring weekly.
e. A hydrologic and hydraulic computer model of the TBI, Willow Reserve, and surrounding area to understand the hydrologic regime. The model should be calibrated or validated using Willow Reserve water level data collected during 2006 and 2007. If water levels are highly variable due to surcharge from the TBI, additional engineering may be necessary to reduce bounce in the restored area. The model should also determine under what conditions the TBI surcharges to Willow Reserve (i.e., rainfall event; amount of flow in the TBI; depth of flow in the TBI). The computer model should also be flexible to accommodate a different connection between TBI and Willow Reserve as desired by the selected restoration plan.
f. Grading, erosion control, wetland permits, as necessary.
g. A vegetative management plan detailing restoration activities to create the greatest vegetative diversity within Willow Reserve wetlands.
h. A vegetative management plan for upland restoration to native forest and prairie.

Year 1 – Create Vegetation Restoration Plan

Once the goals of the restoration are determined, a vegetation restoration plan can be created. The plan will provide the direction of the project, refine timelines, identify management techniques, provide project budgets, establish monitoring and maintenance protocol, and allow CRWD to share the ideas and projected outcomes with stakeholders and residents.

Invasive Plant Removal – Year 1–2

Many trees, shrubs, and ground cover will need to be removed to expose native soils for seed preparation. The NRIHA indicated that invasive species such as buckthorn is prevalent in the reserve. Cutting, spraying, and mechanical removal techniques would be indentified and implemented to eradicate buckthorn. To ensure complete removal, a one year or longer period may be needed prior to re-establishment of native vegetation.

Soil Preparation – Year 2

Once the invasive and weedy vegetation is removed, soil preparation would occur to prepare the site for seeding/planting. The soil will be harrowed and prepared for seeding or planting. Late summer and fall provide a good time for this activity as water levels are generally low.

Seeding and Planting Communities – Year 2-3

The time of year of seeding is important and would be detailed in the restoration plan. Plantings could occur at various times of the year dependent on the species.

Plant Community Monitoring and Maintenance – Year 3-8

Potentially the most important step in the restoration process is ongoing maintenance to ensure native vegetation is established. Activities such as mowing, herbicide spraying, mechanical removal, and site burning are all used in maintenance of invasive species. Native vegetation communities can thrive once a dense cover is established to prevent establishment of invasive species. A commitment to long term maintenance is critical to the overall success of the restoration. Biotic evaluation should also be performed periodically to document recovery of the biotic community.

Goal Addressed: Willow Reserve 1
Responsible Agency: CRWD
Partners/Cooperators: City of Saint Paul, District 6 Council, and residents
Estimated Cost: Variable (mentioned in Action #11)
Schedule: 2010 through 2018

ACTION #13 – Tailor and implement educational outreach activities for Willow Reserve and its watershed.

Some level of educational activities should be implemented at Willow Reserve depending on the outcome of Action #11. Emphasizing the natural link between Loeb Lake and Willow Reserve could be achieved through the establishment of a visual connection, or through the creation of a designated walking route. Perimeter signage, clean-up days, or direct mailing could draw attention to the area's designation as a park wildlife preserve, its stormwater management function, and its value as a unique urban habitat that contributes to the decrease of the heat island effect. Also, benches and interpretive areas could be added at the perimeter without adding trails within the reserve. Plans to manage invasives or install park structures would require approval by the city prior to implementation.

Goal Addressed: Willow Reserve 2
Responsible Agency: CRWD
Partners/Cooperators: City of Saint Paul and District 6 Council
Estimated Cost: $15,000 or more depending on the outcome of Action #11
Schedule: 2010 and ongoing

ACTION #14 – Monitor the water quality entering and discharging from Willow Reserve.

The mission of CRWD is to "protect, manage, and improve the water resources of the CRWD." Therefore, any level of restoration planned for Willow Reserve should also attempt to improve the water quality within and/or discharging from Willow Reserve.

Currently, the major hydrologic input to Willow Reserve is stormwater runoff surcharge from TBI following rainfall events. Runoff from TBI enters the Willow Reserve basin and either quickly discharges back into TBI or remains in the basin and is lost through infiltration or evopotranspiration.

Water quality data has not been collected at Willow Reserve, so the quality of water discharging to the TBI after rain events and that remaining in Willow Reserve is unknown. Therefore, sampling should begin to investigate water quality discharging to Willow Reserve from TBI, within Willow Reserve, and discharging from Willow Reserve to TBI. The resulting analysis of the water quality data will provide direction to the stakeholders when considering a restoration plan.

Goal Addressed:	Willow Reserve 3
Responsible Agency:	CRWD
Partners/Cooperators:	City of Saint Paul
Estimated Cost:	$16,000 one-time costs; $10,000/year
Schedule:	2010 and ongoing

Table 11. LLWRMP 10-year implementation plan summary.

Management Action	Estimated Total Cost	Responsible Agency	Partners / Cooperators	Proposed Implementation Years									
				2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Loeb Lake													
1. Investigate the performance of the southeast pond.	$25,000	CRWD	SPPR										
2. Install a skimmer structure on the pipe connecting the southeast pond to Loeb Lake to retain floatable debris.	$10,000	SPPR	CRWD										
3. Assess the current municipal good housekeeping practices and determine the need for increased level of practices in the watershed.	To Be Determined	CRWD	SPPW										
4. Continue to monitor the current suite of water quality parameters (including zooplankton), while adding the recording of the spatial presence of filamentous algae by visual observation.	$5,000/year	RCPW, DNR	CRWD										
5. Tailor and implement an education program for Loeb Lake based on an assessment of current residential practices.	$15,000 one-time; $5,000/yr	CRWD	District 6, DNR, SPPR										
6. Restore the shoreline of Loeb Lake.	To Be Determined	SPPR	CRWD										
7. Monitor the presence of invasive plant species. Specifically, record the spatial presence of curly leaf pondweed and Eurasian water milfoil by visual observation.	To Be Determined	RCPW, DNR	CRWD										
8. Work with SPPR and the DNR to develop an aquatic plant management plan.	To Be Determined	DNR	CRWD, SPPR										
9. Work with the DNR to develop a fish stocking plan that maintains top predators in an effort to maintain good water quality.	To Be Determined	DNR	CRWD										
10. Install stormwater treatment practices in the Loeb Lake South subwatershed as opportunities arise.	Variable	CRWD, SP	Residents, Businesses										
Willow Reserve													
11. Form a stakeholder group to define the desired ultimate condition of Willow Reserve.	To Be Determined	CRWD	SPPR, SPPW, District 6, Residents										
12. Develop and implement the restoration plan recommended by the stakeholder group.	Variable	CRWD	SP, District 6, Residents										
13. Tailor and implement educational outreach activities for Willow Reserve and its watershed.	$15,000 or more	CRWD	SP, District 6										
14. Monitor the water quality entering and discharging from Willow Reserve.	$16,000 one-time; $10,000/yr	CRWD	SP										

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11.0 Abbreviations & Acronyms

Abbreviation or Acronym	Meaning
CRWD	Capitol Region Watershed District
DNR	Minnesota Department of Natural Resources
FiN	Fishing in the Neighborhood Program
MPCA	Minnesota Pollution Control Agency
NRIHA	Willow Reserve Natural Resources Inventory and Habitat Assessment
OHW	Ordinary High Water Level
RCPW	Ramsey County Public Works Department
RCP	Reinforced Concrete Pipe
SP	City of Saint Paul
SPPR	City of Saint Paul Parks & Recreation Department
SPPW	City of Saint Paul Public Works Department
TBI	Trout Brook Storm Sewer Interceptor

Maps

CAPITOL REGION WATERSHED DISTRICT

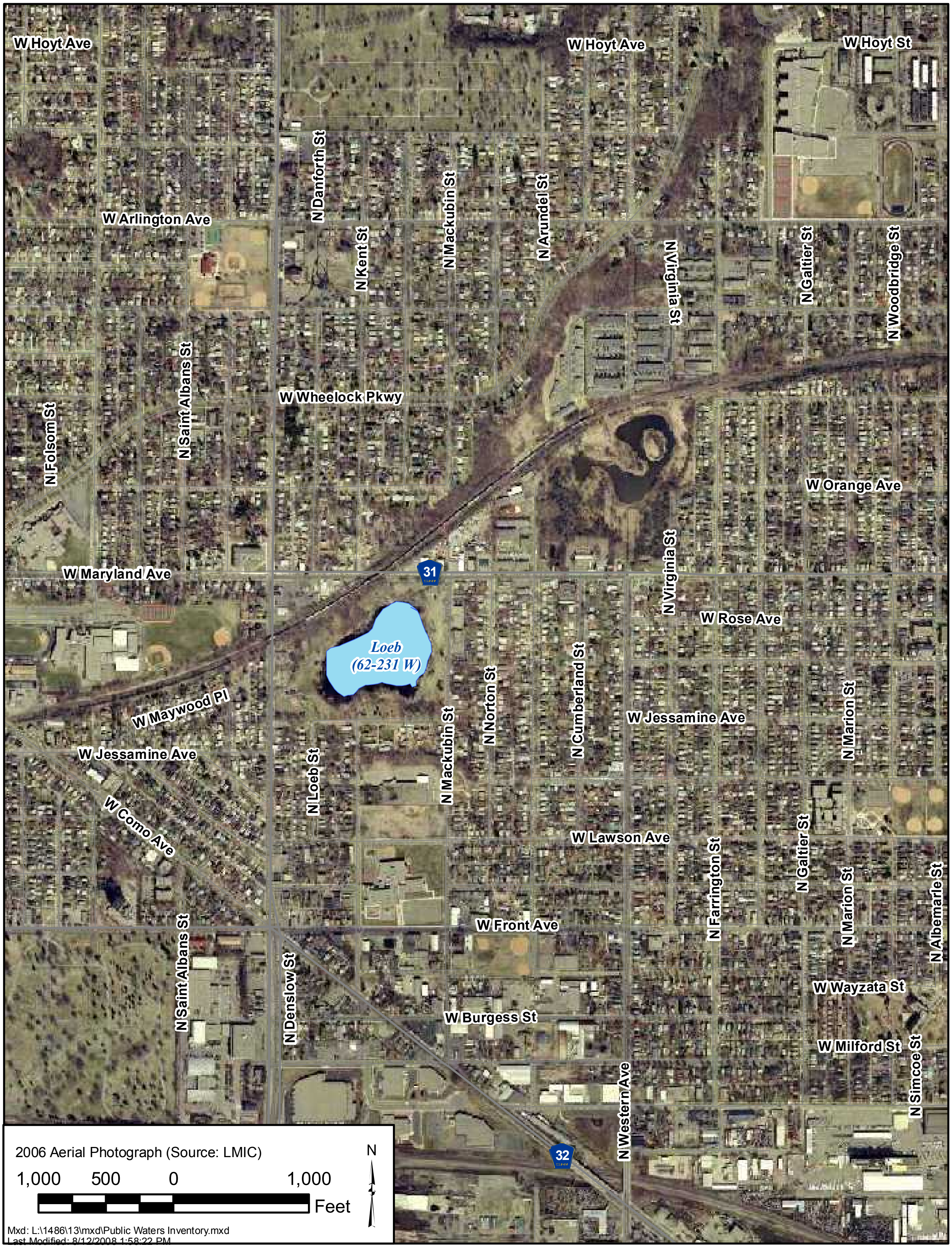
Location Map

Wenck Associates, Inc.
Environmental Engineers

1800 Pioneer Creek Center
Maple Plain, MN 55359-0429

AUG 2008

Map 1



CAPITOL REGION WATERSHED DISTRICT

Public Waters Inventory

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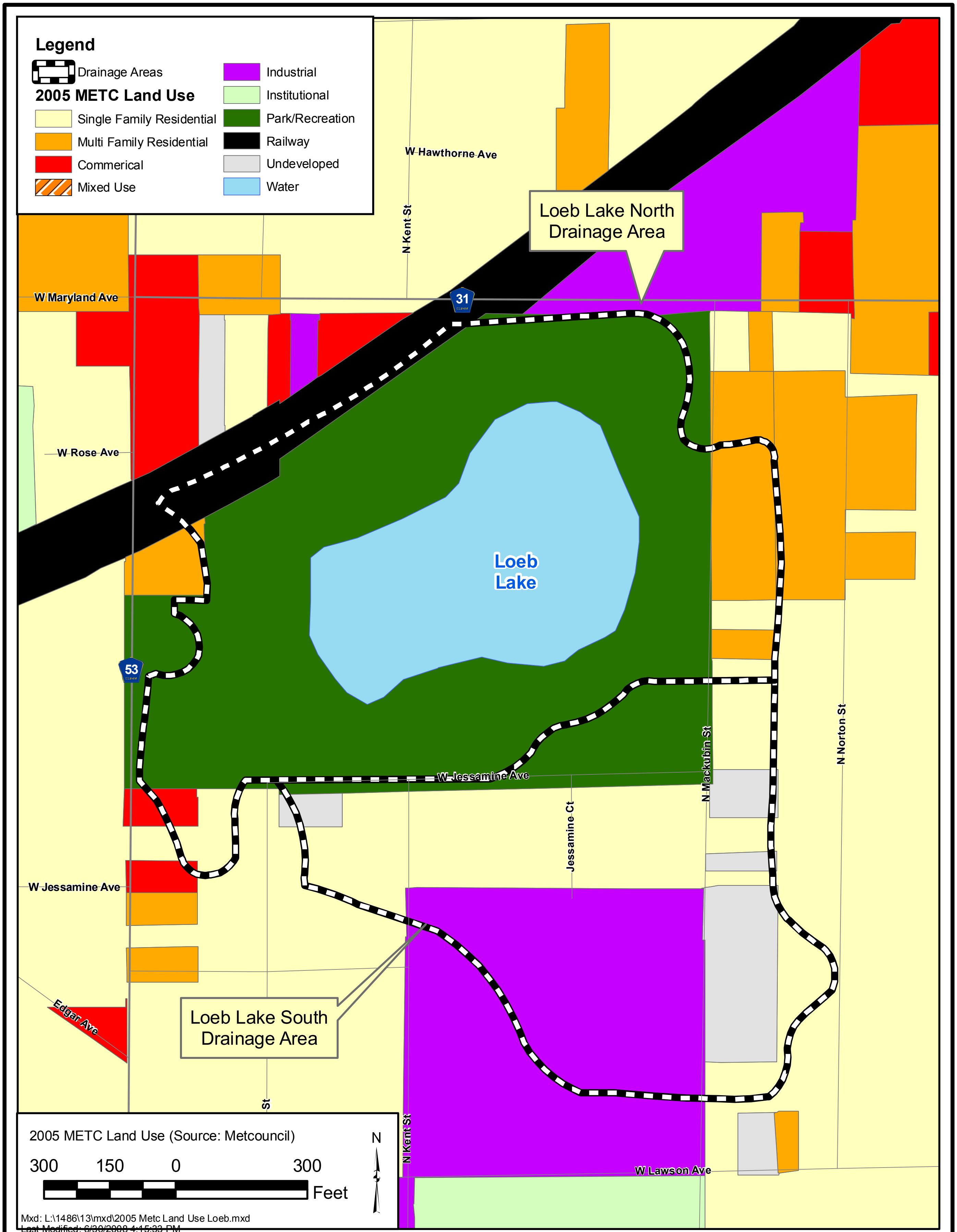
Map 2

CAPITOL REGION WATERSHED DISTRICT	Wenck	AUG 2008
Loeb Lake Drainage Area	Wenck Associates, Inc. Environmental Engineers 1800 Pioneer Creek Center Maple Plain, MN 55359-0429	Map 3



CAPITOL REGION WATERSHED DISTRICT

Loeb Lake Land Use

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Map 4

CAPITOL REGION WATERSHED DISTRICT

Loeb Lake Soil Survey Map

Wenck

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Map 5

CAPITOL REGION WATERSHED DISTRICT

Willow Reserve Drainage Area

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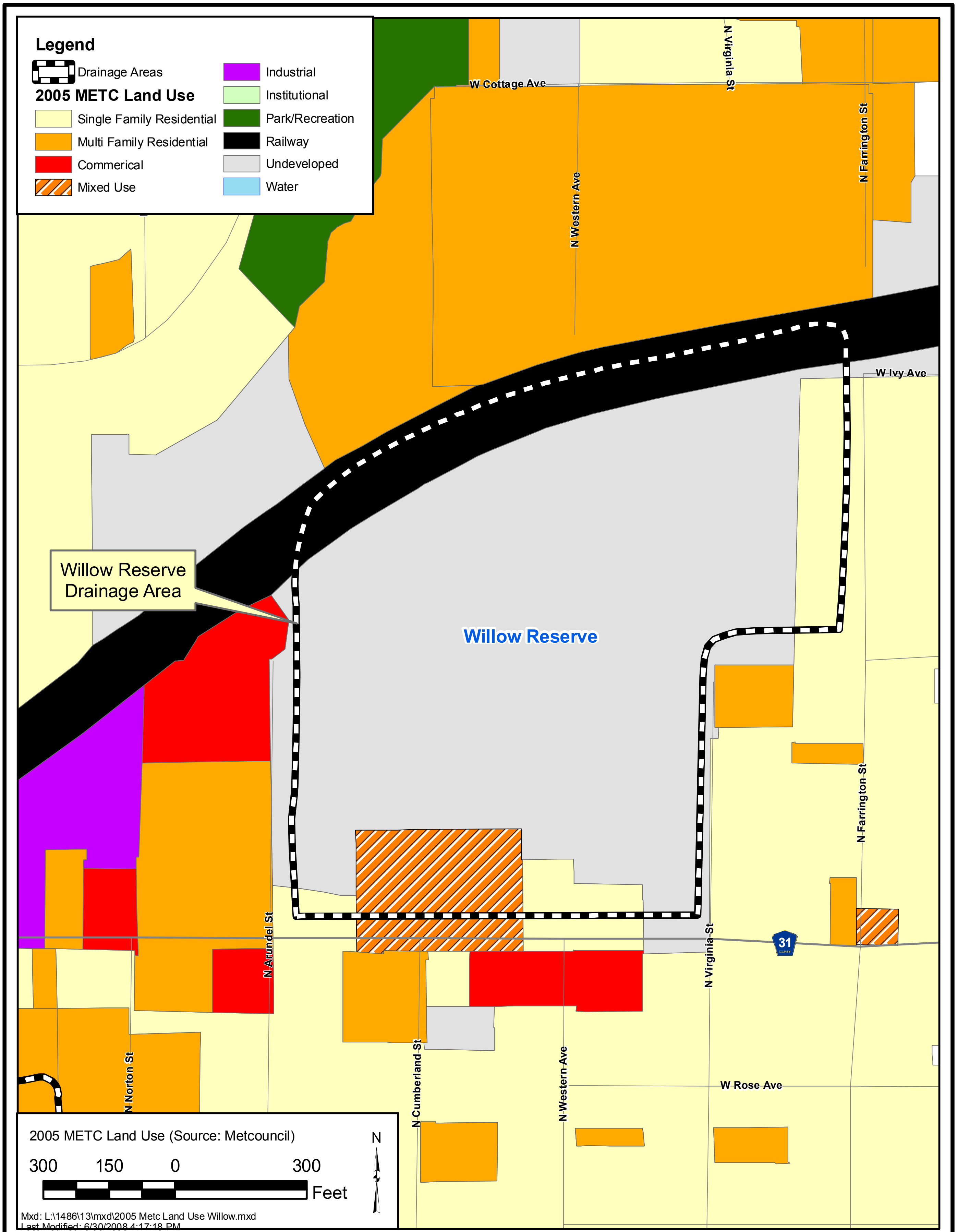
Map 6



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Willow Reserve Land Use

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Map 7

CAPITOL REGION WATERSHED DISTRICT

Willow Reserve Soil Survey Map

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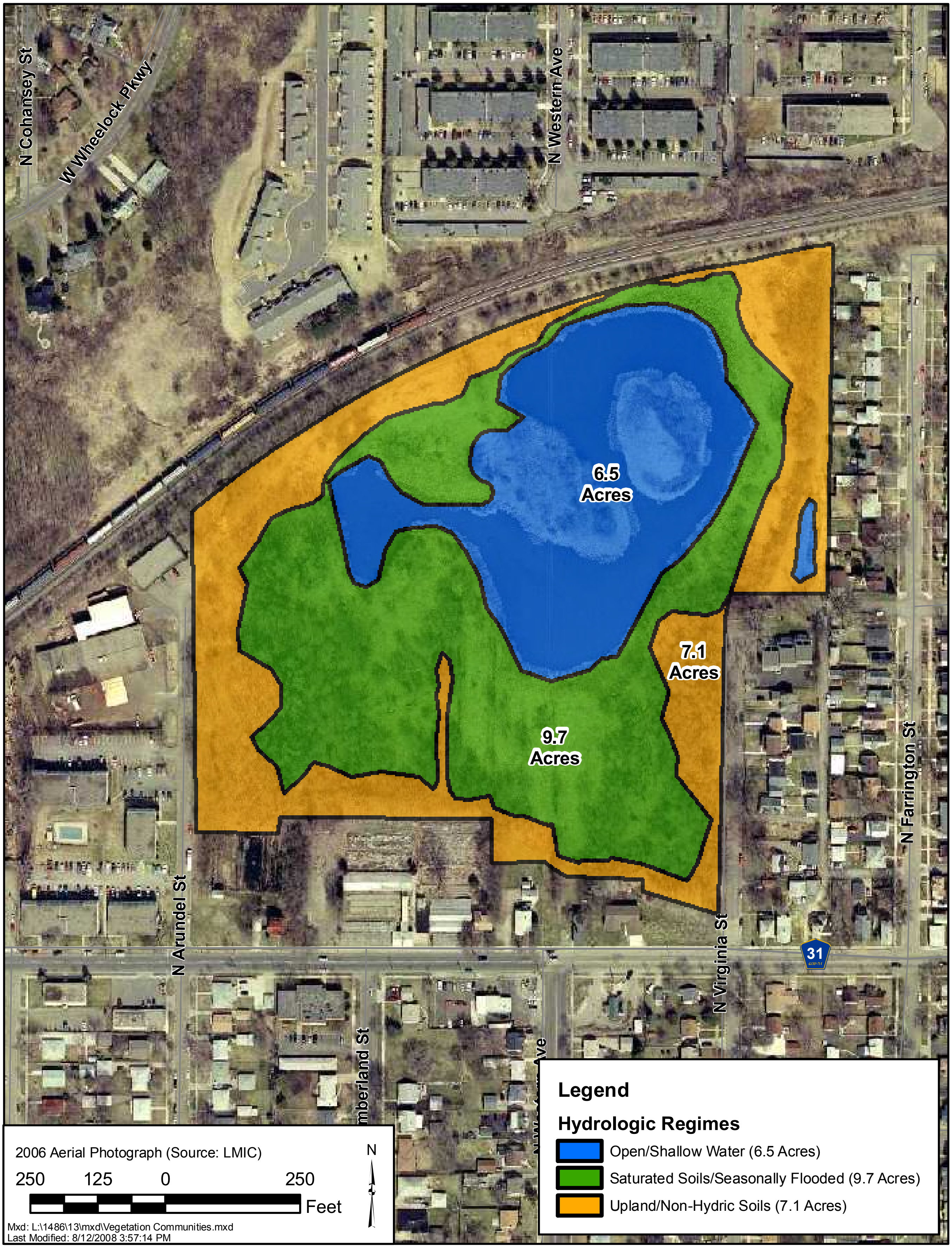
Map 8



CAPITOL REGION WATERSHED DISTRICT

Hydrologic Regimes

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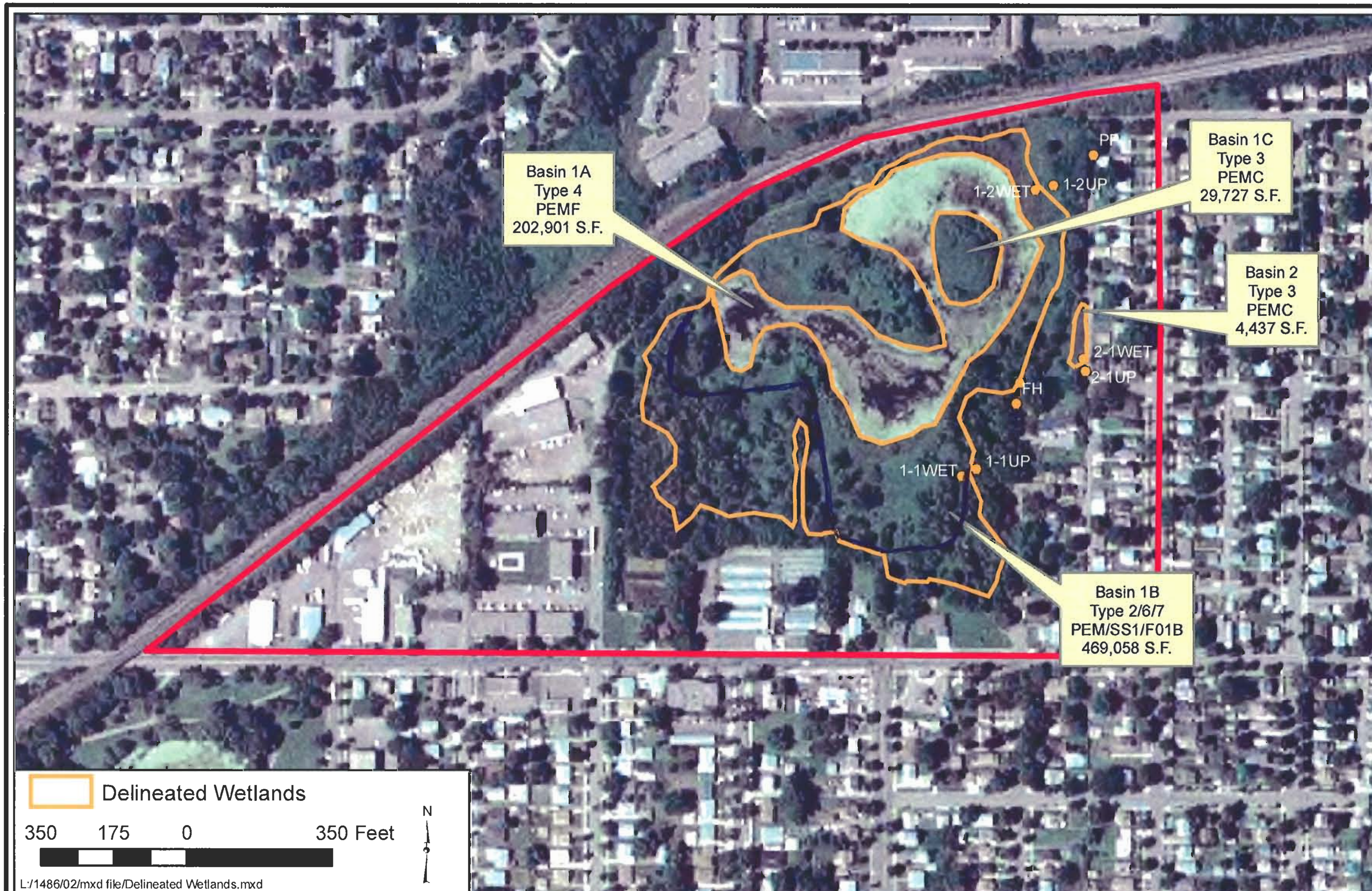
Map 9

Appendix A

Willow Reserve Delineated Wetlands

4



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Delineated Wetlands		Figure 5

Appendix B

Loeb Lake Water Budget

Loeb Lake

	[ac-ft]	[10^6 m^3]
Lake Volume =	84	0.10
	[ac]	[km^2]
Surface Area =	10	0.04
	[ft]	[m]
Depth of Epilimnion =	8.7	2.7
	[ft]	[m]
Maximum Depth =	28	8.5

= INPUT PARAMETERS

= EQUATION (DO NO CHANGE)

NOTES: [1] Negative (< 0) groundwater values indicate groundwater export from the lake, positive (> 0) values indicate inflow.

	Measured Lake Parameters				Predicted Lake Parameters			INFLOW VOLUME			Groundwater[1]		OUTFLOW VOLUME		
Date	Lake Level [ft]	Lake Surface Area [ac]	Storage [ac-ft]	Lake Volume [ac-ft]	Lake Level [ft]	Lake Surface Area	Lake Volume [ac-ft]	Watershed Discharge [ac-ft]	Precipitation [ac-ft]	Σ Inflow [ac-ft]	Interval Volume [ac-ft]	Average Rate ft/day	Evaporation [ac-ft]	Down-stream Lakes or Tributaries [ac-ft]	Σ Outflow [ac-ft]
5/15/2003	851.25	10.1	0.0	84.9	851.25	10.1	84.9	0.0	0.0	0	0.0	0.0	0.0	0	0.0
5/30/2003	851.15	10.0	-1.0	83.9	851.15	10.0	83.9	1.3	1.4	2.7	-2.5	-0.02	1.2	0	3.7
6/12/2003	851.22	10.0	0.7	84.6	851.22	10.0	84.6	0.5	0.5	2.0	1.0	0.01	1.3	0	1.3
6/26/2003	851.40	10.2	1.8	86.4	851.40	10.2	86.4	4.8	4.3	9.2	-5.9	-0.04	1.4	0	7.3
7/15/2003	851.18	10.0	-2.2	84.2	851.18	10.0	84.2	1.6	1.8	3.4	-3.1	-0.02	2.5	0	5.6
7/30/2003	851.15	10.0	-0.3	83.9	851.15	10.0	83.9	0.2	0.2	1.8	1.5	0.01	2.2	0	2.2
8/15/2003	851.13	10.0	-0.2	83.7	851.13	10.0	83.7	0.0	0.0	2.1	2.1	0.01	2.3	0	2.3
9/3/2003	851.05	9.9	-0.8	82.9	851.05	9.9	82.9	0.5	0.6	1.8	0.7	0.00	2.6	0	2.6
9/16/2003	851.02	9.9	-0.3	82.6	851.02	9.9	82.6	1.2	1.3	2.4	-1.2	-0.01	1.5	0	2.7
10/1/2003	851.10	10.0	0.8	83.4	851.10	10.0	83.4	0.5	0.6	2.5	1.3	0.01	1.7	0	1.7
10/15/2003	851.13	10.0	0.3	83.7	851.13	10.0	83.7	0.3	0.4	1.4	0.7	0.00	1.1	0	1.1
10/29/2003	851.13	10.0	0.0	83.7	851.13	10.0	83.7	0.1	0.1	1.1	0.9	0.01	1.1	0	1.1
11/14/2003	851.12	10.0	-0.1	83.6	851.12	10.0	83.6	0.5	0.6	1.0	-0.6	0.00	0.6	0	1.2
12/10/2003	851.10	10.0	-0.2	83.4	851.10	10.0	83.4	0.1	1.4	1.4	-1.0	0.00	0.7	0	1.6
2/26/2004	851.28	10.1	0.0	85.1	851.28	10.1	85.1	0.00	0.0	0.0	0.0	0.00	0.0	0	0.0
3/18/2004	851.18	10.0	-1.0	84.1	851.18	10.0	84.1	1.1	1.2	2.3	-2.9	-0.01	0.4	0	3.3
4/15/2004	851.15	10.0	-0.3	83.8	851.15	10.0	83.8	9.1	0.6	9.7	-9.0	-0.03	1.0	0	10.0
4/22/2004	851.18	10.0	0.3	84.1	851.18	10.0	84.1	1.4	1.5	2.9	-2.3	-0.03	0.3	0	2.6
3/9/2006	850.48	9.5	0.0	80.1	850.48	9.5	80.1	0.00	0.0	0.0	0.0	0.00	0.0	0	0.0
4/19/2006	850.75	9.7	2.6	82.7	850.75	9.7	82.7	15.0	3.9	18.9	-15.0	-0.04	1.3	0	16.4
5/2/2006	850.94	9.9	1.9	84.6	850.94	9.9	84.5	2.7	2.9	5.6	-3.0	-0.02	0.7	0	3.8
5/17/2006	850.88	9.8	-0.6	84.0	850.88	9.8	83.9	1.2	1.3	2.5	-1.9	-0.01	1.2	0	3.1
5/30/2006	850.71	9.7	-1.7	82.3	850.71	9.7	82.3	0.3	0.4	0.8	-1.4	-0.01	1.0	0	2.4
6/16/2006	850.43	9.5	-2.7	79.6	850.43	9.5	79.6	1.5	1.7	3.2	-4.3	-0.03	1.6	0	5.9
6/27/2006	850.47	9.5	0.4	80.0	850.47	9.5	79.9	0.5	0.6	1.5	0.4	0.00	1.1	0	1.1
7/13/2006	850.10	9.3	-3.5	76.5	850.10	9.3	76.4	0.1	0.1	0.2	-1.6	-0.01	2.1	0	3.7
7/24/2006	850.01	9.2	-0.8	75.7	850.01	9.2	75.6	1.1	1.2	2.3	-1.6	-0.02	1.6	0	3.1
8/9/2006	850.30	9.4	2.7	78.4	850.30	9.4	78.3	4.3	4.2	8.5	-3.6	-0.02	2.3	0	5.9
8/24/2006	850.18	9.3	-1.1	77.3	850.18	9.3	77.1	1.2	1.3	2.5	-1.5	-0.01	2.2	0	3.6
9/8/2006	850.34	9.4	1.5	78.8	850.34	9.4	78.6	2.0	2.2	4.2	-0.8	-0.01	1.9	0	2.7
9/20/2006	850.20	9.4	-1.3	77.5	850.20	9.4	77.3	0.4	0.5	0.9	-0.9	-0.01	1.4	0	2.2
10/3/2006	850.20	9.4	0.0	77.5	850.20	9.4	77.3	1.2	1.3	2.6	-1.1	-0.01	1.4	0	2.6
10/18/2006	850.12	9.3	-0.7	76.7	850.12	9.3	76.5	0.3	0.4	0.8	-0.4	0.00	1.1	0	1.5
10/31/2006	850.01	9.2	-1.0	75.7	850.01	9.2	75.5	0.1	0.1	0.1	-0.1	0.00	1.1	0	1.1
11/17/2006	849.96	9.2	-0.5	75.2	849.96	9.2	75.1	0.0	0.1	0.1	0.0	0.00	0.6	0	0.6
11/30/2006	849.98	9.2	0.2	75.4	849.98	9.2	75.3	0.3	0.8	1.0	-0.4	0.00	0.5	0	0.9
1/1/2007	850.14	9.3	0.0	78.0	850.14	9.3	78.0	0.00	0.0	0.0	0.0	0.00	0.0	0	0.0
2/1/2007	850.01	9.2	-1.2	76.8	850.01	9.2	76.8	0.3	0.4	0.8	-1.7	-0.01	0.3	0	2.0
3/28/2007	850.45	9.5	4.1	80.9	850.45	9.5	80.8	12.5	3.2	15.7	-10.8	-0.02	0.9	0	11.7
5/18/2007	850.31	9.4	-1.3	79.6	850.31	9.4	79.5	6.9	3.9	10.9	-9.4	-0.02	2.8	0	12.2
6/1/2007	850.26	9.4	-0.5	79.1	850.26	9.4	79.0	1.1	1.2	2.2	-1.6	-0.01	1.1	0	2.7
6/14/2007	850.14	9.3	-1.1	78.0	850.14	9.3	77.9	1.0	1.1	2.2	-1.8	-0.01	1.5	0	3.3

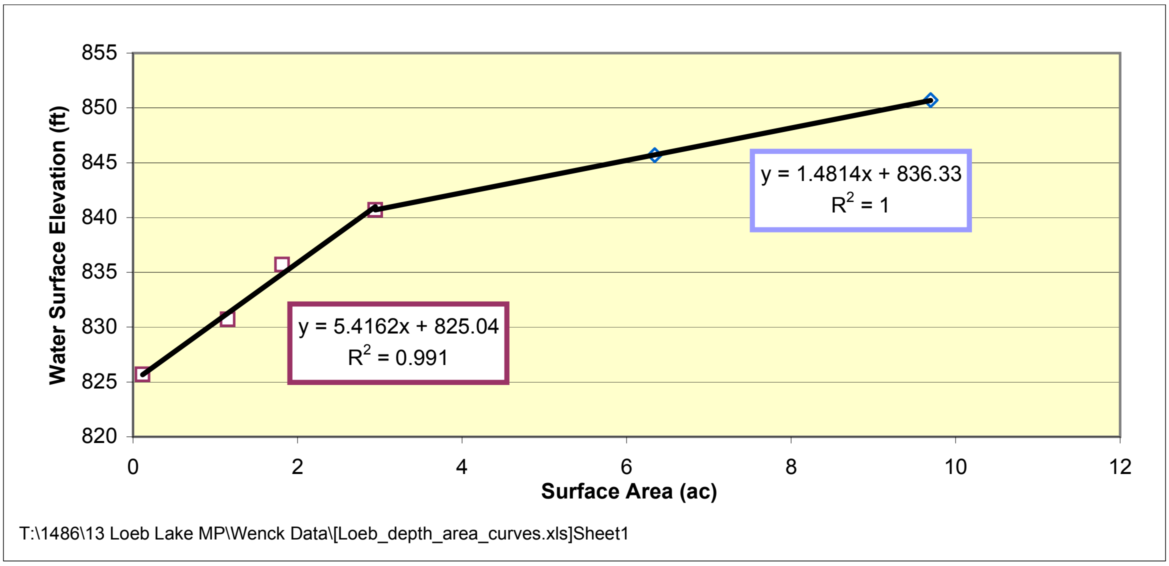

Figure B1. Loeb Lake area vs. stage (elevation) relationship.

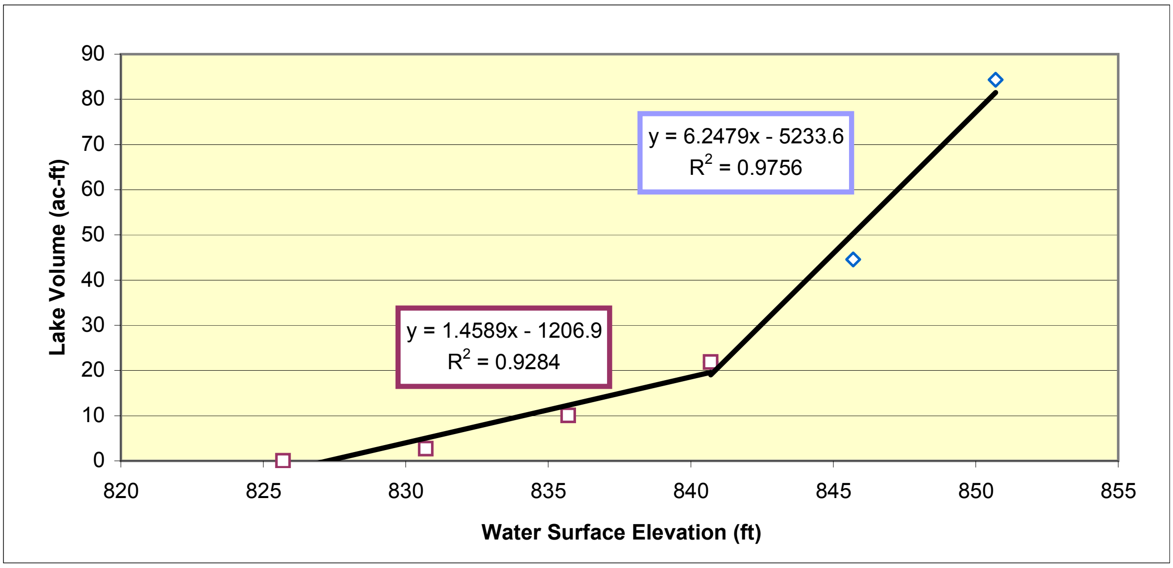

Figure B2. Loeb Lake stage (elevation) vs. volume relationship.

Appendix C

Loeb Lake Water Quality Data

Loeb Lake 2004 Water Quality Data

LAKENAME	DNRID	Date	Surface	Z-M	STRAT-M	EPIL-Y,N	DO-MG/L	T-DEGC	SEC-M	CCHLA-MG/M3	P	Bottom	TP-MG/L	SRP-MG/L	PH-SU	CL-MG/L	TALK-MG/L	THARD-MG/L	NO3N-MG/L	NH3N-MG/L	TKN-MG/L
LOEB	62-0231	5/4/04	y	0.00	2.5	Y	10.84	14.28	3	5.557	0.926		0.049	0.013	8.25	40	72	118	0.009	0.009	0.923
LOEB	62-0231	5/4/04		1.00	2.5	Y	10.94	14.20							8.26						
LOEB	62-0231	5/4/04		1.50	2.5	Y				3.462	0.346		0.058	0.009			126		0.009	0.009	1.18
LOEB	62-0231	5/4/04		2.01	2.5	Y	10.56	13.85							8.26						
LOEB	62-0231	5/4/04		3.00	2.5	N	1.70	10.72							8.26						
LOEB	62-0231	5/4/04		3.50	2.5	N							0.087	0.033		48		154	0.009	0.061	0.68
LOEB	62-0231	5/4/04		4.01	2.5	N	0.47	5.39							8.26						
LOEB	62-0231	5/4/04		5.00	2.5	N	0.32	4.49							8.26						
LOEB	62-0231	5/4/04		5.98	2.5	N	0.27	4.41							8.26						
LOEB	62-0231	5/4/04		6.80	2.5	N						y	0.81	0.021		60	180	180	0.009	3.99	5
LOEB	62-0231	5/4/04		6.99	2.5	N	0.24	4.52							8.26						
LOEB	62-0231	5/4/04		7.40	2.5	N	0.23	4.62							8.26						
LOEB	62-0231	5/25/04	y	0.00	2.5	Y	10.60	15.57	4.1	3.250	0.342		0.023	0.016	8.25	34	98	98	0.009	0.033	0.48
LOEB	62-0231	5/25/04		1.02	2.5	Y	10.57	15.50							8.32						
LOEB	62-0231	5/25/04		1.50	2.5	Y				4.876	0.599		0.023						0.009	0.015	1.42
LOEB	62-0231	5/25/04		1.95	2.5	Y	10.48	15.48							8.33						
LOEB	62-0231	5/25/04		3.04	2.5	N	3.79	13.85							7.78						
LOEB	62-0231	5/25/04		3.50	2.5	N							0.032	0.009		38	134	134	0.009	0.042	0.913
LOEB	62-0231	5/25/04		4.00	2.5	N	1.69	8.67							7.49						
LOEB	62-0231	5/25/04		5.00	2.5	N	0.54	5.15							7.24						
LOEB	62-0231	5/25/04		6.02	2.5	N	0.47	4.68							7.13						
LOEB	62-0231	5/25/04		7.00	2.5	N	0.48	4.62				y	0.573	0.011	7.03	49	198	182	0.009		2.68
LOEB	62-0231	5/25/04		7.60	2.5	N	0.54	4.76							6.86						
LOEB	62-0231	6/16/04	y	0.00	2.5	Y	10.57	22.87	4	2.537	0.605		0.032	0.031	9.19	29	72	70		0.009	0.7
LOEB	62-0231	6/16/04		1.00	2.5	Y	10.70	22.86							9.35						
LOEB	62-0231	6/16/04		2.01	2.5	Y	11.66	20.42		8.098	3.239		0.052	0.009	9.18				0.009	0.009	0.346
LOEB	62-0231	6/16/04		3.01	2.5	N	9.29	17.16							8.62						
LOEB	62-0231	6/16/04		4.00	2.5	N	1.01	12.70					0.048	0.009	7.96	36	138	156	0.009	0.009	0.958
LOEB	62-0231	6/16/04		5.01	2.5	N	0.73	7.67							7.56						
LOEB	62-0231	6/16/04		6.00	2.5	N	0.56	5.20							7.42						
LOEB	62-0231	6/16/04		7.00	2.5	N	0.50	4.83							7.27						
LOEB	62-0231	6/16/04		7.60	2.5	N								0.009		50	228	180	0.009	5.3	6.16
LOEB	62-0231	6/16/04		8.01	2.5	N	0.55	4.83							7.18						
LOEB	62-0231	6/16/04		8.10	2.5	N	0.49	4.92							7.08						
LOEB	62-0231	7/13/04	y	0.00	2.5	Y	9.35	25.16	2.5	3.276	0.605		0.031	0.012	9.31	31	66	60	0.009	0.009	0.524
LOEB	62-0231	7/13/04		1.01	2.5	Y	11.36	24.47							9.46						
LOEB	62-0231	7/13/04		2.01	2.5	Y	13.91	22.10		18.111	8.322		0.072	0.009	9.45				0.009	0.012	1.67
LOEB	62-0231	7/13/04		3.01	2.5	N	5.08	19.19							7.78						
LOEB	62-0231	7/13/04		3.50	2.5	N							0.043	0.009		36	128	128	0.009	0.009	0.741
LOEB	62-0231	7/13/04		4.02	2.5	N	0.48	15.48							7.27						
LOEB	62-0231	7/13/04		5.00	2.5	N	0.12	9.75							7.1						
LOEB	62-0231	7/13/04		6.02	2.5	N	0.11	6.59							7.03						
LOEB	62-0231	7/13/04		7.01	2.5	N	0.09	5.64							6.96						
LOEB	62-0231	7/13/04		7.60	2.5	N						y	2.03	0.009		45	236	188	0.009	9.83	12.2
LOEB	62-0231	7/13/04		8.00	2.5	N	0.08	5.31							6.9						
LOEB	62-0231	7/13/04		8.30	2.5	N	0.06	5.43							6.76						
LOEB	62-0231	7/28/04	y	0.00	2.5	Y	8.03	23.63	2.7	20.872	20.146		0.033	0.01	8.83	36	76	66	0.009	0.009	0.319
LOEB	62-0231	7/28/04		1.01	2.5	Y	8.07	23.66							8.9						
LOEB	62-0231	7/28/04		2.02	2.5	Y	8.03	23.65		20.244	17.174		0.047	0.014	8.94				0.009	0.009	1.36
LOEB	62-0231	7/28/04		3.01	2.5	N	0.47	20.25							7.59						
LOEB	62-0231	7/28/04		4.02	2.5	N	0.14	15.53					0.074	0.009	7.3	42	142	144	0.009	0.107	1.47
LOEB	62-0231	7/28/04		5.01	2.5	N	0.10	9.89							7.05						
LOEB	62-0231	7/28/04		6.02	2.5	N	0.08	6.77							7.01						
LOEB	62-0231	7/28/04		6.20	2.5	N						y	0.687	0.02		49	206	176	0.009	4.89	6.99
LOEB	62-0231	7/28/04		6.80	2.5	N	0.07	6.30							6.86						

Loeb Lake 2004 Water Quality Data

LAKENAME	DNRID	Date	Surface	Z-M	STRAT-M	EPIL-Y,N	DO-MG/L	T-DEGC	SEC-M	CCHLA-MG/M3	P	Bottom	TP-MG/L	SRP-MG/L	PH-SU	CL-MG/L	TALK-MG/L	THARD-MG/L	NO3N-MG/L	NH3N-MG/L	TKN-MG/L
LOEB	62-0231	8/18/04	y	0.02	2.5	Y	12.52	21.20	2.8	12.526	9.527		0.046	0.009	8.88	36	90	78	0.009	0.183	0.694
LOEB	62-0231	8/18/04		1.01	2.5	Y	12.66	21.14							8.95						
LOEB	62-0231	8/18/04		1.50	2.5	Y				15.739	12.443		0.048	0.009					0.019	0.065	0.568
LOEB	62-0231	8/18/04		2.00	2.5	Y	1.40	20.05							7.55						
LOEB	62-0231	8/18/04		3.03	2.5	N	0.24	18.73							7.25						
LOEB	62-0231	8/18/04		4.04	2.5	N	0.13	14.12					0.079	0.009	6.88	37	120	106	0.009	0.009	1.42
LOEB	62-0231	8/18/04		5.02	2.5	N	0.12	9.47							6.89						
LOEB	62-0231	8/18/04		6.01	2.5	N	0.14	7.09							6.92						
LOEB	62-0231	8/18/04		7.04	2.5	N	0.17	5.93				y	1.28	0.018	6.92	50	226	182	0.009		8.81
LOEB	62-0231	8/18/04		7.60	2.5	N	0.17	5.88							6.79						
LOEB	62-0231	9/18/04	y	0.00	3.5	Y	6.90	21.09	3	10.721	4.405		0.035	0.009	8.61	37	84	80	0.009	0.009	1.13
LOEB	62-0231	9/8/04		1.00	3.5	Y	6.88	21.06							8.49						
LOEB	62-0231	9/8/04		2.00	3.5	Y	6.34	20.96		4.605	0.894		0.027	0.009	8.33				0.009	0.009	0.62
LOEB	62-0231	9/8/04		3.00	3.5	Y	0.29	20.42							7.59						
LOEB	62-0231	9/8/04		4.00	3.5	N	0.16	16.29							7						
LOEB	62-0231	9/8/04		4.50	3.5	N							0.149	0.009		44	162	160	0.009	1.32	2.72
LOEB	62-0231	9/8/04		5.00	3.5	N	0.12	11.34							6.85						
LOEB	62-0231	9/8/04		6.00	3.5	N	0.10	8.47							6.87						
LOEB	62-0231	9/8/04		6.20	3.5	N						y	0.978	0.014		49	216	208	0.009	6.65	8.13
LOEB	62-0231	9/8/04		6.80	3.5	N	0.09	7.49							6.79						

Loeb Lake 2005 Water Quality Data

LAKENAME	DNRID	Date	YRIDNO	Surface	Z-M	STRAT-M	EPIL-Y,N	DO-MG/L	T-DEGC	SEC-M	CCHLA-MG/M3	P	Bottom	TP-MG/L	SRP-MG/L	TPM-MG/L	OPM-MG/L	PH-SU	TURB-NTU	CL-MG/L	TALK-MG/L	THARD-MG/L	SPCON-UMHOS
LOEB	62-0231	5/4/05	20050072	Y	0.00	3.5	Y	11.91	10.31	3.8	5.341	0.336		0.093	0.009	2	1.7	11.91	2.4	44.1	116	122	348
LOEB	62-0231	5/4/05	20050073		1.00	3.5	Y	11.88	10.27									11.88					348
LOEB	62-0231	5/4/05	20050074		2.02	3.5	Y	11.69	9.86		2.571	0.198		0.079	0.009	5.4	4.5	11.69	2.7				350
LOEB	62-0231	5/4/05	20050075		3.00	3.5	Y	11.6	8.92									11.6					352
LOEB	62-0231	5/4/05	20050076		4.02	3.5	N	7.45	7.46									7.45					447
LOEB	62-0231	5/4/05	20050077		5.00	3.5	N	2.66	5.12					0.142	0.01			2.66	33	57.8	162	160	511
LOEB	62-0231	5/4/05	20050078		6.02	3.5	N	1.38	4.92									1.38					577
LOEB	62-0231	5/4/05	20050079		7.00	3.5	N	0.73	5.01									0.73					684
LOEB	62-0231	5/4/05	20050080		7.30	3.5	N						y	1.84	0.01				150	99.8	206	300	
LOEB	62-0231	5/4/05	20050081		7.54	3.5	N	0.39	5.12									0.39					774
LOEB	62-0231	5/4/05	20050082		8.26	3.5	N	0.32	5.25									0.32					684
LOEB	62-0231	5/26/05	20050409	Y	0.00	2.5	Y	11.17	17.28	4.0	1.737	0.371		0.024	0.009	1.366667	0.666667	11.17	1				293
LOEB	62-0231	5/26/05	20050410		1.01	2.5	Y	11.14	17.24									11.14					292
LOEB	62-0231	5/26/05	20050411		2.00	2.5	Y	11.69	16.37		1.768	0.398		0.021	0.009	1.833333	0.933333	11.69	1	42	84	88	304
LOEB	62-0231	5/26/05	20050412		3.00	2.5	N	10.65	12.64									10.65					351
LOEB	62-0231	5/26/05	20050413		4.00	2.5	N	4.31	9.49					0.047	0.009			4.31	1.5	50.4	124	128	422
LOEB	62-0231	5/26/05	20050414		5.00	2.5	N	1.91	6.46									1.91					491
LOEB	62-0231	5/26/05	20050415		6.01	2.5	N	0.2	5.26									0.2					594
LOEB	62-0231	5/26/05	20050416		7.00	2.5	N	0.12	5.16									0.12					693
LOEB	62-0231	5/26/05	20050417		7.20	2.5	N						y	1.1	0.009				130	67.2	204	162	
LOEB	62-0231	5/26/05	20050418		7.88	2.5	N	0.19	5.27									0.19					785
LOEB	62-0231	5/26/05	20050419		8.03	2.5	N	0.18	5.24									0.18					789
LOEB	62-0231	6/14/05	20050757	Y	0.00	2.5	Y	9.29	23.54	4.2	2.783	-0.038		0.022	0.009	1.4	1	9.29	1.5				265
LOEB	62-0231	6/14/05	20050758		1.00	2.5	Y	9.15	23.54									9.15					265
LOEB	62-0231	6/14/05	20050759		1.50	2.5	Y				2.919	0.000		0.029	0.009	1.7	1.45		1.5	42	68	66	
LOEB	62-0231	6/14/05	20050760		2.00	2.5	Y	8.22	22.52									8.22					302
LOEB	62-0231	6/14/05	20050761		3.00	2.5	N	10.38	17.57									10.38					374
LOEB	62-0231	6/14/05	20050762		4.01	2.5	N	2.46	12.18					0.06	0.009			2.46	2.5	47.2	128	122	445
LOEB	62-0231	6/14/05	20050763		5.00	2.5	N	0.71	8.19									0.71					523
LOEB	62-0231	6/14/05	20050764		6.01	2.5	N	0.42	5.83									0.42					674
LOEB	62-0231	6/14/05	20050765		7.00	2.5	N	0.34	5.36									0.34					785
LOEB	62-0231	6/14/05	20050766		7.20	2.5	N						y	1.09	0.01				150	63	220	280	
LOEB	62-0231	6/14/05	20050767		8.00	2.5	N	0.99	5.36									0.99					840
LOEB	62-0231	6/14/05	20050768		8.09	2.5	N	0.29	5.48									0.29					872
LOEB	62-0231	7/7/05	20051126	Y	0.00	3.5	Y	6.98	23.83	3.8	1.930	0.203		0.023	0.017	1	1	6.98	1.5				285
LOEB	62-0231	7/7/05	20051127		1.00	3.5	Y	6.6	23.41									6.6					285
LOEB	62-0231	7/7/05	20051128		2.01	3.5	Y	3.45	22.95		3.480	0.528		0.035	0.009	1.5	1.2	3.45	1.5	41	70	70	289
LOEB	62-0231	7/7/05	20051129		3.00	3.5	Y	2.35	21.11									2.35					351
LOEB	62-0231	7/7/05	20051130		4.01	3.5	N	0.38	15.84									0.38					437
LOEB	62-0231	7/7/05	20051131		4.50	3.5	N							0.069	0.009				4	48	130	132	
LOEB	62-0231	7/7/05	20051132		5.00	3.5	N	0.2	10.62									0.2					520
LOEB	62-0231	7/7/05	20051133		6.00	3.5	N	0.14	6.87									0.14					678
LOEB	62-0231	7/7/05	20051134		7.01	3.5	N	0.11	5.8									0.11					805
LOEB	62-0231	7/7/05	20051135		7.70	3.5	N						y	1.42	0.009				160	58	220	180	
LOEB	62-0231	7/7/05	20051136		8.01	3.5	N	0.1	5.5									0.1					887
LOEB	62-0231	7/7/05	20051137		8.40	3.5	N	0.07	5.57									0.07					925
LOEB	62-0231	7/7/05	20051138		8.60	3.5	N	0.07	5.54									0.07					991
LOEB	62-0231	8/1/05	20051471	Y	0.00	3.5	Y	9.81	25.92	3.7	6.928	0.346		0.019	0.01	2.6	2	9.81	1.5				301
LOEB	62-0231	8/1/05	20051472		1.01	3.5	Y	8.22	25.74									8.22					300
LOEB	62-0231	8/1/05	20051473		2.01	3.5	Y	2.79	24.75		7.869	0.274		0.026	0.017	2.8	2.4	2.79	1.5	46	82	82	310
LOEB	62-0231	8/1/05	20051474		3.01	3.5	Y	0.78	23.02									0.78					351
LOEB	62-0231	8/1/05	20051475		4.01	3.5	N	0.59	17.05					0.024	0.021			0.59	2	49	122	130	440
LOEB	62-0231	8/1/05	20051476		5.01	3.5	N	0.55	11.62									0.55					518
LOEB	62-0231	8/1/05	20051477		6.00	3.5	N	0.2	7.89									0.2					678
LOEB	62-0231	8/1/05	20051478		7.02	3.5	N	0.15	6.52									0.15					787

Loeb Lake 2005 Water Quality Data

LAKENAME	DNRID	Date	YRIDNO	Surface	Z-M	STRAT-M	EPIL-Y,N	DO-MG/L	T-DEGC	SEC-M	CCHLA-MG/M3	P	Bottom	TP-MG/L	SRP-MG/L	TPM-MG/L	OPM-MG/L	PH-SU	TURB-NTU	CL-MG/L	TALK-MG/L	THARD-MG/L	SPCON-UMHOS
LOEB	62-0231	8/1/05	20051479		7.70	3.5	N						y	0.856	0.016				200	67	230	240	
LOEB	62-0231	8/1/05	20051480		8.00	3.5	N	0.11	5.79									0.11					937
LOEB	62-0231	8/1/05	20051481		8.22	3.5	N	0.09	5.83									0.09					594
LOEB	62-0231	8/1/05	20051482		8.54	3.5	N	0.1	5.97									0.1					783
LOEB	62-0231	8/16/05	20051816	Y	0.00	3.5	Y	6.05	23.49	3.3	3.764	0.957		0.015	0.009	2.7	2.3	6.05	1.5				332
LOEB	62-0231	8/16/05	20051817		1.02	3.5	Y	6.24	23.38									6.24					332
LOEB	62-0231	8/16/05	20051818		2.00	3.5	Y	5.01	23.31		6.116	1.349		0.031	0.009	3.5	2.9	5.01	1.5	41	94	88	334
LOEB	62-0231	8/16/05	20051819		3.01	3.5	Y	2.24	22.51									2.24					361
LOEB	62-0231	8/16/05	20051820		4.02	3.5	N	0.32	17.84									0.32					469
LOEB	62-0231	8/16/05	20051821		4.50	3.5	N							0.092	0.009				6	48	140	138	
LOEB	62-0231	8/16/05	20051822		5.01	3.5	N	0.24	11.75									0.24					580
LOEB	62-0231	8/16/05	20051823		6.01	3.5	N	0.2	8.44									0.2					739
LOEB	62-0231	8/16/05	20051824		7.01	3.5	N	0.16	6.61									0.16					863
LOEB	62-0231	8/16/05	20051825		7.40	3.5	N						y	0.915	0.009				200	66	250	200	
LOEB	62-0231	8/16/05	20051826		8.03	3.5	N	0.13	5.96									0.13					1026
LOEB	62-0231	8/16/05	20051827		8.32	3.5	N	0.11	6.41									0.11					1063
LOEB	62-0231	9/30/05	20052281.1	Y	0.00	4.5	Y	-0.69	16.89	4.0	3.753	0.528		0.022	0.009	1.6	1.266667	-0.69	3				345
LOEB	62-0231	9/30/05	20052282.1		1.01	4.5	Y	4.7	16.83									4.7					345
LOEB	62-0231	9/30/05	20052283.1		2.00	4.5	Y	5.01	16.73		4.646	0.479		0.02	0.009	2.266667	1.533333	5.01	1.5	38	102	100	344
LOEB	62-0231	9/30/05	20052284.1		3.01	4.5	Y	4.52	16.6									4.52					350
LOEB	62-0231	9/30/05	20052285.1		4.01	4.5	Y	3.87	16.33									3.87					354
LOEB	62-0231	9/30/05	20052286.1		5.01	4.5	N	1.65	14.39									1.65					561
LOEB	62-0231	9/30/05	20052287.1		5.50	4.5	N							0.03	0.009				3	40	112	110	
LOEB	62-0231	9/30/05	20052288.1		6.04	4.5	N	0.27	10.81									0.27					700
LOEB	62-0231	9/30/05	20052289.1		7.00	4.5	N	0.15	7.92									0.15					856
LOEB	62-0231	9/30/05	20052290.1		7.50	4.5	N	0.11	7.5									0.11					947
LOEB	62-0231	9/30/05	20051364.26		7.70	4.5	N	0.06	7.34									0.06					964

Loeb Lake 2006 Water Quality Data

LAKENAME	DNRID	Date	Surface	Z-M	DO-MG/L	T-DEGC	SEC-M	CCHLA-MG/M3	Bottom	TP-MG/L	SRP-MG/L	TPM-MG/L	OPM-MG/L	PH-SU	TURB-NTU	CL-MG/L	TALK-MG/L	THARD-MG/L	SPCON-UMHOS	NO3N-MG/L	NH3N-MG/L	TKN-MG/L
LOEB	62-0231	5/3/06	Y	0.28	10.29	15.59	3.7	3.3		0.027	0.014			7.60		39			342	0.009	0.093	1
LOEB	62-0231	5/3/06		1.03	10.24	15.57								7.64					341			
LOEB	62-0231	5/3/06		2.00	9.43	14.31		4.6		0.031	0.009			7.65					345	0.009	0.066	1.11
LOEB	62-0231	5/3/06		2.98	5.26	12.16								7.42					394			
LOEB	62-0231	5/3/06		3.99	1.54	7.45				0.106	0.009			7.17	4.6	49			455			
LOEB	62-0231	5/3/06		5.00	0.79	5.25								7.01					508			
LOEB	62-0231	5/3/06		6.01	0.38	5.09								6.91					542			
LOEB	62-0231	5/3/06		7.01	0.19	5.12								6.80					601			
LOEB	62-0231	5/3/06		7.30					y	0.5	0.009				92	56						
LOEB	62-0231	5/3/06		8.00	0.15	5.23								6.69					710			
LOEB	62-0231	5/3/06		8.20	0.20	5.28								6.61					788			
LOEB	62-0231	5/24/06	y	0.16	11.83	20.04	4.0	1.1		0.022	0.009			7.70	1	38			312	0.009	0.066	0.947
LOEB	62-0231	5/24/06		1.00	13.30	19.80								8.41					313			
LOEB	62-0231	5/24/06		2.00	13.21	17.24		2.0		0.013	0.009			8.42	1				327	0.009	0.042	0.88
LOEB	62-0231	5/24/06		3.01	11.62	14.35								8.15					382			
LOEB	62-0231	5/24/06		4.01	9.45	10.69				0.045	0.009			7.86	1.6	45			455			
LOEB	62-0231	5/24/06		5.00	2.00	6.52								7.44					499			
LOEB	62-0231	5/24/06		6.00	0.35	5.28								7.13					575			
LOEB	62-0231	5/24/06		6.50					y	0.259	0.009				60	49						
LOEB	62-0231	5/24/06		7.01	0.23	5.26								6.97					666			
LOEB	62-0231	5/24/06		7.10	0.16	5.35								6.86					730			
LOEB	62-0231	6/14/06	y	0.21	11.12	22.31	4.44			0.041	0.035			8.62	1.4	46			287	0.009	0.038	1.05
LOEB	62-0231	6/14/06		1.00	11.64	21.69								8.76					284			
LOEB	62-0231	6/14/06		2.02	7.67	20.65				0.033	0.01			8.45	1.1				293	0.009	0.047	0.856
LOEB	62-0231	6/14/06		3.01	8.47	18.94								8.14					358			
LOEB	62-0231	6/14/06		3.50						0.028	0.009				1.4	46						
LOEB	62-0231	6/14/06		4.01	0.53	13.78								7.57					458			
LOEB	62-0231	6/14/06		5.01	0.19	8.28								7.31					496			
LOEB	62-0231	6/14/06		5.60					y	0.178	0.011				62	65						
LOEB	62-0231	6/14/06		6.01	0.13	5.79								7.05					606			
LOEB	62-0231	6/14/06		6.20	0.13	5.76								7.01					616			
LOEB	62-0231	7/6/06	y	0.00	8.40	24.90	4.0	2.1		0.022	0.012				1.4	51			298	0.009	0.095	1.18
LOEB	62-0231	7/6/06		1.00	8.30	24.60																
LOEB	62-0231	7/6/06		2.00	7.30	24.20		9.3		0.037	0.015				1.8				294	0.009	0.119	0.771
LOEB	62-0231	7/6/06		3.00	5.10	20.90																
LOEB	62-0231	7/6/06		3.50						0.044	0.02				2.6				417			
LOEB	62-0231	7/6/06		4.00	1.60	14.70																
LOEB	62-0231	7/6/06		5.00	1.20	10.00																
LOEB	62-0231	7/6/06		6.00	1.00	6.60																
LOEB	62-0231	7/6/06		6.50					y	0.27	0.019				110	55			600			
LOEB	62-0231	7/6/06		7.00	1.00	5.90																
LOEB	62-0231	7/6/06		8.00																		
LOEB	62-0231	7/31/06	y	0.17	5.82	29.42	2.8	6.6		0.027	0.009			7.76	1.4	51			310	0.009	0.121	1.46
LOEB	62-0231	7/31/06		1.01	5.89	29.38								7.92					310			
LOEB	62-0231	7/31/06		1.50				7.2		0.034	0.015				1.4					0.009	0.066	1.23
LOEB	62-0231	7/31/06		2.04	2.15	26.82								7.8					328			
LOEB	62-0231	7/31/06		3.03	0.35	22.53								7.58					381			
LOEB	62-0231	7/31/06		3.50						0.037	0.01				2.5							
LOEB	62-0231	7/31/06		4.04	0.19	16.16								7.31					449			
LOEB	62-0231	7/31/06		5.01	0.14	10.66								6.89					557			
LOEB	62-0231	7/31/06		6.00	0.13	7.82								6.76					637			
LOEB	62-0231	7/31/06		7.00	0.13	6.58								6.63					709			
LOEB	62-0231	7/31/06		7.50					y	1.22	0.012				160	61						

Loeb Lake 2006 Water Quality Data

LAKENAME	DNRID	Date	Surface	Z-M	DO-MG/L	T-DEGC	SEC-M	CCHLA-MG/M3	Bottom	TP-MG/L	SRP-MG/L	TPM-MG/L	OPM-MG/L	PH-SU	TURB-NTU	CL-MG/L	TALK-MG/L	THARD-MG/L	SPCON-UMHOS	NO3N-MG/L	NH3N-MG/L	TKN-MG/L
LOEB	62-0231	7/31/06		8.01	0.13	5.91								6.43					954			
LOEB	62-0231	7/31/06		8.10	0.12	6.16								6.33					991			
LOEB	62-0231	8/21/06	y	0.26	7.35	24.38	3.6	3.6		0.029	0.009			7.95	1	40			325	0.009	0.061	0.823
LOEB	62-0231	8/21/06		1.02	7.17	24.26								7.98					325			
LOEB	62-0231	8/21/06		2.00	1.72	23.71		4.1		0.049	0.01			7.74	1.2	40			332	0.009	0.084	1.43
LOEB	62-0231	8/21/06		3.01	0.74	23.21								7.62					340			
LOEB	62-0231	8/21/06		4.00	0.34	17.92								7.25					445			
LOEB	62-0231	8/21/06		4.50					y	0.143					48	51						
LOEB	62-0231	8/21/06		5.02	0.21	12.05								6.86					571			
LOEB	62-0231	8/21/06		6.00	0.17	9.01								6.75					633			
LOEB	62-0231	8/21/06		7.00	0.16	7.53								6.66	110	61			709			
LOEB	62-0231	8/21/06		7.70	0.10	6.95								6.59					802			
LOEB	62-0231	9/7/06	y	0.28	8.56	22.41	3.8	2.2		0.015	0.009			8.09	1.8	48			326	0.009	0.1	1.01
LOEB	62-0231	9/7/06		1.00	8.20	22.33								8.14					325			
LOEB	62-0231	9/7/06		2.02	4.75	22.00		3.6		0.028	0.009			7.77	2.5				331	0.009	0.117	1.18
LOEB	62-0231	9/7/06		3.00	0.95	21.36								7.37					338			
LOEB	62-0231	9/7/06		4.03	0.53	18.85				0.085				6.97	4				420			
LOEB	62-0231	9/7/06		5.00	0.52	12.57								6.68					586			
LOEB	62-0231	9/7/06		6.02	0.51	9.62			y	0.059				6.57	81	57			639			
LOEB	62-0231	9/7/06		7.02	0.51	7.91								6.46					704			
LOEB	62-0231	9/7/06		7.50	0.55	7.55								6.26					823			
LOEB	62-0231	9/28/06	y	0.22	7.05	14.88	3.5	8.9		0.029	0.009			7.66	1.7	42			369	0.009	0.532	1.2
LOEB	62-0231	9/28/06		1.02	6.58	14.88								7.63					369			
LOEB	62-0231	9/28/06		2.00	6.18	14.86		8.4		0.034	0.009			7.6	2				369	0.009	0.461	1.16
LOEB	62-0231	9/28/06		3.03	4.99	14.72								7.56					372			
LOEB	62-0231	9/28/06		4.00	3.08	14.55								7.48					373			
LOEB	62-0231	9/28/06		5.03	0.96	13.24								6.99					517			
LOEB	62-0231	9/28/06		5.50						0.144	0.055				1152	50						
LOEB	62-0231	9/28/06		6.00	0.49	10.07								6.78					677			
LOEB	62-0231	9/28/06		6.70					y	0.113	0.064				1650	50						
LOEB	62-0231	9/28/06		7.00	0.45	8.21								6.73					742			
LOEB	62-0231	9/28/06		7.70	0.45	7.50								6.55					883			

Loeb Lake 2007 Water Quality Data

LAKENAME	DNRID	Date	YRIDNO	Z-M	STRAT-M	EPIL-Y,N	DO-MG/L	T-DEGC	SEC-M	CCHLA-MG/M3	P	Bottom	TP-MG/L	SRP-MG/L	TDP-MG/L	PH-SU	TURB-NTU	CL-MG/L	TALK-MG/L	THARD-MG/L	SPCON-UMHOS	NO3N-MG/L	NH3N-MG/L	TKN-MG/L
LOEB	62-0231	5/4/07	20070092	0.0	1.5	Y	9.24	17.31	3	3.1	1		0.022	0.009		7.93	1.5	48			408	0.009	0.017	0.638
LOEB	62-0231	5/4/07	20070093	1.0	1.5	Y	9.99	17.33		2.7	0.8		0.02	0.009		7.85	1.5				408	0.009	0.037	1.1
LOEB	62-0231	5/4/07	20070094	2.0	1.5	N	14.64	15.11								7.71					402			
LOEB	62-0231	5/4/07	20070095	2.5	1.5	N							0.029	0.009			1.9	44						
LOEB	62-0231	5/4/07	20070096	3.0	1.5	N	15.84	8.34								7.53					400			
LOEB	62-0231	5/4/07	20070097	4.0	1.5	N	1.1	6.01								7.35					410			
LOEB	62-0231	5/4/07	20070098	5.0	1.5	N	0.37	5.26								7.18					465			
LOEB	62-0231	5/4/07	20070099	6.0	1.5	N	0.27	5.04				Y	0.077	0.009		7.04	51	42			610			
LOEB	62-0231	5/4/07	20070100	6.7	1.5	N	0.24	5.02								6.96					689			
LOEB	62-0231	6/4/07	20070395	0.0	2.5	Y	9.84	21.25	3.9	1.6	0.2		0.019	0.009		8.84	1.5	50			361	0.009	0.014	0.868
LOEB	62-0231	6/4/07	20070396	1.0	2.5	Y	9.76	21.06								8.84					360			
LOEB	62-0231	6/4/07	20070397	2.0	2.5	Y	9.36	20.77		2.9	0.6		0.026	0.009		8.63	1.6				370	0.009	0.034	0.531
LOEB	62-0231	6/4/07	20070398	3.0	2.5	N	9.55	16.46								8.09					413			
LOEB	62-0231	6/4/07	20070399	4.0	2.5	N	2.54	11.24					0.048	0.009		7.61	1.7				423			
LOEB	62-0231	6/4/07	20070400	5.0	2.5	N	0.56	7.79								7.46					462			
LOEB	62-0231	6/4/07	20070401	6.0	2.5	N	0.26	5.62				y	0.162	0.009		7.53	74	60			633			
LOEB	62-0231	6/4/07	20070402	7.0	2.5	N	0.21	5.22								7.41					752			
LOEB	62-0231	6/4/07	20070403	7.8	2.5	N						y	1.31	0.009			360							
LOEB	62-0231	6/4/07	20070404	8.0	2.5	N	0.24	5.23								7.35					898			
LOEB	62-0231	6/4/07	20070405	9.0	2.5	N	0.22	5.32								7.26					1032			
LOEB	62-0231	6/21/07	20070743	0.0	2.5	Y	9.7	24.24	3.9	1.2	0.1		0.012	0.009		8.92	1.2	50			321	0.009	0.023	0.545
LOEB	62-0231	6/21/07	20070744	1.0	2.5	Y	9.75	24.24								9.03					320			
LOEB	62-0231	6/21/07	20070745	2.0	2.5	Y	9.79	23.73		1.9	0.4		0.009	0.009		9.01	1.4	50			320	0.009	0.03	0.653
LOEB	62-0231	6/21/07	20070746	3.0	2.5	N	12.09	20.28								8.53					401			
LOEB	62-0231	6/21/07	20070747	3.5	2.5	N							0.024	0.009			2.3	45						
LOEB	62-0231	6/21/07	20070748	4.0	2.5	N	9.25	14.03								7.94					427			
LOEB	62-0231	6/21/07	20070749	5.0	2.5	N	4.53	9.37								7.49					474			
LOEB	62-0231	6/21/07	20070750	6.0	2.5	N	1.29	6.37								7.04					639			
LOEB	62-0231	6/21/07	20070751	6.4	2.5	N						y	0.445	0.009			180	65						
LOEB	62-0231	6/21/07	20070752	7.0	2.5	N	0.48	5.69								6.89					777			
LOEB	62-0231	6/21/07	20070753	7.2	2.5	N	0.34	6.09								6.83					792			
LOEB	62-0231	7/10/07	20071054	0.0	2.5	Y	8.13	26.75	4.0	1.9	0.5		0.018	0.009		8.65	0.9	50			336	0.009	0.052	0.811
LOEB	62-0231	7/10/07	20071055	1.0	2.5	Y	7.85	26.77								8.84					336			
LOEB	62-0231	7/10/07	20071056	2.0	2.5	Y	7.74	26.76		1.8	0.1		0.016	0.009		8.85	1.3	50			336	0.013	0.029	1.36
LOEB	62-0231	7/10/07	20071057	3.0	2.5	N	5.69	21.85								7.84					427			
LOEB	62-0231	7/10/07	20071058	3.5	2.5	N							0.03	0.009			2.2	45						
LOEB	62-0231	7/10/07	20071059	4.0	2.5	N	2.8	15.41								7.44					460			
LOEB	62-0231	7/10/07	20071060	5.0	2.5	N	0.36	9.24								6.73					531			
LOEB	62-0231	7/10/07	20071061	6.0	2.5	N	0.29	6.62								6.68					702			
LOEB	62-0231	7/10/07	20071062	6.2	2.5	N						y	0.531	0.009			270	65						
LOEB	62-0231	7/10/07	20071063	7.0	2.5	N	0.27	5.99								6.65					846			
LOEB	62-0231	7/10/07	20071064	7.1	2.5	N	0.27	5.94								6.68					873			
LOEB	62-0231	7/30/07	20071388	0.0	2.5	Y	8.84	28.05	3.4	3.3	0.2		0.013	0.009		8.5	1.4	55			349	0.009	0.009	0.909
LOEB	62-0231	7/30/07	20071389	1.0	2.5	Y	8.9	28.02								8.57					349			
LOEB	62-0231	7/30/07	20071390	2.0	2.5	Y	7.91	27.64		4.5	0.4		0.019	0.009		8.44	1.5				347	0.009	0.009	1.12
LOEB	62-0231	7/30/07	20071391	3.0	2.5	N	3.83	25.04								7.62					385			
LOEB	62-0231	7/30/07	20071392	4.0	2.5	N	2.51	19.63					0.031	0.009		7.2	2	55			444			
LOEB	62-0231	7/30/07	20071393	5.0	2.5	N	0.9	12.5								6.57					501			
LOEB	62-0231	7/30/07	20071394	6.0	2.5	N	0.33	7.84								6.12					694			
LOEB	62-0231	7/30/07	20071395	6.7	2.5	N						y	0.245	0.009			300	75						
LOEB	62-0231	7/30/07	20071396	7.0	2.5	N	0.21	6.58								6.17					792			
LOEB	62-0231	7/30/07	20071397	7.7	2.5	N	0.2	6.35								6.18					883			
LOEB	62-0231	8/15/07	20071719	0.0	2.5	Y	6.62	25.88	2.5	7.8	0.5		0.016	0.009		8.26	1.7	50			348	0.014	0.062	0.987
LOEB	62-0231	8/15/07	20071720	1.0	2.5	Y	6.39	25.88								8.32					348			
LOEB	62-0231	8/15/07	20071721	1.5	2.5	Y				8.2	0.5		0.023	0.009			1.9	50				0.009	0.022	0.868
LOEB	62-0231	8/15/07	20071722	2.0	2.5	Y	5.76	25.85								8.24					351			
LOEB	62-0231	8/15/07	20071723	3.0	2.5	N	1.25	24.2								7.7					373			
LOEB	62-0231	8/15/07	20071724	3.5	2.5	N							0.043	0.009			4.4	50						
LOEB	62-0231	8/15/07	20071725	4.0	2.5	N	0.5	17.82								7.18					435			
LOEB	62-0231	8/15/07	20071726	5.0	2.5	N	0.36	11.42								6.74					561			
LOEB	62-0231	8/15/07	20071727	6.0	2.5	N	0.31	8.07								6.64					694			
LOEB	62-0231	8/15/07	20071728	6.7	2.5	N						y	0.2	0.009			255	60						

Loeb Lake 2007 Water Quality Data

LAKENAME	DNRID	Date	YRIDNO	Z-M	STRAT-M	EPIL-Y,N	DO-MG/L	T-DEGC	SEC-M	CCHLA-MG/M3	P	Bottom	TP-MG/L	SRP-MG/L	TDP-MG/L	PH-SU	TURB-NTU	CL-MG/L	TALK-MG/L	THARD-MG/L	SPCON-UMHOS	NO3N-MG/L	NH3N-MG/L	TKN-MG/L
LOEB	62-0231	8/15/07	20071729	7.0	2.5	N	0.29	7.01								6.63					764			
LOEB	62-0231	8/15/07	20071730	7.3	2.5	N	0.26	6.66								6.62					815			
LOEB	62-0231	9/5/07	20072033	0.0	1.5	Y	10.58	25.7	2.8	7.5	-0.7		0.016	0.009		8.48	2.9	55			337	0.009	0.009	1.13
LOEB	62-0231	9/5/07	20072034	1.0	1.5	Y	10.19	25.26		5.6	-0.5		0.018	0.009		8.45	2.6				335	0.009	0.009	0.555
LOEB	62-0231	9/5/07	20072035	2.0	1.5	N	6.68	23.65								7.84					357			
LOEB	62-0231	9/5/07	20072036	2.5	1.5	N							0.016	0.009			1.7	50						
LOEB	62-0231	9/5/07	20072037	3.0	1.5	N	2.15	21.92								7.37					370			
LOEB	62-0231	9/5/07	20072038	4.0	1.5	N	0.7	18.55								6.96					414			
LOEB	62-0231	9/5/07	20072039	5.0	1.5	N	0.41	13.18								6.4					539			
LOEB	62-0231	9/5/07	20072040	5.5	1.5	N						y	0.149	0.009			105	80						
LOEB	62-0231	9/5/07	20072041	6.0	1.5	N	0.32	9.21								6.26					679			
LOEB	62-0231	9/5/07	20072042	7.0	1.5	N	0.26	7.26								6.25					782			
LOEB	62-0231	9/5/07	20072043	7.1	1.5	N	0.24	7.28								6.25					798			
LOEB	62-0231	9/26/07	20072363	0.0	4.5	Y	9.06	18.53	2.5	9.5	-0.2		0.023	0.009		7.77	2.4	45			342	0.009	0.009	1.24
LOEB	62-0231	9/26/07	20072364	1.0	4.5	Y	8.55	18.47								7.74					344			
LOEB	62-0231	9/26/07	20072365	2.0	4.5	Y	6.54	18.21		9.9	0		0.028	0.009		7.49	2.2				349	0.012	0.009	1.22
LOEB	62-0231	9/26/07	20072366	3.0	4.5	Y	4.08	17.6								7.27					374			
LOEB	62-0231	9/26/07	20072367	4.0	4.5	Y	0.52	16.65								7.04					382			
LOEB	62-0231	9/26/07	20072368	5.0	4.5	N	0.32	14.19					0.055	0.009		6.59	8.6	51			515			
LOEB	62-0231	9/26/07	20072369	5.8	4.5	N						y	0.214	0.009			160	51						
LOEB	62-0231	9/26/07	20072370	6.0	4.5	N	0.31	10.27								6.37					718			
LOEB	62-0231	9/26/07	20072371	7.0	4.5	N	0.29	8.15								6.38					795			
LOEB	62-0231	9/26/07	20072372	7.1	4.5	N	0.26	8.33								6.34					819			

Appendix D

Loeb Lake Internal Load and Response Modeling Data

2004 Loading Summary for Loeb Lake

	Water Budgets				Phosphorus Loading		
Inflow from Drainage Areas							
		Drainage Area	Runoff Depth	Discharge	Phosphorus Concentration	Loading Calibration Factor (CF)[1]	Load
	Name	[acre]	[in/yr]	[ac-ft/yr]	[ug/L]	[--]	[lb/yr]
1	Watershed	38	9.7	31	202	1.0	17
2							
3							
4							
5							
	Summation	*38*	*10*	*31*	*202.4*		*16.9*
Failing Septic Systems							
	Name	Area [ac]	# of Systems	Failure [%]	Load / System	[lb/ac]	[lb/yr]
1	Watershed	38	0	0%	4.2	0.0	0.0
2							
3							
4							
5							
	Summation	*38*	*0*	*0%*		*0.0*	*0.0*
Inflow from Upstream Lakes							
				Discharge	Estimated P Concentration	Calibration Factor	Load
	Name			[ac-ft/yr]	[ug/L]	[--]	[lb/yr]
1					-	1.0	
2					-	1.0	
3					-	1.0	
	Summation			*0*	-		*0*
Atmosphere							
	Lake Area	Precipitation	Evaporation	Net Inflow	Aerial Loading Rate	Calibration Factor	Load
	[acre]	[in/yr]	[in/yr]	[ac-ft/yr]	[lb/ac-yr]	[--]	[lb/yr]
	10	32.8	32.8	0.00	0.24	1.0	2.3
			Dry-year total P deposition =		0.222		
			Average-year total P deposition =		0.239		
			Wet-year total P deposition =		0.259		
			(Barr Engineering 2004)				
Groundwater							
	Lake Area	Groundwater Flux		Net Inflow	Phosphorus Concentration	Calibration Factor	Load
	[acre]	[ft/yr]		[ac-ft/yr]	[ug/L]	[--]	[lb/yr]
	10	0.0		0.00	0	1.0	0
Internal							
	Lake Area	Anoxic Factor			Release Rate	Calibration Factor	Load
	[acre]	[days]			[mg/m^2-day]	[--]	[lb/yr]
	10	52.0			0.50	1.0	2
			Net Discharge [ac-ft/yr] =	**31**		**Net Load [lb/yr] =**	**21**

NOTES

[1] Loading calibration factor used to account for special circumstances such as wetland systems, fertilizer use, or animal waste, among others, that might apply to specific loading sources.

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Predicted & Observed Values Ranked Against CE Model Development Dataset

Segment: **1** **Segname 1**

	Predicted Values--->			Observed Values--->		
Variable	**Mean**	**CV**	**Rank**	**Mean**	**CV**	**Rank**
TOTAL P MG/M3	28.6	0.21	28.4%	35.4		36.8%
TOTAL N MG/M3	673.0		26.7%	673.0		26.7%
C.NUTRIENT MG/M3	23.9	0.15	30.8%	27.5		37.2%
CHL-A MG/M3	14.1	0.32	70.2%	10.0		53.3%
SECCHI M	3.4	0.25	93.6%	3.0		91.1%
ORGANIC N MG/M3	484.7	0.24	51.8%			
TP-ORTHO-P MG/M3	22.9	0.38	38.8%	35.0		56.4%
HOD-V MG/M3-DAY	225.4	0.22	92.5%			
MOD-V MG/M3-DAY	152.7	0.31	87.3%			
ANTILOG PC-1	141.6	0.42	33.8%	95.1		23.5%
ANTILOG PC-2	20.2	0.11	98.5%	15.1		94.7%
(N - 150) / P	18.3	0.21	54.2%	14.8		41.8%
INORGANIC N / P	33.0	1.24	54.2%			
TURBIDITY 1/M	0.1		1.1%	0.1		1.1%
ZMIX * TURBIDITY	0.2		0.0%	0.2		0.0%
ZMIX / SECCHI	0.8	0.25	0.1%	0.9		0.2%
CHL-A * SECCHI	48.4	0.13	98.6%	30.0		93.6%
CHL-A / TOTAL P	0.5	0.26	92.7%	0.3		71.7%
FREQ(CHL-a>10) %	59.7	0.33	70.2%	37.8		53.3%
FREQ(CHL-a>20) %	19.1	0.73	70.2%	7.7		53.3%
FREQ(CHL-a>30) %	6.3	1.01	70.2%	1.9		53.3%
FREQ(CHL-a>40) %	2.3	1.23	70.2%	0.5		53.3%
FREQ(CHL-a>50) %	0.9	1.40	70.2%	0.2		53.3%
FREQ(CHL-a>60) %	0.4	1.55	70.2%	0.1		53.3%
CARLSON TSI-P	52.5	0.06	28.4%	55.6		36.8%
CARLSON TSI-CHLA	56.6	0.05	70.2%	53.2		53.3%
CARLSON TSI-SEC	42.2	0.08	6.4%	44.2		8.9%

2005 Loading Summary for Loeb Lake

Water Budgets				Phosphorus Loading		

Inflow from Drainage Areas

	Name	Drainage Area [acre]	Runoff Depth [in/yr]	Discharge [ac-ft/yr]	Phosphorus Concentration [ug/L]	Loading Calibration Factor (CF)[1] [--]	Load [lb/yr]
1	Watershed	38	10.3	33	203	1.0	18
2							
3							
4							
5							
	Summation	*38*	*10*	*33*	*202.5*		*17.9*

Failing Septic Systems

	Name	Area [ac]	# of Systems	Failure [%]	Load / System	[lb/ac]	[lb/yr]
1	Watershed	38	0	0%	4.2	0.0	0.0
2							
3							
4							
5							
	Summation	*38*	*0*	*0%*		*0.0*	*0.0*

Inflow from Upstream Lakes

	Name	Discharge [ac-ft/yr]	Estimated P Concentration [ug/L]	Calibration Factor [--]	Load [lb/yr]
1			-	1.0	
2			-	1.0	
3			-	1.0	
	Summation	*0*	-		*0*

Atmosphere

Lake Area [acre]	Precipitation [in/yr]	Evaporation [in/yr]	Net Inflow [ac-ft/yr]	Aerial Loading Rate [lb/ac-yr]	Calibration Factor [--]	Load [lb/yr]
10	36.7	36.7	0.00	0.24	1.0	2.3
			Dry-year total P deposition =	0.222		
			Average-year total P deposition =	0.239		
			Wet-year total P deposition =	0.259		
			(Barr Engineering 2004)			

Groundwater

Lake Area [acre]	Groundwater Flux [m/yr]		Net Inflow [ac-ft/yr]	Phosphorus Concentration [ug/L]	Calibration Factor [--]	Load [lb/yr]
10	0.0		0.00	0	1.0	0

Internal

Lake Area [acre]	Anoxic Factor [days]			Release Rate [mg/m^2-day]	Calibration Factor [--]	Load [lb/yr]
10	36.0			0.50	1.0	2
			Net Discharge [ac-ft/yr] = 33			**Net Load [lb/yr] = 22**

NOTES

[1] Loading calibration factor used to account for special circumstances such as wetland systems, fertilizer use, or animal waste, among others, that might apply to specific loading sources.

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Predicted & Observed Values Ranked Against CE Model Development Dataset

Segment: **1** **Segname 1**

	Predicted Values--->			**Observed Values--->**		
Variable	**Mean**	**CV**	**Rank**	**Mean**	**CV**	**Rank**
TOTAL P MG/M3	29.2	0.21	29.1%	20.0		16.6%
TOTAL N MG/M3	1100.0		55.8%	1100.0		55.8%
C.NUTRIENT MG/M3	27.4	0.18	37.1%	19.4		22.3%
CHL-A MG/M3	16.6	0.34	77.1%	4.0		13.4%
SECCHI M	3.0	0.28	91.3%	3.8		95.1%
ORGANIC N MG/M3	542.3	0.27	60.4%			
TP-ORTHO-P MG/M3	27.4	0.40	46.2%			
HOD-V MG/M3-DAY	244.7	0.23	94.0%			
MOD-V MG/M3-DAY	165.8	0.32	89.5%			
ANTILOG PC-1	185.3	0.48	41.6%	32.0		6.0%
ANTILOG PC-2	20.7	0.11	98.7%	9.8		78.7%
(N - 150) / P	32.5	0.21	83.0%	47.5		93.4%
INORGANIC N / P	308.8	7.79	99.1%			
TURBIDITY 1/M	0.1		1.1%	0.1		1.1%
ZMIX * TURBIDITY	0.2		0.0%	0.2		0.0%
ZMIX / SECCHI	0.9	0.28	0.2%	0.7		0.0%
CHL-A * SECCHI	50.5	0.13	98.8%	15.2		71.3%
CHL-A / TOTAL P	0.6	0.26	95.3%	0.2		51.3%
FREQ(CHL-a>10) %	69.5	0.27	77.1%	3.7		13.4%
FREQ(CHL-a>20) %	27.2	0.67	77.1%	0.2		13.4%
FREQ(CHL-a>30) %	10.4	0.96	77.1%	0.0		13.4%
FREQ(CHL-a>40) %	4.2	1.19	77.1%	0.0		13.4%
FREQ(CHL-a>50) %	1.9	1.37	77.1%	0.0		13.4%
FREQ(CHL-a>60) %	0.9	1.52	77.1%	0.0		13.4%
CARLSON TSI-P	52.8	0.06	29.1%	47.3		16.6%
CARLSON TSI-CHLA	58.2	0.06	77.1%	44.2		13.4%
CARLSON TSI-SEC	44.0	0.09	8.7%	40.8		4.9%

2006 Loading Summary for Loeb Lake

Water Budgets				Phosphorus Loading		

Inflow from Drainage Areas

	Name	Drainage Area [acre]	Runoff Depth [in/yr]	Discharge [ac-ft/yr]	Phosphorus Concentration [ug/L]	Loading Calibration Factor (CF)[1] [--]	Load [lb/yr]
1	Watershed	38	10.5	33	190	1.0	17
2							
3							
4							
5							
	Summation	*38*	*11*	*33*	*190.0*		*17.1*

Failing Septic Systems

	Name	Area [ac]	# of Systems	Failure [%]	Load / System	[lb/ac]	[lb/yr]
1	Watershed	38	0	0%	4.2	0.0	0.0
2							
3							
4							
5							
	Summation	*38*	*0*	*0%*		*0.0*	*0.0*

Inflow from Upstream Lakes

	Name	Discharge [ac-ft/yr]	Estimated P Concentration [ug/L]	Calibration Factor [--]	Load [lb/yr]
1			-	1.0	
2			-	1.0	
3			-	1.0	
	Summation	*0*	-		*0*

Atmosphere

Lake Area [acre]	Precipitation [in/yr]	Evaporation [in/yr]	Net Inflow [ac-ft/yr]	Aerial Loading Rate [lb/ac-yr]	Calibration Factor [--]	Load [lb/yr]
10	31.9	31.9	0.00	0.24	1.0	2.3
		Dry-year total P deposition =		0.222		
		Average-year total P deposition =		0.239		
		Wet-year total P deposition =		0.259		
		(Barr Engineering 2004)				

Groundwater

Lake Area [acre]	Groundwater Flux [m/yr]		Net Inflow [ac-ft/yr]	Phosphorus Concentration [ug/L]	Calibration Factor [--]	Load [lb/yr]
10	0.0		0.00	0	1.0	0

Internal

Lake Area [acre]	Anoxic Factor [days]			Release Rate [mg/m^2-day]	Calibration Factor [--]	Load [lb/yr]
10	52.0			0.50	1.0	2
		Net Discharge [ac-ft/yr] =	**33**		**Net Load [lb/yr] =**	**22**

NOTES

[1] Loading calibration factor used to account for special circumstances such as wetland systems, fertilizer use, or animal waste, among others, that might apply to specific loading sources.

File: **C:\Bathtub\Loeb 2006.btb**

Predicted & Observed Values Ranked Against CE Model Development Dataset

Segment: **1** **Segname 1**

	Predicted Values--->			Observed Values--->		
Variable	**Mean**	**CV**	**Rank**	**Mean**	**CV**	**Rank**
TOTAL P MG/M3	29.2	0.21	29.1%	20.0		16.6%
TOTAL N MG/M3	1100.0		55.8%	1100.0		55.8%
C.NUTRIENT MG/M3	27.4	0.18	37.1%	19.4		22.3%
CHL-A MG/M3	16.6	0.34	77.1%	10.0		53.3%
SECCHI M	3.0	0.28	91.3%	3.0		91.1%
ORGANIC N MG/M3	542.3	0.27	60.4%			
TP-ORTHO-P MG/M3	27.4	0.40	46.2%			
HOD-V MG/M3-DAY	244.7	0.23	94.0%			
MOD-V MG/M3-DAY	165.8	0.32	89.5%			
ANTILOG PC-1	185.3	0.48	41.6%	95.1		23.5%
ANTILOG PC-2	20.7	0.11	98.7%	15.1		94.7%
(N - 150) / P	32.5	0.21	83.0%	47.5		93.4%
INORGANIC N / P	308.8	7.79	99.1%			
TURBIDITY 1/M	0.1		1.1%	0.1		1.1%
ZMIX * TURBIDITY	0.2		0.0%	0.2		0.0%
ZMIX / SECCHI	0.9	0.28	0.2%	0.9		0.2%
CHL-A * SECCHI	50.5	0.13	98.8%	30.0		93.6%
CHL-A / TOTAL P	0.6	0.26	95.3%	0.5		93.0%
FREQ(CHL-a>10) %	69.5	0.27	77.1%	37.8		53.3%
FREQ(CHL-a>20) %	27.2	0.67	77.1%	7.7		53.3%
FREQ(CHL-a>30) %	10.4	0.96	77.1%	1.9		53.3%
FREQ(CHL-a>40) %	4.2	1.19	77.1%	0.5		53.3%
FREQ(CHL-a>50) %	1.9	1.37	77.1%	0.2		53.3%
FREQ(CHL-a>60) %	0.9	1.52	77.1%	0.1		53.3%
CARLSON TSI-P	52.8	0.06	29.1%	47.3		16.6%
CARLSON TSI-CHLA	58.2	0.06	77.1%	53.2		53.3%
CARLSON TSI-SEC	44.0	0.09	8.7%	44.2		8.9%

2007 Loading Summary for Loeb Lake

	Water Budgets				Phosphorus Loading		
Inflow from Drainage Areas							
		Drainage Area	Runoff Depth	Discharge	Phosphorus Concentration	Loading Calibration Factor (CF)[1]	Load
	Name	[acre]	[in/yr]	[ac-ft/yr]	[ug/L]	[--]	[lb/yr]
1	Watershed	38	12.4	39	189	1.0	20
2							
3							
4							
5							
	Summation	*38*	*12*	*39*	*188.6*		*20.1*
Failing Septic Systems							
	Name	Area [ac]	# of Systems	Failure [%]	Load / System	[lb/ac]	[lb/yr]
1	Watershed	38	0	0%	4.2	0.0	0.0
2							
3							
4							
5							
	Summation	*38*	*0*	*0%*		*0.0*	*0.0*
Inflow from Upstream Lakes							
				Discharge	Estimated P Concentration	Calibration Factor	Load
	Name			[ac-ft/yr]	[ug/L]	[--]	[lb/yr]
1					-	1.0	
2					-	1.0	
3					-	1.0	
	Summation			*0*	-		*0*
Atmosphere							
	Lake Area	Precipitation	Evaporation	Net Inflow	Aerial Loading Rate	Calibration Factor	Load
	[acre]	[in/yr]	[in/yr]	[ac-ft/yr]	[lb/ac-yr]	[--]	[lb/yr]
	10	36.0	36.0	0.00	0.24	1.0	2.3
			Dry-year total P deposition =		0.222		
			Average-year total P deposition =		0.239		
			Wet-year total P deposition =		0.259		
				(Barr Engineering 2004)			
Groundwater							
	Lake Area	Groundwater Flux		Net Inflow	Phosphorus Concentration	Calibration Factor	Load
	[acre]	[m/yr]		[ac-ft/yr]	[ug/L]	[--]	[lb/yr]
	10	0.0		0.00	0	1.0	0
Internal							
	Lake Area	Anoxic Factor			Release Rate	Calibration Factor	Load
	[acre]	[days]			[mg/m^2-day]	[--]	[lb/yr]
	10	34.0			0.50	1.0	1
			Net Discharge [ac-ft/yr] =	**39**		**Net Load [lb/yr] =**	**24**

NOTES

[1] Loading calibration factor used to account for special circumstances such as wetland systems, fertilizer use, or animal waste, among others, that might apply to specific loading sources.

File: **C:\Bathtub\Loeb 2007.btb**

Predicted & Observed Values Ranked Against CE Model Development Dataset

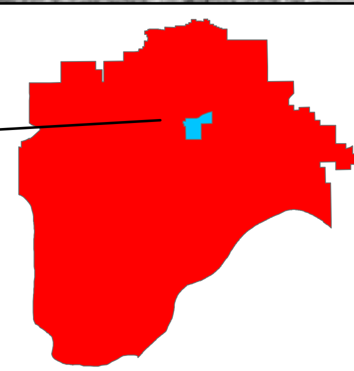
Segment: **1** **Segname 1**

	Predicted Values--->			**Observed Values--->**		
Variable	**Mean**	**CV**	**Rank**	**Mean**	**CV**	**Rank**
TOTAL P MG/M3	28.4	0.21	28.1%	17.0		12.5%
TOTAL N MG/M3	1100.0		55.8%	1100.0		55.8%
C.NUTRIENT MG/M3	26.7	0.19	35.9%	16.6		17.0%
CHL-A MG/M3	16.2	0.34	75.9%	10.0		53.3%
SECCHI M	3.1	0.27	91.8%	3.0		91.1%
ORGANIC N MG/M3	531.3	0.27	58.9%			
TP-ORTHO-P MG/M3	26.5	0.40	44.9%			
HOD-V MG/M3-DAY	241.1	0.23	93.7%			
MOD-V MG/M3-DAY	163.3	0.32	89.1%			
ANTILOG PC-1	176.5	0.48	40.1%	95.1		23.5%
ANTILOG PC-2	20.6	0.11	98.7%	15.1		94.7%
(N - 150) / P	33.4	0.21	84.0%	55.9		96.0%
INORGANIC N / P	304.6	8.04	99.0%			
TURBIDITY 1/M	0.1		1.1%	0.1		1.1%
ZMIX * TURBIDITY	0.2		0.0%	0.2		0.0%
ZMIX / SECCHI	0.9	0.28	0.2%	0.9		0.2%
CHL-A * SECCHI	50.1	0.13	98.8%	30.0		93.6%
CHL-A / TOTAL P	0.6	0.26	95.3%	0.6		95.8%
FREQ(CHL-a>10) %	67.8	0.29	75.9%	37.8		53.3%
FREQ(CHL-a>20) %	25.6	0.69	75.9%	7.7		53.3%
FREQ(CHL-a>30) %	9.5	0.99	75.9%	1.9		53.3%
FREQ(CHL-a>40) %	3.8	1.21	75.9%	0.5		53.3%
FREQ(CHL-a>50) %	1.6	1.39	75.9%	0.2		53.3%
FREQ(CHL-a>60) %	0.8	1.55	75.9%	0.1		53.3%
CARLSON TSI-P	52.4	0.06	28.1%	45.0		12.5%
CARLSON TSI-CHLA	57.9	0.06	75.9%	53.2		53.3%
CARLSON TSI-SEC	43.7	0.09	8.2%	44.2		8.9%

Appendix E

Loeb Lake Area Aerial Photos and Saint Paul Storm Sewer Map

Loeb Lake Study Area
1940 Aerial Photo



N
W E
S

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Map by RCD, 4-21-05

Capitol Region Watershed District

Loeb Lake Study Area
1953 Aerial Photo

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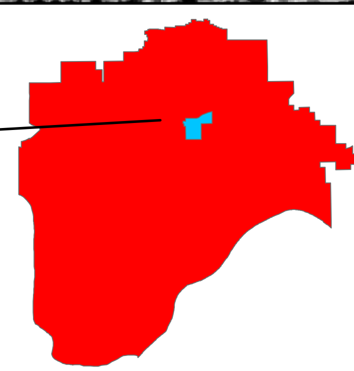

Map by RCD, 4-21-05

Capitol Region Watershed District

Loeb Lake Study Area
1974 Aerial Photo

N W E S

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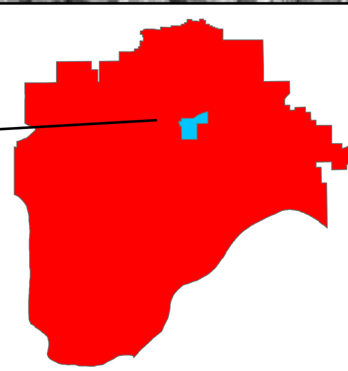

Map by RCD, 4-21-05

Capitol Region Watershed District

Loeb Lake Study Area
1985 Aerial Photo

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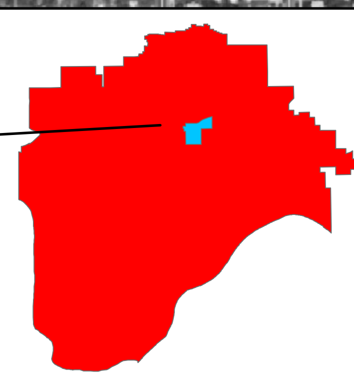
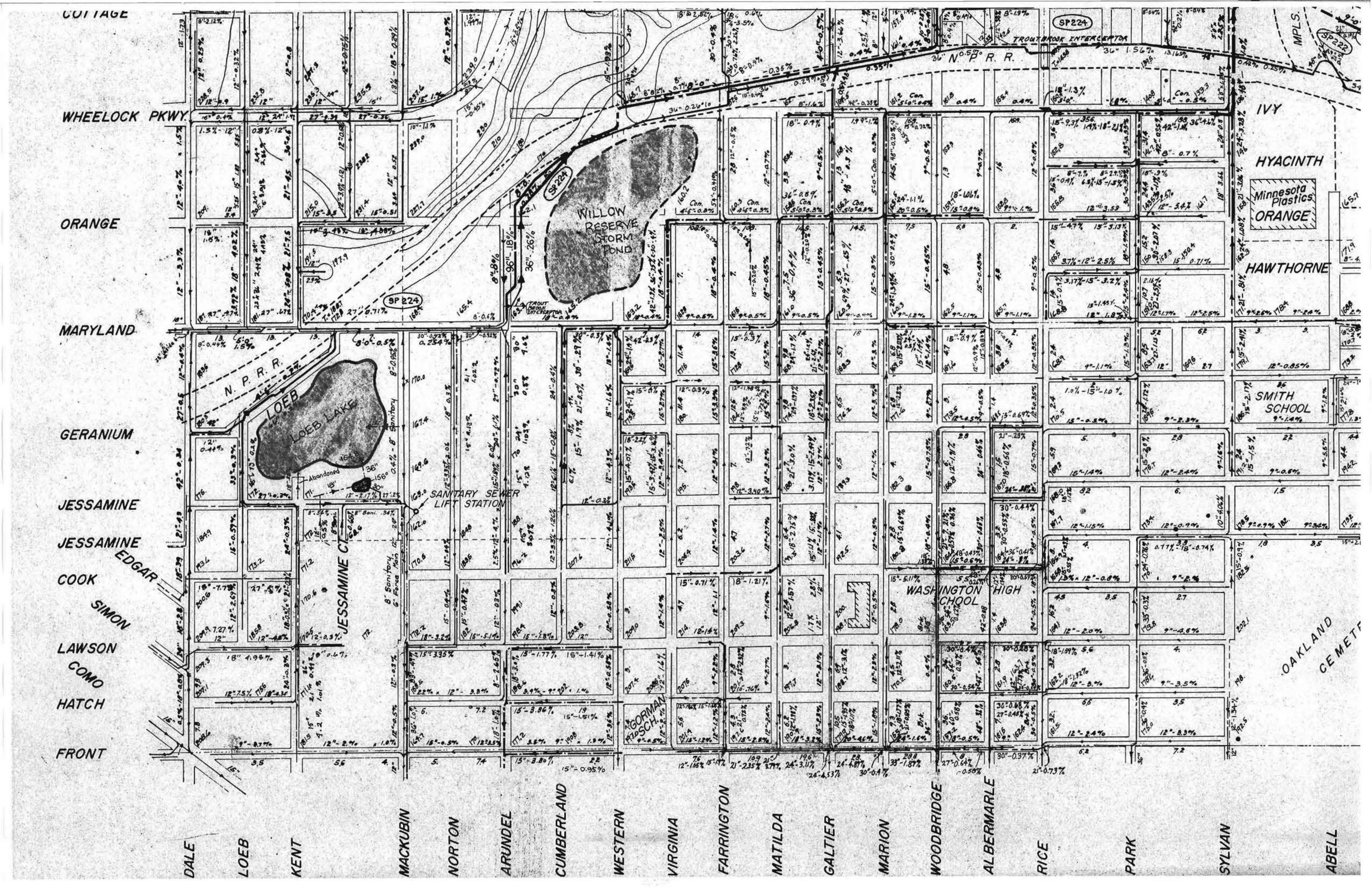
Loeb Study Area



Map by RCD, 4-21-05

Capitol Region Watershed District



COTTAGE
WHEELOCK PKWY
ORANGE
MARYLAND
GERANIUM
JESSAMINE
JESSAMINE
EDGAR
COOK
SIMON
LAWSON
COMO
HATCH
FRONT
IVY
HYACINTH
Minnesota Plastics
ORANGE
HAWTHORNE
SMITH SCHOOL
TROUTBROOK INTERCEPTOR
N. P. R. R.
SP224
SP222
MPLS.
WILLOW RESERVE STORM POND
LOEB LAKE
LOEB
Abandoned
SANITARY SEWER LIFT STATION
JESSAMINE CT
WASHINGTON HIGH SCHOOL
GORMAN SCH.
OAKLAND CEMETERY
DALE
LOEB
KENT
MACKUBIN
NORTON
ARUNDEL
CUMBERLAND
WESTERN
VIRGINIA
FARRINGTON
MATILDA
GALTIER
MARION
WOODBRIDGE
ALBERMARLE
RICE
PARK
SYLVAN
ABELL