The Limnological Institute

A conservation organization providing research and solutions for the preservation of our inland waters.

2005 Dutch Hollow Lake Water Quality Technical Report

Prepared by:

Aquatic Engineering

Post Office Box 3634

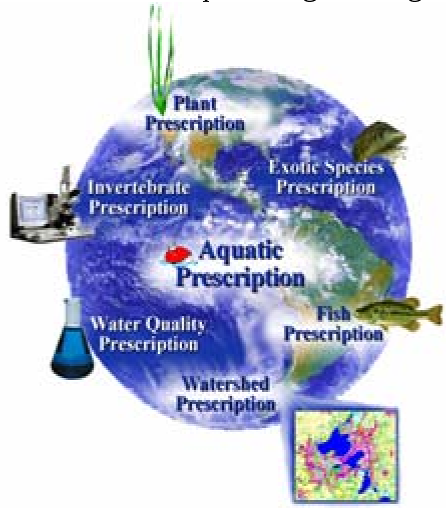
La Crosse, WI 54602-3634

Phone: 608-781-8770

Fax: 608-781-8771

E-mail: info@aquaticengineering.org

Web Site: www.aquaticengineering.org



2005 Dutch Hollow Lake Water Quality Technical Report

August 2007

By J. E. Britton[1], and N. D. Strasser[2]

In cooperation with the Wisconsin Department of Natural Resources

1 Aquatic Engineering, Inc.; jbritton@aquaticengineering.org
PO Box 3634, La Crosse, WI 54602-3634
Phone: 866-781-8770
www.aquaticengineering.org

08/03/2007

Signature Date

2 Aquatic Engineering, Inc.; nstrasser@aquaticengineering.org
PO Box 3634, La Crosse, WI 54602-3634
Phone: 866-781-8770
www.aquaticengineering.org

08/03/2007

Signature Date

Acknowledgements

The 2005 Dutch Hollow Lake water quality monitoring activities were completed with the assistance of the Dutch Hollow Lake Property Owners Association, Inc., and through a WDNR-administered Lake Planning Grant (# LPL-1029-05), which provided 75% of the monitoring costs. A special thanks to the following individuals for their help throughout the project:

Dutch Hollow Lake Property Owners Association, Inc.

Dale Nelson	President
James Ryan	Vice President
Linda Reeder	Treasurer
Mary Peterson	Board Member
Tom Schneider	Board Member
Tom Miller	Board Member
Bette Simono	Board Member
Judy Skrabel	Board Member
Joan Whitehurst	General Manager

Wisconsin Department of Natural Resources

Susan Graham	Lake Coordinator
Pat Sheahan	Environmental Grants Specialist
Eileen Trainor	Environmental Grants Specialist

Executive Summary

Dutch Hollow Lake is a 210-acre drainage lake located in the townships of LaValle and Woodland in Sauk County, WI. The lake is an impoundment of Dutch Hollow Creek and has a maximum depth of 40 feet.

In 2004, the Dutch Hollow Lake Property Owners Association, Inc. (DHLPOA) contracted The Limnological Institute (TLI) to write a grant for Wisconsin Department of Natural Resources (WDNR) funding. Once the grant was awarded, TLI contracted Aquatic Engineering, Inc., (AEI) to perform the technical monitoring and the Wisconsin State Laboratory of Hygiene (WSLOH) to perform laboratory water quality analyses.

Water quality measurements collected in 2005 show that Dutch Hollow Lake is a mesotrophic system that becomes thermally stratified in the summer and has physical parameters typical of young, deep drainage lakes. Total phosphorus, chlorophyll *a*, and Secchi readings were used to calculate the trophic status, and all support the mesotrophic status.

The major nutrient inputs are thought to be from the watershed and groundwater interactions. There could also be possible inputs from septic systems and internal loading from sediments. More investigation is required to determine the exact nutrient inputs by category.

Table of Contents

Acknowledgements ii

Executive Summary v

1.0 Introduction 1

1.1 Project Scope 1

2.0 Review of Existing Information 3

2.1 Water Clarity 3

2.2 Trophic Status 3

2.3 Watershed Analysis and Nutrient Modeling 4

3.0 Methods 7

3.1 Water Sample Collection 7

3.2 On-Site Water Quality Measurements 7

3.3 Trophic Status Calculations 8

3.4 Watershed Delineation and WiLMS Analysis 8

4.0 Results 11

4.1 Phosphorous 11

4.2 Chlorophyll *a* 12

4.3 Secchi Depth 13

4.4 Other Parameters 13

Total Suspended Solids (TSS) 13

Total Kjeldahl Nitrogen (TKN) 14

Temperature 14

Conductivity 15

Dissolved Oxygen 16

4.5 Watershed Delineation and WiLMS Analysis 17

5.0 Discussion 23

5.1 Trophic Status Index 23

5.2 Nutrients 24

5.3 Watershed Delineation and WiLMS Analysis 25

6.0 Recommendations 27

7.0 References 29

Appendix A – Profile Data (collected on site) 31
Appendix B – WSLOH Water Quality Reports 35
Appendix C – WiLMS Modeling output 43

List of Figures

Figure 1. Total phosphorus measurements for Dutch Hollow Lake (Sauk County, WI) 2005. 11
Figure 2. Chlorophyll *a* measurements for Dutch Hollow Lake (Sauk County, WI) 2005. 12
Figure 3. Secchi depth readings from the water quality sample location in Dutch Hollow Lake (Sauk County, WI) 2005. 13
Figure 4. Temperature profiles for Dutch Hollow Lake (Sauk County, WI) 2005. 15
Figure 5. Dissolved oxygen profiles for Dutch Hollow Lake (Sauk County, WI) 2005. 16
Figure 6. Watershed delineation for Dutch Hollow Lake (Sauk County, WI) 2005. Data used is not current. 18
Figure 7. Land use coverage for the Dutch Hollow watershed. Data used is not current. 19
Figure 8. Phosphorus contributions within the Dutch Hollow Lake watershed. 20

List of Tables

Table 1. Land use date from watershed assessment used in WiLMS Analysis. Data used is not current. 17
Table 2. Annual phosphorus loads based on scenario reductions. 21

1.0 Introduction

1.1 Project Scope

Dutch Hollow Lake is a 210-acre drainage lake located near the townships of LaValle and Woodland in Sauk County, WI (WBIC 1286500; T13N R2-3E S13,14 and 18,19). The lake has a maximum depth of 40 feet and a mean depth of approximately 15 feet (no official reported mean depth found). The watershed of Dutch Hollow Lake is a mix of residential development, natural grassland and deciduous forest. The lake does not appear to experience eutrophic conditions, but the Association is proactive in managing their resource and preventing further water quality degradation.

In 2004, the Dutch Hollow Lake Property Owners Association, Inc. (DHLPOA) contracted The Limnological Institute (TLI) to write a grant for Wisconsin Department of Natural Resources (WDNR) funding. The purpose of the funding was to conduct baseline water quality monitoring in 2005. The WDNR approved the application and awarded the grant (LPL-1029-05) to TLI.

Once the grant was awarded, TLI contracted Aquatic Engineering, Inc. (AEI) to perform the technical monitoring and the Wisconsin State Laboratory of Hygiene (WSLOH) to perform laboratory water quality analyses. This report covers the water quality parameters sampled on site and water quality analyzed at the WSLOH.

Deliverables listed in the grant and covered in this report include:

- Water analysis for total phosphorus, total Kjeldahl nitrogen, chlorophyll *a*, and total suspended solids from the surface and bottom depths
- Secchi depth monitoring throughout the summer
- Trophic Status Index calculations
- Water column profiles for dissolved oxygen, pH, and conductivity
- Watershed delineation and WiLMS nutrient modeling

The balance of this report covers those items and provides a discussion and recommendations for water quality management for Dutch Hollow Lake.

2.0 Review of Existing Information

2.1 Water Clarity

A review of past Secchi depth measurements was conducted. Sample data were discovered for 1990 through 2002. The data found were sorted by date and only samples taken June through September (growing season) were analyzed. The results show that the water clarity of Dutch Hollow Lake is very slowly improving (Figure 1).

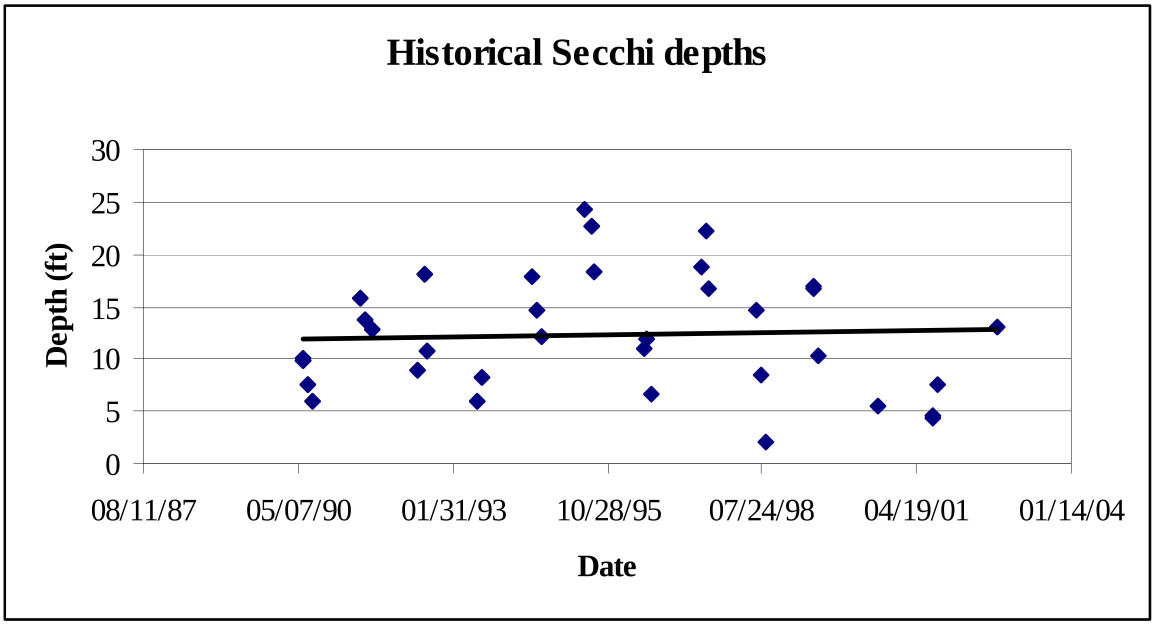


Figure 1. Historical Secchi depths for Dutch Hollow Lake (Sauk County, WI).

2.2 Total Phosphorus

Data were available from 1988 through 2005. Data from June through September were used for each year available. Only epilimnetic collections were evaluated. We also removed approximately 6 values over 100 mg/L because they were thought to be outliers resulting from sample contamination, rain events, improper storage, or improper shipping. Using the remaining values we see that total phosphorus concentrations have remained relatively unchanged since 1988 (Figure 2).

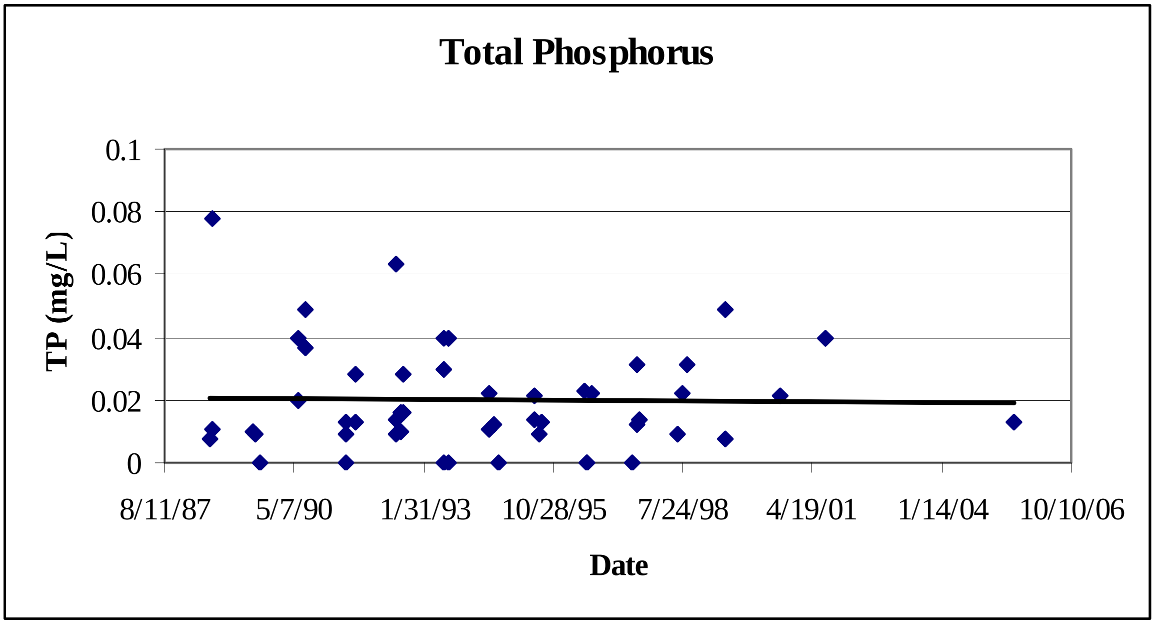


Figure 2. Historical total phosphorus values for Dutch Hollow Lake (Sauk County, WI).

2.3 Chlorophyll a

Data were available from 1988 through 2005. Data collected between June and September each year were analyzed. The data reveal that chlorophyll a levels have increased slightly since 1988 (Figure 3).

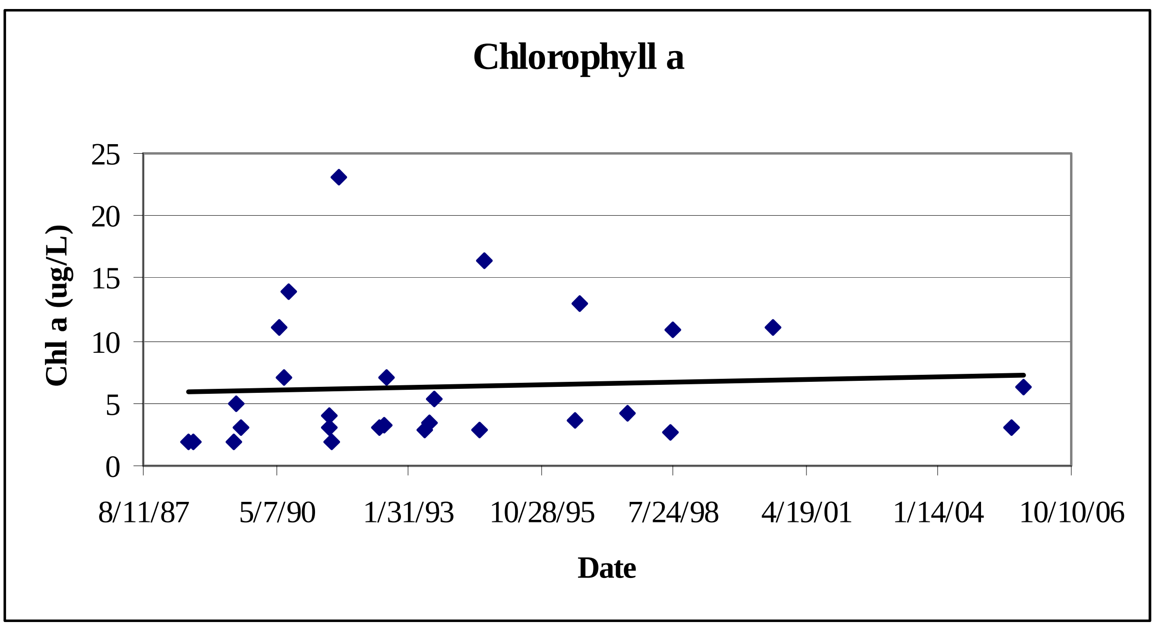


Figure 3. Historical chlorophyll a concentrations for Dutch Hollow Lake (Sauk County, WI).

2.4 Watershed Analysis and Nutrient Modeling

There is no existing watershed analysis or nutrient response modeling information for Dutch Hollow Lake. The DHLPOA has not previously contracted professional monitoring or assessment.

3.0 Methods

3.1 Water Sample Collection

A sample site was established at the deepest location in the lake (approximately 35 feet deep and near the "no wake" buoy closest to the La Valle boat launch) located at the northeast end of the lake. At this site, ecologists from AEI performed all water measurements and collections from June through October in 2005. Surface samples were collected at elbow depth (approximately 1.5 feet), and bottom samples were collected by lowering a Van Dorn sampling device to approximately one foot above the sediment. Water samples were then placed on ice and delivered to the WSLOH in Madison, WI. where samples were analyzed for total phosphorus, chlorophyll *a*, total Kjeldahl nitrogen, and total suspended solids.

3.2 On-Site Water Quality Measurements

Depth profiles were collected at the water quality monitoring sample site during the summer sampling events (June through October). Data points were collected at three-foot intervals throughout the water column for dissolved oxygen, pH, conductivity, and temperature with a SONDE YSI probe or a HACH Sension probe. The probes were calibrated prior to each sampling event. The SONDE dissolved oxygen probe was calibrated with oxygen-saturated deionized water to 100% saturation, and the HACH DO probe was calibrated with water-saturated air. The pH probes were calibrated using a two-point bracketing standards method where the low standard was pH 7.0 and the upper standard was pH 10.01. The conductivity probes were calibrated using a diluted conductivity standard.

3.3 Trophic Status Calculations

Trophic status was calculated for Dutch Hollow Lake water samples using the following equations (the units of measurement required for each parameter are included as a subscript in the equation):

$TSI_{SD} = 60 – 14.41* \ln (SD_m)$

$TSI_{chl} = 9.81* \ln (chl_{\mu g}) + 30.6$

$TSI_{TP} = 14.42 * \ln (TP_{\mu g}) + 4.15$

The following scale is used to evaluate trophic status (Lillie and Mason 1983):

TSI < 30	oligotrophic
40 < TSI < 50	mesotrophic
TSI > 50	eutrophic

3.4 Watershed Delineation and WiLMS Analysis

Watershed delineation was created by importing 1-arc-second National Elevation Dataset (NED) data obtained from the USGS into ArcGIS 9.1. Then, using the ArcHydro tools, which are supported by the Spatial Analyst extension, the NED data was run through a series of terrain preprocessing functions (fill sinks, flow direction, flow accumulation, stream definition, catchment grid delineation, and catchment polygon processing) to create a catchment polygon feature. All catchment polygons that overlap the lake were then merged into one polygon. Any polygons present below (down stream from) the dam were removed. The single resulting polygon was the watershed analyzed for nutrient input purposes.

Land use data was obtained from the WDNR WebView service. The data was imported into Arc GIS, clipped to the watershed boundaries, split into land use categories and summed by total acreage. Current color aerial photos were obtained from the USDA, compared to WDNR data, and analyzed for discrepancies. Some rural residential areas were not present in the DNR data set and were added to the land use types by creating polygons based on aerial photographs showing residences. The rural residential land use type was not "ground-truthed" but is much more representative of actual land use than the available DNR data.

Nutrient loads estimates were created using WiLMS modeling and data from the land use analysis and public use survey. Precipitation, evaporation, soil coefficients and other Sauk County default data were used when available. Assumptions[1] made for the septic system estimates were:

1. 61 homes
2. 2.7 people per average home
3. 50% seasonal (30 homes, 60 days per year) and 50% year-round (31 homes, 365 days per year) residents

To calculate the capita years for the septic analysis, the following equation was used:

31 homes x (365 occupancy days/year / 365 days per year) x 2.7 people per home = 83.7

30 home x (60 occupancy days/year / 365 days per year) x 2.7 people per home = 13.3

Total = 97.0 capita years

Nutrient reduction scenarios were run based on reducing non-point source phosphorus loading by 25, 50 and 75 percent. No point sources of pollution were identified during the scope of this work, and therefore no point sources were entered into WiLMS modeling. The total expected annual phosphorus load was reported for each scenario.

[1] Association provided numbers for assumptions

4.0 Results

The water quality measurements collected in 2005 show that Dutch Hollow Lake is a mesotrophic system that becomes thermally stratified in the summer and has physical parameters typical of young, deep drainage lakes. Total phosphorus, chlorophyll *a*, and Secchi readings all support the mesotrophic status. Although water samples collected near the sediment suggest phosphorus concentrations spike in the summer due to internal loading, reasonable estimates could not be made because the size and duration of a hypolimnion could not be determined.

4.1 Phosphorous

Total phosphorus (TP) was reported for each sampling event (Figure 1). The average monthly surface TP for Dutch Hollow Lake in 2005 was 14 µg/L and ranged from 8 µg/L to 20 µg/L. The TSI_{TP} value for Dutch Hollow Lake in 2005 was 46.7. The August hypolimnetic phosphorus concentration was 93 µg/L (more than six times the surface concentration), which suggests that internal loading and/or groundwater interaction is contributing to elevated phosphorus levels.

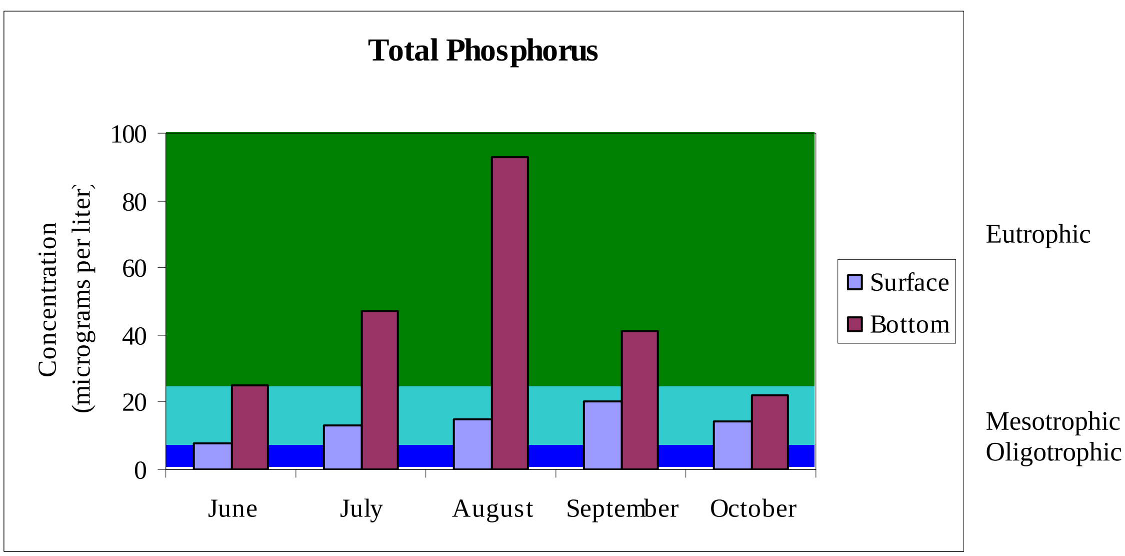


Figure 4. Total phosphorus measurements for Dutch Hollow Lake (Sauk County, WI) 2005.

4.2 Chlorophyll *a*

Chlorophyll *a* was also reported for the June through October sampling events (Figure 2). The average chlorophyll *a* for Dutch Hollow Lake in 2005 was 6.1 µg/L and ranged from 2.34 µg/L to 12.9 µg/L. The TSI_{chl} value for Dutch Hollow Lake in 2005 was 48.3.

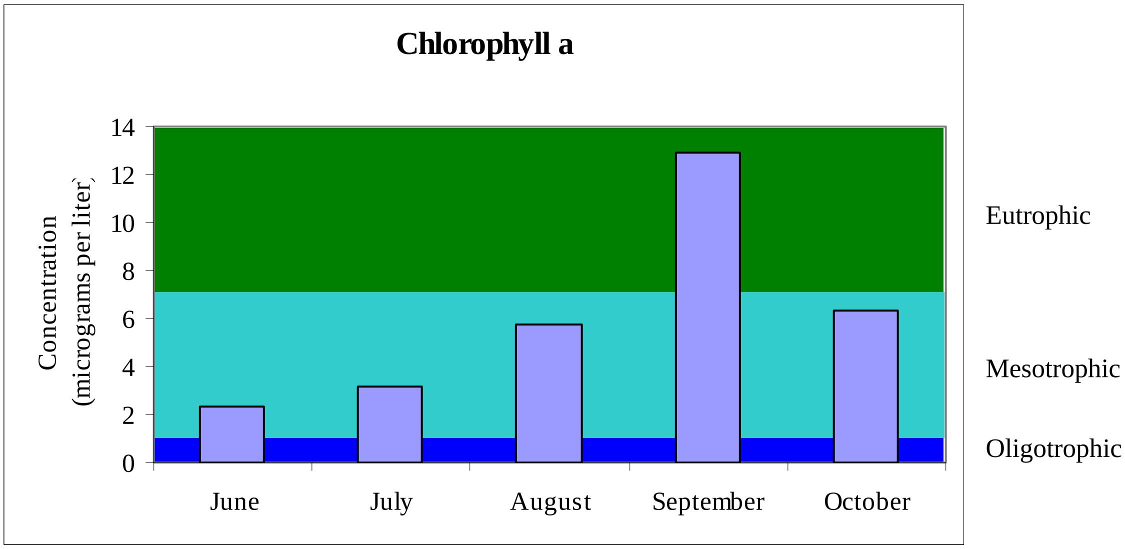


Figure 5. Chlorophyll *a* measurements for Dutch Hollow Lake (Sauk County, WI) 2005.

4.3 Secchi Depth

Secchi disk readings were collected four times in 2005 and averaged 8.25 feet (Figure 3). The maximum value observed was 10.5 feet and the minimum was 6.0 feet. The TSI_{SD} for Dutch Hollow Lake in 2005 was 46.7.

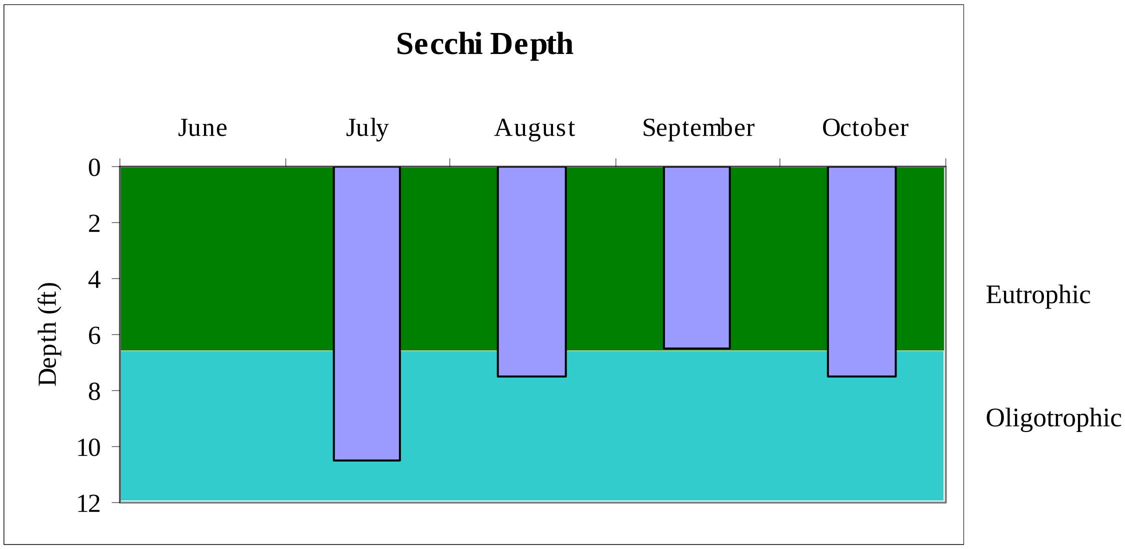


Figure 6. Secchi depth readings from the water quality sample location in Dutch Hollow Lake (Sauk County, WI) 2005.

4.4 Other Parameters

Other parameters measured were total suspended solids, total Kjeldahl nitrogen, soluble reactive phosphorus, temperature, conductivity, and pH. These chemical and physical parameters affect water quality in many different ways and are discussed separately in the following sections.

Total Suspended Solids (TSS)

Total suspended solids are considered the solids in water that can be trapped by a filter that may include materials likes silt, decaying plants, animal matter, and sewage. A high concentration of TSS can lead to problems for aquatic life in that TSS can block light penetration. Decreased light amounts can lead to a decrease in photosynthesis. Another adverse effect of high TSS is that reduced visibility in the lake water makes it difficult for predators to locate and capture their prey. Total suspended solids were determined for the June sampling at the surface and bottom (depth of 30 feet) and for the July sampling at the surface of Dutch Hollow Lake. The only detectable TSS was from the June sampling from the bottom, which was 3 mg/L.

Total Kjeldahl Nitrogen (TKN)

The Kjeldahl technique is a laboratory test for measuring the amount of organic nitrogen contained in water. The organic nitrogen concentration is actually the total Kjeldahl nitrogen concentration minus the ammonia concentration. Organic nitrogen may be either dissolved or suspended particulate matter in water. High levels of organic nitrogen in water may indicate excessive production of organic pollution from the watershed. Animal and human waste, decaying organic matter, and live organic material like tiny algae cells can cause organic nitrogen enrichment of lake water (Tippecanoe Environmental Lake and Watershed Foundation 2005). Nitrogen, like phosphorus, is an essential macronutrient needed for algal production. Most lakes, however, are phosphorus limited, and attempts to reduce lake nitrogen levels may have little effect on algal biomass (Holdren 2001). The average surface TKN for Dutch Hollow Lake in 2005 was 283 µg/L. The N:P ratio (TKN:TP) was approximately 20 to 1 (by mass) and supports the fact that Dutch Hollow Lake is phosphorus limited (generally any ratio over 7:1 N:P by weight is phosphorus limited).

Temperature

Temperature plays a major role in water quality, especially in lakes that become thermally stratified. Thermal stratification occurs when water in the top layer of a lake becomes heated by the sun and insufficient mixing action allows the warm water layer at the surface (epilimnion) to "float" on top of a cooler, more dense layer of water near the bottom (hypolimnion). As summer progresses, the difference in density between the two layers increases, and when the difference becomes too great for wind energy to mix, the lake becomes stratified (Holdren et al. 2001). The region between the epilimnion and hypolimnion is called the metalimnion. The particular depth within the metalimnion where the rate of change in temperature is greatest is called the thermocline (Holdren et al. 2001).

In 2005, Dutch Hollow Lake became thermally stratified. The difference in temperature from surface to bottom, approximately 17 degrees Celsius, was greatest during the June and July sampling period, with June showing the strongest thermocline (Figure 4).

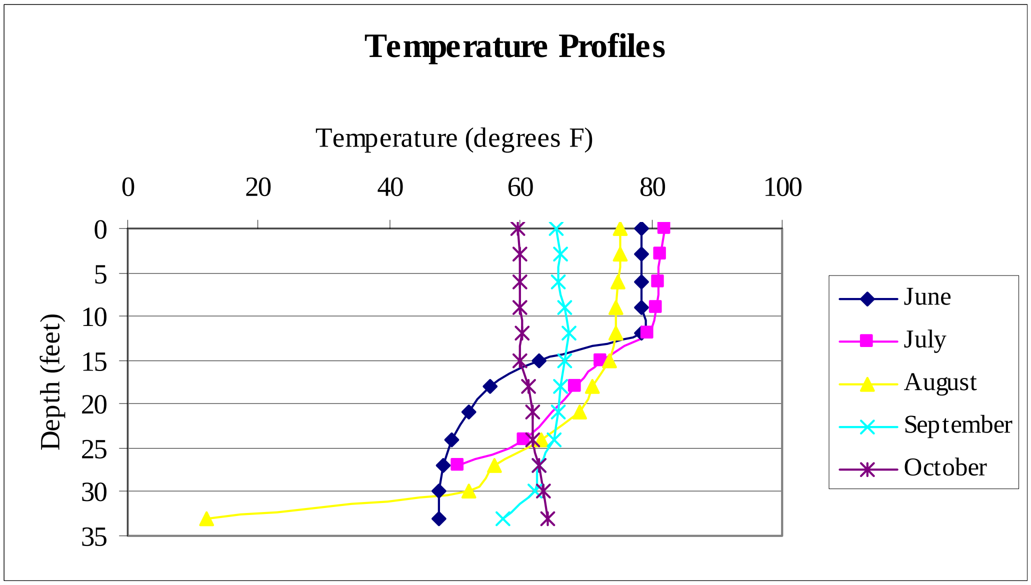


Figure 7. Temperature profiles for Dutch Hollow Lake (Sauk County, WI) 2005.

Conductivity

Conductivity in lake water comes from a variety of sources like agricultural and industrial runoffs that contribute large amounts of dissolved salts that raises conductivity. In addition, sewage from septic tanks and treatment facilities also add to the conductive properties in water. Another source of conductive properties comes from the hypolimnion of thermally stratified lakes. As planktonic algae die throughout the summer, a "rain" of dead algal cells is constantly falling on the sediments of the lake. The dead algal cells are decomposed by bacteria in or near sediments by breaking high energy bonds stored in the algal cell wall. When this occurs, CO_2 is released into the water where it rapidly dissolves into carbonic acid, bicarbonate, and carbonate ions that contribute to the conductive properties of the lake water. On average, surface conductivity in 2005 was 226 µS/cm, while the average bottom conductivity in 2005 was 297 µS/cm. These values are typical of freshwater lakes.

Dissolved Oxygen

Dissolved oxygen plays an important role in both the lake biology and chemical properties because anoxic conditions make certain compounds more soluble in water. The chemical and biological properties are most affected during summer stratification when the oxygen-poor hypolimnion does not mix with the oxygen-rich epilimnion. As reported earlier, Dutch Hollow Lake thermally stratified in 2005. In addition to thermal stratification, an oxygen gradient was present in the lake from June to September (Figure 5). Readings from those months show that dissolved oxygen levels began dropping sharply between the 12- and 18-foot sample points. The surface oxygen saturation in June was 110%, while at 24 feet deep it was not detectable. A similar, but less dramatic, decrease in oxygen saturation was present during the July sampling period. This oxygen depletion was due to the strong thermocline that formed and prevented mixing of the water column. Oxygen concentrations are usually low near the sediment regardless of the presence of a thermocline because of the biological oxygen demand of algae, plankton and bacteria. Decomposition of organic waste near the sediment consumes oxygen faster than it can be replaced by photosynthesis and natural water mixing in the lake. A potential adverse effect of oxygen depletion is potential phosphorus release.

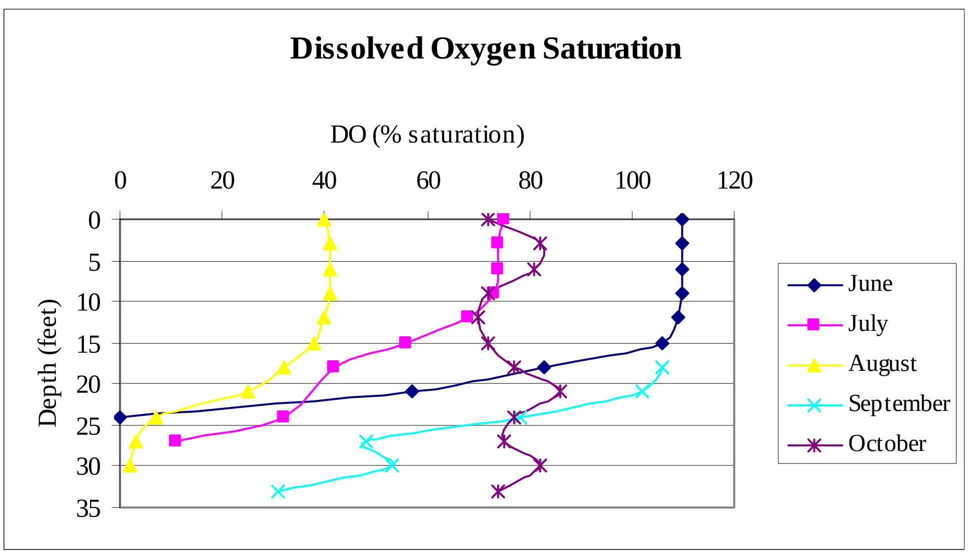


Figure 8. Dissolved oxygen profiles for Dutch Hollow Lake (Sauk County, WI) 2005.

4.5 Watershed Delineation and WiLMS Analysis

The watershed delineation resulted in a 3,055.5 acre watershed (Figure 6). The watershed is almost evenly divided by three dominant land use types – forest, mixed agriculture, and pasture or grassland, and by four minor types – row crops, rural residential, wetlands, and open water (Table 1 and Figure 7). The water residence time in the lake is 1.6 years.

Table 1. Land use data from watershed assessment used in WiLMS Analysis.

Land Use Category	Coverage (acres)	Percent of Watershed
Row Crops	44.7	1.4
Wetlands	56.1	1.8
Pasture Grassland	823.6	27.0
Mixed Agriculture	722.3	23.6
Residential Rural	378.0	12.4
Open Water	145.0	4.7
Forest	885.8	29.0
Total	**3,055.5**	**99.9**

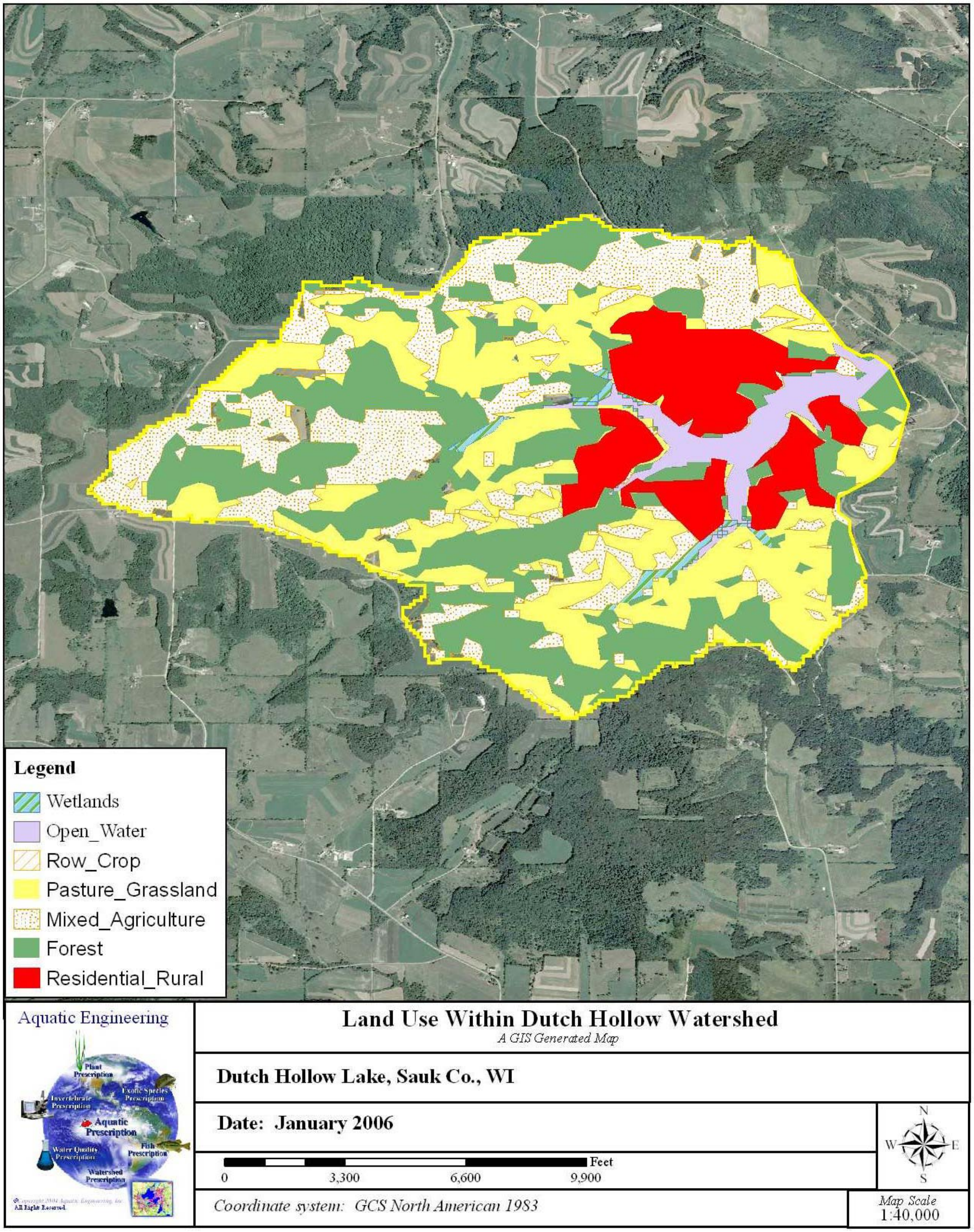


Figure 9. Land use coverage for the Dutch Hollow watershed.

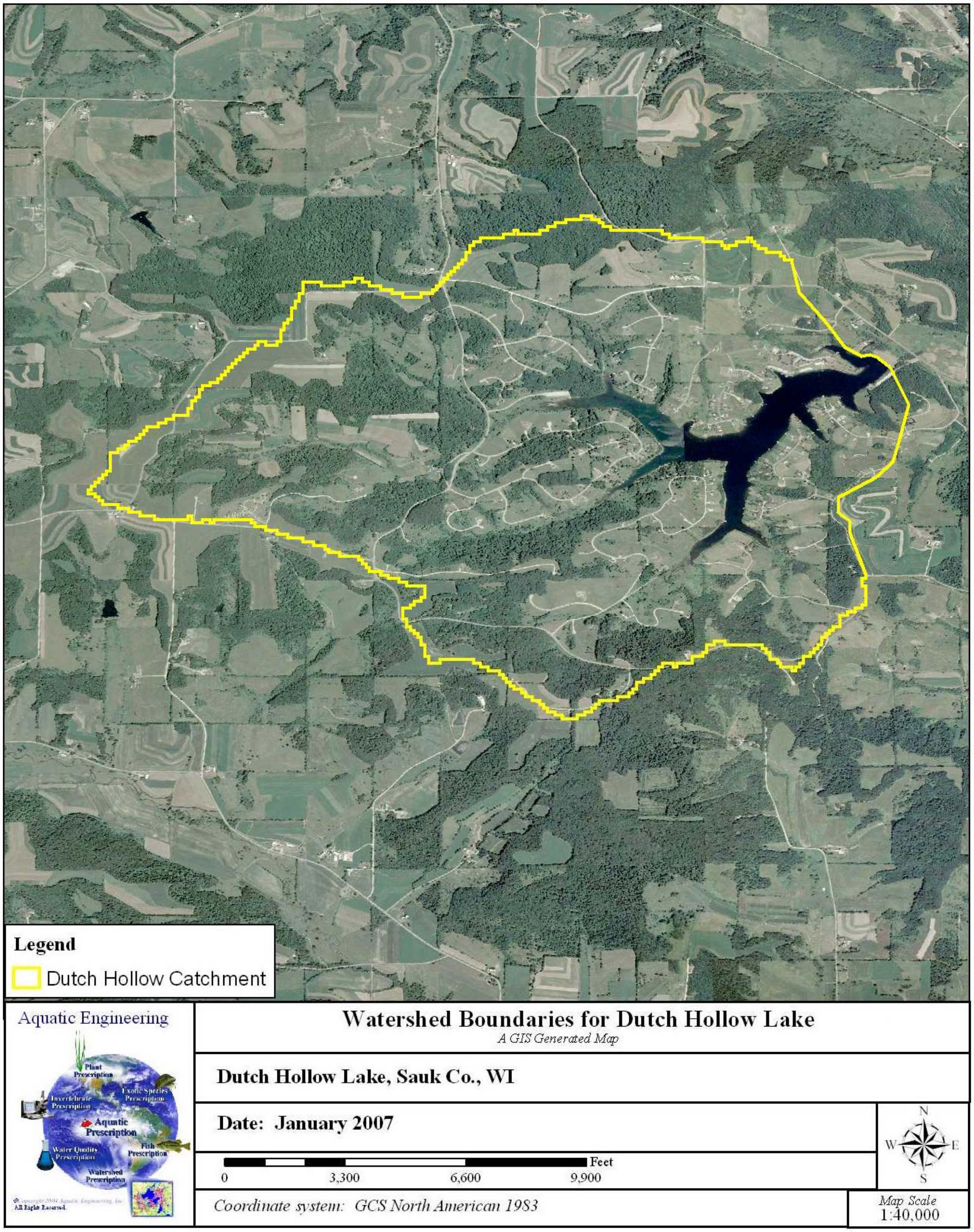


Figure 10. Watershed delineation for Dutch Hollow Lake (Sauk County, WI) 2005.

Forest land contributes the majority of phosphorus within the watershed (Figure 8). Scenarios 1 through 3 show what watershed nutrient loading looks like under various assumptions. Scenario 1 shows the current status of the watershed. Scenarios 2 and 3 show 25 and 50 percent reduction of non-point source contributions. These scenarios are representative of possible improvements due to implementing watershed BMPs.

Scenario 4 shows what the watershed phosphorus contributions would look like if residential development occurred at all 1,163 residentially zoned lots. Assumptions made for WiLMS modeling were:

- The area of rural development remained the same (378 acres of <1 home per acre)
- 322 acres of new development at 1 home per ½ acre (700 total residential acres zoned minus current development)
- Septic capita years quadrupled (approximately 300 current homes and 1,163 possible)
- Phosphorus contributions approximately ½ of what 1 home per ¼ acre produces

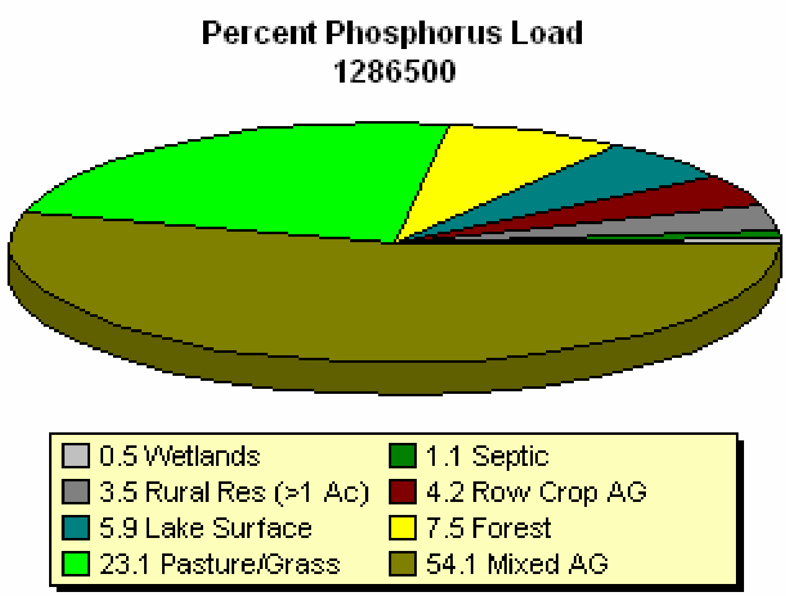


Figure 11. Phosphorus contributions within the Dutch Hollow Lake watershed.

Non-point source reduction modeling shows decreasing phosphorus loads nearly identical to the percent decrease entered into the model (Table 2). This is because non-point sources were the majority contributor of all sources analyzed. If point sources (internal loading, pumping water, etc.) were identified and entered into the model, a less direct correlation would exist.

Table 2. Annual phosphorus loads based on scenario reductions.

Percent decrease of non-point source load	Total phosphorus loading (kg/year)
0	432.1
25	331.7
50	231.2
100 percent residential development	407.6

The scenario in which the entire Dutch Hollow community was developed with single-family homes actually shows a decrease in phosphorus load per year. This is because pasture and mixed agricultural land was substituted for low density residential development. The agricultural land is entered in the WiLMS model to produce between 0.3 and 0.8 kilograms of phosphorus per hectare per year while low density residential development only contributes 0.25 kilograms per hectare per year.

This decrease exists only because of the nuances of the model. In reality, some existing land owners own more than one lot and therefore have enough land to keep a portion natural while converting another portion to cultivated lawn. If the entire development occurred, most homeowners would likely maintain cultivated lawns which will decrease the percentage of natural grasslands now listed.

5.0 Discussion

5.1 Trophic Status Index

TSI values for Dutch Hollow Lake in 2005 show that it was a mesotrophic lake, which was supported by Secchi depth, chlorophyll *a*, and total phosphorus measurements. Dutch Hollow Lake has qualities expected of mesotrophic status, with phosphorus and chlorophyll *a* concentrations peaking during mid summer and inversely proportional to water clarity.

The water clarity of Dutch Hollow Lake was very good in the spring and fall of 2005. The water became slightly tinted in the summer due to planktonic algae growth, but there is no evidence that planktonic blooms have affected recreation or perceived value of the lake.

Secchi depths in 2005 were slightly worse than the historical average but were very similar to results measured in 1990, 93, 96, 98 and in 2001. These readings can change from year to year as environmental conditions change. When rainfall is low, water residence time increases and algae can become more problematic. Conversely, when too much rain falls, runoff increases the nutrient load to the lake which can also increase algae growth. Values observed in 2005 are normal for Dutch Hollow Lake and do not identify decreased water clarity as a pattern.

Phosphorus and chlorophyll concentrations were near their historical averages. Like Secchi depth, these can fluctuate based on environmental conditions. Measurements observed in 2005 do not indicate decreasing water quality or excessive nutrient inputs.

Residents indicated in the public use survey that protecting water clarity was by far their top concern. Because the immediate watershed is small and mostly contained within the bounds of the Association, the property owners have a great deal of control over the water quality in Dutch Hollow Lake and should implement watershed Best Management Practices (BMPs) to protect the lake from eutrophic conditions.

BMPs include vegetative buffer strips, storm water retention systems, sediment traps, water gardens, lawn care methods, and various other aspects of the watershed. The WDNR, US Environmental Protection Agency (EPA), Sauk County Land Conservation Department, and University of Wisconsin Extension (UW-Extension) offices have information regarding types of BMPs, methods of implementing them, and expected benefits. Relevant information from these agencies can be found at the following web addresses:

http://www.co.sauk.wi.us/dept/land/index.html

http://dnr.wi.gov/org/water/wm/nps/publications/pubs.htm

http://epa.gov/owow/nps/wetmeasures/

http://www.uwex.edu/ces/cty/sauk/

As part of a future monitoring strategy, the TSI values can be calculated and compared to historical data and will indicate whether the eutrophication process is increasing, decreasing, or remaining constant. The TSI value of a lake can change dramatically from year to year when environmental conditions are significantly different, so strong baseline data are required to determine actual trends. Monitoring water quality will also help determine the success of implemented BMPs.

5.2 Nutrients

There is evidence of internal loading of phosphorus in Dutch Hollow Lake, supported by the increased hypolimnetic concentrations. There is not enough known regarding the hydrology of the lake to determine what groundwater interactions contribute to the water column. Questions discovered regarding the hydrology of Dutch Hollow are:

1. Contribution of natural ground water interactions
2. Effects of pumping water into the lake

The lake is clearly phosphorus limited (driven) which means plants and algae are limited in growth by the amount of phosphorus in the lake. An addition of phosphorus will correlate to increased plant and algae growth. Residents can limit phosphorus inputs by maintaining their septic systems, implementing watershed BMPs, and using phosphorus-free fertilizers.

5.3 Watershed Delineation and WiLMS Analysis

Nutrient loading by land use type modeling was conducted using historical data corrected using 2006 color aerial photographs. A more exact nutrient model could be constructed if the land use information were updated and verified by surveying on the ground. The state and county are best equipped to perform land use classifications and should be contacted if an updated nutrient budget is necessary.

In addition to land use contributions, the WiLMS analysis did not consider nutrients originating from ground water interactions, point sources, or internal loading. A complete hydrologic budget and well monitoring is necessary for determining ground water contributions. A more detailed water quality sampling protocol is necessary to determine the extent of internal loading. Items which need investigation before an internal load estimate can be made are:

- ✓ Contributions from natural ground water
- ✓ Contributions from pumping ground water
- ✓ Contributions from tributaries (intermittent and permanent)
- ✓ Average hypolimnetic TP for several sample sites throughout the anoxic zone
- ✓ Size of anoxic zone (total water volume and total sediment area anoxic)
- ✓ Duration of anoxic period

The water quality of Dutch Hollow is excellent and conditions have remained relatively unchanged since 1988. Changes in water quality are not expected unless major changes in land use within the watershed occur. Performing a hydrologic budget and monitoring for internal loading would be significant investments for managing water quality. The Association should begin planning for these activities in the event water quality conditions begin to decline. In the mean time, water quality protection should be a major focus of the Association's plan.

Trophic response models were also run through WiLMS using the average annual TP, Chl a, and Secchi depths. Results are included in Appendix C after the WiLMS scenarios and show the lake experiences slightly less chlorophyll a and better Secchi depths than would be predicted based on total phosphorus measurements. The differences between expected results and observed results are minor. This means the lake is behaving consistently with other impoundments within the same region of Wisconsin. The same modeling shows that approximately five percent of days will have chlorophyll a concentrations which exceed nuisance criteria (i.e., the lake will likely experience nuisance algae conditions one day in every twenty; approximately 4 days per summer).

Septic system leachate accounts for approximately 1 percent of total nutrient inputs. This is not a surprise and since most systems on the lake are relatively new, the model is likely on the high end. The Association should develop a regular septic examination schedule and have each system inspected once every 5 to 10 years. This will help prevent any future problems from going unnoticed.

6.0 Recommendations

The water quality of Dutch Hollow Lake is impacted by two main components – surface runoff and internal loading/ground water interaction. Septic systems may also contribute to nutrient inputs, but the amount of contribution is unknown.

The Dutch Hollow Lake Association should take the following steps to improve the quality of water within the lake:

Short-term

- Public education and implementation of buffer strips and shoreline restoration. This should include Association "demonstrations" of rain gardens, buffer strips, and other BMPs.
- Take semi-monthly surface and bottom water samples from May to October one year out of every three and have them analyzed for TP, Chl *a*, and TKN.
- Participate in WDNR's Self-Help Secchi depth monitoring. Secchi depth should be recorded once per week from May to October.

Long-term

- Work with the County and local townships while they create their land use and zoning regulations to help minimize effects of current and future development.
- Consider an Association "savings account" for future management activities.
- Enforce existing septic system ordinances for homes within the watershed. Systems should have aggressive minimum inspection requirements to prevent nutrient loading from old or malfunctioning systems. A sanitary survey is recommended as part of future ordinance enforcements.

•

7.0 References

Holdren, C., W. Jones, and J. Taggart. 2001. Managing Lakes and Reservoirs. N. Am. Lake Mange. Soc. And Terrene Inst. In coop. with Off. Water Assess. Watershed Prot. Div. U.S. Environ. Prot. Agency, Madison, WI.

Lillie, R. A. and J. W. Mason. 1983. Limnological Characteristics of Wisconsin Lakes. Wisconsin Department of Natural Resources Technical Bulletin 138, Madison, WI.

Tippecanoe Environmental Lake and Watershed Foundation. website accessed on February 2, 2005 http://www.telwf.org/watertesting/watertesting.htm

Appendix A – Profile Data (collected on site)

June	23	2005		
Depth	DO%	Temp (F)	pH	Cond (uS/cm)
0	110	78.4	8.52	0.246
3	110	78.6	8.59	0.246
6	110	78.6	8.61	0.246
9	110	78.6	8.63	0.246
12	109	78.6	8.63	0.246
15	106	62.8	8.34	0.256
18	83	55.2	8.09	0.257
21	57	52.0	7.98	0.261
24	0	49.5	7.67	0.266
27		48.2	7.52	0.268
30		47.7	7.48	0.268
33		47.5	7.46	0.270

July	21	2005		
Depth	DO%	Temp (C)	pH	Cond (uS/cm)
0	75	82.2	8.64	0.226
3	74	81.3	8.68	0.226
6	74	81.1	8.70	0.226
9	73	81.0	8.72	0.226
12	68	79.5	8.53	0.232
15	56	72.4	8.12	0.252
18	42	68.3	7.89	0.261
21				
24	32	60.6	7.80	0.279
27	11	50.6	7.63	0.297
30				
33				

August	24	2005		
Depth	DO%	Temp (C)	pH	Cond (uS/cm)
0	40	75.4	8.54	0.224
3	41	75.2	8.67	0.224
6	41	75.0	8.72	0.225
9	41	74.7	8.76	0.224
12	40	74.7	8.79	0.223
15	38	73.6	8.70	0.228
18	32	70.9	8.37	0.241
21	25	68.9	8.10	0.249
24	7	63.1	7.81	0.272
27	3	55.9	7.70	0.280
30	2	52.2	7.48	0.292
33				

September	22	2005		
Depth	DO%	Temp (C)	pH	Cond (uS/cm)
0	na	65.5	7.14	0.534
3	na	66.0	8.31	0.257
6	na	65.8	7.82	0.198
9	na	66.9	7.87	0.200
12	na	67.5	8.46	0.188
15	na	66.7	8.52	0.203
18	106	66.2	7.63	0.199
21	102	65.7	8.35	0.187
24	78	65.3	8.24	0.201
27	48	63.0	7.94	0.218
30	53	62.2	7.70	0.222
33	31	57.4	7.40	0.255

October	17	2005		
Depth	DO%	Temp (C)	pH	Cond (uS/cm)
0	72	59.5	7.64	0.349
3	82	59.9	7.61	0.219
6	81	59.9	7.65	0.207
9	72	59.9	7.52	0.206
12	70	60.3	7.74	0.207
15	72	60.1	7.76	0.206
18	77	61.3	7.80	0.206
21	86	61.9	7.80	0.207
24	77	61.9	8.12	0.207
27	75	63.0	8.20	0.207
30	82	63.5	7.76	0.203
33	74	64.2	8.21	0.207

Appendix B – WSLOH Water Quality Reports

Date	sample location	Parameter	Value	Units
6/23/2005	SURFACE	TEMPERATURE AT LAB	ICED	C
6/23/2005	SURFACE	RESIDUE TOTAL NFLT (TOTAL SUSPENDED SOLIDS)	ND	MG/L
6/23/2005	SURFACE	NITROGEN KJELDAHL TOTAL	ND	MG/L
6/23/2005	SURFACE	PHOSPHORUS TOTAL	0.008	MG/L
6/23/2005	SURFACE	SAMPLE SIZE LITERS	200	ML
6/23/2005	SURFACE	CHLOROPHYLL A, FLUORESCENCE (WELSCHMAYER 1994)	2.34	UG/L
6/23/2005	BOTTOM - 30FT, VAN DORN SAMPLER	TEMPERATURE AT LAB	ICED	C
6/23/2005	BOTTOM - 30FT, VAN DORN SAMPLER	RESIDUE TOTAL NFLT (TOTAL SUSPENDED SOLIDS)	3	MG/L
6/23/2005	BOTTOM - 30FT, VAN DORN SAMPLER	NITROGEN KJELDAHL TOTAL	0.35	MG/L
6/23/2005	BOTTOM - 30FT, VAN DORN SAMPLER	PHOSPHORUS TOTAL	0.025	MG/L
7/21/2005	SURFACE SAMPLE AT MID LAKE SITE	TEMPERATURE AT LAB	ICED	C
7/21/2005	SURFACE SAMPLE AT MID LAKE SITE	RESIDUE TOTAL NFLT (TOTAL SUSPENDED SOLIDS)	ND	MG/L
7/21/2005	SURFACE SAMPLE AT MID LAKE SITE	NITROGEN KJELDAHL TOTAL	0.22	MG/L
7/21/2005	SURFACE SAMPLE AT MID LAKE SITE	PHOSPHORUS TOTAL	0.013	MG/L
7/21/2005	SURFACE SAMPLE AT MID LAKE SITE	SAMPLE SIZE LITERS	200	ML
7/21/2005	SURFACE SAMPLE AT MID LAKE SITE	CHLOROPHYLL A, FLUORESCENCE (WELSCHMAYER 1994)	3.13	UG/L
7/21/2005	BOTTOM SAMPLE FROM MID LAKE SITE	TEMPERATURE AT LAB	ICED	C
7/21/2005	BOTTOM SAMPLE FROM MID LAKE SITE	RESIDUE TOTAL	156	MG/L
7/21/2005	BOTTOM SAMPLE FROM MID LAKE SITE	PHOSPHORUS TOTAL	0.047	MG/L

Date	sample location	Parameter	Value	Units
8/24/2005	MID-LAKE - VAN DORN SAMPLE	TEMPERATURE AT LAB	ICED	C
8/24/2005	MID-LAKE - VAN DORN SAMPLE	RESIDUE TOTAL	166	MG/L
8/24/2005	MID-LAKE - VAN DORN SAMPLE	NITROGEN KJELDAHL TOTAL	1.07	MG/L
8/24/2005	MID-LAKE - VAN DORN SAMPLE	PHOSPHORUS TOTAL	0.093	MG/L
8/24/2005	MID-LAKE - SURFACE GRAB	TEMPERATURE AT LAB	ICED	C
8/24/2005	MID-LAKE - SURFACE GRAB	RESIDUE TOTAL	126	MG/L
8/24/2005	MID-LAKE - SURFACE GRAB	NITROGEN KJELDAHL TOTAL	0.32	MG/L
8/24/2005	MID-LAKE - SURFACE GRAB	PHOSPHORUS TOTAL	0.015	MG/L
8/24/2005	MID-LAKE - SURFACE GRAB	SAMPLE SIZE LITERS	200	ML
8/24/2005	MID-LAKE - SURFACE GRAB	CHLOROPHYLL A, FLUORESCENCE (WELSCHMAYER 1994)	5.74	UG/L
9/22/2005	BOTTOM, CENTER LAKE - VAN DORN SAMPLER	TEMPERATURE AT LAB	ICED	C
9/22/2005	BOTTOM, CENTER LAKE - VAN DORN SAMPLER	RESIDUE TOTAL	162	MG/L
9/22/2005	BOTTOM, CENTER LAKE - VAN DORN SAMPLER	NITROGEN KJELDAHL TOTAL	0.75	MG/L
9/22/2005	BOTTOM, CENTER LAKE - VAN DORN SAMPLER	PHOSPHORUS TOTAL	0.041	MG/L
9/22/2005	TOP, CENTER LAKE - ELBOW DEPTH	TEMPERATURE AT LAB	ICED	C
9/22/2005	TOP, CENTER LAKE - ELBOW DEPTH	RESIDUE TOTAL	130	MG/L
9/22/2005	TOP, CENTER LAKE - ELBOW DEPTH	NITROGEN KJELDAHL TOTAL	0.29	MG/L
9/22/2005	TOP, CENTER LAKE - ELBOW DEPTH	PHOSPHORUS TOTAL	0.02	MG/L
9/22/2005	TOP, CENTER LAKE - ELBOW DEPTH	SAMPLE SIZE LITERS	200	ML
9/22/2005	TOP, CENTER LAKE - ELBOW DEPTH	CHLOROPHYLL A, FLUORESCENCE (WELSCHMAYER 1994)	12.9	UG/L

Wisconsin Department of Natural Resources
Laboratory Report

02/16/2006 *Lab:* **113133790** *Sample:* **IQ010662** *Page 1 of 1*

Laboratory: **Wisconsin State Laboratory of Hygiene** *DNR ID* **113133790**
2601 Agriculture Dr.
Madison **WI** **537077996**
Phone : **800-442-4618** *Fax Phone :* **608-224-6276**

Sample:

Field #:	**101705BOT**	*Sample #:*	**IQ010662**
Collection Start:	**10/17/2005 12:30 pm**	*Collection End:*	
Collected by:	**STRASSER**	*Waterbody/Outfall Id:*	**1286500**
ID #:		*ID Point #:*	
County:	**Sauk**	*Account #:*	**LM012**
Sample Location:	**DUTCH HOLLOW LAKE**		
Sample Description:	**WATER QUALITY SITE - VAN DORN**		
Sample Source:	**SU**	*Sample Depth:*	**F33.0**
Date Reported:	**11/07/2005**	*Sample Status:*	**COMPLETE**
Project No:	**LPL1029**		

Analyses and Results:

Analysis Method		*Analysis Date*	*Lab Comment*				
TOTAL KJELDAHL NITROGEN (AS N) (EPA :		**10/25/2005**					
Code	*Description*	*Cas No*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
625	**NITROGEN KJELDAHL TOTAL**	E1644079	**0.70**	MG/L	0.14		0.4

Analysis Method		*Analysis Date*	*Lab Comment*				
TOTAL PHOSPHORUS (AS P) (EPA 365.1)		**10/25/2005**					
Code	*Description*	*Cas No*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
665	**PHOSPHORUS TOTAL**	7723140	**0.022**	MG/L	0.005		0.016

Analysis Method		*Analysis Date*	*Lab Comment*				
TOTAL SOLIDS (SM 2540B)		**10/20/2005**					
Code	*Description*	*Cas No*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
500	**RESIDUE TOTAL**	E1640382	**152.**	MG/L	50		167

Analysis Method		*Analysis Date*	*Lab Comment*				
TEMPERATURE ON RECEIPT-ICED		**10/18/2005**					
Code	*Description*	*Cas No*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
136	**TEMPERATURE AT LAB**	E1645696	**ICED**	C		0	

Wisconsin Department of Natural Resources
Laboratory Report

Laboratory: Wisconsin State Laboratory of Hygiene
2601 Agriculture Dr.
Madison WI 537077996
Phone : 800-442-4618 Fax Phone : 608-224-6276

DNR ID 113133790

Sample:

Field #:	101705TOP	Sample #:	IQ010663
Collection Start:	10/17/2005 10:30 am	Collection End:	
Collected by:	STRASSER	Waterbody/Outfall Id:	1286500
ID #:		ID Point #:	
County:	Sauk	Account #:	LM012
Sample Location:	DUTCH HOLLOW LAKE		
Sample Description:	WATER QUALITY SITE - ELBOW DEPTH		
Sample Source:	SU	Sample Depth:	F0.5
Date Reported:	11/07/2005	Sample Status:	COMPLETE
Project No:	LPL1029		

Analyses and Results:

Analysis Method	Analysis Date	Lab Comment
VOLUME LAB FILT FOR CHLOROPHYLL A (	10/24/2005	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
32000	SAMPLE SIZE LITERS		200	ML			

Analysis Method	Analysis Date	Lab Comment
CHLOROPHYLL A, FLUORESCENCE (EPA 445.0)	10/25/2005	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
99717	CHLOROPHYLL A, FLUORESCENCE (WELSCHMAYER 1994)	479618	6.33	UG/L	0.26		0.87

Analysis Method	Analysis Date	Lab Comment
TOTAL KJELDAHL NITROGEN (AS N) (EPA :	10/25/2005	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
625	NITROGEN KJELDAHL TOTAL	E1644079	0.30	MG/L	0.14		0.4

Analysis Method	Analysis Date	Lab Comment
TOTAL PHOSPHORUS (AS P) (EPA 365.1)	10/25/2005	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
665	PHOSPHORUS TOTAL	7723140	0.014	MG/L	0.005		0.016

Analysis Method	Analysis Date	Lab Comment
TOTAL SOLIDS (SM 2540B)	10/20/2005	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
500	RESIDUE TOTAL	E1640382	140.	MG/L	50		167

Analysis Method		*Analysis Date*	*Lab Comment*				
TEMPERATURE ON RECEIPT-ICED		**10/18/2005**					
Code	*Description*	*Cas No*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
136	**TEMPERATURE AT LAB**	E1645696	**ICED**	C		0	

Appendix C – WiLMS Modeling output

Date: 1/29/2007 Scenario: 1

Lake Id: 1286500

Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 2910.5 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 1940.3 acre-ft
Lake Surface Area <As>: 210.0 acre
Lake Volume <V>: 3150.0 acre-ft
Lake Mean Depth <z>: 15.0 ft
Precipitation - Evaporation: 1.6 in.
Hydraulic Loading: 1968.3 acre-ft/year
Areal Water Load <qs>: 9.4 ft/year
Lake Flushing Rate <p>: 0.62 1/year
Water Residence Time: 1.60 year
Observed spring overturn total phosphorus (SPO): 8.0 mg/m^3
Observed growing season mean phosphorus (GSM): 14.0 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		Loading (kg/ha-year)				Loading (kg/year)		
Row Crop AG	44.7	0.50	1.00	3.00	4.2	9	18	54
Mixed AG	722.3	0.30	0.80	1.40	54.1	88	234	409
Pasture/Grass	823.6	0.10	0.30	0.50	23.1	33	100	167
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	378.0	0.05	0.10	0.25	3.5	8	15	38
Wetlands	56.1	0.10	0.10	0.10	0.5	2	2	2
Forest	885.8	0.05	0.09	0.18	7.5	18	32	65
Lake Surface	210.0	0.10	0.30	1.00	5.9	8	25	85

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description		Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)		0.30	0.50	0.80	
# capita-years	97.0				
% Phosphorous Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		0.58	4.85	15.52	1.1

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	368.2	952.6	1842.4	100.0
Total Loading (kg)	167.0	432.1	835.7	100.0
Areal Loading (lb/ac-year)	1.75	4.54	8.77	
Areal Loading (mg/m^2-year)	196.50	508.46	983.38	
Total PS Loading (lb)	0.0	0.0	0.0	
Total PS Loading (kg)	0.0	0.0	0.0	
Total NPS Loading (lb)	348.1	885.7	1620.8	
Total NPS Loading (kg)	157.9	401.8	735.2	

Date: 1/29/2007 Scenario: 2

Lake Id: 1286500
Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 2910.5 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 1940.3 acre-ft
Lake Surface Area <As>: 210.0 acre
Lake Volume <V>: 3150.0 acre-ft
Lake Mean Depth <z>: 15.0 ft
Precipitation - Evaporation: 1.6 in.
Hydraulic Loading: 1968.3 acre-ft/year
Areal Water Load <qs>: 9.4 ft/year
Lake Flushing Rate <p>: 0.62 1/year
Water Residence Time: 1.60 year
Observed spring overturn total phosphorus (SPO): 8.0 mg/m^3
Observed growing season mean phosphorus (GSM): 14.0 mg/m^3
% NPS Change: -25%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		Loading (kg/ha-year)				Loading (kg/year)		
Row Crop AG	44.7	0.50	1.00	3.00	4.1	7	14	41
Mixed AG	722.3	0.30	0.80	1.40	52.9	66	175	307
Pasture/Grass	823.6	0.10	0.30	0.50	22.6	25	75	125
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	378.0	0.05	0.10	0.25	3.5	6	11	29
Wetlands	56.1	0.10	0.10	0.10	0.5	2	2	2
Forest	885.8	0.05	0.09	0.18	7.3	13	24	48
Lake Surface	210.0	0.10	0.30	1.00	7.7	8	25	85

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description		Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)		0.30	0.50	0.80	
# capita-years	97.0				
% Phosphorous Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		0.58	4.85	15.52	1.5

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	281.1	731.2	1437.2	100.0
Total Loading (kg)	127.5	331.7	651.9	100.0
Areal Loading (lb/ac-year)	1.34	3.48	6.84	
Areal Loading (mg/m^2-year)	150.05	390.27	767.10	
Total PS Loading (lb)	0.0	0.0	0.0	
Total PS Loading (kg)	0.0	0.0	0.0	
Total NPS Loading (lb)	261.1	664.3	1215.6	
Total NPS Loading (kg)	118.4	301.3	551.4	

Date: 1/29/2007 Scenario: 3

Lake Id: 1286500
Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 2910.5 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 1940.3 acre-ft
Lake Surface Area <As>: 210.0 acre
Lake Volume <V>: 3150.0 acre-ft
Lake Mean Depth <z>: 15.0 ft
Precipitation - Evaporation: 1.6 in.
Hydraulic Loading: 1968.3 acre-ft/year
Areal Water Load <qs>: 9.4 ft/year
Lake Flushing Rate <p>: 0.62 1/year
Water Residence Time: 1.60 year
Observed spring overturn total phosphorus (SPO): 8.0 mg/m^3
Observed growing season mean phosphorus (GSM): 14.0 mg/m^3
% NPS Change: -50%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low Loading (kg/ha-year)	Most Likely Loading (kg/ha-year)	High Loading (kg/ha-year)	Loading %	Low Loading (kg/year)	Most Likely Loading (kg/year)	High Loading (kg/year)
Row Crop AG	44.7	0.50	1.00	3.00	3.9	5	9	27
Mixed AG	722.3	0.30	0.80	1.40	50.6	44	117	205
Pasture/Grass	823.6	0.10	0.30	0.50	21.6	17	50	83
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	378.0	0.05	0.10	0.25	3.3	4	8	19
Wetlands	56.1	0.10	0.10	0.10	0.5	1	1	1
Forest	885.8	0.05	0.09	0.18	7.0	9	16	32
Lake Surface	210.0	0.10	0.30	1.00	11.0	8	25	85

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description		Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)		0.30	0.50	0.80	
# capita-years	97.0				
% Phosphorous Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		0.58	4.85	15.52	2.1

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	194.1	509.8	1032.0	100.0
Total Loading (kg)	88.0	231.2	468.1	100.0
Areal Loading (lb/ac-year)	0.92	2.43	4.91	
Areal Loading (mg/m^2-year)	103.59	272.09	550.82	
Total PS Loading (lb)	0.0	0.0	0.0	
Total PS Loading (kg)	0.0	0.0	0.0	
Total NPS Loading (lb)	174.1	442.9	810.4	
Total NPS Loading (kg)	79.0	200.9	367.6	

Date: 1/29/2007 Scenario: 4

Lake Id: 1286500

Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 2910.5 acre

Total Unit Runoff: 8.00 in.

Annual Runoff Volume: 1940.3 acre-ft

Lake Surface Area <As>: 210.0 acre

Lake Volume <V>: 3150.0 acre-ft

Lake Mean Depth <z>: 15.0 ft

Precipitation - Evaporation: 1.6 in.

Hydraulic Loading: 1968.3 acre-ft/year

Areal Water Load <qs>: 9.4 ft/year

Lake Flushing Rate <p>: 0.62 1/year

Water Residence Time: 1.60 year

Observed spring overturn total phosphorus (SPO): 8.0 mg/m^3

Observed growing season mean phosphorus (GSM): 14.0 mg/m^3

% NPS Change: 0%

% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		Loading (kg/ha-year)				Loading (kg/year)		
Row Crop AG	44.7	0.50	1.00	3.00	4.4	9	18	54
Mixed AG	561.3	0.30	0.80	1.40	44.6	68	182	318
Pasture/Grass	662.6	0.10	0.30	0.50	19.7	27	80	134
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	378.0	0.05	0.10	0.25	3.8	8	15	38
Wetlands	56.1	0.10	0.10	0.10	0.6	2	2	2
Forest	885.8	0.05	0.09	0.18	7.9	18	32	65
LD Urban (1/2 Ac)	322.0	0.15	0.25	0.40	8.0	20	33	52
Lake Surface	210.0	0.10	0.30	1.00	6.3	8	25	85

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description		Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)		0.30	0.50	0.80	
# capita-years	388.0				
% Phosphorous Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		2.33	19.40	62.08	4.8

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	357.6	898.5	1787.1	100.0
Total Loading (kg)	162.2	407.6	810.6	100.0
Areal Loading (lb/ac-year)	1.70	4.28	8.51	
Areal Loading (mg/m^2-year)	190.89	479.58	953.83	
Total PS Loading (lb)	0.0	0.0	0.0	
Total PS Loading (kg)	0.0	0.0	0.0	
Total NPS Loading (lb)	333.8	799.5	1462.8	
Total NPS Loading (kg)	151.4	362.7	663.5	

Expanded Trophic Response Module

Total Phosphorus: 14 mg/m^3
Growing Season
Chorophyll a: 6.1 mg/m^3
Secchi Disk Depth: 2.5 m

Wisconsin Regional Prediction Equations:

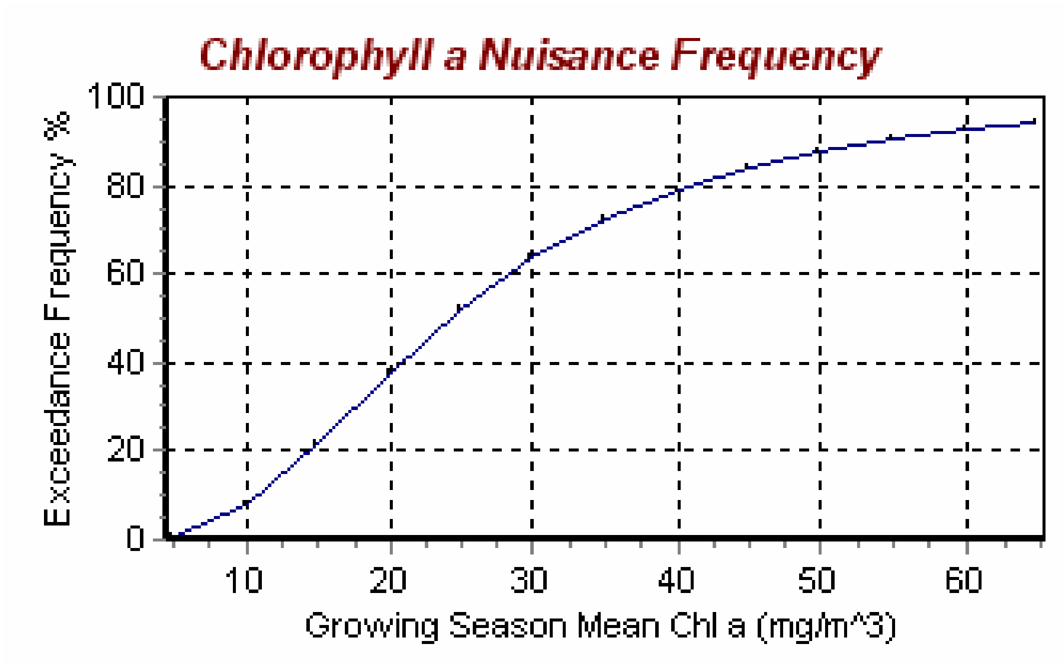
	Region	Stratified Seepage	Stratified Drainage	Mixed Seepage	Mixed Drainage
Use Chlorophyll_a To Predict Secchi Disk Depth (m)	South	2.0	2.1	1.0	1.2
	Central	2.7	2.6	2.4	No Data
	North	2.7	2.4	2.2	1.5
Use Total Phosphorus To Predict Secchi Disk Depth (m)	South	2.3	2.1	1.1	1.0
	Central	2.9	1.8	1.9	No Data
	North	2.7	2.7	2.1	1.7
Use Total Phosphorus To Predict Chlorophyll_a (mg/m^3))	South	5.4	6.5	6.4	7.2
	Central	5.2	11.0	7.6	No Data
	North	6.2	5.5	6.9	9.6

Expanded Trophic Response Module

Total Phosphorus: 14 mg/m^3
Growing Season
Chorophyll a: 6.1 mg/m^3
Secchi Disk Depth: 2.5 m

Wisconsin Statewide Prediction Equations:

	Natural Lakes Stratified	Natural Lakes Mixed	Impoundments Stratified	Impoundments Mixed
Secchi Disk Depth using Chlorophyll_a:	2.5	2.0	2.1	1.5
Secchi Disk Depth using Total Phosphorus:	2.6	1.9	2.1	1.4
Chlorphyll_a using Total Phosphorus:	6.1	7.3	7.2	7.3


Chlorophyll a Nuisance Frequency
Exceedance Frequency %
100
80
60
40
20
0
10
20
30
40
50
60
Growing Season Mean Chl a (mg/m^3)

Appendix D – Historical Water Quality Data (Summarized)

Total Phosphorus

Fieldwork Start	location	Description	Result	Units
7/21/05	TOP	PHOSPHORUS TOTAL	0.013	MG/L
8/3/01	TOP	PHOSPHORUS TOTAL	0.04	MG/L
8/3/01	TOP	PHOSPHORUS TOTAL	0.04	MG/L
8/8/00	TOP	PHOSPHORUS TOTAL	0.021	MG/L
6/23/99	TOP	PHOSPHORUS TOTAL	0.008	MG/L
6/23/99	TOP	PHOSPHORUS TOTAL	0.049	MG/L
8/18/98	TOP	PHOSPHORUS TOTAL	0.031	MG/L
7/23/98	TOP	PHOSPHORUS TOTAL	0.022	MG/L
6/23/98	TOP	PHOSPHORUS TOTAL	0.009	MG/L
8/18/97	TOP	PHOSPHORUS TOTAL	0.014	MG/L
7/29/97	TOP	PHOSPHORUS TOTAL	0.012	MG/L
7/29/97	TOP	PHOSPHORUS TOTAL	0.031	MG/L
6/24/97	TOP	PHOSPHORUS TOTAL	*0.025	MG/L
8/13/96	TOP	PHOSPHORUS TOTAL	0.022	MG/L
7/7/96	TOP	PHOSPHORUS TOTAL	*0.013	MG/L
7/7/96	TOP	PHOSPHORUS TOTAL	*0.034	MG/L
6/18/96	TOP	PHOSPHORUS TOTAL	0.023	MG/L
8/8/95	TOP	PHOSPHORUS TOTAL	0.013	MG/L
7/17/95	TOP	PHOSPHORUS TOTAL	0.009	MG/L
6/6/95	TOP	PHOSPHORUS TOTAL	0.014	MG/L
6/6/95	TOP	PHOSPHORUS TOTAL	0.021	MG/L
8/24/94	TOP	PHOSPHORUS TOTAL	*0.0130	MG/L
7/26/94	TOP	PHOSPHORUS TOTAL	0.012	MG/L
7/26/94	TOP	PHOSPHORUS TOTAL	*0.246	MG/L
6/22/94	TOP	PHOSPHORUS TOTAL	0.011	MG/L
6/22/94	TOP	PHOSPHORUS TOTAL	0.022	MG/L
8/10/93	TOP	PHOSPHORUS TOTAL	<0.02	MG/L
8/10/93	TOP	PHOSPHORUS TOTAL	0.04	MG/L
8/10/93	TOP	PHOSPHORUS TOTAL	0.04	MG/L
7/7/93	TOP	PHOSPHORUS TOTAL	0.04	MG/L
7/7/93	TOP	PHOSPHORUS TOTAL	0.03	MG/L

Fieldwork Start	location	Description	Result	Units
7/7/93	TOP	PHOSPHORUS TOTAL	<0.02	MG/L
8/26/92	TOP	PHOSPHORUS TOTAL	0.016	MG/L
8/26/92	TOP	PHOSPHORUS TOTAL	0.028	MG/L
8/26/92	TOP	PHOSPHORUS TOTAL	0.199	MG/L
7/29/92	TOP	PHOSPHORUS TOTAL	0.01	MG/L
7/29/92	TOP	PHOSPHORUS TOTAL	0.016	MG/L
7/29/92	TOP	PHOSPHORUS TOTAL	0.147	MG/L
6/24/92	TOP	PHOSPHORUS TOTAL	0.009	MG/L
6/24/92	TOP	PHOSPHORUS TOTAL	0.014	MG/L
6/24/92	TOP	PHOSPHORUS TOTAL	0.063	MG/L
8/29/91	TOP	PHOSPHORUS TOTAL	0.013	MG/L
8/29/91	TOP	PHOSPHORUS TOTAL	0.028	MG/L
8/29/91	TOP	PHOSPHORUS TOTAL	0.136	MG/L
6/11/91	TOP	PHOSPHORUS TOTAL	0.009	MG/L
6/11/91	TOP	PHOSPHORUS TOTAL	0.013	MG/L
6/11/91	TOP	PHOSPHORUS TOTAL	*0.036	MG/L
8/9/90	TOP	PHOSPHORUS TOTAL	0.037	MG/L
8/9/90	TOP	PHOSPHORUS TOTAL	0.049	MG/L
8/9/90	TOP	PHOSPHORUS TOTAL	0.276	MG/L
6/6/90	TOP	PHOSPHORUS TOTAL	0.02	MG/L
6/6/90	TOP	PHOSPHORUS TOTAL	0.02	MG/L
6/6/90	TOP	PHOSPHORUS TOTAL	0.04	MG/L
8/17/89	TOP	PHOSPHORUS TOTAL	<0.02	MG/L
7/19/89	TOP	PHOSPHORUS TOTAL	0.009	MG/L
6/28/89	TOP	PHOSPHORUS TOTAL	0.01	MG/L
8/17/88	TOP	PHOSPHORUS TOTAL	0.011	MG/L
8/17/88	TOP	PHOSPHORUS TOTAL	0.078	MG/L
8/17/88	TOP	PHOSPHORUS TOTAL	0.127	MG/L
7/19/88	TOP	PHOSPHORUS TOTAL	0.008	MG/L
9/22/05	BOT	PHOSPHORUS TOTAL	0.041	MG/L
9/22/05	BOT	PHOSPHORUS TOTAL	0.02	MG/L
8/24/05	BOT	PHOSPHORUS TOTAL	0.093	MG/L

Fieldwork Start	location	Description	Result	Units
8/24/05	BOT	PHOSPHORUS TOTAL	0.015	MG/L
7/21/05	BOT	PHOSPHORUS TOTAL	0.047	MG/L
9/16/02	BOT	PHOSPHORUS TOTAL	0.28	MG/L
9/16/02	BOT	PHOSPHORUS TOTAL	0.014	MG/L
8/18/98	BOT	PHOSPHORUS TOTAL	0.199	MG/L
7/23/98	BOT	PHOSPHORUS TOTAL	0.264	MG/L
6/23/98	BOT	PHOSPHORUS TOTAL	*0.08	MG/L
8/18/97	BOT	PHOSPHORUS TOTAL	0.062	MG/L
6/24/97	BOT	PHOSPHORUS TOTAL	*0.060	MG/L
8/13/96	BOT	PHOSPHORUS TOTAL	0.027	MG/L
6/18/96	BOT	PHOSPHORUS TOTAL	0.025	MG/L
8/8/95	BOT	PHOSPHORUS TOTAL	0.061	MG/L
7/17/95	BOT	PHOSPHORUS TOTAL	0.04	MG/L
8/24/94	BOT	PHOSPHORUS TOTAL	*0.0250	MG/L
6/10/93	BOT	PHOSPHORUS TOTAL	0.04	MG/L
6/10/93	BOT	PHOSPHORUS TOTAL	0.02	MG/L
6/10/93	BOT	PHOSPHORUS TOTAL	0.06	MG/L
7/11/91	BOT	PHOSPHORUS TOTAL	0.05	MG/L
7/11/91	BOT	PHOSPHORUS TOTAL	0.028	MG/L
7/11/91	BOT	PHOSPHORUS TOTAL	0.008	MG/L
7/9/90	BOT	PHOSPHORUS TOTAL	0.144	MG/L
7/9/90	BOT	PHOSPHORUS TOTAL	0.044	MG/L
7/9/90	BOT	PHOSPHORUS TOTAL	0.02	MG/L
8/17/89	BOT	PHOSPHORUS TOTAL	0.169	MG/L
8/17/89	BOT	PHOSPHORUS TOTAL	0.04	MG/L
7/19/89	BOT	PHOSPHORUS TOTAL	0.055	MG/L
7/19/89	BOT	PHOSPHORUS TOTAL	0.021	MG/L
6/28/89	BOT	PHOSPHORUS TOTAL	0.031	MG/L
6/28/89	BOT	PHOSPHORUS TOTAL	0.015	MG/L
7/19/88	BOT	PHOSPHORUS TOTAL	0.122	MG/L
7/19/88	BOT	PHOSPHORUS TOTAL	0.035	MG/L

Chlorophyll a

Fieldwork Start	Description	Result	Units
10/17/05	CHLOROPHYLL A, FLUORESCENCE (WELSCHMAYER 1994)	6.33	UG/L
7/21/05	CHLOROPHYLL A, FLUORESCENCE (WELSCHMAYER 1994)	3.13	UG/L
8/3/01	CHLOROPHYLL A UNCORRECTED	*10.	UG/L
8/3/01	CHLOROPHYLL A UNCORRECTED	*9.	UG/L
8/8/00	CHLOROPHYLL A UNCORRECTED	11	UG/L
6/23/99	CHLOROPHYLL A UNCORRECTED	*0.92	UG/L
4/7/99	CHLOROPHYLL A UNCORRECTED	7.58	UG/L
2/9/99	CHLOROPHYLL A UNCORRECTED	*1	UG/L
8/18/98	CHLOROPHYLL A UNCORRECTED	*19.8	UG/L
7/23/98	CHLOROPHYLL A UNCORRECTED	10.8	UG/L
6/23/98	CHLOROPHYLL A UNCORRECTED	2.75	UG/L
4/6/98	CHLOROPHYLL A UNCORRECTED	*24.4	UG/L
8/18/97	CHLOROPHYLL A UNCORRECTED	4.12	UG/L
7/29/97	CHLOROPHYLL A UNCORRECTED	*2.01	UG/L
6/24/97	CHLOROPHYLL A UNCORRECTED	*1.4	UG/L
4/14/97	CHLOROPHYLL A UNCORRECTED	*2.21	UG/L
3/4/97	CHLOROPHYLL A UNCORRECTED	*1.58	UG/L
8/13/96	CHLOROPHYLL A UNCORRECTED	13	UG/L
7/7/96	CHLOROPHYLL A UNCORRECTED	3.63	UG/L
6/18/96	CHLOROPHYLL A UNCORRECTED	*2.11	UG/L
4/24/96	CHLOROPHYLL A UNCORRECTED	*1.68	UG/L
2/13/96	CHLOROPHYLL A UNCORRECTED	*3.13	UG/L
8/8/95	CHLOROPHYLL A UNCORRECTED	*1.6	UG/L
7/17/95	CHLOROPHYLL A UNCORRECTED	*0.3	UG/L
6/6/95	CHLOROPHYLL A UNCORRECTED	*0.59	UG/L
3/23/95	CHLOROPHYLL A UNCORRECTED	*3.34	UG/L
8/24/94	CHLOROPHYLL A UNCORRECTED	16.4	UG/L
7/26/94	CHLOROPHYLL A UNCORRECTED	2.9	UG/L
6/22/94	CHLOROPHYLL A UNCORRECTED	*2.44	UG/L
4/6/94	CHLOROPHYLL A UNCORRECTED	5.48	UG/L
2/17/94	CHLOROPHYLL A UNCORRECTED	*0.393	UG/L

Fieldwork Start	Description	Result	Units
8/10/93	CHLOROPHYLL A UNCORRECTED	5.32	UG/L
7/7/93	CHLOROPHYLL A UNCORRECTED	3.49	UG/L
6/10/93	CHLOROPHYLL A UNCORRECTED	2.92	UG/L
4/29/93	CHLOROPHYLL A UNCORRECTED	6.9	UG/L
2/15/93	CHLOROPHYLL A UNCORRECTED	2.91	UG/L
8/26/92	CHLOROPHYLL A UNCORRECTED	6.98	UG/L
7/29/92	CHLOROPHYLL A UNCORRECTED	3.22	UG/L
6/24/92	CHLOROPHYLL A UNCORRECTED	3	UG/L
3/31/92	CHLOROPHYLL A UNCORRECTED	4	UG/L
3/31/92	CHLOROPHYLL A UNCORRECTED	**	UG/L
8/29/91	CHLOROPHYLL A UNCORRECTED	23	UG/L
7/11/91	CHLOROPHYLL A UNCORRECTED	2	UG/L
6/11/91	CHLOROPHYLL A UNCORRECTED	3	UG/L
6/11/91	CHLOROPHYLL A UNCORRECTED	4	UG/L
4/2/91	CHLOROPHYLL A UNCORRECTED	3.37	UG/L
2/12/91	CHLOROPHYLL A UNCORRECTED	*0.8	UG/L
8/9/90	CHLOROPHYLL A UNCORRECTED	14	UG/L
7/9/90	CHLOROPHYLL A UNCORRECTED	7	UG/L
6/6/90	CHLOROPHYLL A UNCORRECTED	11	UG/L
4/5/90	CHLOROPHYLL A UNCORRECTED	4	UG/L
2/21/90	CHLOROPHYLL A UNCORRECTED	3	UG/L
8/17/89	CHLOROPHYLL A UNCORRECTED	3	UG/L
7/19/89	CHLOROPHYLL A UNCORRECTED	5	UG/L
6/28/89	CHLOROPHYLL A UNCORRECTED	2	UG/L
4/13/89	CHLOROPHYLL A UNCORRECTED	16	UG/L
3/9/89	CHLOROPHYLL A UNCORRECTED	4	UG/L
8/17/88	CHLOROPHYLL A UNCORRECTED	2	UG/L
7/19/88	CHLOROPHYLL A UNCORRECTED	2	UG/L
7/1/80	CHLOROPHYLL A CORRECTED	2.30E+01	UG/L
7/1/80	CHLOROPHYLL A UNCORRECTED	2.70E+01	UG/L

Secchi Depth

Fieldwork Start	Description	Result	Units
09/16/02	SECCHI DEPTH - FEET	13	FEET
09/16/02	SECCHI DEPTH HIT BOTTOM	N	Y/N
09/02/01	SECCHI DEPTH	2.33	M
08/08/01	SECCHI DEPTH	1.36	M
08/03/01	SECCHI DEPTH - FEET	4.5	FEET
08/03/01	SECCHI DEPTH HIT BOTTOM	N	Y/N
08/08/00	SECCHI DEPTH - FEET	5.5	FEET
08/08/00	SECCHI DEPTH HIT BOTTOM	N	Y/N
07/27/99	SECCHI DEPTH	3.14	M
06/23/99	SECCHI DEPTH	5.1	M
06/23/99	SECCHI DEPTH - FEET	17	FEET
06/23/99	SECCHI DEPTH HIT BOTTOM	N	Y/N
04/07/99	SECCHI DEPTH	2.6	M
04/07/99	SECCHI DEPTH - FEET	8.5	FEET
04/07/99	SECCHI DEPTH HIT BOTTOM	N	Y/N
02/09/99	SECCHI DEPTH	4.25	M
02/09/99	SECCHI DEPTH - FEET	13.5	FEET
02/09/99	SECCHI DEPTH HIT BOTTOM	N	Y/N
08/18/98	SECCHI DEPTH	0.6	M
07/23/98	SECCHI DEPTH	2.6	M
06/23/98	SECCHI DEPTH	4.5	M
04/06/98	SECCHI DEPTH	1.5	M
08/18/97	SECCHI DEPTH	5.1	M
07/29/97	SECCHI DEPTH - FEET	22.3	FT
06/24/97	SECCHI DEPTH	5.7	M
04/14/97	SECCHI DEPTH	5.25	M
03/04/97	SECCHI DEPTH	7.25	M
08/13/96	SECCHI DEPTH - FEET	6.6	FT
07/07/96	SECCHI DEPTH	3.6	M
07/07/96	SECCHI DEPTH	3.6	M
06/18/96	SECCHI DEPTH - FEET	10.9	FT

Fieldwork Start	Description	Result	Units
04/24/96	SECCHI DEPTH	6.8	M
02/13/96	SECCHI DEPTH	1	M
08/08/95	SECCHI DEPTH	5.6	M
08/08/95	SECCHI DEPTH	5.6	M
07/17/95	SECCHI DEPTH	6.9	M
07/17/95	SECCHI DEPTH	6.9	M
06/06/95	SECCHI DEPTH	7.4	M
06/06/95	SECCHI DEPTH	7.4	M
03/23/95	SECCHI DEPTH	3.7	M
03/23/95	SECCHI DEPTH	3.7	M
03/23/95	SECCHI DEPTH - FEET	12.3	FEET
03/23/95	SECCHI DEPTH HIT BOTTOM	N	Y/N
08/24/94	SECCHI DEPTH	3.7	M
08/24/94	SECCHI DEPTH	3.7	M
07/26/94	SECCHI DEPTH	4.5	M
07/26/94	SECCHI DEPTH	4.5	M
06/22/94	SECCHI DEPTH	5.45	M
04/06/94	SECCHI DEPTH	3	M
02/17/94	SECCHI DEPTH	4.8	M
02/17/94	SECCHI DEPTH	4.8	M
08/10/93	SECCHI DEPTH	2.5	M
08/10/93	SECCHI DEPTH	2.5	M
07/07/93	SECCHI DEPTH	1.8	M
07/07/93	SECCHI DEPTH	1.8	M
07/07/93	SECCHI DEPTH	1.8	M
08/26/92	SECCHI DEPTH	3.3	M
08/26/92	SECCHI DEPTH	3.3	M
08/26/92	SECCHI DEPTH	3.3	M
07/29/92	SECCHI DEPTH	5.5	M
07/29/92	SECCHI DEPTH	5.5	M
07/29/92	SECCHI DEPTH	5.5	M
06/24/92	SECCHI DEPTH	2.7	M

Fieldwork Start	Description	Result	Units
06/24/92	SECCHI DEPTH	2.7	M
06/24/92	SECCHI DEPTH	2.7	M
03/31/92	SECCHI DEPTH	3.9	M
03/31/92	SECCHI DEPTH	3.9	M
08/29/91	SECCHI DEPTH	3.9	M
08/29/91	SECCHI DEPTH	3.9	M
08/29/91	SECCHI DEPTH	3.9	M
07/11/91	SECCHI DEPTH	4.2	M
07/11/91	SECCHI DEPTH	4.2	M
07/11/91	SECCHI DEPTH	4.2	M
06/11/91	SECCHI DEPTH	4.8	M
06/11/91	SECCHI DEPTH	4.8	M
06/11/91	SECCHI DEPTH	4.8	M
04/02/91	SECCHI DEPTH	3.2	M
08/09/90	SECCHI DEPTH	1.8	M
08/09/90	SECCHI DEPTH	1.8	M
08/09/90	SECCHI DEPTH	1.8	M
07/09/90	SECCHI DEPTH	2.3	M
07/09/90	SECCHI DEPTH	2.3	M
07/09/90	SECCHI DEPTH	2.3	M
06/06/90	SECCHI DEPTH	3.04	M
06/06/90	SECCHI DEPTH	3	M
06/06/90	SECCHI DEPTH	3	M
04/05/90	SECCHI DEPTH	2.8	M
04/05/90	SECCHI DEPTH	2.8	M