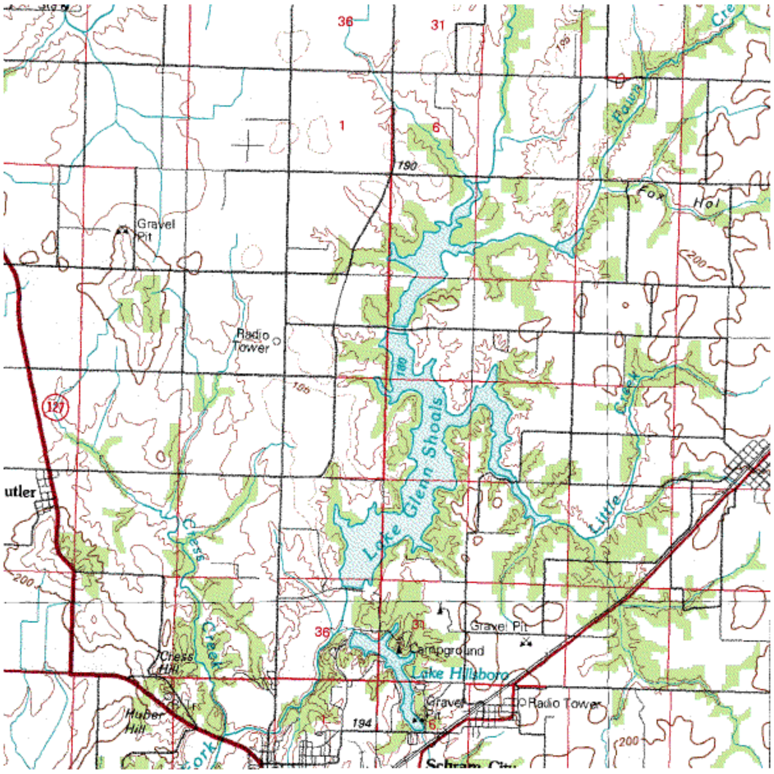
City of Hillsboro
Glenn Shoals Lake



Illinois Environmental Protection Agency

CLEAN LAKES PROGRAM

Phase 1 Diagnostic Feasibility Study

GLENN SHOALS LAKE
CITY OF HILLSBORO, MONTGOMERY COUNTY, ILLINOIS

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For the City of Hillsboro
In Cooperation with the Illinois Environmental Protection Agency

ZAHNISER INSTITUTE
FOR ENVIRONMENTAL STUDIES

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GLENN SHOALS LAKE
CITY OF HILLSBORO, MONTGOMERY COUNTY, ILLINOIS
EXECUTIVE SUMMARY

Prepared by:
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Lake Status

Glenn Shoals Lake has four main purposes. These purposes include flood control, water supply, recreation, and esthetics. The following lake uses are discussed from the most important to the least important. Glenn Shoals Lake was designed to be a flood control lake. Flood control was the primary use for the lake which qualified it for federal funding through the U. S. Department of Agriculture and it still continues to serve this function. This is a very important purpose for Glenn Shoals providing stability for downstream homes and croplands.

The secondary purpose for the lake is public drinking and water supply. Glenn Shoals provides drinking water to over 10,800 households in the area. It is used for general water supply for the residents in Hillsboro, Schram City, Taylor Springs, Coffeen, Grahm Correctional Center and as a rural water supply through the Montgomery Water Co.

Recreation is the third use for the lake. Glenn Shoals serves the surrounding area with a wide range of recreational activities. Hillsboro residents as well as those from surrounding cities can enjoy duck hunting, camping, hiking, fishing, and boating. Glenn Shoals offers the same types of recreation as other lakes within 50 miles. Although it is not provided in Glenn Shoals Lake, supervised recreational swimming is available in nearby Hillsboro Lake.

Finally, Glenn Shoals provides an esthetically pleasing feature for the community. The natural beauty of the lake and its surrounding shoreline are a source of pleasure for those who visit. The scenery and esthetic beauty of Glenn Shoals attracts people to the lake to engage in recreational activities, build homes nearby or observe birds and other wildlife. The value of the lake in this respect is not measured in dollars but is appreciated by each visitor according to his or her own personal preference. However, the esthetic value has a major impact on the economic value that most people place on property. The presence of the esthetic environment provided by the lake is also healthy and psychologically beneficial for local residents and visitors alike.

The life of the lake is determined by two factors. First, since the lake is constantly filling with sediments, there will come a time when it will no longer hold enough water to adequately meet the demands of the community for drinking and other water supply. At the present sedimentation rates, many of the shallower portions of the lake could be filled in the next 20-40 years while in other parts of the lake the changes will be hardly noticeable for a number of years. The second deals with the quality of the water as a result of suspended solids, nutrients and pesticides entering the lake from the watershed. The watershed is over 75% cropland and the fertilizer added to crops is the major source of pollution. Chemical pollution (nutrients and pesticides) can be addressed by continuing to encourage farmers in the watershed to use best management practice (BMP). The BMP's for sedimentation reduction would include but not be limited to, no-till, grass strips, terracing, stream bank erosion control, and reforestation. Other means such as storm water wetland basins should also be studied. These federally funded programs should be extended because they would greatly extend the useful life of the lake.

The nutrient and sediment budget (Table 12) shows that 45,000 tons were added to the lake in 2001. This compares to the 39,593 tons calculated for the NRCS 1995 unpublished survey. These data indicate that there is almost a ton of sediment deposited per acre of watershed per year. The nutrient levels in the water are presented in Table14. The average Nitrogen measured was (3-5 mg/l) which is higher than the historical (kjeldahl nitrogen of 1.04-1.3 mg/l). The phosphorus is currently 0.1 - 0.2 mg/l while the historical data shows an average of 0.134 mg/l (Table15; ROL 1b). If BMPs (remediation techniques) could reduce the phosphorous (P) and total suspended solids (TSS) input, by half, the life of the lake could be doubled.

Lake Quality Problems

Glenn Shoals has three major water quality factors that present problems for the lake. These factors are: sediment entering the lake, excessive nutrients in the lake, and degraded recreation and esthetic quality caused by suspended solids and algae blooms that result from excess sediments and nutrients entering the lake. These problems occur primarily from non-point source pollution in the watershed.

The first problem identified is sediments entering the lake. The sediment loading in Glenn Shoals Lake is due mostly to the surrounding watershed. The lake's watershed covers 51,200 acres of primarily agricultural land. Run-off from the watershed brings excess nutrients and sediment into the lake. The nutrients disperse or dissolve in the water and the sediment settles to the bottom of the lake slowly filling it. In 2001 Glenn Shoals Lake received 45,000 tons of sediment. Also, adding to the problem of sedimentation is internal loading and shoreline erosion. These are minimal contributor to the sedimentation problem.

The second problem with Glenn Shoals is excessive nutrients in the lake. The two major nutrients associated with good water quality are, Phosphorus (P) levels and Nitrogen (N) levels. These two major nutrients determine the health of the lake. Plants use N and P for their growth and development. High levels of nutrients create a good environment for algal blooms and high eutrophic conditions, causing damage to the lake. High eutrophic conditions create higher amounts of decaying plant material, which in turn uses more oxygen and produces more dissolved phosphorus. Low oxygen levels in the water can be detrimental to fish and aquatic inverterbrates. The major cause of excess nutrients in the lake is run-off from the watershed, especially that arising from agricultural properties. The minor contributors are waterfowl and atmospheric deposition from rainfall. Waterfowl and rainfall have had limited impact on the water quality of Glenn Shoals Lake.

Degraded recreation and esthetic quality is the last problem concerning Glenn Shoals Lake. As the quality of the lake deteriorates fish populations decline. Also, the esthetic or natural beauty of a lake and shoreline is degraded when the lake becomes laden with excess nutrients. Water recreational activities will also be limited with reduced water quality of the lake. Since the lake supports duck hunting, boating, hiking, camping, and fishing, the degradation that results from increased sediments and nutrients is a concern to the managers, owners and users of Glenn Shoals Lake. The recreational activities of duck hunting, boating, camping, and fishing are also a source of revenue for the City of Hillsboro.

These three lake quality problems 1) sediment loading, 2) nutrient loading and 3) reduction in recreational and esthetic quality can be alleviated and the life of the lake extended for many more years. The current sediment load is approximately 45,000 tons per year. This will be 46 acre feet per year. The sediment filling the lake will not be uniform. The areas near the incoming streams will fill first and will pose navigation problems in the next 20 to 40 years, significantly reducing the total surface area of the lake. This will probably be accompanied by excess algae blooms that can produce taste and/or odor problems with the drinking water. The deeper part of the lake will fill later and should last for many years. Even though the lake can survive for many years without mitigation the size will continue to decline and quality will continue to deteriorate. However with proper management the useful life can be doubled or tripled.

The lake was designed so that the volume would support the water needs of the community even with a 2 year drought. In the normal design structure this requires a 70-75% capacity of the original volume of 12,500 acre ft. This means that a 25% loss (3125 Acre ft.), if it occurs at the current rate of 46 acre ft/year, will be exceeded in 70 years. After this the 2 year drought reserve would not be available. Even before this time, the turbidity, taste and odor problems will multiply and the treatment cost to produce potable water will be greatly increased.

The most viable alternatives for preserving the lake (Glenn Shoals) are to try to prevent particulates and nutrients from entering the lake. Since humans by nature tend to increase both particulates and nutrients and individuals living closer to the lake have a much greater effect per area, it is our recommendation that Hillsboro do everything possible to keep the natural trees and other vegetation wherever possible. This would suggest that all public lands should be kept natural. Thus we recommend no additional sale or leasing of public property.

Mitigation and Restoration

There are 24 possible mitigation or restoration alternatives proposed for Glenn Shoals Lake (Table 30). The costs of the alternatives range from an estimated $5,000,000 to practically nothing. Out of the 24 possible alternatives, 10 were chosen as the best fit for the needs of Glenn Shoals Lake and budget of the City of Hillsboro. The 10 alternatives being recommended are those that will most effectively address the issues of improving lake quality and prolonging the life of the lake, while managing the cost to the city.

Alternatives (2), (3), (19) and (20) would have no real impact on the City of Hillsboro’s funds. These alternatives would be covered by other federal, state, county, or regional agencies. Alternatives (2) and (3) would reduce the amount of sediment coming into the lake along with unwanted excess nutrients thus improving the water quality of the lake. Alternative (19) and

(20) would specifically help reduce the amount of nutrients (P and N) entering the lake from septic tanks and fields.

Alternatives (22) and (16) would cost between $1,000 and $10,000. Alternative (22) would help reduce the amount of nutrients and some sedimentation that come into the lake. By reducing the area affected by water ski boats alternative (16) would greatly help the amount of shoreline erosion on Glenn Shoals Lake. This water ski area should be the first to be completely rip-raped.

Although alternatives (7), (8), (15) are the most expensive possible alternatives selected, these alternatives along with (2) would have the greatest impact on sustaining the life of the lake, improving the life of the lake, and improving the lake quality.

TABLE 31 (duplicate) Restoration and Mitigation Alternatives for Glenn Shoals Lake (2000-01)

Alt. No.	Restoration Alternative	Estimated Cost	Reduce Sediment Obj. 1	Reduce Solids Obj. 2	Reduce Pollution Obj. 3	Aquatic Life Obj. 4	Rec Use Obj. 5	Extended Lake life Years
1	Stream Bank Stabilizatoin **	$150,000	+	+	O	+	+	
2	Conservation Practices ** Soil Testing of Farmland	N/A	+	+	+	+	+	
3	Riparian buffers **	N/A	+	+	+	+	+	
4	Sediment Control Struct's **	$200,000	+	+	+	+	+	2yrs.
5	Storm Water Detention **	$500,000	+	+	+	+	+	3yrs.
6	Draw Down Structure 14	$1,000	+	O	O	O	+	N/A
7	Meisen. Struc. & Wetland	$632,000	+	+	+	+	+	52yrs
8	Irving Cove Structure	$512,500	+	+	+	+	+	6yrs
9	Dredging Irving Cove *	$1,996,500	+	O	O	O	+	
10	Dredging Fawn Cove *	$2,715,240	+	O	O	O	+	
11	Dred’g North End of Lake *	$4,871,460	+	O	O	O	+	
12	Draw Down North End	$5,000	+	O	O	O	+	N/A
13	Cove Dredging	$120,000	+	O	O	O	+	N/A
14	Brood Pond	$15,000	O	O	O	+	+	0
15	Lake Rip-Rap	$1,391,960	+	+	+	+	+	1 yr
16	Designated Ski Area ***	$1,000	+	+	O	O	+	
17	Increase Patrol and Fees ***	$0	+	+	O	O	+	
18	Construction Site BMP's **	N/A	+	+	O	O	+	
19	Septic Tank Inspection **	$0	O	O	+	+	+	
20	Public Land Preservation ***	$0	+	+	+	+	+	<1 yr
21	Phase 2 monitoring prog.	$35,000	O	O	O	O	O	0
22	Add Barley Bales	$5,000/yr	O	+	O	+	+	
23	Lake Education Programs (This meets objective #6)	$5,000	O	O	O	O	O	

Legend:

+ = Positive effect	* No estimated life projection; cost prohibitive project.
O = No effect	** Watershed project; to assist NRCS City should form a resource committee
- = Negative effect	*** Requires passing a City Ordinance.
N/A = Not available	

Objectives for Lake Restoration

Objective 1 – Reduce the rate and extent of sedimentation.
Objective 2 – Reduce total suspended solids.
Objective 3 – Reduce nutrient and pesticide input from the watershed.
Objective 4 – Improve the aquatic life of the lake.
Objective 5 – Improve the recreational use of the lake.
Objective 6 – Educate the public on the importance of good water quality

Table 15 (Duplicate) Glenn Shoals Lake Historical Data 1981-1999

	ROL-1b	**ROL-1t**	**ROL-2**	**ROL-3**
Ammonia Nitrogen				
Minimum	0.04 mg/L (1981)	0.01mg/L (1993)	0.09 mg/L (1997)	0.07 mg/L (1993)
Maximum	1.1 mg/L (1989)	0.46 mg/L (1997)	0.57 mg/L (1993)	0.52 mg/L (1993)
Average	0.31 mg/L	0.15 mg/L	0.19 mg/L	0.2 mg/L
Median	0.24 mg/L	0.1 mg/L	0.11 mg/L	0.19 mg/L
Kjeldahl Nitrogen				
Minimum	0.4 mg/L (1989)	0.4 mg/L (1989)	0.61 mg/L (1997)	0.72 mg/L (1993)
Maximum	1.9 mg/L (1989)	1.4 mg/L (1989)	1.8 mg/L (1989)	1.9 mg/L (1993)
Average	1.04 mg/L	0.89 mg/L	1.04 mg/L	1.3 mg/L
Median	1.01 mg/L	0.89 mg/L	0.96 mg/L	1.3 mg/L
pH				
Minimum	7.6 (1983)	6.7 (1983)	6.8 (1983)	6.7 (1983)
Maximum	7.6 (1997)	8.6 (1989)	8.9 (1989)	8.6 (1993)
Average	7.1	7.8	7.8	7.7
Median	7.1	7.7	8	7.7
Secchi				
Minimum	N/A	2 inches (1983)	2 inches (1983)	1 inch (1983)
Maximum	N/A	42 inches (1993)	26 inches (1997)	19 inches (1981)
Average	N/A	21.3 inches	15.4 inches	9.6 inches
Median	N/A	22 inches	14.5 inches	9.5 inches
Chlorophyll a				
Minimum	N/A	1.48 µg/L (1993)	3.05 µg/L (1993)	17.2 µg/L (1993)
Maximum	N/A	107.54 µg/L (1989)	69.7 µg/L (1989)	82.2 µg/L (1997)
Average	N/A	21.96 µg/L	31.5 µg/L	44.3 µg/L
Median	N/A	13.66 µg/L	23.1 µg/L	46.3 µg/L
Nitrate + Nitrite Nitrogen				
Minimum	0.01 mg/L (1997)	0.01 mg/L (1997)	0.1 mg/L (1989)	0.01 mg/L (1997)
Maximum	1.8 mg/L (1993)	2.2 mg/L (1993)	2.1 mg/L (1993)	2.5 mg/L (1993)
Average	0.88 mg/L	0.85 mg/L	0.82 mg/L	0.98 mg/L
Median	0.97 mg/L	0.73 mg/L	0.65 mg/L	0.70 mg/L
Phosphorus				
Minimum	0.054 mg/L (1981)	0.04 mg/L (1989)	0.07 mg/L (1989)	0.108 mg/L (1989)
Maximum	0.313 mg/L (1983)	0.314 mg/L (1983)	0.315 mg/L (1983)	0.537 mg/L (1993)
Average	0.134 mg/L	0.1 mg/L	0.12 mg/L	0.216 mg/L
Median	0.122 mg/L	0.076 mg/L	0.09 mg/L	0.194 mg/L

Source: EPA STORET Data

Table14 (Duplicate**)** NUTRIENT AND SEDIMENT BUDGET FOR GLEN SHOALS LAKE (2000-2001)

INFLOW	**TOTAL PHOSPHORUS**		**TOTAL NITROGEN**		**TOTAL SUSPENDED SOLIDS**	
	Kg/yr	**%**	**Kg/yr**	**%**	**Kg/yr**	**%**
TRIBUTARIES						
Shoal Creek ROL02	61,249	41%	1,015,670	64%	22,149,839	54%
Structure 14 ROL03	34,275	23%	315,213	20%	10,572,686	26%
Little Creek North ROL04	27,392	18%	126,816	8%	4,136,016	10%
Little Creek South ROL05	27,520	18%	127,412	8%	4,155,435	10%
ATMOSPHERIC	304	> 1%	3,300	> 1%	N/A	
INTERNAL	394	> 1%	3,149	> 1%	N/A	
SHORELINE	N/A		N/A		364,820	>1%
Total Inflow	**151,134**	**100%**	**1,591,560**	**100%**	**41,013,976**	**100%**
OUTFLOW						
SPILLWAY	54,571	36%	268,576	17%	2,192,614	5%
DRINKING WATER	183	> 1%	2,323	> 1%	21,615	>1%
Total Outflow	**54,754**	**36%**	**270,899**	**17%**	**2,214,229**	**5%**
	TOTAL PHOSPHORUS		**TOTAL NITROGEN**		**TOTAL SUSPENDED SOLIDS**	
		Retained		**Retained**		**Retained**
	Kg/yr	%	Kg/yr	%	Kg/yr	%
NET LOADING	**96,563**	**64%**	**1,320,661**	**83%**	**39,164,567**	**95%**
	Tons/yr		Tons/yr		Tons/yr	
	106		146		43,170	

Illinois Clean Lakes Program

Phase I Diagnostic- Feasibility Study of Glenn Shoals Lake, Montgomery County, Illinois

PART 1

Diagnostic Study

INTRODUCTION

On December 12th of 2000, the City of Hillsboro, Illinois, with the assistance of Greenville College's Zahniser Institute for Environmental Studies (ZIES) and the United States Department of Agriculture Natural Resources Conservation Service's (USDA-NRCS) Montgomery County office, submitted a grant application narrative to the Illinois Environmental Protection Agency (IEPA) for an IEPA sponsored Phase 1 Diagnostic-Feasibility Study of Glenn Shoals Lake. The State of Illinois cost-sharing for this type of study is provided by the Illinois Environmental Protection Agency through its Illinois Clean Lakes Program (ICLP), a Conservation 2000 funded program. Phase 1 studies are limited to publicly-owned lakes that have extensive public access and recreational use. The basic purpose of a Phase 1 study is to identify lake problems, diagnose causes, and develop feasible courses of action to correct the problems.

On May 14, 2001 the City of Hillsboro and IEPA formally executed an intergovernmental agreement relative to the Phase 1 Glenn Shoals Lake Study, outlining the scope of the work and each agency's specific responsibilities and costs. In general terms, the City of Hillsboro was responsible for the overall performance of the study, and IEPA was primarily responsible for reviewing the City of Hillsboro's work, and conducting water quality and sediment sampling analyses. Of the $125,000 slated to be used on the project, $75,000 (60%) came from the IEPA and $50,000 (40%) was provided by the City of Hillsboro.

The City of Hillsboro subcontracted the data collection, data analyses and report drafting to ZIES, under the terms of an agreement dated April 10, 2001. ZIES also served as the primary liaison to IEPA on behalf of the City of Hillsboro.

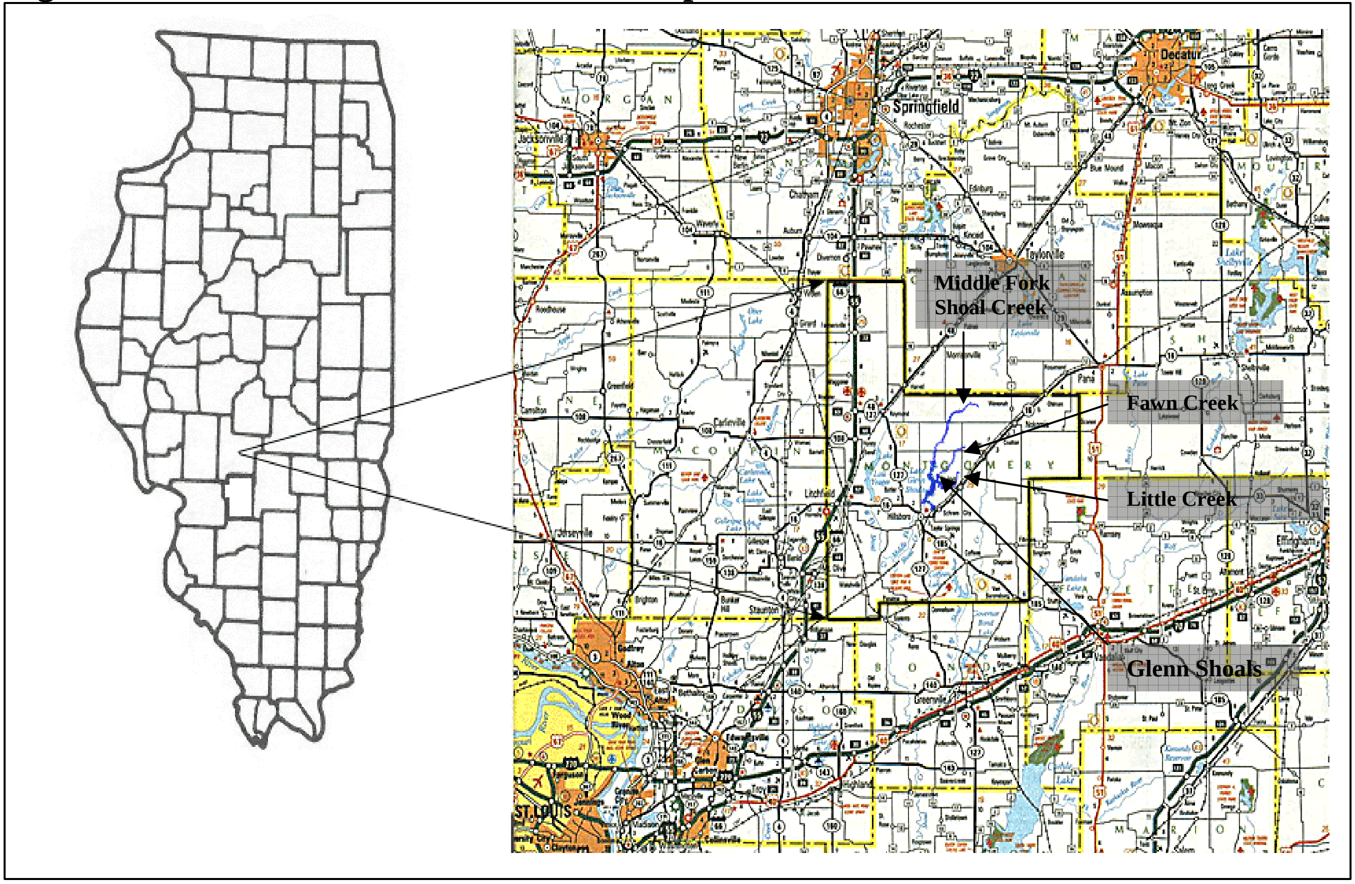
A.1. Lake Identification and Location (Table 1)

A. Official name of lake
B. State and county in which located
C. Name of nearest municipality
D. Latitude and longitude of lake center
E. EPA Region
F. EPA major basin name and code
G. EPA minor basin name and code
H. Names of major tributaries
I. Name of water body which receives lake’s discharge
J. Approved State water quality standards for the lake

Table 1 Lake Identification and Location

Lake Name	Glenn Shoals Lake
State	Illinois
County	Montgomery
Nearest Municipalities	Schram City - 1/4 mile East of South End Hillsboro - 1 1/4 miles South
Latitude, Longitude of the Lake:	Latitude 39°12' North / Longitude 89°28' East
EPA Region	Region 5
EPA Major Basin Name	Lower Mississippi River Code: 07
EPA Minor Basin Name	Lower Kaskaskia River Code: 14
Major Tributaries	Middle Fork Shoal Creek Fawn Creek Little Creek
Receiving Water Body	Middle Fork Shoal Creek
Water Quality Standards Applicable Criteria	State of Illinois, Rules and Regulations Title 35: Environmental Protection Chapter I: Pollution Control Board Part 302 Subpart B: General Use Water Quality Standards Subpart C: Public and Food Processing Water Supply Standards
Ownership	City of Hillsboro
Surface Area	1,250 Acres (510 Hectares)
Maximum Depth	23 Feet (7 Meters)
Mean Depth	10 Feet (3 Meters)
Storage Volume	12,700 acre-feet (15,671,800 m^3)
Average Retention Time	0.5 years
Watershed Area	51,200 Acres (20,720 Hectares)
Shoreline Length	26.6 miles (~ 42.8 Kilometers)
Ratio of Watershed Area to Water Surface Area	51200/1250 = 41/1

Figure 1 - Glenn Shoals Lake Location Map



A. 2. Geological and Soils Description of Drainage Basin

A.2.a Geological Description

Lake Glenn Shoals lies in the center of the Springfield Plain (Figure 4), in the Illinois Basin of the Central Lowland Province. The area's stratigraphy is a product of the Illinoian glaciation of Pleistocene Epoch. The loess deposits (Figure 3) produced by regional glaciation range from 0 - 50 inches (1.3 m) thick in the southern portion of the Glenn Shoals watershed, and 50-150 inches (3.8 m) thick in the northern portion. Glacial till underlying this is Illinoisan moraine and ground moraine (Figure 2), of the Glasford formation. Bedrock in this area is Pennsylvanian in origin, of the Bond and Mattoon formations. This bedrock layer is 150 to 300 feet (46 to 91 m) thick. It is thickest in the southern portion, averaging 250 feet (76 m) thick. It is composed of limestone calcareous clays, and shale (Figure 5).

A.2.b. Groundwater Hydrology

Sandstone and gravel aquifers are uncommon in the region of Lake Glenn Shoals. This is attributed to the imperviousness of the shale layers of the bedrock. Groundwater for well extraction is more commonly found in the glacial till, 25 to 30 feet (7-9 m) below the surface, although wells of this nature are prone to drying up during droughts.

A.2.c Topography

The Glenn Shoals Lake watershed is comprised of six sub-basins. For the purposes of this report these are known as the Glenn Shoals North, Glenn Shoals East, Glenn Shoals West, Structure 14, Irving North, and Irving South sub-basins. The Structure 14 sub-basin is so named because of the existence of a sediment pond located there. These sub-basins are illustrated in Figure 6 (Figure 7- key to Figure 6), Sub-Watershed Delineation. The general lay of the ground within the Glenn Shoals watershed is slightly to moderately rolling, with moderately steep to steep areas bordering lake shore and tributaries. A United States Geological Survey 7.5 min. map was used to estimate percent slopes for the six sub-basins. (Table 2)

Table 2 Topography of Glenn Shoals Watershed

% Slope	Acres	Sediment Delivery in Tons/Year
0-2	45,420	4,769
3-5	4,845	3,537
6-10	2,624	4,251
11- 30	3,300	1,436

Source: Natural Resources Conservation Service

Figure 2 - Quaternary Deposits in Illinois

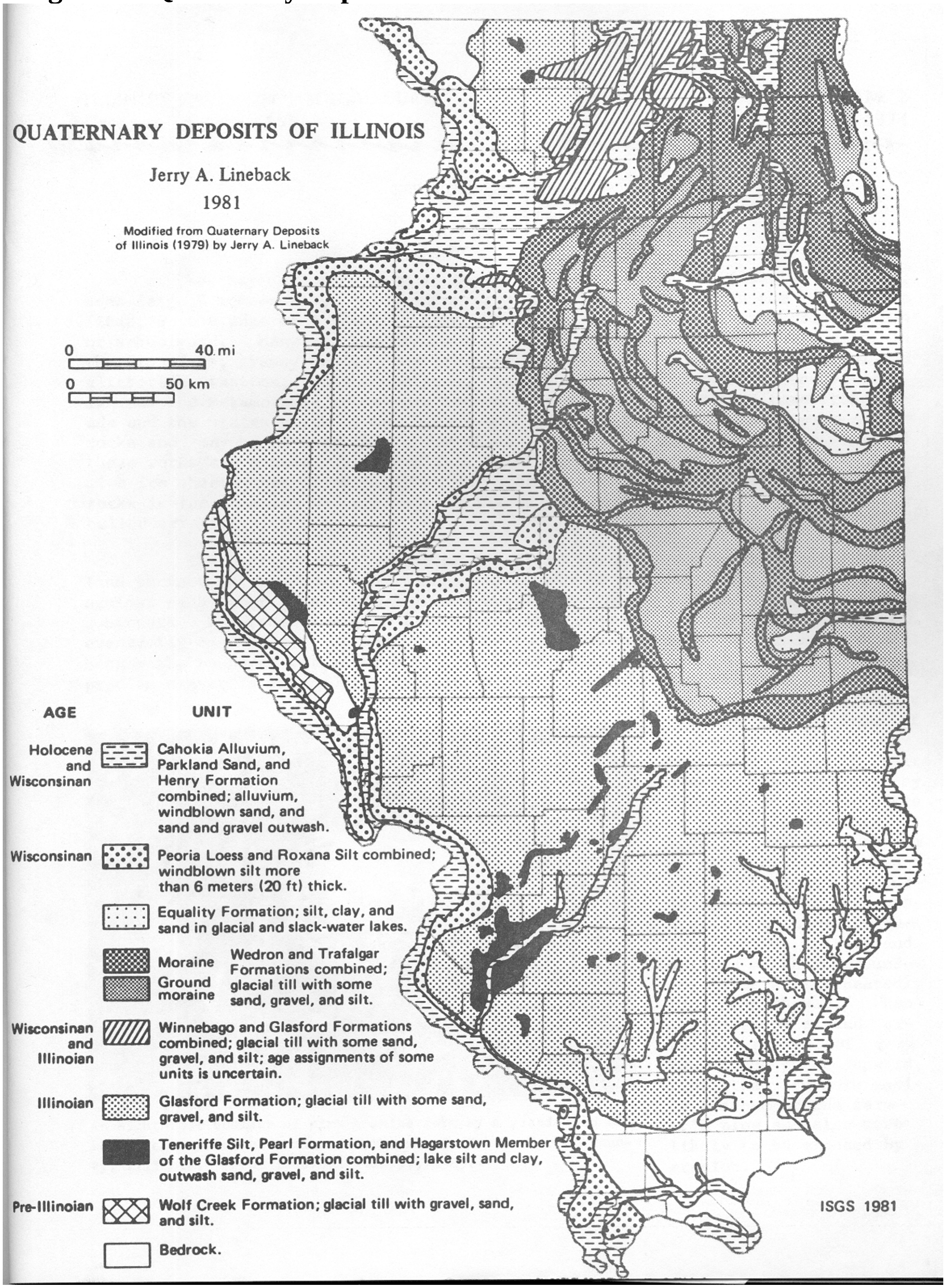


Figure 3 - Loess Thickness in Illinois

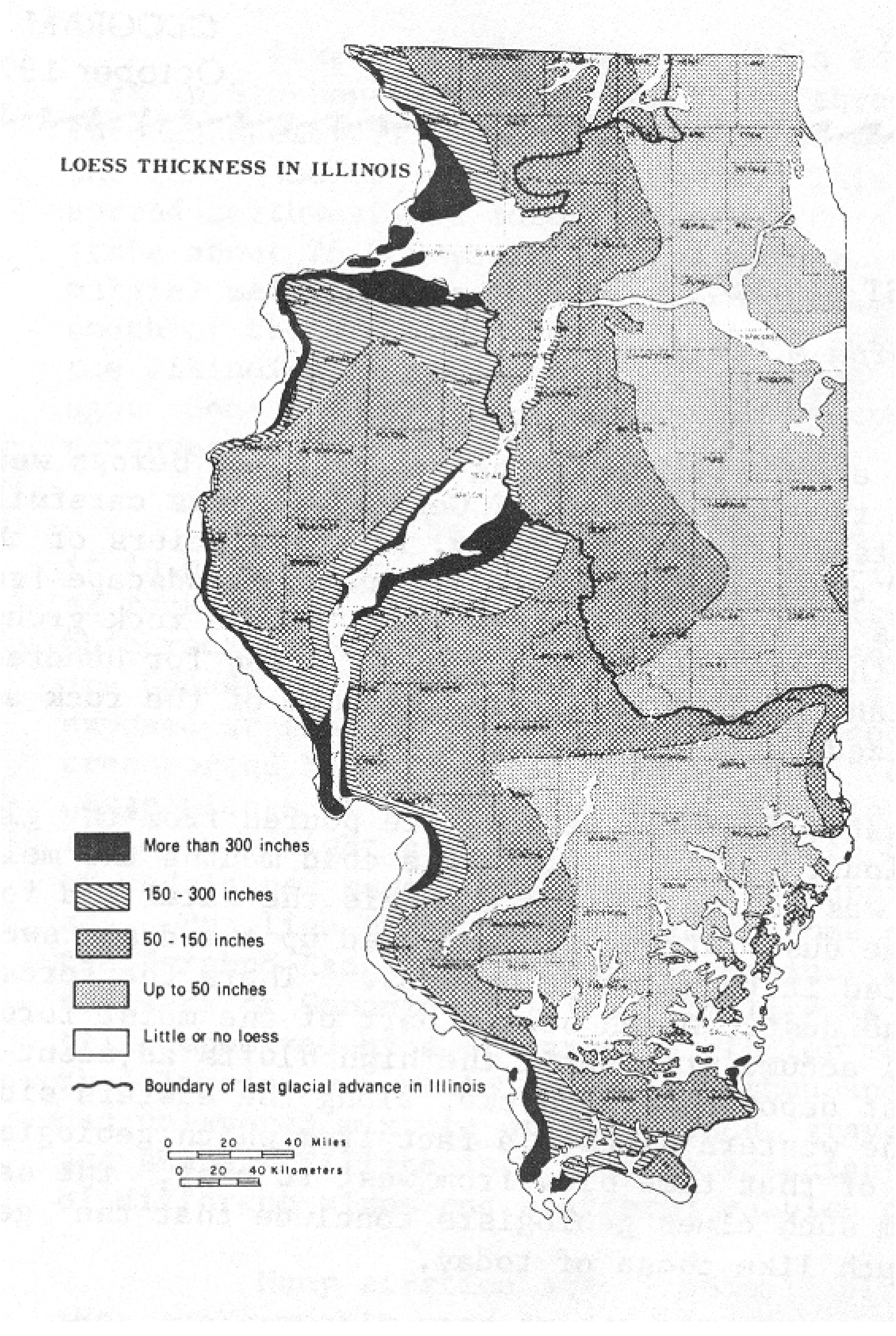


Figure 4 - Physiographic Regions on Illinois

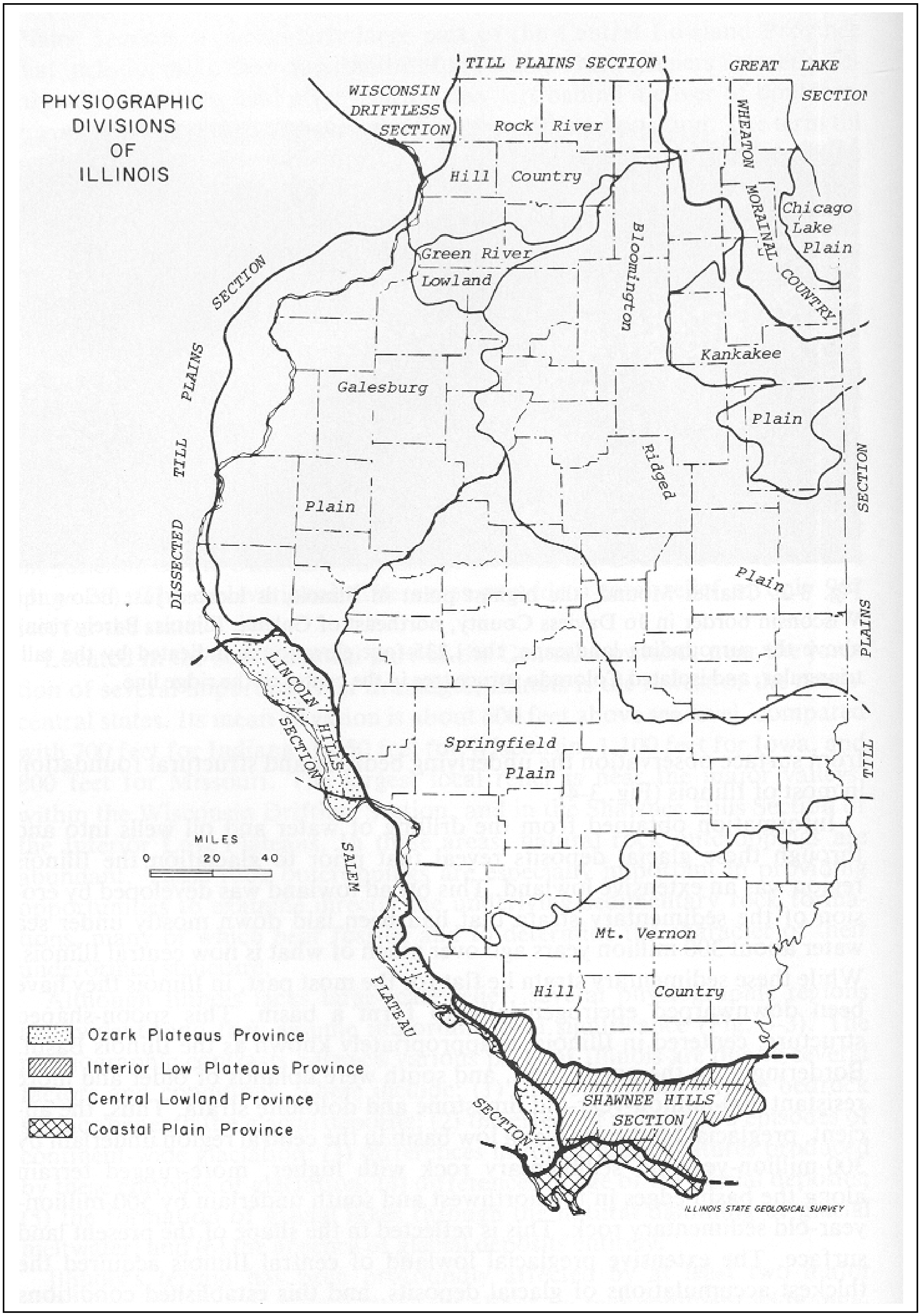
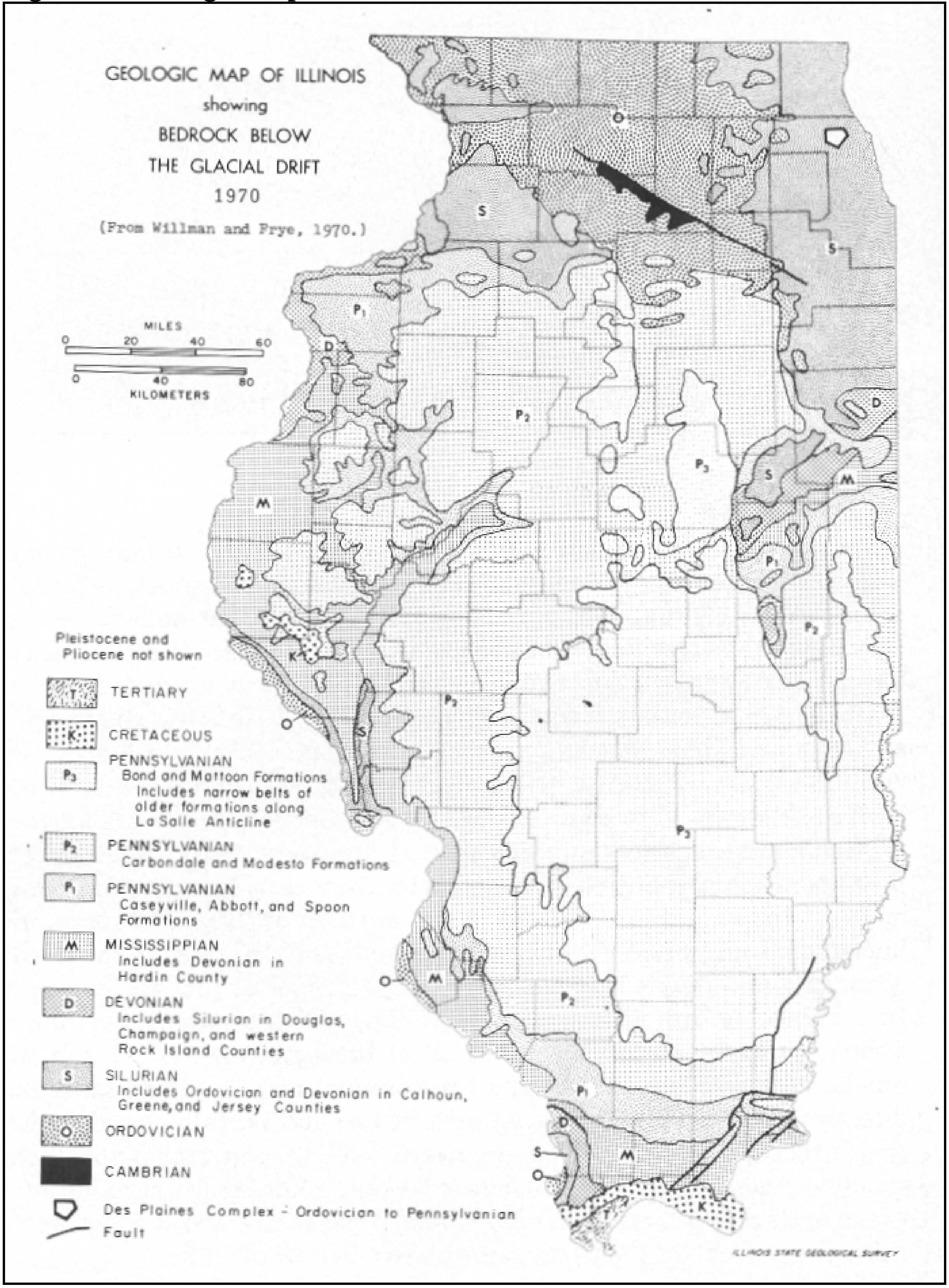


Figure 5 - Geologic Map of Illinois



A.2.d Soils

There are 6 major soil associations found in the Glenn Shoals Lake watershed. The following table (Table 3) gives a description of each and approximate percentages comprising each sub-basin. A map of these associations can be found in Figure 6**.**

Table 3 Major Soil Associations

Soil Association	Descri-ption	Glenn Sh. North	Glenn Sh. West	Glenn Sh. East	Structure 14	Irving North	Irving South
Virden-Herrick	Dark-colored, poorly drained to somewhat poorly drained soils on upland flats.	20%	2%	0%	0%	0%	0%
Oconee-Velma-Tamalco	Nearly level to strongly sloping, moderately dark colored soils that have a slowly permeable, moderately permeable, or very slowly permeable subsoil.	6%	33%	8%	10%	6%	0%
Hickory-Hosmer	Gently-sloping to very steep, light colored, moderately well drained to well drained soils on uplands adjacent to streams.	0%	0%	0%	0%	0%	27%
Cowden-Piasa	Level, moderately dark colored soils that have a slowly or very slowly permeable subsoil.	0%	25%	65%	13%	16%	48%
Herrick-Piasa Association	Level, dark colored and moderately dark colored soils that are on upland divides and that have moderately slowly or very slowly permeable subsoil.	74%	40%	12%	77%	78%	25%
Lawson-Radford	Level, dark-colored, somewhat poorly drained soils on flood plains.	0%	0%	15%	0%	0%	0%

Figure 6 - Glenn Shoals Lake – Subwatershed Soils

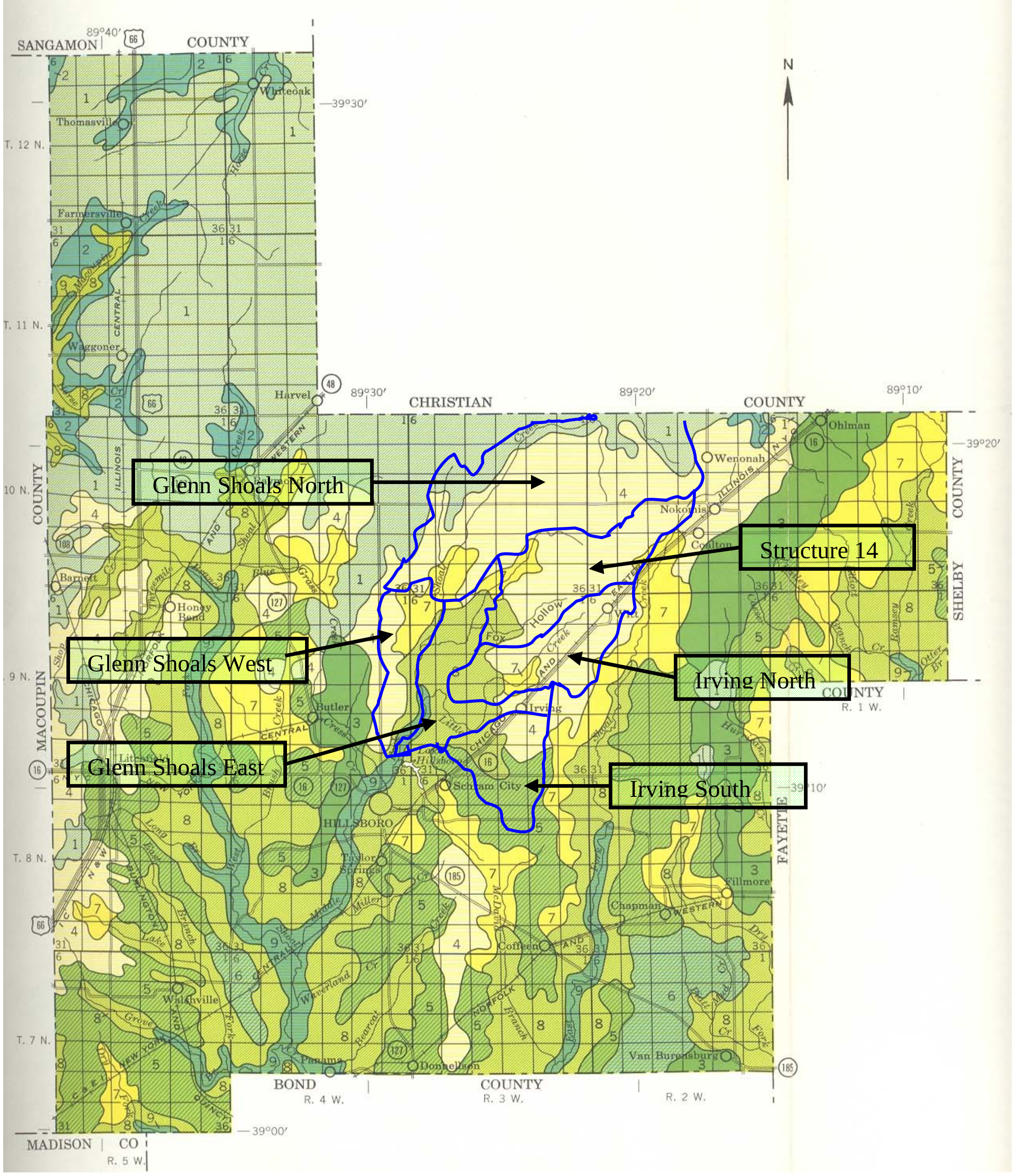
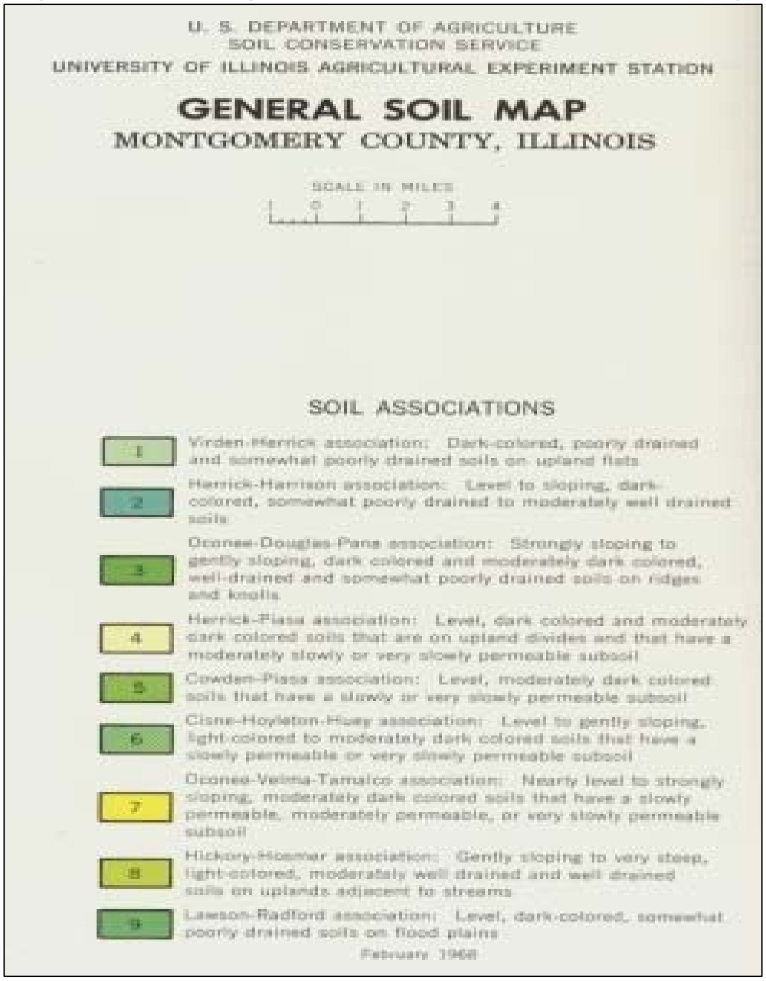


Figure 7- Montgomery County Soil (Key to Figure 6)



U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
UNIVERSITY OF ILLINOIS AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP
MONTGOMERY COUNTY, ILLINOIS

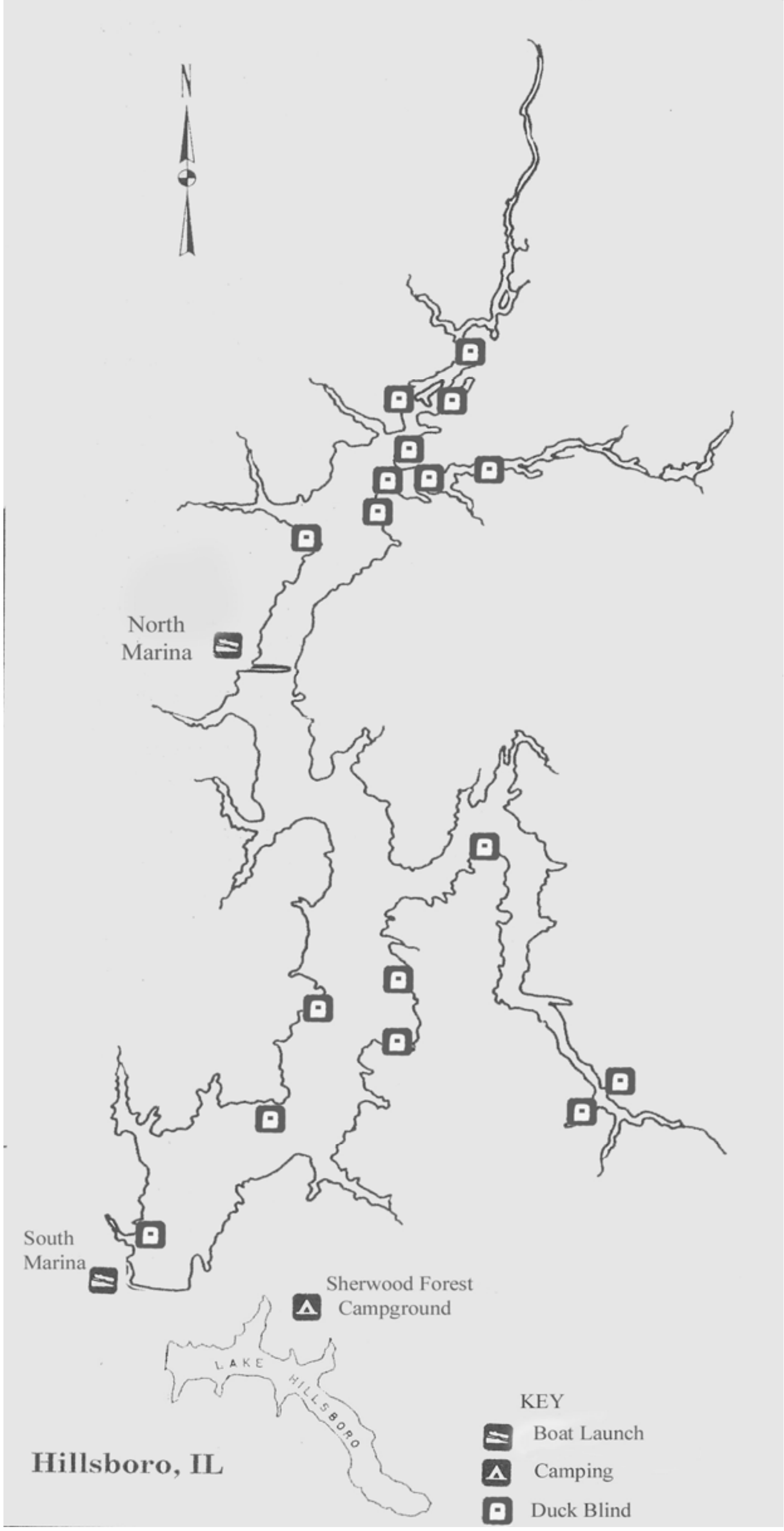
SOIL ASSOCIATIONS

1	Virden-Herrick association: Dark-colored, poorly drained and somewhat poorly drained soils on upland flats
2	Herrick-Harrison association: Level to sloping, dark-colored, somewhat poorly drained to moderately well drained soils
3	Oconee-Douglas-Pana association: Strongly sloping to gently sloping, dark colored and moderately dark colored, well-drained and somewhat poorly drained soils on ridges and knolls
4	Herrick-Piasa association: Level, dark colored and moderately dark colored soils that are on upland divides and that have a moderately slowly or very slowly permeable subsoil
5	Cowden-Piasa association: Level, moderately dark colored soils that have a slowly or very slowly permeable subsoil
6	Cisne-Hoyleton-Huey association: Level to gently sloping, light-colored to moderately dark colored soils that have a slowly permeable or very slowly permeable subsoil
7	Oconee-Velma-Tamalco association: Nearly level to strongly sloping, moderately dark colored soils that have a slowly permeable, moderately permeable, or very slowly permeable subsoil
8	Hickory-Hosmer association: Gently sloping to very steep, light-colored, moderately well drained and well drained soils on uplands adjacent to streams
9	Lawson-Radford association: Level, dark-colored, somewhat poorly drained soils on flood plains

February 1968

A.3.a Description of Public Access

Figure 8 - Identification and Location Map



A.3.b Description of Access Points

Lake Glenn Shoals has two boat launches open to the public. The south access area is located on the west shore of the lake, just north of the dam. The locations of these facilities are marked on Figure 8, Facilities Location Map. This area has a two-lane boat ramp, a 225 ft. x 275 ft. parking area, restrooms, a pay telephone, and a covered picnic area. A marina with two large buildings and 34 covered slips is also present. The buildings are capable of serving as a restaurant, bait shop and supplies facilities. The City of Hillsboro is currently seeking an operator for this establishment. The north boat launch has a two-lane boat ramp, a 250 ft. x 240 ft. parking lot, and restrooms. The lake is open to the public for boating, provided that users purchase a municipal lake sticker. Glenn Shoals Lake can be used 365 days and 24 hours a day. There are no restrictions on the time or season that you can use Lake Glenn Shoals. The fee structure for municipal lake stickers is presented in Table 4.

Table 4 City of Hillsboro Municipal Boat License Fees

	Residents	County	Non-county	Out-of-State
Rowboats and Canoes	$5.00	$8.00	$10.00	X
Boats with Motors				
1-20 Horsepower	$10.00	$20.00	$25.00	X
21-50 Horsepower	$20.00	$30.00	$35.00	X
51-100 Horsepower	$25.00	$48.00	$60.00	X
101-200 Horsepower	$35.00	$75.00	$125.00	X
201-up & Inboard	$40.00	$100.00	$150.00	X
Sailboats	$8.00	$27.00	$32.00	X
Jet-ski	$40.00	$72.00	$90.00	$125.00
Daily Permit All Boats	$6.00	$9.00	$12.00	$12.00
Senior Citizens (65 yrs.)	20 Horse & Under 50% of above rates		Over 20 Horse 25% of above rates	

The City of Hillsboro, the responsible agency, leases land on the lake for recreation. Fifteen points on the main body of the lake are leased to duck hunters for installing duck blinds. A forty-dollar annual fee is charged per location. The locations of these points are marked on Figure 8, Facilities Location Map. Additionally, 182 lake lots with 100 ft. of shoreline and 50 ft. of setback are available for lease. A listing of fees may be found in Table 5 and appendix D, City of Hillsboro Permits, Licenses, & Fees.

Table 5 City of Hillsboro – Permits, Licenses & Fees

Sherwood Forest Camping Rates			
Permanent Campers			$500.00
Extra With Air Conditioning			$180.00
Campers for 30 Days			$200.00
Extra With Air Conditioning			$250.00
Trailers (Daily)			$10.00
Tents Without Electricity (Daily)			$6.00
Tents With Electricity (Daily)			$7.00
Blue Grass Weekends (Daily)			$7.00
Pool and Beach Swimming Rates			
Resident - Daily		Non Resident – Daily	
Child	$2.00	Child	$2.00
Adult	$3.00	Adult	$3.00
Season Passes			
Resident		Non Resident	
Child	$30.00	Child	$33.00
Adult	$35.00	Adult	$38.00
Family - Up to 5 Members	$65.00	Family - Up to 5 Members	$75.00
Lake Lots - Glenn Shoals Lake			
Hillsboro Residents	$100.00	Deposit	$25.00
County Residents	$125.00	Deposit	$50.00
Non-County Residents	$200.00	Deposit	$100.00
Other Fees			
Water Deposit (Renters Only)	$100.00	Water on Fee	$20.00
Water Bill - Vacation Rate	$10.00	Water off Fee	$20.00
Parking Fines If Not Paid Within 15 Days	$5.00 $25.00	Dog and Cat Fines - First Offense Second Offense	$50.00 $100.00
Liquor License	$600.00	Water Tap On Fee	$350.00
Road Bonds	$250.00	Sewer Tap On Fee	$300.00
Fire Subs	$40.00	Challcombe House Rental Four Hours	$25.00
Fire Runs	$250.00	All Day ($25.00 Refundable Deposit When You Pick Up The Key)	$40.00
Duck Blind Fee			$40.00
Refund When Blind Removed			$15.00

A.3.c Routes and distances to Access Points

The approximate center of Glenn Shoals Lake is 4.8 miles northeast of the approximate center of the City of Hillsboro, 15 miles from the City of Litchfield, 25 miles from the City of Greenville, 46 miles from the City of Vandalia, and 42 miles from the City of Taylorville.

Major roads near the lake include Highway 16, Highway 127, and Highway 185. The City of Hillsboro provides a confluence of these highways, from which the lake is accessible via city and county roads (Figure 1, Location Map).

A.3.d Public transportation availability

There is no public transportation serving the lake area.

A. 4. Description of Size and Economic Structure of Potential Use Population

A.4.a Size of resident population

The Glenn Shoals Lake user population is comprised mainly of area residents, with additional constituency from the surrounding counties, with some as far away as the St. Louis metropolitan area. Within 50 miles (80 km), the potential user population is estimated to be 773,182. Table 6 shows the populations of counties with at least half of their area within the 50 miles (80 km). Table 7 shows the populations of cities with populations greater than 10,000 within the 50 miles (80 km). Population figures were taken from United States Census Bureau statistics. The nearest major metropolitan area to Glenn Shoals Lake is St. Louis, approximately 50 miles (80 km) in a straight-line. The St. Louis metropolitan area includes Franklin, Jefferson, Lincoln, St. Louis, St. Charles, and Warren counties in Missouri, and Clinton, Jersey, Madison, Monroe, and St. Clair counties in Illinois with a combined population of 2,603,607. The locations of the cities and counties shown in Tables 6 and 7 are shown in Figure 1, Location Map.

A.4.b Size of any significant seasonal user

Special seasonal users of campground facilities, ect. In the immediate vicinity of Glenn Shoals lake occur at near by Hillsboro Lake. This alleviates the pressures for such facilities at Glenn Shoals. The major seasonal use of Glenn Shoals Lake is from duck hunters. The revenue from duck blind fees is shown in Table 9.

A.4.c Distribution of population

Even though the immediate counties are not very densely populated there is a great potential use of Glenn Shoal from cities within 50 miles of the Lake.

Table 6

Potential User Population by Counties Accessible Within 50 Miles (80 km) Radius

County	*Population*
Bond	**17,633**
Christian	**35,372**
Clinton	**35,535**
Effingham	**34,264**
Fayette	**21,802**
Greene	**14,761**
Jersey	**21,668**
Macoupin	**49,019**
Madison	**258,941**
Marion	**41,691**
Montgomery	**30,652**
Sangamon	**188,951**
Shelby	**22,893**

Table 7

Potential Users by City

Cities With Population > 10,000 Within 50 Miles (80 Km) Radius

City	*Population*
Alton	**30,496**
Centralia	**14,136**
Collinsville	**24,707**
Effingham	**12,384**
Edwardsville	**21,491**
Fairview Heights	**15,034**
Granite City	**31,301**
O'Fallon	**21,910**
Springfield	**111,454**
Swansea	**10,579**
Taylorville	**11,427**
Wood River	**11,296**
total:	**316,215**

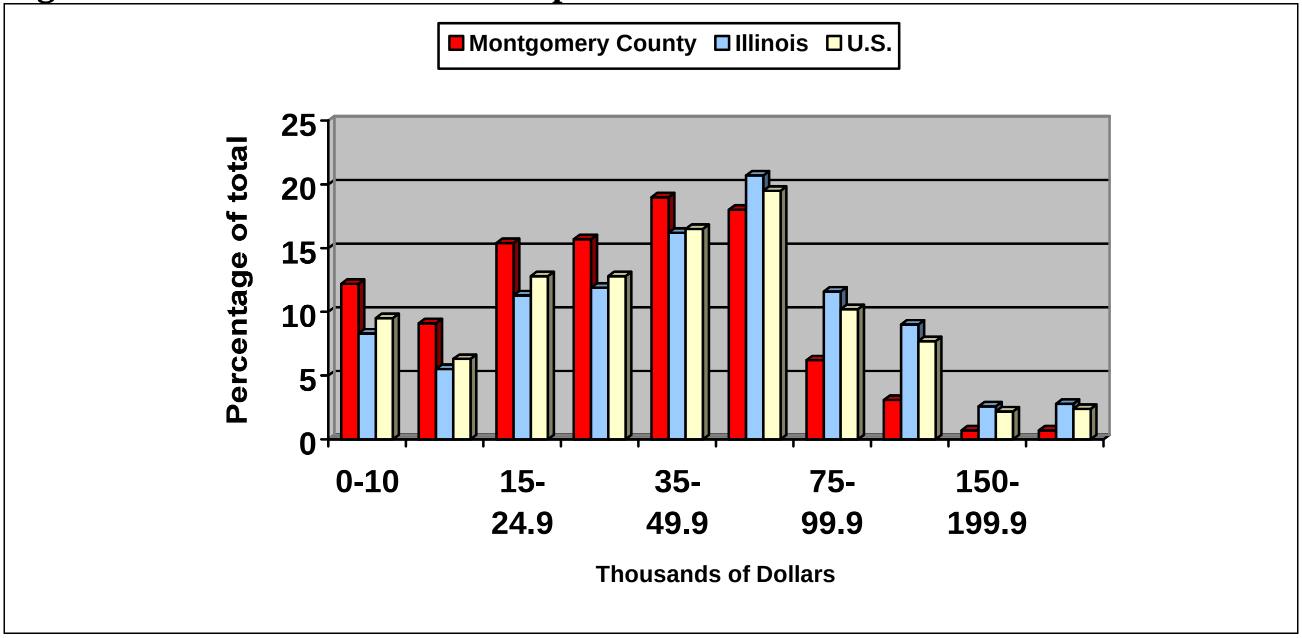
A.4.d Pertinent economic characteristics

1. General income

Table 8 Household Income in 1999

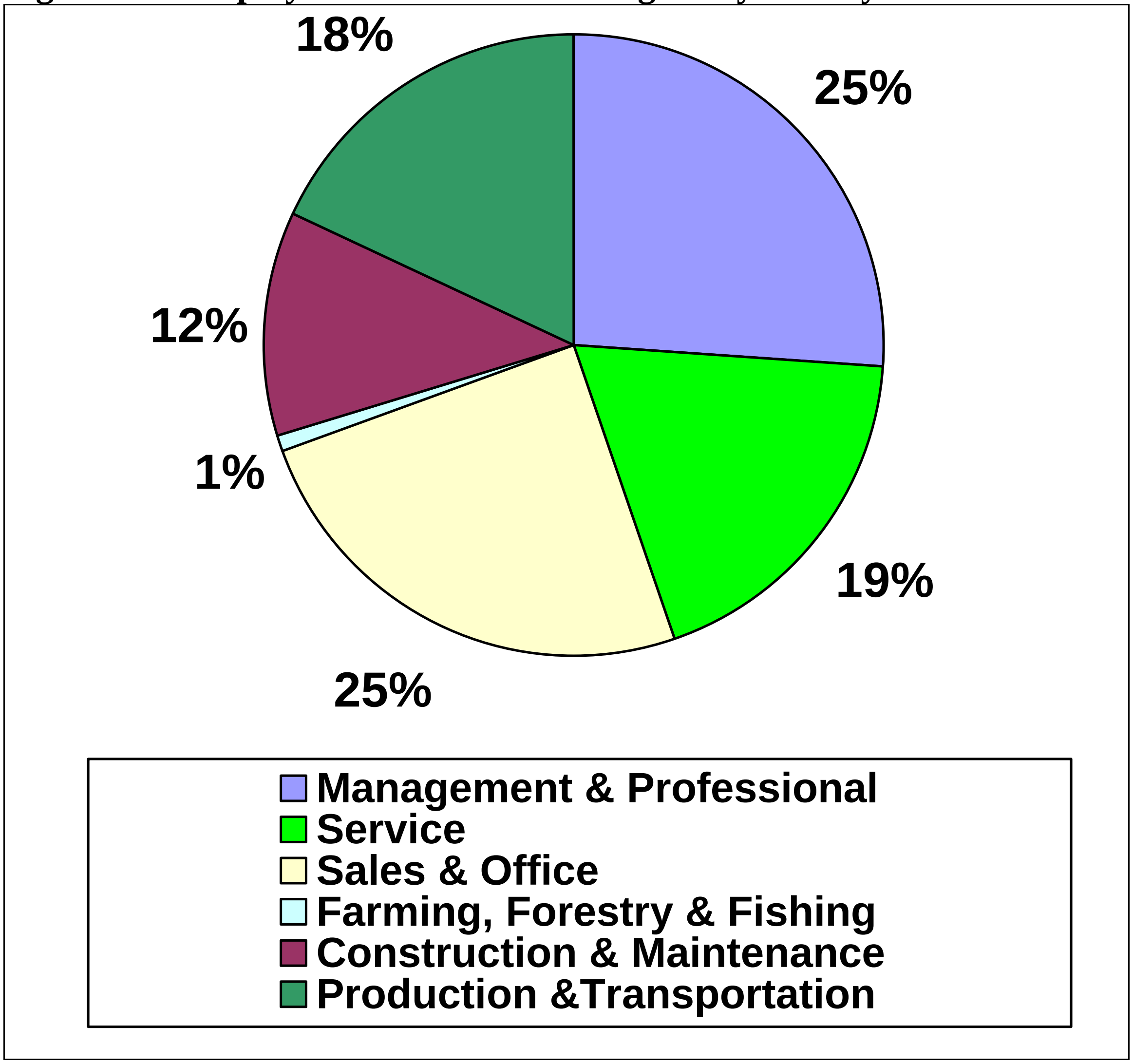
	Montgomery County		Illinois		U. S.
Households	11,525	100.0%	4,592,740	100.0%	
$0-$10,000	1,411	12.2%	383,299	8.3%	9.5%
$10,000-$14,999	1,045	9.1%	252,485	5.5%	6.3%
$15,000-$24,999	1,773	15.4%	517,812	11.3%	12.8%
$25,000-$34,999	1,806	15.7%	545,962	11.9%	12.8%
$35,000-$49,999	2,186	19.0%	745,180	16.2%	16.5%
$50,000-$74,999	2,076	18.0%	952,940	20.7%	19.5%
$75,000 to $99,999	711	6.2%	531,760	11.6%	10.2%
$100,000 to $149,999	363	3.1%	415,348	9.0%	7.7%
$150,000 to $199,999	76	0.7%	119,056	2.6%	2.2%
$200,000 or more	78	0.7%	128,898	2.8%	2.4%
Median Household Income	33,123		46,590		

Figure 9 - Household Income Comparison



2. Major employment sources

Figure 10 - Employment Sectors in Montgomery County



3.	Chronic unemployment	NA
4.	Housing shortages	NA
5.	Urban blight	NA

6. Relationship of lake to local economy

The lake provides a number of services that directly or indirectly affect the local economy (figure 10). The major affecters are flood control, potable water and recreation. Having sufficient water at a reasonable price will encourage industry as well as private individuals to locate in the area. The influx of industry (jobs) and people into the area will increase the standard of living and tax base, and cause a rise in the economy. The available recreation on or near the lake will enable those with discretionary financial resources to spend time there taking part in the recreational activities. These people, whether local or distant, usually purchase goods and services at local establishments (figure 9). This will facilitate an increase in the general (over-all) economy. Thus, a rising tide will raise all economic boats.

A. 5. Summary of Historical Lake Uses

A.5.a Inventory of present and past lake uses

The lake was built in 1978. The primary function was flood control. The secondary uses included; water supply, recreation and esthetics. The lake currently supplies water to 10,889 households. The lake also meets the recreational needs of many boaters, skiers and fishermen. The shore, because of the esthetic appeal, currently has a number of homes situated there.

Table 9 RECORD OF LAKE REVENUE BY TYPES OF RECREATIONAL USAGE

	1999	**2000**	**2001**	**2002**	**2003**
Cabin Fee’s	$900.00	$666.00	$1,314.00	$1,320.00	$1,200.00
Lease Lot Fee’s (homes)	$14,985.00	$24,085.00	$16,360.00	$16,485.00	$17,360.00
Camping Fee’s	$62,009.00	$69,843.50	$72,295.00	$64,736.70	$48,838.25
Boat Permits	$25,628.75	$27,350.25	$29,553.30	$32,749.63	$33,144.99
Lake Lot Fee’s	$28,967.00	$29,889.25	$30,963.75	$30,355.00	$29,167.00
Duck Blinds	$385.00	$515.00	$360.00	$255.00	$315.00
Marina Slips	~	$6,800.00	$6,600.00	$6,950.00	$6,350.00

A.5.b Statistics on present and historical usage

The data in Table 9 indicates an increase in boat usage and cabin usage while the other numbers would suggest that usage of other facilities seem to have leveled off or may have been reduced.

A.5.c Analysis of relationship between historical trends in lake water quality

1. Flood control
– Total maximum volume is 25,000 acre feet with 11,800 acre feet devoted to flood control. 11,800 x 1233.5 = 14555300 m sq.
2. Water supply (potable)
– 845 acre feet used for potable water to supply the needs of 10,889 households
3. Recreation

The water quality has continued to lessen because of the watershed problems and not by any increased usage of the lake.

4. Aesthetic enjoyment

The numbers would suggest that the aesthetic uses are relatively stable over the last five years.

5. Research and education

No known research is currently being carried out on the lake.

A.6 Population Segments Adversely Affected by Lake Degradation

There is no niche populating that depends entirely on the lake for economic support. Those closest to this would be business people that sell boats, fishing supplies, and skiing supplies. However is seems that the potable water affects everyone in Hillsboro and many of the surrounding smaller communities. Over 10,800 families use either Glenn Shoals Lake or Hillsboro Lake as their water source. Lake degradation will affect the 10,800 water users the 30-50 boaters and innumerable fishermen. The hypereutrophication and filling of the lake will have a significant effect on the cost and/or quality of potable water. However, the hypereutrophication and partial filling (by sediment) of the lake should not significantly affect the flood control potential due to the fact that much of the temporary storage results from limited outflow which temporally raises the level of the lake to the emergency overflow level. However, the hypereutrophication and filling of the lake with sediment will have a significant effect on the cost and quality of potable water.

A. 7. Comparison of Lake Uses to Uses of Other Lakes in Region

A.7.a Summary of statistics on other publicly-owned lakes within 80 km

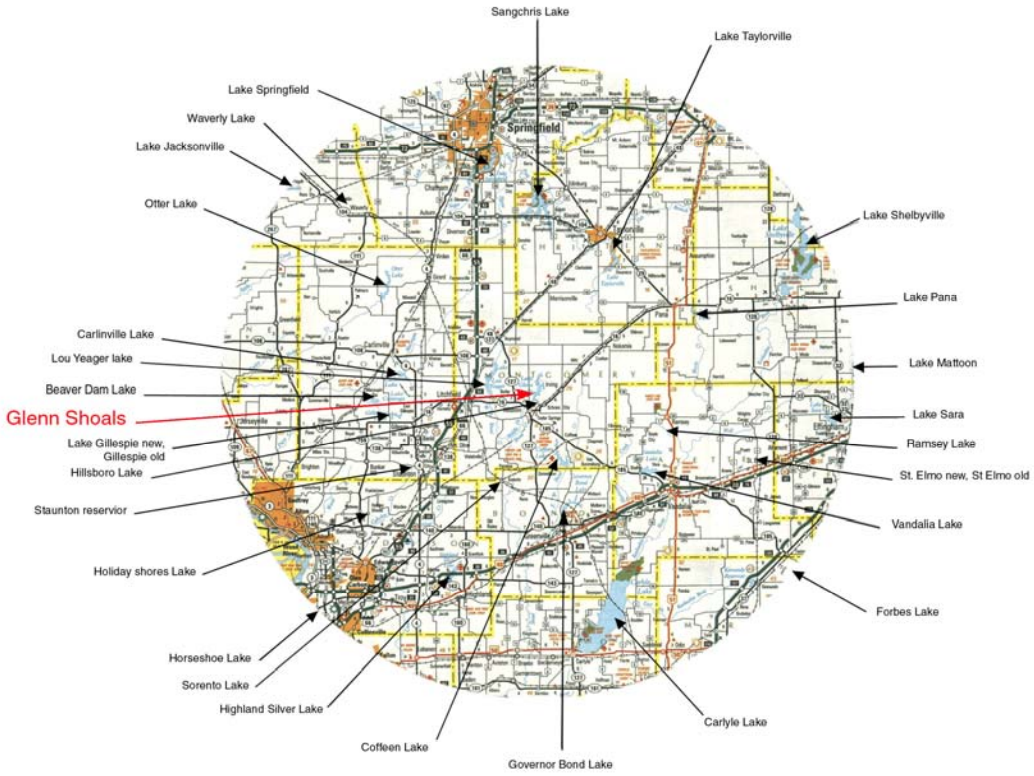
Table 10 Comparison of Lake Uses Within 80 Km

	Code	Acres	Fishing	Boating	Hiking	Swimming	Hunting	Camping	Horseback
Glenn Shoals	ROL	1,085	X	X	X		X	X	
	ROT	94	X	X	X			X	
Springfield	REF	3,797	X	X	X	X			
Sangchris	REB	2,321	X	X	X		X	X	
Shelbyville	ROC	11,100	X	X	X	X	X	X	X
Otter	RDF	723	X	X					
Ramsey	ROE	46	X	X	X	X			
Taylorville	REC	1,286	X	X					
Sara	RCE	614	X	X					
Mattoon	RCF	988	X	X					
Staunton	RJA	84	X	X	X				
Old Gillespie	SDT	71	X	X	X			X	
New Gillespie	SDU	207	X	X	X				
Lou Yaeger	RON	1,304	X	X	X			X	
Coffeen	ROG	1,070	X	X	X	X			
Governor Bond	ROP	775	X	X	X			X	X
Greenville Old	ROY	22	X	X	X				
Highland Silver	ROZA	550	X	X	X				
	ROZH	11							
St. Elmo New (Nellie)	ROM	59	X	X	X				
St.Elmo Old	ROQ	25		X					
Carlyle	ROA	24,580	X	X	X	X	X	X	
Vandalia	ROD	660	X	X	X				
Beaver Dam	RDH	57	X	X	X	X	X	X	
Horseshoe	RJC	1,890	X	X	X	X	X	X	
Forbes	RCD	542	X	X	X	X	X	X	X
Jacksonville	RDI	442	X	X	X			X	
Waverly	SDC	112	X	X					
Pana	ROF	205	X	X					
Carlinville	RDG	168	X	X	X	X		X	
Holiday shores	RJN	430	X	X					

A.7.b Discussion of relationship of lake under study to other lakes

There are approximately 31 lakes within the 50 miles (80 Km) radius of Glenn Shoals Lake (Figure 11). Most of the lakes have fishing, boating, hiking, camping and water supply as common uses. Some lakes also include swimming, hunting and ridding horses as secondary uses (Table 10). Other lakes are useful for flood control but unlike Glenn Shoals most are not designed with flood control as one of the primary lake functions. Glenn Shoals does not have swimming or camping, however there are locations for both of these functions, nearby, on the city’s other lake (Lake Hillsboro). When these lakes are considered in tandem they provide, in close proximity, most of the uses of the larger lakes in this part of Illinois. The lake is underutilized. This seems to be because the lake is not as well known as others in the region. This is related to the fact that the location is much farther from the major interstates (Figures 1,11) than other similar lakes in the area. The owners would like to see more people use the lake.

Figure 11 - Lakes within 80 Kilometers of Glenn Shoals Lake



A. 8. Inventory of Point Source Pollution Discharges

There is one single potential point source for nutrients. The city of Irving, population of 516, uses a lagoon to break down their sewage. The effluent from this lagoon provides a potential point loading source for the two nutrients of most concern (nitrogen and phosphorous) for the hypereutrophication of the lake.

TABLE 11 Point Source Inventory

Name	NPDES #	Receiving water	Discharge flow	Constituents	Conc/mass	Abatement
Village of Irving	ILG580198	Ditch	2,700 m^3/day	Suspended solids	14 mg/l	none

The seasonal emptying of this sewage lagoon produces up to .72 million gallons or 2,700 m^3 per day of nutrient enriched water. Besides the nutrients there are 14 mg/l of suspended solids. The discharge flows into a ditch in Irving under NPDES permit number ILG580198 (see Table 11). This information was obtained by a phone conversation with Ron Merriman, waste water treatment manager for Irving.

As a result of this seasonal discharge, months may go by before any discharge occurs. Heavy seasonal rains may cause numerous days of discharge, where the average approaches the maximum allowable of 2,840 m^3/day. The water enters a ditch which joins other ditches forming Little Creek which then enters Glenn Shoals Lake.

A. 9. Land Uses and Nonpoint Pollutant Loadings

INITIAL FORESTRY STATEMENT
GLENN SHOALS LAKE WATERSHED

This watershed is highly agricultural, although it has been impacted by residential development in places. The farmland is mostly of former prairie or prairie-forest transition. Closer to the lake is sloping ground which once was all forest, although much of it was converted to pasture and is now either in slow succession towards forest vegetation or is being used for residential purposes. There are some areas still fairly representative of the original forest type, but these are mostly on the east side of the south end of the lake.

The original forest was almost totally of the oak-hickory type, species consisting of white, black, red, and chinkapin oak, hickories, elm, basswood, walnut, cherry, ash, and miscellaneous others. Post oak was found on high ridges. Soils involved are 8 Hickory, 214 Hosmer, and 64 Stoy. Existing forest cover is variable as to current pattern, composition, quality, and stage of development.

There is considerable argument and speculation as to the condition the original stands were in when settlement began. It is generally conceded that the advent of European settlement had considerable effect on forest areas: stands were cleared of forest for agricultural production, or were grazed, or were subjected to more or to less burning than before. Timber harvest has had its effect, in some cases only slightly negligible and in some cases highly impacted. Lately, hard maple has come in many stands, gradually preempting former species and with an apparent monocultural (one species only) end result. Whether such changes occurred cyclically or episodically in the past is not known, but it is apparent that forest compositions are currently in a state of great flux. When this correspondent arrived here some thirty plus years ago, many stands were fenced and intensively grazed, even though “loitering” was the chief livestock value if the forest was heavily stocked (adjoining grass areas accessible to livestock being requisite in such cases); now, these areas have largely been abandoned to grazing and are in varying stages of succession back to forest, the end result being a factor of time, species seed source, and whim of nature. Few stands are being actively managed with long range goals in view. Hardwood timber is still harvested, sometimes of high quality and value, but usually with little regard or provision for the remaining stand or development of harvest replacement. Suboptimal areas also lack management input. From a watershed standpoint, a considerable amount of reforestation can be beneficially applied here.

The watershed value of most forested land is considerable. The branches, leaf litter, root systems, etc., all contribute to breaking the force of rain, protecting the soil from erosion and inducing the absorption of water into the soil rather than allowing runoff. In the recent and nearby Lake Yaeger watershed study, it was recognized that 41% of sheet and rill erosion emptying into the lake came from former forest sites (Hickory/Hosmer/Stoy soil association) now being farmed, and that simple reforestation could eliminate that much of the lake's problem. A program of encouraging reforestation and stand management was written into the resource plan of that lake.

Ideally, forest areas should be retained in or restored to their original composition. The native stands offer the most from almost all forest-value standpoints, not least of which relates to watershed, but also to economic (timber value), wildlife, and (arguably) aesthetic values. The prospect of hard maple takeover is a special case; good hard maple has good timber value, and it can be aesthetically pleasing, but its wildlife value is quite low and its presence leads to bare soil and erosion concerns. Degraded forests lack economic value. The usual recommendation in these cases is to change course via several silvicultural practices (possibly also involving planting). Non forest areas can be reforested using proven practices.

Although this will be unpopular in some wood quarters and cause controversy, it would be good from a watershed standpoint if a fringe of woody vegetation (if not proper forest) be maintained around the lake, residential sites included. Especially, vegetation should be maintained at and just above the waterline, not kept bare as in many places at present.

If any silt retention structures are ever acquired and constructed, these too should be vegetated right down to the waterline.

An active watershed program can do much to promote beneficial forestry practices as outlined above. Education, encouragement, publicity, and special funding inducements can be involved, and there are state and federal resources to be tapped into and there is continuing advisement available form this IDNR forestry office.

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A.9.a Land uses in the watershed

Montgomery County Tillage Practices

According to the Illinois Soil Transect Survey summary, 75% (Table 12) of the cropland in Montgomery County is farmed using conservation tillage. Conservation tillage can greatly reduce the amount of soil erosion and help reduce the amount of sediment that collects in lakes. Conservation tillage also helps reduce nutrient loading from agriculture runoff.

Table 12 Montgomery County Tillage Practices

	Corn/acres	Soybean/acres	Small grains/acres	Total
Conventional	74237	5939	0	80176
Reduced	51223	39345	3712	94280
Mulch	17074	57905	2227	77206
No-Till	13363	49738	11878	74979
N/A/ Unknown	0	742	0	742
Total	155897	153669	17817	327383
% Conservation Tillage (Not conventional)	52%	96%	100%	75%

Source: Illinois Soil Conservation Transect Survey Summary (2000)

A.9.b The area of each land use as a percentage of the total drainage area

Sub-watershed Delineation

In an effort to develop a better understanding of the non-point pollution contribution of the different areas around the watershed the overall watershed was further divided into six sub-watersheds (Figure 6). ZIES staff with the help from NRCS used Arcview software (Figure 12) and land use data to determine the acres of each type of land use for each sub-watershed (Table 13).

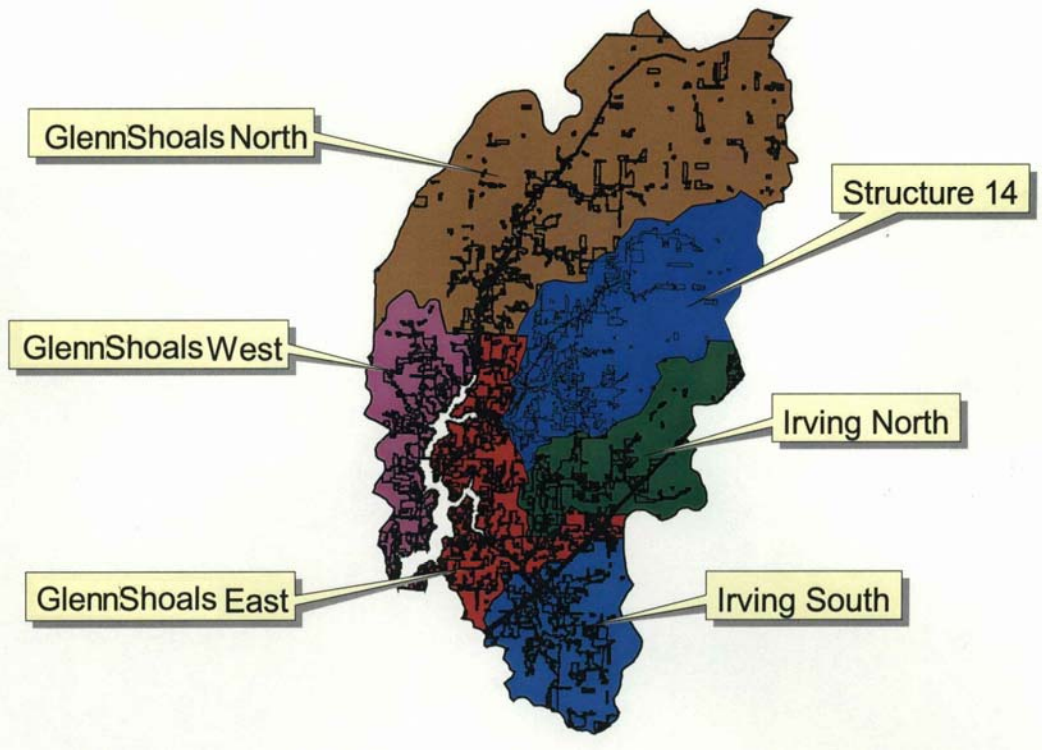
Table 13 Glenn Shoals Land Use

Land Use	Glenn Shoals North	Glenn Shoals East	Glenn Shoals West	Structure 14	Irving North	Irving South
	Acres	Acres	Acres	Acres	Acres	Acres
Cropland	16,763	1,960	2,731	7,283	4,065	3,695
Grass/Past	1,092	1,974	965	1,575	812	947
Urban	9	85	10	4	52	21
Wetland	97	141	45	67	30	48
Woodland	128	1,140	466	448	153	425
Total	18,089	5,300	4,217	9,377	5,112	5,136
Percent	38.3%	11.2%	8.9%	19.9%	10.8%	10.9%

A.9.c Land use map

See Table 13 for subwatershed land use.

Figure 12 Sub-watershed Delineation



Glenn Shoals Lake Watershed Land Use

The watershed surrounding Glenn Shoals Lake is dominated by agriculture. Ninety-two percent of the land is agriculture. Sixteen percent of this agricultural land is grassland and pasture. Less than one percent is urban. One percent is wetland and six percent is woodland. Runoff from agricultural land can contribute significantly to the sediment and nutrient loads for a lake. The NRCS estimates that 39,593 tons of sediment enters the lake every year. Sediments bring fertilizers and pesticides that are deposited into the lake. High amounts of phosphorus and nitrogen run off contribute to the eutrophication of the lake by increasing algae growth. This algae growth also contributes to turbidity and lack of water clarity. Residential activities in the watershed can also contribute to sedimentation and nutrition loading of the lake. Lawn fertilizers from homes as well as nutrients from septic systems contribute to the nutrients entering the lake. Construction projects can add large amounts of sediment to the lake if control structures are not in place. Lake front property that is not properly protected with rip-rap or other erosion control material can contribute significant amounts of sedimentation into the lake.

A.9.d Nonpoint source pollutant loading by land use category

The loading, as represented by the tributaries, reflect the 4 major watersheds. The two smaller areas, Glenn Shoals East and Glenn Shoals West make only minor contributions. Since the water (mineral and suspended solids loadings) did not form a major stream the data was not collected. This loading may have become a minor part of the other four tributaries. Table 14 gives the loading from the four major areas. ROL02 = Glenn Shoals North; ROL03 = structure 14; ROL04 = Irving North and ROL05 = Irving South.

Since ROL02 (Shoal creek) or Glenn Shoals North and ROL03 (structure 14) provide most of the loading (TSS 83%, N 76%, P 68%) it would seem prudent to contain the loading form these two areas (Table 14).

Table14 NUTRIENT AND SEDIMENT BUDGET FOR GLENN SHOALS LAKE

INFLOW	**TOTAL PHOSPHORUS**		**TOTAL NITROGEN**		**TOTAL SUSPENDED SOLIDS**	
	Kg/yr	**%**	**Kg/yr**	**%**	**Kg/yr**	**%**
TRIBUTARIES						
Shoal Creek ROL02	61,249	41%	1,015,670	64%	22,149,839	54%
Structure 14 ROL03	34,275	23%	315,213	20%	10,572,686	26%
Little Creek North ROL04	27,392	18%	126,816	8%	4,136,016	10%
Little Creek South ROL05	27,520	18%	127,412	8%	4,155,435	10%
ATMOSPHERIC	304	> 1%	3,300	> 1%	N/A	
INTERNAL	394	> 1%	3,149	> 1%	N/A	
SHORELINE	N/A		N/A		364,820	>1%
Total Inflow	**151,134**	**100%**	**1,591,560**	**100%**	**41,013,976**	**100%**
OUTFLOW						
SPILLWAY	54,571	36%	268,576	17%	2,192,614	5%
DRINKING WATER	183	> 1%	2,323	> 1%	21,615	> 1%
Total Outflow	**54,754**	**36%**	**270,899**	**17%**	**2,214,229**	**5%**

	TOTAL PHOSPHORUS		**TOTAL NITROGEN**		**TOTAL SUSPENDED SOLIDS**	
		Retained		**Retained**		**Retained**
	Kg/yr	%	Kg/yr	%	Kg/yr	%
NET LOADING	**96,563**	**64%**	**1,320,661**	**83%**	**39,164,567**	**95%**
	Tons/yr		Tons/yr		Tons/yr	
	106		146		43170	

A. 10. Baseline and Current Limnological Data

A.10.a Summary analysis and discussion of historical baseline limnological data

.

Table 15 Glenn Shoals Lake Historical Data 1981-1999

	ROL-1b	**ROL-1t**	**ROL-2**	**ROL-3**
Ammonia Nitrogen				
Minimum	0.04 mg/L (1981)	0.01mg/L (1993)	0.09 mg/L (1997)	0.07 mg/L (1993)
Maximum	1.1 mg/L (1989)	0.46 mg/L (1997)	0.57 mg/L (1993)	0.52 mg/L (1993)
Average	0.31 mg/L	0.15 mg/L	0.19 mg/L	0.2 mg/L
Median	0.24 mg/L	0.1 mg/L	0.11 mg/L	0.19 mg/L
Kjeldahl Nitrogen				
Minimum	0.4 mg/L (1989)	0.4 mg/L (1989)	0.61 mg/L (1997)	0.72 mg/L (1993)
Maximum	1.9 mg/L (1989)	1.4 mg/L (1989)	1.8 mg/L (1989)	1.9 mg/L (1993)
Average	1.04 mg/L	0.89 mg/L	1.04 mg/L	1.3 mg/L
Median	1.01 mg/L	0.89 mg/L	0.96 mg/L	1.3 mg/L
pH				
Minimum	7.6 (1983)	6.7 (1983)	6.8 (1983)	6.7 (1983)
Maximum	7.6 (1997)	8.6 (1989)	8.9 (1989)	8.6 (1993)
Average	7.1	7.8	7.8	7.7
Median	7.1	7.7	8	7.7
Secchi				
Minimum	N/A	2 inches (1983)	2 inches (1983)	1 inch (1983)
Maximum	N/A	42 inches (1993)	26 inches (1997)	19 inches (1981)
Average	N/A	21.3 inches	15.4 inches	9.6 inches
Median	N/A	22 inches	14.5 inches	9.5 inches
Chlorophyll a				
Minimum	N/A	1.48 µg/L (1993)	3.05 µg/L (1993)	17.2 µg/L (1993)
Maximum	N/A	107.54 µg/L (1989)	69.7 µg/L (1989)	82.2 µg/L (1997)
Average	N/A	21.96 µg/L	31.5 µg/L	44.3 µg/L
Median	N/A	13.66 µg/L	23.1 µg/L	46.3 µg/L
Nitrate + Nitrite Nitrogen				
Minimum	0.01 mg/L (1997)	0.01 mg/L (1997)	0.1 mg/L (1989)	0.01 mg/L (1997)
Maximum	1.8 mg/L (1993)	2.2 mg/L (1993)	2.1 mg/L (1993)	2.5 mg/L (1993)
Average	0.88 mg/L	0.85 mg/L	0.82 mg/L	0.98 mg/L
Median	0.97 mg/L	0.73 mg/L	0.65 mg/L	0.70 mg/L
Phosphorus				
Minimum	0.054 mg/L (1981)	0.04 mg/L (1989)	0.07 mg/L (1989)	0.108 mg/L (1989)
Maximum	0.313 mg/L (1983)	0.314 mg/L (1983)	0.315 mg/L (1983)	0.537 mg/L (1993)
Average	0.134 mg/L	0.1 mg/L	0.12 mg/L	0.216 mg/L
Median	0.122 mg/L	0.076 mg/L	0.09 mg/L	0.194 mg/L

Source: EPA STORET Data

The IEPA has sampled Glenn Shoals Lake since 1981 under their Ambient Lake Monitoring Program (ALMP). The historical data from IEPA sampling is presented in Table 15 for comparison purposes to 2001-2002 data

BASELINE LIMNOLOGICAL DATA

Morphometric Data

The physical characteristics of Glenn Shoals Lake can be summed up as morphometric data for the lake. This is existing data on size, depth, retention time, etc. (Table 16).

Table 16 Morphometric Data

	English	Metric
Watershed Area	51,200 acres	20,720 hectares
Surface Area	1,250 acres	510 hectares
Shoreline Length	26.6 miles	42.8 Kilometers
Mean Depth	10 feet	3.05 meters
Maximum Depth	23 feet	7 meters
Storage Volume	12,700 acre-feet	15,671,800 m^3
Flood Water Storage	12,160 acre-feet	14,999,141 m^3
Total Storage	25,000 acre-feet	30,837,050 m^3
Retention Time	0.5 years	
Lake Type	Reservoir / Dam / Flood Control	
Year Constructed	1978	

Bathymetric Map

A bathymetric map was made by ZIES using a Trimble GPS unit and sonar depth finding equipment. GPS points were collected throughout the lake in a zigzag pattern. The GPS technology allowed the staff to collect points with an exact knowledge of the location of these points. Along with the GPS points, depth points were taken. All depths were corrected for height of water above or below the spillway. All depths are in relation to the surveyed spillway elevation. The data from the GPS unit and depth gage were sent to Hurst-Rosche Engineer (HR) from Hillsboro. HR produced a contour map (Figure 13) and calculated the volume (4.14 billion gallons). The area of the lake was calculated to be 1,250 acres.

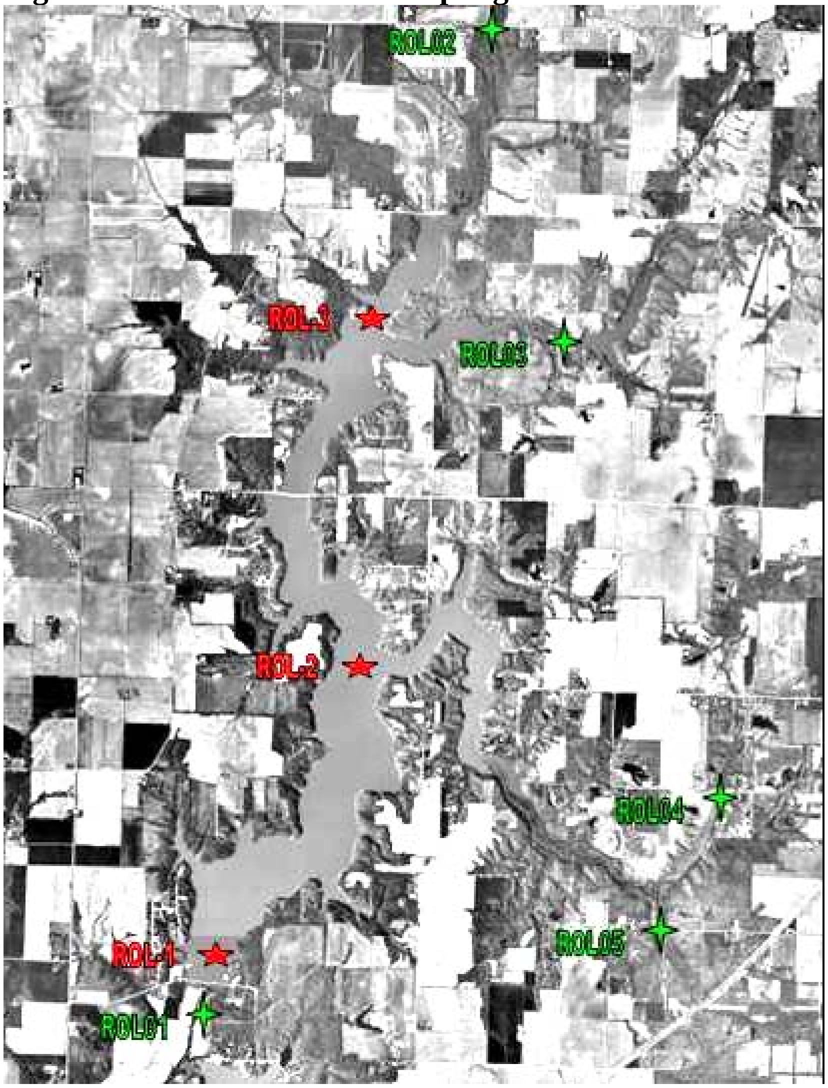
Bathymetric map

A.10.b Presentation, analysis, and discussion of one year of current baseline limnological data

Lake Monitoring

Under the IEPA's ambient lake monitoring program Glenn Shoals lake has been historically sampled at three sites (Table 15): ROL-1t (top sample), ROL-1m (medium depth) and ROL-1b (bottom sample) near the spillway; ROL-2 near the mouth of the Irving arm; and ROL-3 at the north end of the lake.

Figure 14 A. Lake Sampling Sites



ZIES staff collected samples at the same historical sites ROL-1t, ROL-1b, ROL-2 and ROL-3. (Figure 14 A). Samples were collected according to IEPA protocol and sent to IEPA laboratories for analyses. Samples were analyzed for total suspended solids (TSS), volatile suspended solids (VSS), total phosphorus, dissolved phosphorus, Kjeldahl nitrogen, nitrate + nitrite nitrogen and ammonia nitrogen. In addition to samples analyzed at IEPA laboratories ZIES staff tested for pH, temperature, and dissolved oxygen on-site using a Hydrolab water quality sampling probe.

Suspended Materials

High concentrations of suspended materials in the water can have adverse effects on a lake's health. Suspended materials in the water can have a significant impact on the plant and animal species in a lake environment. Highly turbid waters will decrease the amount of available sunlight, which will reduce the amount of plant material and limit the depth at which plant life will be found. Turbid waters will affect reproduction and development. The reproduction processes affected are primarily behavior and egg laying. The development includes all phases including zygote, embryo, juvenile and adult. The growth rates may be reduced by turbidity at all stages of development.

There are several ways that suspended materials in Glenn Shoals Lake were measured. The components measured included: total suspended solids (TSS), volatile suspended solids (VSS), non-volatile suspended solids (NVSS) and Secchi depth. Water samples were collected by ZIES staff and analyzed for TSS and VSS at IEPA laboratories. NVSS was determined by comparing TSS to VSS (NVSS = TSS – VSS). Secchi depth (Figure 18) was measured and recorded by ZIES staff when water samples were collected.

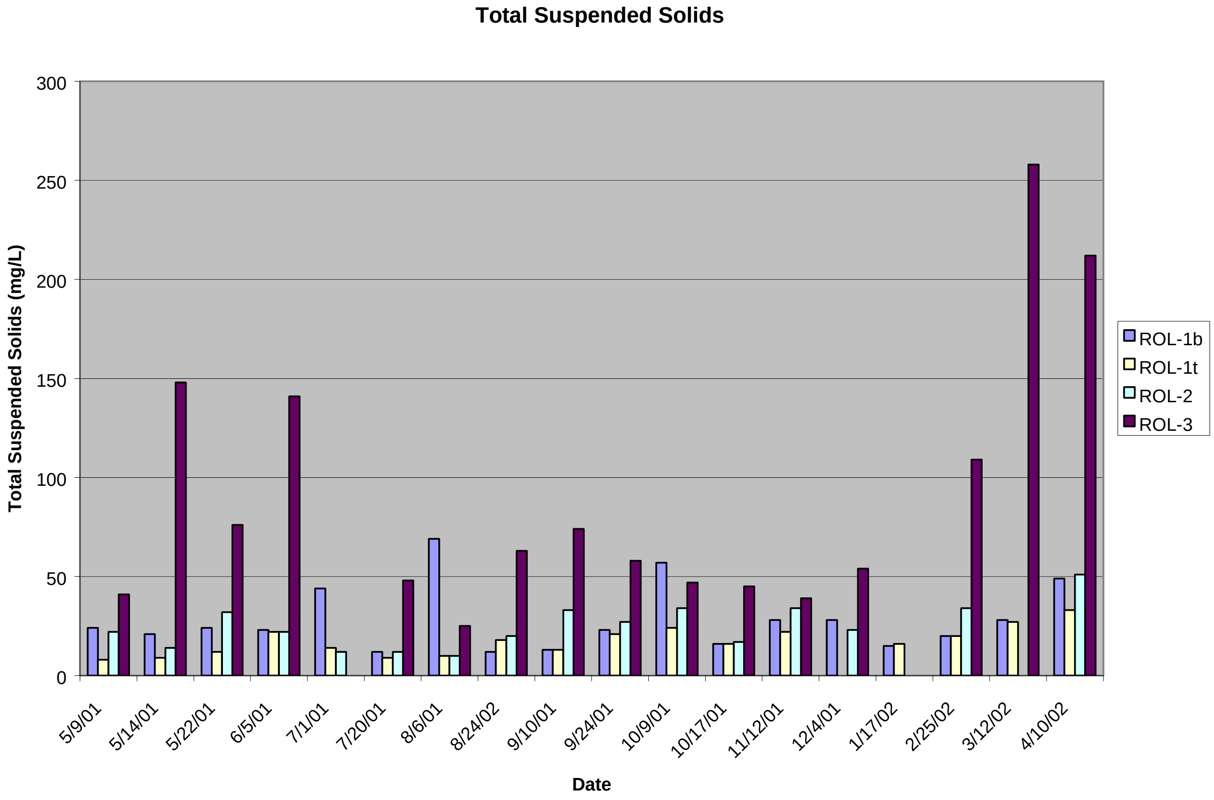
Peak concentrations of TSS, VSS and NVSS corresponded with rain events on several dates (Figures 15, 16, 17). However, sources other than rainfall runoff must account for some of the suspended materials and turbidity in the lake water. Fish, especially carp, can also stir the sediments near the bottom of the lake adding to the turbidity. ROL-3 had more turbid waters than the other sites in the lake. This site is located on the north end of the lake (Figure 14 A) where most of the stream discharge enters the lake. Such an area would experience highly turbid waters after a rain and would be more susceptible to algal blooms from nutrient runoff.

The relationship between VSS and NVSS gives an indication of the source of suspended solids in the water. At all locations NVSS was a higher percentage than VSS. This indicates that there is a large amount of non-organic material. This distribution is likely an indication that soil washing in from the tributaries or bottom sediments being stirred up are more significant contributors of the turbidity than algae. ROL-1t VSS was 24% and NVSS 76%, ROL-2 VSS 32% and NVSS 68%, ROL-3 VSS 19% and NVSS 81%. This high percentage of NVSS points to inorganic, sedimentary derived, suspended solids being the major contributor of turbidity throughout the lake. The issue of turbidity is another important problem that will be addressed again in Part 2: Feasibility Study.

Total Suspended Solids

Total Suspended Solids (TSS) is a measurement of all of the suspended material in the water, including both organic and inorganic materials. Total suspended solids would include materials such as algae, decaying plant materials, minerals, and soil particles. Total suspended solids peaked 3/12/2002 at 258 mg/L at ROL-3 on the north end of the lake (Figure 15).

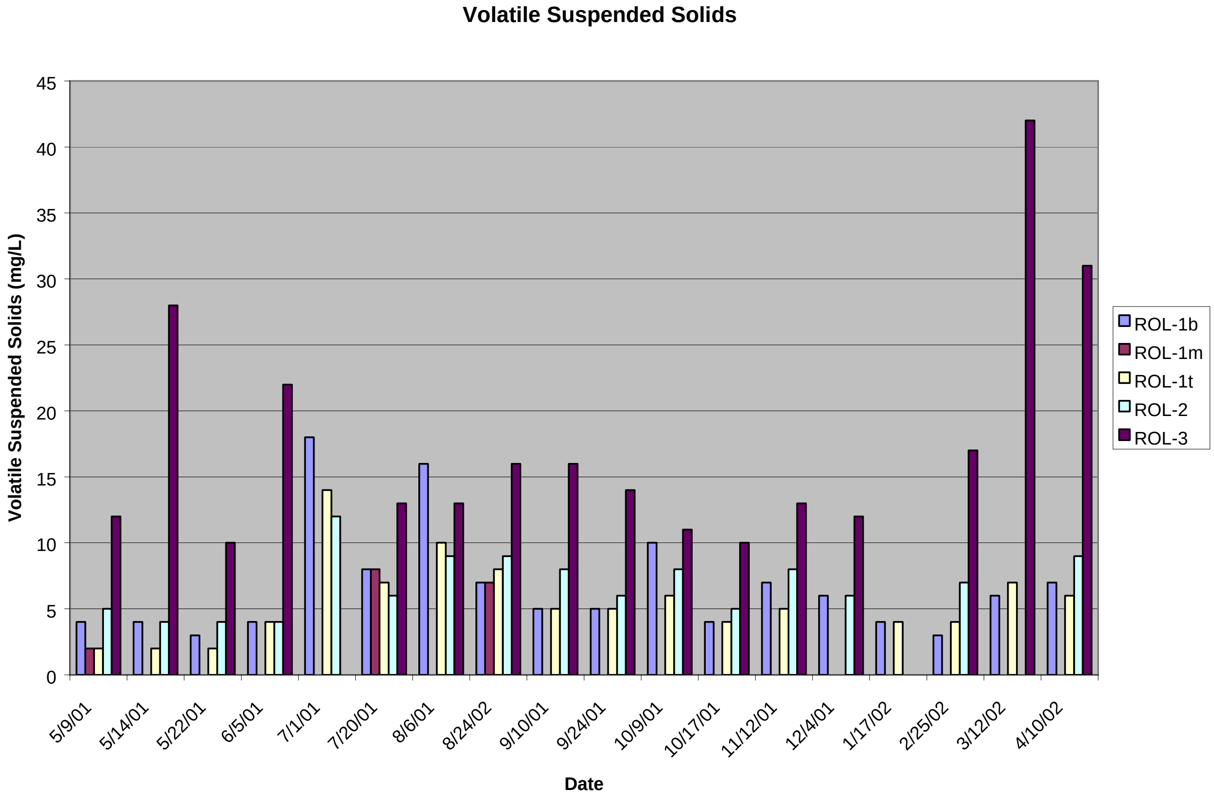
Figure 15 – Total Suspended Solids



Volatile Suspended Solids

Volatile suspended solids (VSS) is a measurement of only the organic material suspended in the water. This material would include algae, decaying plant material and all other organic material suspended in the water (Figure 16). VSS peaked on the same dates as TSS and NVSS and corresponded with, low Secchi depths and high chlorophyll a data (Figures 15, 16, 17, 18).

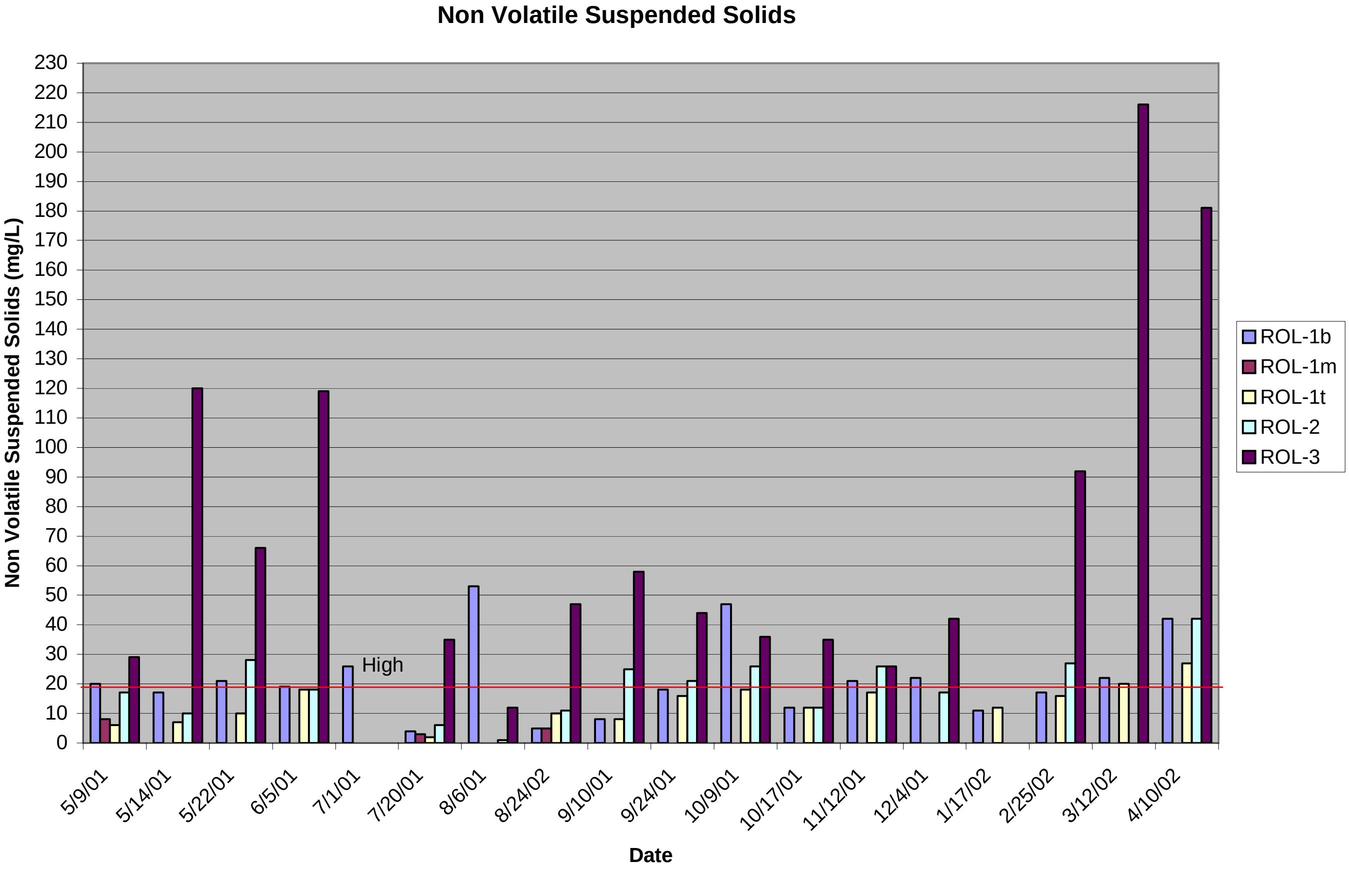
Figure 16 – Volatile Suspended Solids



Non-Volatile Suspended Solids

Non-Volatile Suspended Solids (NVSS) is obtained by subtracting the VSS from the TSS. NVSS is the non-organic portion of TSS. NVSS is used by the IEPA as a parameter in their Aquatic Life Use Impairment Index (ALI). Lake site ROL-3 had higher concentrations of NVSS on most dates than the other sites (Figure 17).

Figure 17 – Non Volatile Suspended Solids

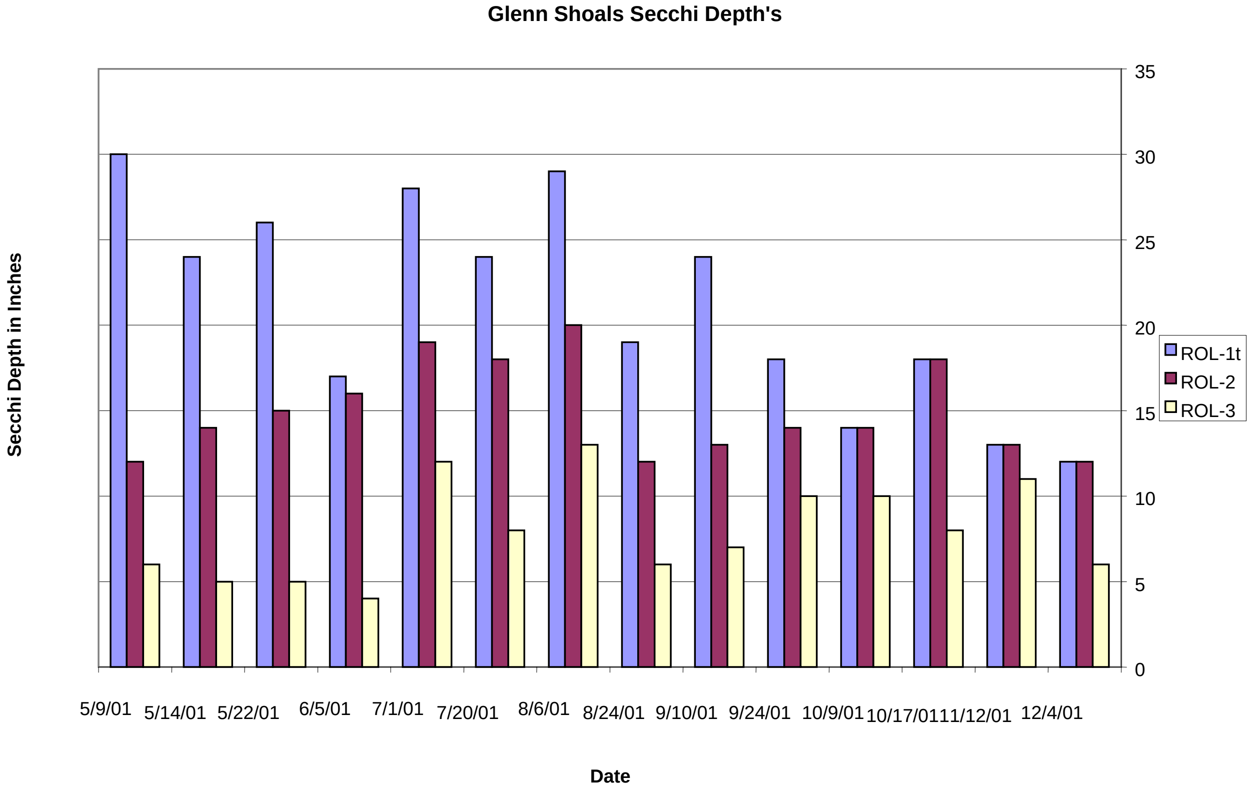


Secchi Readings

The Secchi disk is one of the most widely used tools to measure water clarity. Secchi transparency and color are used to determine criteria for lake water quality. The Secchi disk is a simple circular disk divided into alternate black and white quadrants. The disk is lowered into the water and the depth at which it can no longer be seen is the Secchi depth. It is one of the criteria in Carlson's Trophic State Index, which is used to determine the trophic status (Carlson 1977). Photosynthesis can generally occur at 2-3 times the Secchi depth (Kirschner 1995).

Secchi readings are a parameter used in calculating the trophic status of a lake. The IEPA uses the trophic status as a parameter in both their guidelines for Aquatic Life Use Impairment (ALI) and their Recreation Use Impairment (RUI). The IEPA also uses Secchi readings as a parameter in their swimming guidelines. All the Secchi readings must be greater than 24 inches to gain full support for swimming (Illinois 305(b) Report). For Glenn Shoals Lake there were five dates in the swimming season that the Secchi reading at any of the sites was greater than 24 inches and these all occurred at ROL-1 at the south end of the lake (Figure 18). The high Secchi reading tended to correspond to low TSS, VSS and NVSS readings (Figures15, 16, 17). ROL-3 had consistently shallower Secchi readings throughout the study than sites ROL-1 and ROL-2. Historically the water clarity in Glenn Shoals has averaged 21.3 inches at ROL-1t, 15.4 inches at ROL-2 and 9.5 inches at ROL-3 (Table 15).

Figure 18 – Secchi Depth's



Turbidity

The turbidity as expressed by the Secchi depth readings (more turbid = shallower readings) is an indication of the combination of organic particles (mostly algae) and inorganic particles (mostly soil-clay) in the water column. Turbidity is an indication of a lake's health. High turbidity (shallow secchi readings) indicates poor health. This is a major problem with the lake (Figure 18).

Using information from the shoreline erosion study (Figure 37), calculations were made to estimate the amount of sediment delivered to the lake from shoreline erosion. Using estimates of 40 lbs of soil per linear foot entering the lake from areas with severe erosion, 30 lbs per linear foot for areas with moderate erosion, and 20 lbs per linear foot for areas that are undercut, approximately 364,820 kg per year of soil enters the lake from shoreline erosion (Hill 1994). This amounts to 1% of the total sediment entering the Lake (Table14).

Dissolved Oxygen and Temperature

Dissolved oxygen is an important factor in the overall health of a lake. Oxygen levels are a key factor in the health of fish and other organisms. Low oxygen levels can cause fish kills and limited oxygen levels can decrease the number and size of fish for a given lake. Low levels of oxygen near the bottom allow nutrients to be released; adding to the eutrophication of the lake.

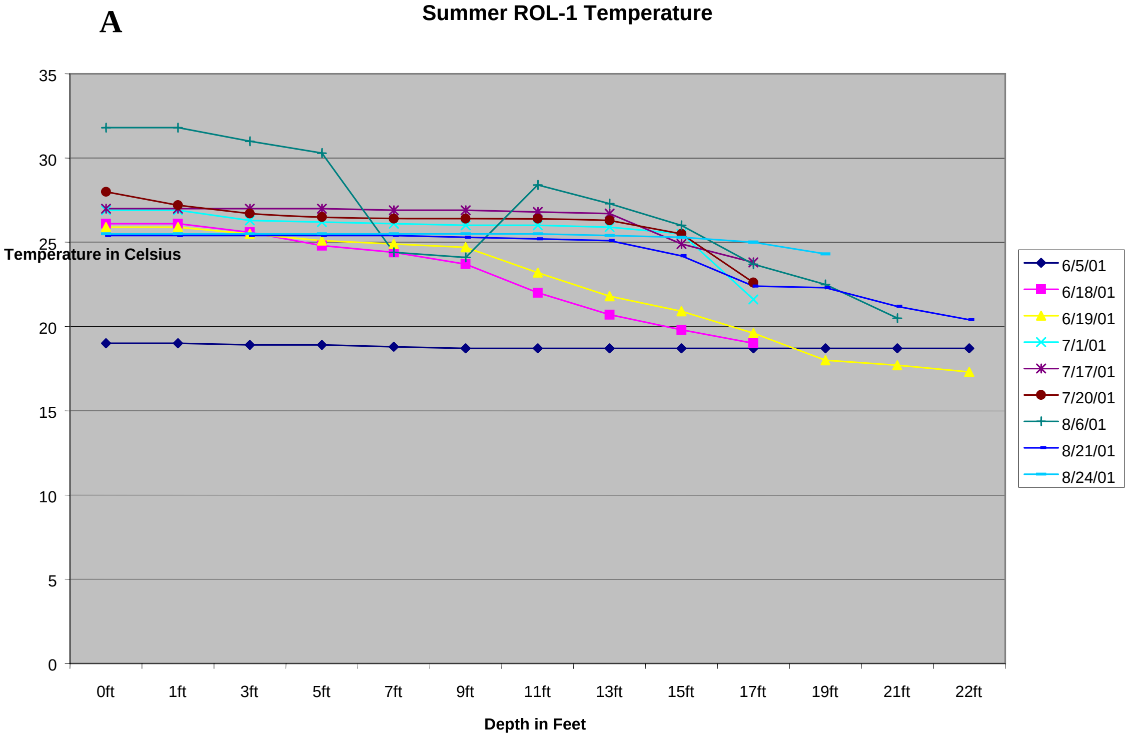
Lake oxygen level is controlled by a variety of factors. Plants and algae release oxygen into the water through photosynthesis. Wind, moving across the water with sufficient force to produce waves, causes a natural mixing of oxygen with the water. This will increase oxygen up to the maximum soluble at a given temperature. Microbial respiration uses oxygen during decomposition of organic materials in the lake. The interactions of these processes determine the oxygen level of the lake.

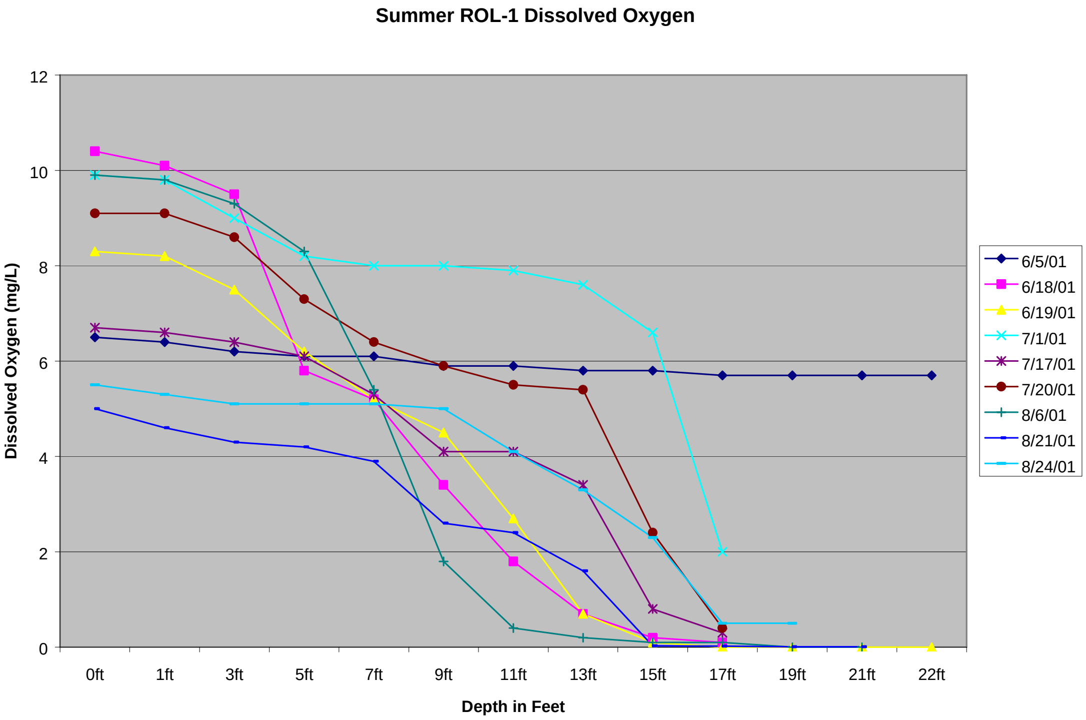
Water temperature is important for many other biological and chemical processes as well as determining oxygen concentration in the lake. Different types of algae grow better at different temperatures. Density gradients due to temperature differences cause the stratification of lakes. Cold water remains near the bottom of the lake and microbial decomposition of organic materials depletes the oxygen levels. As long as the lake remains stratified the oxygen continues to be depleted.

Regulations set by the IEPA and Illinois Pollution Control Board (IPCB) state that dissolved oxygen (DO) shall not fall below 6 mg/L for longer than a 16 hour period and never allowing the DO to fall below 5 mg/L at 1 foot depth (IPCB Part 302). Levels below 3mg/L will likely cause fish kills. The south end of Glenn Shoals Lake demonstrated conditions found in a typical stratified lake. During the winter, the temperature was uniform throughout the lake and the dissolved oxygen was well mixed at all depths. During the late spring and summer months, the lake stratified (Figure 19, 20, 21). The cold water sank to the bottom of the lake and warm water remained near the surface. Wind action and algae growth keeps the upper levels oxygen rich while microbial decomposition processes near the bottom depleted the available oxygen. Chemical reactions which are allowed to take place under low oxygen conditions release nutrients bound to the sediment. During the fall as the temperature changed the water mixed and the dissolved oxygen and temperature levels became more uniform at all depths. This mixing also mixed the released nutrients from the bottom, resulting in internal nutrient loading. This stratified condition was found on the south end of the lake at sites ROL-1 and ROL-2 (Figures 19, 20). The north end of the lake had more uniform oxygen and temperature throughout the year (Figure 21). This is most likely due to the fact that the water is much shallower at this end of the lake. Here, wave action mixed the water and stratification did not occur.

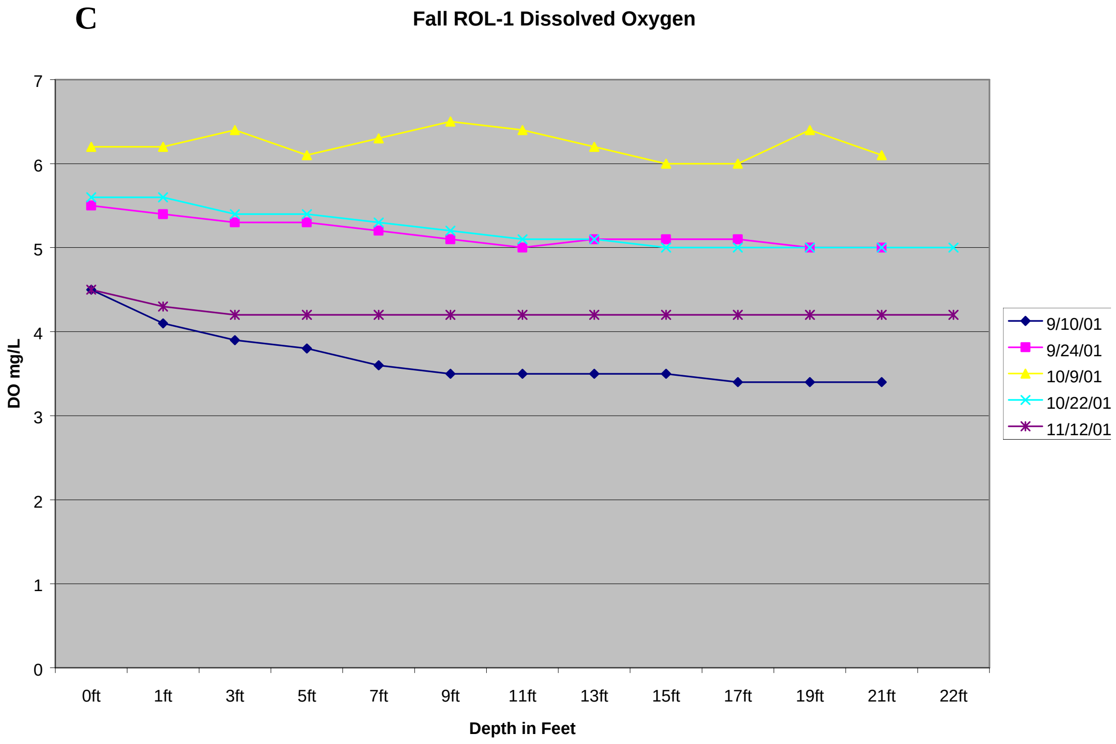
Figure 19

A

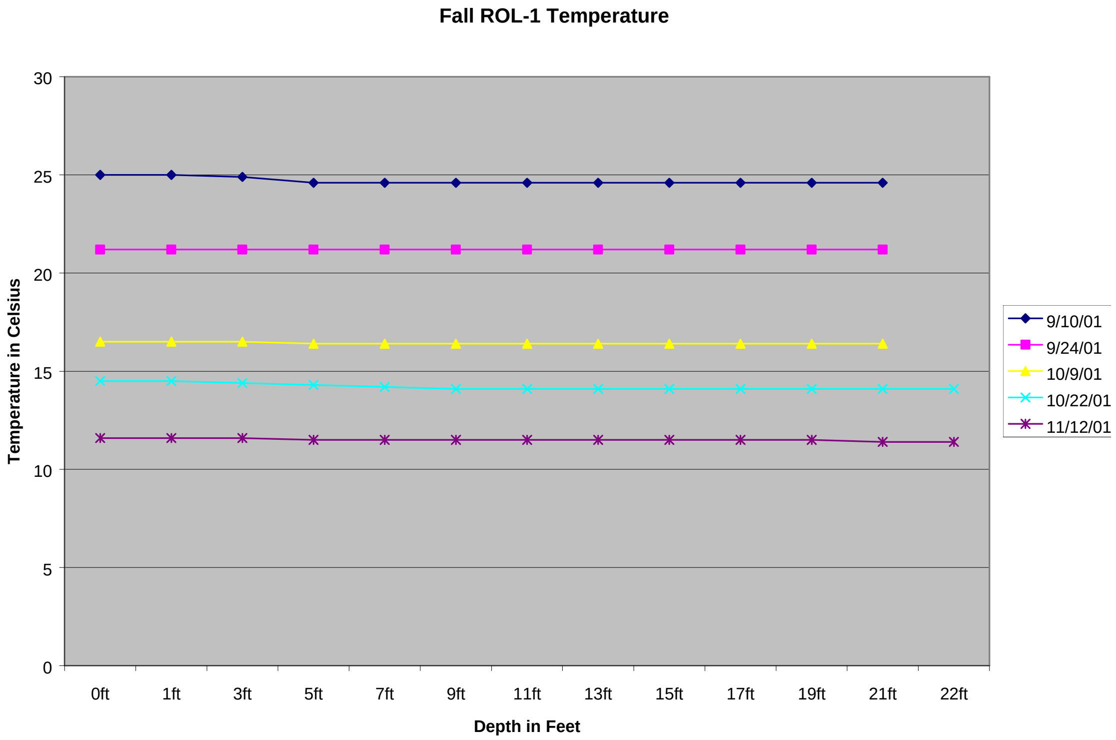



Summer ROL-1 Dissolved Oxygen
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
0ft
1ft
3ft
5ft
7ft
9ft
11ft
13ft
15ft
17ft
19ft
21ft
22ft
Depth in Feet
6/5/01
6/18/01
6/19/01
7/1/01
7/17/01
7/20/01
8/6/01
8/21/01
8/24/01

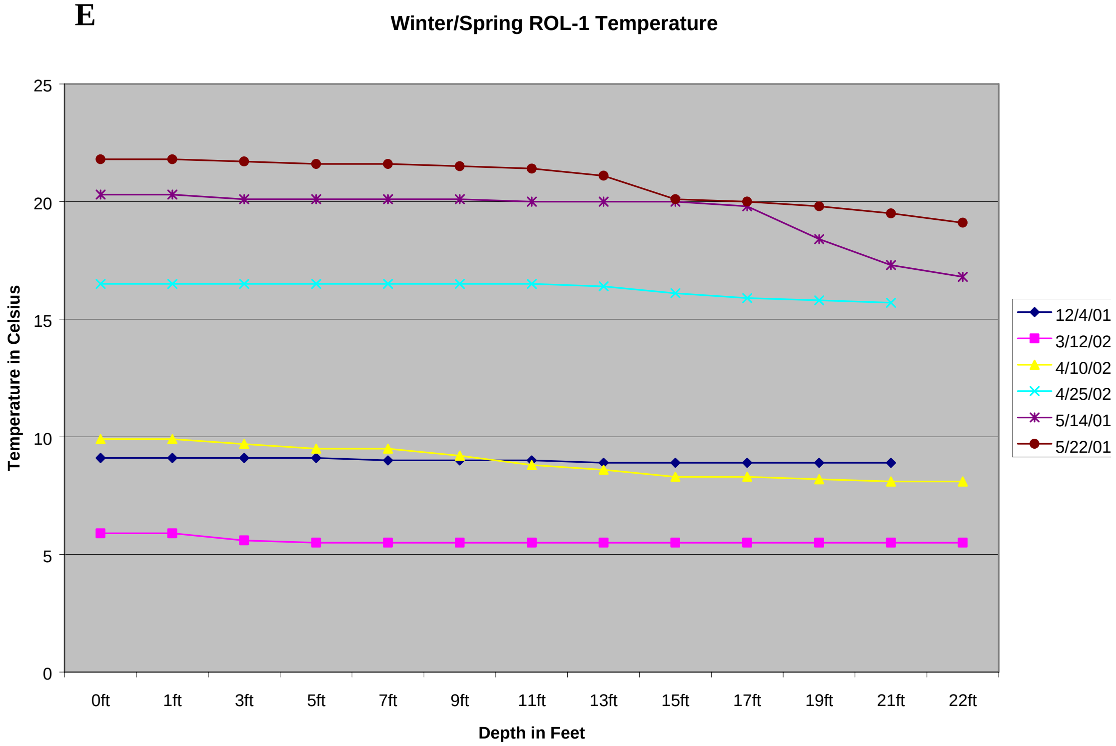
C


Fall ROL-1 Dissolved Oxygen
DO mg/L
0
1
2
3
4
5
6
7
0ft
1ft
3ft
5ft
7ft
9ft
11ft
13ft
15ft
17ft
19ft
21ft
22ft
Depth in Feet
9/10/01
9/24/01
10/9/01
10/22/01
11/12/01

D


Fall ROL-1 Temperature
Temperature in Celsius
0
5
10
15
20
25
30
0ft
1ft
3ft
5ft
7ft
9ft
11ft
13ft
15ft
17ft
19ft
21ft
22ft
Depth in Feet
9/10/01
9/24/01
10/9/01
10/22/01
11/12/01

E


Winter/Spring ROL-1 Temperature
Temperature in Celsius
25
20
15
10
5
0
0ft
1ft
3ft
5ft
7ft
9ft
11ft
13ft
15ft
17ft
19ft
21ft
22ft
Depth in Feet
12/4/01
3/12/02
4/10/02
4/25/02
5/14/01
5/22/01

F

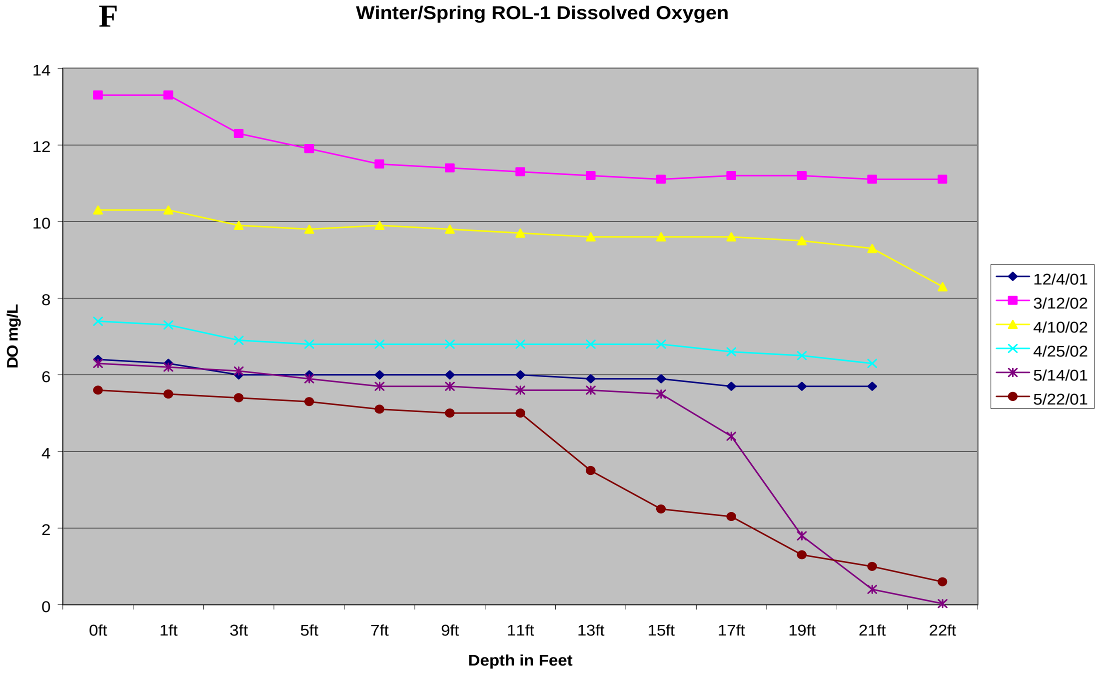
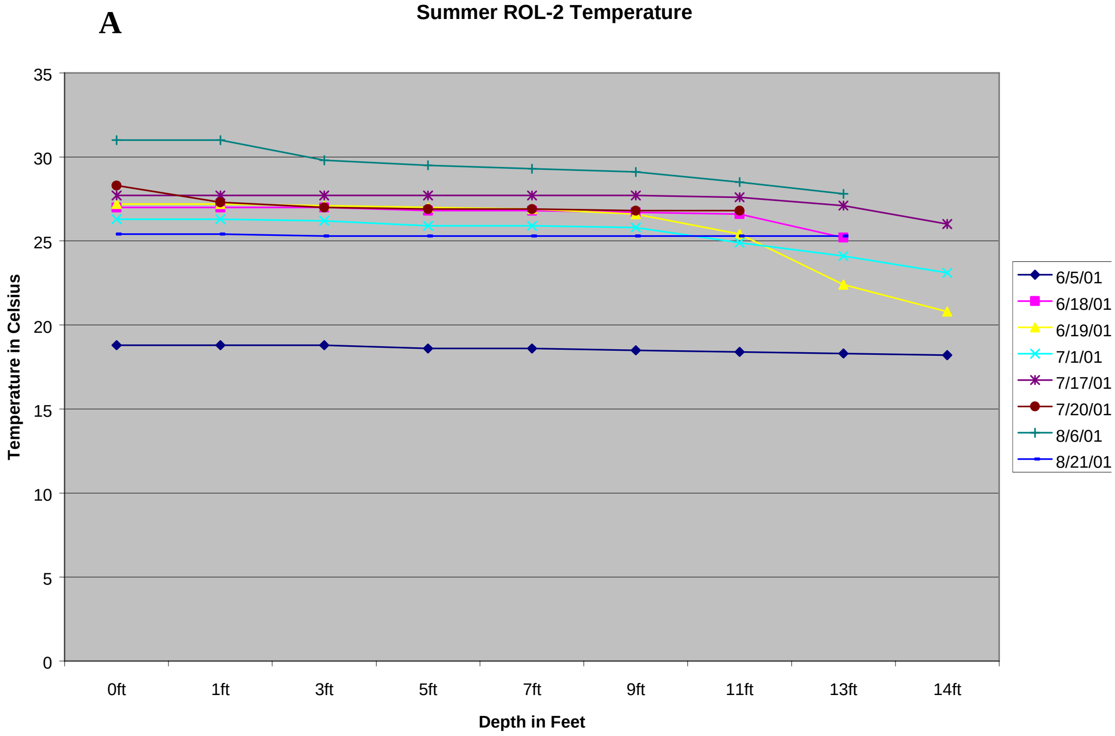
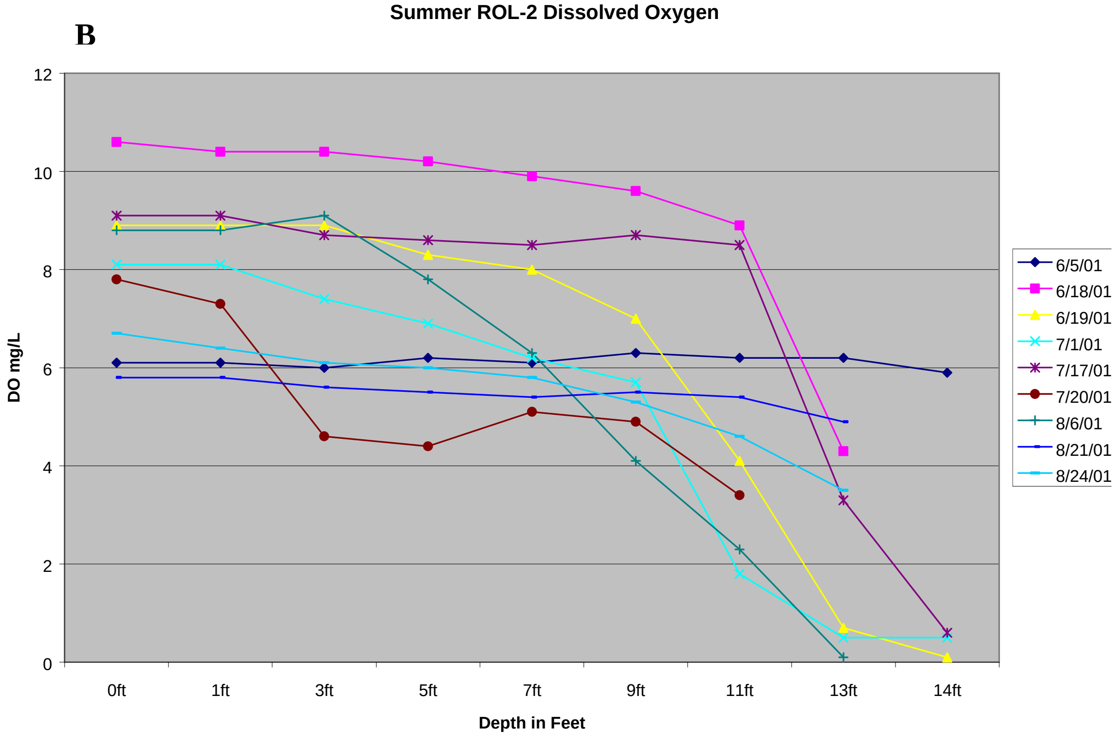

Winter/Spring ROL-1 Dissolved Oxygen
DO mg/L
14
12
10
8
6
4
2
0
0ft
1ft
3ft
5ft
7ft
9ft
11ft
13ft
15ft
17ft
19ft
21ft
22ft
Depth in Feet
12/4/01
3/12/02
4/10/02
4/25/02
5/14/01
5/22/01

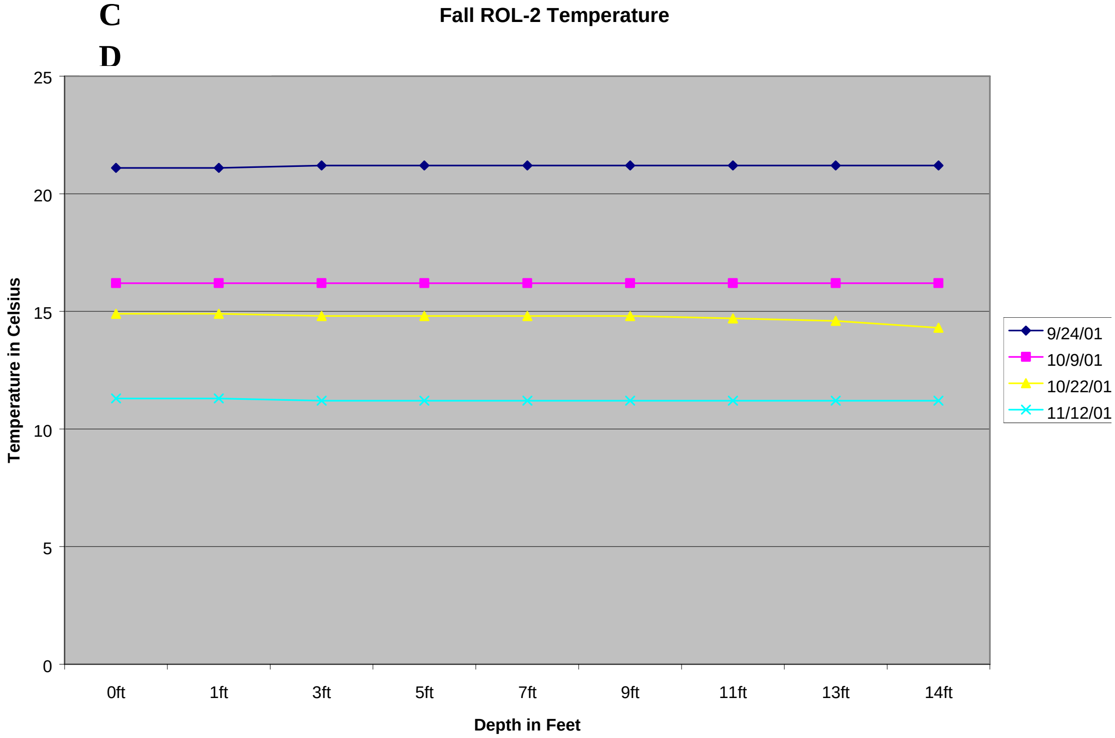
Figure 20

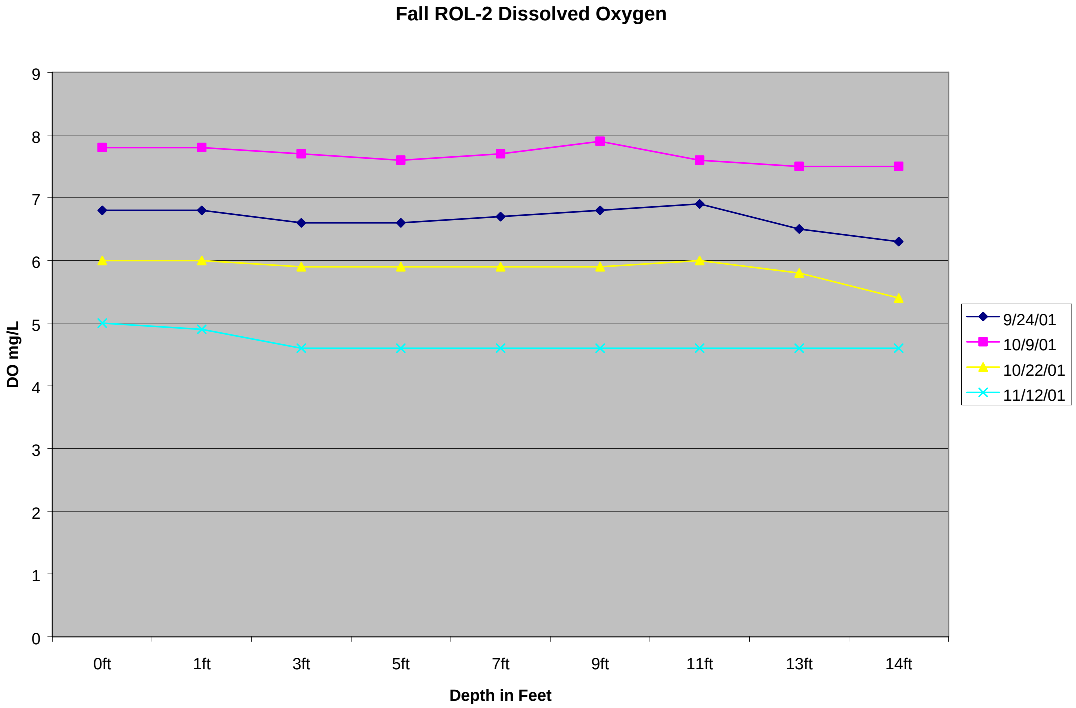

A
Summer ROL-2 Temperature
Temperature in Celsius
35
30
25
20
15
10
5
0
0ft
1ft
3ft
5ft
7ft
9ft
11ft
13ft
14ft
Depth in Feet
6/5/01
6/18/01
6/19/01
7/1/01
7/17/01
7/20/01
8/6/01
8/21/01


B
Summer ROL-2 Dissolved Oxygen
DO mg/L
12
10
8
6
4
2
0
0ft
1ft
3ft
5ft
7ft
9ft
11ft
13ft
14ft
Depth in Feet
6/5/01
6/18/01
6/19/01
7/1/01
7/17/01
7/20/01
8/6/01
8/21/01
8/24/01

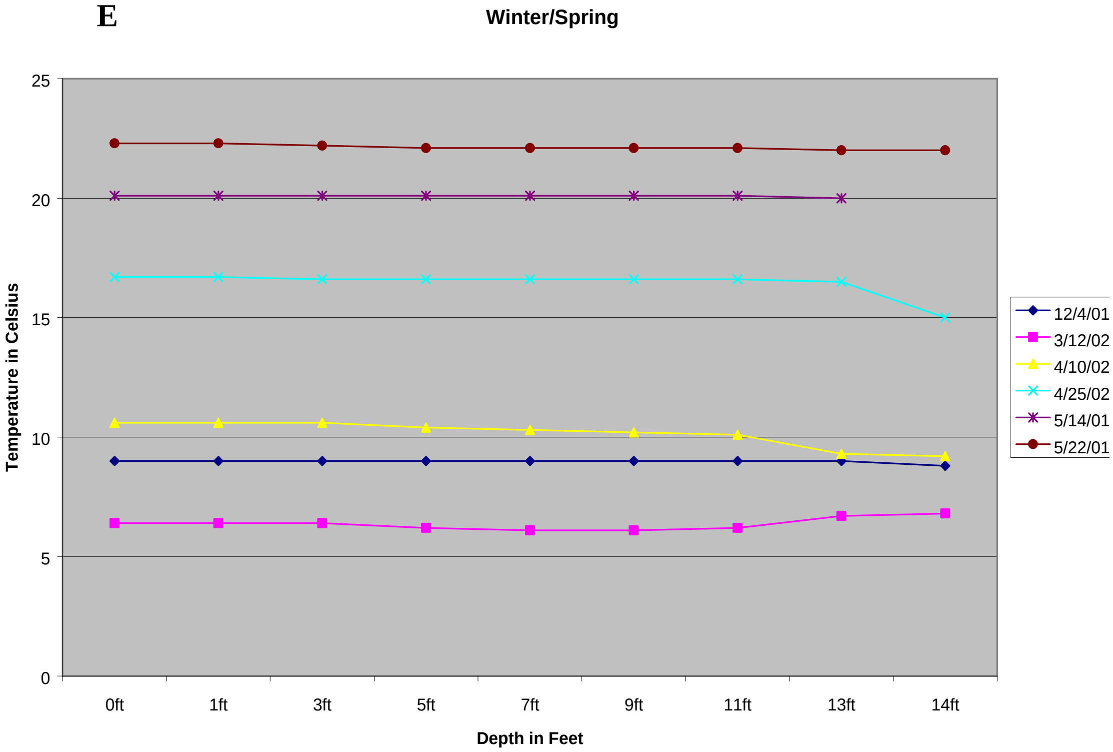
C

D


Fall ROL-2 Temperature
Temperature in Celsius
25
20
15
10
5
0
0ft
1ft
3ft
5ft
7ft
9ft
11ft
13ft
14ft
Depth in Feet
9/24/01
10/9/01
10/22/01
11/12/01


Fall ROL-2 Dissolved Oxygen
DO mg/L
9
8
7
6
5
4
3
2
1
0
0ft
1ft
3ft
5ft
7ft
9ft
11ft
13ft
14ft
Depth in Feet
9/24/01
10/9/01
10/22/01
11/12/01

E


Winter/Spring
Temperature in Celsius
0
5
10
15
20
25
0ft
1ft
3ft
5ft
7ft
9ft
11ft
13ft
14ft
Depth in Feet
12/4/01
3/12/02
4/10/02
4/25/02
5/14/01
5/22/01

F

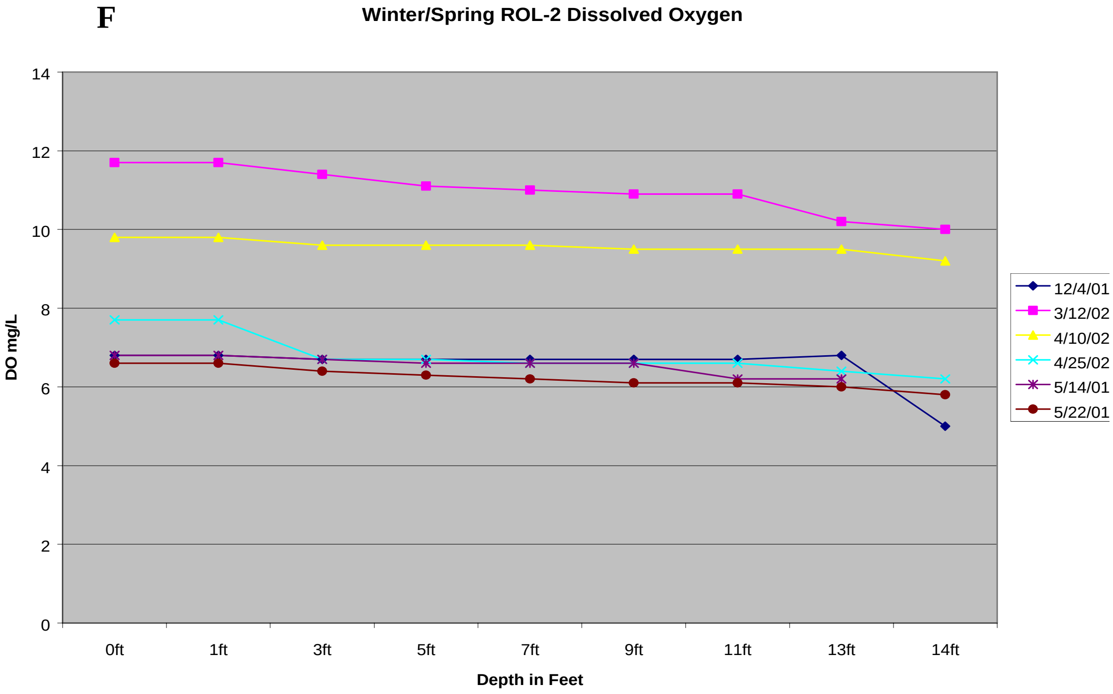
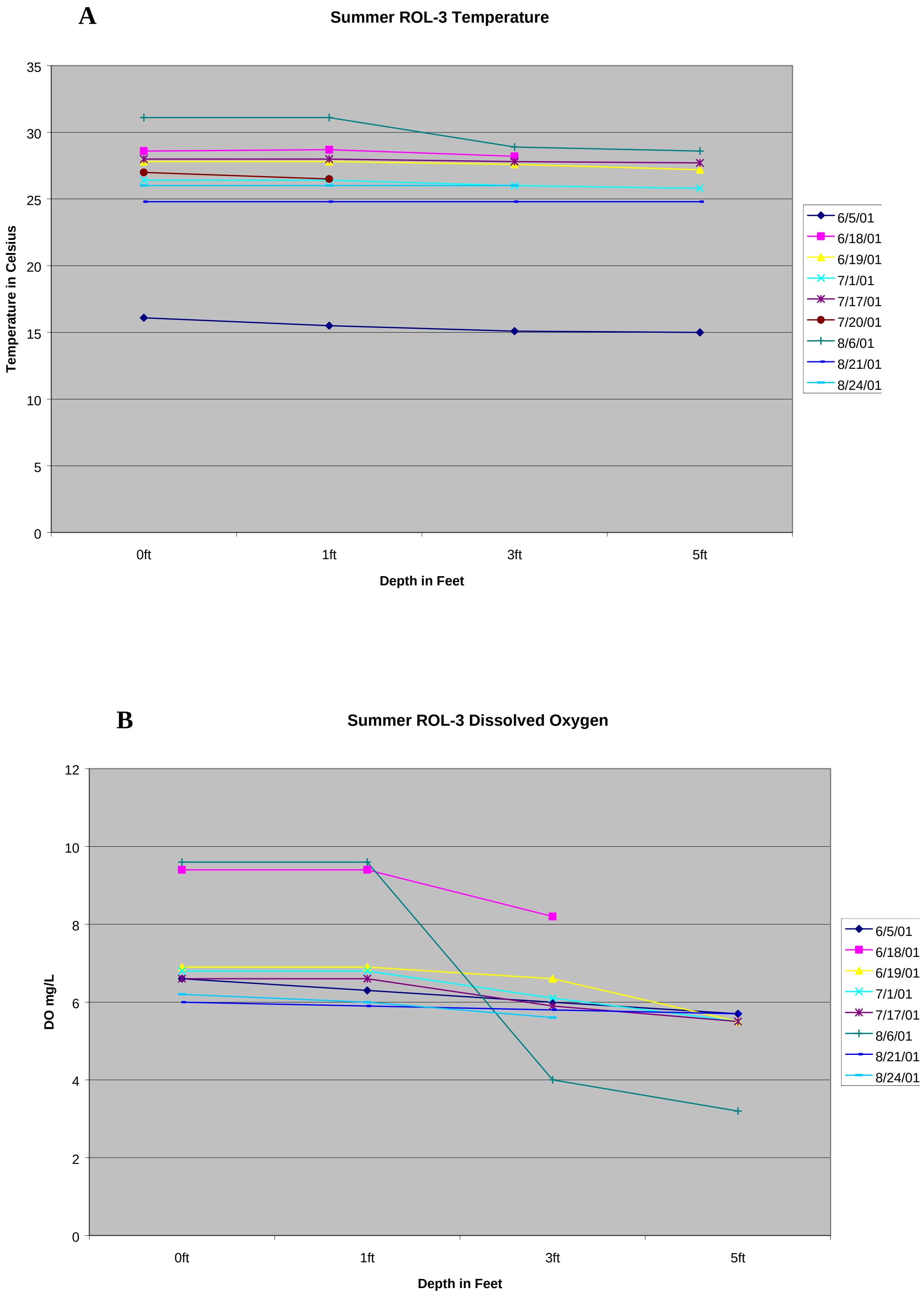
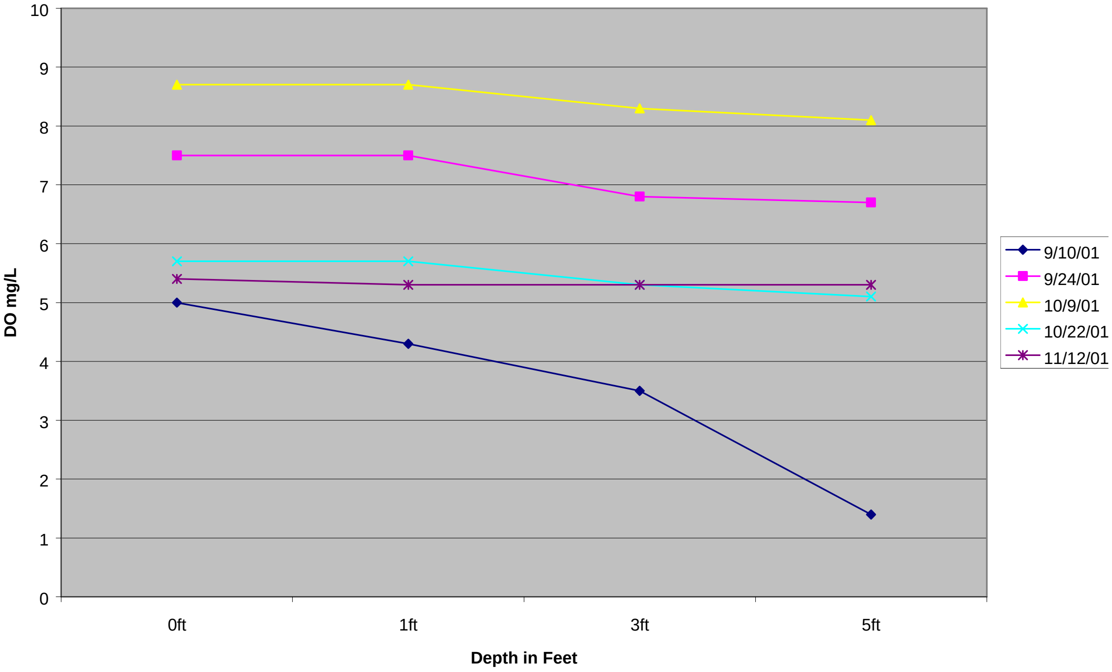

Winter/Spring ROL-2 Dissolved Oxygen
DO mg/L
0
2
4
6
8
10
12
14
0ft
1ft
3ft
5ft
7ft
9ft
11ft
13ft
14ft
Depth in Feet
12/4/01
3/12/02
4/10/02
4/25/02
5/14/01
5/22/01

Figure 21


A
Summer ROL-3 Temperature
Temperature in Celsius
35
30
25
20
15
10
5
0
0ft
1ft
3ft
5ft
Depth in Feet
6/5/01
6/18/01
6/19/01
7/1/01
7/17/01
7/20/01
8/6/01
8/21/01
8/24/01
B
Summer ROL-3 Dissolved Oxygen
DO mg/L
12
10
8
6
4
2
0
0ft
1ft
3ft
5ft
Depth in Feet
6/5/01
6/18/01
6/19/01
7/1/01
7/17/01
8/6/01
8/21/01
8/24/01

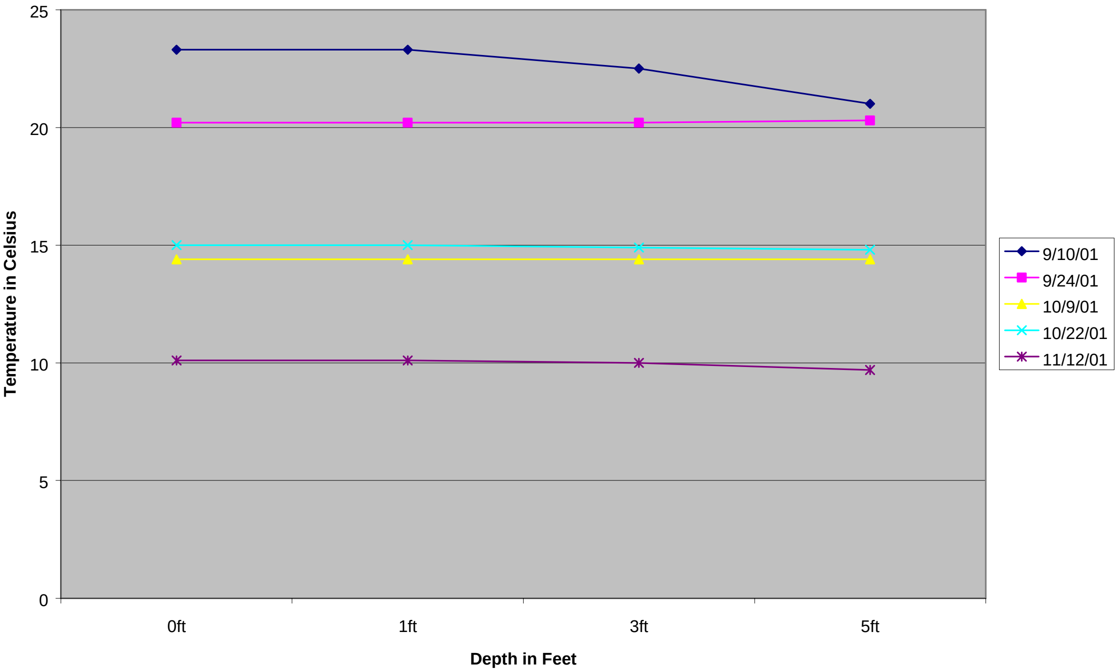
C

Fall ROL-3 Dissolved Oxygen

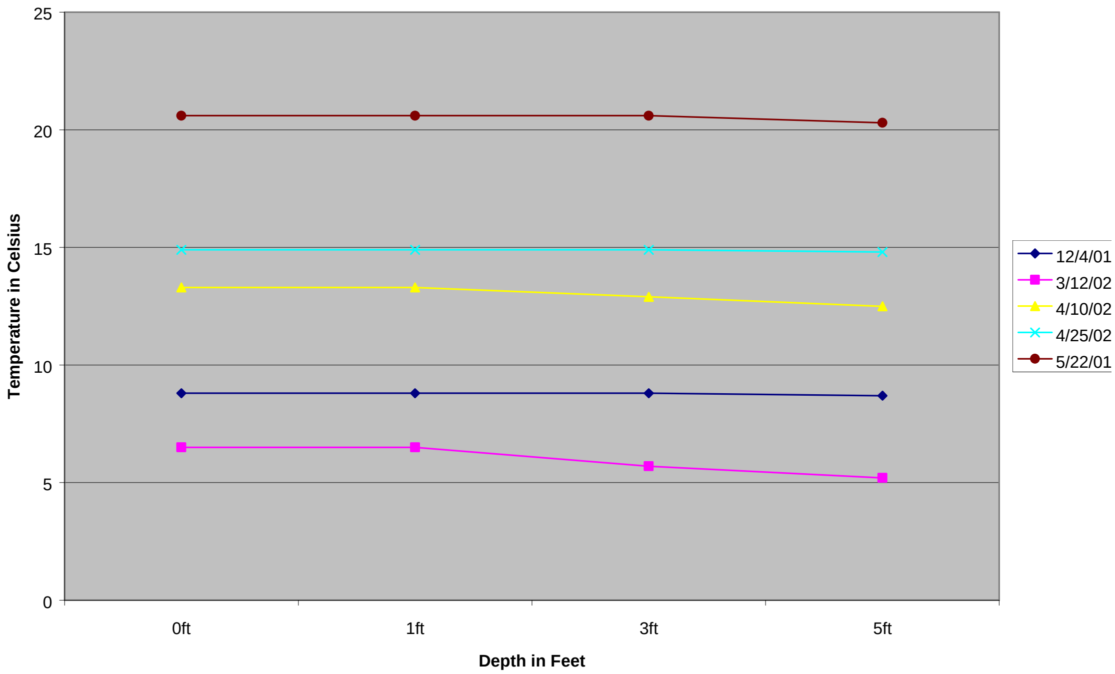


D

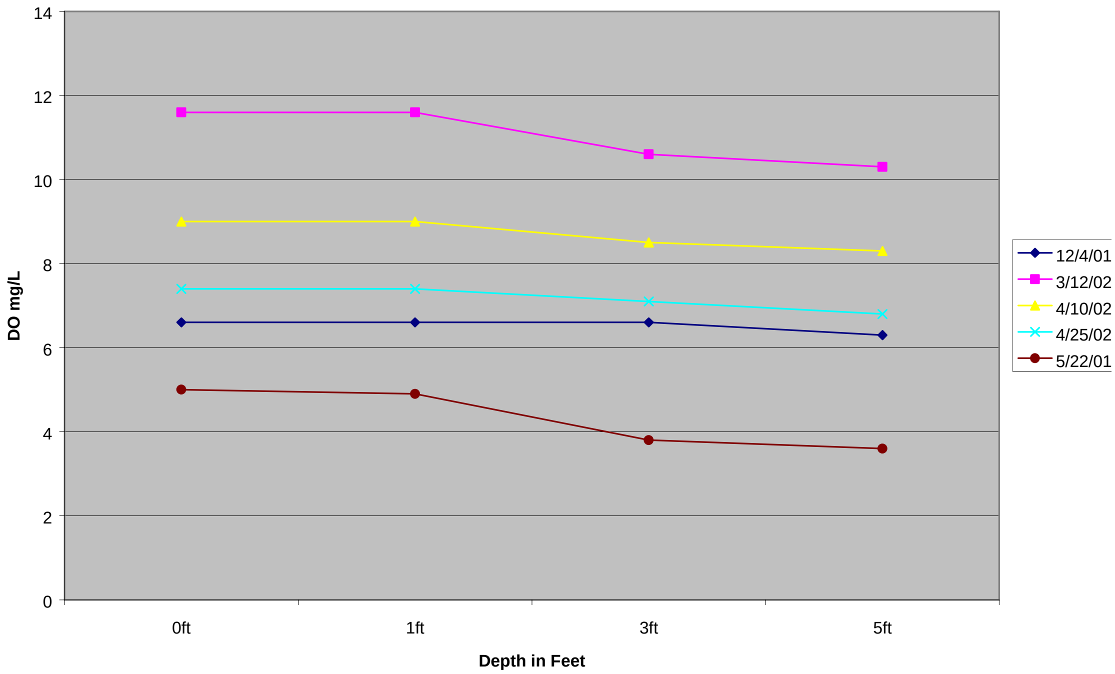
Fall ROL-3 Temperature



E


Winter/Spring

F

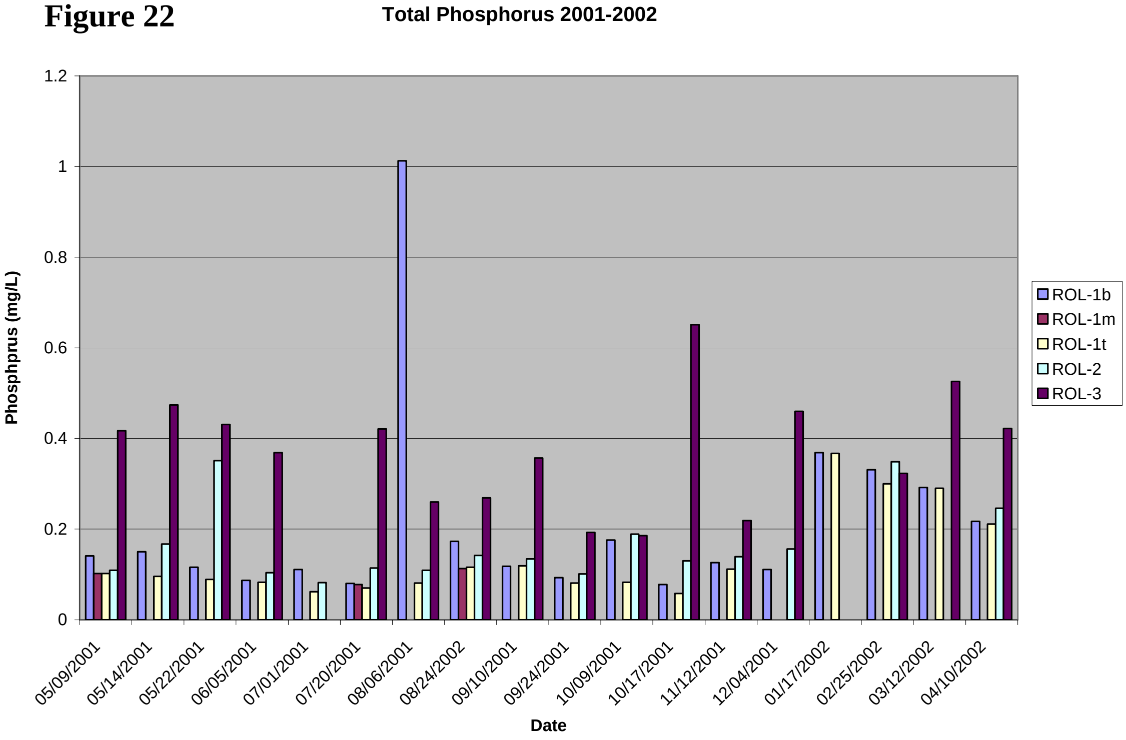

Winter/Spring ROL03 Dissolved Oxygen

Phosphorus

Phosphorus is a required nutrient for plant growth. The over- or under-abundance of phosphorus is a likely factor in determining the quantity as well as the quality of macrophytes and algae growth in the lake. High phosphorus concentrations can lead to the eutrophication of a lake. Phosphorus is not always readily available for plant consumption. Most phosphorus in sediment is tightly bound to soil particles and therefore not available to plants. This phosphorus is considered to be in an insoluble form. If dissolved oxygen levels near the bottom of the lake become low, anaerobic decomposition of organic materials will release phosphorus in a soluble form readily available for plant use (Hill 1994). Phosphorus control is a key component to good lake management and restoration. The Illinois standard for phosphorus states that phosphorus as P shall not exceed 0.05 mg/L in any reservoir or lake with a surface area of 8.1 hectares or more (Title 35 Water Quality Standards). The phosphorous level did exceed the standard. The 10/17/01 sample from ROL-3 at .65 mg/L and the 3/12/02 sample from ROL-3 was 0.5 mg/L (Figure 22). While the highest reading was from ROL-1b at 1.1 mg/L. This last and highest reading is probably related to the conversion of insoluble phosphorous to soluble phosphorous on the bottom of the lake. This was caused by stratification which in turn causes lack of oxygen and the release of phosphorous by anaerobic organisms.

The problem of excess phosphorous is compounded by the fact that there is more total phosphorous in the tributaries than in the lake. Another part of the problem is that the incoming water has a 69.6% dissolved phosphorous (useable by plants) while the lake has only a 59.3% P in the dissolved form (Table 17, 21). This would suggest that the algae in the lake are using the dissolved phosphorous for growth and the dead cells are settling to the bottom and adding to the phosphorous in the sediment. This will be a continuing problem as yearly stratification and overturn cycles will continue to release an abundance of newly dissolved phosphorous.

Figure 22



Total Phosphorus 2001-2002
Phosphprus (mg/L)
1.2
1
0.8
0.6
0.4
0.2
0
05/09/2001
05/14/2001
05/22/2001
06/05/2001
07/01/2001
07/20/2001
08/06/2001
08/24/2002
09/10/2001
09/24/2001
10/09/2001
10/17/2001
11/12/2001
12/04/2001
01/17/2002
02/25/2002
03/12/2002
04/10/2002
Date
ROL-1b
ROL-1m
ROL-1t
ROL-2
ROL-3

Table 17 Dissolved Phosphorus ROL (Lake)

Date	Depth ft ROL1	Soluble P mg/l	Total P mg/l	% Soluble
9-May	1ft	0.094	0.102	92.2
9-May	11 ft	0.092	0.102	90.2
9-May	21 ft	0.101	0.141	71.6
18-Jun	9 ft	0.051	0.067	76.1
18-Jun	17 ft	0.03	0.06	50.0
1-Jul	14 ft	?	0.111	
1-Jul	1 ft	?	0.062	
20-Jul	1 ft	0.032	0.07	45.7
20-Jul	9 ft	0.017	0.078	21.8
20-Jul	15 ft	0.02	0.08	25.0
24-Aug	1ft	0.053	0.116	45.7
24-Aug	11 ft	0.052	0.113	46.0
24-Aug	19 ft	0.077	0.173	44.5
17-Oct	1ft	0.058	0.091	63.7
17-Oct	9ft	0.043	0.075	57.3
17-Oct	18ft	0.043	0.078	55.1
	SUMS	0.763	1.519	785.0

Date	Depth ft ROL2	Soluble P mg/l	Total P mg/l	% Soluble	
9-May	1ft	0.07	0.109	64.2	
18-Jun	1ft	0.054	0.081	66.7	
20-Jul	1ft	0.057	0.114	50.0	
24-Aug	1ft	0.054	0.142	38.0	
17-Oct	1ft	0.077	0.13	59.2	
	ROL3				
9-May	1ft	0.104	0.417	24.9	
18-Jun	1ft	0.096	0.219	43.8	
20-Jul	1ft	0.142	0.186	76.3	
20-Jul	3ft	0.268	0.421	63.7	
17-Oct	1ft	0.511	0.651	78.5	
24-Oct	1ft	0.142	0.269	52.8	
	SUMS	1.575	2.739	618.2	
		Total	2253.2	**Average of totals**	59.3%

Nitrogen

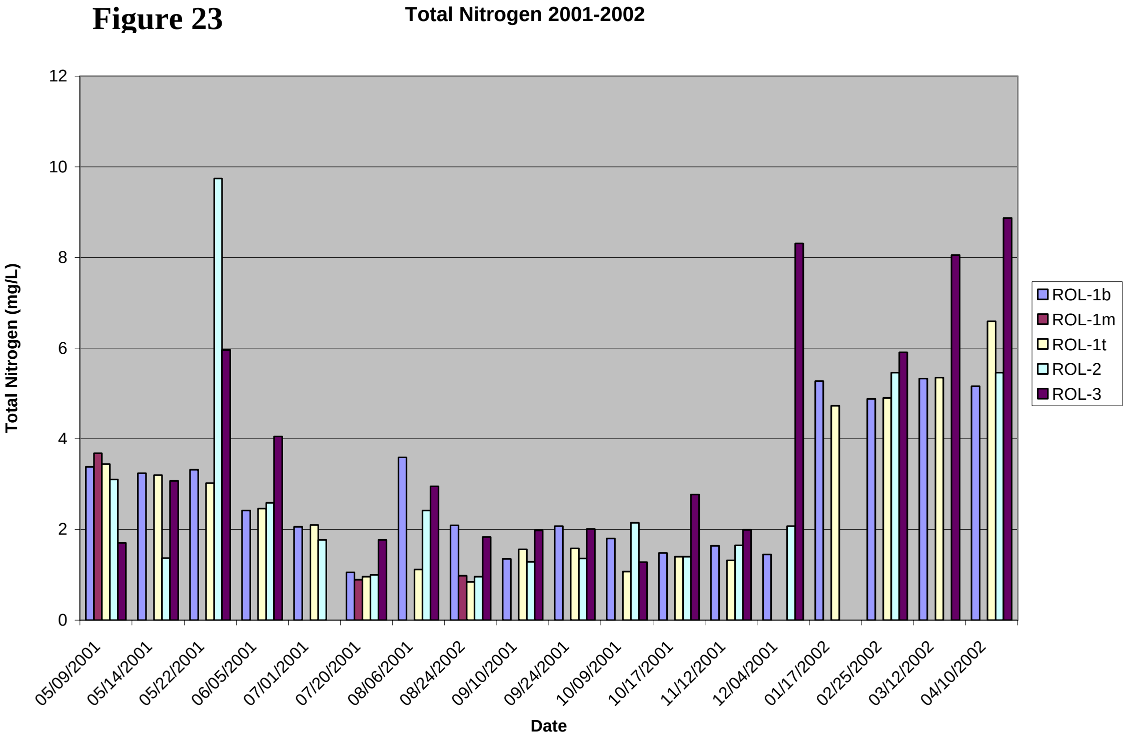
Nitrogen is an important nutrient for plant growth as its availability will affect plant and algae growth leading to eutrophication of a lake. The forms of nitrogen sampled included ammonia, nitrate, and nitrite nitrogen. These three are summed to give the value of the total kjeldahl nitrogen. The total kjeldahl is used to calculate the organic nitrogen.

Note: for all measures of "nitrogen, kjeldahl total mg/l" after may 2000 the value may not be accurate because the reported values failed to meet the quality controls criteria for precision or accuracy.

Total Nitrogen

Total nitrogen is a calculated value. It is the sum of kjeldahl nitrogen, nitrite and nitrate nitrogen. It is used to determine the ratio of nitrogen to phosphorus. This determination will yield the limiting nutrient for a lake. A ratio of total nitrogen to total phosphorus of greater than 7:1 is defined as a phosphorus limited lake. Glenn Shoals Lake had a ratio of 14.2:1 and therefore phosphorus is the limiting nutrient. Nitrogen does, however, play a role as a polluter and therefore should be controlled when possible. It should be noted that nitrogen is much harder to control than phosphorus. Total nitrogen levels peaked in the lake at ROL-2 on 5/22/2001 at 9.74 mg/L (Figure 23). Historical total nitrogen averages of 1.95 mg/L are lower than the 2001-2002 data of 2.81 mg/L. This increase over the historical data is an indication that nitrogen levels also need to be controlled (Table 15).

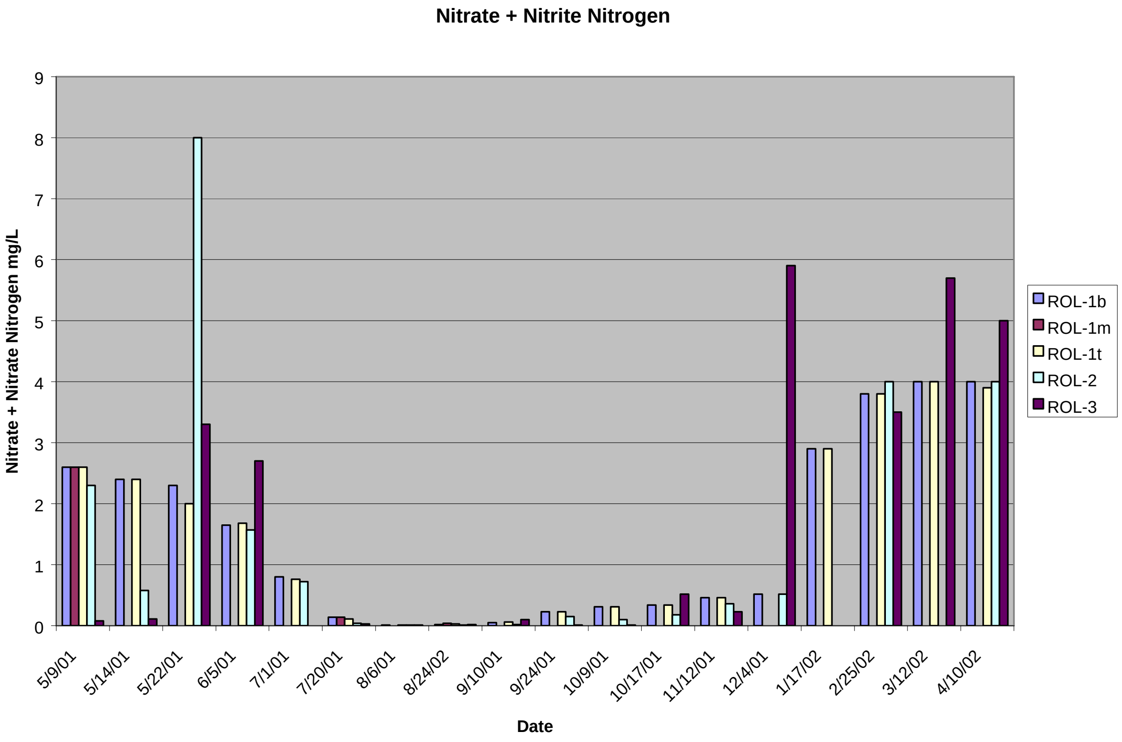
Figure 23


Total Nitrogen 2001-2002
Total Nitrogen (mg/L)
0
2
4
6
8
10
12
05/09/2001
05/14/2001
05/22/2001
06/05/2001
07/01/2001
07/20/2001
08/06/2001
08/24/2002
09/10/2001
09/24/2001
10/09/2001
10/17/2001
11/12/2001
12/04/2001
01/17/2002
02/25/2002
03/12/2002
04/10/2002
Date
ROL-1b
ROL-1m
ROL-1t
ROL-2
ROL-3

Nitrate + Nitrite Nitrogen

Nitrate + Nitrite nitrogen are inorganic forms of nitrogen which can enter a lake through agricultural runoff, septic tank effluent and other forms of waste. Due to the fact that increased levels of nitrates can cause physiological effects for infants less than 6 months old, nitrate concentrations are of particular concern for drinking water reservoirs. The standard for nitrate is 10mg/L. Concentrations greater than 10 mg/L can have dangerous effects for infants. All samples for Glenn Shoals Lake fell well below 10 mg/L; the peak being 8.0mg/L at ROL-2 on 5/22/2001(Figure 24). The 2001-2002 nitrate + nitrite nitrogen average values are higher than historic averages. The historic nitrate + nitrite nitrogen for lake site ROL-1t is 0.85mg/L while the 2001-2002 average is 1.50mg/L. Lake site ROL-2 historic nitrate + nitrite nitrogen average is 0.82mg/L while the 2001-2002 average is 1.41mg/L. Lake site ROL-3 historic nitrate + nitrite nitrogen average is 0.98mg/L while the 2001-2002 average is 1.70mg/L (Table 15).

Figure 24

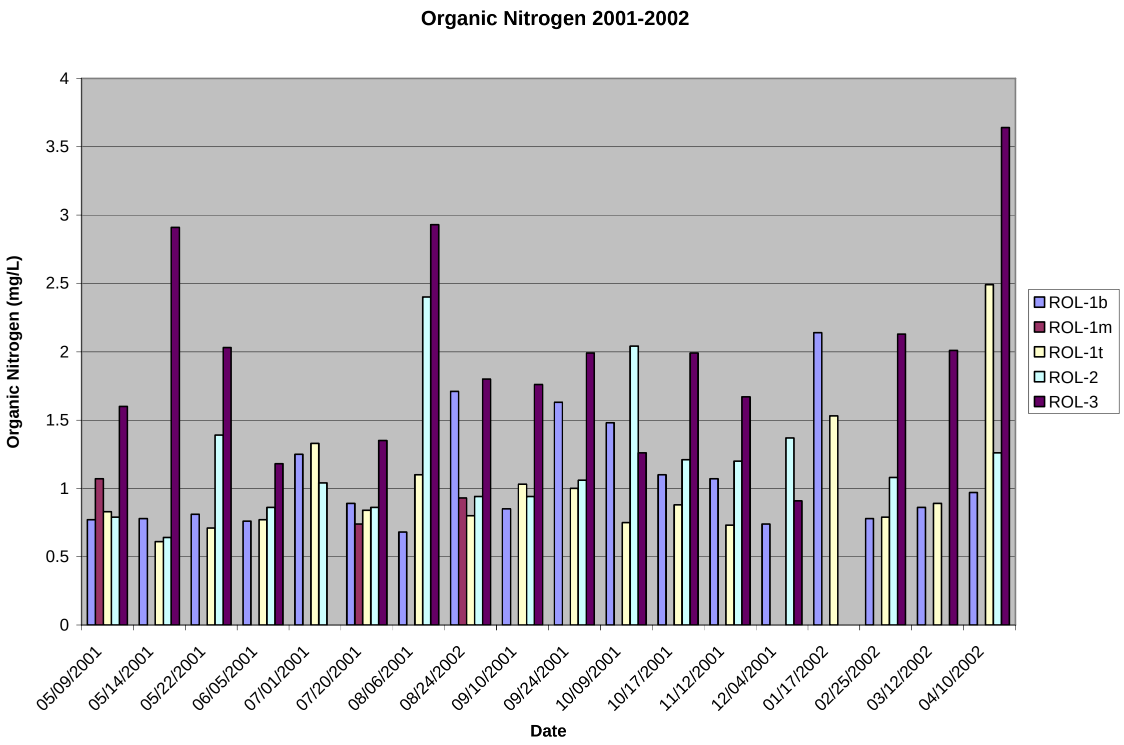


Organic Nitrogen

Organic nitrogen can enter a lake through decaying organic matter, septic systems, agricultural waste and waterfowl. Levels in Glenn Shoals Lake were recorded above 0.5mg/L and were consistently higher than the historical levels. Levels peaked at 3.64mg/L on 4/10/2002 at ROL-3 (Figure 25). ROL-1t 2001-2002 organic nitrogen levels were higher than historical averages with a 2001-2002 average of 1.00mg/L and a historic average of 0.04mg/L. Lake site ROL-2 2001-2002 organic nitrogen levels were higher than historical averages with a 2001-2002 average of 1.19mg/L and a historic average of 0.22mg/L. Lake site ROL-3 2001-2002 organic nitrogen levels were also higher than historical averages with a 2001-2002 average of 1.95mg/L and a historic average of 0.32mg/L (Table 15).

Since organic nitrogen is a calculated value based on TKN the value may be suspect. See the note under the heading Nitrogen.

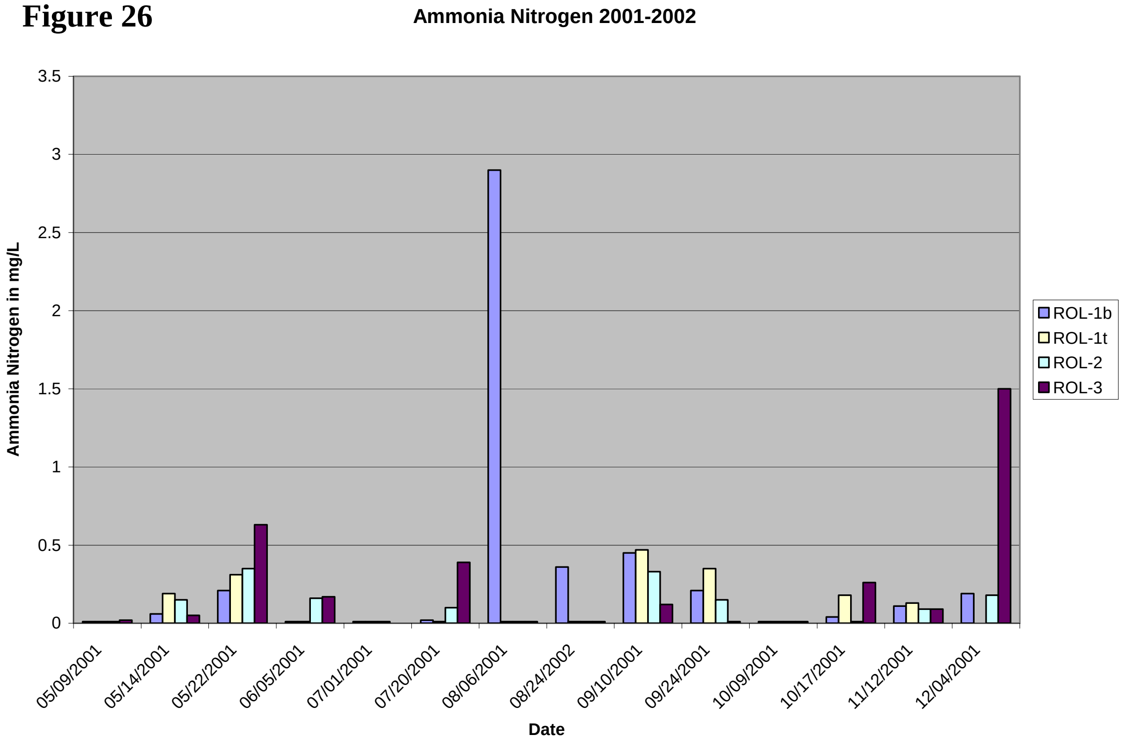
Figure 25



Ammonia Nitrogen

Ammonia nitrogen is the form of nitrogen that is most readily usable for plant growth. High ammonia concentrations can also have adverse affects on fish and other aquatic organisms. Ammonia is made available after bacterial decomposition of organic matter which is found in the sediment at the bottom of the Lake. The pollution control board Part 302 states that total ammonia shall in no case exceed 15 mg/L, with a guideline of 0.25 mg/L. Twenty three percent of the samples from Glenn Shoals Lake were above the 0.25 mg/L guideline. None of the samples exceeded the 15mg/L standard (Figure 26). The peak concentration of 2.9mg/L 8/6/2001 was found at ROL-1b at the bottom of the lake, which would be expected. These peak concentrations are most commonly a result of bacterial decomposition processes. Lake site ROL-1t 2001-2002 ammonia nitrogen levels were higher than historical averages with a 2001-2002 average of 0.18mg/L and a historic average of 0.15mg/L. Lake site ROL-2 2001-2002 ammonia nitrogen levels were lower than historical averages with a 2001-2002 average of 0.13 mg/L and a historic average of 0.19mg/L. Lake site ROL-3 2001-2002 ammonia nitrogen levels were higher than historical averages with a 2001-2002 average of 0.25 mg/L and a historic average of 0.20mg/L (Table 15, Figure 26).

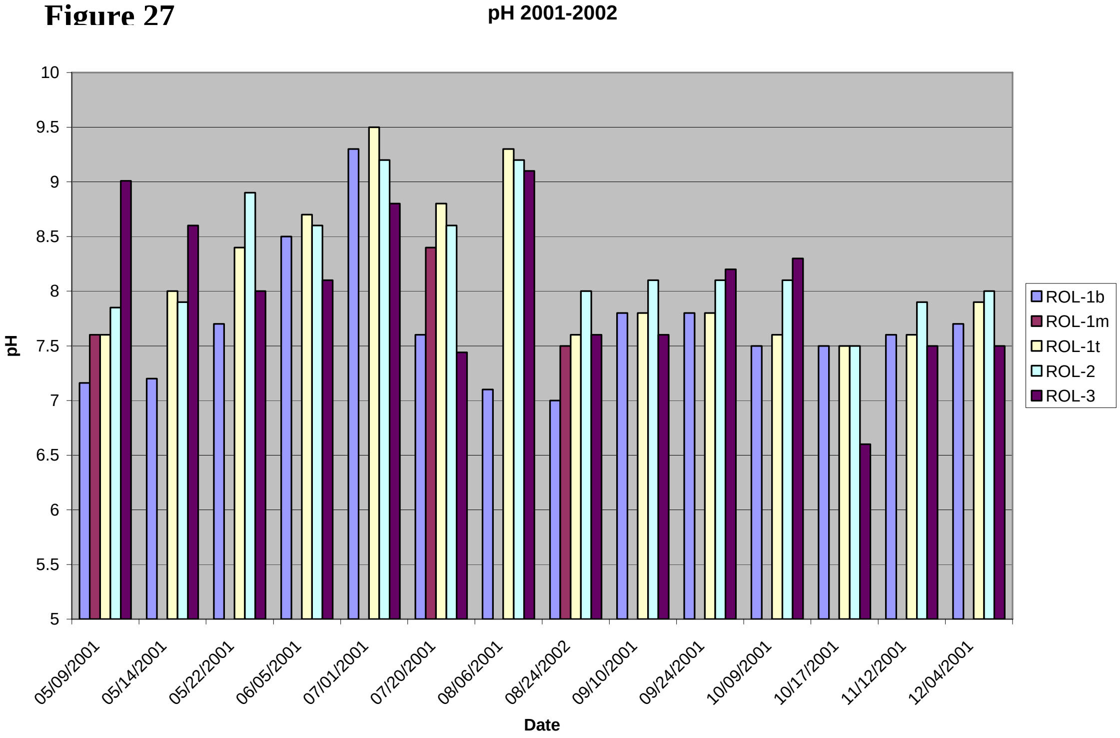
Figure 26



pH

A lake's pH is a measure of the acidity of the water. The pH measures the hydrogen ions present in solution on a scale of 0-14. A reading of 7 is neutral. A reading higher than 7 is basic or alkaline. A reading less than 7 is acidic. The pH range for most lakes is between 6 and 9. The pH standard in Illinois is within the range of 6.5 to 9 except for natural causes. The loss of carbon dioxide during photosynthesis results in an increase in pH of the photic, or lighted, zone. As decomposition occurs near the bottom of the lake, the pH will decrease. Therefore pH levels near the bottom of the lake are often lower than near the surface. Organic material is decomposing and photosynthesis is not occurring. With the exception of two sampling dates, 7/1/2001 and 8/6/2001, the pH in Glenn Shoals Lake was within the range of 6.5 to 9 during the study. On these two dates, at three of the sample sites, the pH was higher than 9 but lower than 9.5 (Figure 27). The water in Glenn Shoals Lake during the study period was more alkaline than acidic. Historical lake average pH for site ROL-1t is 7.8, ROL-2 is 7.8 and ROL-3 is 8.6. The 2001-2002 lake average pH for site ROL-1t was 8.1, ROL-2 was 8.2 and ROL-3 was 8.0. Historical data peaks were higher than the 2001-2002 peaks (Table 15).

Figure 27



TRIBUTARY MONITORING

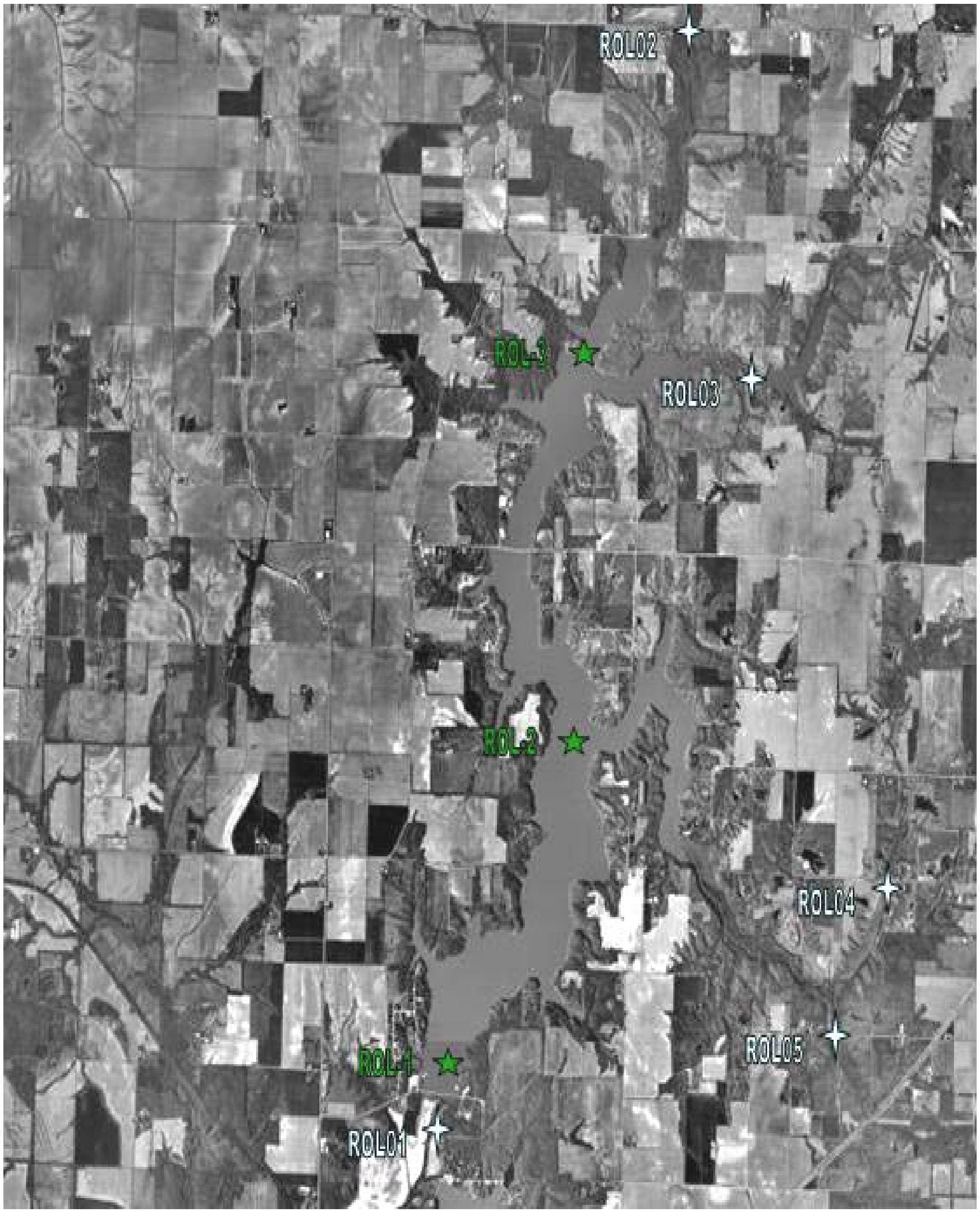
Turbidity

Turbidity is a measure of suspended materials in the water. Turbidity was measured using a Hydrolab water measurement instrument and was calibrated to a known turbidity test standard (NTUs). Turbidity is a measure of materials in the water causing light to scatter. Turbidity in the tributaries is an indicator of bank and soil erosion in the watershed and along the stream. (Figure18).

Sampling stations were located in all of the major tributaries in an effort to develop an understanding of the volume of water, nutrients and other material entering the lake (Figure 14). These stations were located near the mouths of tributaries where reasonable access was available. A staff gauge was placed at each of these sites. A staff gauge is a measuring rod that allows relational water depths to be observed and recorded in tenths of a foot. Cross-sectional areas were taken at each of the staff gauge sites. Four staff gauge sites were placed in the tributaries around the lake. The relationship between the staff gauge reading and the cross-sectional area was used to determine volumes of water entering the lake from each tributary. The staff gauge locations were labeled ROL01 through ROL05 (Figure 14). ROL01 is located near the spillway and was used to determine the lake outflow. ROL02 is located on Witt Road bridge, crossing shoal creek, ROL03 is located at the mouth of structure 14 a detention basin on fawn creek, both ROL02 and ROL03 converge at lake site ROL-3. ROL04 is located on 1400N on the bridge that crosses little creek, ROL05 is located on 1325 N east of the new bridge constructed crossing the south arm of little creek, both ROL04 and ROL05 join together and empty into the lake near site ROL-2.

City personnel recorded daily staff gauge readings at ROL01 – ROL05. These five sites gave data for all of the major tributaries entering the lake as well as the outflow. During storm events (more than ½ inch of rain) ZIES staff collected water samples from all five sites and recorded staff heights for each site. Water samples were collected and shipped according to IEPA protocol to IEPA laboratories for analysis. Water samples were analyzed for total suspended solids, volatile suspended solids, phosphorus, nitrate + nitrite nitrogen, ammonia nitrogen and kjeldahl nitrogen. ZIES staff tested for pH on site using a Hydrolab probe during collection of the other water samples. ZIES also measured flow using a Global water works flow probe. The flow data was used to determine sediment and nutrient loading for each site.

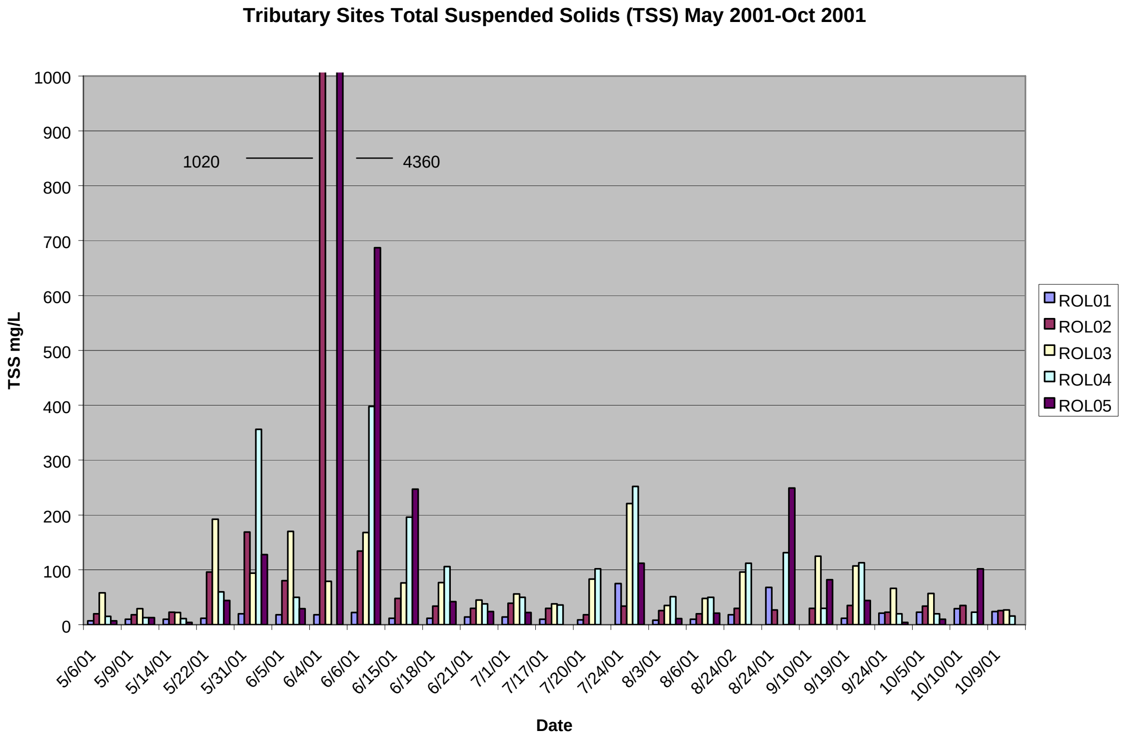
Figure 14 B - Tributary Sampling Sites



Total Suspended Solids

Total suspended solids (TSS) is a measurement of all of the suspended material in the water including both organic and inorganic materials. This would include materials such as algae, decaying plant materials, minerals, and soil particles. (Figure 28). Peak levels corresponded with rain events. Values of TSS were used to calculate Sediment loading.

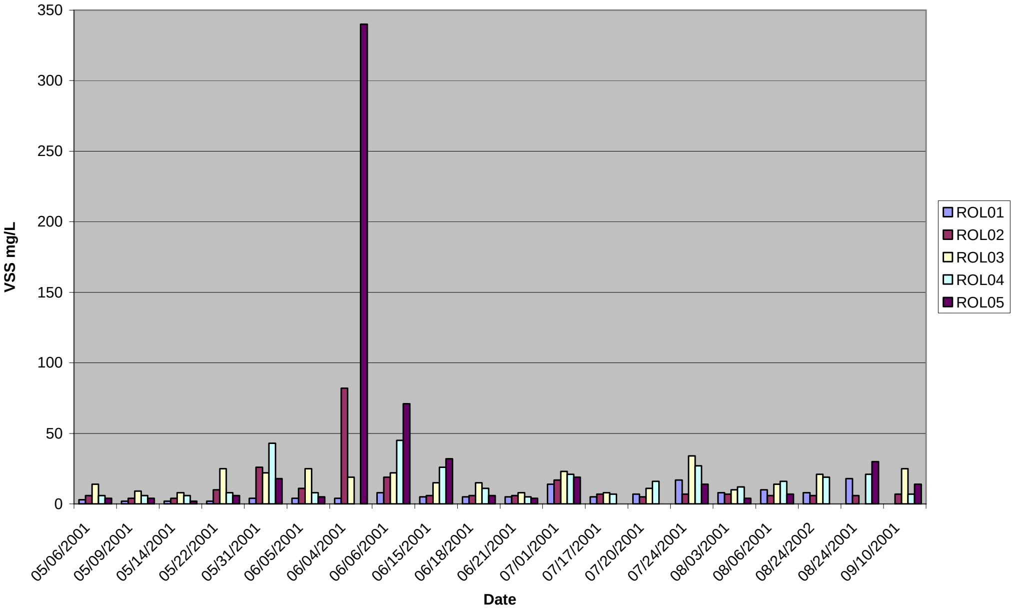
Figure 28 – Total Suspended Solids



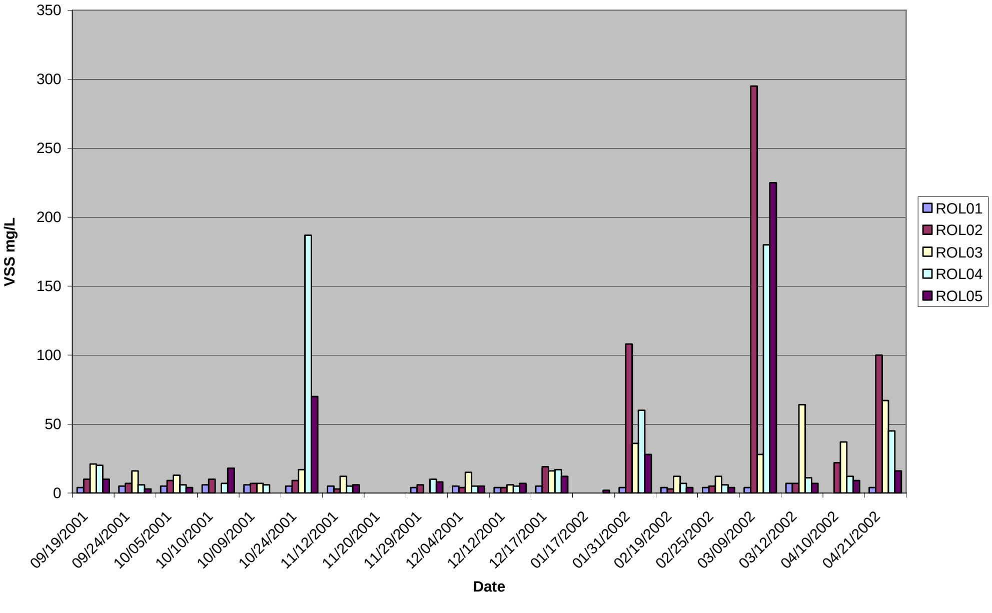
Volatile Suspended Solids

Volatile suspended solids (VSS) is a measurement of the organic material and salts suspended in the water. This is as opposed to the non volatile which remains after heating the TSS to 550^o C. This material would include algae, decaying plant material and all other organic material that is suspended in the water. (Figure 29). Peak VSS levels corresponded to rain indicating that organic materials were washing into the tributaries and/or algae growth increased during such rainfall events.

Figure 29 – Volatile Suspended Solids



Tributary Sites Volatile Suspended Solids (VSS) May 2001- Sept 2001



Tributary Sites Volatile Suspended Solids (VSS) Sept 2001- Apr 2002

Nitrate + Nitrite Nitrogen

Nitrate and nitrite are inorganic forms of nitrogen, which can enter a lake through agricultural runoff, septic tank effluent and other forms of waste (Meyers 1999). The higher concentrations were found in May, June, and December through April (Figure 30, 31). The high concentration in May and June correspond to fertilizer application for such crops as corn and soybeans.

Figure 30 – Nitrate + Nitrite Nitrogen

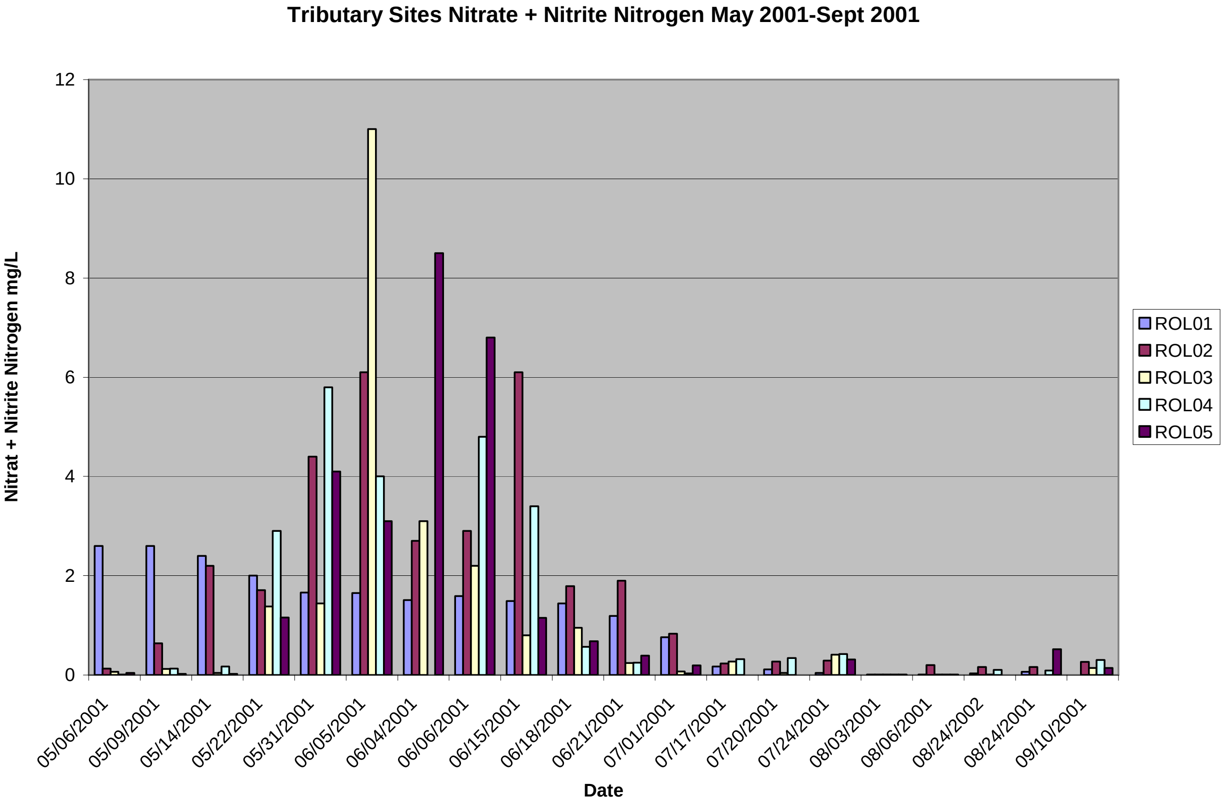
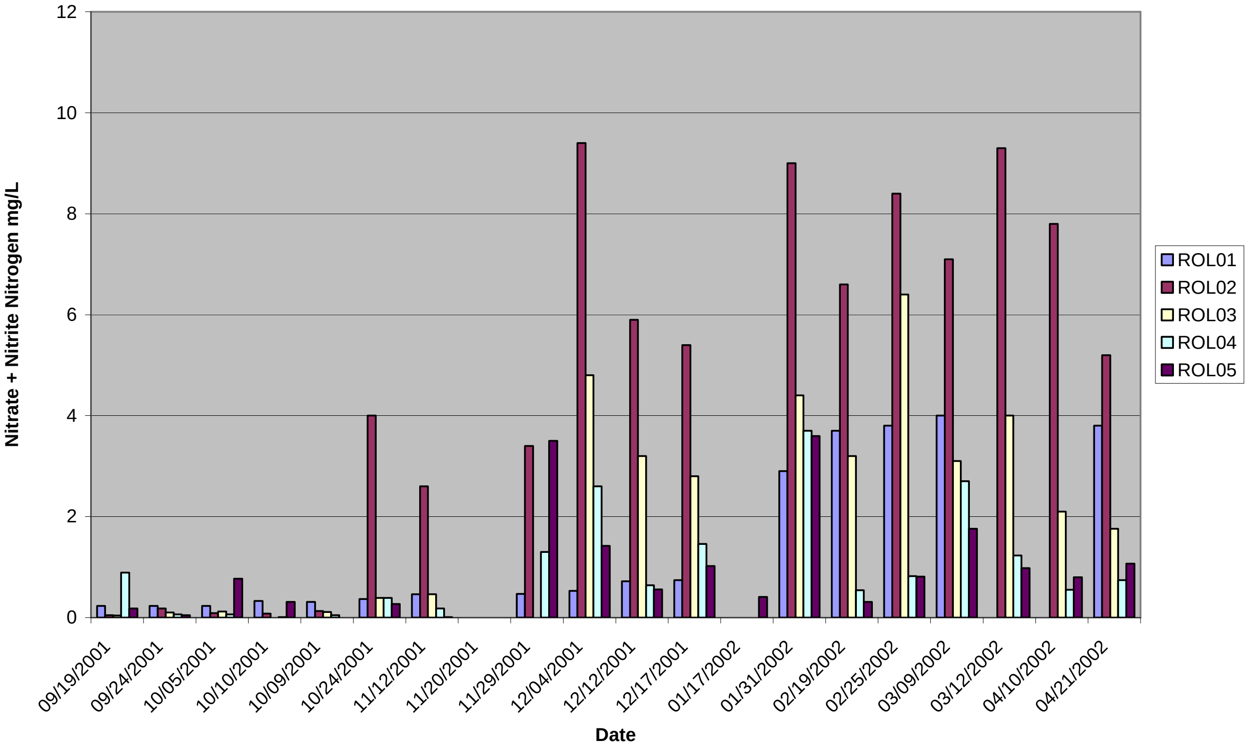


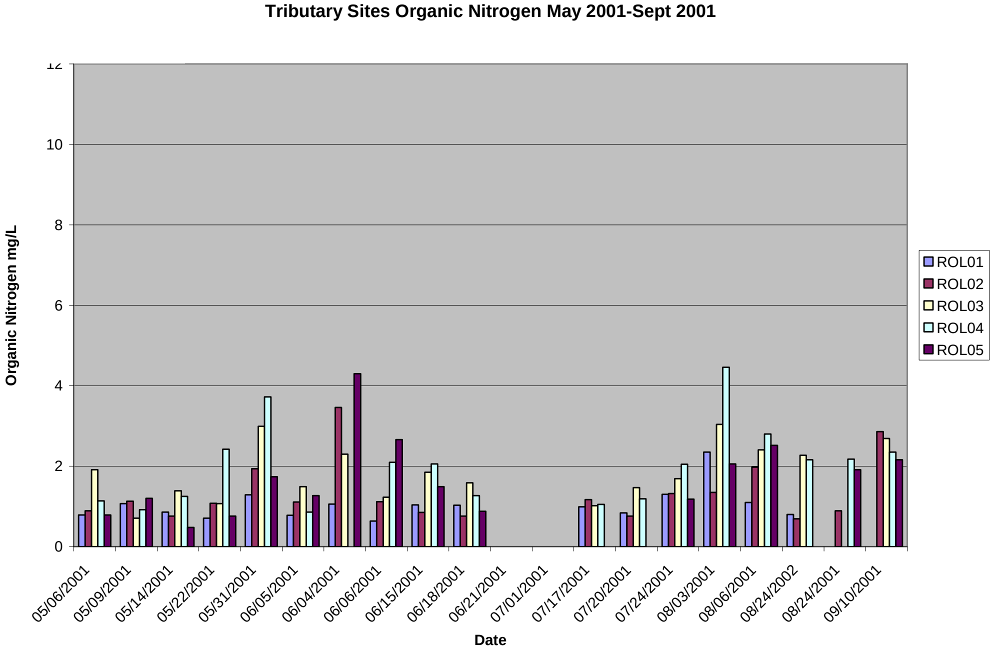
Figure 31 Tributary Sites Nitrate + Nitrite Nitrogen Sept 2001- April 2002

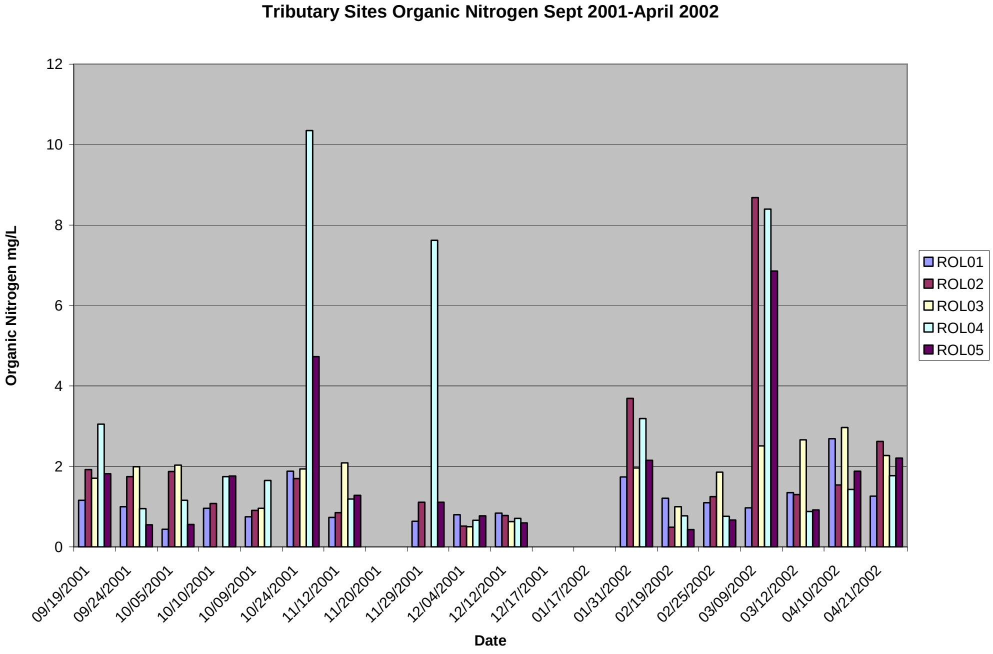


Organic Nitrogen

Kjeldahl nitrogen is ammonia nitrogen plus organic nitrogen. Organic nitrogen is calculated by subtracting ammonia nitrogen from kjeldahl nitrogen. Organic nitrogen can enter tributaries through decaying organic matter, septic systems and agricultural waste (Myers 1997). Organic nitrogen peaked in the tributaries at ROL 04 on 11/24/01 at 10.35 mg/L (Figure 32).

Figure 32 – Organic Nitrogen

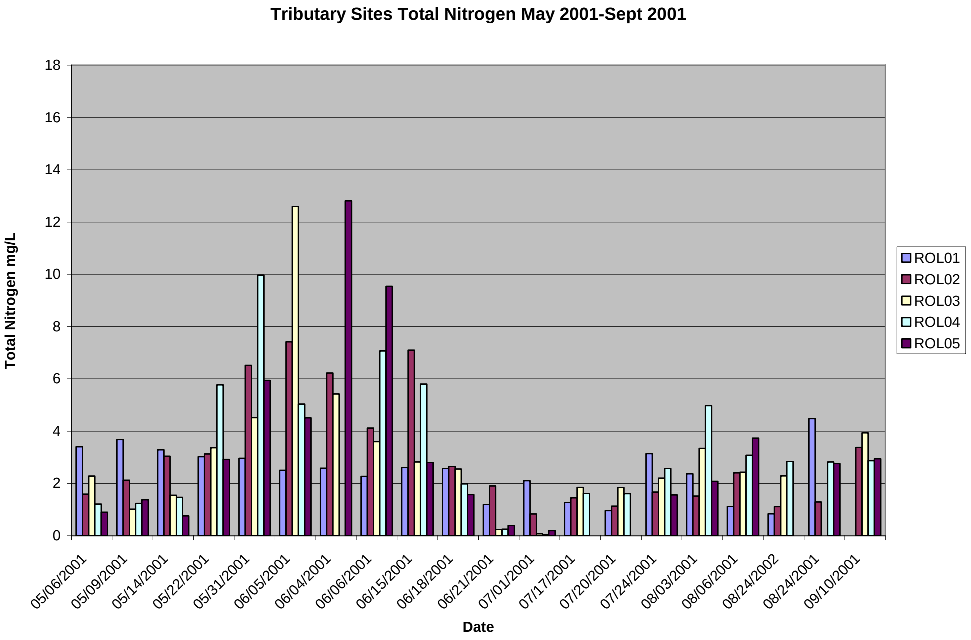


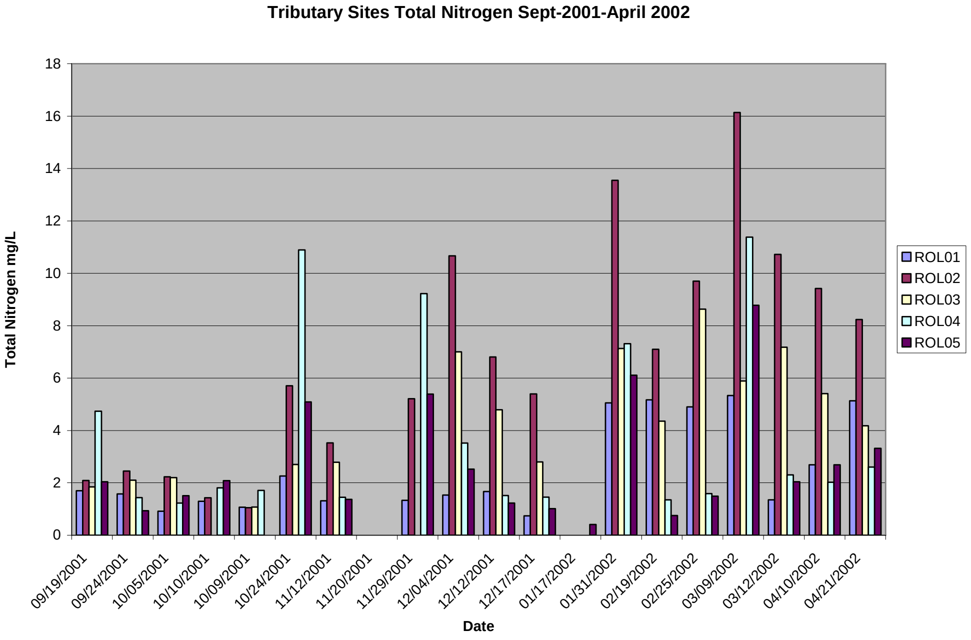


Total Nitrogen

Total nitrogen is the sum of all nitrogen. It is calculated by adding kjeldahl nitrogen and nitrate and nitrite. It was found at consistently higher concentrations at ROL 02 and peaked at this site on 3/09/02 at 16.2 mg/L (Figure 33).

Figure 33 – Total Nitrogen

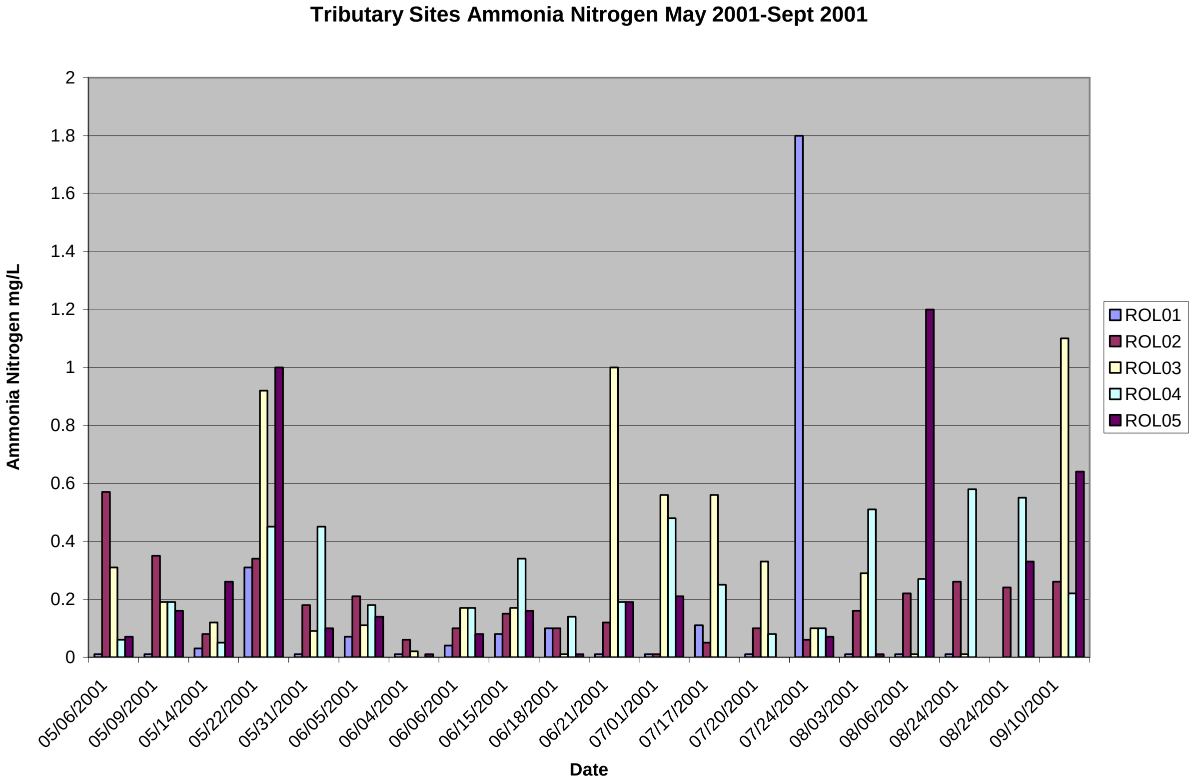


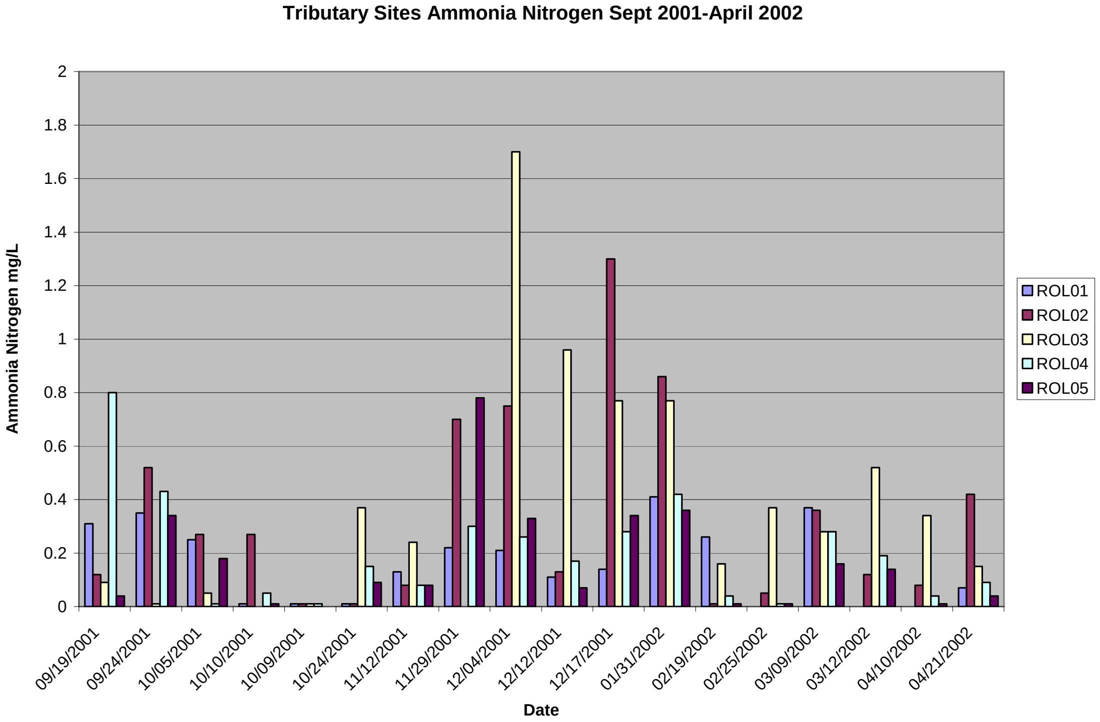


Ammonia Nitrogen

Ammonia nitrogen is the form of nitrogen that is most readily usable for plant growth. High ammonia concentrations can also have adverse affect on fish and other aquatic organisms. The IPCB Part 302 states that total ammonia shall in no case exceed 15 mg/L. No tributary sample exceeded this standard (Figure 34, 35).

Figure 34 – Ammonia Nitrogen

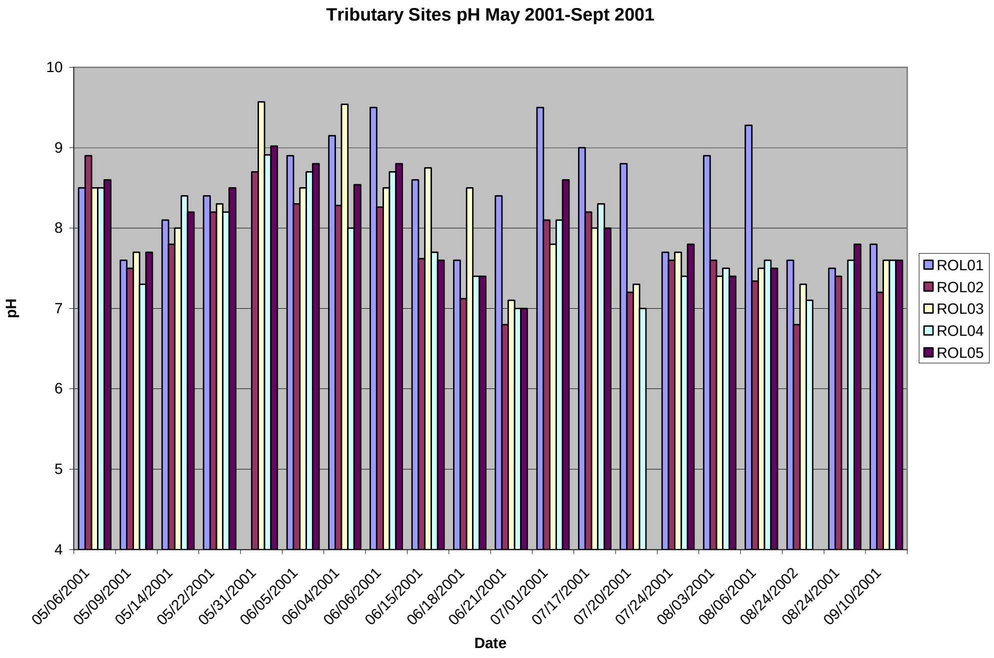




pH

The pH measures the acidity of water. The pH measures the hydrogen ions present in solution on a scale of 0-14. A reading of 7 is neutral. A reading higher than 7 is basic or alkaline. A reading less than 7 is acidic. The Illinois standard states that the pH should be within the range of 6.5 to 9. pH was measured by ZIES staff at the time of other water sample collection using a Hydrolab water sampling probe. On five occasions the pH was greater than 9.0 (Figure 35).

Figure 35 – pH


Tributary Sites pH May 2001-Sept 2001
pH
10
9
8
7
6
5
4
Date
05/06/2001
05/09/2001
05/14/2001
05/22/2001
05/31/2001
06/05/2001
06/04/2001
06/06/2001
06/15/2001
06/18/2001
06/21/2001
07/01/2001
07/17/2001
07/20/2001
07/24/2001
08/03/2001
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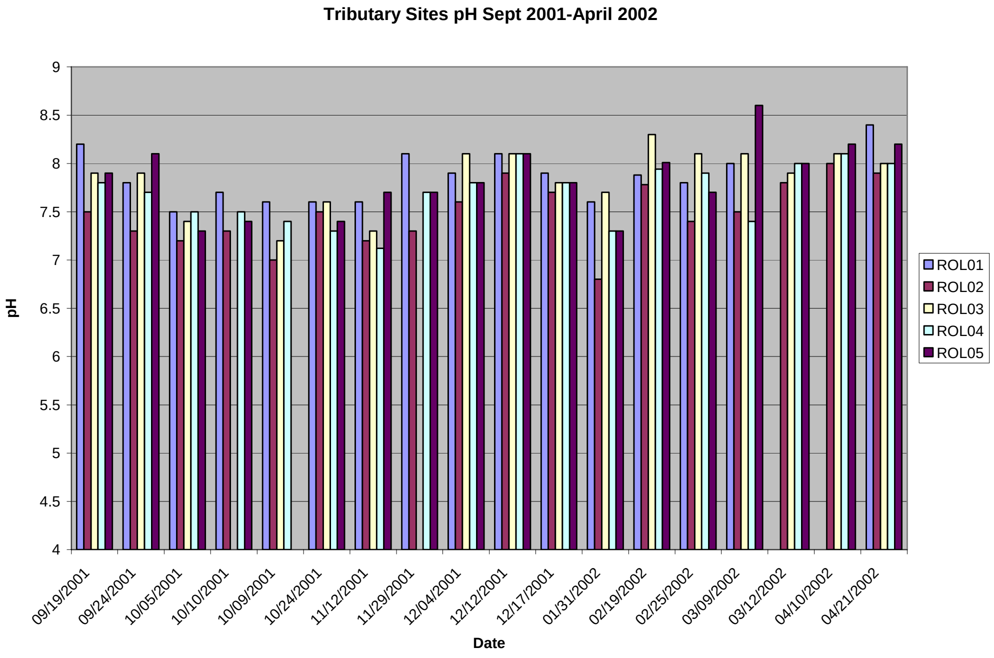
08/24/2002
08/24/2001
09/10/2001
ROL01
ROL02
ROL03
ROL04
ROL05


Tributary Sites pH Sept 2001-April 2002
pH
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
Date
09/19/2001
09/24/2001
10/05/2001
10/10/2001
10/09/2001
10/24/2001
11/12/2001
11/29/2001
12/04/2001
12/12/2001
12/17/2001
01/31/2002
02/19/2002
02/25/2002
03/09/2002
03/12/2002
04/10/2002
04/21/2002
ROL01
ROL02
ROL03
ROL04
ROL05

SEDIMENTATION SURVEY

In 1995 under the direction of Rodger Windhorn the NRCS conducted a sediment survey of Glenn Shoals Lake. The following are excerpts from his report. They used GPS technology and the GIS program GRASS to compute sediment volumes. At the same time, sediment samples from randomly selected locations were collected to be analyzed at Soil Mechanics Lab in Lincoln, NE. These samples helped to make a general characterization of the sediment.

All samples submitted to the Soil Mechanics Lab had the following analyses run on them: Particle-size determination (amount of sand, silt, and clay); Atterberg limits; dispersion characteristics (dispersive clay present); and natural moisture content. All samples were collected using a bucket auger, through up to 20 feet of water. The sediment samples represent the "hard bottom" sediments that could not be penetrated with the depth finder. The "soft sediments" can not be sampled with this type of sampling equipment due to their very high water content.

For Lake Glenn Shoals, the sediment data was not uniform, with some samples indicating almost no sand, and some containing as much as 20% sand. Nearly all of the samples in this lake were a LEAN CLAY (CL), which means they do not contain as much highly plastic and pliable clay. The clay content generally runs from 17% to 30% except on a few samples. The increased amount of sand present is probably due to at least two factors: one, the transport of larger and heavier particles is greater, and second, the larger lake has more bank and shoreline erosion, which in many cases, is cutting into the glacial till surrounding the lake. Glacial till contains significantly more sand than the loess material. Also, there are at least two tributaries flowing into the lake that appear to be carrying more sand. These samples contain between 14% and 17% sand. In general, the sediment in Glenn Shoals is somewhat coarser than most lakes in this area it also contains less clay, and probably also reflects the result of more wave and wind action on the shoreline.

Sediment Sampling

To develop a better understanding of the types of materials in the sediment, grab samples were collected and analysis at IEPA laboratories. This data reveals the types of materials (pesticides and heavy metals) that have been trapped in the sediment (Tables 18,19). The information will give baseline data to make informed decisions about restoration techniques, including dredging of the lake bottom. High concentrations of pesticides and heavy metals in the sediment could limit or totally eliminate the dredging options.

The 1995 report estimates 39,593 tons of sediment is entering the lake every year. According to these estimates forty-five percent of the lake volume has been lost to sediments since the construction. This was later revised to fifteen to forty-five percent (Windhorn 1996).

Table 18 Glenn Shoals Sediment Survey

Slope	Acres	Tons/Acre/Year	Gross Sheet and Rill Erosion	Del Rate	Sediment Delivered Tons/Year
0-2%	45,420	2.1	95,382	.05	4,769
2-5%	4,845	7.3	35,369	.10	3,537
5-10%	2,624	10.8	28,339	.15	4,251
10-30%	3,300	2.9	9,570	.15	1,436
				Total Sheet and Rill	13,993
				Total Ephemeral and Gully	8,600
				Total Shoreline	17,000
				Total	39,593

Source: NRCS 1995 Sediment Survey

Sediment

The causes of sedimentation are of two types. First is the actual input, primarily of inorganic materials (soil particles) brought in by water and rarely, by wind. The second is nutrients released into the lake by fertilizers added to crops and by nitrogen fixing organisms in the tributaries and in the lake. The nitrogen fixing as well as phosphorous release and uptake is tied closely to the rate of growth (photosynthesis). The potential photosynthetic rate in the lake is measured by the amount of chlorophyll a. The two nutrients are of primary importance to the development and health of the lake. Both N and P need to be studied. Since they are cyclic it is important to follow their movements through the lake.

Let us look at N first. The air is the major reservoir and consists of 80% nitrogen gas. This form of N is not usable by most plants. Only Blue green algae (bacteria) can convert N_2 to a usable form. There are enough of these organisms in most wetlands or aquatic systems to supply the needs for all plants (both micro – and mactrophytes). Since it is often difficult if not impossible to control N we need to try to restrain the available P.

The reservoir for P is in the soil. P also comes in available (soluble) and unavailable (non-soluble or attached to soil particles such as clay) forms. We can hope to a) reduce the P coming into the lake and b) reduce the amount that is in an available form in the lake. Most incoming P is brought in by the tributaries through flooding. This brings in clay particles with attached P as well as dissolved phosphorous. When this dissolved P is taken in by plants and the plants die and become part of the sediment on the bottom of a lake it is no longer available to plants. This will stay in the unavailable form until lake stratification occurs (no mixing of upper and lower layers). In Glenn Shoals this occurs in the summer when the deeper cold water does not mix with the upper warm water because the cold water is denser than warm water. In time, the oxygen on the bottom of the lake is used up and nutrients are released.

Table 19 Glenn Shoals Organic Sediments

	ROL-1 µg/kg	ROL-2	ROL-3
Total PCBS	10K	10K	10K
Hexachlorobenzene	1.0K	1.0K	1.0K
Trifluralin	10K	10K	10K
Alpha-BHC	1.0K	1.0K	1.0K
Gamma-BHC (Lindane)	1.0K	1.0K	1.0K
Atrazine	50K	50K	50K
Heptachlor	1.0K	1.0K	1.0K
Aldrin	1.0K	34	1.0K
Alachlor	10K	10K	10K
Metribuzin	10K	10K	10K
Metolachlor	25K	25K	25K
Heptachlor Epoxide	1.0K	1.0K	1.0K
Pendimethalin	10K	10K	10K
Gamma-Chlordane	2.0K	2.0K	2.0K
Alpha-Chlordane	2.0K	2.0K	2.0K
Total Alpha and Gammas Chlordane	5.0K	5.0K	5.0K
Dieldrin	1.0K	1.3	1.0K
Captan	10K	10K	10K
Cyanazine	25K	25K	25K
Endrin	1.0K	1.0K	1.0K
P P'-DDE	1.0K	1.0K	1.0K
P P'-DDD	1.0K	1.0K	1.0K
P P'-DDT	1.0K	1.0K	1.0K
Total DDT	10K	10K	10K
Methoxychlor	5.0K	5.0K	5.0K

INSERT TABLE 20 – GLEN SHOALS SEDIEMT METALS

During fall turnover phosphorus, along with nitrogen, is released back into the epilimnion of the lake where it can be used by algae and other plants. This process is referred to as internal loading. The stratification necessary to promote this process occurs in the south end of the lake. The surface area of the lake bottom that would experience anaerobic conditions was determined from the bathymetric map to be 218,700 m^2. Assuming a phosphorus release rate of 15mg/m^2/day (Nurnberg 1984) and a nitrogen release rate of 120 mg/m^2/day (Filles 1975), approximately 394 kg of phosphorus and 3149 kg of nitrogen were released from the sediments (Table 14). This nutrient release would generally occur during the three months when oxygen was depleted at the bottom of the lake (Figure 19, 20).

SHORELINE EROSION

Shoreline erosion is important to consider when looking at the overall health of a lake. Erosion can affect a lake in many ways including sedimentation, loss of shoreline vegetation, interference with light, release of nutrients, stress on fish, oxygen depletion and loss of underwater habitat (Fuller 1997). Sedimentation due to erosion can have a significant impact on the volume of the lake over time. Although shoreline erosion is not the only source, it can contribute significantly to this problem. Erosion can affect shoreline vegetation and habitats by destroying plants and trees near the shoreline. Suspended sediments will interfere with light, interfering with the food chain. Nutrients eroded into the lake can increase algae growth and lead to oxygen depletion. Fish, such as bass, relay on sight to feed. Increased turbidity can affect their feeding. Erosion degrades both plant and fish habitats.

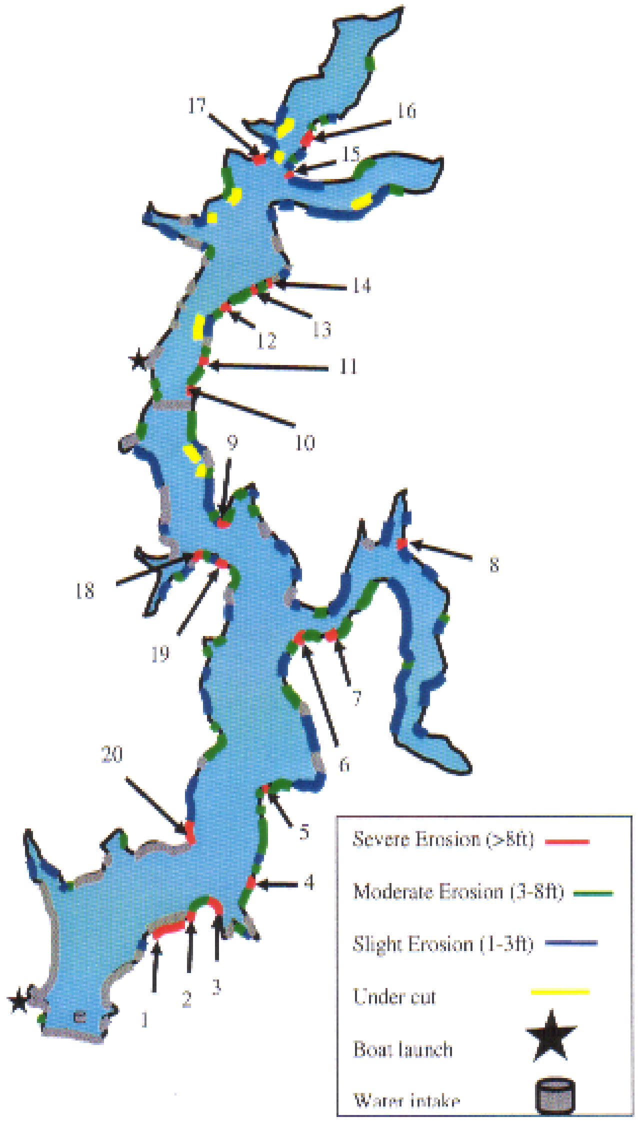
There are several causes for shoreline erosion – both controllable and uncontrollable. Some of the primary causes of shoreline erosion are wave action and ice sheets activity, the waves are the primary problem and the size and energy of the waves determine the amount of erosion. Waves are caused by wind (Fuller 1997) and by the activity of power boats. The size and power of the wave is a function of water displaced by the boat and the power produced by the motor. This in turn determines the damage to the shoreline. The shoreline erosion can be reduced by protecting the surface. Vegetation and Rip Rap are very beneficial in protecting the shore.

To obtain a better understanding of the shoreline erosion situation on Glenn Shoals Lake, ZIES staff did an intensive survey of the shoreline around Glen Shoals Lake (Figure 36, 37). A map was generated to show shoreline erosion. The shoreline was labeled in the following manor: rip-rap, undercut, slight bank erosion 1-3 ft, moderate bank erosion 3-8 ft and severe bank erosion 8 or more feet.

The survey indicates that there are 15,612 linear feet of rip-rap, 2,952 linear feet of severe erosion, 11,017 feet of moderate erosion and 17,878 feet of slight erosion (Figure 36, 37). The problem of sedimentation caused by bank erosion is being gradually improved but it needs to be attacked on a broader front. The problem of moderate and severe erosion (14,000 feet) should be corrected as soon as possible.

Figure 36 – Shoreline Erosion
Top – Riprap
Bottom – Without riprap

Figure 37 – Glenn Shoals Shoreline Erosion Survey



Length X Height
1. 540'X 40'
2. 204'X 30'
3. 260'X 35'
4. 62'X 28'
5. 115'X 18'
6. 190'X 30'
7. 180'X 24'
8. 40'X 31'
9. 112'X 23'
10. 40'X 24'
11. 100'X 25'
12. 75'X 15'
13. 105'X 31'
14. 110'X 27'
15. 120'X 26'
16. 220'X 31'
17. 147'X 22'
18. 79'X 33'
19. 117'X 21'
20. 250'X 25'

A.10.c Trophic Condition of the Lake

By all measurements (chlorophyll a, Secchi depth, nutrients) of the Carlson's Trophic State Index (TSI) Glenn Shoals Lake is hypereutrophic. The Carlson's Trophic State Index allows one to compare lakes and to estimate the trophic status of a lake from either the Secchi depth, chlorophyll a or total phosphorous. The average secchi reading of .546m (21.3 inches), chlorophyll a at a reading of 40 μg/L and the average total phosphorus of 200 μg/L all places it in the hypereutrophic range. This does not agree with the IEPA assessment by Phyllis Borland-Lau that states that the lake is eutrophic.

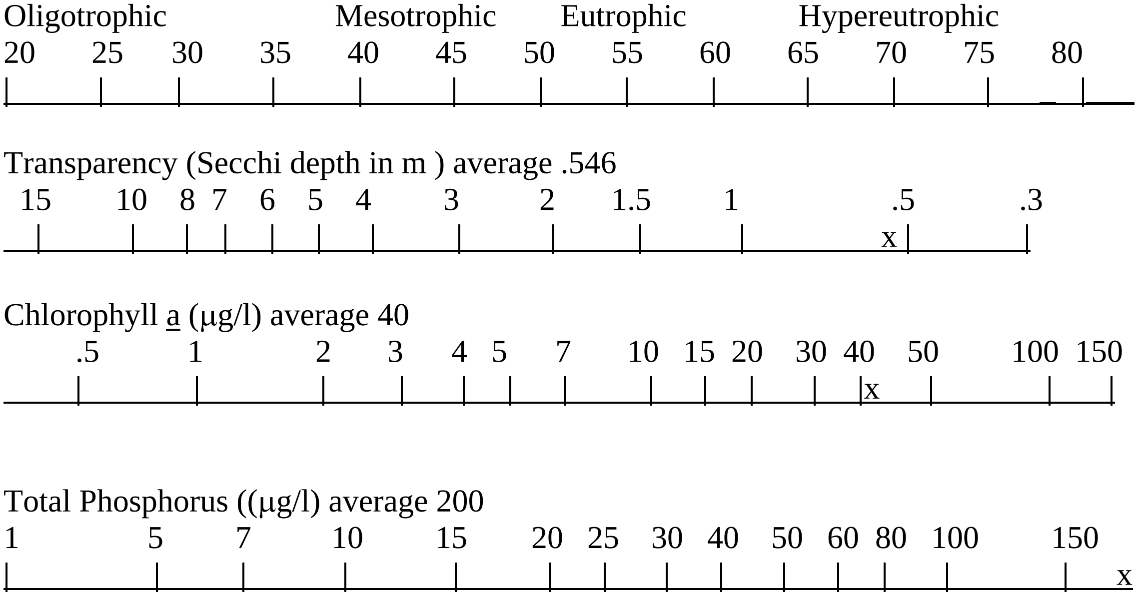
This data, placing the lake in a hypereutrophic state, would suggest that the lake and/or watershed is in immediate need of major modification to address this problem.. Phosphorus or Nitrogen is normally the limiting factor in most lakes. Glenn Shoals has Phosphorus as it's limiting factor. Howerver, all three of these are interrelated. That is, the more nutrients the more chlorophyll a is produced and the less transparency the lake has.

Lakes in this area that have watersheds which are mostly covered by row crop agriculture tend to be slightly eutrophic to hypereutrophic. As can be seen from the levels indicated in Figure 38 on each index, all three place Glenn Shoals Lake in the hypereutrophic (upper) level.

The mark to strive for in Glenn Shoals is probably in the TSI of 50. This is an area between the mesotrophic (preferred) and the eutrophic (slightly over fertile). As can be seen the phosphorus needs to be reduced by approximately 70%. If this is done the two other indices should follow since nutrients (in this case P, the limiting factor) are the controlling factors for each of these indices. If the barley bales are able to reduce algae growth then P may not need to be reduced by quite that much.

The following graphic (Figure 38)gives one a pictoral view of the relationships of these indices. The phosphorus scale is a direct measurement in μg/l. The chlorophyll a scale is also in μg/l. However, the Secchi (transparency) readings are in meters. Note, the uneven scaling of the three parameters to provide a common equal scaling of the trophic state index. For each trophic scale increase the phosphorus doubles and the algae biomass (as represented by chlorophyll a) increases about 2.8 fold. The trophic scale ranges from 0 to 100 , however the important section (where most lakes seem to fall) is between 20 and 80 so the following only includes this area.

Figure 38 **Trophic State Index**



A.10.d Limiting Algae Nutrients

Estimated Nutrient Loading from Birds

Birds can contribute significant amounts of nutrients to the lake when found in large numbers. A bird survey was conducted on Glenn Shoals Lake to estimate the number and types of birds using the lake (Table 25). Bird counts on Glenn Shoals were not found in large enough numbers to significantly contribute to the lakes nutrient loading.

Estimated Nutrient Loading from Lake Sediment

The lake itself can be a major contributor of nutrient loading. Nutrients bound in the sediments on the bottom on of the lake, as well as nutrients in dying plant material; contribute to the nutrient loading of the lake. When the dissolved oxygen level near the bottom of the lake is depleted, phosphorus trapped in the sediments is released. During fall turnover phosphorus, along with nitrogen is released back into the epilimnion of the lake where is can be used by algae and other plants. This process is referred to as internal loading. The stratification necessary to promote this process occurs in the south end of the lake. The surface area of the lake bottom that would experience anaerobic conditions was determined from the bathymetric map to be 218,700 m^2. Assuming a phosphorus release rate of 15mg/m^2/day (Nurnberg 1984) and a nitrogen release rate of 120 mg/m^2/day (Filles1975), approximately 394 kg of phosphorus and 3149 kg of nitrogen were released from the sediments (Table 14). This nutrient release would generally occur during the three months when oxygen was depleted near the bottom of the lake.

Estimated Sediment from Shoreline Erosion

Using information from the shoreline erosion study (Figure 37), calculations were made to estimate the amount of sediment delivered to the lake from shoreline erosion. Using conservative estimates of 40lbs of soil per linear foot entering the lake from areas with severe erosion, 30lbs per linear foot for areas with moderate erosion, and 20lbs per linear foot for areas that are undercut, approximately 364,820 kg per year of soil enters the lake from shoreline erosion (Hill 1994). This amounts to 1% of the total sediment entering the Lake (Table 14).

Nutrients and sediment can enter the tributaries from a variety of different sources: sheet erosion, fertilizers, livestock waste, septic systems, atmospheric sources, stream bank erosion, wildlife, etc. Nutrients from atmospheric sources, lake sediments, and wildlife (Table 14) are described below.

Estimated Sediment and Nutrient Loading from the Tributaries

Nutrients and sediments coming form the tributaries were measured during rain events and concentration relationships were developed between acre-feet of water and measured concentrations of nutrients and sediments. Using daily water volumes calculated from staff gage flow relationship, the nutrients and sediments in kilograms were calculated for each tributary using best fit equation (Figures 13, 14, 15). The highest concentration of nutrients (41% P, 64% N) entered the lake form Shoal Creek, which is to be expected since it represents the largest sub watershed.

Nutrients in the atmosphere should be considered non-point sources of pollution. These nutrients can enter the lake indirectly by washing in from the watershed or by being directly deposited on the water surface. Of the principle nutrients, phosphorus and nitrogen, nitrogen is found in high concentrations in the atmosphere. Most of this is in a form that is unavailable to most organisms. Available nitrogen is deposited into the atmosphere primarily from burning fossil fuels (mostly NO_2 – Nitrites). Automobiles and power plants are the two main sources of available nitrogen. In the area around Glen Shoals Lake, deposits of nitrogen can be expected in the range of 1.3 – 1.8 tons per square mile or an average of 1.55 tons per square mile (Pucket 1994).
Phosphorus is found in much lower concentrations than nitrogen. Phosphorus concentrations in the rural area surrounding Glenn Shoals Lake would be found at .03 milligrams of phosphorus per liter of rainwater (Litke 1999). Using these estimates, 3,300 Kg of nitrogen and 304 Kg of phosphorus are deposited directly onto the lake surface every year (Table 14).

A.10.e Hydraulic budget

An annual water budget was calculated for Glenn Shoals Lake. This is a best estimate of the amount of water coming into and leaving the lake. To determine the amount of water entering the lake, stream staff gauges were placed in the major tributaries as close to the lake as possible. City staff members recorded the stream height on the staff gauge on a daily basis. Cross-sections of the streams were measured at each of the gauge sites. A relationship was established for the area of the cross-section in relationship to staff gauge height. Next, flow measurements in feet-per-second were measured using a Global Water flow measuring instrument. Next, flow and area measurements were combined to establish a relationship between staff height and cubic feet-per-second of water passing the cross-section. Calculations were then used to determine the acre-feet per day of water entering the lake for each measured tributary.

At Little Creek entering Irving Cove two staff gauge stations were established for ease of access. One was established for Little Creek north (Rolo4) and one for Little Creek south (Rolo5). Flow relationship data at the southern station ROL05 was not accurate. A consistent flow curve was not established in part due to construction of a new bridge during the project. Land use for the northern station ROL04 Irving North sub-watershed was almost identical, so flow data was used from this station to estimate water volumes for ROL05. Also, data from Structure 14 (Rolo3) was not accurate so the data from Rolo2 was used to estimate the flow for Rolo3. In addition to water flowing in from the watershed, rain which fell directly onto the lake surface was calculated from daily rain amounts recorded at the park office just south of the lake.

An additional staff gauge was placed near the outflow of the lake. It was used to determine the height of water flowing out of the lake. This information was used to calculate the amount of water flowing out of the lake over the spillway. The calculations were made using weir equations: $Q=CLH^{(3/2)}$, where Q is the water discharged in cubic feet-per-second, C is the coefficient based on H, L is the length of the outlet (Haan 1994). It is possible that in a large rain event at the weir an orifice equation would be needed. During the study period the lake level never was high enough that the orifice would control the flow so the weir equation was used. Evaporation was calculated using 50 years of historical evaporation rates in Illinois (Roberts 1967). Water withdrawn by the water treatment plant was also considered as part of the out-flow. From discussions with city personal two thirds of the City’s water was estimated to come from Glenn Shoals Lake. All of the in-flow and out-flow data is presented in Table 21.

Table 21 Hydrologic Budget for Glenn Shoals Lake 2000-2001

	In Flow			Out Flow			
	Acre feet added			Acre Feet Withdrawn			
Month	Tributaries	Rainfall	Total In	Drinking water	Flow over spillway	Evaporation	Total Out
May	21484	930	22414	70	1634	529	2233
Jun	40871	582	41453	71	12952	608	13631
July	6960	551	7511	84	204	698	986
Aug	12941	500	13414	83	108	585	776
Sep	4232	422	4654	73	999	410	1482
Oct	11482	740	12222	71	5680	262	6013
Nov	5777	150	5927	67	2187	135	2389
Dec	35067	1125	36192	67	13058	65	13190
Jan	10168	360	10528	66	3200	68	3334
Feb	21238	405	21643	60	12231	101	12392
Mar	37099	1046	38145	67	15897	214	16178
Apr	29752	1403	31155	66	20053	360	20479
Total	237071	8214	245285	845	88203	4035	93083

A.10.f Phosphorus budget

Phosphorus

Phosphorus is a component founding in both agricultural and residential fertilizer. It can also leach from septic systems and feed lots. Large amounts of phosphorus runoff can lead to poor water quality in the lake. High phosphorus levels can lead to algae blooms and poor water quality. The IPCB part 302 states phosphorus as P shall not exceed 0.05 mg/L in any reservoir or lake with a surface area of 8.1 Hectares or more, or in any stream at the point where it enters any such reservoir or lake. Each tributary site on one or more dates exceeded this standard (Figure 39, 40).

Figure 39 – Phosphorus A.

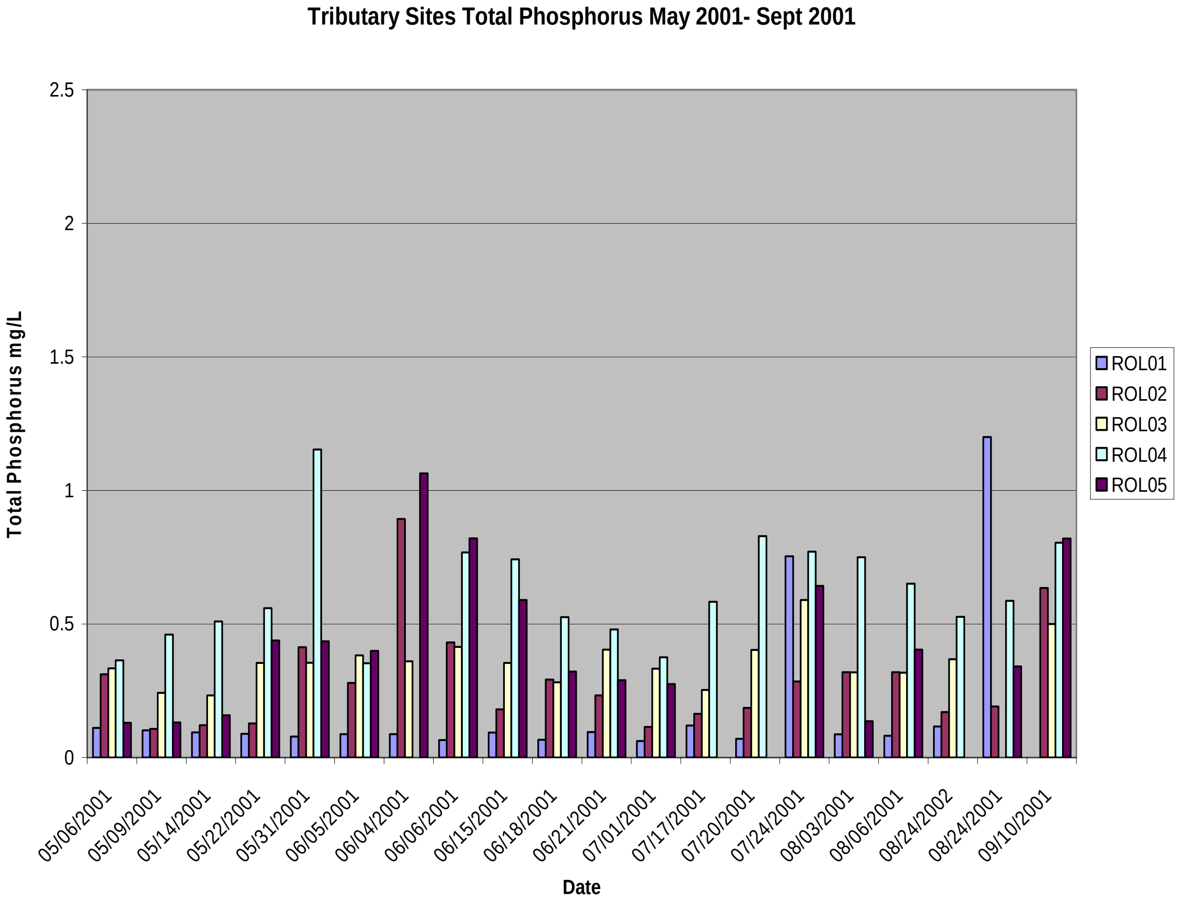


Figure 39

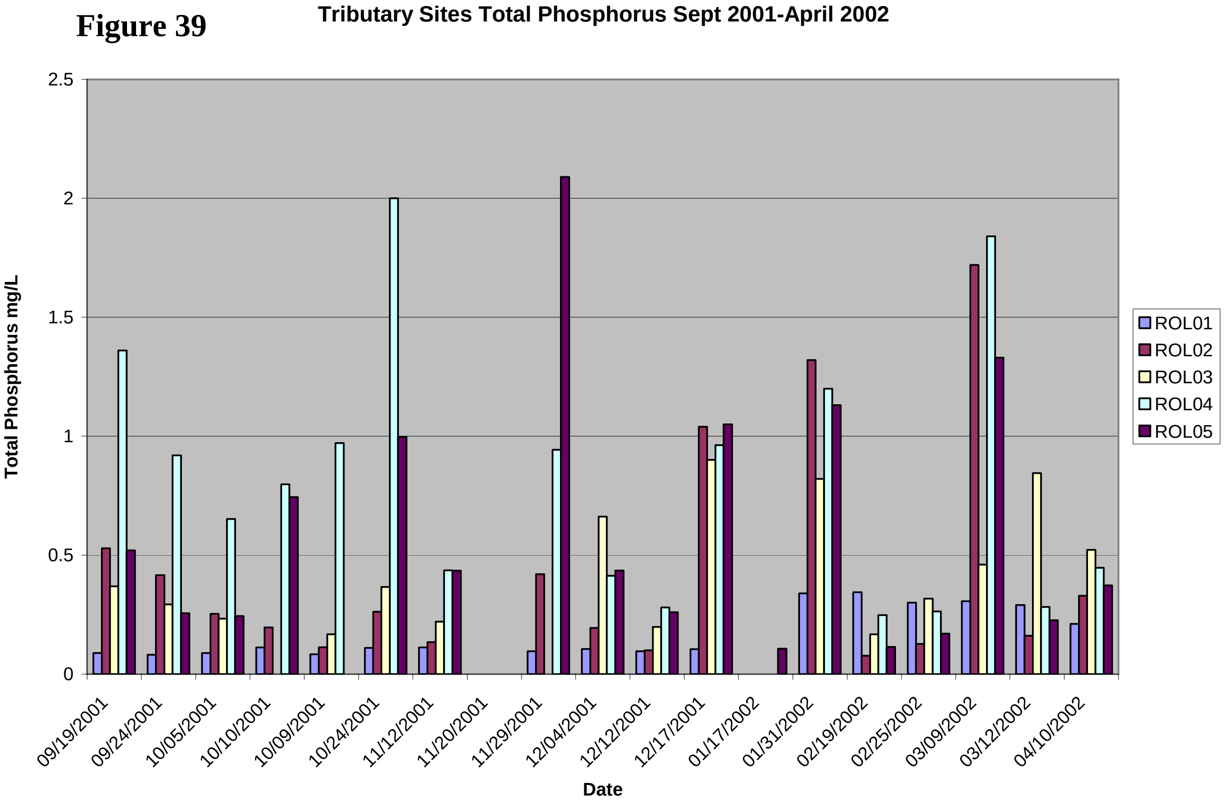

Tributary Sites Total Phosphorus Sept 2001-April 2002
Total Phosphorus mg/L
2.5
2
1.5
1
0.5
0
09/19/2001
09/24/2001
10/05/2001
10/10/2001
10/09/2001
10/24/2001
11/12/2001
11/20/2001
11/29/2001
12/04/2001
12/12/2001
12/17/2001
01/17/2002
01/31/2002
02/19/2002
02/25/2002
03/09/2002
03/12/2002
04/10/2002
Date
ROL01
ROL02
ROL03
ROL04
ROL05

Table 22 Dissolved Phosphorus ROLO (Tributaries)

Depth ft	Soluble P	Total P	% Soluble
ROL02	**mg/l**	**mg/l**	
1ft	0.107	0.158	67.7
1ft	0.142	0.186	76.3
1ft	0.101	0.17	59.4
1ft	0.812	0.936	86.8
ROL03			
1ft	0.119	0.242	49.2
1ft	0.165	0.403	40.9
1ft	0.101	0.368	27.4
1ft	0.49	0.64	76.6
ROL04			
1ft	0.301	0.46	65.4
1ft	0.623	0.829	75.2
1ft	0.227	0.527	43.1
1ft	0.891	0.946	94.2
ROL05			
1ft	0.112	0.131	85.5
	Sum	**Sum**	**Sum**
	.191	.996	47.7
		69.9%	**% of Totals**

A.11. Biological Resources and Ecological Relationships

BIOLOGICAL MONITORING

In addition to the physical and chemical measurements taken several biological parameters were studied as a part of the project. These studies included a phytoplankton survey, chlorophyll a analysis, macrophyte survey, fish survey, bacteriological analysis and wildlife summary.

Endangered Birds in Illinois

In August an osprey (*Pandion haliaetus*) was spotted. The osprey is listed as an endangered species in Illinois. The osprey was seen from the northern boat launch flying over the east bank of the lake.

A.11.a Composition of lake fish fauna

Fisheries are a major concern for Glen Shoals Lake. Fishing is one of the main recreational activities that take place on the lake. Glen Shoals Lake is known for its good fishing. Sport fishers come from a large area for the bass, bluegill, crappie, and catfish. Maintaining quality-fishing stocks is an important component for overall lake management. The Illinois Department of Natural Resources has done a very good job managing the fisheries for Glen Shoals Lake, in part through the efforts of Charlie Marbut, IDNR Fisheries Manager. Water quality can have a direct impact on the fish population in the lake.

As part of the Clean Lakes requirement Charlie Marbut of the IDNR conducted a fish flesh analysis. Fish were sampled using electro fishing and gill nets. All samples were within the regulatory limits for the specific compounds analyzed (Table 24). The IDNR in cooperation with the City sets fishing regulations (number and size limits) in addition to developing a lake management plan which involves conducting regular fish surveys.

The following is the Lake Management Status Report submitted by Charlie Marbut on April 10, 2002 (Tables 23, 24).

Table 23

LAKE MANAGEMENT STATUS REPORT

Date of Report:	Fisheries Manager:	District No:
04-10-02	Charley Marbut	15

Lake Name:	County:	Water No:
Glenn Shoals	Montgomery	180

Ownership (S, PUC, PUO)	ACREAGE:
PUC	1200

LM STATUS REPORTS WILL INCLUDE THE FOLLOWING SECTIONS:

1. Listing of the Sport Fish Regulations in Effect
2. Listing of Management Activities Completed with Evaluation of Success
3. Lake Management Plan Progress Table
4. Recommendation for Observed Problem Trends

---

1. Largemouth Bass - 15 inch minimum length limit, 3 fish/day.
   Striped Bass Hybrid - 17 inch minimum length limit, 3 fish/day.

2. Stocked 12,000 (2”) striped bass hybrids - 05-25-01 - successful.
   Stocked 3,800 (4-6") largemouth bass from brood pond - 09-13-01
   Stocked 24,000 (4") largemouth bass from hatchery - 8-14-01
   Fall population survey; 3 hours - 09/13/01 - successful.

Table 23 A.

BLG	LMP GOALS	1999	2000	2001
YAR	1 - 5	-	-	-
PSD	20 - 40	5	3	8
RSD-7	10 - 15	0	0	0
Wr	90 - 110	99	106	97
CPUE (#/HR)		105	200	97

Bluegill: The bluegill population appears to have declined since the 1992 survey. In 1992, 10% of the bluegill collected were less than 4.0 inches as compared to 31% in 1997, 27% in 1998, 28% in 1999, 23% in 2000, and 19% in 2001. 70% were 4.0 - 5.9 inches in 1992 compared to 65% in 1997, 72% in 1998, 66% in 1999, 72% in 2000, and 73% in 2001. 20% were 6.0 inches or larger in 1992 compared to 4% in 1995, 1% in 1998, 6% in 1999, 3% in 2000, and 8% in 2001. Wr values (flesh condition) was good at 97. Good numbers of 4.0 - 5.9 inch fish were present and hopefully will grow and provide quality fishing in one or two years. The number of fish larger than 6 inches did increase by 5% in 2001, however no bluegill were collected larger than 7.0 inches. This bluegill population is typical of a large semi turbid reservoir with a fluctuating water level.

Table 23 B.

WHC	LMP GOALS	1999	2000	2001
PSD	40 – 60	46	25	63
RSD-<9.0	50	63	79	63
9.0 - 10.9	40	31	16	25
> 11.0	10	6	5	12
Wr	90 – 110	96	94	102
CPUE(#/hr)		53	31	27

The crappie population remains good. The peak of the population is 6.5 to 8.5 inches (55%), 62% were 7.0 to 9.0 inches and 37% were larger than 9.0 inches. 12% of the fish collected were larger than 11.0 inches. Flesh condition (Wr) was good at 102. The crappie population continues to develop. 37% of the population would be harvestable if there were a 9 inch minimum length limit.

Table 23 C.

CCF	LMP GOALS	1999	2000	2001
PSD	40 - 60	21	20	33
RSD-15	15 - 20	30	28	37
Wr	90 - 110	95	101	95
CPUE(#/hr)		21	23	11

Channel Catfish: The channel cat population remains stable. Reproduction and recruitment is good. Successful spawning has occurred each year since 1995. Length frequency distribution continues to improve. 34 (11 per hour) fish were collected and 41% were between 5 and 12 inches. 27% were between 12 and 15 inches, 27% were 15 to 20 inches, and 6% were 20 inches or larger. The fish were in good flesh condition.

Table 23 D.

LMB	LMP GOALS	1999	2000	2001
YAR	1-5	-	-	-
PSD	40 - 70	72	82	67
RSD-18	5	11	9	9
8.0 – 11.9	30	29	22	34
12 - 14.9	32	21	36	24
> 15.0	38	49	42	42
CPUE(#/ hr)	68	66	64	47
< 8.0	18	13	25	7
8 - 11.9	20	17	9	14
12 - 14.9	18	10	14	9
> 15.0	12	26	16	17
Wr	90 - 110	107	107	107

Largemouth Bass: The bass population continues to remain stable. CPUE is below the desired number, indicating a low density. Reproduction remains low. 14% of the bass collected were 7.9 inches or smaller, 30% were between 8 and 11.9 inches, 20% were 12 to 14.9 inches, and 36% were larger than 15.0 inches. Of these, 8% were 18 inches or larger. The length frequency distribution is good and will provide good angling in 2002. The fish are in good flesh condition with an average Wr of 107.

Striped Bass Hybrid: One hybrid striped bass was collected at 5.5 inches in length. None of the larger fish were collected.

Tiger Muskie: No tiger muskie were collected.

Flathead Catfish: 1 fish was collected at 39.5 inches in length.

Table 23 E.

GZS	LMP GOALS	1999	2000	2001
PSD	30 - 60	0	2	8
CPUE(#/hr)	150	384	640	412
<4(#/hr\%)	45 \ 30	95 \ 25	363 \ 57	279 \ 68
4.0 - 5.9	60 \ 40	222 \ 58	224 \ 35	93 \ 23
6.0 - 7.9	30 \ 20	18 \ 5	18 \ 3	22 \ 5
> 8.0	15 \ 10	49 \ 12	35 \ 5	17 \ 4
Wr	90 - 110	101	102	98

Gizzard Shad: The gizzard shad population exceeds LMP goals and appears to have a good length frequency distribution. 68% of the fish were smaller than 4.0 inches and are of the size to provide excellent forage for the small and mid-sized predators. 28% of the population was between 4 and 7 inches and of a suitable size for the larger predators.

Carp: 83 fish were collected (28 fish/hr) ranging in length from 7 to 22 inches. The peak of the population ranges from 9 to 14.5 inches in length.
11% of the carp collected were larger than 3 pounds.

4. Recommendations

Conduct a fall population survey in 2002.
Continue stocking largemouth bass from the brood pond.

Table 24 Fish Tissue Samples from Glenn Shoals Lake

Collected by: DNR	C. MARBUT	ELECTRO FISHING & GILL NETS	
Date: 9/12/2001			

SPECIES	**LARGEMOUTH BASS SMALL**	**LARGEMOUTH BASS LARGTE**	**CARP LARGE**	**CHANNEL CATFISH LARGE**
# of Fish	5	5	5	5
ALDRIN	.01K	.01K	.01K	.01K
TOTAL CHLORDANE	.02K	.03K	0.02K	.O4K
TOTAL DDT AND ANALOGS	.01K	.01K	.01K	.01K
DIELDRIN	.01K	.01K	.01K	.01K
TOTAL PCBS	0.1K	0.1K	0.1K	0.1K
HEPTACHLOR	.01K	.01K	.01K	.01K
HEPTACHLOR EPOXIDE	.01K	.01K	.01K	.01K
TOXAPHENE	1.0K	1.0K	1.0K	1.0K
METHOXYCHLOR	.05K	.05K	.05K	.05K
HEXACHLOROBENZENE	.01K	.01K	.01K	.01K
GAMMA-BHC (LINDANE)	.01K	.01K	.01K	.01K
ALPHA-BHC	.01K	.01K	.01K	.01K
MIREX	.01K	.01K	.01K	.01K
ENDRIN	.01K	.01K	.01K	.01K
LIPID CONTENT %	0.46	1.5	1.4	1.4
# OF INDIV. IN SAMPLE	5	5	5	5
SAMPLE WEIGHT LBS	0.67A	2.01A	3.69A	2.28A
FISH SPECIES (NUM)	31	31	12	16
FISH SPECIES-ALPHA	LMB	LMB	C	CHC
ANATOMY (NUMERIC)	86	86	86	86
ANALYZING AGENCY	1	1	1	1
LENGTH OF FISH INCH	10.6A	15.4A	20.0A	19.6A

ALL CHEMICALS IN UG/G NOTE: K = LESS THAN VALUE

Fish Tissue Data

The fish were collected by the use of electro fishing and gill nets. A total of 679 fish represented by eight (8) different species were collected. There were three species of fish tissue presented in Table 23. The three species tested for pesticides were large mouth bass, carp, and channel catfish. The fish tissue analysis was done by IDNR under Charlie Marbut the Fisheries Manager. Fish tissue data would lead one to conclude that there are no major problems with the fish.

The fish tissue samples were all within the legal limits for the compounds that are shown in Table 24. All of the compounds were at or below the recommended IEPA Toxicology Lab limits for human consumption

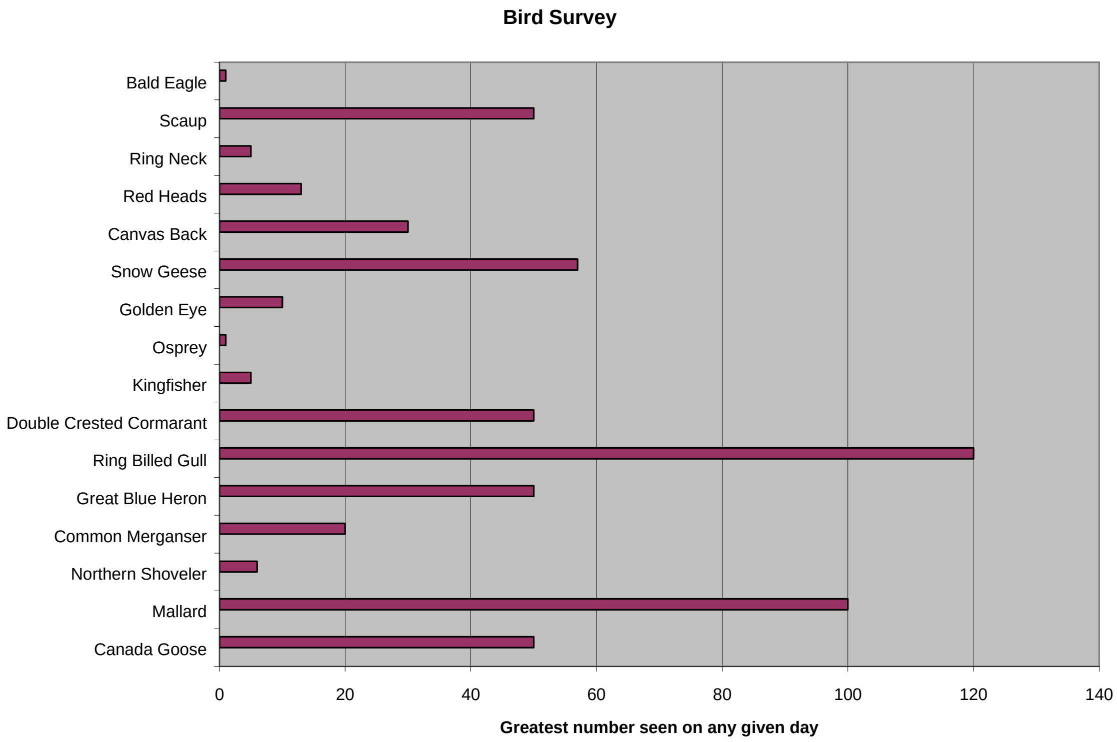
A.11.b Identification and approximate numbers of waterfowl supported by the lake

To develop an understanding of the numbers and types of birds and waterfowl using the lake ZIES staff recorded bird observations while taking water samples throughout the lake. During the winter and spring Greenville College ornithology students volunteered to help monitor waterfowl and other birds. This information was used to compile a table of the types of birds that would be directly on or near the water (Table 25). Birds can contribute significant amount of pollution to a lake through fecal matter if they are found in large numbers throughout the year. Mallard ducks were most commonly found on the lake in large numbers during the winter and spring. Other birds observed in large numbers included great blue heron, ring-billed gull, double-crested cormorant and scaup. A single bald eagle was observed in February. There were never large enough numbers of waterfowl observed to have a major impact on the water quality, although birds most likely play a small role in water pollution and nutrient loading to the lake.

Table 25 **Bird Count Estimates**

Common Name	Scientific Name	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR
Canada Goose	*Branta canadensis*								50		10	14	
Mallard	*Anas platyrhynchus*						5		80		100	70	
Northern Shoveler	*Anas elypeata*											6	
Common Merganser	*Mergus merganser*										20	5	
Great Blue Heron	*Ardea herodias*	10	20	50	34	20	15	10	10		11	10	10
Ring Billed Gull	*Larus delawarensis*	20	20	10	25	20	120	90	100		25	70	20
Double Crested Cor.	*Phalacrocorax auritus*	50	50	40	45								
Osprey	*Pandion haliaetus*				1								
Kingfisher	*Ceryle alcyon*			5									
Buffle-head	*Bucephala albeola*										10		
Snow Goose	*Chen caerulescens*											57	
Canvas Back	*Aythya valisineria*											30	
Red Head	*Aythya americana*											13	
Scaup	*Aythya affinis*											50	
Ring Neck	*Aythya collaris*											5	
Bald Eagle	*Haliaeetus leucocephalus*										1		

Figure 40 – Bird Survey of Glenn Shoals Lake



C J Liddell
USDA – NRCS
Hillsboro, IL 62049

3 September 2002

Re: Glenn Shoals Lake

Practical environmental concerns, such as long-term water quality, sustainable forests, and productive agricultural lands get people motivated to come together in locations to address such issues. Glenn Shoals Lake Watershed Planning Committee is just such an example. To people who live in central Illinois, the land is very close to us no matter how far today's technology removes us from it. Land use of Glenn Shoals Lake Watershed is dominated by production of agricultural products. We owe the wealth we derive from that land use to the right combination of climate, moisture, and soil. While most central Illinois residents are not involved in farming these days, we undeniably still have close ties to the land based on predominant land use around us. We realize we have to balance the demands placed on our natural resources with the long-term care and stewardship of them.

Long-term management of our natural resources requires us to take stock in the past, assess current conditions and plan for the future. This is done in the context of place, *e.g.* Glenn Shoals Lake Watershed, prior to conversion to other uses, Montgomery County was tallgrass prairie, prairie marsh, oak savannas, upland oak/hickory and floodplain forest. Today, only a few thousand acres of fragmented forest and tiny remnants of native prairie and savanna remain (Table 26). Subsequently, not only has the diversity of natural communities diminished along with natural processes needed to sustain them, but so has diversity of native plants and animal species. Once abundant, birds, *i.e.* Passenger Pigeon and Carolina Parakeet, actually became extinct (Table 27) while many other species, *i.e.* bison and timber wolves, were greatly reduced to the point of extirpation from the State of Illinois (Table 27). Pre-settlement vegetation and soil survey records suggest that this watershed was dominated by tallgrass prairie. Currently, most endangered and threatened (E & T) species known to exist in Montgomery County are prairie species (Table 28). Additionally included is a subjective list of currently E & T species that have an historic range that includes Montgomery County (Table 28). Some species may be present if extensively searched for in appropriate habitat. As with E & T species currently being monitored in the county, these potential species are at low population levels due to lack of suitable habitat. Experiences over the last twenty years suggest populations of E & T species can increase if managed properly. Therefore, from a natural heritage perspective, we should strive to design a conservation plan on this watershed that will meet the fundamental objectives of the whole community while simultaneously attempting to enhance conditions for rare resources. Well designed efforts to create grassland habitat can significantly benefit prairie wildlife populations. Examples of E & T species potentially benefiting from grassland management include Northern Harrier, Loggerhead Shrike, Ear-leaved Foxglove, and Prairie Rose Gentian (Table 29).

Cursory surveys around the Glen Shoals Lake area reflect a prairie history with remnants of prairie present and several locations have a high potential for restoration.

In conclusion, we want to continue to protect and manage extant natural areas and associated rare species. With assistance and support of local residents, a broad-based management plan can be implemented in an attempt to meet everyone's objectives. We look forward to working with the various constituents and to hearing new ideas as we address the watershed goals and objectives for Glen Shoals Lake.

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Table 26. Illinois Natural Area Inventory Sites in Montgomery County.

Site Name	Township, Range, Sections	General Description
Irving Railroad Prairie	009N003W 13	Mesic Tallgrass Prairie
Robert's Cemetery Savanna Nature Preserve	009N005W 01	Small Prairie Cemetery
Shoal Creek Barrens Nature Conservation Area	009N005W 25	Open Oak Woodlands, Barrens, Flatwoods

Table 27: Extinct and Extirpated Species of Illinois as noted by Illinois Endangered Species Board. (Bold type denotes extinct species.)

Species	Scientific Name	Date Extirpated
Fish		
Ohio Lamprey	*Ichtyomoxon bdellium*	1937
Longjaw Cisco	*Coregonus alpenae*	1983
Blackfin Cisco	*Coregonus nigripinnis*	1950's
Muskellunge	*Esox masquinongy*	1876 (reintroduced)
Rosefin Shiner	*Lythrurus ardens*	1900
Gilt Darter	*Percina evides*	1932
Stargazing Darter	*Percina uranidea*	unknown
Crystal Darter	*Crystallaria asprella*	1901
Birds		
Roseate Spoonbill	*Ajaia ajaia*	1887
Whooping Crane	*Grus americana*	1871
Sandhill Crane	*Grus canadensis*	1972 (nesting again since 1979)
Trumpeter Swan	*Cygnus buccinator*	1887
Eskimo Curlew	*Numenius borealis*	1879
Long-billed Curlew	*Numenius americanaus*	unknown
Swallow-tailed Kite	*Elanoides forticatus*	1913
Osprey	*Pandion haliaetus*	1952 (nested again 1986)
Peregrine Falcon	*Falco peregrinus*	1951 (reintroduced 1986)
Ruffled Grouse	*Bonsas umbellus*	1892 (reintroduced 1967)
Sharp-tailed Grouse	*Tympanuchus phasianellus*	1894
Wild Turkey	*Melagrus gallopavo*	1935 (reintroduced 1960)
Passenger Pigeon	*Ectopistes migratorius*	1914
Carolina Parakeet	*Conuropsis carolinensis*	1890
Common Raven	*Corvus corax*	1901

Mammals		
Beaver	*Castor canadensis*	1860’s (reintroduced 1935)
Timber Wolf	*Canis lupus*	1880’s
Red Wolf	*Canis rufus*	1893
Black Bear	*Ursus americanus*	1870’s
Pine Marten	*Martes americana*	1855
Fisher	*Martes pennanti*	1859
Cougar (Mountain Lion)	*Felis concolor*	1860’s
Elk	*Cervus elaphus*	1850’s
Bison	*Bison bison*	1814
Porcupine	Erethizon dorsatum	Unknown

Table 28. Endangered and threatened species currently monitored in Montgomery County.

Common Name	Scientific Name	Status
Henslow’s Sparrow	*Ammodramus henslowii*	E
Red-shouldered Hawk	*Buteo lineatus*	T
Savanna Blazing Star	*Liatris scariosa* var. *nieuwlandii*	T
Loggerhead Shrike	*Lanius ludovicianus*	E
Northern Harrier	*Circus cyaneus*	E
Prairie Rose Gentian	*Sabatia campestris*	E
Royal Catchfly	*Silene regia*	E
Eastern Blue-eyed Grass	*Sisyrinchium atlanticum*	E
Ear-leaved Foxglove	*Tomanthera auriculata*	T
Buffalo Clover	*Trifolium reflexum*	E

Table 29. Currently listed species potentially occurring in Montgomery County. May occur as migtants or non-breeders.

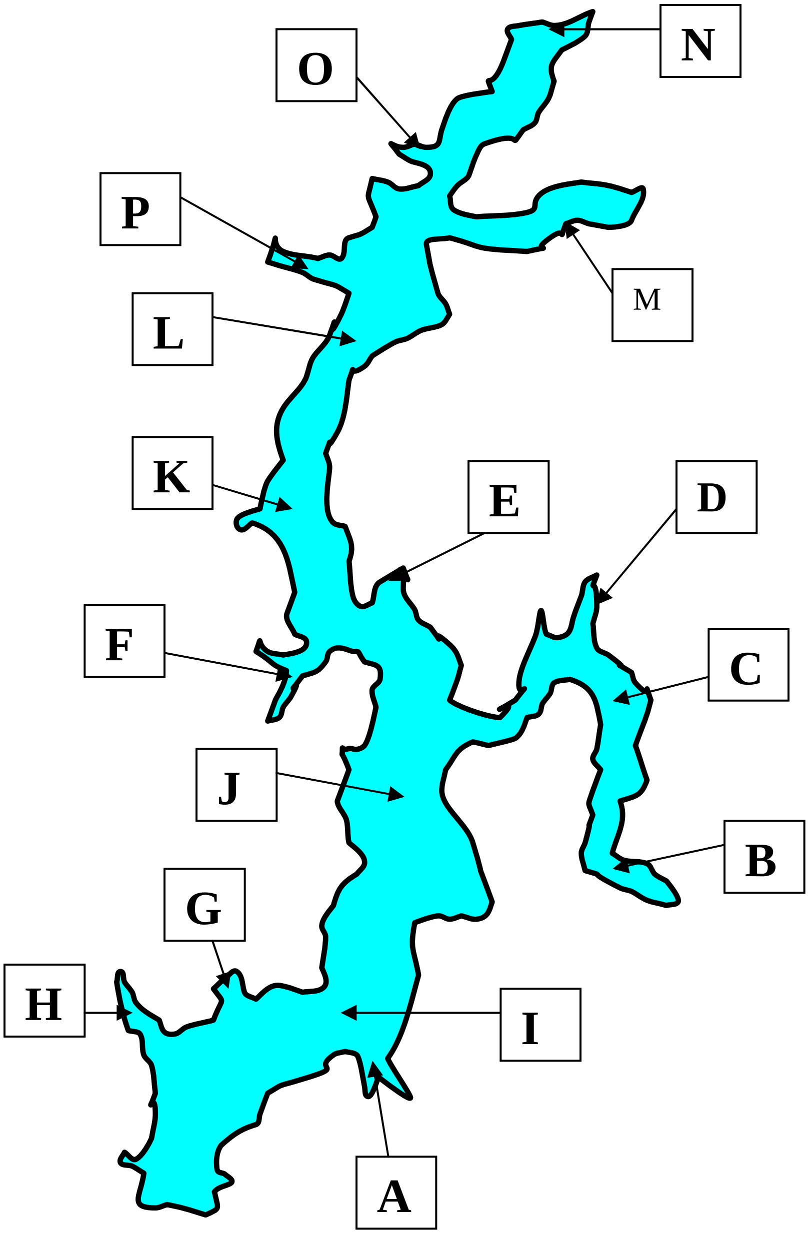
Common Name	Scientific Name
Birds	
Short-eared Owl	*Asio flammeus*
Upland Sandpiper	*Bartramia longicauda*
American Bittern	*Botaurus lentiginosis*
Brown Creeper	*Certhia Americana*
Bald Eagle	*Haliaeetus lucocephalus*
Least Bittern	*Ixobrychus exilis*
Osprey	*Pandion haliaaetus*
Pied-billed Grebe	*Podilymbus podiceps*
King Rail	*Rallus elegans*
Bewick's Wren	*Thyromanes bewickii*
Barn Owl	*Tyto alba*
Fish	
Western Sand Darter	*Ammocrypta clarum*
Bigeye Chub	*Hybopsis amblops*
Pallid Shiner	*Hybopsis amnis*
Bigeye Shiner	*Notripis boops*
Blacknose Shiner	*Notripis heterolepis*
Mammals	
River Otter	*Lontra canadensis*
Indiana Bat	*Myotis sodalist*
Snakes	
Kirtland's Snake	*Clonophis kirtlandi*
Plants	
Large Ground Plum	*Astragalus cassicarpus* var. *trichocalyx*
Fibrous-rooted Sedge	*Carex communis*
White Lady's Slipper	*Cypripedium candidum*
Prairie Trout Lily	*Erythronium mesochoreum*
Heart-leaved Plantain	*Plantago cordata*
Pink Milkwort	*Polygala incarnate*
Grass-leaved Lily	*Stenanthium gramineum*
Prairie Spiderwort	*Tradescantia bracteata*
Green Trillium	*Trillium viride*
False Hellebore	*Veratrum woodii*

A.11.c Identification of other wildlife

Macrophyte Survey Glenn Shoals Lake

Lake Name: Glenn Shoals Lake
County Name: Montgomery
Dates Surveyed: July and August 2001
Lake Size: 1250 Acres

Figure 41 Macrophyte sampling sites



Macrophyte Survey

Macrophytes are an important indicator of the quality of a lake. The IEPA uses macrophytes as one factor in determining aquatic life and recreational use impairment indices (ALI, RUI). If there is an overabundance of macrophytes, lake usage can be impaired. Factors such as water depth, clarity and climate influence macrophytes growth. The amount of aquatic or semi-aquatic macrophytes located on Glenn Shoals lake would be considered minimal. This is most likely a result of highly turbid waters, steep banks and water level fluctuations. According to IEPA water quality reports the macrophytes on the lake do not significantly contribute to its overall impairment. It is important, however, to understand the types and locations of macrophytes. They can play many important roles including providing fish habitat, sediment stops, oxygen source and pollution filters.

ZIES staff did an extensive macrophyte survey during July and August 2001. This survey consisted of collecting and mapping macrophytes throughout the lake. The lake was divided into sixteen areas where macrophytes were identified. These areas were labeled A-P. (Figure 41) Plants in these areas were identified by their scientific name (Steyermark 1999). The density of each type of plant was identified as sparse, moderate or dense. This information was used to generate a map and table (Figure 41 and Table 30).

The water level on Glenn Shoals lake between July and August averaged 1 inch below pool. The average secchi transparency at site ROL-1 was 25 inches, at site ROL-2 was 17 inches, and at site ROL-3 was 10 inches. The majority of Glenn Shoals lake had very turbid waters and steep banks. There were not major areas of open water with macrophytes although there were several coves with significant numbers of macrophytes. The dominant species were *Amorpha fruticosa*, *Justicia americana*, and *Salix interior*. These three species were found in dense concentration in several locations around the lake.

Due to the high turbidity and steep banks throughout, most areas in the lake have little in the way of a good macrophyte population. There was a fairly large number of species found around the lake but many are semi-aquatic growing along the bank in seasonally flooded areas. *Justicia americana* is the main aquatic plant within the system. This plant surrounded almost every cove to about three feet in depth and covered large sections of bank in the main body. Table 29 shows the survey did not simply account for the aquatic vegetation growing in the lake but included the bank vegetation which plays a role in bank stabilization and overall water quality.

There were three major areas within the lake that contain a large amount of aquatic vegetation. These areas are designated B, M, and N on Figure 41. All of the three areas have several things in common the first being that they are all coves where major tributaries feed into the lake. Second is that the depth in these areas is mainly shallower than three feet creating large areas where there is very little boat traffic. Finally the three areas lack a steep bank leaving good size flood plains during times of high water. This creates seasonal wetlands which can collect large amounts of sediment by slowing water flowing in the lake and macrophytes which absorb nutrients.

Area B is just one part of a larger cove on the lake but was separated into its own section because of the different characteristics it displays compared to the rest of the lake. The perimeter of this area has little change in elevation within 50ft of the shoreline. The shoreline is heavily vegetated with wetland species such as *Ammania coccinea*, *Amorpha fruticosa*, *Boehmeria cylindrical*, *Leersia oryzoides*, *Lindernia anagallidea*, *Sagittaria latifolia*, and *Salix interior*. There are several other indicator species in this area shown in Table 30. Also appearing throughout the area are large mats of aquatic vegetation containing Jussiaea *repens* and Justicia *americana*.

Area M contains fairly steep banks throughout most of the cove creating upland vegetation patterns fairly close to the lake level. However a small area in the back of the cove and up into the tributary shows similar characteristics to Area B with a little different species composition. The shoreline is densely vegetated with *Acer saccarinum*, *Amorpha fruticosa*, *Cephalanthus occidentalis*, and *Salix interior*. Starting at the mouth of the tributary and continuing several hundred yards upstream large mats of *Jussiaea repens* and *Justicia americana* almost completely cover the creek.

Area N is the location of the Northern most tributary on the lake. The creek channel is still prevalent through the center of this cove being the only area free of vegetation. The remainder of the cove is covered with a dense mat of *Jussiaea repens* and *Lemna minor*. The east shoreline of this area is vegetated with *Acer rubrum*, *Cephalanthus occidentalis*, and *Salix interior*. This shoreline is rather narrow before rising into upland habitat. The west side is a large flat, barely above the water level at normal pool, vegetated mainly by *Leersia oryzoides* but also supporting many other wetland species.

Due to highly turbid water in Glenn Shoals Lake, actual submerged aquatic vegetation is almost nonexistent. However, there are several species of emergent vegetation which make up the macrophytes that live within the body of the lake. Because of the lack of truly aquatic macrophytes this survey included vegetation surrounding the lake related to lowlands, floodplains, and seasonal wetlands that play an important role in this lake system.

Table 30a **PLANT NAME**	**DENSITY and LOCATION**															
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**
Acer negundo (boxelder)	M	M	M										M			
Acer rubrum (red maple)		S	S		M		S	S	S				M	S		S
Acer saccharinum (silver maple)	M		M		D				M		M	D	D		S	
Acer saccharum (sugar maple)	S	S							M	M			S			
Acorus calamus (sweet flag)					D	M										
Adiantum pedatum (maiden hair fern)													S			
Alisma trviale (northern water plantain)	S															
Amaranthus sp. (pigweed)		M		S		S		M	S		S			S		
Ammannia coccinea (tooth-cup)		D		S		S		S		S			S	S		
Amorpha fruticosa (false indigo)	M	D	D	D	D	D		D	M	D	D	D	D			D
Ampelamus albidus (climbing milkweed)								S				S				
Andropogon gerardii (big bluestem)										S		S				
Apocynum cannabinum (Indian hemp)				S		S	S	S	S	S		S				
Asclepias incarnata (swamp milkweed)	M	S	S	M	M	M	S	M		S	S	S	S		S	S
Asclepias syriaca(common milkweed)			S		S	S				S	S		S			
Aster sp. (aster)				S		S		M	S							S
Bidens sp. (begger ticks)	S			S			S									S
Boehmeria cylndrica (false nettle)	D	D	M		M		M	M		S		S	M		S	D
Carex crawfordii (crawfords sedge)						S										
Carex cristatella (sedge)								S								
Carex lupulina (hop sedge)						S	S									
Carex sp (sedge).				S	S					S						
Carya sp. (hickory)				S		M	S	M		S						
Cassia fasciculate (partridge pea)					S					S						
Cephalanthus occidentalis (buttonbush)	S	S	M	S	M						D	M	D	M	S	M
Cercis canadensis (redbud)	M		S	S	S	M		M	S	S	S	S		M		M
Chasmanthium latifolium (river oats)	M		M	D		S										
Conobea multiphyta (no c.n.)		S														

Table 30b PLANT NAME	DENSITY and LOCATION															
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**
Convolvulus sp (bindweed).											M					
Cornus obliqua (swamp dogwood)			S			S		S			S	S	S			S
Cuscuta pentagona (dodder)	S		S							S	S	S				
Cyperus sp. (sedge)		S												S		
Desmodium sp. (beggar ticks)			S													
Echinochloa sp. (barnyard grass)	D	S		M				M						S		
Eclipta alba (yerba de tajo)						S	S									
Elaeagnus angustifolia (autumn olive)			S		S						S	S				
Eleocharis compressa (spike rush)				S				M								
Eleocharis erythropoda (spike rush)								M		S			S	S		S
Eleocharis obtuse (spike rush)	D	S		S		M		S								S
Eleocharis palustris (spike rush)						M										M
Elymus virginicus (wild rye)								S								
Equisetum arvense (common horsetail)	M					S		S								
Equisetum hyemale (winter scouring rush)		M							S	S	M	S				
Eupatorium purpureum (green-stemmed joe-pye weed)								M	S							
Eupatorium rugosum (white snakeroot)						S				S			S			
Fraxinus pennsylvanica (green ash)	S		S										M			
Hibiscus militaris (rose mallow)	S				S			M		S						
Impatiens capensis (spotted touch-me-not)	S															
Ipomoea pandurata (wild potato vine)	S	S	S	S	S	S	S		S	S	S	S	S			
Juglans nigra (walnut)						M										
Jussiaea repens (floating primrose willow)		D		S		M	S	S					D	D	D	M
Justicia americana (water willow)	D	D	D	D	D	D	D	D	D	D	D	D	D			D
Leersia oryzoides (ricecut grass)	M	D	M	M		S	S	D	S	S		S		D	M	M
Lemna minor (lesser duckweed)	S			S		S	S	S				S		M		
Lindernia anagallidea (false pimpernel)		D		M		M		S		S		S		S		

Table 30c PLANT NAME	DENSITY and LOCATION															
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Lysimachia nummularia (moneywort)	S							S		S	S	S				
Maclura pomifera (osage orange)	S		S			S		S								
Onoclea sensibilis (sensitive fern)													S			
Parthenocissus quinqefolia (virgina creeper)												S				
Phlaris arundinacea (reed canary grass)	M	S	M			S	S	D	S	S	M	S		S	D	D
Phragmites australis (common reed)	M		S							S	S					
Phytolacca americana (pokeweed)						S						S				
Plantago rugelii (rugel plantain)								S								
Platanus occidentalis (sycamore)	M	D	S	S	S	M		M		M	M	D	M	M		
Polygonum coccinium (water smartweed)												M		M	M	M
Polygonum hydropiper (water pepper)							S									
Polygonum hydropiperoides (wild water pepper)															M	
Polygonum lapathifolium (smartweed)		S		S	M	S			S	S		S				S
Polygonum pensylvanicum (pinkweed)							S									
Populus deltoides (cottonwood)	M	M	M	S	S							M	S			
Quercus alba (white oak)			S	S		S		S		M		S				
Quercus imbricaria (shingle oak)	S	S	S	S		M		S	M	M						M
Quercus macrocarpa (bur oak)						S		S	M	S						
Quercus prinoides (dwarf chestnut oak)				S	S			S	M							M
Rhus glabra (smooth sumac)			S			S				S						
Rhus radicans (poison ivy)	D	D	D	D	D	D	D	D	M	D	D	M	D	D	M	D
Robinia psuedo-acacia (black locust)			S		M					S				S		
Rosa multiflora (Japanese rose)	M	S	S	M		M		M		S	M	S				
Rumex crispis (sour dock)	S					S		S	S			S			M	
Rumex verticillatus (swamp dock)	S	S		S				M						S	D	M
Sagittaria latifolia (duck potato)	D	D	M	M		M						S		S	S	D
Salix glauca (willow)	S															
Salix interior (sandbar willow)	D	D	D	M	D	D	D	D	D	M	M	D	D	D	D	D
Schoenoplectus tabernaemontani (great bulrush)														S		

Table 30d PLANT NAME	DENSITY and LOCATION															
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**
Scirpus atrovirens (common bulrush)				S		S		S								
Scirpus americanis (three square)	S						M	S		M						
Setaria viridis (green foxtail)	M		S		M	S						M	S			
Silphium perfoliatum (cup plant)			S					S								
Spartina pectinata (slough grass)												S				
Taxodium distichum (bald cypress)											S	S				
Teucrium canadense (wood sage)	S		S			S		S			S					
Typha latifolia (common cat-tail)												S		S		
Ulmus americanus (american elm)	M	S	S		M	M		M	M	M	S		M			S
Verbascum thapsus (mullein)										S						
Verbena urticifolia (white vervain)	S															
Vernonia sp. (ironweed)						S										
Vitis sp. (grape)	S	S	S	S	S	S	S	S		S		S	S			
Woodsia obtuse (blunt-lobed woodsia)													S			
Xanthium sp. (cocklebur)						M		M		S				S		S
Zizaniopsis miliacea (water millet)			S	S	S		M	M	S	S	M					

Phytoplankton

Phytoplankton are photosynthetic organisms that live suspended in the water column. Developing an understanding of the types of phytoplankton found in a lake will give insight into the lake's health. High concentrations of blue-green algae (Cyanobacteria) are usually an indicator of a eutrophic lake because they thrive in organically rich waters. Phytoplankton are at the bottom of the food chain, providing food material for larger organisms including fish. Communities of phytoplankton are good indicators of a lake's trophic status and can influence the overall biological health of a lake. They influence food availability, light penetration, and oxygen availability. As phytoplankton die, they contribute to loss of oxygen, sedimentation and filling of a lake.

Algae Genera Cell Density and Cell Volumes

As part of the IEPA's ALMP program, Zahniser staff collected water samples to be tested for genera, cell density and cell volumes. Phytoplankton analysis was conducted at Western Illinois University in the lab of Dr. Larry M. O'Flaherty. The report is as follows:

Lake Glenn Shoals Report

Lake Glenn Shoals was sampled at three sites on 9 May, 18 June, 20 July, 24 August and 17 October, 2001 (Appendix A: List of Taxa; Summary of Numbers and Biovolumes). No record of sampling in previous years was available. Peak production of phytoplankton occurred on 20 July at Site 1 (16,124/mL), 9 May at Site 2 (20,180/mL) and 24 August at Site 3 (22,748/mL) (Table: Phytoplankton Totals; Graph: Total Phytoplankton). Blue-greens (Cyanophyta) dominated the phytoplankton at every site on every date in 2001 (Graph: Cyanophyta).

Diatoms (**Bacillariophyta**) reached their maximum densities at sites 2 and 3 on 9 May (1080/mL-Site 2; 4810/mL-Site 3) and at Site 1 on 18 June (1590/mL) (Appendix A: Phytoplankton Totals; Graph: Bacillariophyta). Diatom densities were 100 or more/mL on all dates in 2001. Densities of *Cyclotella meneghiniana* accounted for most of the diatom totals at each site on each date except for 18 June at Site 3 when *Nitzschia palea* was in the majority (Appendix A: Numbers and Biovolumes of Individual Taxa-Site1; Site 2; Site 3). The only other diatoms in densities of 100 or more/mL at each site were *Cyclotella chaetoceros*, *Nitzschia acicularis*, *N. linearis* and *N. palea*. *C. chaetoceros* was at this level only at Site 1 on 18 June (122/mL) and Site 2 (173/mL) after which it was not seen. *N. acicularis* was at 153/mL at Site 1 and 112/mL at Site 2 on 24 August. It was in a density of 214/mL on 9 May and 173/mL on 24 August at Site 3. *N. linearis* was in a density of 100 or more/mL only on 24 August at Site 3 (173/mL). Of the three species of *Nitzschia*, *N. palea* was at this density at Site 3 on 9 May (601/mL), at sites 1 and 3 on 18 June (326/mL-Site 1; 703/mL-Site 3), at sites 2 and 3 on 20 July (122/mL-Site 2; 897/mL-Site 3) and at all three sites on 24 August (296/mL-Site 1; 183/mL-Site 2; 255/mL-Site 3) (Appendix A: Numbers and Biovolumes of Individual Taxa-Site1; Site 2; Site 3). These three species of *Nitzschia* are tolerant of high concentrations of organic materials. They often develop on the bottom in shallow areas and enter the phytoplankton from there or they are brought in from tributaries of a lake following rainfall. They and the rest of the diatoms found in the samples from Lake Glenn Shoals are indicative of eutrophic conditions (Appendix A: List of Taxa).

Green algae (**Chlorophyta**) reached their peak production at sites 1 and 2 on 18 June (1468/mL-Site 1; 1091/mL-Site 2) and at Site 3 on 9 May (4229/mL) (Appendix A: Phytoplankton Totals; Graph: Chlorophyta). Except for the density of 51/mL observed on 9 May at Site 1, all of the densities at the three sites exceeded 100/mL on each date. In fact, except for that date and 17 October, the densities at Site 1 exceeded those at sites 2 and 3 on every date and total production of greens at Site 3 exceeded those at Site 2 on all dates except 17 October. The number of different taxa at each site was fairly similar with 32 at Site 1, 37 at Site 2 and 38 at Site 3 and all were indicative of eutrophic conditions. Some taxa were found at only one site while others were found at two of three sites and not always on the same date (Appendix A: List of Taxa). Examples of these taxa are *Actinastrum hantzschii* var. *fluviatile*, *Carteria* spp., *Chlorogonium elongatum*, *Chodatella quadriseta* and *C. wratislawiensis* (these two were only at Site 3). Only two taxa were found on every date at each site. These were *Ankistrodesmus falcatus* var. *acicularis* and *Scenedesmus abundans*.

The only green algae at Site 1 on 9 May were five taxa (*A. falcatus* var. *acicularis*, *Cosmarium* sp., *S. abundans*, *Schroederia setigera*, *Tetraedron gracile*) each at a density of 10/mL (Appendix A: Numbers and Biovolumes of Individual Taxa-Site 1). At Site 2 on 9 May, *A. falcatus* was at 183/mL and *S. abundans* at 143/mL were >100/mL. *S. setigera* was at 31/mL and other green algae present were not in the sample from Site 1. At Site 3 on this date, seven greens were at 100 or more/mL including *A. hantzschii* var. *fluviatile* (530/mL), *A. falcatus* (316/mL), *Carteria multifilis* (112/mL), *Chlorogonium elongatum* (265/mL), *S. abundans* (2028/mL), *S. setigera* (153/mL) and *Tetraedron trigonum* var. *trigonum* (357/mL) . Besides *A. falcatus* and *S. abundans*, only *S. setigera* and *T. trigonum* were at Site 2. The ranking of the most numerous green algae on 18 June at Site 1 was *Scenedesmus abundans* (683/mL), *Ankistrodesmus falcatus* var. *acicularis* (173/mL) and *Scenedesmus denticulatus* (163/mL). At Site 2, this ranking was *S. abundans* (316/mL), *Kirchneriella lunaris* var. *lunaris* (194/mL), *S. denticulatus* (143/mL), *A. falcatus* (132/mL) and *Dictyosphaerium pulchellum* (122/mL). At Site 3, it was *S. abundans* (336/mL), *A. falcatus* (143/mL) and *Carteria* sp. (No. 1) at 102/mL. Many of the other greens seen in the samples from sites 1 and 2 were present at Site 3, but not in densities >100/mL. On 20 July at Site 1, the ranking was again *S. abundans* (367/mL) followed by *D. pulchellum* and *Schroederia setigera* both at 173/mL. At Site 2, it was *S. abundans* (224/mL) and *Carteria multifilis* (102/mL) and these were the only greens at 100 or more/mL. Both *D. pulchellum* and *S. setigera* were in the sample, however. At Site 3, four taxa were in densities of >100/mL. These were *A. falcatus* (214/mL), *S. abundans* (153/mL), *S. setigera* (112/mL) and *Tetraedron trigonum* (122/mL). Once again, those in highest densities at the other two sites were in the sample from Site 3 as well. On 24 August at Site 1, *D. pulchellum* was most numerous at 316/mL followed by *A. falcatus* (194/mL), *A. hantzschii* var. *fluviatile* (153/mL), *S. abundans* (112/mL) and *S. setigera* (102/mL). At Site 2, *Chlorogonium elongatum* var. *elongatum* (132/mL) and *A. hantzschii* var. *fluviatile* (112/mL) were the only two greens at >100/mL. These two were at Site 1 and those most numerous at Site 1 were at Site 2, but in lower densities than those seen at Site 1. At Site 3, *C. elongatum* and *D. pulchellum* both at 153/mL were followed by *A. hantzschii* (132/mL) and again all of the taxa at the other two sites were at Site 3 as well. None of the greens was in a density of 100/mL on 17 October at Site 1, but the three with the highest densities were *S. abundans* (82/mL), *S. dimorphus* and *Closterium acutum* (each at 51/mL) and *D. pulchellum* (41/mL). At Site 2, five taxa were in densities of >100/mL. In rank order, these were *A. falcatus* and *S. abundans* (both at 143/mL), *S. dimorphus* (122/mL) and *Kirchneriella lunaris* and *S. schroederia* (both at 102/mL). As was the case at Site 1, none of the green algae at Site 3 was in a density of >100/mL. The ranking of the top four was *A. falcatus* (41/mL), *S. abundans* and *S. dimorphus* (31/mL) and *D. pulchellum* (20/mL). These results demonstrate that the distribution of taxa was similar at each site as might be expected since each located on the same lake. Differences in site characteristics, however, caused the densities of different taxa to vary from site to site.

No chrysophytes (**Chrysophyta)** were seen in the samples from Lake Glenn Shoals (Appendix A: List of Taxa). This lack may have resulted from two factors. The first was that no samples were taken during periods of low temperatures when competition from other algae is low. The second factor may be that there was no period of low competition due to the abundance of blue-greens in the lake on the dates sampled.

Cryptomonads (**Cryptophyta**) were at their highest levels at sites 1 (1305/mL) and 2 (948/mL) on June 18 and at Site 3 (958/mL) on 9 May (Appendix A: Summary of Numbers and Biovolumes; Phytoplankton Totals; Graph: Cryptophyta). Overall, the total production of cryptomonads was not exceedingly high in Lake Glenn Shoals in 2001 as compared to other lakes sampled in that and other years. Except for the 9 May date when total density was only 51/mL, Site 2 had the highest production of these algae on every other date. These algae have typically appeared in spring and fall when temperatures are lower, after heavy rainfalls or algicide application in the summer or in lakes with destratifiers in place. More recently, they have been in samples and at densities of >100/mL in lakes during a period when blue-greens are in high densities and water temperatures would be expected to be higher. This was the case with Lake Glenn Shoals on 24 August, 2001 at Site 2 (795/mL). On 17 October, they were not at Site 1 and were at low densities at sites 2 (92/mL) and 3 (10/mL). *Cryptomonas* sp. (No. 1) was more numerous at each site on every date than was *Cryptomonas erosa* except on 17 October when neither was in the sample from Site 1 (Tables: Numbers and Biovolumes of Individual Taxa-Site 1; Site 2; Site 3). The only exception was on 20 July at Site 1 when *C. erosa* (at 31/mL) was at a slightly higher density than *C.* sp. (20/mL). The latter appears to be more tolerant of high concentrations of organic materials and often appears after treatment with algicides or when a destratifier is operating in the lake.

As was mentioned, blue-greens (**Cyanophyta**) dominated the phytoplankton totals on every date in 2001 (Appendix A: Phytoplankton Totals; Graph: Cyanophyta). The three indicators of eutrophic conditions or developing eutrophic conditions, *Anabaena spiroides* var. *crassa*, *Aphanizomenon flos-aquae* and *Microcystis aeruginosa*, were in samples in July and August (Appendix A: List of Taxa). None of the three was in a "bloom" density (1000/mL or One Million/L), however. *A. spiroides* var. *crassa* reached it highest density of 173/mL on 20 July at Site 1 and was at 61/mL on 24 August (Table: Numbers and Biovolumes of Individual Taxa-Site 1). *Aphanizomenon* was at its highest density (132/mL) on 20 July and at 71/mL on 24 August. At Site 2 on 20 July, *A. spiroides* var. *crassa* was at 51/mL and *Aphanizomenon* at 92/mL (Appendix A: Numbers and Biovolumes of Individual Taxa-Site 2). They were at 20/mL and 31/mL, respectively, on 24 August. *A. spiroides* var. *crassa* was at 31/mL and *Aphanizomenon* at 10/mL on 20 July at Site 3 (Appendix A: Numbers and Biovolumes of Individual Taxa-Site 3). The former was at 10/mL on 24 August and the latter was not in that sample. *Microcystis* was in samples from only sites 1 and 2 and was at 20/mL at Site 1 and 10/mL at Site 2 on 20 July (Appendix A: List of Taxa; Numbers and Biovolumes of Individual Taxa-Site 1; Site 2).

The most abundant (1000 or more/mL) blue-greens on every date at every site were *Anacystis montana* and *Gomphosphaeria lacustris*. These two organisms are considered to be innocuous, but do, of course, take nutrients from the water, increase turbidity and produce color in lakes. The bad news for Lake Glenn Shoals in 2001 was the presence of three species in abundance on some dates and another species that further indicated that high temperatures existed. The three in abundance were *Merismopedia quadruplicata*, *Raphidiopsis curvata* and *Schizothrix calcicola* and the fourth in low densities only on the 24 August was *Anabaenopsis elenkinii*. Their presence indicated that shallows had developed in the lake and the lake had high temperatures during the summer of 2001. *Merismopedia* and *Schizothrix* develop on the bottom in these shallows, float into the water column and continue their increase in numbers as members of the phytoplankton. *Schizothrix* will form mats of filaments on the bottom. Bubbles of oxygen (day) and carbon dioxide (night) form under these mats causing them to float as pieces which eventually break into individual filaments seen in the water samples. *Raphidiopsis* and *Anabaenopsis* develop as a result of the warming of the water by light penetrating to the bottom in the shallows or by the heating of particulate matter (and suspended algal cells) in the water. Another source of this increase in temperature can be a thermal input from a power plant or other facility. *Merismopedia* reached its maximum densities at Site 1 on 20 July (1539/mL) and was high (877/mL) on 24 August (Appendix A: Numbers and Biovolumes of Individual Taxa-Site 1). It peaked at Site 2 on 24 August at 948/mL and was high (887/mL) on 20 July (Appendix A: Numbers and Biovolumes of Individual Taxa-Site 2). At Site 3, the peak occurred on 24 August (1192/mL), was high on 20 July (999/mL) and >100/mL on 9 May at 275/mL and 18 June at 448/mL (Appendix A: Numbers and Biovolumes of Individual Taxa-Site 3). *Raphidiopsis* reached a peak in density at each site on 24 August (1192/mL-Site 1; 1070/mL-Site 2; 1284/mL-Site 3). It was high (856/mL) at Site 1 on 20 July and in densities of >100/mL at sites 2 and 3 on 20 July (377/mL-Site 2; 122/mL-Site 3) and at sites 1 and 2 on 17 October (183/mL-Site 1; 234/mL-Site 2). *Schizothrix* reached its highest density at Site 1 on 20 July at 2038/mL, was in nearly as high a number on 24 August (2018/mL) and at >100/mL on 18 June (234/mL) and 17 October (122/mL). At Site 2, it peaked on 24 August at 1570/mL, was high on 20 July (866/mL) and 17 October (785/mL) and at its lowest density on 18 June (82/mL). Its highest density at Site 3 again occurred on 24 August (1865/mL) as it had at Site 2, but was lower on 20 July (469/mL), 17 October (122/mL) and 9 May (82/mL) and "Present" on 18 June. *Schizothrix* was not in the samples from sites 1 and 2 on 9 May. As was mentioned, *Anabaenopsis elenkinii* appeared in the samples from each site on 24 August. It was at 20/mL at Site 1, 10/mL at Site 2 and 31/mL at Site 3.

Euglenoids (**Euglenophyta**) reached their peak density (3027/mL) at Site 3 on 9 May (Table: Phytoplankton Totals; Graph: Euglenophyta). Except for 17 October, they were in higher densities on every date at Site 3 than they were at sites 1 and 2. Site 1 exhibited the lowest density of these algae on every date in 2001. The only euglenoid to reach a density of 100 or more/mL on any date at Site 1 was *Trachelomonas volvocina* which was at 143/mL on 24 August. It was the only one present at Site 1 on 18 June (at 20/mL), was the second most numerous (at 20/mL) after a *T.* sp. (cylindrical-granular at 61/mL) on 20 July and one of two euglenoids present on 17 October (each at 10/mL). *T. volvocina* was the most numerous euglenoid at Site 2 on 9 May (20/mL), 18 June (82/mL), 24 August (255/mL) and 17 October (92/mL) and second at 71/mL to a *T.* sp. (urn-shape) at 82/mL on 20 July. As was mentioned, the numbers of euglenoids at Site 3 was higher than at the other two sites and the densities of individual taxa and their dominance of the total production varied from date to date. On 9 May, *Euglena viridis* was the most abundant (1000 or more/mL) euglenoid at 1580/mL followed by an *E.* sp. (12.5 x 25.0 µm) at 703/mL, *T. volvocina* at 306/mL and another *E.* sp. (10.0 x 20.0 µm) at 163/mL. *E. viridis* was again dominant on 18 June at 499/mL, a *T.* sp. (cylindrical-granular) was at 204/mL and *T. volvocina* was fourth in ranking at 61/mL. Other euglenoids seen in the sample from that date were in densities of <100/mL. On 20 July, *E. viridis* was the only one at >100/mL (112/mL) with *T. volvocina* second at 82/mL. *T. volvocina* at 194/mL was the only species at 100 or more/mL on 24 August. *E. viridis* was at 61/mL which was third in ranking behind an *E.* sp. Finally on 17 October, *T. volvocina* was the euglenoid with the highest density (41/mL). No *Euglena* species were in the samples from Site 1 and those at Site 2 (including *E. viridis*) were in low densities. All of the euglenoids seen in the samples from 2001 are those tolerant of high levels of organic material and indicative of eutrophic conditions.

Dinoflagellates (**Pyrrhophyta**) were not major contributors to the total phytoplankton production on any date in 2001. They were at their highest density for the three sites at Site 2 on 20 July at 112/mL (Appendix A: Summary of Numbers and Biolvolumes-Site 2; Phytoplankton Totals). They were at 10/mL on 18 June and 31/mL on 20 July at Site 1 and in a countable number at Site 3 (51/mL) only on 20 July (Appendix A: Summary of Numbers and Biovolumes-Site 1; Site 3; Phytoplankton Totals). *Glenodinium gymnodinium* was the only dinoflagellate present on 18 June at Site 1 (at 10/mL) and on 20 July at sites 2 (112/mL) and 3 (51/mL) (Appendix A: Numbers and Biovolumes of Individual Taxa-Site 1; Site 2; Site 3). *G. gymnodinium* at 20/mL was accompanied by a *G.* sp. at Site 1 on 20 July. The latter species was at 10/mL on that date.

Summary of algae data

Lake Glenn Shoals was eutrophic in 2001. This conclusion is based on the presence of taxa indicative of eutrophic conditions. These taxa included diatoms such as *Cyclotella meneghiniana* and the *Nitzschia* spp., the green algae such as *Ankistrodesmus falcatus* var. *acicularis* and *Scenedesmus abundans*, the euglenoids and especially the blue-greens. All three blue-green taxa indicative of eutrophic conditions were present in 2001. These three are *Anabaena spiroides* var. *crassa*, *Aphanizomenon flos-aquae* and *Microcystis aeruginosa*. On a positive note, none of these three species were in a “bloom” density of 1000/mL or One Million/L. Four other blue-green species were of concern since they are characteristically found in lakes with extensive shallows and high summer temperatures. These were *Anabaenopsis elenkinii, Merismopedia quadruplicata*, *Raphidiopsis curvata* and *Schizothrix calcicola*. *Raphidiopsis* was at “bloom” densities on a number of dates in August at all three sites and was high (>100/mL) on other dates in July and October. Its presence in October at sites 1 and 2 gave an indication that water temperatures were still high enough for its survival. These higher water temperatures may have accounted for the lack of cryptophytes on that 17 October date.

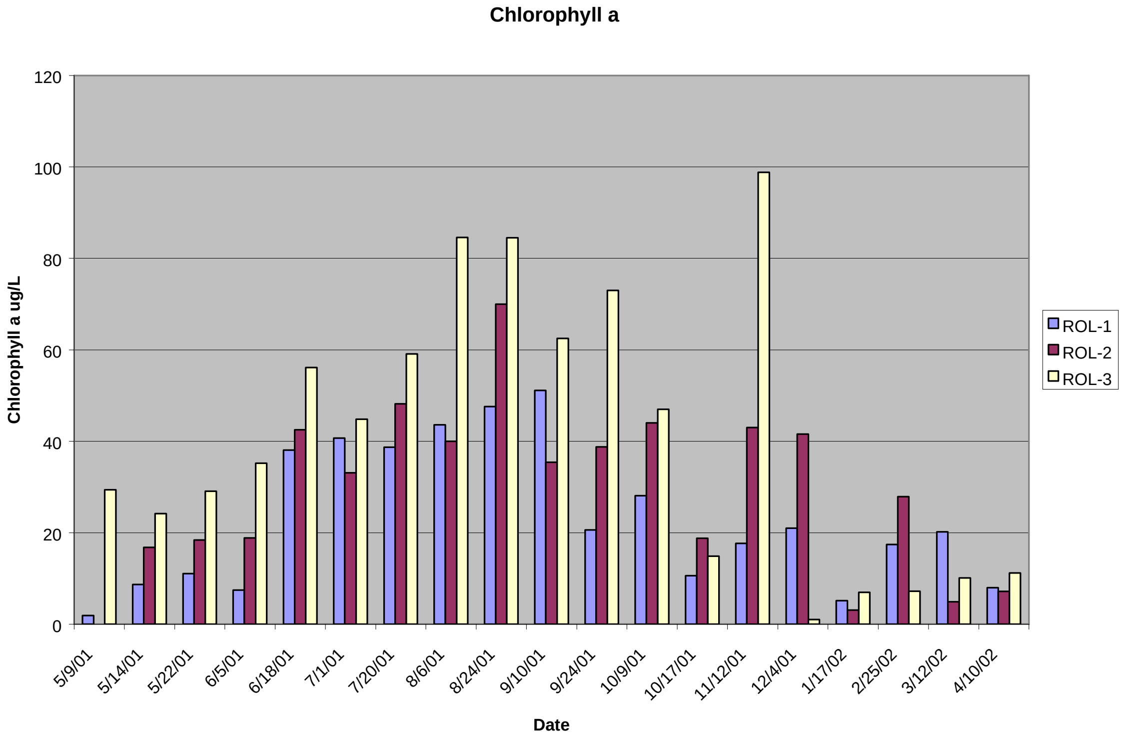
Phytoplankon and Zooplankton taxa listings are found in Appendix A.

Chlorophyll a

Chlorophyll a is a pigment found in all green plants and is necessary for photosynthesis. The amount of chlorophyll a found in the water is used as a measure of the amount of algae present in the water. Chlorophyll is the key element needed for photosynthesis. It is the basic ingredient for all life in a lake. Chlorophyll a concentrations are used as a variable in determining the degree of eutrophication and trophic status of a lake. According to the Illinois 305(b) report, chlorophyll a samples in lakes which fall between 7.5μg/L and 55μg/L can be classified as eutrophic and concentrations higher than 55μg/L can be classified as hypereutrophic. The 305(b) guidelines for listing of overall use support impairment in lakes uses the ranges between 20-92μg/L as slight, ranges between 92-426μg/L as moderate and anything higher than 426μg/L as High. Chlorophyll a samples were collected at seven sites by ZIES staff as part of the Illinois Volunteer Lake Monitoring Program (VLMP) and analyzed at IEPA laboratories. All sample values were corrected for pheophytin a. The corrected chlorophyll a values equal only the living chlorophyll a.

Chlorophyll a was found in the slightly elevated range on most dates. ROL-1 peaked on 9/10/01 at 51.1 μg/L. ROL-2 peaked on 8/24/01 at 70 μg/L. ROL-3 peaked on 11/12/01 at 98.8 μg/L (Figure 42).

Figure 42 – Chlorophyll a



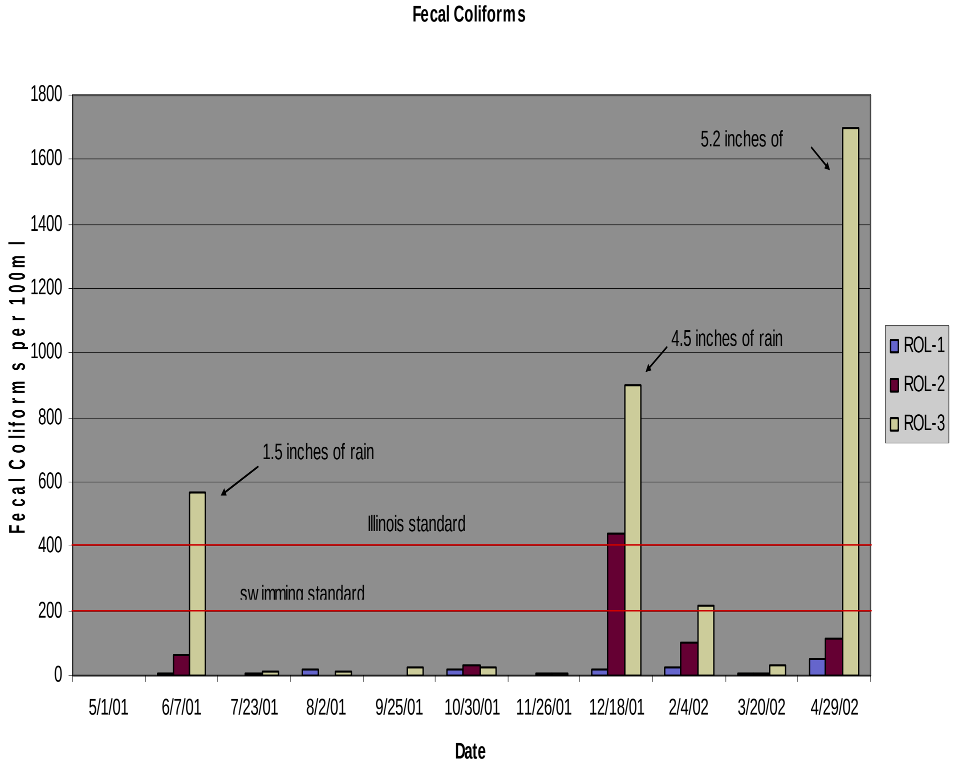
Bacteriology

Bacteriological samples were checked for coliform bacteria (Figure 43). Fecal coliforms are bacteria found in the gastrointestinal tract of warm-blooded animals. Fecal coliforms are indicators of human and/or animal waste contamination. It is important for drinking and recreational waters (swimming and beach areas) to be free from pathogenic organisms. High levels of coliforms and streptococcus are often a result of leaching of septic systems, feedlot runoff, large waterfowl populations, cattle grazing and run-off from wildlife areas. The Illinois standards for fecal coliforms state that they shall not exceed a geometric mean of 200 per 100 ml nor shall more than 10% of at least five samples during any 30-day period exceed 400 per 100 ml in protected waters. Protected waters are areas that support primary contact or flow through or are adjacent to parks or residential areas (IPCB Part 302.209). The IEPA 305(b) water quality report sets a guideline of non-support for swimming when the geometric mean of all fecal coliforms samples is greater than or equal to 200 per100ml or 25% of all samples exceeds 400 per 100 ml.

Bacteriological samples were collected by ZIES staff and analyzed at Madison County Environmental Labs in Edwardsville, Illinois.

Peak concentrations of coliforms corresponded to significant rain events. The highest concentrations were found at the north end of the lake (ROL-3) after rain events. Since five samples were never taken on a given date site it is not known if the high concentrations would have exceeded the IEPA standard.

Figure 43 – Fecal Coliform



A.11.d Discussion of the relationships of the organisms identified in a, b & c above

There is a great diversity of flora and fauna found in Glenn Shoals lake and it's surrounding habitats. The interactions between these organisms and with their surroundings is approaching the point of potential concern in that lake conditions are becoming limiting factors in sustaining populations.

A.11.e Comments on the effects of water quality problems on biological resources.

The two major problems affecting the lake, turbidity and excess nutrients have a major effect on the quality and quantity of primary production in the lake. The lack of light penetration caused by turbidity, which is clearly significant when one looks at the secchi readings in (Figure 18 and 28), has a major effect on overall primary production. Whereas the excess nutrients mainly affects the quality of that primary production (relative numbers of algae species).

The number and size of fish, which is affected by their growth rate, are dependent on the food chain. The initial and probably most important link in that chain is the algae. With excess nutrients the less palatable bluegreen algae are at a distinct advantage while the more nutritious green algae numbers are reduced by the competition. Food production by algae in the initial step moves up the food chain where each level has less than optimal food supply. This limit in food results in fewer and smaller fish at the top of the lakes food pyramid.

Since fish are often food for many other organisms, such as mink, raccoons, turtles and cormorants etc., many organisms suffer by having their numbers also reduced.

Part 2

FEASIBILITY STUDY OF GLENN SHOALS LAKE

B.1. Pollution Control and Restoration Procedures

INTRODUCTION

This study has identified many causes of impairment for Glenn Shoals Lake. Restoration proposals will be directed at solving the most significant of these causes, including high sedimentation, stream bank erosion and high nutrient inputs from the watershed.

Recommended methods for restoring and enhancing lake water quality can be sorted into several different categories. These categories include watershed practices, in-lake practices and general practices. Through a significant amount of work the NRCS has identified several restoration items that would significantly improve the overall quality of Glenn Shoals Lake. These will be listed in the appropriate sections of this report.

As with any restoration proposal it is important that all involved parties have an opportunity to voice their opinions. It is meant at this point in time for the restoration proposals to be reviewed for comment by all interested parties and agreements made before submittal of this report for Clean Lakes Phase II funding.

EXISTING LAKE QUALITY PROBLEMS AND THEIR CAUSES

According to the IEPA 303(d) Report Glenn Shoals Lake was assessed for its designated uses and the following areas were impaired: overall use partial support, aquatic life full support, fish consumption full support, swimming partial support, public water partial support. Causes for these impairments include: nutrients (slight cause), organic enrichment/low DO (slight cause), and excessive algae. The sources that contribute to the impairments include: non irrigated crop production (high contributor), stream bank (high contributor), in-place contaminants (high contributor), boating, habitat modification and forest/grassland/parkland (slight contributor).

Clean Lakes data from this study identifies many of these same problems for the lake including:

Sedimentation and Loss of Storage Volume

The NRCS sedimentation survey indicates that fifteen percent of the volume of the lake has been lost due to siltation. The sediment budget estimates that more than forty five thousand tons of sediment entered the lake during the study period (Table 14). The TSS 39,164,567 kg/yr is equal to 43,170 tons per year. High levels of total suspended solids, volatile suspended solids, non-volatile suspended solids and low secchi readings in the lake (Figure 15, 16, 17,18) and high levels of total suspended solids, volatile suspended solids, and non-volatile suspended solids in the tributaries (Figure 28,29) are all indications of current silting problems in the lake and tributaries. All of these contribute to the high rates of sedimentation in the lake.

Shoreline Erosion

Turbid Waters

High levels of Total Suspended Solids, Non-Volatile Suspended Solids and shallow secchi reading are all indicators of turbid waters. Turbid waters can have negative affects on aquatic life, recreational use of the lake and the overall use of the lake.

High Levels of Nutrients including Phosphorus

The nutrient budget estimates that 1,751 metric tons of nitrogen and 166 metric tons of phosphorus entered the lake during the study period. These nutrients can have negative affects on aquatic life and lead to algae blooms especially following peak runoff events. Phosphorus is of special concern since it was identified as the limiting nutrient for the lake.

Low Dissolved Oxygen

During the summer months the lake stratified and oxygen was depleted near the lake bottom. Anoxia can result in internal nutrient release; during the fall lake turnover these nutrients can be released to the surface and cause algae blooms and poor water taste for treated waters.

OBJECTIVES FOR LAKE RESTORATION

Lake management involves the management of complex ecosystems and restoration involves a number of entities with varied interests. However, overall lake restoration and management can be designed in such a way as to meet the majority of the desired outcomes, and most of the desired outcomes will benefit all of those interested in a cleaner longer lasting lake and better water quality. The restoration program should be evaluated and opportunities for comment should be given to all interested parties if the program is to be successful.

Objective 1 - Reduce the sedimentation rate by 50%

Objective 2 – Reduce total suspended solids entering the lake by 50%

Objective 3 – Reduce nutrients (Table 14) by 40% and pesticide input from the watershed

Objective 4 – Improve the habitat for aquatic life in the lake

Objective 5 – Improve the recreational use (boating, fishing, and water skiing) of the lake

Objective 6 – Improve the quality of water used for the production of potable water

Objective 7 – Educate the public on the importance of good water quality

B.1.a. ALTERNATIVES TECHNIQUES CONSIDERED FOR LAKE RESTORATION

Alternatives for lake restoration have been identified and cost evaluated (Table 31). These proposed restorations are presented for review and consideration as a component of this Clean Lakes Study. Each element of the restoration plan will be matched with one or more of the restoration objectives in addition to the rationale and cost estimates for implementation. The major sub-areas of the restoration plan include in-lake and general watershed activities.

TABLE 31 Restoration and Mitigation Alternatives for Glenn Shoals Lake (2000)

Alt. No.	Restoration Alternative	Estimated Cost	Reduce Sediment Obj. 1	Reduce Solids Obj. 2	Reduce Pollution Obj. 3	Aquatic Life Obj. 4	Rec Use Obj. 5	Extended Lake life Years
1	Stream Bank Stabilizatoin **	$150,000	+	+	O	+	+	
2	Conservation Practices ** Soil Testing of Farmland	N/A	+	+	+	+	+	
3	Riparian buffers **	N/A	+	+	+	+	+	
4	Sediment Control Struct's **	$200,000	+	+	+	+	+	2yrs.
5	Storm Water Detention **	$500,000	+	+	+	+	+	3yrs.
6	Draw Down Structure 14	$1,000	+	O	O	O	+	N/A
7	Meisen. Struc. & Wetland	$632,000	+	+	+	+	+	52yrs
8	Irving Cove Structure	$512,500	+	+	+	+	+	6yrs
9	Dredging Irving Cove *	$1,996,500	+	O	O	O	+	
10	Dredging Fawn Cove *	$2,715,240	+	O	O	O	+	
11	Dred'g North End of Lake *	$4,871,460	+	O	O	O	+	
12	Draw Down North End	$5,000	+	O	O	O	+	N/A
13	Cove Dredging	$120,000	+	O	O	O	+	N/A
14	Brood Pond	$15,000	O	O	O	+	+	0
15	Lake Rip-Rap	$1,391,960	+	+	+	+	+	1 yr
16	Designated Ski Area ***	$1,000	+	+	O	O	+	
17	Increase Patrol and Fees ***	$0	+	+	O	O	+	
18	Construction Site BMP's **	N/A	+	+	O	O	+	
19	Septic Tank Inspection **	$0	O	O	+	+	+	
20	Public Land Preservation ***	$0	+	+	+	+	+	<1 yr
21	Phase 2 monitoring prog.	$35,000	O	O	O	O	O	0
22	Add Barley Bales	$5,000/yr	O	+	O	+	+	
23	Lake Education Programs (This meets objective #6)	$5,000	O	O	O	O	O	

Legend:

+ = Positive effect
O = No effect
- = Negative effect
N/A = Not available

* No estimated life projection; cost prohibitive project.
** Watershed project; to assist NRCS City should form a resource committee
*** Requires passing a City Ordinance.

Objectives for Lake Restoration

Objective 1 – Reduce the rate and extent of sedimentation.
Objective 2 – Reduce total suspended solids.
Objective 3 – Reduce nutrient and pesticide input from the watershed.
Objective 4 – Improve the aquatic life of the lake.
Objective 5 – Improve the recreational use of the lake.
Objective 6 – Educate the public on the importance of good water quality

Watershed Activities

Alternative 1: Stream Bank Stabilization - Meets objectives 1,2,4,5 and 6

Stream banks can be a major contributor of sediments to the lake. The IEPA 303(d) report lists stream bank erosion as a major cause of impairment. The NRCS has identified stream bank erosion as a major contributor of sedimentation in watersheds with similar characteristics as those found in the Glenn Shoals watershed. The stabilization of 2,000 feet of stream banks using rock riffles, rip-rap, bend-way weirs, peak stone etc. throughout the watershed will have a significant impact on sediment reduction (Figure 44, 45). Estimated cost for this alternative is $150,000.

Figure 44 - Rip-Rap Stabilization

Source: University of Illinois Extension

Figure 45 - Rock Riffles

Source: University of Illinois Extension

Alternative 2: Promote Conservation Practices - Meets objectives 1, 2, 3, 4, 5, 6 and 7

Field Borders--Installing field borders around fields will reduce the amount of sediments and nutrients entering the lake, which will improve the water clarity and quality. It will have the added benefit of increasing wildlife habitat.

Soil testing should result in more appropriate use of fertilizers and a reduced nutrient load for the lake. The theory is that when farmers realize through required soil tests that they are applying excessive expensive nutrients they will opt to reduce the amount of fertilizer applied. Since the main concern is for the quantity of phosphorus that is being used, perhaps a government program could be established that would pay for the soil testing for at least the phosphorus. This program would be administered through the NRCS office. With a majority of the area farmers participating, the nutrient load to the lake should be reduced by 10%. This will be accomplished through programs conducted by NRCS or the University of Illinois Extension Office at no cost to the city. (Figure 46)

Figure 46 – Field Borders

Source: University of Illinois Extension

Conservation tillage—Conservation practices can significantly reduce the amount of sediments entering the lake. No-till planting, by utilizing crop residue, will significantly reduce erosion and maintain or improve soil organic matter. (Figure 47)

Figure 47 – Conservation Tillage

Source: University of Illinois Extension

Alternative 3: Increase Riparian Buffers - Meets objectives 1, 2, 3, 4, 5

Increasing the number of acres of riparian buffers in the watershed will help stabilize the soils along the tributaries and will have the added benefit of improving wildlife habitat. This alternative, adding Riparian buffers, will be accomplished through existing CRP subsidies which will pay farmers to implement them. (Figure 48) Funding would be through existing Federal programs administered through the NRCS office.

Figure 48 – Riparian Buffers

Source: University of Illinois Extension

Alternative 4: Sediment Control Structures - Meets objectives 1, 2, 3, 4 and 5

The NRCS has identified a number of possible locations for sediment control structures throughout the watershed. It will not be possible to build all of them due to funding and not all site locations will be available. It is proposed that $200,000 be allocated towards the construction of these sediment control structures. The estimated cost to build all of the structures would be $505,000. These structures will significantly reduce sediment entering the lake.

Narrative from NRCS Glenn Shoals Resource Plan:

Twenty-six potential basin sites (Table 32) are located on the attached USGS map (Figure 49). These sites may not be either publicly accepted or economically feasible. With the exception of site 5B, attempts were made to locate all the basins in deeply incised draws, where the impact on croplands and developing areas would be minimized. For the purposes of estimating costs it is assumed that all basins are dry; that is, no permanent water would be impounded. Also, a rough estimate of costs to construct small basins of $50.00 per acre drained was assumed.

The twenty-six structure sites identified total approximately 10,000 acres. If all twenty-six basins were constructed and trap efficiency was 75%, the total reduction in sediment yield to Glenn Shoals Lake would be 17,250 tons of sediment per year.

Table 32 Potential Sediment Control Basins

Structure Number	**Drainage Area in Acres**	**Estimated Cost**
1A	70	$3,500
2A	41	$2,050
3A	32	$1,600
4A	22	$1,100
5A	61	$3,050
6A	39	$1,950
7A	193	$9,650
8A	149	$7,450
9A	149	$7,450
10A	39	$1,950
11A	121	$6,050
12A	72	$3,600
1B	72	$3,600
2B	31	$1,550
3B	413	$20,650
4B	105	$5,250
5B	4235	$211,750
6B	110	$5,500
7B	594	$29,700
8B	1010	$50,500
9B	1560	$78,000
10B	121	$6,050
11B	259	$12,950
12B	242	$12,100
13B	154	$7,700
14B	209	$10,450
Total	**10,103**	**$505,150**

Add Map (pg118 on Adams) goes here. Full page. Figure 49 USGS Possible Stormwater Retention Ponds

Alternative 5: Storm Water Detention Wetlands - Meets objectives 1,2,3,4,5 and 6
Storm water wetlands have the benefit of reducing sedimentation and filtering nutrients. These systems will have a major impact on nutrient reduction from the watershed. There are a variety of different structures that can be built. It is possible that they can be teamed with one of the of control structures which can reduce the nutrient and sediment loading occurring from these sites. $500,000 should be allocated towards the construction of these systems in site appropriate locations. A particularly effective BMP, and one which will be emphasized for Glenn Shoals Lake, is the multiple extended detention wetland system, which effectively reduces sedimentation as well as nutrient loading. These structures have the added benefit of significantly improving habitat values along riparian corridors of tributaries and drainage ways in the watershed. These systems are commonly known as storm water wetlands, and are described in some detail below. Much of the following information is excerpted from T. Schueller et. al., Design of Storm Water Wetland Systems (1992). See Appendix C, Structure 15B.

Storm water wetlands can be defined as constructed systems that are explicitly designed to mitigate the impacts of storm water quality and quantity that are attributable to various watershed land uses. They do so by temporarily storing storm water runoff in shallow pools that create growing conditions suitable for emergent and riparian wetland plants. The runoff storage, complex micro-topography and emergent plants in the storm water wetland together form an ideal matrix for the removal of watershed pollutants (Table 33) if plant materials are removed on a regular basis. There are a variety of different designs depending on site location. Two of the designs are illustrated below (Figure 50, 51).

Table 33 Projected Long Term Pollutant Removal Rates For Storm Water Wetland in the Mid-Atlantic Region [a, c]

Pollutant	**Removal Rate (%)**
Total Suspended Solids	75%
Total Phosphorus	45%
Total Nitrogen	25%
Organic Carbon [b]	15%
Lead	75%
Zinc	50%
Bacteria	2 log reduction

([a]) *Removal rates apply to storm water wetlands sized as shown in T. Schueller et. al. (1992). Removal rates for pocket wetlands may be lower. These are projected rates, and have not be confirmed by actual monitoring.*

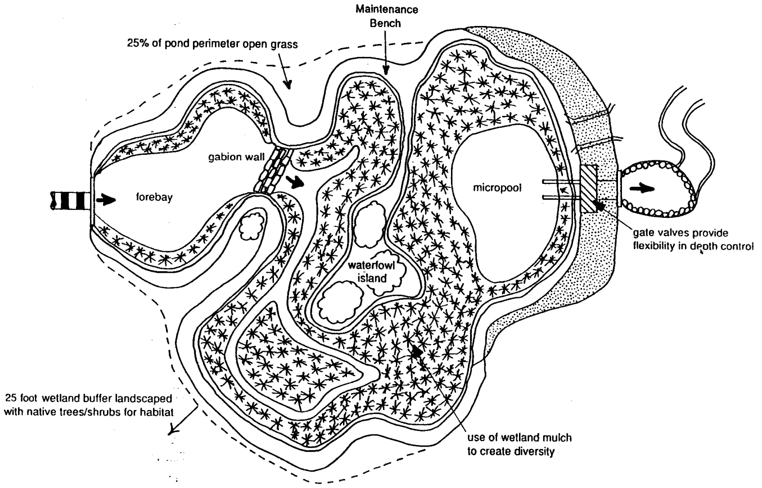
([b]) *Includes five-day, BOD, Total Organic Carbon or Chemical Oxygen Demand.*

([c]) *Phosphorus and nitrogen removal in pond/wetland systems (Design No. 2) are higher due to the effect of the pool. Initally P removal of 65% and N removal of 40% are likely.*

Shallow Marsh System

The shallow marsh design has a large surface area, and requires a reliable source of base flow or groundwater supply to maintain the desired water elevations to support emergent wetland plants (Figure 50). Consequently, the shallow marsh system requires a lot of space and a sizeable contributing watershed area (often in excess of 25 acres) to support the shallow permanent pool.

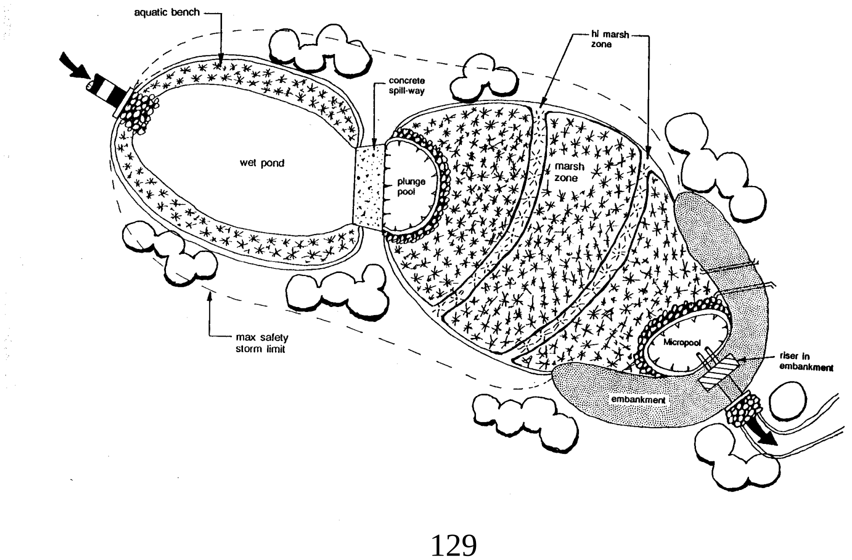
Figure 50 - Shallow Marsh Storm Water Wetland



Pond/Wetland System

The pond/wetland design utilizes two separate cells for storm water treatment (Figure 51). The first cell is a wet pond and the second cell is a shallow marsh. The multiple functions of the wet pond are to trap sediments, reduce incoming runoff velocity, and to remove pollutants. The pond/wetland system consumes less space than the shallow marsh because the bulk of the treatment is provided by the deeper pool rather than the shallow marsh. The nutrient numbers (Table 32) are only valid if a method of removal of the organic materials are utilized in an ongoing manner.

Figure 51 - Pond/Wetland Storm Water System.



Alternative 6: Drawdown Structure 14 Pond to Compact Sediments

The Structure 14 silt basin was designed to be drawn down. The structure should be drawn down in the summer months to compact the sediments and extend the life of the structure. This process will prolong the life of this structure. The costs associated would be for workers' time to draw down and restock the pond this would be approximately $1,000 annually.

Alternative 7: In-lake Control Structure at Meisenheimer Road **-** Meets objectives 1, 2, 4 and 5

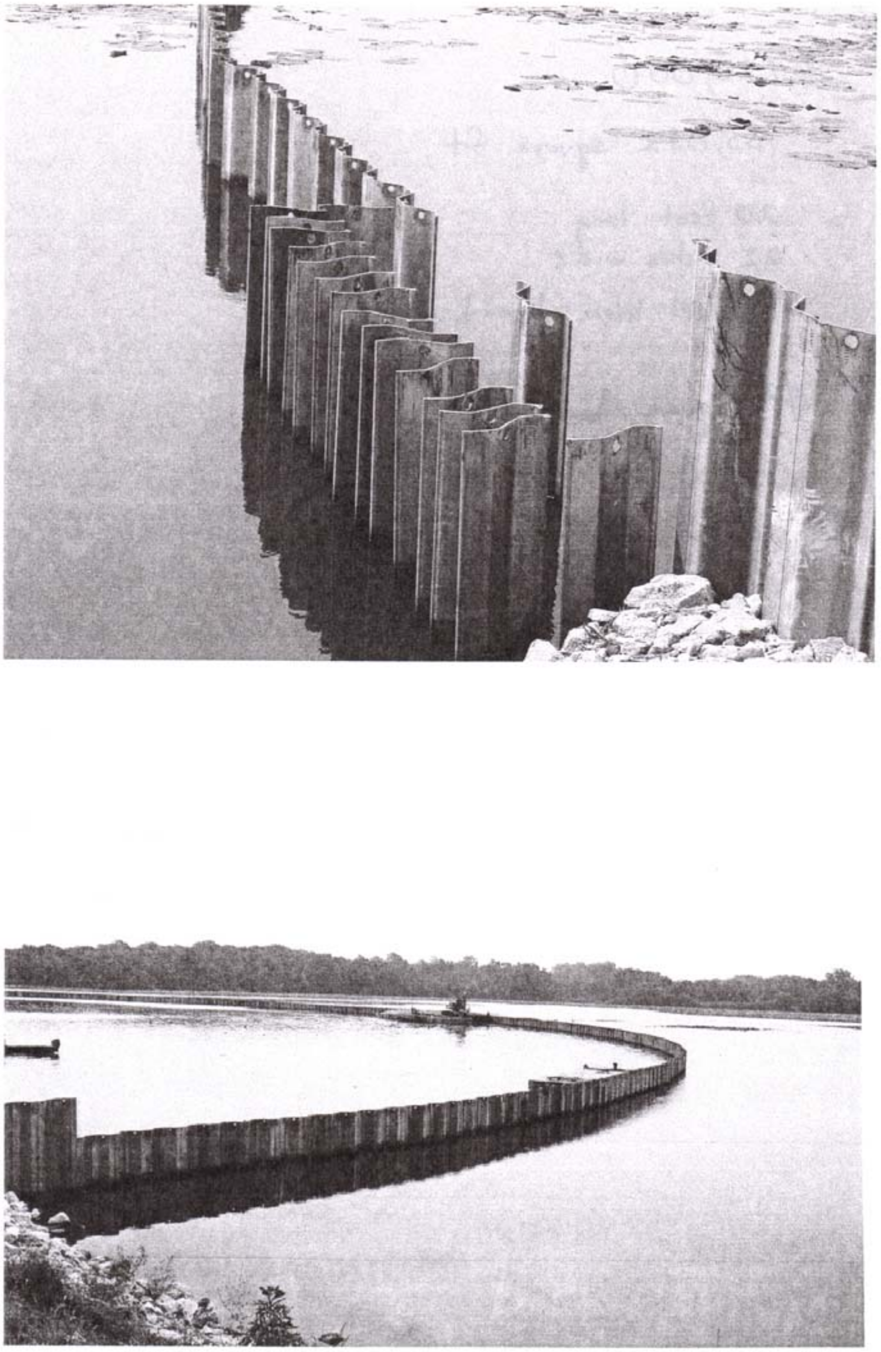
As currently envisioned the structure would be one foot above normal pool (591') except for a notch of 20' wide by 10'deep. This will slow the water to allow the suspended materials to settle out. While the notch will allow normal pool to continue to be at 590' and will provide a place for boats to move back and forth from the upper to the lower end of the lake.

It would be possible to control the sedimentation of the lower portion of the lake by building this in lake control structure (Figure 52) at Meisenheimer Road. It would have two major benefits. The first benefit would be that the structure would reduce the amount of sediment in the south end of the lake and act as a sediment control structure. With an estimated trap efficiency of 50%, 21,000 metric tons of sediment would have been eliminated from the lake south of Meissenhimer Road during the year of the Clean Lakes study period.

The second would be as a nutrient trap. This nutrient trap could be temporary or, by removing the organic materials (plant materials), could perform a long term use. The expected removal rates could range from 10% to as much as 50% if the organic materials, containing the trapped nutrients, were removed frequently (yearly).

Because of the size and location the in lake control structure would be highly efficient however only the two larger streams would be impacted. There would be no affect on ROL04 and ROL05. A negative affect will be that the structure would effectively divide the lake into two smaller lakes or eventually a lake and a wetland. Thus, in time the upper portion of the lake would become a wetland. The estimated cost for this 690 foot long structure would be $572,000 for the structure and $60,000 for engineering and permitting.

Figure 52 - In-Lake Control Structure at Meisenheimer Road

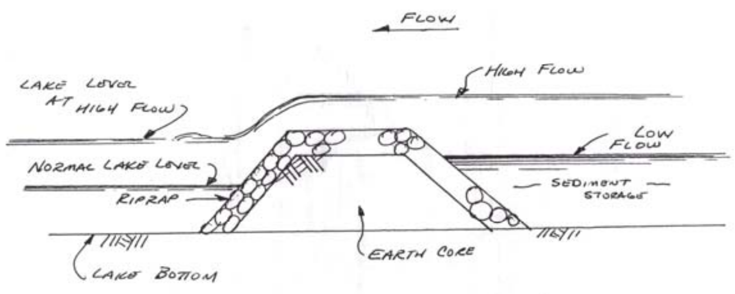


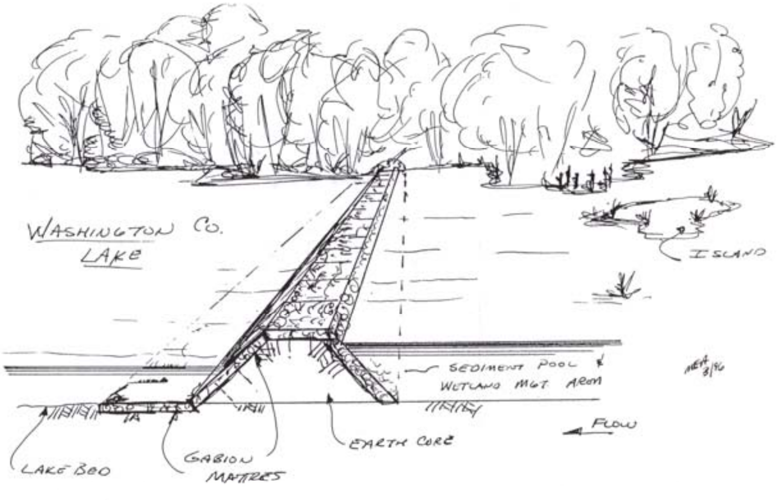
Source: Christian County NRCS

Alternative 8: Create In-Lake Sediment Control Structure and Wetland System in Irving Cove (drains Rolo4 & Rolo5) - Meets objectives 1, 2, 3, 4, 5

The Irving cove, below where the water from Rolo4 and Rolo5 come together, has a watershed of 10,204 acres. During the study period it accounted for 16% of total suspended solids, 14% of total nitrogen and 32% of total phosphorus (Table 14). The structure would be a combination of a sediment control structure and development of a wetland filtering system (Figure 53). The structure would be 550 feet long; would cost $439,000 for construction, $38,000 for engineering/permitting and $35,500 for wetland development. This would compliment alternative 7 and will reduce the sediment coming in from ROL04 and ROL05 below the in-lake control structure in alternative 7.

Figure 53 - In-Lake Sediment Control and Wetlands





Source: NRCS Documents

Alternative 9: Dredging Irving Cove - Meets objectives 1, 5

The hydraulic dredging of 25 acres of Irving cove an additional 5 feet of depth would increase the total volume of the lake. It would also add more recreational area to the lake. Estimated costs are $1,996,500 for the dredging of 201,667 cubic yards at an estimated cost of $10 per cubic yard. Considerations for finding an appropriate location site for the dredged materials along with transportation of the material to site must be further evaluated

Alternative 10: Dredging Fawn Creek Cove - Meets objectives 1, 5

The dredging of 34 acres of fawn creek cove an additional 5 feet of depth would increase the volume of the lake. It would also add more recreational area to the lake. Care should be taken not to destroy existing wetland and wildlife habitat. Estimated costs are $2,715,240 for the dredging of 274,267 cubic yards. Considerations for finding an appropriate location site for the dredged materials along with transportation the material to site must be further evaluated.

Alternative 11: Dredging North End of Lake - Meets objectives 1, 5

Dredging 61 acres at the north end of the lake, north of the fawn creek cove, an additional 5 feet of depth would increase the volume of the lake (Figure 54). It would also add more recreational area to the lake. Care should be taken not to destroy existing wetland and wildlife habitat. Estimated costs are $4,871,460 for the dredging of 492,067 cubic yards. Considerations for finding an appropriate location site for the dredged materials along with transportation the material to site must be further evaluated.

Figure 54 - Dredging

Environmental dredge graphics courtesy of Keene Engineering

Alternative 12: Drawdown North End of the Lake - Meets objectives 1, 5

If the north end of the lake was drained for the summer it would allow the sediments that existed in this portion of the lake to be compacted increasing the overall volume of the lake. Draining only the north end of the lake would allow fish to be maintained in the lower portion of the lake. The estimated cost for this includes the manpower time for city staff to drain the lake. In addition the loss of recreational income from summer activities on this end of the lake should be considered. Cost estimates $5,000.

Alternative 13: Mechanical Dredging of Smaller Lake Coves - Meets objectives 1, 5

There are several smaller lake coves found throughout the lake that could be mechanically dredged. These coves could be dredged by the construction of temporary dams no higher than 10 feet and preferable 5-8 feet. After the temporary dam is in place the water behind it can be pumped out and the cove can be mechanically dredged. The placement of the dredged material must be considered, although it is likely that a suitable site could be found near by. The cost estimates for this would be approximately $75,000 for each cove depending on the site location. Three strategic coves could be done for $200,000.

Alternative 14: Create Brood Pond on South End of the Lake - Meets objectives 4, 5

A brood pond will enable fisheries managers to better stock the lake. In addition, if Alternative 6 is created, the brood pond on the north end of the lake will not be available for stocking the south end of the lake. In 1998 a preliminary design for a brood pond was produced. Using this design a cost can be estimated at $15,000 for the construction of this brood pond (Appendix B).

Alternative 15: Lake Rip-rapping - Meets objectives 1, 2, 3, 4

The city has undergone a large rip-rapping effort to stabilize the existing shoreline and to prevent the sediments from the shoreline from adding to lake turbidity and filling of the lake. The previous mechanism of prison labor is not currently available for this work and other considerations need to be made for continued rip-rapping. Cost estimates from a rip-rapping company are around $40 per linear foot for most areas and $80 + for other areas. With proper design the rip-rap is more likely to remain stable over a longer period of time. The shoreline erosion survey identified 28,895 linear feet of slight to moderate erosion and 2,952 linear feet of sever erosion. If all of the erosion was addressed it would cost $1,391,960 to rip-rap the entire lake. It is recommended that a smaller portion of 3,000 to 5,000 linear feet of rip-rapping be done every year. This rip-rapping would cost between $125,000 and $210,000 including design work.

General Alternatives

Alternative 16: Create Ski-Only Areas - Meets objectives 1, 2, 5

In an effort to better support varied recreational needs for the lake a ski only area will be designated by lake patrol staff. This should be an area that is in the deeper portion of the lake and that has the majority of the shoreline rip-rapped. Skiing in this area will allow other recreational activities to take place on the lake. It will also prevent shoreline erosion caused from skiing activities by limiting skiing to protected areas. The cost for this area will be the cost of rip-rapping the ski area $40 per linear foot, and the cost of markers for the ski area $1,000.

Alternative 17: Increase Patrols and Fees -Meets objectives 1, 2, 5

It is important that existing lake rules are followed and that fees are appropriate to actual costs to the city to maintain the facilities. It is recommended that the city council review their current fees for camping, boat permits and other activities and adjust them as needed.

Alternative 18: Construction Site BMP's - Meets objectives 1, 2, 4, 5

The city will investigate development of mandatory guidelines requiring use of Best Management Practices, such as silt fencing, for all construction within the watershed. Construction projects which disturb one acre or more will be required to provide for silt basins to trap sediments which run off of the site.

Alternative 19: Septic Tank Inspection Program - Meets objectives 3, 4, 5

A regular septic tank inspection for the areas draining into the lake would help prevent sewage contaminant from entering the lake. It will help prevent the spread of disease and reduce the nutrient inputs from these systems. It can be a recommendation from the city that the Montgomery County Department of Health conduct the inspections and report the results to the city. This should be covered by the Department of Health budget.

Alternative 20: Public Land Preservation

By keeping public land along the lake and the tributaries in natural vegetation the influx of nutrients and suspended materials can be greatly reduced.

Alternative 21: Phase II monitoring program

When these alternatives are completed the granting agencies will require that at least one year of monitoring be completed to be able to asses how well the modifications are working to improve the quality of the lake. The city should also continue with a monitoring program to be able to asses the rate of lake change and if any new modifications need to be utilized. The data could be very helpful if another grant was needed to improve the lake.

Alternative 22: Add barley bales

Illinois Environmental Protection Agency has done some preliminary work that suggest that bales of barley added to ponds can greatly reduce the buildup of algae (Corley 2003). Besides reducing the buildup of algae barley bales may also be important in determining the composition of species present. It is presumed that the number of bluegreen algae will be reduced while the more palatable green algae can maintain their numbers to supply the start of the food-chain for higher organisms like fish. Because of the limited cost we contend that it is worth the few thousand to find out if this method of adding 8-12 large barley bales to the lake can be used to reduce the algae blooms found in larger lakes like Glenn Shoals. The reduction of blooms will reduce the algae caused nutrient sediments. This in turn will reduce the nutrients released during the yearly turnover. This will reduce the nutrient load of the lake and will produce a qualitative and quantitative improvement in primary production. The cost for ten barley bales and their strategic location will be $5,000.

Alternative 23: Lake Educational Programs - Meets objective 4, 5, 6

It is important to educate the public on the importance of water quality and ways that individuals can help improve it. This will be accomplished through water quality publications being made available and lake seminars for school groups and interested persons. The cost estimate for these programs is $5,000 per year.

Source: Illinois EPA

B.1.b Expected water quality improvement

Reduce the sedimentation rate by 50%

Reduce total suspended solids entering the lake by 50%

Reduce nutrients (Table 18) by 40% and pesticide input from the watershed

Improve the habitat for aquatic life in the lake

Improve the recreational use (boating, fishing, and water skiing) of the lake

Improve the quality of water used for the production of potable water

B.1.c A detailed description of activities to be undertaken and anticipated lake water quality

See the section in the summary and table 31

See appendix B and C for details concerning the activities to be undertaken.

B. 2. Benefits Expected From Restoration

B2.a. Statement of project objectives

See the objectives listed in B. 1.

B.2.b Discussion of relationship between proposed restoration actions and anticipated water quality changes.

The recommended proposals are designed to primarily maintain the water quality currently available on the Lake. The one recommendation that could provide the most long term benefit is the BMP's throughout the watershed by area farmers. Their reduction of nutrient load by 10-20% could greatly improve the Secchi readings by reducing the algae population in the lake.

B.2.c Discussion of relationship of benefits

The development of areas to slow the water, especially during storm surges, either prior to entering the lake or in the upper end of the lake will reduce the turbidity and can greatly extend the useful life of the lake. The two proposals that best accomplish this task is the Meisenheimer structure which will cause the particulates to participate out in the upper end of the lake and the storm water retention basins. Each of these types of structures will eventually need to be drawn down and cleaned out. The frequency and design of this ongoing process will greatly affect the life of the lake and the quality of the water.

B.2.d Quantitative estimation of benefits

Storm water wetlands can be defined as constructed systems that are explicitly designed to mitigate the impacts of storm water quality and quantity that are attributable to various watershed land uses. They do so by temporarily storing storm water runoff in shallow pools that create growing conditions suitable for emergent and riparian wetland plants. The runoff storage, complex micro-topography and emergent plants in the storm water wetland together form an ideal matrix for the removal of watershed pollutants (Table 32). There are a variety of different designs depending on site location (Figure 50, 51).

Table 33 (Duplicate) **Projected Long Term Pollutant Removal Rates For Storm Water Wetland in the Mid-Atlantic Region** [a, c]

Pollutant	**Removal Rate (%)**
Total Suspended Solids	75%
Total Phosphorus	45%
Total Nitrogen	25%
Organic Carbon [b]	15%
Lead	75%
Zinc	50%
Bacteria	2 log reduction

([a]) *Removal rates apply to storm water wetlands sized as shown in T. Schueller et. al. (1992). Removal rates for pocket wetlands may be lower. These are projected rates, and have not be confirmed by actual monitoring.*

([b]) *Includes five-day, BOD, Total Organic Carbon or Chemical Oxygen Demand.*

([c]) *Phosphorus and nitrogen removal in pond/wetland systems (Design No. 2) are higher due to the effect of the pool. Initally P removal of 65% and N removal of 40% are likely.*

B. 3. Phase 2 Monitoring Program

B.3.a Monitoring program

As part of the restoration program the EPA requires monitoring of the practices implemented in the program. This will give all parties data to evaluate the effectiveness of the restoration program.

The IEPA should continue to monitor the lake under its ambient lake monitoring program. The city should begin monitoring the lake under the IEPA's volunteer lake monitoring program and establish and expand upon this program to monitor all months of the year and include tributary monitoring program similar to that in the Clean Lakes study. The cost estimate is $35,000/year.

Source: Illinois EPA

Tributary Monitoring

Water Quantity
1. Stage-discharge relationships or permanent stations
2. Flow characteristics

Water Quality
1. Total Phosphorus
2. Nitrate + Nitrite Nitrogen
3. Ammonia Nitrogen
4. Total Suspended Solids
5. Non-Volatile Suspended Solids
6. pH

Frequency

Once monthly October-March and twice monthly April-September, with an additional 12-15 storm samples each year

In-Lake Monitoring

Water Quality

1. Total Phosphorus
2. Nitrate + Nitrite Nitrogen
3. Ammonia Nitrogen
4. Total Kjeldahl nitrogen
5. Total Suspended Solids
6. Volatile Suspended Solids
7. Secchi Depth

8. Temperature and DO profiles
9. pH

Frequency

Once monthly October-March and twice monthly April-September, at all historical sampling sites

B.3.b. Provision for continued monitoring for at least one year after Construction

Although, IEPA requires continual monitoring for at least one year after implementation is complete the lake would be best served if a continuing monitoring program could be established. This could provide data to determine if the modifications were continuing to work or if new restoration procedures are needed. The data could also provide strong evidence for new grant proposals for future restoration procedures.

B. 4. Schedule and Budget

See Tables 31 and 34.

B.4.a Proposed milestone work schedule

Table 34	**Work Schedule**		
	2005		
	J F M A M J J A S O N D	**Start**	**Completed**
Watershed Management: Develop controls	___________________	1/1	5/30
Implement controls	_____________________________	6/1	12/31
Agric. BMP Identify Pract. .	__________	1/1	3/30
Implement Pract	________________________________	3/30	11/30
Dredging: Engineering	___________________	1/30	6/30
Construction	__________________________	6/30	12/31
Nutrient control: Design	___________	2/1	4/30
Construction	________________________________	4/30	12/30
Monitoring & Managment	____	1/1	12/30

B.4.b Proposed budget

Budgetary proposals are given in tables 31 and 35.

B.4.c Proposed payment schedule

NA

B. 5. SOURCES OF MATCHING FUNDS

Funding sources for this program include both state and federal agencies, as well as the City of Hillsboro and private sources (foundations, watershed land owners, etc.). Tables 31 and 35 provide details regarding the potential funding sources for this program as it is implemented.

Funding associated with larger projects, such as dredging and rip-rapping the entire lake constitutes a substantial investment by the various granting sources and may not be financially feasible.

B. 6. Relationship to Other Pollution Control Programs

To fully accomplish the tasks listed (Table 35), relationships with Federal and State agencies must be cultivated. It is only with their assistance, can Lake Glenn Shoals become the top quality, long lasting lake it was designed to become. The city personnel needs to work with IEPA, NRCS, SCS, ASCS and Federal Water Quality Management Planning(208) Administrators. The possible funding and guidance that these, and other, agencies can provide will be invaluable.

B. 7. Public Participation Summary

On Jan. 15, 2004, Dr. Ahern made a presentation to those who responded to the articles in the papers concerning the problems and possible solutions at Glenn Shoals Lake. There were approximately ten people in attendance. Most of the questions were concerning material already covered in the main report, these were answered with reasonable ease by Dr. Ahern and Dr. Lang or by a representative of the city. The questions were honest and friendly. The city wants to continue on with the process to protect the lake as soon as possible. There were two Questions that we were unable to answer as fully as we would like.

Insert Table 35 here.

The first was about the actual costs for each of the suggested mitigation/restoration proposals. Since the information was collected three or fours years ago the numbers need to be checked to establish their validity. Also, since the numbers were based on a lake that was three years younger and with three years less sediment this is a valid request. This will be done and the numbers updated in Table 31.

The second question was: "Why are nutrients a Problem? What is acceptable and how far are we from being there?" We were able to give a general answer that was satisfactory at the time, however we need to include more discussion on the trophic condition of the lake to explain this to anyone that may have this question in the future. To accomplish this, Carlson's trophic state Index will be used to show how the lake's averages for chlorophyll a, Secchi depth readings and total phosphorus relates to the trophic state index. This added information will be placed in the Phase I report under section A (10) C, Trophic Condition of the Lake.

1. October 22 nd City Council Power Point Slide presentation.
2. October 24th NRCS Lake advisory meeting
3. Janurary 15th 2004 City Hall, public meeting with Power Point presentation and opportunity for comment for all concerned citizens.

B. 8. Operation and Maintenance (O&M) Plan

B.8.a&b Operation and maintenance requirements and Proposed duration for each component of the project

The City of Hillsboro as owner of Glenn Shoals Lake is primarily responsible for operation and maintenance of the lake and the various components of the restoration program. There are components that will not be under their jurisdiction and legal agreements about access and maintenance of these components need to be made before the construction of these elements. The operation and maintenance aspects of each program component are as follows:

See alternatives 1-23 Table 31. Alternative 1 will not require ongoing O & M but will be evaluated as to effectiveness. Alternatives 2 and 3 will not require ongoing O&M. Alternatives 4 and 5 would require O&M for the life of the structures. Such maintenance would be provided by City personnel. Alternatives 6 and 7 would require O&M every one to three years. Such maintenance would be provided by City personnel. Alternative 8 would require periodic evaluation of its effectiveness and periodic cleaning as sediment accumulates (every 5-6 years). Alternatives 9, 10, 11 and 13 would not require ongoing O&M. Alternative 12 would be an ongoing O&M project for the city but would only be done every 5 to 10 years. Alternative 14 would require O&M for the life of the structure. Alternative 15 will not require ongoing O & M. Alternatives 16, 17, 18, 19 and 20 will not require ongoing O & M but will require continued monitoring of new policies and ordinances. Alternative 21 will be a funded monitoring program to test the effectiveness of the alternatives implemented. Alternative 22 will require annual O&M. Alternative 23 will not require ongoing O & M, but will require continued monitoring of new policies and ordinances.

Sediment Control Structures

Operation of these facilities would only include periodic maintenance. City maintenance personnel will make sure outlet structures are clear of debris. With consultation from the NRCS maintenance personnel will also periodically drawdown these structures to consolidate the sediments. Proper legal easements and access to the sites need to be arranged before construction of each structure.

Storm Water Detention Wetlands

Operation of these facilities would only include the periodic drawdown and cleaning out of the fore bay or sediment basin area of each system. This will be done as needed every 5-10 years. City maintenance personnel will keep the outlet structures clear of debris. City maintenance personnel will conduct periodic drawdown and cleaning out of the sediment basin as needed every 5-10 years.

Structure at Meisenhimer Road

The design of this structure should be made to provide for minimal maintenance. City personnel will need to periodically clear debris from the structure to maintain flow.

Irving Cove Structure

The design of this structure should be made to provide for minimal maintenance. City personnel will need to periodically clear debris from the structure.

Brood Pond

City personnel in coordination with the IDNR will maintain the fisheries in this structure.

Ski Only Area

City lake patrol will maintain the ski area by insuring that the boundary markers remain in the appropriate location as well as enforcing ski regulations.

B.8.c Agencies which will be responsible for O & M

Sections B.8.a, and B.8.b above, indicate the agencies responsible for the Operation & Maintenance plan.

B.8.d Measures for implementing the plan

The Lake Committee will work in conjunction with the City Council of Hillsboro to coordinate the implementation of the Operation & Maintenance plan.

B.8.e Funding sources

Funding sources for this program include both state and federal agencies, as well as the City of Hillsboro and private sources (foundations, watersjhed land owners, etc.).

Clearly, the funding associated with larger projects, such as the structure at Meisenhimer road, constitutes a substantial investment by the various granting sources. The City of Hillsboro is committed to pursuing ebvery technically and financially viable project described in this report, but accepts that without successful pursuit of IDNR C2000 funding or other state or federal financial support, some projects may not be feasible. It is ultimately the responsibility of those agencies dictating the water quality goals to be met by the City of Hillsboro to financially support the measures needed.

B. 9. Copies of Permits or Pending Applications

Various permits will be required before implementation of several of the restoration proposals.

Core of Engineers Section 404a permitting will be required for some shoreline stabilization, dredging some sediment control structures, and storm water wetland systems.

Illinois Department of Water Resources floodway permits will be submitted for shoreline stabilization, dredging, brood pond, Meisenhimer road structure, Irving Cove structure and sediment control structures.

The State Historical Preservation Society will be notified of all of the projects and will respond with potential for archaeological resources at project sites.

Illinois EPA Division of Water Pollution Control permit is required for retention ponds for hydraulic dredging.

An Illinois Department of Water Resources dam permit is required to construct or modify embankments which impound more than a certain size body of water. The structure at Meisenhimer road will need these permits. The structure on Irving cove will need IDWR permits if it impounds more than 50-acre-feet and the embankments are greater than 6 feet in height.

B. 5. SOURCES OF MATCHING FUNDS

Funding sources for this program include both state and federal agencies, as well as the City of Hillsboro and private sources (foundations, watershed land owners, etc.). The following tables provide details regarding the potential funding sources for this program as it is implemented.

Funding associated with larger projects, such as dredging and rip-rapping the entire lake constitutes a substantial investment by the various granting sources and may not be financially feasible.

Table 34. Glenn Shoals Lake Restoration Alternatives, Funding and Mechanism

		Begin	IEPA	Section 319	MCSWCS				
Restoration Alternative	**Total**	**Spring 2004**	**PH II/ LEAP**	**Aug/TMDL**	**IL Dept of Ag**	**City**	**Other**	**Source**	**Mechanism**
Stream Bank	$150,000	$50,000		$ 6,250	$ 37,500		$ 6,250		SWCS
Conservation Practices	N/A								NRCS
Riparian Buffers	N/A								NRCS
Sediment Control Struct	$200,000	$75,000	$37,500	$37,500					Contractor
Storm Water Detention	$500,000	$200,000	$ 80,000	$120,000.0					Contractor
Draw Down Structure 14	$1,000	$1,000				$ 1,000			City
Raise North End of Lake	$460,000								
Irving Cove Structure	$312,500	$312,500	$156,250	$156,250					Contractor
Dredging Irving Cove	$1,996,500								
Dredging Fawn Cove	$2,715,240								
Dredg North End of Lake	$4,871,460								
Draw Down North End	$5,000	$5,000							
Cove Dreding	$120,000	$120,000				$5,000	$115,000	Private	Cont/City
Brood Pond	$15,000	$15,000		$ 15,000				PH 2	Contractor
Lake Rip-Rap	$1,391,960	$35,000	$ 35,000					IEPA	Cont/City
Ski Only Area	$1,000	$1,000				$1,000			City
Increase Patrol and	N/A								City

Fees									
Construction Site BMP's	N/A								City
Septic Tank Inspection	N/A								HD
Lake Eduction Programs	$5,000	$5,000	$ 2,500			$2,500		LEAP	City
Monitoring	$35,000	$35,000				$ 35,000			city
Barley Bales		$5,000							
			PH II/ LEAP	**Aug 319**	**IL Dept of Ag**	**City**	**Other**		
	Total	$857,500	$311,250	$ 335,000	$ 37,500	$44,500.00	$121,250.00		
	Percent		36.30%	39.07%	4.37%	5.19%	14.14%		

B. 6. Relationship to Other Pollution Control Programs

To fully accomplish the tasks listed (Table 33), relationships with Federal and State agencies must be cultivated. It is only with their assistance, can Lake Glenn Shoals become the top quality, long lasting lake it was designed to become. The city personnel needs to work with IEPA, NRCS, SCS, ASCS and Federal Water Quality Management Planning(208) Administrators. The possible funding and guidance that these, and other, agencies can provide will be invaluable.

B. 7. Public Participation Summary

On Jan. 15, 2004, Dr. Ahern made a presentation to those who responded to the articles in the papers concerning the problems and possible solutions at Glenn Shoals Lake. There were approximately ten people in attendance. Most of the questions were concerning material already covered in the main report, these were answered with reasonable ease by Dr. Ahern and Dr. Lang or by a representative of the city. The questions were honest and friendly. The city wants to continue on with the process to protect the lake as soon as possible. There were two Questions that we were unable to answer as fully as we would like.

The first was about the actual costs for each of the suggested mitigation/restoration proposals. Since the information was collected three or fours years ago the numbers need to be checked to establish their validity. Also, since the numbers were based on a lake that was three years younger and with three years less sediment this is a valid request. This will be done and the numbers updated in Table 30.

The second question was: “Why are nutrients a Problem? What is acceptable and how far are we from being there?” We were able to give a general answer that was satisfactory at the time, however we need to include more discussion on the trophic condition of the lake to explain this to anyone that may have this question in the future. To accomplish this, Carlson’s trophic state Index will be used to show how the lake’s averages for chlorophyll a, Secchi depth readings and total phosphorus relates to the trophic state index. This added information will be placed in the Phase I report under section A (10) C, Trophic Condition of the Lake.

1. October 22 nd City Council Power Point Slide show
2. October 24th NRCS Lake advisory meeting
3. Janurary 15th 2004 City Hall Power Point for all concerned citizens.

B. 8. Operation and Maintenance Plan

A. Operation and maintenance requirements for each component of the project

The City of Hillsboro as owner of Glenn Shoals Lake is primarily responsible for operation and maintenance of the lake and the various components of the restoration program. There are components that will not be under their jurisdiction and legal agreements about access and maintenance of these components need to be made before the construction of these elements. The operation and maintenance aspects of each program component are as follows:

Sediment Control Structures

Operation of these facilities would only include periodic maintenance. City maintenance personnel will make sure outlet structures are clear of debris. With consultation from the NRCS maintenance personnel will also periodically drawdown these structures to consolidate the sediments. Proper legal easements and access to the sites need to be arranged before construction of each structure.

Storm Water Detention Wetlands

Operation of these facilities would only include the periodic drawdown and cleaning out of the fore bay or sediment basin area of each system. This will be done as needed every 5-10 years. City maintenance personnel will keep the outlet structures clear of debris. City maintenance personnel will conduct periodic drawdown and cleaning out of the sediment basin as needed every 5-10 years.

Structure at Meisenhimer Road

The design of this structure should be made to provide for minimal maintenance. City personnel will need to periodically clear debris from the structure to maintain flow.

Irving Cove Structure

The design of this structure should be made to provide for minimal maintenance. City personnel will need to periodically clear debris from the structure.

Brood Pond

City personnel in coordination with the IDNR will maintain the fisheries in this structure.

Ski Only Area

City lake patrol will maintain the ski area by insuring that the boundary markers remain in the appropriate location as well as enforcing ski regulations.

B. Proposed duration of the O & M program with justification

C. Agencies which will be responsible for O & M

D. Measures for implementing the plan

E. Funding sources

B. 9. Copies of Permits or Pending Applications

Various permits will be required before implementation of several of the restoration proposals.

Core of Engineers Section 404a permitting will be required for some shoreline stabilization, dredging some sediment control structures, and storm water wetland systems.

Illinois Department of Water Resources floodway permits will be submitted for shoreline stabilization, dredging, brood pond, Meisenhimer road structure, Irving Cove structure and sediment control structures.

The State Historical Preservation Society will be notified of all of the projects and will respond with potential for archaeological resources at project sites.

Illinois EPA Division of Water Pollution Control permit is required for retention ponds for hydraulic dredging.

An Illinois Department of Water Resources dam permit is required to construct or modify embankments which impound more than a certain size body of water. The structure at Meisenhimer road will need these permits. The structure on Irving cove will need IDWR permits if it impounds more than 50-acre-feet and the embankments are greater than 6 feet in height.

Part 3

ENVIRONMENTAL EVALUATION

C. 1. Displacement of People

The restoration plan will not displace any people.

C. 2. Defacement of Residential Areas

Defacement of Residential Areas - Depending on the elevation desired for raising the north end of the lake some residential areas might be affected by flood waters. Efforts will be made to prevent any residential defacement.

C. 3. Changes in Land Use Patterns

The restoration plan will have an effect on land use patterns to a limited extent. The proposed retention pond for dredged material will convert agricultural land for a limited time. The proposed storm water retention basins will permanently affect small areas of farmland. The affected land will be less than 1% of the current agricultural land area.

C. 4. Impacts of Prime Agricultural Land

Impacts on Prime Agricultural Land - There will be little negative changes to prime agricultural lands. Many of the practices will improve and/or maintain the prime agricultural land in the watershed. The storm water retention basins will require the use of some agricultural land, however the effect will actually improve much of the remaining land by reducing the effect of temporary flooding.

C. 5. Impacts on Parkland, Other Public Land, and Scenic Resources

There will be no impacts to parklands, public or scenic resources as a consequence of any activities under this restoration program.

C. 6. Impacts on Historic, Architectural, Archaeological or Cultural Resources

The appropriate people will be apprised of the modifications that will occur. There is no reason to suspect that any historical, architectural or cultural resources will be affected. There will be no impacts to historical, architectural, archaeological, or cultural resources of any kind as a consequence of any activities under this restoration program.

C. 7. Long Range Increases in Energy Demand

There will be no long range increases in energy demand as a consequence of any activities under this restoration program. The improvements should enhance the esthetics and therefore will increase the user population. The increased usage will cause an increase of fuel for automobiles to transport people to and from the lake. Also, more lake usage will cause more fuel consumption by boaters and fishermen.

C. 8. Changes in Ambient Air Quality or Noise Levels

There will be no long term changes in ambient air quality or noise levels as a consequence of any activities under this restoration program. There are likely to be periodic, short-term increases associated with construction of various components of the restoration plan. Since most of this will occur in low population density areas the effects should be minimal.

C. 9. Adverse Effects of Chemical Treatment

Chemical treatment is not a recommended part of the restoration plan.

C. 10. Compliance with Executive Order 11988 on Floodplain Management

This project complies with EO 11988 on Floodplain Management. All projects will be designed not to cause an increase in flood levels. Most of these will actually slow the movement of water in the watershed and would reduce the effects of heavy rains which normally cause flooding.

C. 11. Dredging and Other Channel, Bed, or Shoreline Modifications

Dredged material associated with this project will be placed and confined in an upland area. Materials to be dredged should be free of hazardous materials. Channel modifications, such as stream bank stabilization, will occur in areas which are not jurisdictional waters of the United States under Section 404 of the Clean Water Act. Shoreline stabilization will be conducted in a manner consistent with appropriate permits for such activities. Based on other dredging projects in central Illinois and sediment analyses no special precautions are expected to be necessary for handling dredged material.

C. 12. Adverse Effects on Wetlands and Related Resources

There will be no adverse effects on wetland and related resources as a consequence of any activities under this restoration program. Wetlands and wildlife habitat, riparian buffers and other such resources will be created and enhanced under this program.

C. 13. Feasible Alternatives to Proposed Project

The restoration plan appears to be the best means to meet the objectives set forth in this report. However, it might not be possible to implement all aspects of the plan due to funding constraints. If funding is unavailable, it will be possible to implement portions of this plan.

C. 14. Other Necessary Mitigative Measures Requirements:

There are no other mitigation measures necessary as a part of this restoration program.

ENVIRONMENTAL EVALUATION SUMMARY

1. Displacement of People - The restoration plan will not displace any people.

2. Defacement of Residential Areas - Depending on the elevation desired for raising the north end of the lake some residential areas might be affected by flood waters. Efforts will be made to prevent any residential defacement.

3. Changes in Land Use Pattern - The restoration plan will have an effect on land use patterns to a limited extent. The proposed retention pond for dredged material will convert agricultural land for a limited time.

4. Impacts on Prime Agricultural Land - There will be no negative changes to prime agricultural lands. Many of the practices will improve and maintain the prime agricultural land in the watershed.

5. Impacts on Parkland, Other Public Land and Scenic Resources - There will be no impacts to parklands, public or scenic resources as a consequence of any activities under this restoration program.

6. Impacts on Historic, Architectural, Archaeological or Cultural Resources - There will be no impacts to cultural resources of any kind as a consequence of any activities under this restoration program.

7. Long Range Increases in Energy Demand - There will be no long range increases in energy demand as a consequence of any activities under this restoration program.

8. Changes in Ambient Air Quality or Noise Levels - There will be no long term changes in ambient air quality or noise levels as a consequence of any activities under this restoration program. There are likely to be periodic, short-term

increases associated with construction of various components of the restoration plan.

9. Adverse Effect of Chemical Treatment - Chemical treatment is not a recommended part of the restoration plan.

10. Compliance with Executive Order 11988 on Floodplain Management - This project complies with EO 11988 on Floodplain Management. All projects will be designed not to cause an increase in flood levels.

11. Dredging and Other Channel, Bed or Shoreline Modifications - Dredged material associated with this project will be placed and confined in an upland area. Materials to be dredged should be free of hazardous materials. Channel modifications, such as stream bank stabilization, will occur in areas which are not jurisdictional waters of the United States under Section 404 of the Clean Water Act. Shoreline stabilization will be conducted in a manner consistent with appropriate permits for such activities. Based on other dredging projects in central Illinois and sediment analyses no special precautions are expected to be necessary for handling dredged material.

12. Adverse Effects on Wetlands and Related Resources - There will be no adverse effects on wetland and related resources as a consequence of any activities under this restoration program. Wetlands and wildlife habitat, riparian buffers and other such resources will be created and enhanced under this program.

13. Feasible Alternatives to Proposed Projects - The restoration plan appears to be the best mean to meet the objective set forth in this report. However, it might not be possible to implement all aspects of the plan due to funding constraints. It would be possible to implement smaller portions of this plan.

14. Other Necessary Mitigation Measures - There are no other mitigation measures necessary as part of this restoration program.

ACKNOWLEDGEMENTS

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ADD others from Adam’s and Rachel’s notes!