Casey Lake, Round Lake (in Little Canada), Savage Lake, Twin Lake, and Willow Lake

Lake Status Report

Prepared for
Ramsey-Washington Metro Watershed District

April 2007

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Executive Summary

This lake status report presents the information compiled for a number of previously "unstudied" lakes in the Ramsey-Washington Metro Watershed District (District). These lakes include Casey Lake, Round Lake (Little Canada), Savage Lake, Twin Lake, and Willow Lake.

Casey Lake and Savage Lake are actually managed as District wetlands. Casey Lake and West Savage Lake are classified as District wetland management Class B while East Savage Lake is classified as wetland management Class C. Both wetlands are used for wildlife habitat and aesthetic viewing and there is some anecdotal evidence that West Savage Lake is used for paddling and canoeing as well. Otherwise, there is very limited information available for these resources.

Although classified with a District recreational-use Level 2, it appears that Level 2 uses of Round Lake are limited and that the District should consider reclassifying the lake's recreational-use to Level 3 or Level 4. The preliminary District water quality goals are comparable to the proposed MPCA shallow lake criteria for the North Central Hardwood Forest (CHF) ecoregion. However, because water quality data for Round Lake are extremely limited, more baseline water quality monitoring data will be needed to determine if the preliminary District goals are reasonable. The limited water quality data that has been collected for the lake indicates that the lake has poor water quality. Therefore, it is expected that the District management class for Round Lake will remain as "Improvement."

Twin Lake and Willow Lake have several years of water quality data. Both have good water quality and are currently meeting the proposed MPCA criteria for non-shallow (Twin) and shallow (Willow) lakes in the CHF ecoregion. Therefore, it is recommended that the District water quality goals be changed to reflect the applicable MPCA water quality criteria for each lake. Additionally, the management classes for both lakes should remain as "Prevent further degradation." Changes to the recreational-use levels of Twin Lake (Level 2) and Willow Lake (Level 3) are not recommended.

Casey Lake, Round Lake (in Little Canada) Savage Lake, Twin Lake, and Willow Lake

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1.0 Introduction

One of the primary goals of the Ramsey-Washington Metro Watershed District (District) is to maintain or improve the quality of surface waters to meet or exceed the water quality necessary to support the District's designated beneficial uses. In 1997 the District established beneficial use categories based on desired recreational activities for a waterbody; and revisited again with the 2006 update as part of the development of the *Ramsey-Washington Metro Watershed District Watershed Management Plan* (Plan) (Barr, 1997; Barr, 2006 [draft]),. The recreational-use categories are ranked from Level 1 through Level 5, with Level 1 water bodies having the highest number of recreational uses and best water quality.

In order to help achieve desired water quality goals established in Plan, many of the lakes within the District have been studied in Strategic Lake Management Plans (SLMPs). However, for many of the smaller lakes within the District, SLMPs have not yet been completed and District water quality goals have not been re-evaluated. Because of limited lake information and water quality data, the development of a complete SLMP would not be possible for many of these small water bodies. Instead, a Lake Status Report (LSR) will be developed and recommendations will be made to outline future studies for these lakes.

The purpose of this LSR is to summarize and evaluate the available information for those lakes that have not been previously studied and to determine appropriate water quality goals for each based on their current and desired recreational uses, as outlined in the Plan, and through discussion with District staff. Although none of these lakes have been individually studied, the watershed areas tributary to each of these lakes has already been modeled as part of the development of the larger Phalen Chain of Lakes SLMP (Barr, 2004 [Draft]). The lakes included in this LSR are Casey Lake, Round Lake (in Little Canada), Savage Lake, Twin Lake, and Willow Lake. Figure 1-1 shows the location of each of these lakes.

The Plan (Barr, 2006 [draft]) includes preliminary water quality goals and management classes for each of the District-managed lakes. The water quality goals are defined in terms of total phosphorus (TP), chlorophyll *a* (Chl *a*), and Secchi disc (SD). The goals outlined in the Plan will remain preliminary until an SLMP or other similar study, such as this LSR, is completed and appropriate goals are determined. For the water bodies part of this LSR, the preliminary goals are consistent with either the Minnesota Pollution Control Agency's (MPCA) proposed draft criteria for shallow lakes in the North Central Hardwood Forests (CHF) ecoregion (MPCA, 2005), or the goals listed in the 1997 Plan.

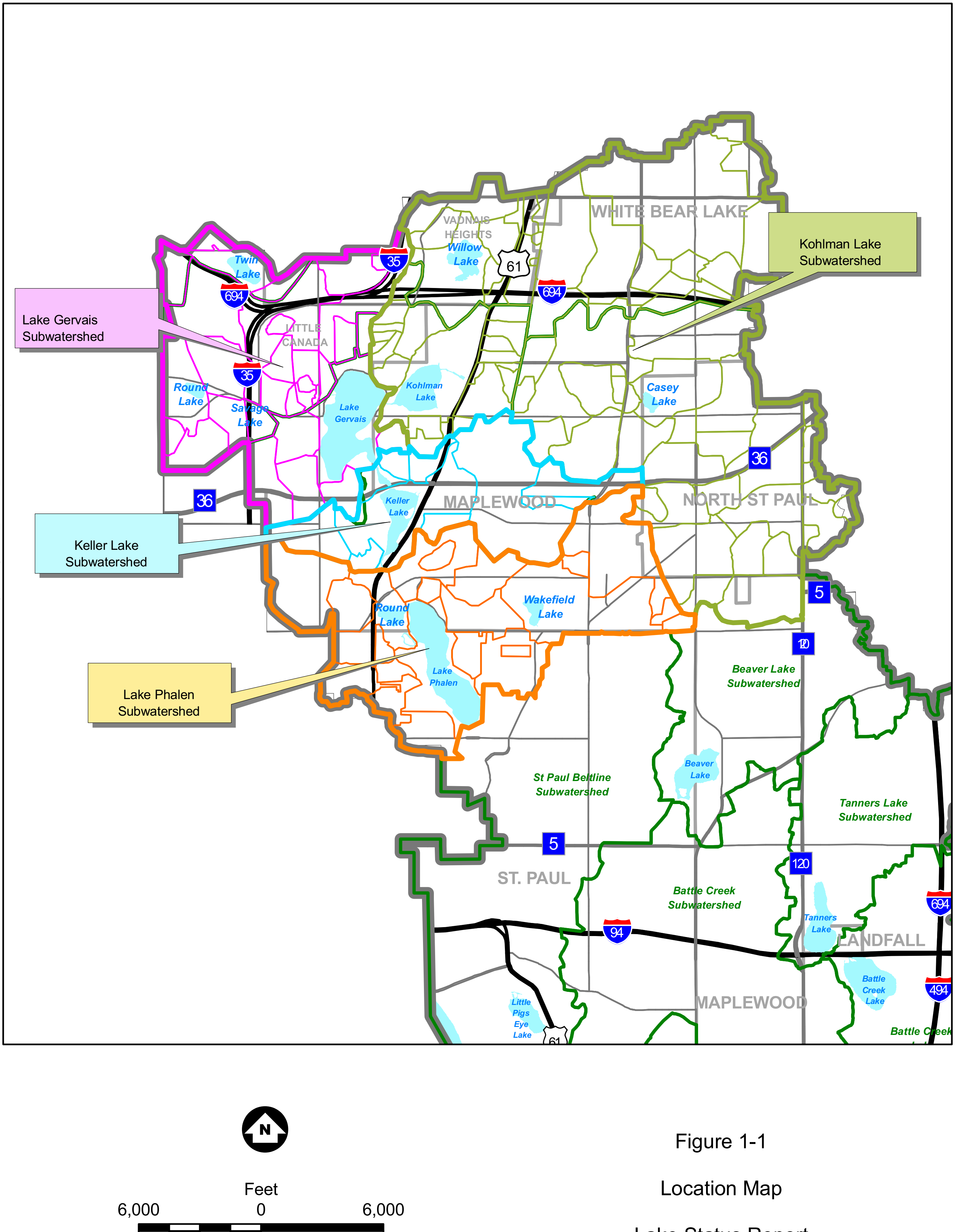

Figure 1-1

Location Map

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For lakes, the District management classes are identified as either “Improvement” or “Prevent further degradation.” An “Improvement” class is warranted if the public perceives a need for water quality improvement and there are feasible management options that will accomplish water quality improvement. A “Prevent further degradation” class is assigned when current water quality meets the goals set for the lake. A “Prevent further degradation” class does not, however, imply inaction. Rather, development requirements, fisheries, shoreline, and macrophyte management; as well as additional water quality improvement projects; are pursued for the lake as opportunities and budgets allow.

For wetlands, the District has developed management Classes A, B, and C, based on a recent inventory and assessment of wetlands within the District. The wetland classification is based on the estimated quality of the wetland, with management Class A being the highest quality wetlands. Water bodies classified as “Water Quality Pond” are constructed treatment ponds only.

Additional classifications of the water bodies based on water quality include the Impaired Waters List under Section 303(d) of the *Federal Clean Water Act* (CWA). Those water bodies that do not meet the water quality standards established under the CWA are included on this list and future development of total maximum daily loads (TMDL) is required. The Minnesota Department of Natural Resources (MDNR) has developed another ecological management classification system for Minnesota lakes (Schupp, 1992) that is based on parameters such as lake size, depth, chemical fertility, and growing season length.

Table 1-1 summarizes the various goals and classifications of each lake. Note that for District-managed wetlands there are no water quality goals established. Additionally, note that the 2006 Preliminary RWMWD Water Quality Goals are those listed in the Plan (Barr, 2006 [draft]). The 2006 Proposed RWMWD Water Quality Goals are the result of this LSR and evaluation of the information available for each of the lakes.

Table 1-1 Summary of RWMWD Recreational-Use Level (2006 Draft Plan), Preliminary RWMWD Water Quality Goals (2006 Draft Plan), Proposed RWMWD Goals (Result of LSR), and Management Class (2006 Draft Plan) as well as 303(d) Impaired Waters and MDNR Ecological Management Class

Water Body	RWMWD Use Level	2006 Preliminary RWMWD Water Quality Goal	2006 Proposed RWMWD Water Quality Goal	RWMWD Management Class	303(d) Impaired Waters Pollutant	MDNR Ecological Class
Casey Lake	N/A	N/A	N/A	Wetland Management Class B	N/A	N/A
Round Lake (Little Canada)	2	45-75 µg/L TP 20-40 µg/L Chl*a* 2-3 ft SD	TBD[4] 45-75 µg/L TP 20-40 µg/L Chl*a* 2-3 ft SD	Improvement	N/A	N/A
Savage Lake	N/A	N/A	N/A	Wetland Management Class B (West of 35E)/C (East of 35E)	N/A	N/A
Twin Lake	2	45-75 µg/L TP 20-40 µg/L Chl*a* 2-3 ft SD	40 µg/L TP[3] 14 µg/L Chl*a*[3] 4.6 ft SD[3]	Prevent further degradation	N/A	30
Willow Lake	3	60 µg/L TP [1,2] 20 µg/L Chl*a* [1,2] 3.3 ft SD [1,2]	60 µg/L TP[1] 20 µg/L Chl*a*[1] 3.3 ft SD[1]	Prevent further degradation	N/A	40

1- Water quality goals are consistent with the MPCA's draft criteria for shallow lakes in the North Central Hardwood Forests (CHF) ecoregion (Minnesota Lake Water Quality Assessment Report: Developing Nutrient Criteria. Third Edition, September, 2005)

2- Goals remain preliminary until a SLMP or other similar study is completed and appropriate goals are determined

3- Water quality goals are consistent with the MPCA's draft criteria for non-shallow lakes in the North Central Hardwood Forests (CHF) ecoregion (Minnesota Lake Water Quality Assessment Report: Developing Nutrient Criteria. Third Edition, September, 2005)

4- TBD – To Be Determined – Currently there is no water quality data for Round Lake to estimate the trophic status of the lake and determine whether or not the Preliminary District Goals are reasonable for this resource.

2.0 Lake Water Quality Analysis

For some of the lakes in this study, there is very limited or no water quality data available for analysis. Below is a discussion of the evaluation techniques used in this study to analyze the water quality data for each lake, when applicable.

2.1 Criteria for Lake Water Quality Evaluation

Historical water quality data was evaluated to determine each lake's level of eutrophication (trophic state). Secchi disc (SD) transparency, total phosphorus (TP) concentration, and chlorophyll *a* (Chl *a*) concentration are the parameters typically considered when discussing the trophic state and overall water quality of a lake. These three parameters were used in this study to evaluate each lake's water quality. Appendix A contains a more detailed discussion of these water quality parameters.

2.1.1 Trophic State

Determining the trophic status of a lake is an important step in diagnosing water quality problems, as it is an indicator of the severity of a lake's algal growth problems and the degree of change needed to meet its recreational goals. To assign a trophic state to each lake, available water quality data was analyzed using the Carlson Trophic State Index, (Carlson, 1977), which assigns a Trophic State Index (TSI) to a lake based on the TP and Chl *a* concentrations as well as SD transparency. The lake classification index is summarized below in Table 2-1.

Table 2-1 Carlson Trophic State Index Classification

Lake Classification	TSI Values	TP Conc. (µg/L)	Chl *a* Conc. (µg/L)	SD Transparency (m)
Oligotrophic	<38	<10.5	<2.0	>4.6
Mesotrophic	38–50	10.5–24.5	2.0–7.5	4.6–2.01
Eutrophic	50–62	24.5–57.0	7.5–26.0	2.01–0.85
Hypereutrophic	>62	>57.0	>26.0	<0.85

In general, oligotrophic classification indicates low productivity (nutrients) and high water clarity. Hypereutrophic status is on the other end of the spectrum with extremely high nutrients levels and very poor water quality that result in severely reduced recreational use.

2.1.2 Trend Analysis

Trend analyses of lake water quality data are completed to determine if a lake has experienced significant degradation or improvement during all (or a portion) of the years for which water quality data are available. Water quality data from the "summer" growing season (June to September) are compiled from previous investigations for each analysis. The summer averages of the water quality data are used to determine water quality trends. Long-term trends are typically determined using standard statistical methods (i.e., linear regression and analysis of variance).

For this report, the District used the Mann-Kendall/Sen's Slope Trend Test to determine water quality trends and their significance. To complete the trend test, the calculated summer average must be based on at least four measured values during the sampling season, and at least 5 years of data are required. The District considers a lakes' water quality to have significantly improved or declined if the Mann-Kendall/Sen's Slope Trend Test is statistically significant at the 95 percent confidence interval. Also, to conclude an improvement requires concurrent decreases in TP and Chl *a* concentrations, as well as increases in SD transparencies; a conclusion of degradation requires the inverse of relationships above.

2.1.3 Biological Data

If available, biological data were compiled and evaluated (in addition to the physical and chemical parameters) for each water body during this study. The type and distribution of aquatic communities are impacted by water quality; thus macrophyte (aquatic weeds), phytoplankton, zooplankton, and fisheries data provide insight into the health of the aquatic ecosystem associated with each water body as well as the overall water quality.

2.1.4 Lake Water Quality Goal Attainability

The Minnesota Lake Eutrophication Analysis Procedure (MINLEAP) is intended to be used as a screening tool for estimating lake conditions and for identifying "problem" lakes. MINLEAP is particularly useful for identifying lakes requiring "protection" versus those requiring "restoration" (Heiskary and Wilson, 1990). In addition, MINLEAP modeling by has been done in the past to identify Minnesota lakes which may be in better or worse condition than they "should be" based on their location, watershed area and lake basin morphometry (Heiskary and Wilson, 1990). The results of this model can be useful in the establishment of realistic water quality goals.

2.1.5 Watershed Pollutant Load Modeling

The P8 (Program for Predicting Polluting Particle Passage through Pits, Puddles and Ponds; IEP, Inc., 1990) Urban Catchment Model was used to estimate flow and water quality constituent loadings to each of the lakes from its contributing watersheds. P8 uses long-term climatic data so that watersheds and BMPs can be evaluated for varying hydrologic conditions.

The P8 models used to evaluate each lake and watershed in this LSR were originally developed and calibrated as part of the development of the larger Phalen Chain of Lakes SLMP (Barr, 2004 [draft]). It was assumed that the P8 model results (flow and water quality) that were calibrated during the development of the Phalen Chain SLMP apply to each of the smaller, individual subwatersheds of the model and that the results of this P8 modeling will still provide general insight into the water volume and water quality loads to each lake. However, if the water quality within these specific lakes becomes a very high priority for the District, we would recommend a more detailed modeling effort be done for each lake.

The P8 models were run for wet (5/1/2001 to 9/30/2002), dry (5/1/1988 to 9/30/1989), and average (5/1/2000 to 9/30/2001) climatic conditions. Temperature data from the Minneapolis-St. Paul International Airport (MSP) and precipitation data combined from several local gages were used for modeling the wet, dry and average years. The Metropolitan Council land use in the tributary watersheds was updated by comparing the 2000 land use classification (used in the development of the original Phalen Chain SLMP) with 2004 aerial photographs of the Metro area. This resulted in new runoff curve numbers and percentages of impervious surface within each watershed. However, since there were no major changes in the land use classifications within each watershed, it was assumed that the original calibration of the P8 model would still be applicable, even with the slightly changed land use parameters.

When evaluating the results of the P8 modeling, it is important to consider that the results provided are more accurate in terms of relative differences than in absolute results. The model provides a realistic estimate of the relative differences in phosphorus and water loadings from the various subwatersheds and major inflow points to the lake. However, since runoff quality is highly variable with time and location, the values for phosphorus loadings given from the model for a specific watershed may not necessarily reflect the actual loadings. Various site-specific factors, such as lawn care practices, illicit point discharges and erosion due to construction or streambank failure are not accounted for in the model. The model provides values that are considered to be “typical” of the region for the watershed’s respective land uses.

3.0 Lake Status Summary

3.1 Casey Lake

3.1.1 Lake and Watershed Characteristics

3.1.1.1 Description of Casey Lake

Casey Lake is located just east of White Bear Avenue (Township 20, Range 22, Section 2) in Casey Lake City Park in North St. Paul. Although called a lake, Casey Lake is actually a 12-acre wetland, as it is not classified as lacustrine under the Cowardin system (Cowardin, 1979) used by the District to categorize water bodies as lakes or wetlands. For this reason, it is considered a district-managed water body rather than a district-managed lake. It is also classified as Protected Public Water in the MDNR Public Waters Inventory (62-5P).

The maximum depth of Casey Lake is 3.5 feet. Approximate bathymetric contours have been created using lake depth survey data gathered by the District in 2002 and can be seen in Figure 3-1. There are no historic lake level data available for Casey Lake.

The primary outlet of Casey Lake is located on the west side of the lake and discharges to a tributary that drains to Kohlman Creek. It is surrounded by emergent vegetation, predominantly cattails. The outlet structure is a beehive over a riser with a 12-inch outlet pipe. The riser extends 2 feet above the top of the outlet pipe. The beehive outlet structure, as shown in Figure 3-2, can accumulate dead plant material and debris. The normal water level (NWL) used for modeling was 925.3 feet MSL and the critical 100-year flood elevation for Casey Lake was determined to be 928.1 feet MSL, as part of the development of the District *Watershed Management Plan* (Barr, 1997; Barr, 2006 [draft]). Figure 3-3 shows the extent of the 100-year critical flood.

Figure 3-1

Casey Lake
Approximate Bathymetry

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(a)

(b)

Figure 3-2
Casey Lake (a) and its outlet (b)
(Photos taken 5/11/2006)

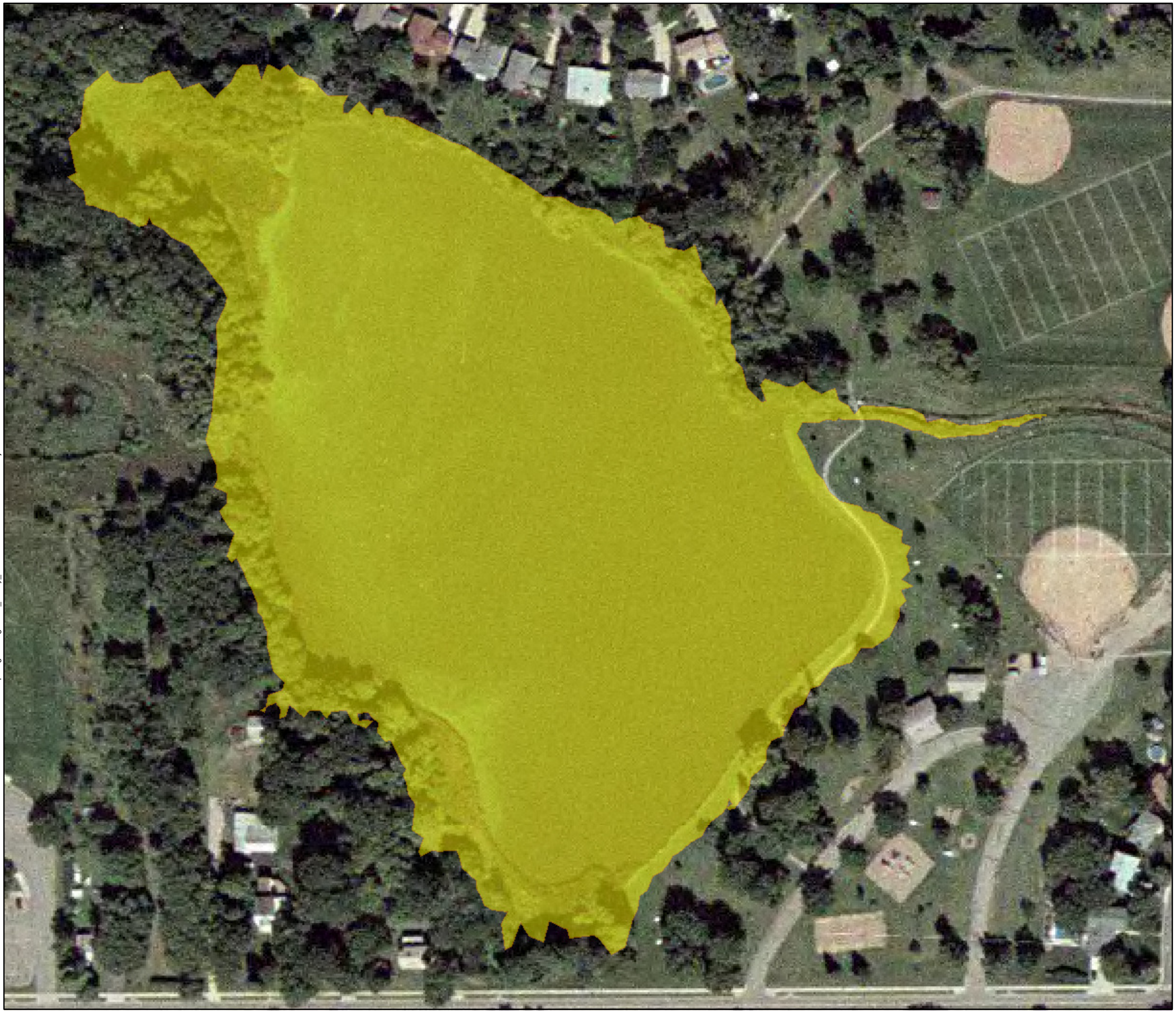

Figure 3-3

Casey Lake
Critical Flood Elevation

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3.1.1.2 Watershed Characteristics

The Casey Lake watershed (including the lake surface area) covers a 240-acre area north of Highway 36 and east of White Bear Avenue) and is part of the larger Kohlman Lake watershed. The land use in the Casey Lake watershed is predominantly low-density residential (76.0%). The breakdown of the remaining land uses in the watershed is as follows: Agricultural (0.2%), High-density residential (1.5%), Institutional (0.5%), Natural/park/open (15.9%), Open water (4.9%), and Wetland (1.0%). Casey Lake, itself, has been classified as a combination of open water and wetland land uses. A map of land use within the Casey Lake watershed can be seen in Figure 3-4.

Drainage from the watershed generally flows to the west/southwest into Casey Lake via the storm sewer system. There are several inlets to Casey Lake coming from the north, east, and south. The drainage area and flow patterns for Casey Lake are shown in Figure 3-5.

3.1.1.3 Recreational-Uses

Because it is actually a wetland, the District has not assigned a recreational-use level to the Casey Lake and does not cite any recreational-uses in the Plan. There is no designated access to Casey Lake, although carry-in access is possible from the parking lot. Local ordinance prohibits the use of motors on Casey Lake. District staff has confirmed that they have not observed anyone boating or canoeing on Casey Lake. However, the adjacent park has picnic tables, a grill, and a shelter available for use as well as benches and a walking path overlooking the lake. Additionally, ducks were observed to be nesting around Casey Lake in the spring of 2006 suggesting that Casey Lake is used by waterfowl and other wildlife.

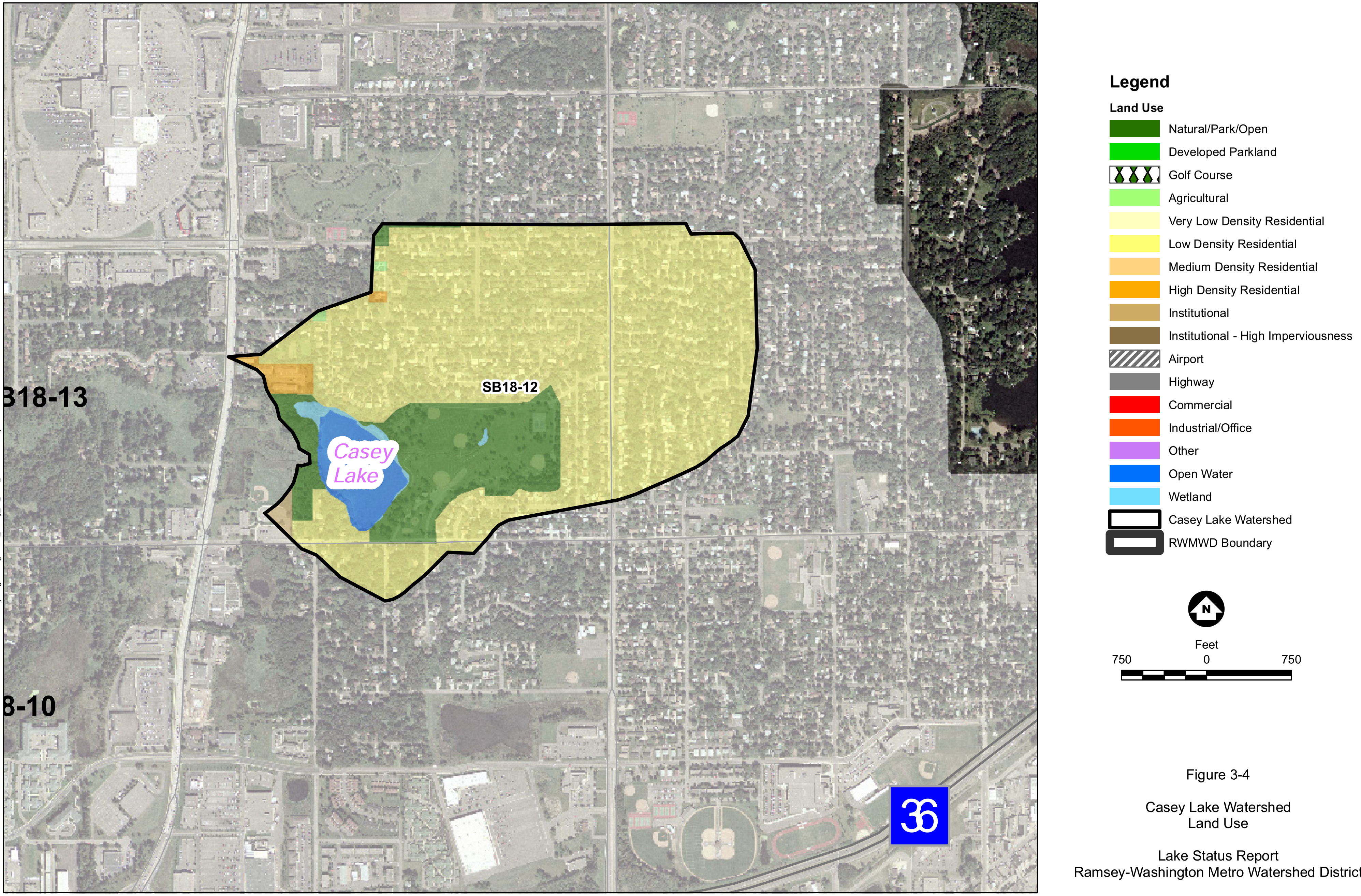

Figure 3-4

Casey Lake Watershed
Land Use

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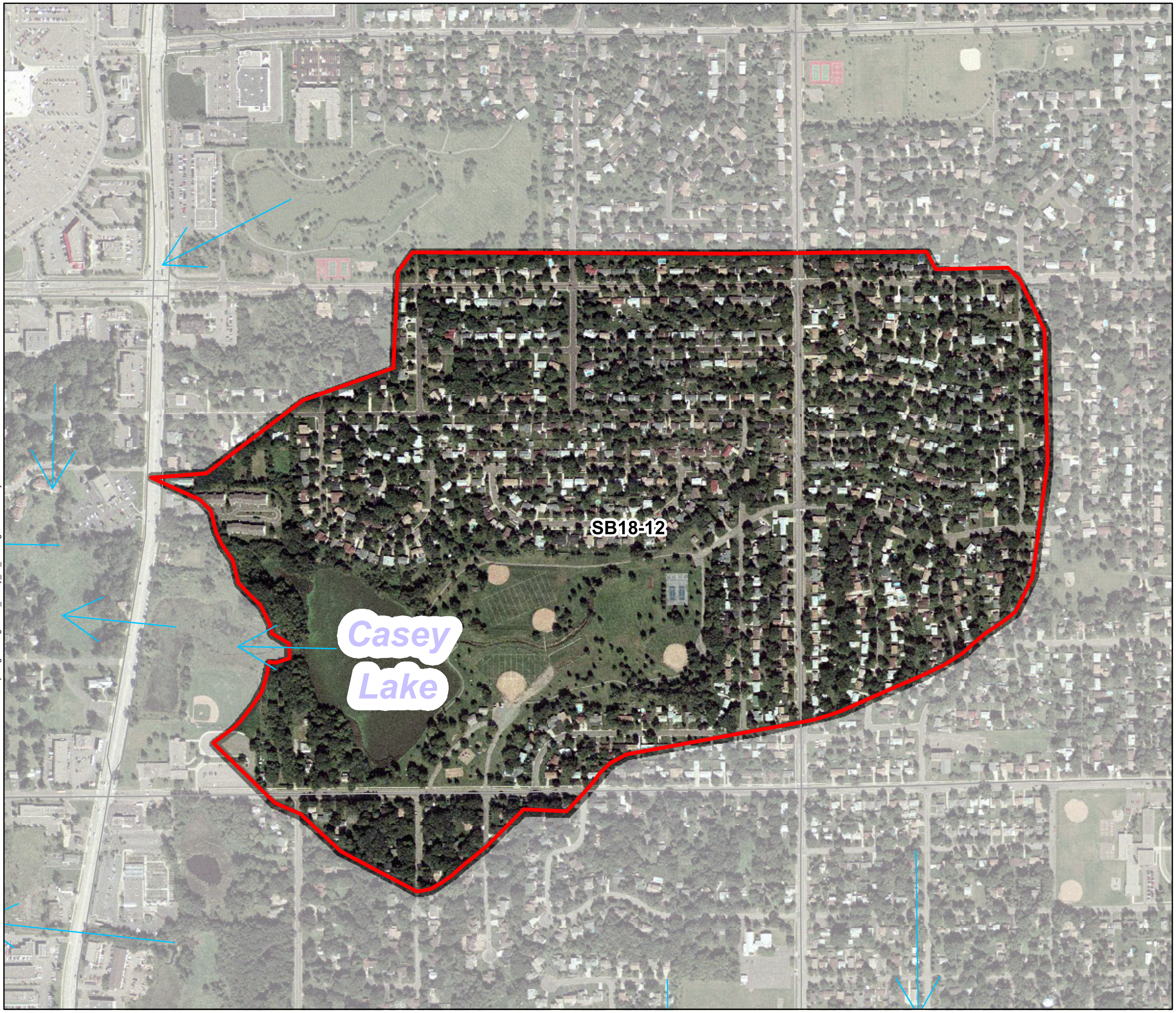

Figure 3-5

Casey Lake Watershed
Subwatersheds & Drainage

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3.1.2 Water Quality Data

3.1.2.1 Water Quality Analysis

There has been no water quality monitoring conducted for Casey Lake other than a brief water quality evaluation completed during the latest MDNR fishery survey in 2001. On the date of the survey, the water quality was considered poor with a Secchi disc depth of only 0.5 feet (0.15 meters).

The latest fishery survey indicated that black bullhead was the most abundant species. Other common species were black crappies, common carp, as well as green sunfish. There is no macrophyte, phytoplankton, or zooplankton information available for Casey Lake.

3.1.2.2 P8 Modeling Results

The P8 Model of the Casey Lake watershed was run for wet, dry, and average climatic conditions. Water and total phosphorus loads from the watershed were determined for each climatic period. The results of this modeling are summarized in Table 3-1.

Table 3-1 P8 Estimated Watershed Runoff and TP Loads to Casey Lake during Wet, Dry, and Average Climatic Conditions

Climatic Condition (Water Year)	Parameter		Load
Wet (10/1/01-9/30/02)	Flow	ac-ft	139.29
	TP	lbs	230.91
Average (10/1/00-9/30/01)	Flow	ac-ft	188.61
	TP	lbs	239.97
Dry (10/1/88-9/30/89)	Flow	ac-ft	110.03
	TP	lbs	169.04

It is important to note that climatic condition periods were selected based on depths of precipitation over a 17-month period that included the summer before the water year of interest because it is assumed that the water and TP load to the lake during this period affects the following year's spring TP concentration. During the 12-month period from October through September (the water year), however, the water and phosphorus loads to the lake were slightly higher during the average year than the wet year.

3.1.3 Recommendations

3.1.3.1 Water Quality Goals

As previously mentioned, Casey Lake is not a district-managed lake but rather a wetland. Therefore, no preliminary District lake water quality goals have been established for Casey Lake. In general, the District's approach to managing wetlands is to achieve no net loss of acreage, function and value.

According to the District's wetlands management classification, Casey Lake falls into Management Class B (Barr, 2006 [draft]). Wetlands under this classification are considered high-quality wetlands that should be protected from development and other pressures of increased use, including indirect effects. This classification requires the maintenance of natural buffers (Minimum = 25 feet, Average = 50 feet) to help retain wetland function.

Results from MINLEAP analysis suggest that the expected water quality in a minimally impacted lake, similar to Casey Lake (based on its location within the Central Hardwood Forest ecoregion and with its basic basin and watershed characteristics), would be expected to be within the following ranges for TP, Chl *a*, and SD, respectively: 63 to 107 μg/L, 21 to 66 μg/L, and 0.5 to 1.2 meters.

3.1.3.2 Recreational Use Level

Use of Casey Lake for canoeing appears to be very limited. However, because there are facilities in the adjacent park, as well as walking paths and observed wildlife, the recreational uses of Casey Lake should include picnicking, aesthetic, and wildlife viewing.

3.1.3.3 Further Studies

If the District identifies water quality in Casey Lake as a high priority, the first recommendation would be to collect additional lake information, including concurrent water quality, macrophyte, and lake level data, as there is currently no data available for Casey Lake related to these parameters.

3.2 Round Lake (in Little Canada)

3.2.1 Lake and Watershed Characteristics

3.2.1.1 Description of Round Lake

Round Lake is located just south of Little Canada Road in Little Canada (Township 29, Range 22, Section 6) and is a 12-acre District-managed lake. It is also classified as a Protected Public Water in the MDNR Public Waters Inventory (62-9P) and is considered a shallow lake, according to the MPCA's criteria (MPCA, 2005).

The maximum depth of Round Lake is 6.6 feet. Approximate bathymetric contours have been created using lake survey data gathered by the District in 2002 and can be seen in Figure 3-6. There is also historic lake level data available for Round Lake from 1934 to 2006 (as seen in Figure 3-7). The primary outlet is located on the eastside of Round Lake and is a 24-inch RCP with a flared-end section and discharges to Gervais Creek. The outlet can be seen in Figure 3-8. The NWL of Round Lake is 901.1 feet MSL. The 100-year flood elevation was determined to be 904.8 feet MSL during the development of the District *Watershed Management Plan* (Barr, 1997; Barr, 2006 [draft]). Figure 3-9 shows the extent of the 100-year critical flood.

3.2.1.2 Watershed Characteristics

The Round Lake watershed (including the lake surface area) covers a 214-acre area south of Owasso Boulevard and east of Highway 49 and is part of the larger Lake Gervais watershed. Commercial and low-density residential land uses are the major land uses with the breakdown within the watershed as follows: Agricultural (0.5%), Commercial (27.6%), High-density residential (12.1%), Industrial/office (9.7%), Low-density residential (33.3%), Natural/Park/Open (8.7%), Open water (5.8%), and Wetland (2.3%). See Figure 3-10 for a map of watershed land use.

Drainage from the watershed flows generally to the east. There are four storm sewer outfalls into Round Lake (per the District survey, 2002). Figure 3-11 shows the general drainage pattern in the Round Lake watershed.

3.2.1.3 Recreational-Uses

Round Lake is surrounded by primarily residential and commercial land uses, and there is no public land or access to the lake. Therefore, the recreational-use is limited to those living around the lake. It currently is classified to have Level 2 recreational-uses according to the District's classification system. With a Level 2 classification, the major associated uses are canoeing, picnicking, and aesthetic viewing. However, there is question as to whether the lake is actually used for canoeing.

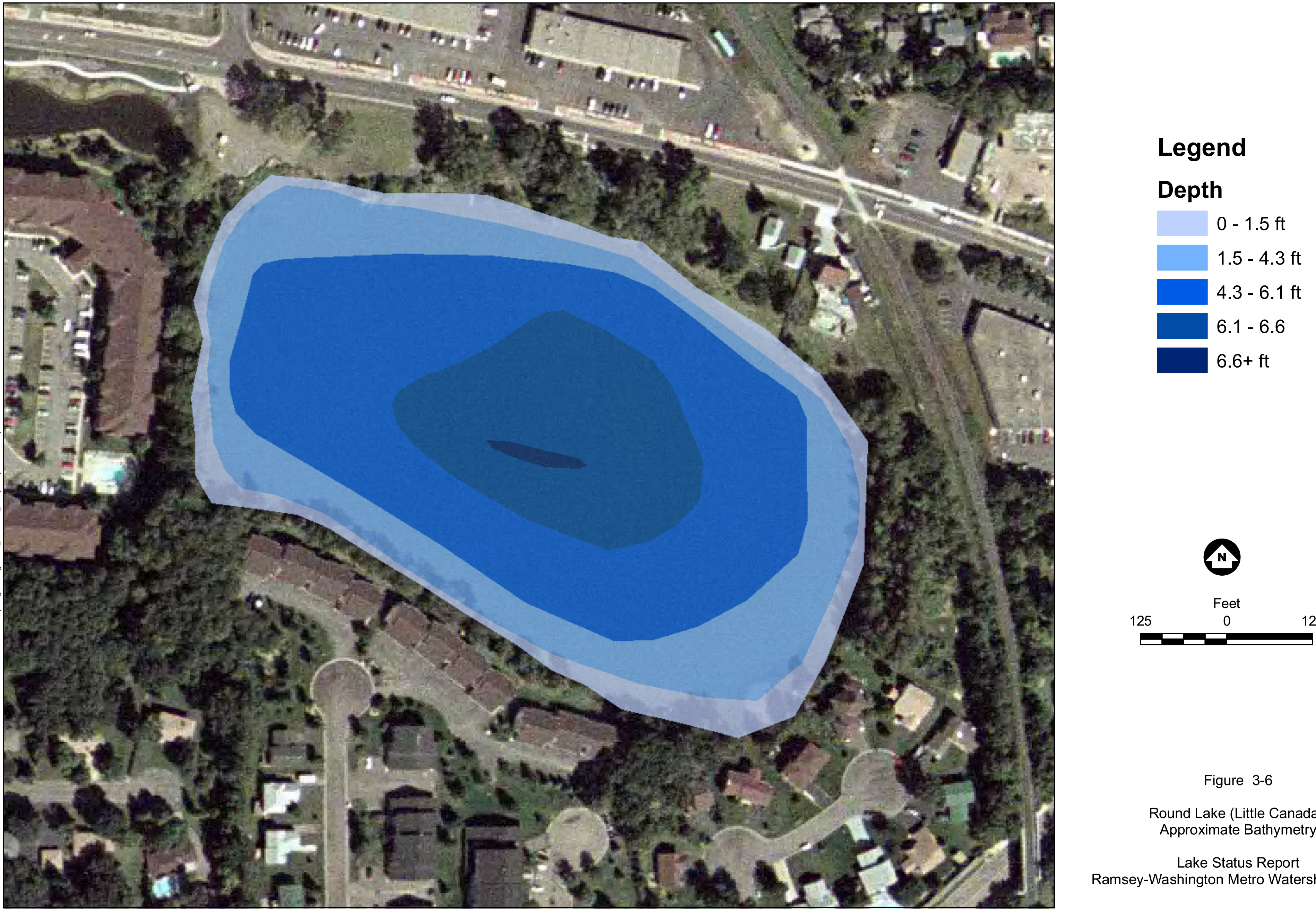

Figure 3-6

Round Lake (Little Canada)
Approximate Bathymetry

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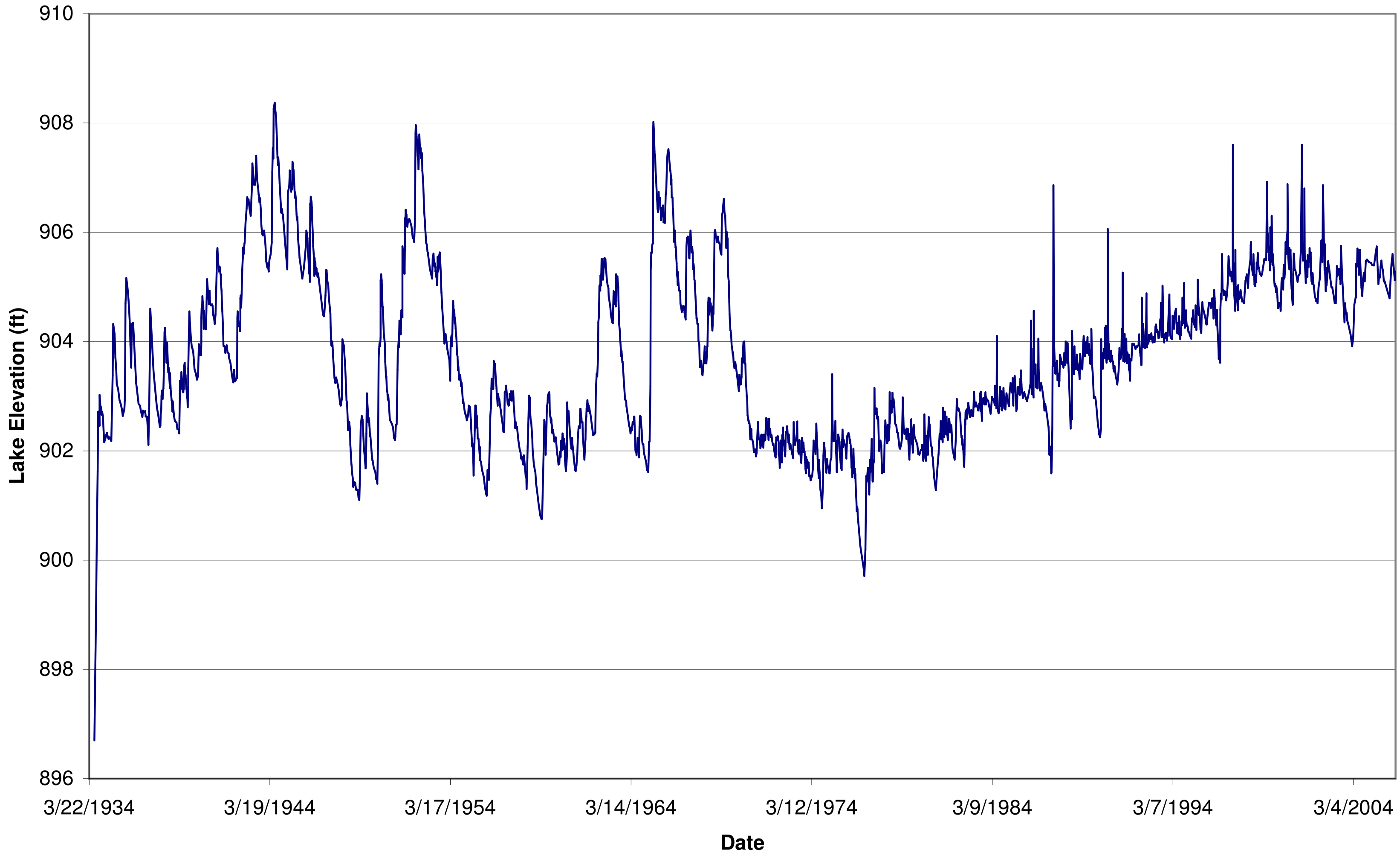

Figure 3-7
Round Lake (Little Canada)
Historic Lake Levels
1934-2006


(a)


(b)


(c)

Figure 3-8
Round Lake in Little Canada (a) and its outlet (b & c)
(Photos taken 5/11/2006)

Legend

Flood Elevation = 904.8 ft MSL

Feet
125 0 125

Figure 3-9

Round Lake (Little Canada)
Critical Flood Elevation

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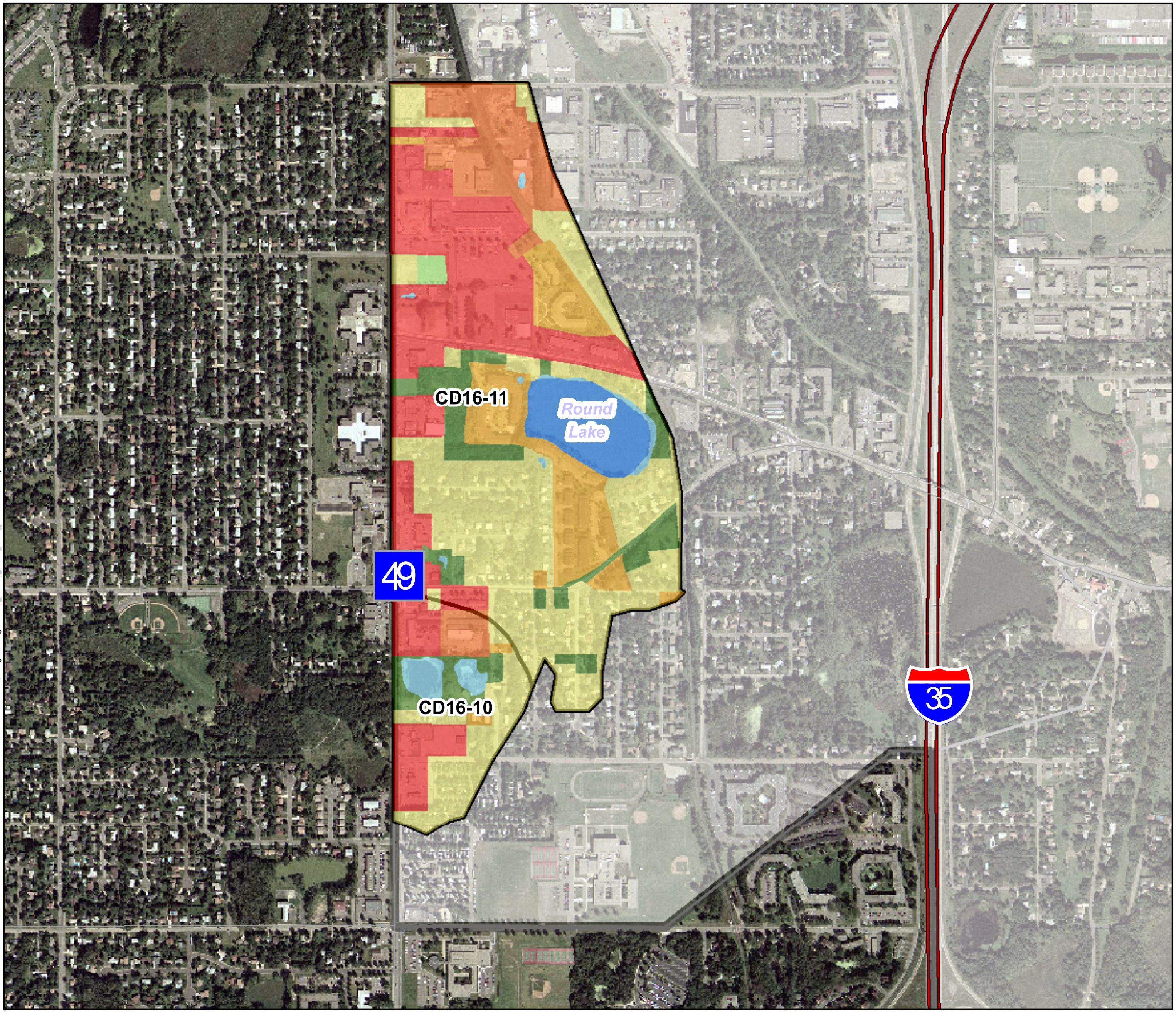

Figure 3-10

Round Lake (Little Canada) Watershed
Land Use

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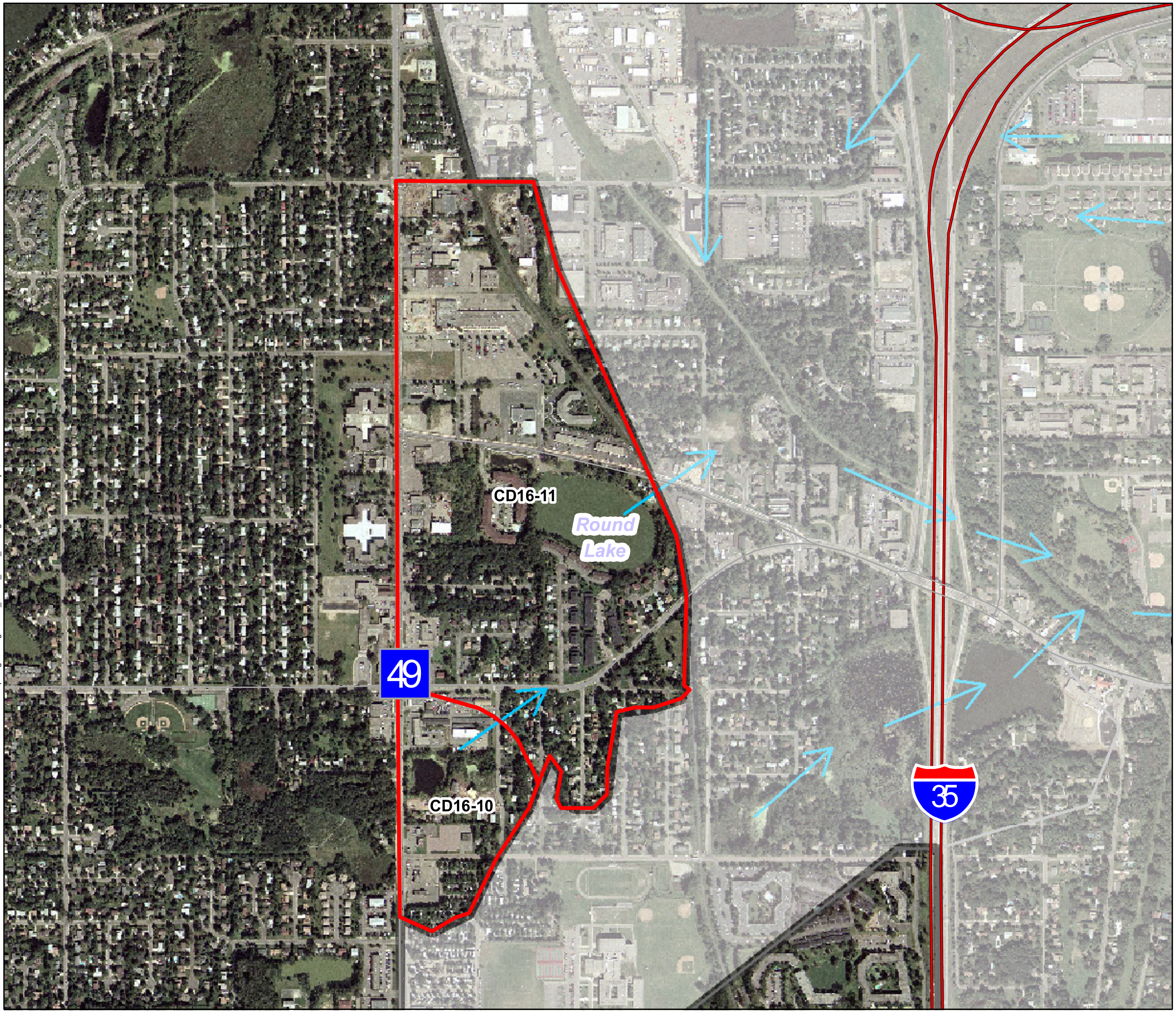

Figure 3-11

Round Lake (Little Canada)
Subwatersheds & Drainage

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3.2.2 Water Quality Data

3.2.2.1 Water Quality Analysis

There is no water quality data for Round Lake with the exception of single Secchi disc measurements from the summers of 1995 and 1996. Therefore, there was insufficient data to run a trend analysis on the data. The mean Secchi disc transparency based on the two observations from the summers of 1995 and 1996 was 0.6 meters. This resulted in a Carlson TSI, based only on Secchi disc values, of 68. This places Round Lake in the Eutrophic to Hypereutropic state, indicating poor water quality and limited recreational-uses.

Visual observations from the same dates as the Secchi disc sampling suggest there was medium to high algae growth in the lake, which are consistent with an eutrophic to hypereutrophic state. No fishery, macroinvertebrate, phytoplankton, or zooplankton surveys have been collected for Round Lake. Additionally, concerns about Round Lake water quality have been expressed by a few shoreline residents as far back as 1995 (District, 2006).

3.2.2.2 P8 Modeling Results

The P8 Model of the Round Lake watershed was run for wet, dry, and average climatic conditions. Water and total phosphorus loads to Round Lake were determined for each climatic period. The results of this modeling are summarized in Table 3-2.

Table 3-2 P8 Estimated Watershed Runoff and TP Loads to Round Lake under Wet, Dry, and Average Climatic Conditions

Climatic Condition (Water Year)	Parameter		Load
Wet (10/1/01-9/30/02)	Flow	ac-ft	294.03
	TP	lbs	272.82
Average (10/1/00-9/30/01)	Flow	ac-ft	310.1
	TP	lbs	250.83
Dry (10/1/88-9/30/89)	Flow	ac-ft	210.5
	TP	lbs	212.59

It is important to note that climatic condition periods were selected based on depths of precipitation over a 17-month period that included the summer before the water year of interest because it is assumed that the water and TP load to the lake during this period affects the following year’s spring TP concentration. During the 12-month period from October through September (the water year), however, the water load to the lake was slightly higher during the average year than the wet year.

Conversely, the TP load was higher in the wet year than in the average year over this 12-month period due to the fact that higher TP loading is often associated with the smaller, more frequent storm events like the ones that occurred between October 2001 and September 2002.

3.2.3 Recommendations

3.2.3.1 Water Quality Goals

Preliminary District water quality goals for TP, Chl *a*, and SD are listed in the updated 2006 draft Plan. These goals are the same as those listed in the 1997 Plan, and the District management class is listed as "Improvement." Round Lake is not listed on the CWA 303(d) Impaired Waters List and it has no MDNR ecological class assigned. See Table 1-1 for a summary of applicable classifications and preliminary goals established for Round Lake.

Results from MINLEAP suggest that the expected water quality in a minimally impacted lake, similar to Round Lake (based on its location within the Central Hardwood Forest ecoregion and with its basic basin and watershed characteristics), would be within the following ranges for TP, Chl *a*, and SD; respectively: 55 to 98 μg/L, 17 to 58 μg/L, and 0.6 to 1.3 meters. When comparing these ranges to the 2006 Preliminary water quality goals established by the District, it appears that the water quality goals are on the low end of the expected ranges predicted by MINLEAP.

3.2.3.2 Recreational-Use Level

Although currently classified as a Level 2 lake, its recreational uses are limited to residents living around the lake, as there is no public access. It is questionable that Round Lake is used for canoeing due to its limited access. It is recommended that the District recreational use category be changed to a Level 3 or Level 4 classification with the desired recreational uses being predominantly aesthetic and wildlife viewing.

3.2.3.3 Further Studies

If the District identifies water quality in Round Lake as a high priority, the first recommendation would be to collect additional lake information, including concurrent water quality, macrophyte, and fishery data, as there is currently not sufficient data for Round Lake to establish the baseline water quality for the lake. Only after understanding the lake's existing water quality can reasonable goals and direct management options be established for the lake.

3.3 Savage Lake

3.3.1 Lake and Watershed Characteristics

3.3.1.1 Description of Savage Lake

Savage Lake is located just south of the intersection of Little Canada Road and Interstate Highway 35E (I-35E) in Little Canada (Township 29, Range 22, Sections 6&7), and is actually bisected by I-35E. Because it is divided by the highway, the eastern and western basins of the lake are connected by a pipe that flows from the west basin into the southwest corner of the eastern basin.

Although called a lake, Savage Lake is actually a 27-acre wetland, as it is not classified as lacustrine under the Cowardin system (Cowardin, 1979) used by the District to categorize waterbodies as lakes or wetlands. For this reason, it is considered a district-managed water body rather than a district-managed lake. It is also classified as Protected Public Water in the MDNR Public Waters Inventory (62-8P/62-147W). The West Savage Lake is 17.4 acres while East Savage Lake is 9.6 acres.

The maximum depth of the western portion of Savage Lake is 5.9 feet, while in the eastern portion the maximum depth recorded is 5.7 feet. Approximate bathymetric contours have been created using lake survey data gathered by the District in 2002 and can be seen in Figure 3-12. The primary outlets of both basins are located on the respective eastern shores. The outlet from West Savage Lake is a 30-inch pipe. The outlet of East Savage Lake was replaced in 2004 and is currently an 18-inch RCP with a flared-end section and an overflow riser pipe. The new outlet established a NWL of 894.1 feet MSL. However, at this elevation, residents felt that water levels in Savage Lake were too low. In order to raise the NWL, permission from the MDNR and all adjacent property owners was obtained. In 2006, a wall was constructed in the riser of the outlet structure that raised the NWL to 895.1 feet MSL. Figure 3-13 shows East and West Savage Lake as well as the primary outlet located in the east basin.

The critical 100-year flood elevation was determined to be 896.5 feet MSL during the development of the District *Watershed Management Plan* (Barr, 1997; Barr, 2006 [draft]) although with the increase in the NWL, the extent of the critical 100-yr flood elevation has likely changed and additional modeling will be required to determine the new elevation. Figure 3-14 shows the extent of the 100-year critical flood for Savage Lake.

3.3.1.2 Watershed Characteristics

The Savage Lake watershed (including the lake surface area) covers a 253-acre area south of Little Canada Road and east of Rice Street. It discharges to Gervais Creek and is part of the larger Gervais

Lake watershed. Institutional and low-density residential land uses are the major land uses with the breakdown within the watershed as follows: Commercial (3.3%), High-density residential (7.3%), Highway (6.5%), Institutional (20.2%), Low-density residential (48.3%), Natural/Park/Open (4.1%), and Open water (10.3%). Savage Lake is included in the open water land use category. See Figure 3-15 for a map of the watershed land uses.

Drainage from the watershed flows to the east. There are four storm sewer outfalls into the western basin of Savage Lake and one outfall identified on the east basin (per the District survey, 2002). The drainage pattern in the watershed can be seen in Figure 3-16.

3.3.1.3 Recreational-Uses

Because it is actually a wetland, the District has not assigned a recreational use category to the Lake and the current Plan has no recreational uses listed. The city of Little Canada's Nadeau Wildlife Area is adjacent to the southwest shore of the western basin of Savage Lake. It is a 5-acre wetland with diverse vegetation providing wildlife habitat and educational opportunities, and the City of Little Canada has recently shown interest in wetlands management in relation to the Nadeau Wildlife Area.

Comments made during a meeting with local residents indicated that people do paddle and canoe on Savage Lake. Visits to Savage Lake indicated that residents along the lake may also use the lake for fishing. Residents of Savage Lake have received lake information from the District regarding their lake concerns and many residents have interest in learning more.

Figure 3-12

Savage Lake
Approximate Bathymetry

Lake Status Report
Ramsey-Washington Metro Watershed District

(a)

(b)

(c)

Figure 3-13

East Savage Lake (a), West Savage Lake (b), and the Primary Outlet of Savage Lake at the time of installation (c) (Photos (a) and (b) taken August 2006, Photo (c) taken February 2004)

Legend

Flood Elevation = 896.5 ft MSL

N

Feet

200 0 200

Figure 3-14

Savage Lake
Critical Flood Elevation

Lake Status Report
Ramsey-Washington Metro Watershed District

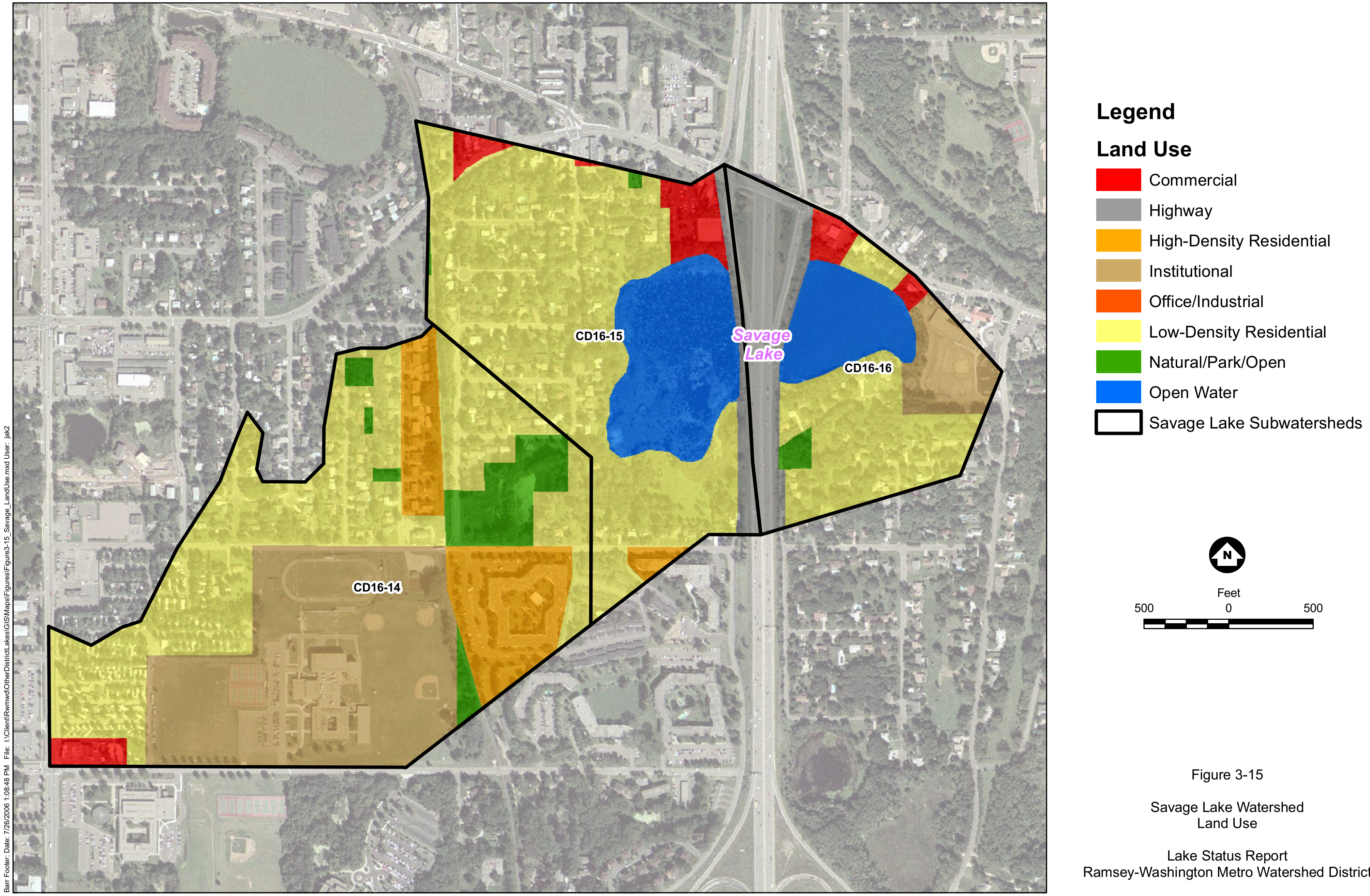

Figure 3-15

Savage Lake Watershed
Land Use

Lake Status Report
Ramsey-Washington Metro Watershed District

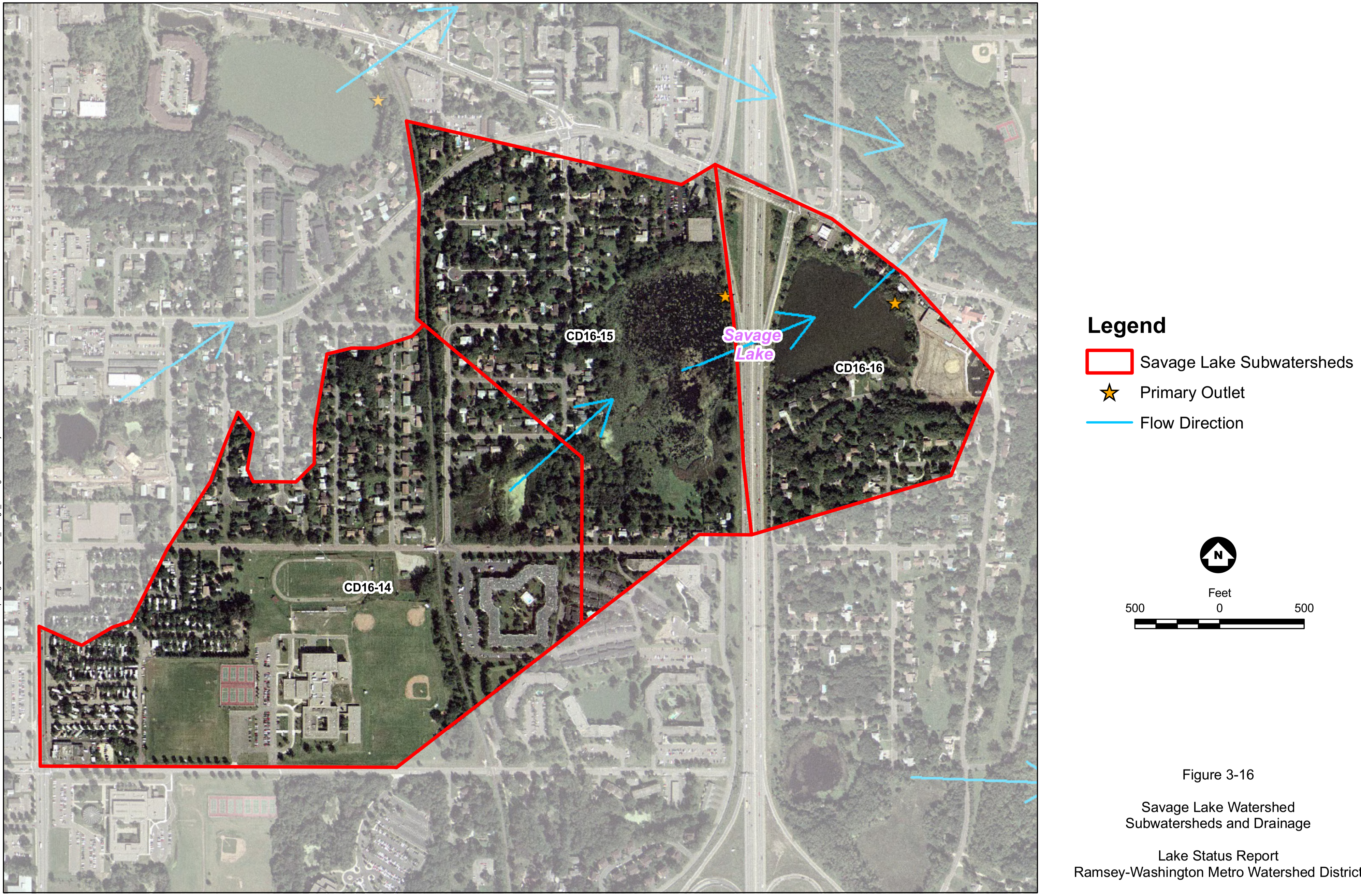

Figure 3-16

Savage Lake Watershed
Subwatersheds and Drainage

Lake Status Report
Ramsey-Washington Metro Watershed District

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3.3.2 Water Quality Data

3.3.2.1 Water Quality Analysis

There is no water quality data for Savage Lake. Additionally, there is no information on fishery, macroinvertebrates, phytoplankton, or zooplankton.

3.3.2.2 P8 Modeling Results

The P8 Model of the Savage Lake watershed was run for wet, dry, and average climatic conditions. Water and total phosphorus loads to Savage Lake were determined for each climatic period. The results of this modeling are summarized in Table 3-3.

Table 3-3 P8 Estimated Watershed Runoff and TP Loads to Savage (East and West) Lake under Wet, Dry, and Average Climatic Conditions

Climatic Condition (Water Year)	Parameter		Load
Wet (10/1/01-9/30/02)	Flow	ac-ft	217.45
	TP	lbs	154.12
Average (10/1/00-9/30/01)	Flow	ac-ft	252.98
	TP	lbs	144.58
Dry (10/1/88-9/30/89)	Flow	ac-ft	161.22
	TP	lbs	109.08

It is important to note that climatic condition periods were selected based on depths of precipitation over a 17-month period that included the summer before the water year of interest because it is assumed that the water and TP load to the lake during this period affects the following year's spring TP concentration. During the 12-month period from October through September (the water year), however, the water load to the lake was slightly higher during the average year than the wet year. Conversely, the TP load was higher in the wet year than in the average year over this 12-month period due to the fact that higher TP loading is often associated with the smaller, more frequent storm events like the ones that occurred between October 2001 and September 2002.

3.3.3 Recommendations

3.3.3.1 Water Quality Goals

As previously mentioned, Savage Lake is actually not a district-managed lake but rather a wetland. Therefore, no preliminary District water quality goals have been established for Savage Lake. In general, the District's approach to managing wetlands is to achieve no net loss of acreage, function, and value.

According to the District's wetlands management classification, the western portion of Savage Lake falls into Management Class B while the eastern basin is Management Class C (Barr, 2006 [draft]). Wetlands under Management Class B are considered high-quality wetlands that should be protected from development and other pressures of increased use, including indirect effects. This classification requires the maintenance of natural buffers to help retain wetland function as well as stormwater pretreatment (Minimum = 25 feet, Average = 50 feet). Wetlands in Management Class C are lower quality, less significant wetlands than those in Management Class B, although still requiring stormwater pretreatment and protective buffers (Minimum = 12.5 feet, Average = 25 feet).

Results from MINLEAP analysis suggest that the expected water quality in a minimally impacted lake, similar to Savage Lake (based on its location within the Central Hardwood Forest ecoregion and with its basic basin and watershed characteristics), would be expected to be within the following ranges for TP, Chl *a*, and SD; respectively: 47 to 88 μg/L, 13 to 49 μg/L, and 0.6 to 1.4 meters.

3.3.3.2 Recreational-Use Level

Because the Nadeau Wildlife Area is adjacent to Savage Lake, recreational-uses of Savage Lake should include canoeing, picnicking, and aesthetic and wildlife viewing. There are also educational opportunities available in the park area. However, because Savage Lake is actually a District-managed wetland, it is not assigned a District recreational-use level.

3.3.3.3 Further Studies

If the District identifies water quality in Savage Lake as a high priority, the first recommendation would be to collect additional lake information, including concurrent water quality, macrophyte, and fishery data, as there is currently no data available for Savage Lake related to these parameters.

3.4 Twin Lake

3.4.1 Lake and Watershed Characteristics

3.4.1.1 Description of Twin Lake

Twin Lake is located just south of Lake Vadnais and Vadnais Boulevard in Little Canada (Township 30, Range 22, Section 31) and is a 35.5-acre District-managed lake. It is classified as Protected Public Water in the MDNR Public Waters Inventory (62-39P), and is a non-shallow lake based on criteria as outlined by MPCA (MPCA, 2005).

It has a maximum depth of 33 feet, and there is lake bathymetry data available from the MDNR. Twin Lake's approximate bathymetry can be seen in Figure 3-17. There is, however, no historic lake level data available for Twin Lake. Twin Lake is a land-locked lake with no primary surface outlet although a high water level discharge pipe will be added to Twin Lake as part of the "Unweave the Weave" project at the I35E/I694 interchange. This pipe will discharge to Gervais Creek. For a photo of Twin Lake, see Figure 3-18. The maximum NWL used in all studies and modeling of Twin Lake is estimated to be 870.7 feet MSL. The critical 100-year flood elevation for Twin Lake was determined to be 873.7 feet MSL (Barr, 1997; Barr, 2006 [Draft]). The extent of the 100-year critical flood is mapped in Figure 3-19.

3.4.1.2 Watershed Characteristics

The Twin Lake watershed (including the lake surface area) covers a 201-acre area north of the junction of I-694 and I-35E and south of Vadnais Boulevard and Vadnais Lake, and it is part of the larger Lake Gervais watershed. The breakdown of land use in the watershed is as follows: Agricultural (6.7%), Highway (0.4%), Institutional (1.4%), Low-density residential development (44.7%), Natural/park/open (28.4%), Open water (16.0%), and Wetland (2.4%). Figure 3-20 shows the distribution of land uses within the Twin Lake watershed.

Drainage from the watershed flows from both the east and the west into Twin Lake (see Figure 3-21) and three storm sewer outfalls to the lake were identified. Additionally, several past studies (Barr, 1975; Barr, 1988; SEH, 1989) of Twin Lake and the surrounding area suggest that during severe rainstorms and flooding conditions, Twin Lake may also receive overflow drainage from Vadnais Lake. Overflow to Twin Lake begins when Vadnais Lake reaches an elevation of 884.6 feet MSL (Barr, 1993). There are a few small stormwater treatment ponds located within the residential areas of the Twin Lake watershed.

As previously mentioned, Twin Lake is a land-locked basin. However, during extremely high flood conditions, the lake backs-up through the 48-inch culvert located under the railroad tracks on the southeast side of the lake, which, under normal conditions, acts as an inlet to Twin Lake. If flood conditions are severe enough, water backing up through this culvert could eventually flow through the culvert under I-694 and discharge to Gervais Creek (formerly County Ditch 16) located south of the lake (Barr, 1993).

3.4.1.3 Recreational Uses

There is currently no public access to Twin Lake, as most of the land adjacent to the lake includes private residential development. Therefore, the recreational use of the lake is typically limited to residents living along the lake. A number of private docks on the lake were observed. Twin Lake has been assigned a District recreational-use level of 2 which includes uses such as canoeing, wildlife habitat, and aesthetic viewing with occasional jet skiing and fishing on the Lake. Additionally, there have not been any citizens expressing concern to the District about lake water quality.

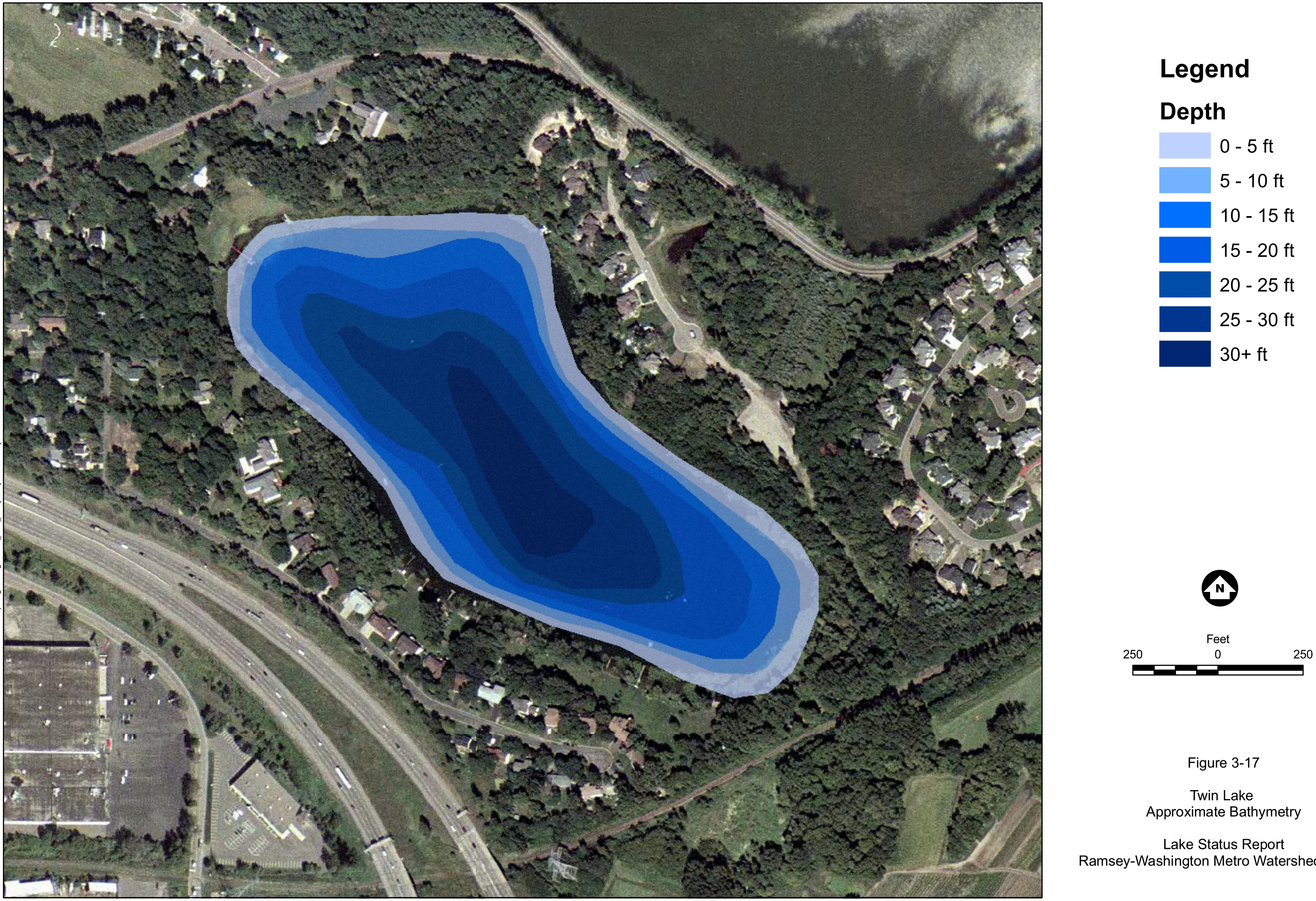

Figure 3-17

Twin Lake
Approximate Bathymetry

Lake Status Report
Ramsey-Washington Metro Watershed District

Figure 3-18
Twin Lake
(Photo Taken 5/11/2006)

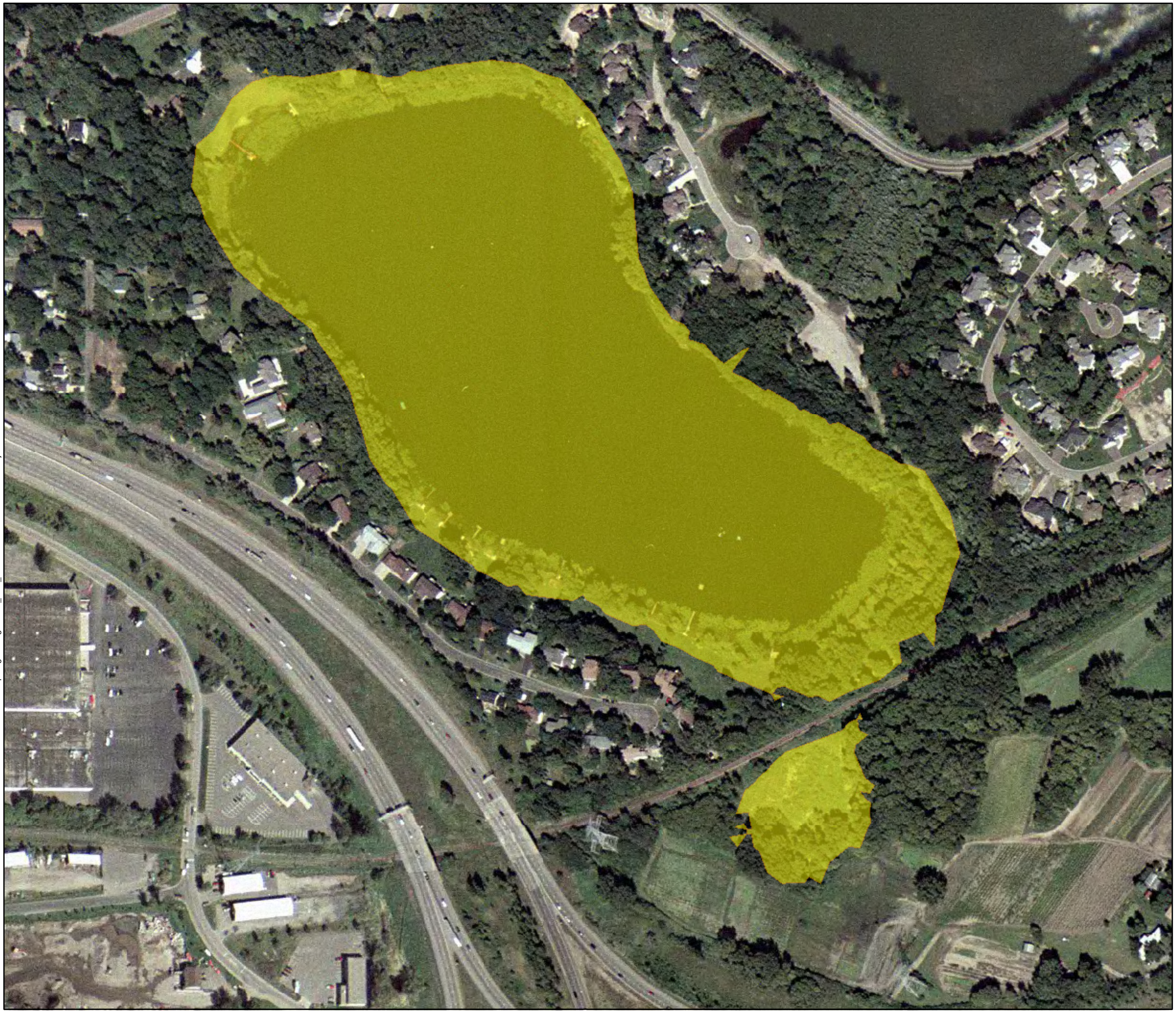

Figure 3-19

Twin Lake
Critical Flood Elevation

Lake Status Report
Ramsey-Washington Metro Watershed District

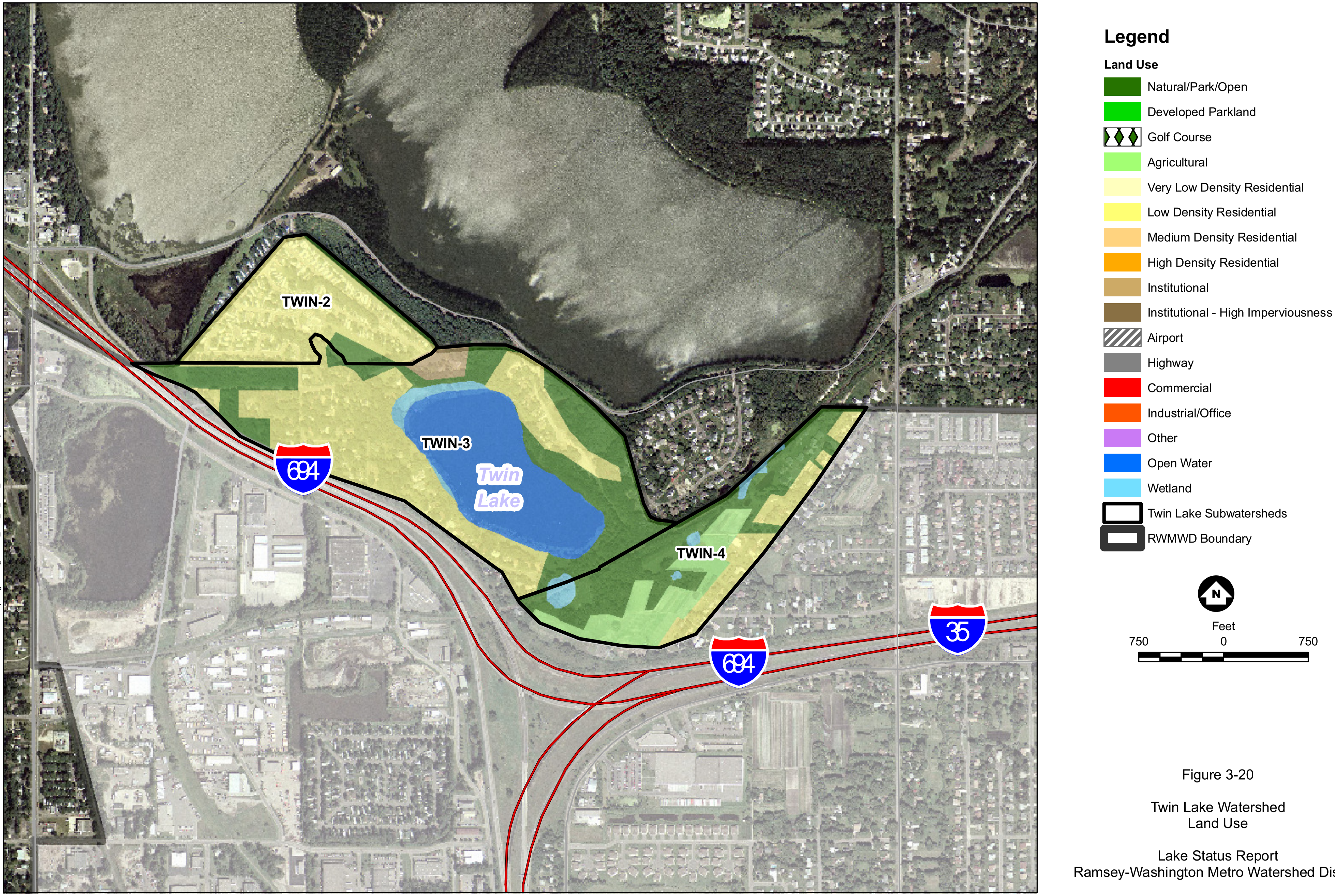

Figure 3-20

Twin Lake Watershed
Land Use

Lake Status Report
Ramsey-Washington Metro Watershed District

Figure 3-21

Twin Lake Watershed
Subwatersheds & Drainage

Lake Status Report
Ramsey-Washington Metro Watershed District

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3.4.2 Water Quality Data

3.4.2.1 Water Quality Analysis

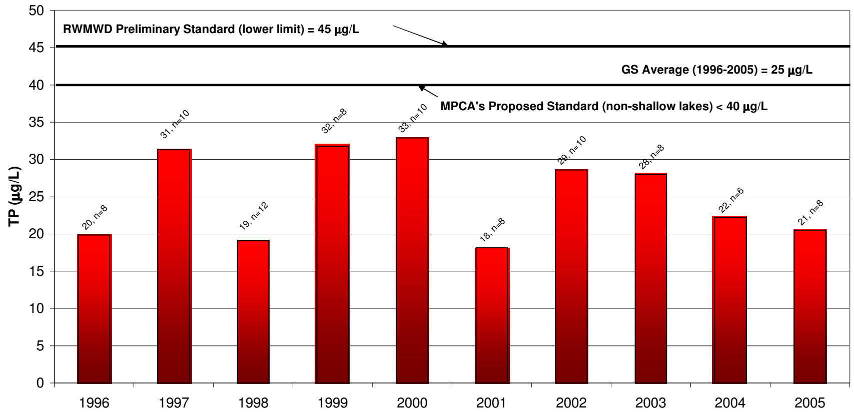
Water quality data is available for Twin Lake from 1996—2005, including data for TP and Chl *a* concentrations as well as SD transparencies. The mean summer average TP and Chl *a* concentrations for Twin Lake were 25 μg/L and 6 μg/L, respectively. The summer average SD transparency was 9.4 feet.

Based on the available data, Twin Lake has a TSI index of 57 for TP, 51 for Chl *a*, and 47 for SD. Overall, Twin Lake would be classified as a mesotrophic to borderline eutrophic lake.

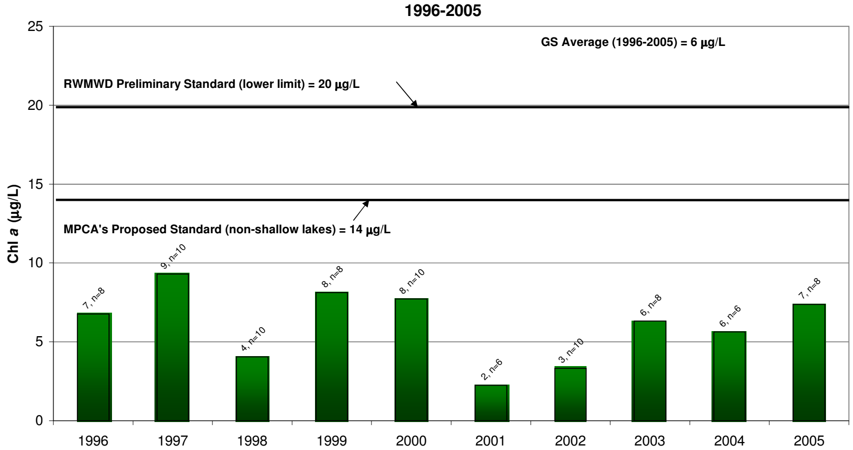
A trend analysis was done on the water quality data available for Twin Lake. The results of this trend analysis suggest that there was neither significant degradation nor improvement in lake water quality over the period of 1996-2005. Twin Lake water quality data is displayed in Figure 3-22. Figure 3-23 shows the relationships between TP, Chl *a*, and SD transparencies for Twin Lake.

The most recent fishery survey was completed in 1996 by the MDNR. The most abundant species surveyed was bluegill. Low to moderate numbers of black crappie were sampled as well as a moderate number of northern pike. Largemouth bass were also sampled in low numbers. Other species present included yellow perch, hybrid sunfish, pumpkinseed, and green sunfish. Review of the past decade of MDNR fishery stocking reports suggests that Twin Lake has not recently been stocked with fish. Additionally, Twin Lake was given an MDNR ecological classification of 30 which suggests a good, permanent fishery. No macroinvertebrate, phytoplankton, or zooplankton surveys have been done for Twin Lake.

TWIN LAKE
Growing Season (June through September) Average
Total Phosphorus Concentrations
1996-2005



TWIN LAKE
Growing Season (June through September) Average
Total Chlorophyll *a* Concentrations
1996-2005



TWIN LAKE
Growing Season (June through September) Average
Secchi Disc Transparencies
1996-2005

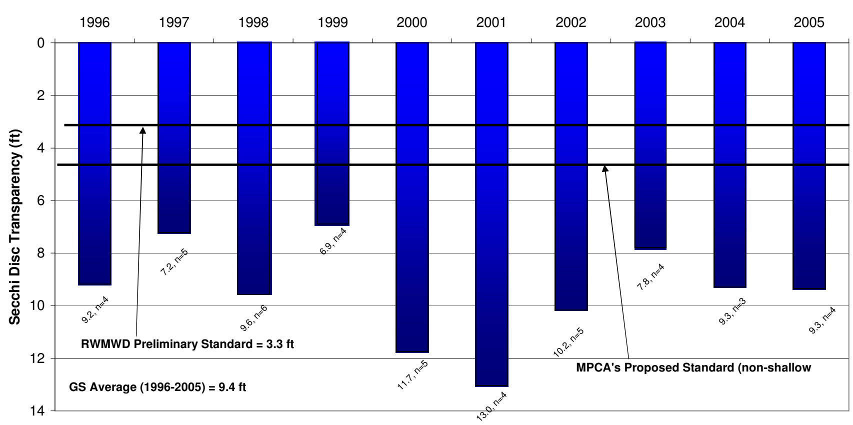
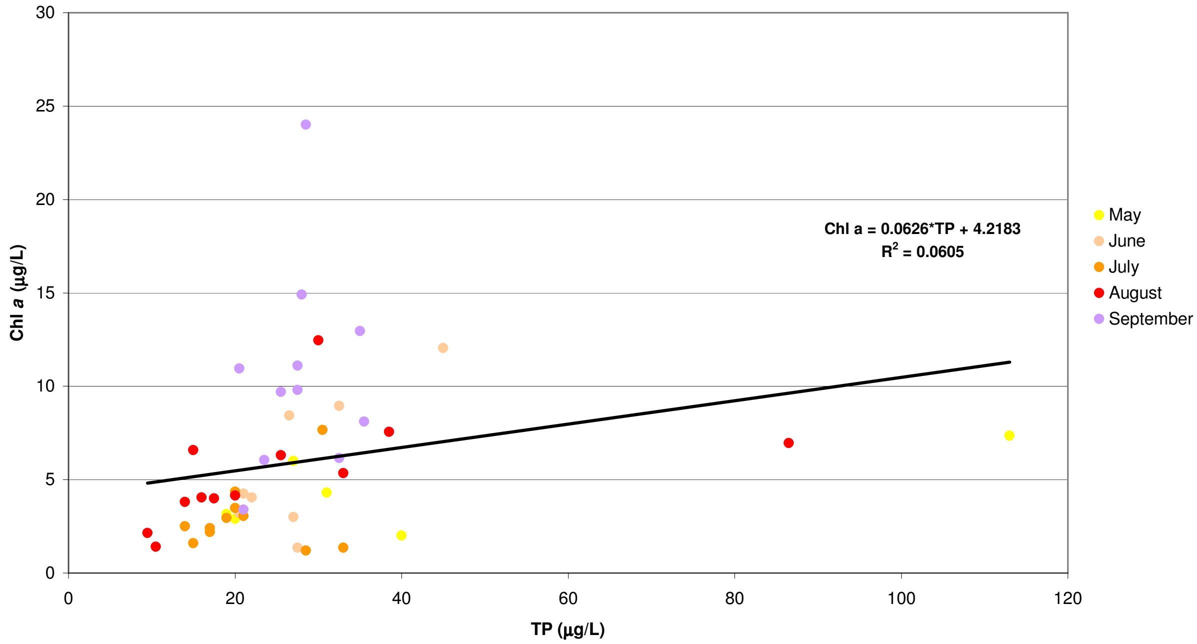


Figure 3-22
Twin Lake Growing Season (June through September)
Averages for Total Phosphorus and Chlorophyll *a*
Concentrations and Secchi Disc Transparency

TWIN LAKE
Chlorophyll *a*-Total Phosphorus Relationship
1996-2005



TWIN LAKE
Secchi Disc-Total Phosphorus Relationship
1996-2005

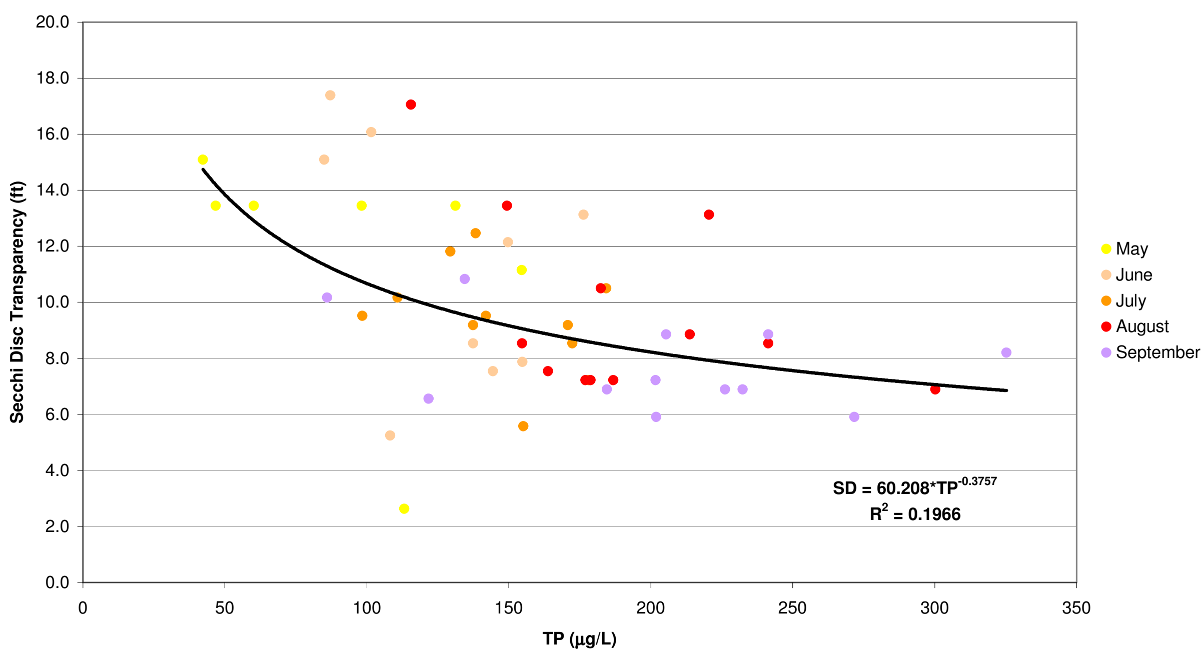


Figure 3-23
Twin Lake Relationship between Total Phosphorus, Chlorophyll *a*, and Secchi Disc Transparency

3.4.2.2 P8 Modeling Results

The P8 Model of the Twin Lake watershed was run for wet, dry, and average climatic conditions. Water and total phosphorus loads to Round Lake were determined for each climatic period. The results of this modeling are summarized in Table 3-4.

Table 3-4 P8 Estimated Watershed Runoff and TP Loads to Twin Lake under Wet, Dry, and Average Climatic Conditions

Climatic Condition (Water Year)	Parameter		Load
Wet (10/1/01-9/30/02)	Flow	ac-ft	68.95
	TP	lbs	68.71
Average (10/1/00-9/30/01)	Flow	ac-ft	105.95
	TP	lbs	70.39
Dry (10/1/88-9/30/89)	Flow	ac-ft	59.75
	TP	lbs	47.93

It is important to note that climatic condition periods were selected based on depths of precipitation over a 17-month period that included the summer before the water year of interest because it is assumed that the water and TP load to the lake during this period affects the following year's spring TP concentration. During the 12-month period from October through September (the water year), however, the water and phosphorus loads to the lake were slightly higher during the average year than the wet year.

3.4.3 Recommendations

3.4.3.1 Water Quality Goals

Preliminary District water quality goals for TP, Chl *a*, and SD are listed in the updated *Watershed Management Plan* (Barr, 2006 [draft]) and are the same as those listed in the 1997 Plan, and the district management class is listed as "Prevent further degradation." Twin Lake is not listed on the CWA 303(d) Impaired Waters List and it has MDNR ecological class of 30 assigned, suggesting a good, permanent fishery.

See Table 1-1 for a summary of applicable classifications and goals established for Twin Lake.

Analysis of the available water quality data suggests that Twin Lake meets or exceeds the preliminary District standards for all three parameters to be considered. Twin Lake also meets the MPCA standards for (non-shallow) lakes in the North Central Hardwood Forest ecoregion. See Figure 3-22.

In addition, results from MINLEAP suggest that the expected water quality in a minimally impacted lake, similar to Twin Lake (based on its location within the Central Hardwood Forest ecoregion and with its basic basin and watershed characteristics), would be within the following ranges for TP, Chl *a*, and SD; respectively: 24 to 54 μg/L, 5 to 23 μg/L, and 0.9 to 2.4 meters. In each of these cases, the observed values fall within or exceed (in the case of SD transparency) these ranges, suggesting that the water quality within Twin Lake is as good as or better than could be expected.

Because Twin Lake has continuously exceeded the proposed MPCA standards for non-shallow lakes, it is recommended that the 2006 District Water Quality Goals for Twin Lake be modified to reflect the MPCA proposed non-shallow lake criteria.

3.4.3.2 Further Studies

Because Twin Lake already has high water quality and meets and exceeds the 2006 District preliminary water quality standards, a prevention of further degradation management approach for this lake seems appropriate.

A prevention of further degradation goal for Twin Lake would involve:

- Enforcement of rules to ensure that new developments do not increase the sediment and phosphorus leaving their sites.
- Monitoring of the fishery, specifically focusing on the presence of benthivorous fish such as carp.
- Monitoring of macrophytes.
- Evaluation of shoreline conditions.

3.5 Willow Lake

3.5.1 Lake and Watershed Characteristics

3.5.1.1 Description of Willow Lake

Willow Lake is located north of Interstate Highway 694 in Vadnais Heights (Township 30, Range 22, Section 33) and is a 75-acre District-managed lake. It is classified as Protected Public Water in the MDNR Public Waters Inventory (62-40P), and it meets the shallow lake criteria as outlined by MPCA (MPCA, 2005).

The maximum depth of Willow Lake is 6 feet. Approximate bathymetric contours have been created using lake survey data gathered by the District in 2002 and are seen in Figure 3-24. Historic lake level data is available for Willow Lake from 1986 to 2006 (See Figure 3-25).

Discharge from the lake flows into Willow Creek (formerly County Ditch 16) which is located just to the east of the lake. A dike was constructed in the early 1980s that diverted the flow of Willow Creek around Willow Lake. During this project, a new outlet was created on the east side of Willow Lake and is a 42-inch CMP including a flap gate for the prevention of backflow into the lake. In addition to the outlet from Willow Lake to Willow Creek, there is also an adjustable weir structure located on Willow Creek just east of where the creek flows under Highway 61, downstream of the lake's primary outlet (See Figure 3-26). This structure is managed by Ramsey County, as the H.B. Fuller Company leases a portion of this land from the County. The NWL of the lake outlet is 880.5 feet MSL and the critical 100-year flood elevation for Willow Lake is 886.2 feet MSL (Barr, 2006 [Draft]). The extent of the 100-year critical flood level can be seen in Figure 3-27 (this figure will be included in the Final Report).

3.5.1.2 Watershed Characteristics

The Willow Lake watershed covers a 518.8-acre area (including lake surface area) north of I-694 in between I-35E and Highway 61, and it is part of the larger Kohlman Lake watershed. The breakdown of land use within the watershed is as follows: Commercial (8.9%), Highway (7.9%), High-density residential (3.2%), Institutional (0.6%), Industrial/office (21.6%), Low-density residential (10.8%), Medium-density residential (0.3%), Natural/park/open (20.9%), Open water (5.9%), and Wetland (19.9%). Willow Lake is included in both the Open water and wetland land use categories. Land use in the Willow Lake watershed is mapped in Figure 3-28.

Drainage from the watershed flows generally from the northwest into Willow Lake and two outfalls into the lake have been identified (per the District survey, 2002). There are a few stormwater treatment ponds located in the watershed upstream of Willow Lake. Willow Lake discharges to Willow Creek, and the drainage pattern of the Willow Lake watershed can be seen in Figure 3-29.

3.5.1.3 Recreational Uses

Willow Lake is completely surrounded by private land owned by the H.B. Fuller Company and has no public access locations. The entire preserve is surrounded by a locked, chain link fence. The Willow Lake Preserve has hiking trails as well as a pier that extends across the southern portion of the lake. It has been assigned a District recreational-use Level of 3, with current uses including canoeing, fishing, wildlife habitat, aesthetic viewing, and picnicking limited to H.B. Fuller employees and their families. Additionally, the Willow Lake Nature Preserve occasionally hosts school groups to provide hands-on educational opportunities.

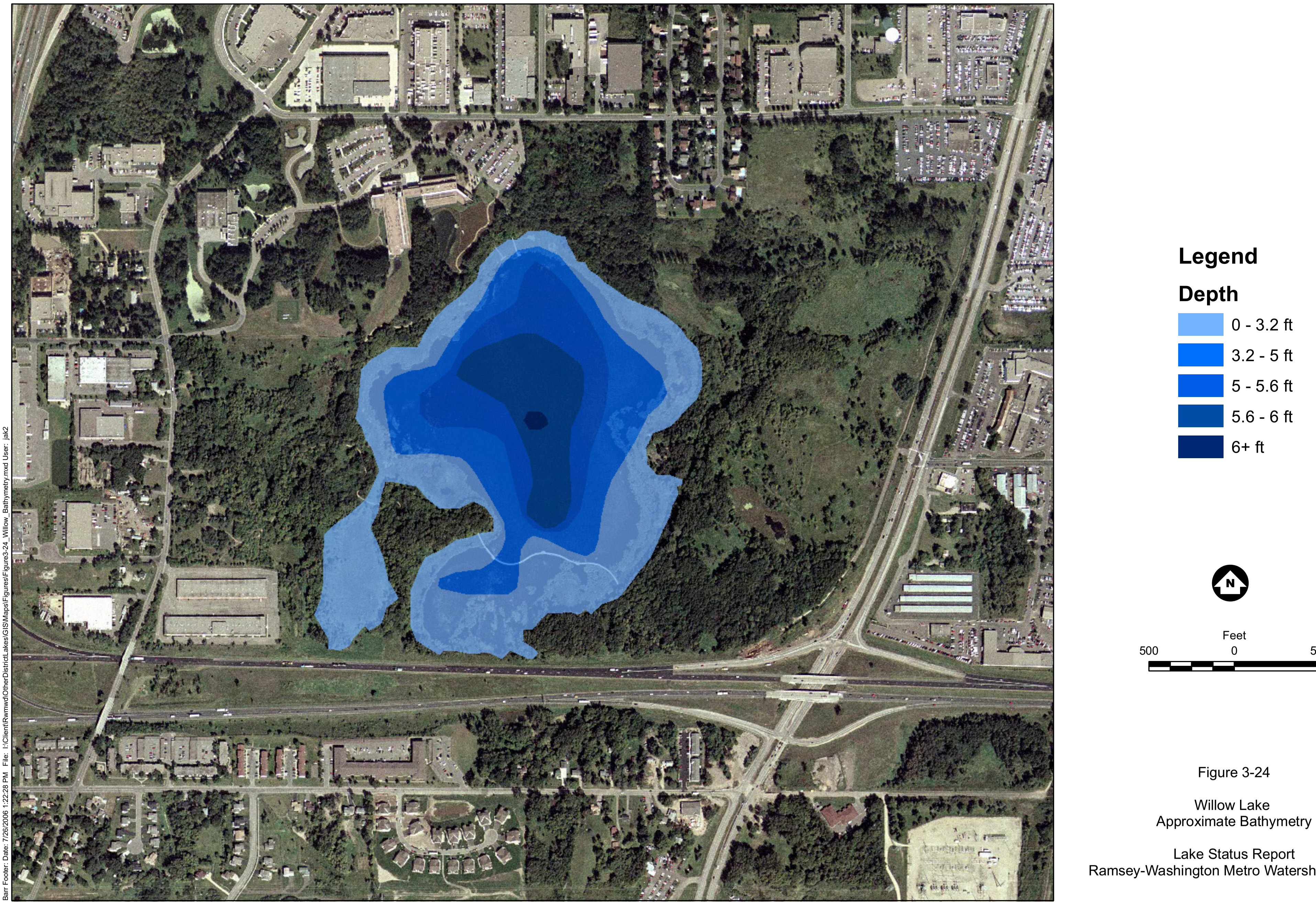


Figure 3-24

Willow Lake
Approximate Bathymetry

Lake Status Report
Ramsey-Washington Metro Watershed District

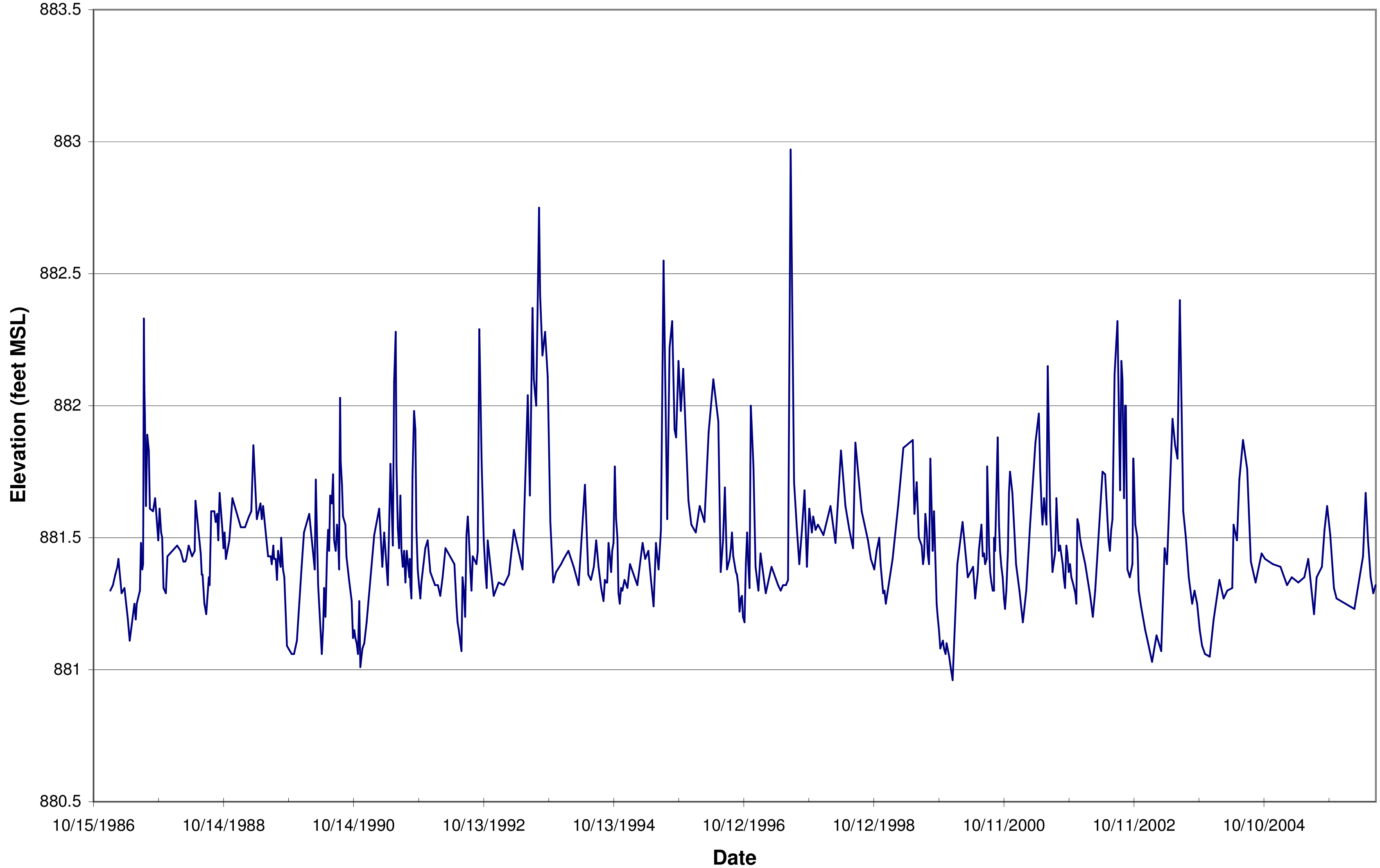


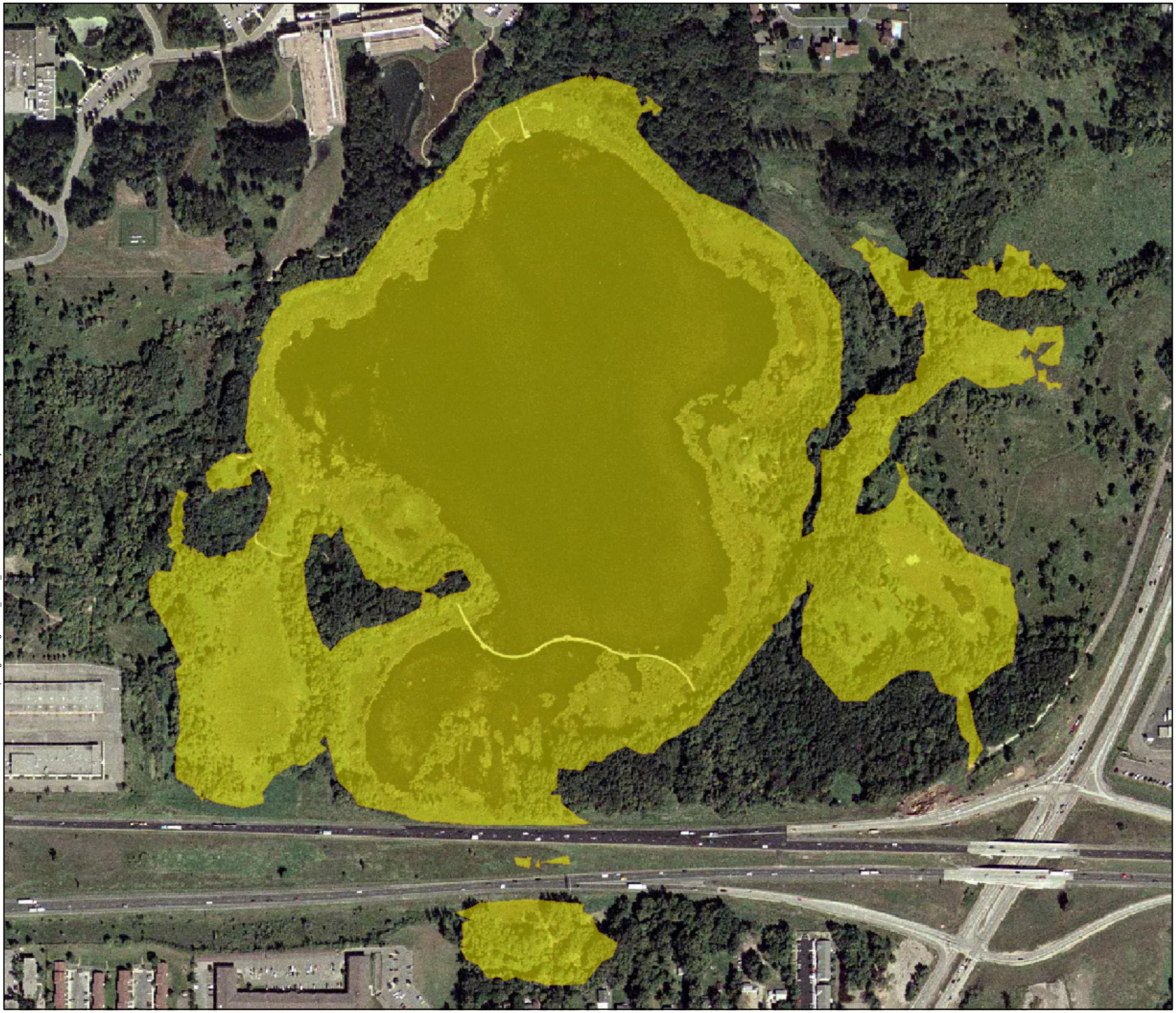
Figure 3-25
Willow Lake Historic Lake Levels
1986 - 2006

(a) (b) (c) (d)

Figure 3-26

Channel from Willow Lake to Outlet Structure (a); Willow Lake Outlet Structure with Flap Gate (located along Willow Creek) (b); Entrance to Adjustable Weir Structure on Willow Creek (c); Looking down on Adjustable Weir Structure (located under Access/Hiking Path in H.B. Fuller Willow Lake Nature Preserve just west of Highway 61) (d)

(Photos Taken on 6/12/2006)



Legend

Flood Elevation = 886.2 ft MSL

N

Feet

500 0 500

Figure 3-27

Willow Lake
Critical Flood Elevation

Lake Status Report
Ramsey-Washington Metro Watershed District

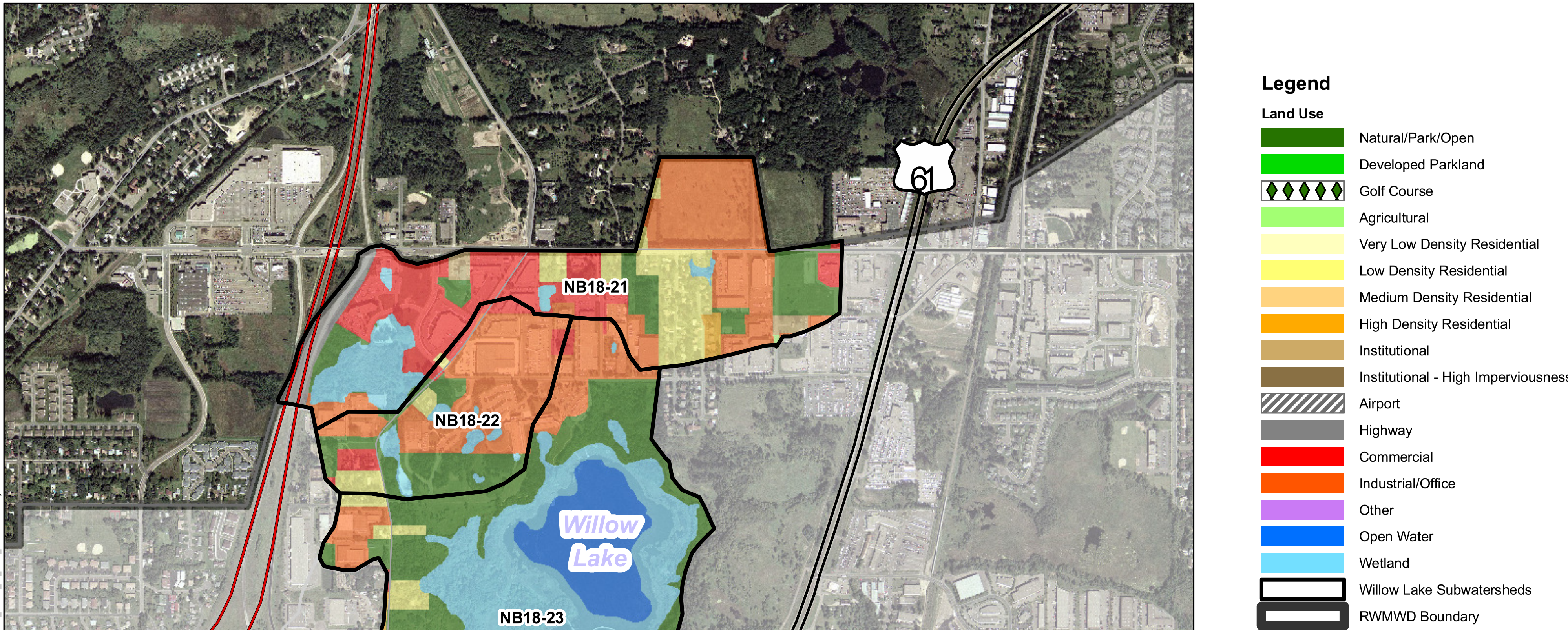


Figure 3-28

Willow Lake Waterhsed
Land Use

Lake Status Report
Ramsey-Washington Metro Watershed District

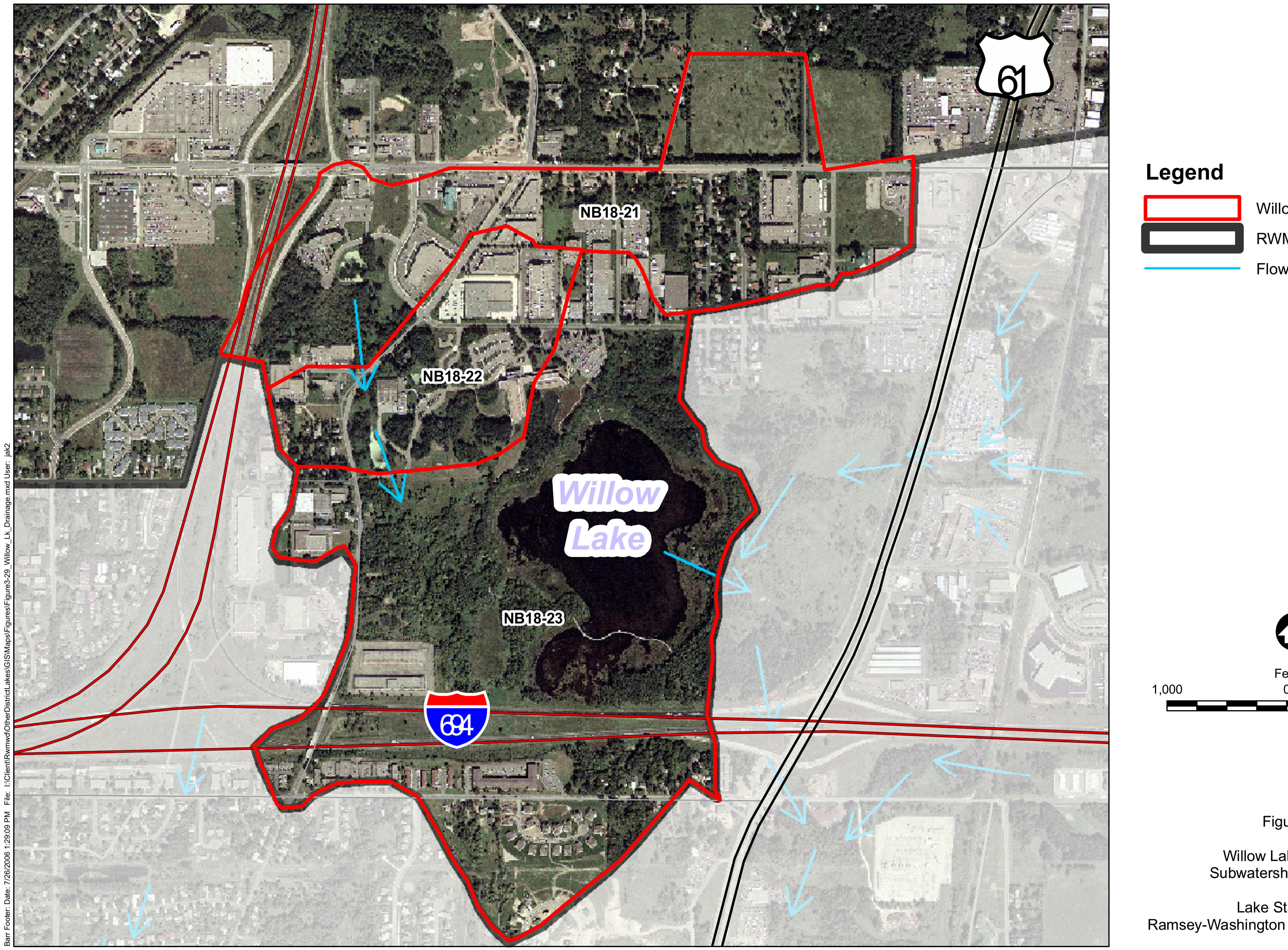


Figure 3-29

Willow Lake Watershed
Subwatersheds & Drainage

Lake Status Report
Ramsey-Washington Metro Watershed District

3.5.2 Water Quality Data

3.5.2.1 Water Quality Analysis

Water quality data is available for Willow Lake from the early 1980's, including data for TP and Chl *a* concentrations as well as SD transparencies. More recent water quality data was collected (1996 to 2001) by the Willow Lake Nature Preserve (H.B. Fuller Company). The summer average TP and Chl *a* concentrations for the years of record in Willow Lake are 47 µg/L and 8 µg/L, respectively. The summer average SD transparency is 5.4 feet (1.65 meters). This data is summarized in Figure 3-30 below. Based on this data, the Carlson TSI for TP is 60. For Chl *a*, it is 51 while for average SD transparency, it is 53, suggesting that Willow Lake is a eutrophic lake. There was not sufficient data to run a trend analysis on the data available.

The most recent fishery survey was completed in 1987 by the MDNR. The survey suggests a lower quality fishery dominated by black bullhead, bluegill, and the hybrid sunfish. No macroinvertebrate, phytoplankton, or zooplankton surveys have been completed for Willow Lake.

3.5.2.2 P8 Modeling Results

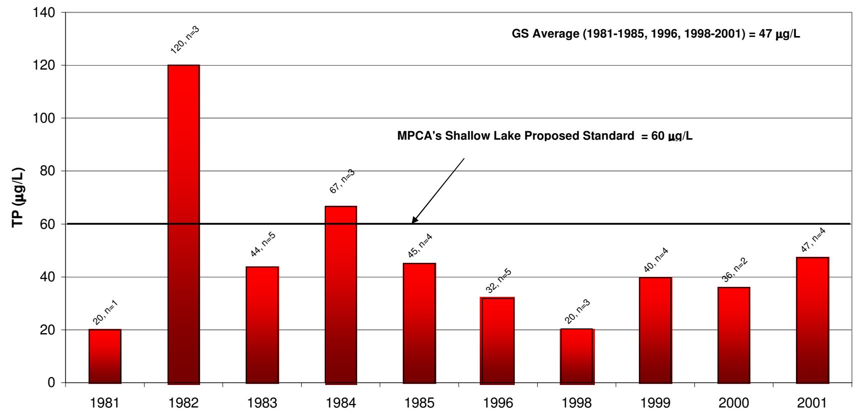
The P8 model for Willow Lake watershed was run for wet, dry, and average climatic conditions. Water and total phosphorus loads to Willow Lake were determined for each climatic period. The results of this modeling are summarized in Table 3-5.

Table 3-5 P8 Estimated Watershed and TP Loads to Willow Lake under Wet, Dry, and Average Climatic Conditions

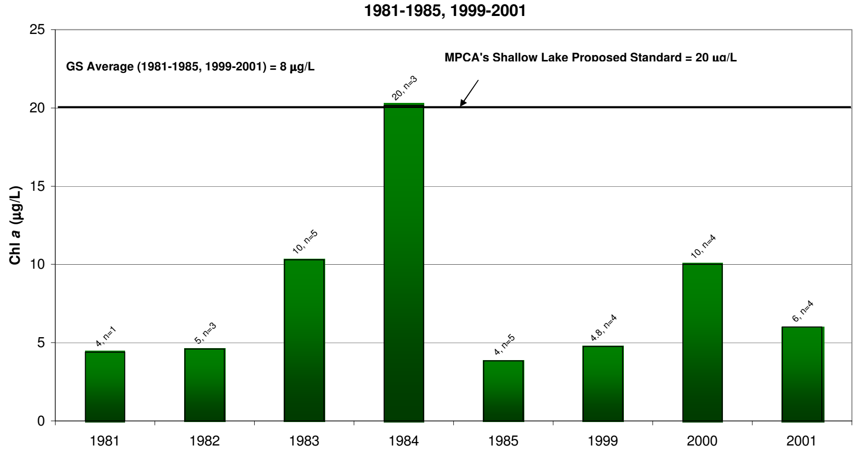
Climatic Condition (Water Year)	Parameter		Load
Wet (10/1/01-9/30/02)	Flow	ac-ft	603.6
	TP	lbs	688.93
Average (10/1/00-9/30/01)	Flow	ac-ft	676.71
	TP	lbs	637.09
Dry (10/1/88-9/30/89)	Flow	ac-ft	428.06
	TP	lbs	441.94

It is important to note that climatic condition periods were selected based on depths of precipitation over a 17-month period that included the summer before the water year of interest because it is assumed that the water and TP load to the lake during this period affects the following year's spring TP concentration. During the 12-month period from October through September (the water year), however, the water load to the lake was slightly higher during the average year than the wet year. Conversely, the TP load was higher in the wet year than in the average year over this 12-month period due to the fact that higher TP loading is often associated with the smaller, more frequent storm events like the ones that occurred between October 2001 and September 2002.

WILLOW LAKE
Growing Season (June through September) Average
Total Phosphorus Concentrations
1981-1985, 1996, 1998-2001



WILLOW LAKE
Growing Season (June through September) Average
Total Chlorophyll *a* Concentrations
1981-1985, 1999-2001



WILLOW LAKE
Growing Season (June through September) Average
Secchi Disc Transparencies
1982,1984-1985, 1996, 1998-2001

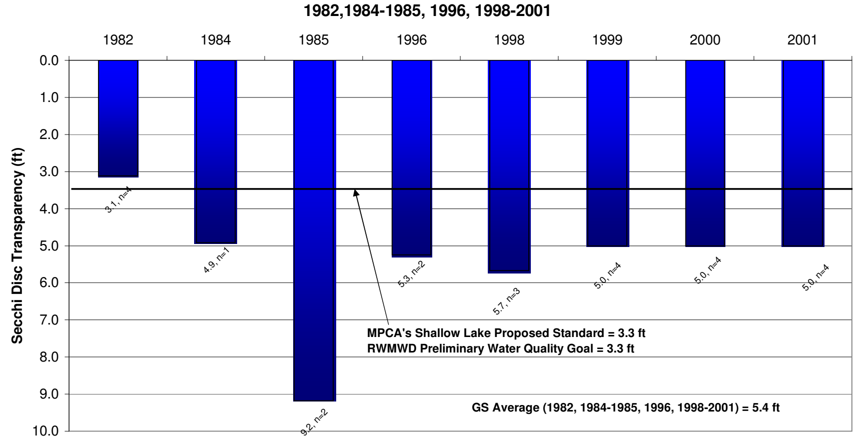


Figure 3-30
Willow Lake Relationship between Total Phosphorus, Chlorophyll *a*, and Secchi Disc Transparency

3.5.3 Recommendations

3.5.3.1 Water Quality Goals

Preliminary District water quality goals for TP, Chl *a*, and SD are listed in the updated 2006 draft *Watershed Management Plan* and are the same as those listed by the MPCA for shallow lakes in the North Central Hardwood Forest. The District management class is listed as "Prevent further degradation." Willow Lake is not listed on the CWA 303(d) Impaired Waters List and it has MDNR ecological class of 41 assigned, suggesting the presence of a lower quality fishery that has the potential to be upgraded with the implementation of specific management practices. See Table 1-1 for a summary of applicable classifications and goals established for Willow Lake. A comparison of the average values of TP, Chl *a*, and SD to the preliminary water quality goals established by the District shows that in all cases, Willow Lake meets the preliminary goal that has been set.

In addition, results from MINLEAP suggest that the expected water quality for a minimally impacted lake, similar to Willow Lake (based on its location within the Central Hardwood Forest ecoregion and with its basic basin and watershed characteristics), would be within the following ranges for TP, Chl *a*, and SD, respectively: 34 to 70 μg/L, 8 to 34 μg/L, and 0.8 to 1.8 meters. In each of these cases, the observed values fall within these ranges, suggesting that the water quality within Willow Lake is consistent with other similar lakes in the CHF ecoregion.

3.5.3.2 Further Studies

Because Willow Lake already has high water quality and meets and exceeds the 2006 District preliminary water quality standards, a prevention of further degradation management approach for this lake is appropriate.

A prevention of further degradation approach typically involves:

- Enforcement of rules to ensure that new developments do not increase the sediment and phosphorus leaving their sites.
- Monitoring of the fishery, specifically focusing on the presence of benthivorous fish such as carp.
- Monitoring of macrophytes.
- Evaluation of shoreline conditions.

4.0 Conclusions

In summary, for some of the lakes studied in this report, there is little information available with regards to water quality, macrophytes, and fisheries. In the case of Casey and Savage Lakes, these resources are actually managed as District wetlands. Because of limited information, updated District water quality management goals cannot be established. Twin and Willow Lakes both have water quality data available and both have good water quality, satisfying the proposed MPCA water quality criteria for non-shallow and shallow lakes.

Table 4-1 below summarizes the proposed District recreational-use levels, water quality goals, and management classes based on evaluation of the data available for each lake.

Table 4-1 Summary of the Proposed RWMWD Recreational-Use Level, Water Quality Goals, and Management Class

Water Body	RWMWD Use Level	2006 RWMWD Water Quality Goal	RWMWD Management Class
Casey Lake	N/A	N/A	Wetland Management Class B
Round Lake (Little Canada)	3-4	TBD[2] 45-75 μg/L TP 20-40 μ g/L Chl*a* 2-3 ft SD	Improvement
Savage Lake	N/A	N/A	Wetland Management Class B/C
Twin Lake	2	40 μg/L TP[3] 14 μg/L Chla[3] 4.6 ft SD[3]	Prevent further degradation
Willow Lake	3	60 μg/L TP[1] 20 μg/L Chla[1] 3.3 ft SD[1]	Prevent further degradation

1- Water quality goals are consistent with the MPCA's draft criteria for shallow lakes in the North Central Hardwood Forests (CHF) ecoregion (Minnesota Lake Water Quality Assessment Report: Developing Nutrient Criteria. Third Edition, September, 2005)

2- TBD – To Be Determined – Currently there is no water quality data for Round Lake to estimate the trophic status of the lake and determine whether or not the Preliminary District Goals are reasonable for this resource.

3- Water quality goals are consistent with the MPCA's draft criteria for non-shallow lakes in the North Central Hardwood Forests (CHF) ecoregion (Minnesota Lake Water Quality Assessment Report: Developing Nutrient Criteria. Third Edition, September, 2005)

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Appendix A

General Concepts in Lake Water Quality

Appendix A: General Concepts in Lake Water Quality

There are a number of concepts and terminology that are necessary to describe and evaluate a lake's water quality. This section is a brief discussion of those concepts, divided into the following topics:

- Eutrophication
- Trophic states
- Limiting nutrients
- Stratification
- Nutrient recycling and internal loading

To learn more about these five topics, one can refer to any text on limnology (the science of lakes and streams).

A.1 Eutrophication

Eutrophication, or lake degradation, is the accumulation of sediments and nutrients in lakes. As a lake naturally becomes more fertile, algae and weed growth increases. The increasing biological production and sediment inflow from a lake's watershed eventually fill the lake's basin. Over a period of many years, the lake successively becomes a pond, a marsh and, ultimately, a terrestrial site. This process of eutrophication is natural and results from the normal environmental forces that influence a lake. Cultural eutrophication, however, is an acceleration of the natural process caused by human activities. Nutrient and sediment inputs (i.e., loadings) from wastewater treatment plants, septic tanks, and stormwater runoff can far exceed the natural inputs to the lake. The accelerated rate of water quality degradation caused by these pollutants does result in unpleasant consequences. These include profuse and unsightly growths of algae (algal blooms) and/or the proliferation of rooted aquatic weeds (macrophytes).

A.2 Trophic States

Not all lakes are at the same stage of eutrophication; therefore, criteria have been established to evaluate the nutrient status of lakes. Trophic state indices (TSIs) are calculated for lakes on the basis of total phosphorus, Chlorophyll *a* concentrations, and Secchi disc transparencies. TSI values range upward from 0, describing the condition of the lake in terms of its trophic status (i.e., its degree of fertility). All three of the parameters can be used to determine a TSI. However, water transparency is typically used to develop the TSI_{SD} (trophic state index based on Secchi disc transparency) because people's perceptions of water clarity are often directly related to recreational-use impairment. The TSI rating system results in the placement of a lake with high fertility in the hypereutrophic status category. Water quality trophic status categories include oligotrophic (i.e., excellent water quality), mesotrophic (i.e., good water quality), eutrophic (i.e., poor water quality), and hypereutrophic (i.e., very poor water quality). Water quality characteristics of lakes in the various trophic status categories are listed below with their respective TSI ranges:

1. **Oligotrophic** – [$20 \leq TSI_{SD} \leq 38$] clear, low productive lakes, with total phosphorus concentrations less than or equal to 10 μg/L, Chlorophyll *a* concentrations of less than or equal to 2 μg/L, and Secchi disc transparencies greater than or equal to 4.6 meters (15 feet).
2. **Mesotrophic** – [$38 \leq TSI_{SD} \leq 50$] intermediately productive lakes, with total phosphorus concentrations between 10 and 25 μg/L, Chlorophyll *a* concentrations between 2 and 8 μg/L, and Secchi disc transparencies between 2 and 4.6 meters (6 to 15 feet).
3. **Eutrophic** – [$50 \leq TSI_{SD} \leq 62$] high productive lakes relative to a neutral level, with 25 to 57 μg/L total phosphorus, Chlorophyll *a* concentrations between 8 and 26 μg/L, and Secchi disc measurements between 0.85 and 2 meters (2.7 to 6 feet).
4. **Hypereutrophic** – [$62 \leq TSI_{SD} \leq 80$] extremely productive lakes which are highly eutrophic and unstable (i.e., their water quality can fluctuate on daily and seasonal basis, experience periodic anoxia and fish kills, possibly produce toxic substances, etc.) with total phosphorus concentrations greater than 57 μg/L, Chlorophyll *a* concentrations of greater than 26 μg/L, and Secchi disc transparencies less than 0.85 meters (2.7 feet).

Determining the trophic status of a lake is an important step in diagnosing water quality problems. Trophic status indicates the severity of a lake's algal growth problems and the degree of change needed to meet its recreational-use goals. Additional information, however, is needed to determine the cause of algal growth and a means of reducing it.

A.3 Limiting Nutrients

The quantity or biomass of algae in a lake is usually limited by the water's concentration of an essential element or nutrient "the limiting nutrient". (For rooted aquatic plants, the nutrients are derived from the sediments.) The limiting nutrient concept is a widely applied principle in ecology and in the study of eutrophication. It is based on the idea that plants require many nutrients to grow, but the nutrient with the lowest availability, relative to the amount needed by the plant, will limit plant growth. It follows then, that identifying the limiting nutrient will point the way to controlling algal growth.

Nitrogen (N) and phosphorus (P) are generally the two growth-limiting nutrients for algae in most natural waters. Analysis of the nutrient content of lake water and algae provides ratios of N:P. By comparing the ratio in water to the ratio in the algae, one can estimate whether a particular nutrient may be limiting. Algal growth is generally phosphorus-limited in waters with N:P ratios greater than 12. Laboratory experiments (bioassays) can demonstrate which nutrient is limiting by growing the algae in lake water with various concentrations of nutrients added. Bioassays, as well as fertilization of in-situ enclosures and whole-lake experiments, have repeatedly demonstrated that phosphorus is usually the nutrient that limits algal growth in freshwaters. Reducing phosphorus in a lake, therefore, is required to reduce algal abundance and improve water transparency. Failure to reduce phosphorus concentrations will allow the process of eutrophication to continue at an accelerated rate.

A.4 Stratification

The process of internal loading is dependent on the amount of organic material in the sediments and the depth-temperature pattern, or “thermal stratification,” of a lake. Thermal stratification profoundly influences a lake’s chemistry and biology. When the ice melts and air temperature warms in spring, lakes generally progress from being completely mixed to stratified with only an upper warm well-mixed layer of water (epilimnion), and cold temperatures in a bottom layer (hypolimnion). Because of the density differences between the lighter warm water and the heavier cold water, stratification in a lake can become very resistant to mixing. When this occurs, generally in mid-summer, oxygen from the air cannot reach the bottom lake water and, if the lake sediments have sufficient organic matter, biological activity can deplete the remaining oxygen in the hypolimnion. The epilimnion can remain well-oxygenated, while the water above the sediments in the hypolimnion becomes completely devoid of dissolved oxygen (anoxic). Complete loss of oxygen changes the chemical conditions in the water and allows phosphorus that had remained bound to the sediments to reenter the lake water.

As the summer progresses, phosphorus concentrations in the hypolimnion can continue to rise until oxygen is again introduced (recycled). Dissolved oxygen concentration will increase if the lake sufficiently mixes to disrupt the thermal stratification. Phosphorus in the hypolimnion is generally not available for plant uptake because there is not sufficient light penetration to the hypolimnion to allow for growth of algae. The phosphorus, therefore, remains trapped and unavailable to the plants until the lake is completely mixed. In shallow lakes this can occur throughout the summer, with sufficient wind energy (polymixis). In deeper lakes, however, only extremely high wind energy is sufficient to destratify a lake during the summer and complete mixing only occurs in the spring and fall (dimixis). Cooling air temperature in the fall reduces the epilimnion water temperature, and consequently increases the density of water in the epilimnion. As the epilimnion water density approaches the density of the hypolimnion water very little energy is needed to cause complete mixing of the lake. When this fall mixing occurs, phosphorus that has built up in the hypolimnion is mixed with the epilimnion water and becomes available for plant and algal growth.

A.5 Nutrient Recycling and Internal Loading

The significance of thermal stratification in lakes is that the density change in the metalimnion (i.e., middle transitional water temperature stratum) provides a physical barrier to mixing between the epilimnion and the hypolimnion. While water above the metalimnion may circulate as a result of wind action, hypolimnetic waters at the bottom generally remain isolated. Consequently, very little transfer of oxygen occurs from the atmosphere to the hypolimnion during the summer.

Shallow water bodies may circulate many times during the summer as a result of wind mixing. Lakes possessing these wind mixing characteristics are referred to as **polymictic** lakes. In contrast, deeper lakes generally become well-mixed only twice each year. This usually occurs in the spring and fall. Lakes possessing these mixing characteristics are referred to as **dimictic** lakes. During these periods, the lack of strong temperature/density differences allows wind-driven circulation to mix the water column throughout. During these mixing events, oxygen may be transported to the deeper portions of the lake, while dissolved phosphorus is brought up to the surface.

Phosphorus enters a lake from either watershed runoff or direct atmospheric deposition. It would, therefore, seem reasonable that phosphorus in a lake can decrease by reducing these external loads of phosphorus to the lake. All lakes, however, accumulate phosphorus (and other nutrients) in the sediments from the settling of particles and dead organisms. In some lakes this reservoir of phosphorus can be reintroduced in the lake water and become available again for plant uptake. This resuspension or dissolution of nutrients from the sediments to the lake water is known as “internal loading”. As long as the lake’s sediment surface remains sufficiently oxidized (i.e., dissolved oxygen remains present in the water above the sediment), its phosphorus will remain bound to sediment particles as ferric hydroxy phosphate. When dissolved oxygen levels become extremely low at the water-sediment interface (as a result of microbial activity using the oxygen), the chemical reduction of ferric iron to its ferrous form causes the release of dissolved phosphorus, which is readily available for algal growth, into the water column. The amount of phosphorus released from internal loading can be estimated from depth profiles (measurements from surface to bottom) of dissolved oxygen and phosphorus concentrations. Even if the water samples indicate the water column is well oxidized, the oxygen consumption by the sediment during decomposition can restrict the thickness of the oxic sediment layer to only a few millimeters. Therefore, the sediment cannot retain the phosphorus released from decomposition or deeper sediments, which result in an internal phosphorus release to the water column. Low-oxygen conditions at the sediments, with resulting phosphorus release, are to be expected in eutrophic lakes where relatively large quantities of organic material (decaying algae and macrophytes) are deposited on the lake bottom.

If the low-lying phosphorus-rich waters near the sediments remain isolated from the upper portions of the lake, algal growth at the lake's surface will not be stimulated. Shallow lakes and ponds can be expected to periodically stratify during calm summer periods, so that the upper warmer portion of the water body is effectively isolated from the cooler, deeper (and potentially phosphorus-rich) portions. Deep lakes typically retain their stratification until cooler fall air temperatures allow the water layers to become isothermal and mix again. Deep lakes are, therefore, frequently dimictic, typically mixing only twice a year. However, relatively shallow lakes are less thermally stable and may mix frequently during the summer periods.

The pH of the water column can also play a vital role in affecting the phosphorus release rate under oxic conditions. Photosynthesis by macrophytes and algae during the day tend to raise the pH in the water column, which can enhance the phosphorus release rate from the oxic sediment. Enhancement of the phosphorus release at elevated pH (pH > 7.5) is thought to occur through replacement of the phosphate ion (PO_4^{-3}) with the excess hydroxyl ion (OH^-) on the oxidized iron compound (James, et al., 2001).

Another potential source of internal phosphorus loading is the die-off of Curlyleaf pondweed, which is an exotic (i.e., non-native) lake weed is present in many of the lakes in Minnesota.

Appendix B

Fisheries & Biological Data

Name: TWIN

Nearest Town: LITTLE CANADA
Primary County: Ramsey

Survey Date: 07/24/1996
Inventory Number: 62-0039-00

Lake Characteristics

Lake Area (acres): 35.50
Littoral Area (acres): 15.50
Maximum Depth (ft): 33.00
Water Clarity (ft): N/A

Dominant Bottom Substrate: muck, marl, detritus
Abundance of Aquatic Plants: abundant
Maximum Depth of Plant Growth (ft): 9.00

Fish Sampled up to the 1996 Survey Year

		Number of fish per net			
Species	**Gear Used**	**Caught**	**Normal Range**	**Average Fish Weight (lbs)**	**Normal Range (lbs)**
Black Crappie	Gill net	0.5	1.9 - 18.0	0.13	0.1 - 0.3
	Trap net	5.2	1.8 - 18.1	0.16	0.2 - 0.3
Bluegill	Gill net	1.5	N/A - N/A	0.06	N/A - N/A
	Trap net	21.1	6.5 - 59.6	0.07	0.1 - 0.2
Golden Shiner	Gill net	0.5	0.7 - 3.9	0.08	0.1 - 0.1
Green Sunfish	Trap net	0.2	0.3 - 2.0	0.09	0.1 - 0.1
Hybrid Sunfish	Gill net	0.5	N/A - N/A	0.04	N/A - N/A
	Trap net	4.2	N/A - N/A	0.04	N/A - N/A
Largemouth Bass	Trap net	0.4	0.3 - 0.8	0.16	0.2 - 1.1
Northern Pike	Gill net	5.0	2.5 - 7.9	4.03	1.8 - 3.3
	Trap net	0.1	N/A - N/A	2.84	N/A - N/A
Pink Salmon	Gill net	0.5	N/A - N/A	0.04	N/A - N/A
Pumpkinseed Sunfish	Trap net	1.6	0.8 - 5.3	0.08	0.1 - 0.2
Snapping Turtle	Trap net	0.2	N/A - N/A	ND	N/A - N/A
Yellow Perch	Gill net	4.5	1.5 - 12.8	0.10	0.1 - 0.2
	Trap net	0.9	0.3 - 1.5	0.11	0.1 - 0.2

Normal Ranges represent typical catches for lakes with similar physical and chemical characteristics.

Length of Selected Species Sampled for All Gear for the 1996 Survey Year

	Number of fish caught in each category (inches)								
Species	***0-5***	***6-8***	***9-11***	***12-14***	***15-19***	***20-24***	***25-29***	***>29***	***Total***
Black Crappie	1	47	0	0	0	0	0	0	48
Bluegill	182	11	0	0	0	0	0	0	193
Green Sunfish	2	0	0	0	0	0	0	0	2

Hybrid Sunfish	39	0	0	0	0	0	0	0	39
Largemouth Bass	2	1	1	0	0	0	0	0	4
Northern Pike	0	0	0	0	0	4	7	0	11
Pink Salmon	1	0	0	0	0	0	0	0	1
Pumpkinseed Sunfish	13	1	0	0	0	0	0	0	14
Yellow Perch	4	13	0	0	0	0	0	0	17

Fish Consumption Advisory

No fish consumption information is available for this lake. For more information, see the "Fish Consumption Advice" pages at the Minnesota Department of Health.

Status of the Fishery (as of 07/24/1996)

Twin Lake does not appear to have winterkilled sevrely in the past five or more years. Thus, populations of several species offer angling opportunities to lake residents. However, there is no public access. Bluegill were the most abundant specices sample, but are small with an average size of 4.5 inches and fewer than 10% being over 6 inches. Low to moderate numbers of small (5 to 8 inch) black crappie are also present. Moderate numbers of northern pike were sampled with lengths ranging from 23 to 30 inches. Largemouth bass were also sampled, but not in high numbers. However, the sampling techniques used were not effective on bass, so numbers could be higher than sampling results indicate. Bass were small - lengths ranged from 5 to 9 inches. Low to moderate numbers of yellow perch, hybrid sunfish, pumpkinseed, and green sunfish are also present, but are generally small.

For Additional Information

Area Fisheries Supervisor:

1200 WARNER ROAD
ST. PAUL, MN 55106
(651) 772-7950

Lake maps can be obtained from:

Minnesota Bookstore
660 Olive Street
St. Paul, MN 55155
(651) 297-3000 or (800) 657-3757
To order, use C1220 for the map-id.

General DNR Information:

DNR Information Center
500 Lafayette Road
St. Paul, MN 55155-4040
(651) 296-6157 or (888) MINNDNR
TDD: (651) 296-5484 or (800) 657-3929
E-Mail: info@dnr.state.mn.us

Turn in Poachers (TIP):

Toll-free: (800) 652-9093

Name: WILLOW

Nearest Town: WHITE BEAR LAKE
Primary County: Ramsey

Survey Date: 09/10/1987
Inventory Number: 62-0040-00

Lake Characteristics

Lake Area (acres): N/A
Littoral Area (acres): N/A
Maximum Depth (ft): 5.00
Water Clarity (ft): N/A

Dominant Bottom Substrate: N/A
Abundance of Aquatic Plants: N/A
Maximum Depth of Plant Growth (ft): N/A

Fish Sampled for the 1987 Survey Year

Species	Gear Used	Number of fish per net: Caught	Number of fish per net: Normal Range	Average Fish Weight (lbs)	Normal Range (lbs)
Muskellunge	Gill net	6.0	N/A - N/A	2.18	N/A - N/A
Largemouth Bass	Gill net	7.0	1.0 - 3.8	1.20	0.2 - 0.7
Hybrid Sunfish	Gill net	11.0	N/A - N/A	0.34	N/A - N/A
Green Sunfish	Gill net	1.0	0.8 - 13.0	0.10	N/A - N/A
Bluegill	Gill net	28.0	N/A - N/A	0.20	N/A - N/A
Black Bullhead	Gill net	43.0	8.0 - 90.0	0.88	0.1 - 0.4
Largemouth Bass	Trap net	0.7	0.2 - 1.1	0.45	0.3 - 1.0
Hybrid Sunfish	Trap net	2.7	N/A - N/A	0.41	N/A - N/A
Bluegill	Trap net	11.7	2.8 - 43.3	0.20	0.1 - 0.3
Black Bullhead	Trap net	1.0	2.5 - 70.2	0.73	0.1 - 0.5

Normal Ranges represent typical catches for lakes with similar physical and chemical characteristics.

Length of Selected Species Sampled for All Gear for the 1987 Survey Year

Number of fish caught in each category (inches)

Species	*0-5*	*6-8*	*9-11*	*12-14*	*15-19*	*20-24*	*25-29*	*>29*	*Total*
Muskellunge	0	0	0	0	0	4	2	0	6
Largemouth Bass	0	1	3	4	1	0	0	0	9
Hybrid Sunfish	0	19	0	0	0	0	0	0	19
Green Sunfish	1	0	0	0	0	0	0	0	1
Bluegill	18	44	0	0	0	0	0	0	62
Black Bullhead	0	0	35	11	0	0	0	0	46

Fish Consumption Advisory

No fish consumption information is available for this lake. For more information, see the "Fish

Consumption Advice" pages at the Minnesota Department of Health.

For Additional Information

Area Fisheries Supervisor:

1200 WARNER ROAD
ST. PAUL, MN 55106
(651) 772-7950

Lake maps can be obtained from:

Minnesota Bookstore
660 Olive Street
St. Paul, MN 55155
(651) 297-3000 or (800) 657-3757
To order, use NOMAP for the map-id.

General DNR Information:

DNR Information Center
500 Lafayette Road
St. Paul, MN 55155-4040
(651) 296-6157 or (888) MINNDNR
TDD: (651) 296-5484 or (800) 657-3929
E-Mail: info@dnr.state.mn.us

Turn in Poachers (TIP):

Toll-free: (800) 652-9093

Name: Casey

Nearest Town: WHITE BEAR LAKE
Primary County: Ramsey

Survey Date: 08/01/2001
Inventory Number: 62-0005-00

Public Access Information

Ownership	Type	Description
City	Carry-in	No formal boat access but carry-in possible from parking lot.

Lake Characteristics

Lake Area (acres): 11.60
Littoral Area (acres): 11.60
Maximum Depth (ft): 3.50
Water Clarity (ft): 0.50

Dominant Bottom Substrate: N/A
Abundance of Aquatic Plants: N/A
Maximum Depth of Plant Growth (ft): N/A

Fish Sampled up to the 2001 Survey Year

		Number of fish per net			
Species	**Gear Used**	**Caught**	**Normal Range**	**Average Fish Weight (lbs)**	**Normal Range (lbs)**
Black Bullhead	Trap net	25.3	N/A - N/A	0.18	N/A - N/A
Black Crappie	Trap net	24.0	N/A - N/A	0.10	N/A - N/A
Common Carp	Trap net	6.3	N/A - N/A	1.30	N/A - N/A
Green Sunfish	Trap net	1.8	N/A - N/A	0.03	N/A - N/A
Snapping Turtle	Trap net	1.5	N/A - N/A	ND	N/A - N/A

Normal Ranges represent typical catches for lakes with similar physical and chemical characteristics.

Length of Selected Species Sampled for All Gear for the 2001 Survey Year

	Number of fish caught in each category (inches)								
Species	***0-5***	***6-8***	***9-11***	***12-14***	***15-19***	***20-24***	***25-29***	***>29***	***Total***
Black Bullhead	0	22	0	0	0	0	0	0	22
Black Crappie	8	4	0	0	0	0	0	0	12
Green Sunfish	4	0	0	0	0	0	0	0	4

Fish Consumption Advisory

No fish consumption information is available for this lake. For more information, see the "Fish Consumption Advice" pages at the Minnesota Department of Health.

Status of the Fishery (as of 08/01/2001)

Casey Lake is located in Casey Lake City Park (City of North St. Paul). It is roughly 12 acres and has a maximum depth of 3.5'. Water quality is poor, with a secchi depth of only 0.5 feet on 8/1/01. There is no designated access, but carry-in access is possible from the parking lot. Local ordinance prohibits the use of motors on Casey Lake.

Black bullhead were the most abundant species sampled. Lengths ranged from 6.5" to 9". Black crappeie were also abundant, but small. Lengths ranged from 5" to 7", with a 6" average. Common carp were abundant, with lengths ranging from 10" to 20". Green sunfish were also sampled.

For Additional Information

Area Fisheries Supervisor:

1200 WARNER ROAD
ST. PAUL, MN 55106
(651) 772-7950

Lake maps can be obtained from:

Minnesota Bookstore
660 Olive Street
St. Paul, MN 55155
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