Kingsbury Park District
Patriots Park Lake

Illinois Environmental Protection Agency

CLEAN LAKES PROGRAM

Phase 1 Diagnostic and Feasibility Study

PATRIOTS PARK LAKE, KINGSBURY PARK DISTRICT, BOND COUNTY, ILLINOIS

Prepared by:

Jerry Sauerwein, Executive Director, Kingsbury Park District
Dan Marsch, Technical Assistant
Matt Shively, Eric Ahern, William Ahern,
Jake Hartter, Zahniser Institute for Environmental Studies
David Patrick, Heartland Ecosystem Services, Inc.
Jeff Stone, Heartland Ecosystem Services, Inc.

TABLE OF CONTENTS

PART 1: DIAGNOSTIC STUDY **Page**

PART 2: FEASIBILITY STUDY **Page**

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

Illinois Clean Lakes Program

Phase I Diagnostic- Feasibility Study of Patriot's Park Lake, Bond County, Illinois

PART 1

DIAGNOSTIC STUDY

INTRODUCTION

Patriot's Park Lake (Greenville Old City Lake), constructed in 1933, is a centerpiece resource for the Kingsbury Park District (KPD). With its convenient access and diverse facilities, the lake is also a major recreational resource for Bond County and surrounding areas (Figure 1). At 26 acres, the lake receives inflow from a total watershed area of 900 acres. Approximately 69% of the watershed is cropland, with the remaining 31% composed of pasture, forest, and urban land uses (Table 9). The lake is entirely owned by the KPD. The lake is also a significant feature of the Shoal Creek Basin and Kaskaskia River (HUC 07140203). Patriot's Park Lake functions in part to control water quality in its contributing watershed area, and so the health of the lake has a significant effect on the health of the larger ecosystem.

Historic data collected by the Illinois Environmental Protection Agency (IEPA) by way of its Ambient Lake Monitoring Program (ALMP), indicated elevated levels of nutrients (nitrogen and phosphorus compounds). This resulted in a major fish kill in 1987. Additionally, there has been an observed loss of volume and surface area in the sediment basin (settling forebay) constructed from a segment of the north end of the lake. The local office of the Natural Resource Conservation Service (NRCS) and its Resource Planning Committee, as well the KPD, have conducted extensive planning and review of the problem. Evidence pointed to use impairment and shortened life span of the lake due to sedimentation, nutrient loading and eutrophication.

In an effort to develop a comprehensive understanding of water quality issues and to aid in developing scientifically sound restoration measures, the KPD applied for a Phase I Diagnostic / Feasibility Study grant from the IEPA. In December of 2000 the KPD submitted a final grant application to the IEPA to study Patriot's Park Lake. The IEPA provided cost sharing for this study through their Clean Lakes Program, funded by the state-sponsored Conservation 2000 (C2K) program in Illinois.

In February of 2001, the Kingsbury Park District was awarded funding for the study of Patriot's Park Lake through the IEPA Clean Lakes Program. Work on the study began in May of 2001 and included extensive field sampling, water quality analyses and data interpretation. The results of this effort are described in the remainder of this diagnostic portion of the report.

Figure 1. Patriot's Park Lake Location

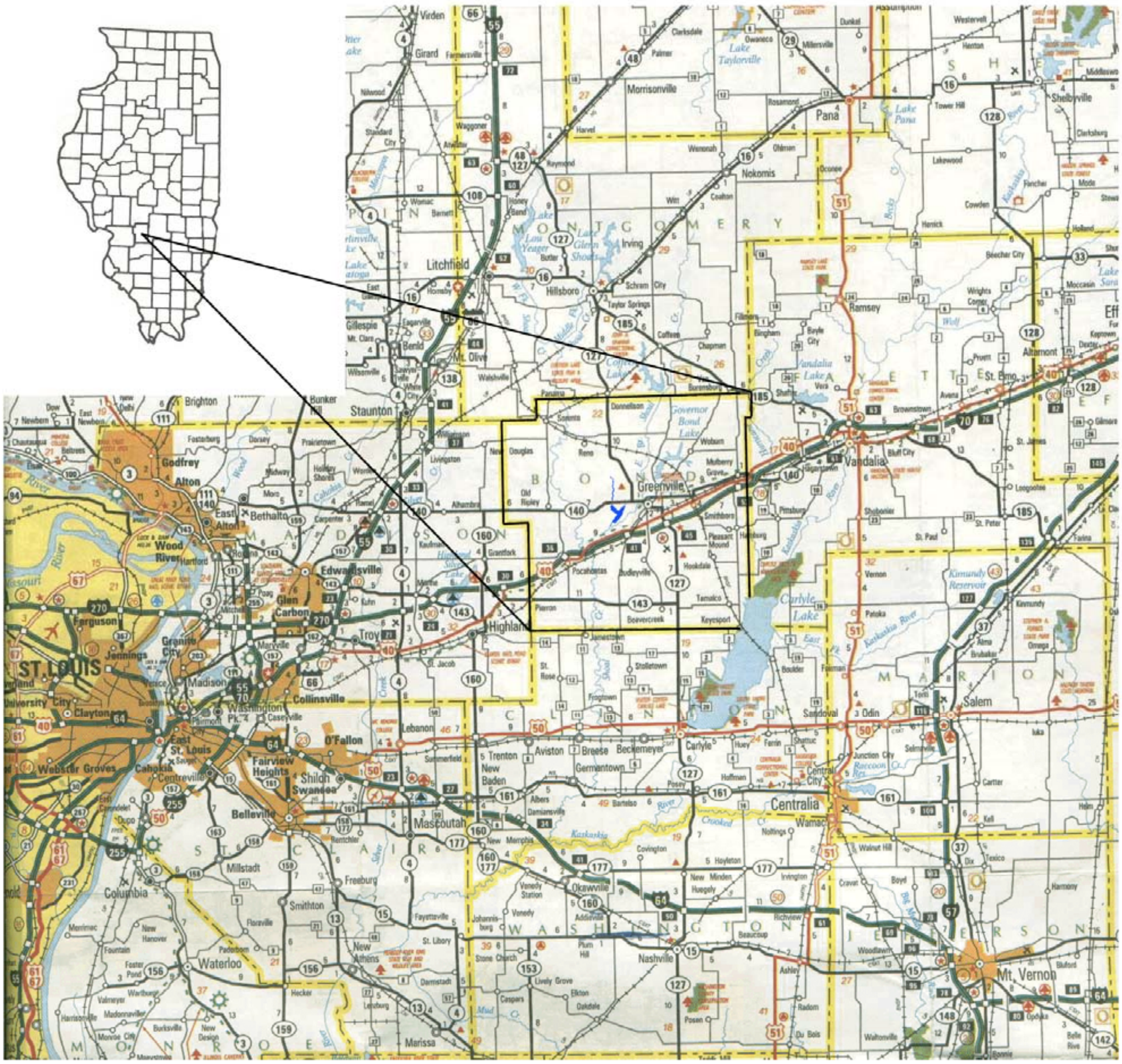


Table 1. Lake Identification and Location

Lake Name	**Patriot's Park (Greenville Old City)**
IEPA Lake Code	**ROY**
State	**Illinois**
County	**Bond**
Nearest City	**Greenville**
Latitude	**38° 53'30"**
Longitude	**89° 26'00"**
USEPA Region	**5**
Major Basin	**07 Upper Mississippi**
Minor Basin	**14 Kaskaskia**
USGS Hydrologic Unit Code	**07140203**
Major Tributary	**None**
Receiving Water Body	**East Fork Shoal Creek**
Water Quality Standards	**Title 35 Environmental Protection; Subtitle C Water Pollution; Chapter I Pollution Control Board; Part 302 Water Quality Standards**

GEOLOGICAL AND SOILS DESCRIPTION OF THE DRAINAGE BASIN

The following geological and groundwater description is primarily taken from a 1995 report compiled by Dr. Leon Winslow, Geology professor at Greenville College (Winslow 1995).

The Greenville area is part of a belt of low ridges and hills that rise above a broad, flat, physiographic area called the Springfield Plain. Here the landscape was shaped largely by great, slow-moving continental masses of ice, called glaciers that covered much of Illinois repeatedly during the past million years or so. Glaciers left deposits of materials on the irregular bedrock surface; these materials, generally unconsolidated, but sometimes as dense as claystone, include pebbly clay (till), water-laid sand and gravel (outwash), and wind-laid silt (loess). The glacial deposits (drift) are 150 feet thick or more in the Greenville area. The soils here, as well as in most of the rest of Illinois, are developed in the upper portion of the glacial deposits.

Evidence for pre-Illinoisan glaciation has been reported. The older glacier came across this area, following about the same path as the Illinoisan glaciers, from a region of snow and ice accumulation in northeastern Canada. Remains of these early deposits have been buried by younger glacial deposits left by Illinoisan glaciers that slowly advanced across the state, establishing the southernmost limit of continental glaciation in North America. Glaciers of Wisconsinan age reached to within about 45 miles northeast of Greenville. Although Wisconsinan drift did not cover the Greenville area, silts and loess of Wisconsinan age do mantle the older Sangamon soil that had developed on the Illinoisan till plain.

Curious features are found on the Illinoisan till plain in the Greenville and adjacent areas: elongated ridges and knolls that trend primarily north-northeast. The elongated ridges are composed largely of sand and gravel, and the knolls scattered across the landscape contain gravel, glacial till, and blocks of ice-thrusted bedrock. The origin of these features has been the object of much debate throughout this century, but the latest research indicates that they are the result of deposition from glaciers that, for the most part, were stagnant. These deposits have been of considerable interest for many years because they are one of the most important sources of building and road materials in southern Illinois.

The relatively loose Quaternary deposits in the Greenville area are underlain by consolidated, layered bedrock strata of late Pennsylvanian age that were deposited in shallow seas that some 275 million years ago repeatedly covered this part of what is now the Mid-continent Region of North America. Relatively thin layers of rock, such as shale, limestone, coal, and sandstone, are exposed only at a few places along stream banks and in quarries and roadcuts. Older strata, known from water, oil and gas prospect wells, have an aggregate thickness here of between 6,000 and 7,000 feet. These strata dip down gently to the south and east into the deeper parts of the Illinois Basin forming a broad, shallow, spoon-shaped bedrock depression that underlies much of southern Illinois and adjacent portions of southwestern Indiana and western Kentucky.

Groundwater (in this area) is obtained from underground reservoirs occurring in beds of saturated glacial sand and gravel or stream alluvium, or in porous or creviced bedrock layers. Groundwater is released slowly in to creeks, lakes, and ponds during dry periods, replenishing water lost through evaporation, outflow, and well water and other withdraws. Exfiltration is not a significant source of water exflow from Patriot's Park Lake.

The original municipal water supply for Greenville was obtained from shallow sand and gravel wells located in the southern part of the city that tapped the Hagarstown Member of the Glasford Formation. In 1923, this location was abandoned when eight new wells ranging from 45 to 60 feet deep were put into service just north of the depot between Second and Third Streets (in Greenville). The combined yield of these new wells was about 195 gallons per minute (gpm). In 1927, seven new wells (average depth, 62 ft.) were opened north of the stockyard; they had a total yield of about 300gpm. Additional exploration, only partially successful, for sand and gravel well sites was undertaken as water demands increased in the 1940s and 1950s. In the late 1960s, damming the Kingsbury Branch north of Greenville formed Governor Bond Lake. This lake covers 775 acres and provides drinking water for the city and surrounding communities. Patriot's Park Lake has never been a municipal raw water source.

The topography of the watershed ranges from nearly level to gently rolling hills which become increasingly steep in proximity to streams. Nearly 70% of the land area in the watershed is in agricultural production. Three percent of the watershed, occurring mostly along streams, is forested. The remainder is either pasture, residential or open water.

Soil Associations

Major soil associations found within the Patriot's Park Lake watershed include:

- Oconee-Darmstadt Association (~54%): Nearly level or gently sloping, somewhat poorly drained soils that have a slowly permeable or very slowly permeable subsoil and formed in loess; on uplands

- Ava-Hickory-Parke Association (~41%): Gently sloping to steep, moderately well drained or well drained soils that have a very slowly permeable or moderately permeable subsoil and formed in glacial till or in loess and glacial drift; on uplands

- Piasa-Cowden Association (~5%): Nearly level, poorly drained soils that have a very slowly permeable or slowly permeable subsoil and formed in loess; on uplands

Table 2. Soil Types and Characteristics

Soil Types in Patriot's Park Lake Watershed			
Type	**Percent**	**Slope**	**Eroded**
Cowden Silt Loam	1.19	0-5	no
Cowden-Piasa Silt Loam	30.44	0-5	no
Oconee Silt Loam	0.59	0-2%	no
Oconee Silt Loam	1.19	2-5%	no
Oconee Silt Loam	3.57	2-5%	yes
Oconee-Darmstadt Silt Loam	5.95	0-3	no
Oconee-Darmstadt Silt Loam	7.25	2-5%	yes
Hosmer Silt Loam	1.1	2-5%	no
Stoy Silt Loam	8.44	0-2%	no
Stoy Silt Loam	10.58	2-5%	no
Stoy Silt Loam	2.62	2-5%	yes
Pike Silt Loam	4.28	2-5%	no
Wakeland Silt Loam	0.71	0-2	no
Percent of total:	77.91		
Percent Eroded Soil Type:	13.44		
Atlas Silty Clay Loam	5.11	5-10%	yes
Parke Silt Loam	1.31	5-12%	yes
Hosmer Silt Loam	1.9	5-10%	yes
Percent of total:	8.32		
Percent Eroded Soil Type:	8.32		
Hickory Silt Loam	13.79	15-30%	no
Percent of total:	13.79		
Percent Eroded Soil Type:	13.79		

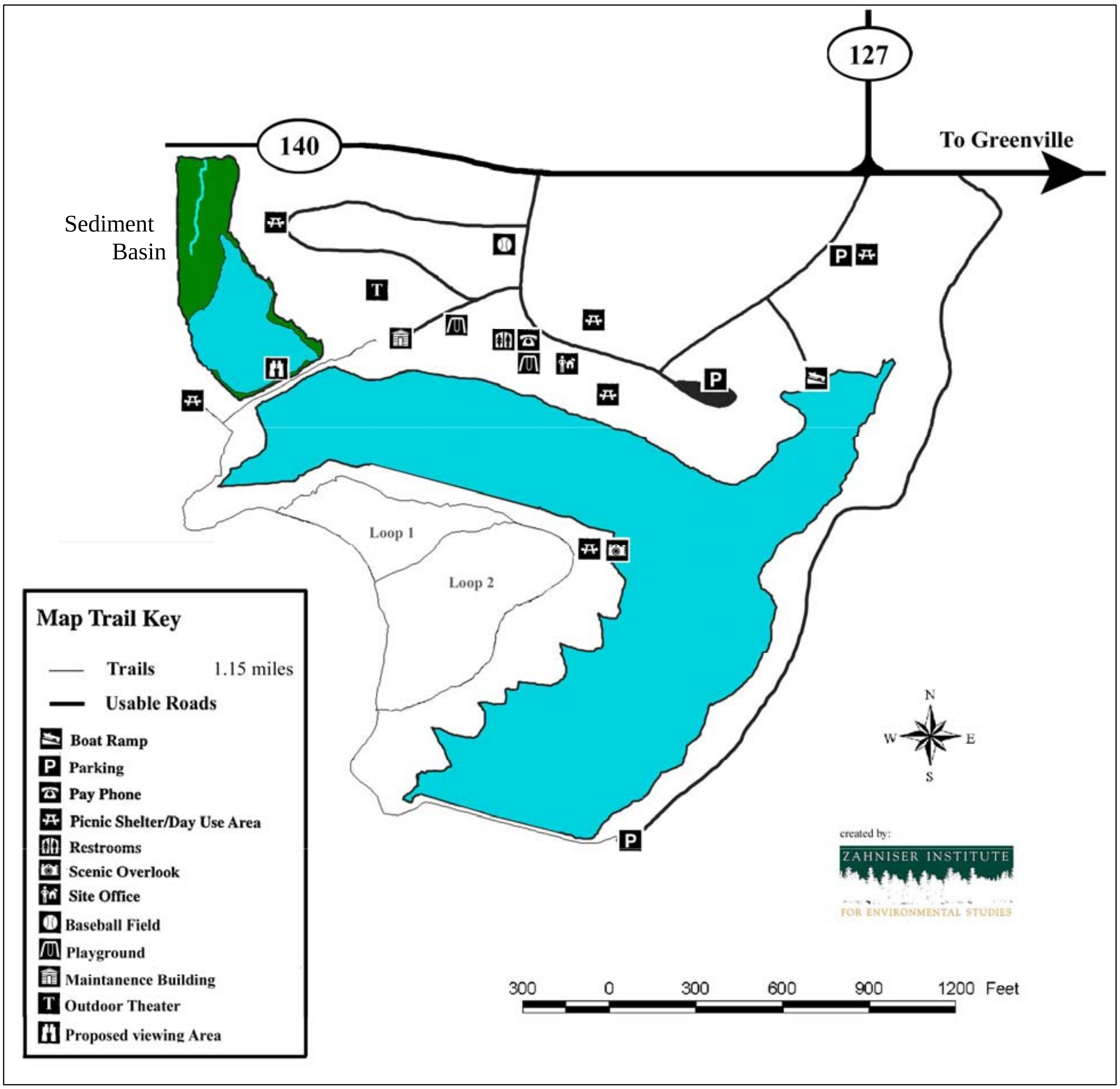
Table 2 presents the actual soil types and percentages found within the watershed. Information on percent slope and erosion is also presented. Soil type areas were measured with a digital planimeter, within a watershed boundary super-imposed on a soils map. Information on erosion is taken from the general soil description, and is not derived from site-specific inventory or other measured means. All information on soils in this report is taken from the Soil Survey of Bond County, Illinois, U.S. Department of Agriculture Soil Conservation Service, 1983.

PUBLIC ACCESS AND BENEFIT

The lake and the surrounding 105-acre park provide substantial benefits to the local and regional population, as well as a highly valued recreational resource. Patriot's Park is a popular fishing location drawing local residents and others throughout the region. The lake was stocked annually from 1992 to 2002 with channel catfish and rainbow trout, and stocked with largemouth bass in five of those ten years. The trout stocking program, which continues annually, is a particular attraction for many recreational anglers every year.

Facilities available at the lake include a playground, four covered pavilions, an amphitheatre, open mowed park grounds, three miles of nature trails through the woodlands around the lake, 14 picnic tables with fixed grills, two large stone fireplaces, four fire pits, a sports field, public restrooms, and a pay telephone (Figure 2). A one-lane, gravel boat ramp is located at the northeast end of the Lake. The KPD charges an annual boat access fee of $5.00 for park district residents, and $10.00 for non-residents. Canoes, rowboats, and trolling-motor driven motor boats are allowed on the lake.

Figure 2. Map of Lake Access.



The KPD is solely responsibly for all park operations and management with the exception of the lake fishery which is managed by the Illinois Department of Natural Resources, Division of Fisheries. The park facilities are open year round from sunrise to sunset.

Patriot's Park and its lake serve as a major resource for local and regional citizens and public groups seeking outdoor recreational facilities. The site has traditionally hosted an annual Independence Day fireworks display, an event that draws thousands of visitors each year. Some outdoor theatre events are also held at the park. Additionally, the large pavilion hosts a steady stream of family reunions, civic functions, corporate outings, Boy Scout Troop meetings and other group recreational experiences. Reservations for this facility must usually be made well in advance. Area college athletic teams use the trails surrounding the lake for cross-country meets every year. The close proximity to Greenville and other cities in the region, combined with the facilities and ample open space available to the public, bring significant numbers of day-use visitors.

Because the diverse facilities within the park occur in such close proximity to the lake, the health of the lake and its viability as a resource are closely tied to the valuation of the other services that the park provides. Extending the life of this water body and the quality of the water and habitat it provides will have a tremendous positive effect on the long-term importance of Patriot's Park as a whole.

Local Interest & Resource Commitment

There have been many gracious volunteer efforts to support the quality of recreation at Patriot’s Park Lake. Within the past decade, volunteers from civic and educational institutions have supplied all equipment and supplies necessary to grade and chip all of the park’s roads, plant trees and ground cover to prevent erosion, surface the hiking/biking trails with wood chips, clear brush to enable greater access, paint structures, and landscape. In possibly the greatest demonstration of appreciation of the lake, 20+ volunteers donated all necessary time, effort, equipment, and supplies to restore the lake’s spillway and associated bridge. The cost of this project was estimated at over $200,000.

Because Patriot's Park Lake is managed by the Kingsbury Park District (a public agency), matters concerning the lake are open for discussion at monthly board meetings. Lake issues repeatedly come up for discussion. Public input is welcome at these meetings, and citizen interests can be presented there.

SIZE AND ECONOMIC STRUCTURE OF POTENTIAL USER POPULATION

Distance From Communities

The approximate center of Patriots Park Lake is 1 ½ miles west of the approximate center of the City of Greenville, 16 miles from the City of Highland, 18 miles from the City of Hillsboro, 18 miles from the City of Vandalia, and 19 miles from the City of Carlyle.

The lake is located approximately 3.5 miles from Interstate 70. Major roads near the lake include Highway 140 and Highway 127. Access to the lake is provided by the Kingsbury Park District through Patriot's Park at the junction of Highways 140 and 127.

Public Transportation

Bond County Transit, which is operated out of the Bond County Senior Center, Inc., provides service to Patriot's Park Lake. Fees for one-way trips are $1.00 for seniors (60+), $1.50 for adults, and $0.50 for children up to twelve years old.

Potential User Population

The user population of Patriot's Park Lake is comprised mainly of residents from Bond County and the surrounding counties as well as portions of the St. Louis metropolitan area. Within 50 miles, the potential user population is estimated to be 819,032. Table 3 shows the populations of counties with at least half of their area within the 50 mile (80 km) radius. Table 4 shows the populations of cities with populations greater than 10,000 within a 50 mile (80 km) radius. Population figures were taken from United States Census Bureau statistics. The nearest major metropolitan area to Patriot's Park Lake is St. Louis, which 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 are described in Tables 3 and 4 and shown in Figure 1, Location Map.

Table 3. Potential User Population By County

Counties Accessible Within 50 Mile (80 km) Radius	
County	*Population*
Bond	**17,633**
Christian	**35,372**
Clinton	**35,535**
Effingham	**34,264**
Fayette	**21,802**
Macoupin	**49,019**
Madison	**258,941**
Marion	**41,691**
Montgomery	**30,652**
St. Clair	**256,082**
Shelby	**22,893**
Washington	**15,148**
Total:	**819,032**

Table 4. Potential User Population by City

Cities With Populations ≥ 10,000 Within 50 Miles (80 km)	
City	*Population*
Alton	**30,496**
Belleville	**41,410**
Centralia	**14,136**
Collinsville	**24,707**
East St. Louis	**31,542**
Edwardsville	**21,491**
Fairview Heights	**15,034**
Glen Carbon	**10,425**
Granite City	**31,301**
O'Fallon	**21,910**
St. Louis	**348,189**
Swansea	**10,579**
Taylorville	**11,427**
Wood River	**11,296**
Total:	**623,943**

Economic characteristics of Bond County

A comparison of household incomes between Bond County, Illinois, and the entire U.S. is given in Table 5. Table 5 shows that, for the year 1999, Bond County had a greater number of households below the $50,000 per house-hold income level than the state or the nation as a whole.

Employment sectors in Bond County

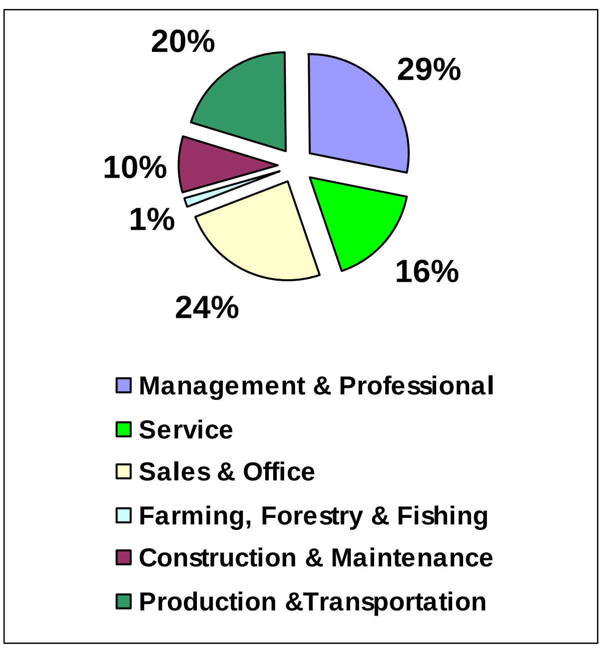
In the past Bond County has traditionally been a farming community. Current employment figures show that only a very small portion of the workforce is employed in the farming industry, while nearly 50% are employed in the management, professional, and service industries (Figure 3).

Table 5. Household Income Comparison (1999)

	Bond County		Illinois		U. S.
Households	6,147	100.0%	4,592,740	100.0%	
$0-$10,000	616	10.0%	383,299	8.3%	9.5%
$10,000-$14,999	433	7.0%	252,485	5.5%	6.3%
$15,000-$24,999	805	13.1%	517,812	11.3%	12.8%
$25,000-$34,999	905	14.7%	545,962	11.9%	12.8%
$35,000-$49,999	1,270	20.7%	745,180	16.2%	16.5%
$50,000-$74,999	1,176	19.1%	952,940	20.7%	19.5%
$75,000 to $99,999	614	10.0%	531,760	11.6%	10.2%
$100,000 to $149,999	236	3.8%	415,348	9.0%	7.7%
$150,000 to $199,999	54	0.9%	119,056	2.6%	2.2%
$200,000 or more	38	0.6%	128,898	2.8%	2.4%
Median Household Income	37,680		46,590		

SUMMARY OF HISTORICAL LAKE USES

Figure 3. Employment Sectors in Bond County



The lake has been a premiere recreational resource since its construction in 1933. Prior to its construction, the area was used as a small golf course. Patriot's Park was originally managed by the City of Greenville. In 1972, the land, facilities and management were transferred to the newly formed Kingsbury Park District. Much of the records for the lake prior to this transition are not accessible. However, historical records show that Patriot's Park and the lake have long been considered an outstanding facility, particularly given its location near smaller communities.

The construction of the park in its original configuration was completed in 1940. Much of the work done there was completed through the use of Civilian Conservation Corp (CCC), Public Works Administration (PWA), and Works Progress Administration (WPA) labor and funds. At the time of the park's construction, nearly 200 men were housed at the CCC camp in Greenville. Funds were also raised from local civic groups. The park has the distinction of being the only park in the state to be financed by a women's organization, the Women's Federate Club of Greenville. At the park's dedication in 1934, a bronze plaque commemorating this honor was unveiled (Bond County Historical Society 1979).

In 1952, the shelter house north of the main drive was added. This facility remains today, and is one of most frequently used facilities at the lake. The band shelter near the west end of the park was constructed in 1960. The shelter and amphitheater began receiving less use in the 1970's, and the shelter covering was torn down in 1980. Recently, electricity was added to the amphitheater area and this facility has experienced a revitalization of use for community theater and other events.

Prior to the mid-1970's, swimming was one of the primary recreational activities enjoyed at Patriot's Park. Figures 4 to 7 show photographs of how the lake appeared at various periods in time. These photographs were obtained from postcards in the collection of a local historian. A large diving tower was present near the north shore of the lake, with smaller diving structures and piers on the beach. The bathhouse and concession stand have now been replaced with a picnic shelter. All of the diving structures were removed prior to 1990, and the remains of the wooden piers were removed prior to 2000. Before the construction of the Greenville Municipal Swimming Pool in 1979, all municipal swimming lessons were held at Patriot's Park. Many of the residents of Greenville and the surrounding communities have important historical ties to the lake because of the time spent there as children. Swimming in Patriot's Park was discontinued in approximately 1974 by the Bond County Health Department due to poor water quality (Bill Davidson, personal communication 2002).

Fishing and lakeside recreation are the two major activities that occur on the lake. Other activities include boating, camping, cross-country skiing, horseback riding, hiking, picnicking and various educational activities. There is very little data regarding past lake usage, but information was obtained from boat permit data and fishing license data and estimates were made based on interviews and personal observations (Table 6).

Figure 4 Diving Structures & Bath House

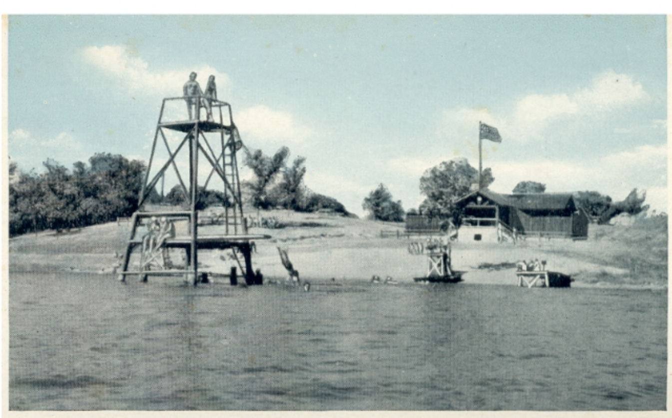


Figure 5. Diving Tower & Other Features.

Figure 6. Bath House

Figure 7. Patriot's Park Lake NW End, Before Sediment Basin Construction

Table 6. Historical Lake Usage

Use	Year	Units
Boat Permits	1999-2003	169 permits
Pavilion	2000	7,547 attendees
	2001	8,551 attendees
	2002	8,996 attendees
D.A.R.E Car Show	2001	800 attendees
	2002	875 attendees
Independence Day	Annual	2,500 attendees
Utlaut Hospital Picnic	Annual	~ 750 attendees
General visitation	Annual	4,000-5,000 daily visits
School Field Trips	Annual	~ 300 participants
Fishing Derby	1999	35 participants
	2000	65 participants
	2001	65 participants
	2002	80 participants
Outdoor Performances	2002 (year begun)	250 attendees

POPULATION SEGMENTS ADVERSELY AFFECTED BY LAKE DEGRADATION

Recreational Fisherman

Low visibility and dissolved oxygen levels can have serious consequences for game fish. Low body weight, low fecundity (birth rates) and periodic fish kills dramatically reduce the average age and body mass of standing stock. Recreational fishermen experience reduced fishable area when shallow sections of a water body are rendered inaccessible by boat due to sedimentation. Recreational fishing is one of the most important activities at the lake, drawing anglers from as far away as the St. Louis metropolitan area.

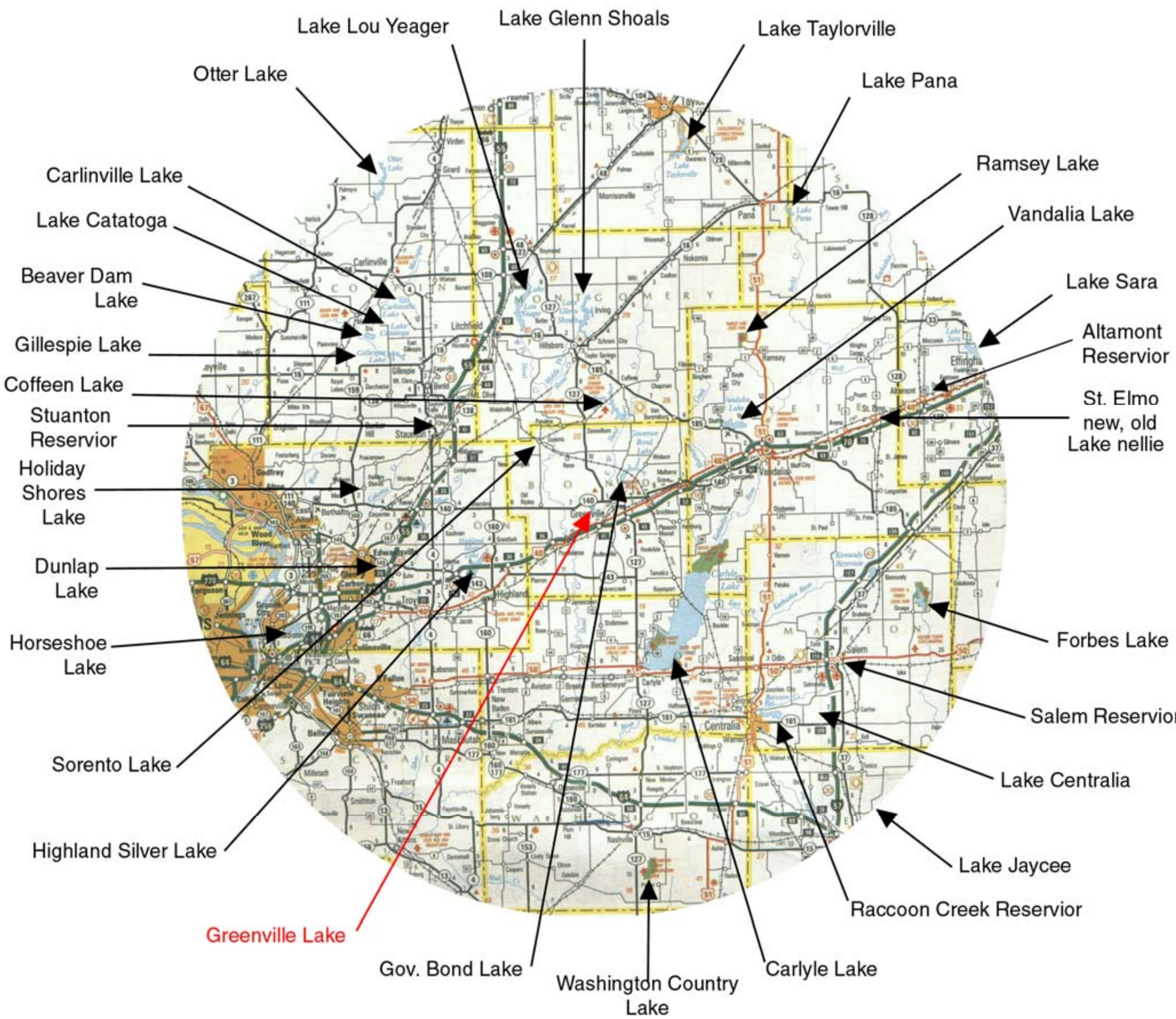
COMPARISON OF LAKE USAGE TO OTHER LAKES WITHIN 80 KM

There are a number of lakes found within 80 kilometers of Patriot's Park Lake (Table 7 and Figure 8). The majority of those lakes are found in the Middle Kaskaskia River/Shoal Creek Watershed. The only other lakes 10 acres or greater located entirely in Bond County are Governor Bond Lake (ROP) at 775 acres and Sorento (ROZH) at 11 acres.

Table 7. Lakes within 80 Kilometers of Patriot's Park Lake

Lake	Code	Acres	Fishing	Boating	Hiking	Camping	Horse Back
Patriot's Park	ROY	26	X	X	X		X
Altamont New	RCJ	57	X	X			
Carlinville	RDG	168	X	X	X	X	
Carlyle	ROA	24580	X	X	X	X	
Centralia	ROI	450	X	X	X		
Coffeen	ROG	1038	X	X	X		
Forbes	RCD	525	X	X	X	X	
Gillespie New	SDU	207	X	X			
Gillespie Old	SDT	71	X	X			
Glenn Shoals	ROL	1350	X	X	X	X	
Governor Bond	ROP	775	X	X	X	X	X
Highland Silver	ROZA	550	X	X	X		
Hillsboro Old	ROT	108.7	X	X	X	X	
Holiday Shores	RJN	430	X	X			
Horseshoe	RJC	2170	X	X	X		
Lou Yaeger	RON	1205	X	X	X	X	
Mount Olive New	RJF	47.8	X	X			
Mount Olive Old	RJG	32.5	X	X			
Nashville City	ROO	37.2	X	X			
Pana	ROF	219.5	X	X			
Otter	RDF	765	X	X	X	X	
Raccoon	ROK	970	X	X	X		
Ramsey	ROE	46	X	X	X	X	
Salem	ROR	74.2	X	X			
Sara	RCE	765	X	X	X	X	
Staunton	RJA	84	X	X			
St. Elmo New	ROM	68	X	X	X	X	
St. Elmo Old	ROQ	25.3	X	X			
Taylorville	REC	1148	X	X	X	X	
Vandalia	ROD	660	X	X	X	X	
Walton Park	ROU	25	X	X			
Washington Co.	RNM	295	X	X	X	X	

Figure 8. Lakes Within 80 Km



INVENTORY OF POINT SOURCE POLLUTION DISCHARGES

There are currently no point source pollution discharges located in the Patriot's Park Lake watershed.

LAND USES AND NONPOINT POLLUTION LOADING

Bond County Tillage Practices

According to the Illinois Soil Transect Survey summary (Table 8), 28% of the cropland in Bond County is farmed using conservation tillage. Conservation tillage can greatly reduce the amount of soil erosion and help reduce the amount of sedimentation that collects in lakes. Conservation tillage also helps reduce nutrient loading from agriculture runoff.

Table 8. Bond County Tillage Practices

	Corn/acres	Soybean/acres	Small grains/acres	Total
Conventional	72,815	36,481	11,453	120,749
Reduced	0	0	0	0
Mulch	424	2,121	3,818	6,363
No-Till	1,697	18,240	20,786	40,723
N/A/ Unknown	0	0	0	0
Total	**74,936**	**56,842**	**36,057**	**167,835**
Percent Conservation Tillage	**3%**	**36%**	**68%**	**28%**

Source: 2001 Illinois Soil Conservation Transect Survey Summary

Patriot's Park Lake Watershed Land Use

The Patriot's Park drainage basin is composed of row crops, pasture, hayland, woodland, wetland and minor development (roadway, low density residential, etc.). A breakdown of land uses as a percentage of the total drainage basin is presented in Table 9. The majority of the drainage basin is used for cultivated row crops.

Table 9. Patriots Park Lake Land Use

Land Use	*Acres*	*Hectares*	*% of Total*
Size	900	364	100
Cropland	623	252	69
Hay/Pasture	99	40	11
Urban/Farmstead	46	18	5
Recreational	73	30	8
Forest	31	13	3.5
Lakes & Ponds	28	11	3.5

Nonpoint Pollution

The primary concerns of nonpoint pollution in the watershed are eroded soils and nutrients from agricultural areas. Septic tank effluent entering the lake does not represent a significant contribution of nutrients but is a concern for introduction of pathogens into the system.

Runoff from agricultural land can contribute significantly to the sediment and nutrient loads for a lake. NRCS investigations in 1996 revealed that within the sediment basin of the lake, the average depth of silt deposits was 61 inches. Given the 63-year time span between the construction of the lake and the NRCS study, the rate of volume loss in the sediment basin would be nearly an inch per year. Additionally, NRCS staff observed a reduction in sediment basin water surface area from an estimated 3.6 acres at its construction to approximately two acres at the time of the study. Recent global positioning system (GPS) data taken by KPD staff confirms the present surface area at normal pool. Within the remaining normally inundated area, depths have been reduced to an average of 1.15 feet. This loss of volume has a significant impact on the effectiveness of the sediment pond.

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 nutrient loading of the lake. Lawn fertilizers from homes as well as nutrients from septic systems contribute to the nutrients entering the lake. There are two potential sources of sewage effluent located on the park property. The caretaker’s house is served by a septic tank and leach field that is greater than 25 years old and the new public restrooms completed in September 2002 are served by a septic tank and sand filter system with a chlorination tank before its discharge point. Both of these systems discharge onto the hillside on the north shore of the lake. The system serving the new restroom facility is checked on a regular basis and chlorine tablets are added as needed. The discharge outlet for this system is approximately 50 feet from the lakeshore. The ground between this outlet and the shoreline edge is heavily vegetated and this vegetation acts as a filter for this effluent. The waste system for the caretaker house consists of a septic tank and a leach field approximately 50 feet from the lakeshore. There is no evidence of any effluent seepage on the ground surface in this area. Unfortunately, the size and condition of this system is not known and the leach field for this system may be inadequate. The septic tank was last pumped in 2002. Construction projects can add large amounts of sediment to the lake if control structures are not in place. Construction runoff is currently not a problem in the watershed. Lake front that is not properly protected with rip-rap or other erosion control material can contribute significant amounts of sediment to the lake. There is an area of severe erosion approximately 10 feet high and 40 feet long on the south side of the lake that is contributing moderate quantities of sediment to the lake.

Estimates of sediment loading by land-use category are given in Table 10.

Table 10. Sediment delivery based on Universal Soil Loss Equation												
SOIL ASSOC.	**TOTAL ACREAGE**	**% SLOPE**	**LAND USE**	**PERCENT OF TOTAL**	**ACREAGE**	**L/S**	**K**	**C**	**A=RKCPL/S (T/AC)**	**SOIL LOSS (TONS)**	**DELIVERY RATE**	**SEDIMENT TO LAKE (TONS)**
1	157	0-2%	agricultural	17.4	152	0.1	0.4	0.4	2.88	437.76	0.25	109.44
			urban	0.6	5	0.1	0.4	0.03	0.216	1.08	0.25	0.27
2	279	0-5%	agricultural	29.7	259	0.15	0.4	0.4	4.32	1118.88	0.3	335.66
			pasture	2.3	20	0.15	0.4	0.05	0.54	10.80	0.3	3.24
5	436	0-5%	agricultural	20.6	180	0.15	0.4	0.4	4.32	777.60	0.3	233.28
			pasture	1.1	10	0.15	0.4	0.05	0.54	5.40	0.3	1.62
			urban	2.2	19	0.15	0.4	0.03	0.324	6.16	0.3	1.85
			woodland	1.1	10	0.15	0.4	0.009	0.0972	0.97	0.3	0.29
		5-12%	agricultural	3.7	32	0.18	0.4	0.4	5.184	165.89	0.5	82.94
			woodland	1.4	12	0.18	0.4	0.009	0.11664	1.40	0.5	0.70
			pasture	2.4	21	0.18	0.4	0.05	0.648	13.61	0.5	6.80
		15-30%	urban	2.5	22	1.5	0.4	0.03	3.24	71.28	0.75	53.46
			pasture	9.7	85	1.5	0.4	0.05	5.4	459.00	0.75	344.25
			woodland	5.2	45	1.5	0.4	0.009	0.972	43.74	0.75	32.81
TOTALS					**872**					**3113.56**		**1206.62**

Soil Association

1. Piasa- Cowden Association: Nearly level, poorly drained soils that have a very slowly permeable subsoil and formed in loess; on uplands.

2. Oconee - Darmstadt Association: Nearly level or gently sloping, somewhat poorly drained soils that have a slowly permeable or very slowly permeable subsoil and formed in loess; on uplands.

5. Ava - Hickory - Park Association: Gently sloping to steep, moderately well drained or well drained soils that have a very slowly permeable or moderately permeable subsoil and formed in glacial till or in loess and glacial drift; on uplands.

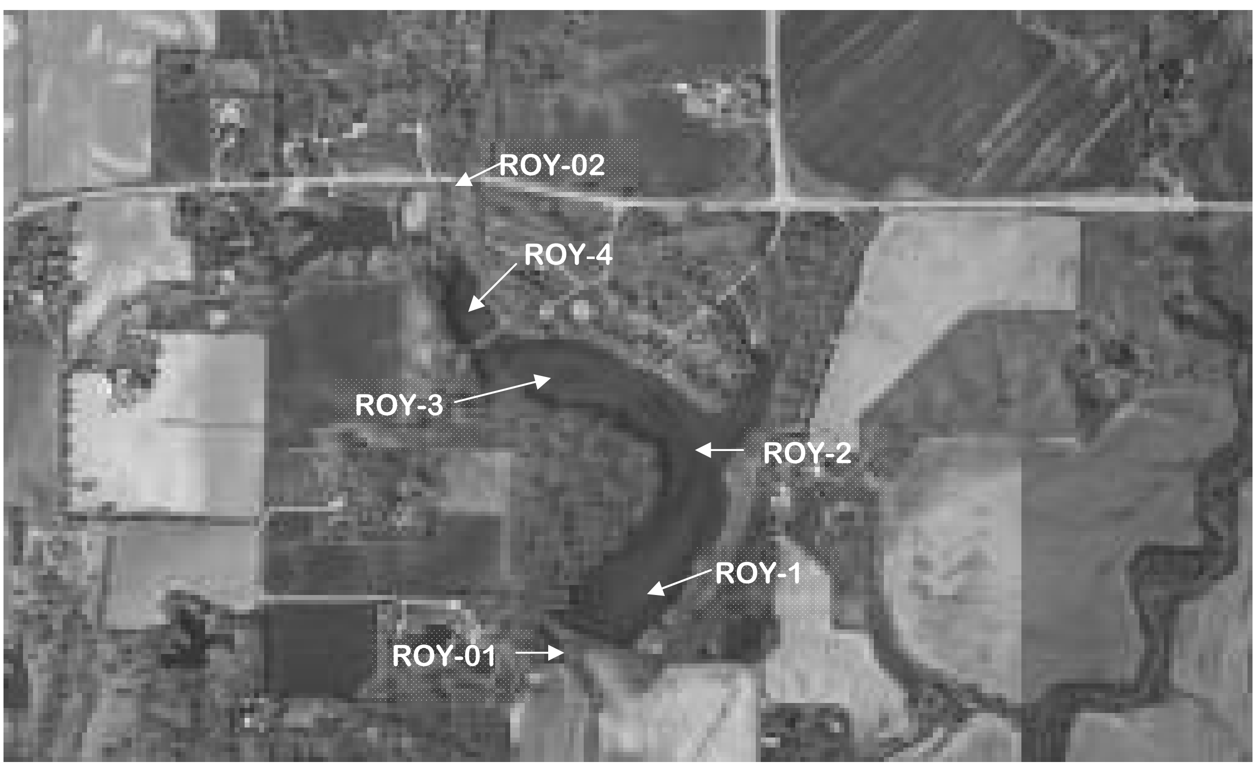
LAKE MONITORING

Three in-lake site locations have been sampled since 1993: ROY-1t (top sample) and ROY-1b (bottom sample) at the south end of the lake; ROY-2 in the center of the lake; and ROY-3 on the north-west end of the lake (Figure 9). Also in this study sediment samples were collected from a site in the silt basin. This site was designated ROY-4.

Current water samples were collected by KPD staff and shipped according to IEPA protocol to IEPA laboratories for analyses. Samples were analyzed for total suspended solids (TSS), volatile suspended solids (VSS), total phosphorus, dissolved phosphorus, kjeldahl nitrogen, nitrate-nitrogen and ammonia nitrogen.

In addition, field water quality data was collected to provide concurrent readings for water temperature, pH, conductivity, dissolved oxygen and turbidity, as well as Secchi disk readings and overall environmental observations (outside temperature, precipitation, etc.).

Figure 9. Patriot's Park Lake Sampling Sites



HYDROLOGIC, SEDIMENT AND NUTRIENT BUDGETS

An annual water budget was calculated for Patriot's Park Lake using established IEPA and state water survey protocol. 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, a staff gauge was placed in the major tributary as close to the lake as possible. This was at site ROY-02, south of Illinois Route 140. Kingsbury Park District staff members recorded the stream height on the staff gauge on a daily basis. Cross-sections of the stream were measured at the gauge site. A relationship was established for the area of the cross-section in relation to staff gauge height and flow velocity in feet-per-second was measured using a Global Water flow measuring instrument. Flow and area measurements were combined to establish a relationship between staff height and stream discharge at the cross-section. Calculations were then used to determine the volume of water, in acre-feet, entering the lake each day from the tributary. In addition to water flowing in from the watershed, direct precipitation onto the lake surface was calculated from daily rain amounts recorded at the caretaker's house located on the north shore of the lake.

The outflow from Patriot's Park Lake included evaporation from the lake and discharge over the spillway. A staff gauge was placed near the outflow of the lake, at ROY-01 in order 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 capacity of the lake's spillway was determined through use of the weir equation: $Q = C\,L\,H^{(3/2)}$, where Q is the outflow rate in cubic feet-per-second, C is the weir coefficient based on H, L is the length of the outlet in feet, and H is the headwater depth in feet (Haan 1994). Evaporation was calculated using 50 years of historical evaporation rates in Illinois (Roberts and Stall 1967). Multiplying the area of the lake by the inches of evaporation, a volume of evaporation was calculated. The difference between the outflow and the inflow is a net hydrologic loading that indicates either a greater inflow or greater outflow. The hydrologic budget presented in Table 11 indicates that during the study period there was a net inflow of approximately 1,330 acre-feet.

Table 11. Hydrologic Budget

	INFLOW			OUTFLOW		
Month	**Tributaries (acre-ft)**	**Lake Precipitation (acre-ft)**	**Monthly Inputs (acre-ft)**	**Spillway Discharge (acre-ft)**	**Lake Evaporation (acre-ft)**	**Monthly Outputs (acre-ft)**
May-01	153.7	8.09	161.82	74.9	10.6	85.5
Jun-01	53.8	4.48	58.25	116.2	12.4	128.5
Jul-01	104.3	6.40	110.70	34.2	14.2	48.4
Aug-01	116.8	6.84	123.61	8.3	11.7	19.9
Sep-01	75.9	5.35	81.23	0.0	8.3	8.3
Oct-01	228.5	10.50	239.01	23.5	5.2	28.7
Nov-01	72.1	5.21	77.28	106.4	2.6	109.0
Dec-01	120.4	6.97	127.35	59.8	1.2	61.0
Jan-02	34.3	3.62	37.97	130.3	1.2	131.5
Feb-02	6.9	2.01	8.89	146.5	1.9	148.4
Mar-02	81.4	5.56	86.97	54.7	4.1	58.8
Apr-02	207.3	9.83	217.13	366.8	7.4	374.2
Annual Total	**1255.3**	**74.86**	**1330.20**	**1121.5**	**80.8**	**1202.3**

Nutrient and Sediment Loading

Nutrients from nonpoint pollution sources consist of nitrogen and phosphorous which originate primarily from the fertilized fields in the watershed. The nutrients are measured as total phosphorous (TP) and total nitrogen (TN). Nutrients and sediment can enter the lake from a variety of different sources: fertilizers, livestock waste, septic systems, atmospheric deposition, waterfowl, etc. As there are very few septic systems within the watershed and the Patriot's Park septic systems are functioning properly there is no significant input from this source. The low numbers of migrating waterfowl visiting the lake and the lack of a resident population of waterfowl would indicate that this is also an insignificant nutrient source to the lake. According to information obtained from Lawrence etal. 1999, total atmospheric nitrogen input may be as high as 1.8 kg/ac in Illinois. Applying this figure to the Patriot's Park watershed area would result in an atmospheric nitrogen input of approximately 47 kg (0.3% of the total input) to the lake. Phosphorus inputs for this part of the country are generally considered negligible (Goldman and Horne, 1983).

Nutrient and sediment loading were both figured two ways. Sediment loading was figured using one method, USLE as shown previously in Table 10, and method 2 using Volatile Suspended Solids shown in Table 13. Nutrient loading was figured first using Nutrient Loss Rates as shown in Table 12, and again a second method shown in Table 14 and 15. Method 2 measured nutrients and sediments coming from the tributary 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 the staff gage flow relationship, the nutrient and sediment loads in kilograms were calculated for the main tributary (Tables 13, 14 and 15).

Nutrient Load from Lake Sediment

The lake itself can be a major contributor of nutrient loading. Nutrients bound in the sediments on the bottom of the lake, as well as nutrients in dying plant material, contribute to the nutrient loading of the lake. When the dissolved oxygen concentration within about 1 m (3 feet) of the bottom of the lake reaches <1mg/L, phosphorus trapped in the sediments is released (Nürnberg, 1995). 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 regeneration. The internal phosphorus load was calculated by first examining the oxygen profiles (Appendix D) to determine the depths at which the dissolved oxygen levels fell below the 1 mg/L level. When this concentration was found within about 1 m (3 feet) of the lake bottom the sediment-water interface was assumed to be anoxic. The period of anoxia, in days, was then multiplied by the corresponding hypolimnetic area (m^2) and then multiplying this number by a phosphorus release rate of 12 mg/m^2/day (Nurnberg, 1984) and a nitrogen release rate of 120 mg/m^2/day (Fillos and Swanson, 1975) for lake sediments under anaerobic conditions. This was done for Site 1 and Site 2 (Appendix F). The phosphorus released from oxic sediments was accounted for by using a rate of 0.3 mg/m^2/day (Nurnberg, 1984). Approximately 805 kg of nitrogen (6% of the total input) and 152 kg of phosphorus (4.7% of the total input) were released from the sediments (Table 14, 15). Estimates of nutrient loading by land-use category are given in Table 12.

Table 12. Annual Nonpoint Nutrient Loading

ANNUAL NONPOINT NUTRIENT LOADING					
		TOTAL PHOSPHORUS		TOTAL NITROGEN	
Non-Point Sources	Ha	NLR	kg/yr	NLR	kg/yr
Agriculture	252.1	4.51	1137	16.1	4058.8
Pasture	55	1.5	82.5	8.7	478.5
Woodland	27.1	0.25	6.775	2.9	78.59
Urban	18.6	1.92	35.712	10	186
TOTAL LOADING			1262		4801.9

Nutrient Loss Rate (NLR) calculated from Lou Yaeger TMDL

Sediment from Shoreline Erosion

Using information from the shoreline erosion study, 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 55,600 kg per year of soil enters the lake from shoreline erosion (Hill 1994). This amounts to 6.5% of the total sediment entering the lake. The main tributary input accounts for the rest of the total.

Patriot's Park Lake Historical Data

The IEPA sampled Patriot's Park Lake in 1993 as part of their Ambient Lake Monitoring Program (ALMP) and this historical data is presented in Tables 16 and 17 for comparison purposes to 2001-2002 data.

Table 13. Sediment Budget

PATRIOT'S PARK SEDIMENT BUDGET SUMMARY MAY 2001 to APRIL 2002			
	INPUTS	OUTPUTS	
Date	Tributaries (kg)	ROY-01 Spillway Discharge (kg)	
May-01	18,381	1,682	16,699
Jun-01	15,557	2,700	12,856
Jul-01	9,606	773	8,833
Aug-01	0	188	-188
Sep-01	0	0	0
Oct-01	6,617	523	6,094
Nov-01	26,236	2,387	23,848
Dec-01	155,976	1,267	154,709
Jan-02	59,816	3,225	56,591
Feb-02	80,682	3,750	76,932
Mar-02	202,082	1,151	200,931
Apr-02	199,153	10,231	188,922
Subtotal	774,106	27,877	746,229
Shoreline Erosion	55,600	0	55,600
Annual Total (kg)	829,706	27,877	801,829
Annual Total (tons)	913	31	882
Total Inflow (kg)			829,706
Total Inflow (tons)			913
Total Outflow (kg)			27,877
Total Outflow (tons)			31
Net Loading (kg)			801,829
Net Loading (tons)			882

Table 14. Nitrogen Budget

PATRIOT'S PARK NITROGEN BUDGET SUMMARY MAY 2001 to APRIL 2002			
	INPUTS	OUTPUTS	
Date	Tributaries (kg)	ROY-01 Spillway Discharge (kg)	
May-01	394	20	374
Jun-01	513	137	376
Jul-01	149	1	147
Aug-01	0	0	0
Sep-01	0	0	0
Oct-01	273	2	271
Nov-01	323	12	311
Dec-01	1,819	354	1,465
Jan-02	1,050	252	798
Feb-02	1,820	408	1,412
Mar-02	3,259	168	3,091
Apr-02	3,045	1,673	1,372
Subtotal	12,643	3,026	9,617
Internal Regeneration	805	0	805
Atmospheric Deposition	47	0	
Annual Total (kg)	13,495	3,026	10,469
Annual Total (tons)	15	3	12
Total Inflow (kg)			13,495
Total Inflow (tons)			15
Total Outflow (kg)			3,026
Total Outflow (tons)			3
Net Loading (kg)			10,469
Net Loading (tons)			12

Table 15. Phosphorus Budget

PATRIOT'S PARK PHOSPHOROUS BUDGET SUMMARY MAY 2001 to APRIL 2002			
	INPUTS	OUTPUTS	
Date	Tributaries (kg)	ROY-01 Spillway Discharge (kg)	
May-01	81	2	79
Jun-01	82	18	63
Jul-01	40	0	40
Aug-01	0	0	0
Sep-01	0	0	0
Oct-01	37	0	37
Nov-01	113	1	112
Dec-01	543	54	489
Jan-02	264	46	218
Feb-02	368	69	299
Mar-02	824	20	805
Apr-02	787	333	454
Subtotal	3,140	545	2,595
Internal Regeneration	152	0	152
Annual Total (kg)	3,292	545	2,747
Annual Total (tons)	4	1	3
Total Inflow (kg)			3,292
Total Inflow (tons)			4
Total Outflow (kg)			545
Total Outflow (tons)			1
Net Loading (kg)			2,747
Net Loading (tons)			3

Table 16. Historical Water Quality Data (IEPA)

PATRIOT'S PARK LAKE HISTORICAL WATER QUALITY DATA													
SITE	Depth feet	Turbidity NTU	Secchi inches	pH	COD mg/l	Total Alkalinity mg/l CaCo3	Phenol Alkalinity mg/l	TSS mg/l	VSS mg/l	Ammonia Nitrogen mg/l	TKN mg/l	Nitrate-Nitrogen mg/l	TP mg/l
Roy-1 Top	1	25	20	9.9	28	104	28	17	9	0.07	0.60	0.02	0.111
Roy-1 Bottom	12	20	---	6.8	28	142	0	27	14	3.90	---	0.01K	1.65

Note: All data collected by IEPA 8-18-93.
"K" means concentration is less than value shown.

Table 17. Historical Sediment Analysis Data (IEPA)

PATRIOT'S PARK LAKE HISTORICAL SEDIMENT ANALYSIS DATA																	
Site	Depth ft	TSS %	VSS %	TKN mg/kg	TP mg/kg	Potassium mg/kg	Arsenic mg/kg	Barium mg/kg	Cadmium mg/kg	Chromium mg/kg	Copper mg/kg	Lead mg/kg	Manganese mg/kg	Nickel mg/kg	Silver mg/kg	Zinc mg/kg	Iron mg/kg
ROY-1	14	28	12.1	2286	1409	2100	8.10	284	1.00K	25	38	31	1000	21	1.00K	98	29000

Note: All data collected by IEPA 8-11-93
See Table 20 for sediment classifications.
"K" means concentration is less than value shown.

CURRENT LIMNOLOGICAL DATA

Current limnological data as reported here includes both existing data from various sources (NRCS, US Geological Survey, State Water Survey, IEPA and USEPA, among others) as well as data collected from the present study. Baseline morphometric data is provided (Table 18) as well as detailed results from the year-long data gathering effort of the KPD.

Table 18. Morphometric Data

Watershed Area	900 acres	364.23 hectares
Surface Area	26 acres	10.52 hectares
Shoreline Length	1.5 miles	2413.5 meters
Mean Depth	8 feet	2.26 meters
Maximum Depth	16.0 feet	4.88 meters
Volume	224.4 acre-feet	276,793.3 cu. meters
Retention Time	0.2 years	
Lake Type	Reservoir / Dam & Spillway	
Year Constructed	1933	

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 life 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, eggs and larva, and can clog fish gills and reduce the growth rate of fish and other aquatic organisms. Turbidity can severely restrict the zone within the lake where visually feeding fish can efficiently find and attack their prey (Thornton et al., 1990).

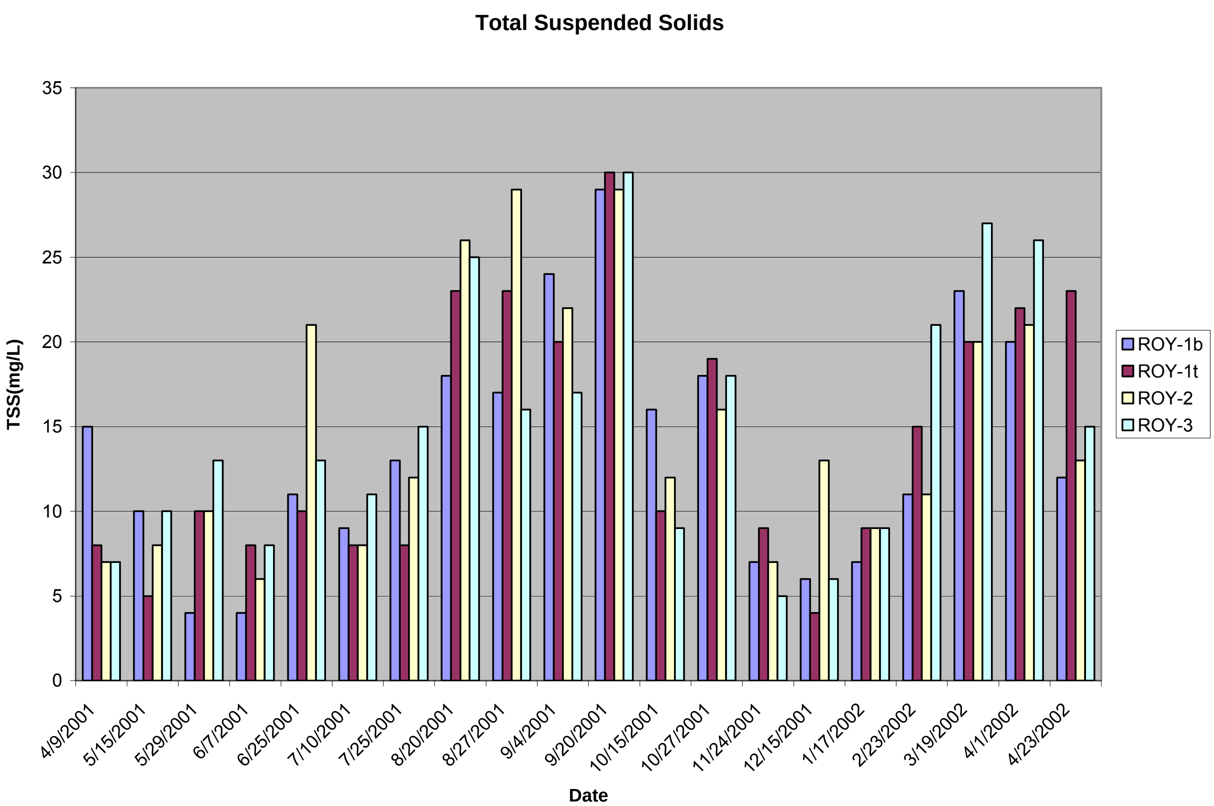
There are several ways that suspended materials in Patriot's Park Lake were measured. The components measured included: total suspended solids (TSS), volatile suspended solids (VSS), non-volatile suspended solids (NVSS) and secchi depth. Water samples were collected by KPD staff and analyzed for TSS and VSS at IEPA laboratories. TSS is the sum of VSS and NVSS. Secchi depth was measured and recorded by KPD staff when water samples were collected.

The relationship between VSS and NVSS gives an indication of the source of suspended solids in the water. At all locations VSS was a higher percentage than NVSS. This indicates that there is a large amount of organic material. This distribution is likely an indication that algae growth in the lake is a greater source of turbidity than soil washing in from the tributaries or bottom sediments being stirred up.

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 on 9/20/2001 at all three sites. TSS levels on this date also appear to be correlated with high volatile suspended solid (VSS) levels and the lowest secchi readings (Figure 13) of the sampling period.

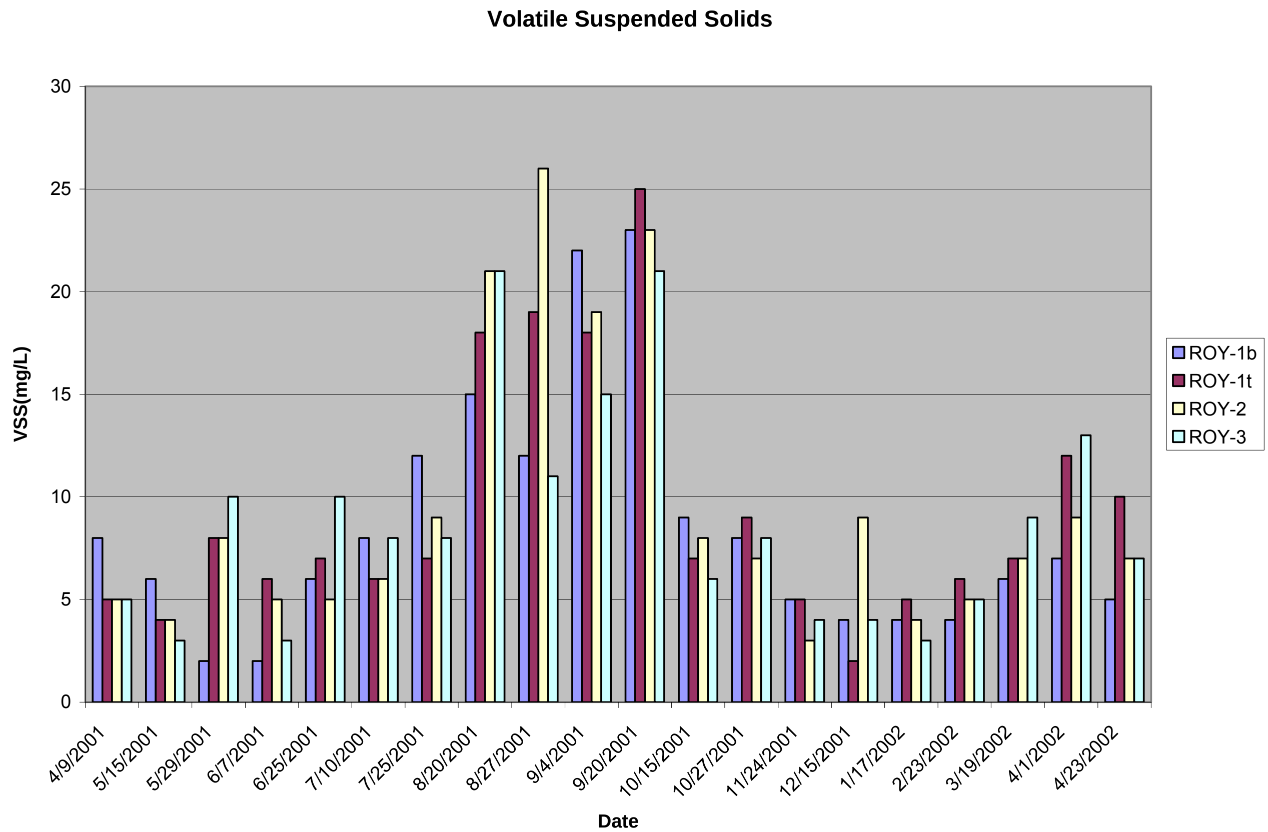
Figure 10.



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. VSS peaked on 9/20/01 at ROY-1 and ROY-3, and 8/27/01 at ROY – 2 (Figure 11). All VSS peak levels corresponded with low Secchi depths and high chlorophyll a numbers (Figures 13, 31). These levels also appear to be correlated with phytoplankton volumes at ROY – 1 (Appendix A) which were at their highest levels during this period.

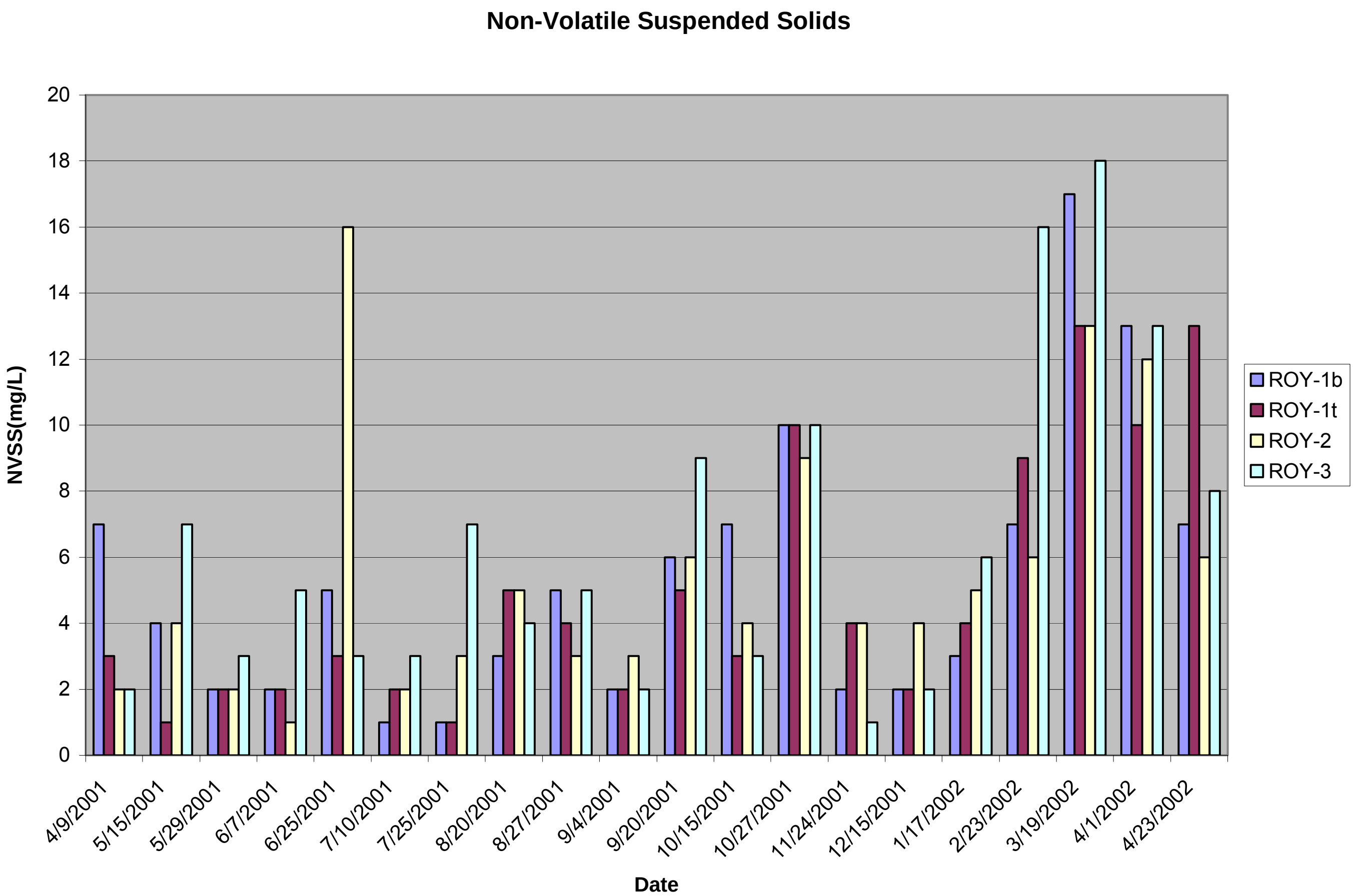
Figure 11.



Non-Volatile Suspended Solids

Non-Volatile Suspended Solids (NVSS) is the portion of TSS that is not VSS. NVSS is the non-organic portion of TSS. This includes soil eroded and transported from the watershed into the lake. NVSS is used by the IEPA as a parameter in their Aquatic Life Use Impairment Index (ALI). Peak readings for Patriot's Park Lake occurred at ROY-2 on 6/25/01 and at sites ROY-1 and ROY-3 on 3/19/02.

Figure 12.

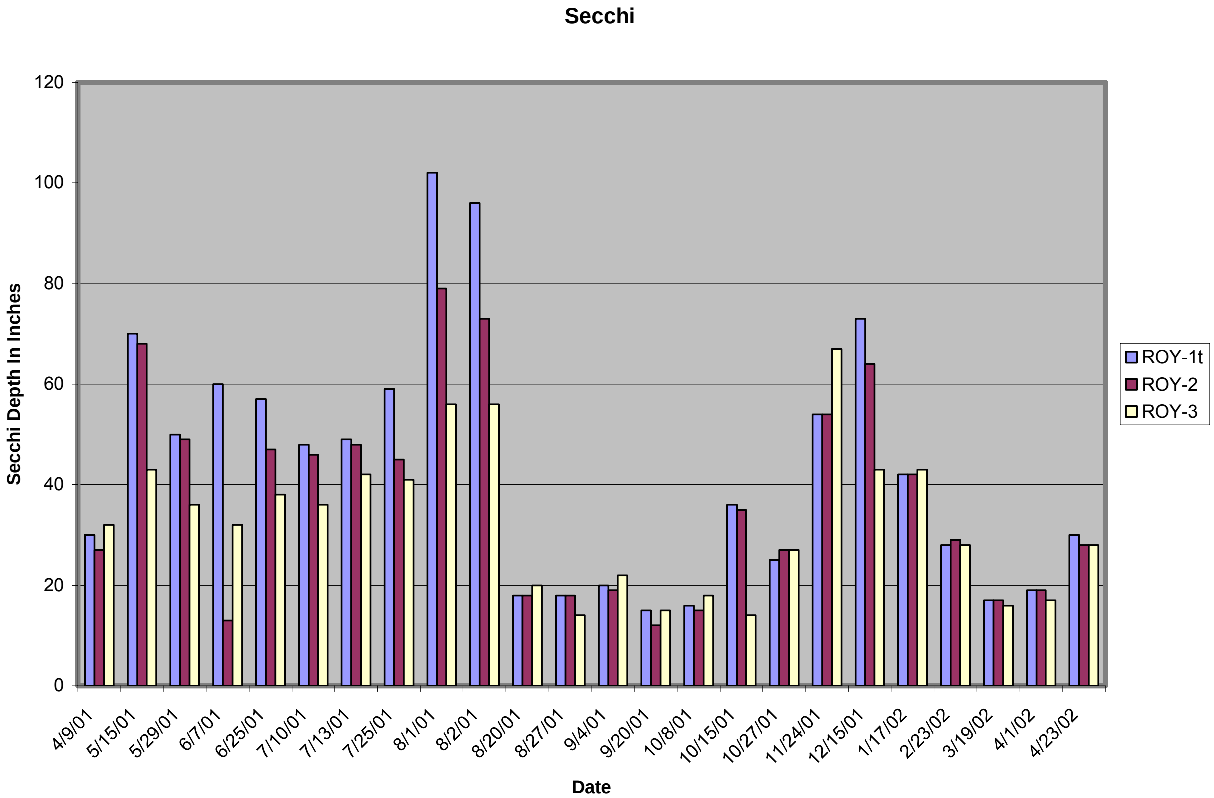


Secchi

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 Patriot's Park Lake the lowest secchi readings were recorded at all sites in August, September and October of 2001 and March and April of 2002 (Figure 13). The late summer/early fall readings correspond with high volatile suspended solid (VSS) readings, high pH levels, high chlorophyll a levels, surface DO concentration at very high, supersaturated levels, and high phytoplankton volumes (Figures 11, 19, 31, Appendix A and D). Low Secchi readings in March and April corresponded with high nonvolatile suspended solid readings. High Secchi readings were recorded on August 1 (102 inches) and August 2, 2001 (96 inches) (Figure 13). These results are not consistent with the information given earlier about the chlorophyll a, pH, D.O. concentration, high VSS levels, and phytoplankton volumes. Additionally, the IEPA field biologist conducting ambient sampling on the lake during the summer reported that during many of his visits he had to physically move aside an algal scum layer in order to take his Secchi disk readings (Holland, pers. comm., 2004). There appears to be no explanation available in the field notes that indicates why these Secchi readings are so high on these dates. Therefore, this data should be viewed with caution. With the exception of the readings on Aug. 1st and 2nd , all high Secchi readings tended to correspond to low TSS and VSS readings throughout the sampling period (Figures 10, 11). ROY-1 and ROY-2 had the highest Secchi readings, suggesting that sediment is falling out of suspension as the velocity of water decreases from upstream to downstream.

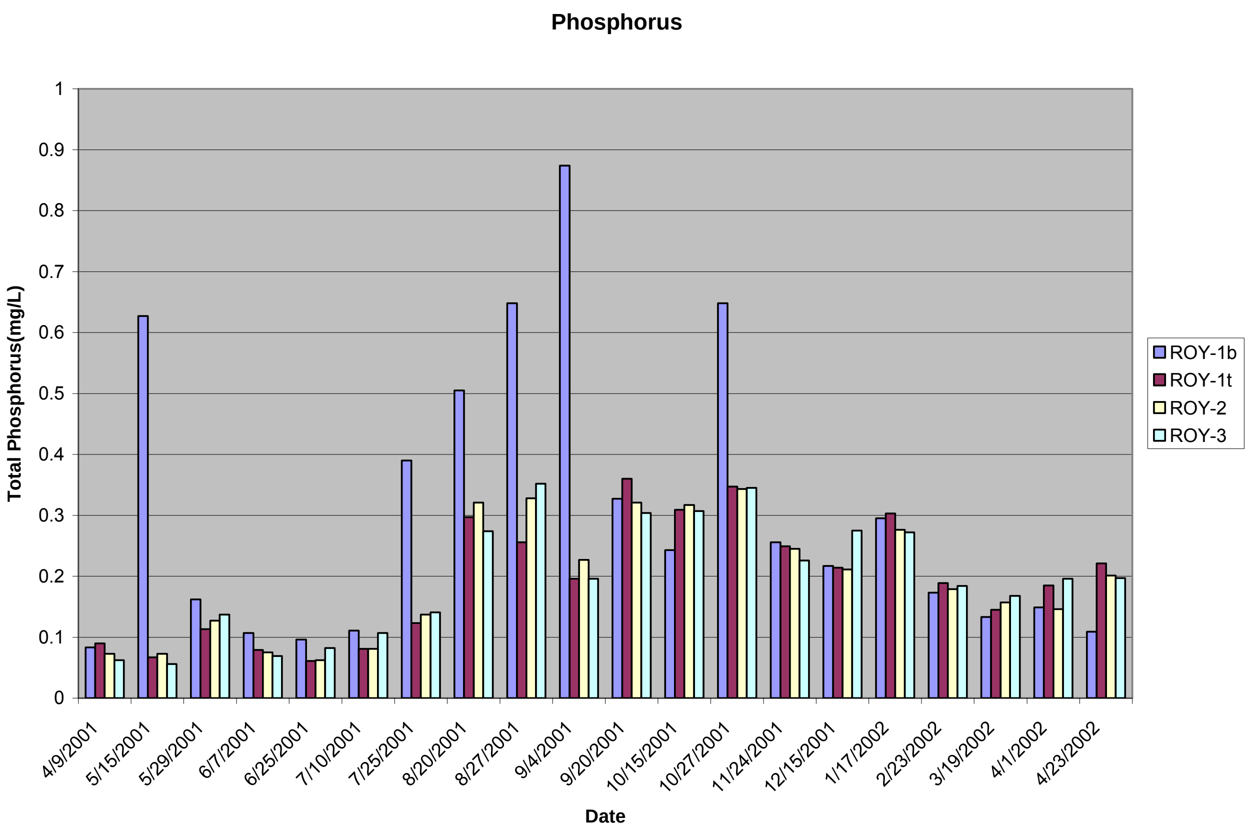
Figure 13.


Secchi
Secchi Depth In Inches
0
20
40
60
80
100
120
4/9/01
5/15/01
5/29/01
6/7/01
6/25/01
7/10/01
7/13/01
7/25/01
8/1/01
8/2/01
8/20/01
8/27/01
9/4/01
9/20/01
10/8/01
10/15/01
10/27/01
11/24/01
12/15/01
1/17/02
2/23/02
3/19/02
4/1/02
4/23/02
Date
ROY-1t
ROY-2
ROY-3

Phosphorus

Phosphorus is a required nutrient for plant growth. The over- or under-abundance of phosphorus is a likely factor in determining the amount of macrophyte and algae growth in a lake. High phosphorus concentrations can lead to lake eutrophication. Phosphorus is not always readily available for plant consumption. Most phosphorus in runoff 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. Based on the Illinois General Use Water Quality standard, any lake or reservoir with a surface area greater than or equal to 20 acres (8 hectares) or any tributary stream where it enters the lake, the total phosphorus concentrations should not exceed 0.05 mg/l. Phosphorus levels in Patriot's Park lake exceeded this level at all times of the year (Figure 14). The highest levels occurred at the bottom of the lake during the months from July through September with one high reading in May and another in October. The peak occurred on 9/4/2001 at 0.87mg/l. When oxygen is available in the water, the phosphorus is bound to solids in the sediment. As oxygen levels at the bottom of the lake decrease in the summer months, phosphorus is released into the water column. This release of dissolved phosphorus acts as a nutrient source for algae, thus contributing to the eutrophication of the lake.

Figure 14.



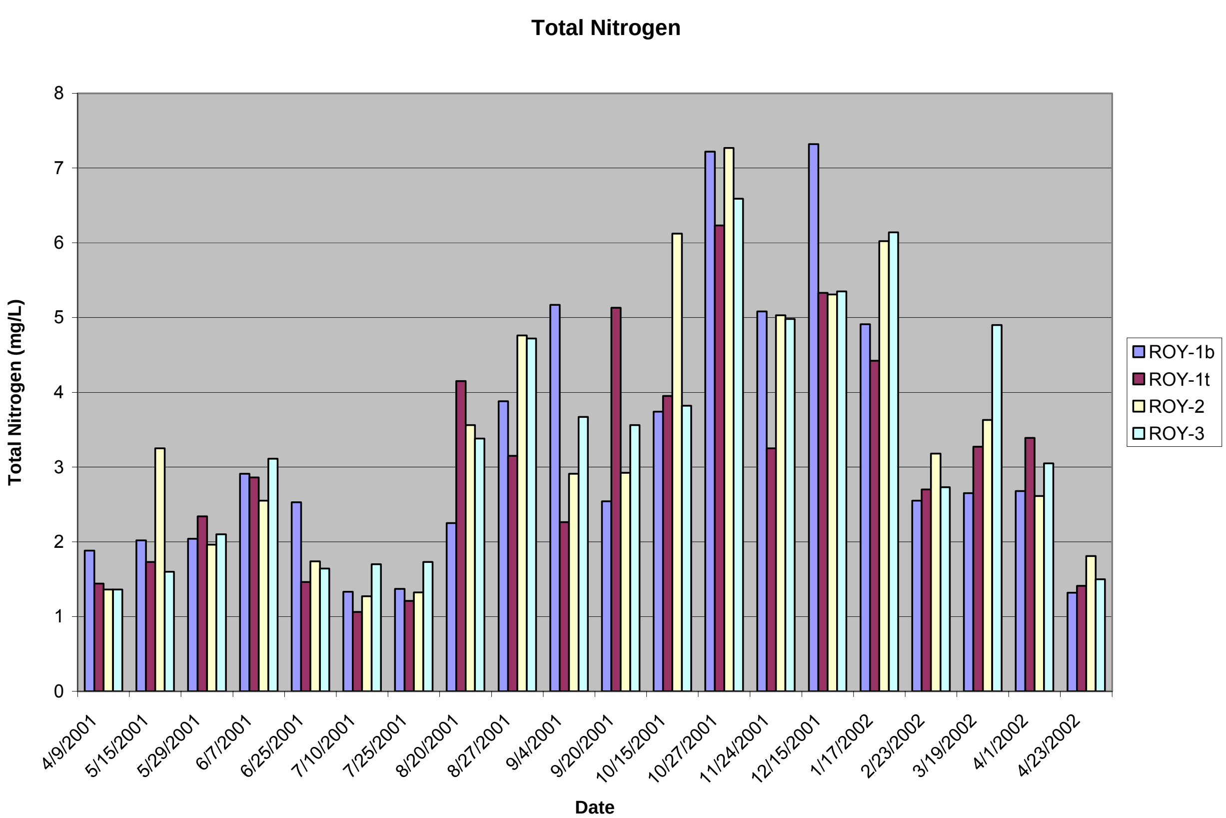
Nitrogen

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 for included ammonia nitrogen, nitrate-nitrogen and total kjeldahl nitrogen. Total kjeldahl nitrogen includes organic and ammonia - nitrogen. Organic nitrogen is calculated by subtracting ammonia-nitrogen from total kjeldahl nitrogen, whereas inorganic nitrogen is the sum of nitrate-nitrogen plus ammonia-nitrogen. Total nitrogen is the sum of nitrate-nitrogen and total kjeldahl nitrogen.

Total Nitrogen

The ratio of total nitrogen to total phosphorous is an indicator of the limiting nutrient for algal growth. A ratio of total nitrogen to total phosphorus of greater than 7:1 is defined as a phosphorus limited lake. Patriot's Park Lake had a ratio of 14:1 and therefore should be described as a phosphorus limited lake. Nitrogen does, however, play a role as a polluter and therefore should be controlled when possible. Total nitrogen levels peaked in the lake at ROY-1b on 12/15/01 at 7.3 mg/l (Figure 15).

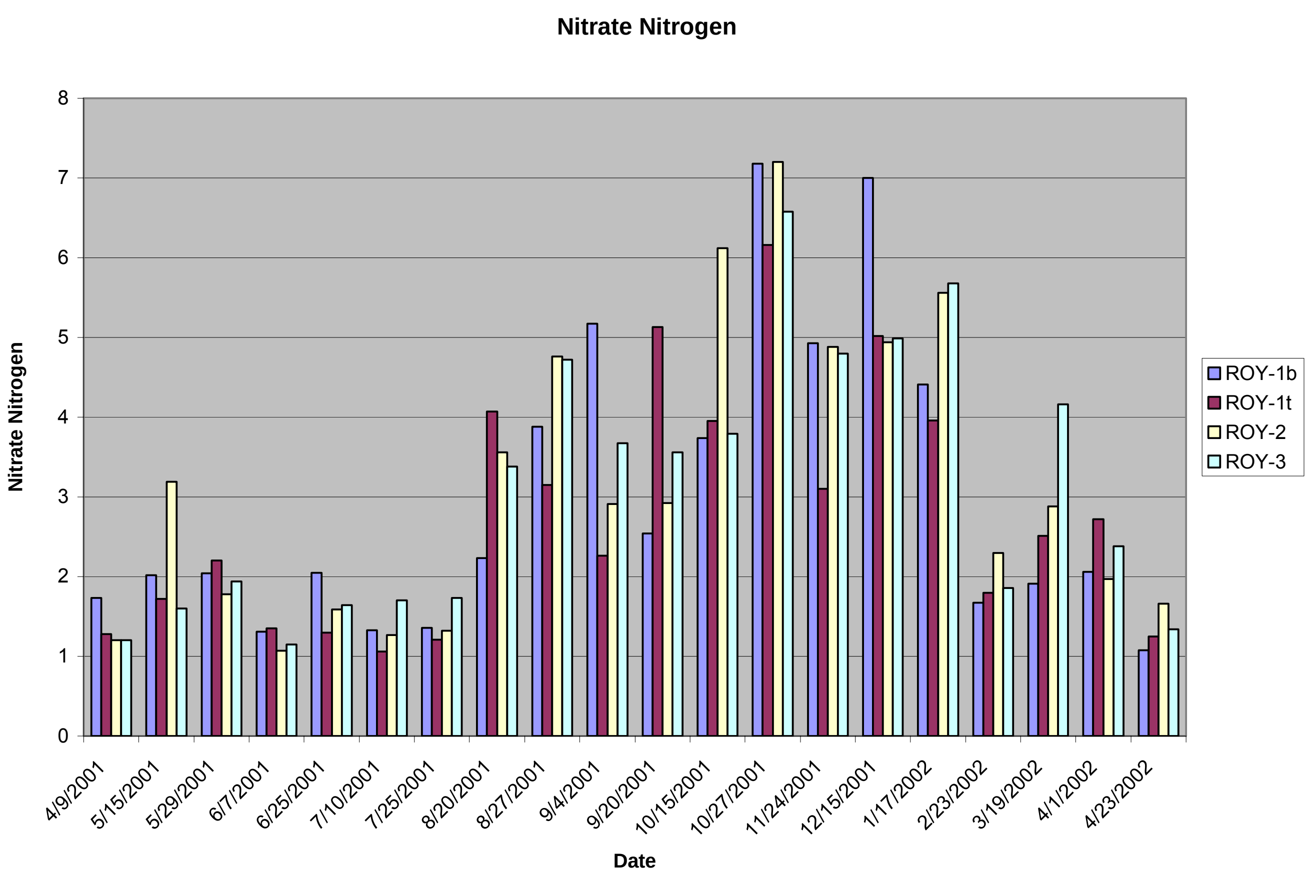
Figure 15.



Nitrate Nitrogen

Nitrate nitrogen is an inorganic form of nitrogen which can enter a lake through agricultural runoff, septic tank effluent and other forms of waste. Finished water quality standards in Illinois state that nitrate nitrogen levels should not exceed 10 mg/l. Nitrate nitrogen is considered to be a nutrient that stimulates algal growth. All samples for Patriot's Park Lake fell below 10 mg/l (Figure 16). The levels were lowest during the spring and early summer months and grew to their peak levels in the fall reaching a high of 7.2mg/l on 10/27/2001 at ROY-1b and ROY-2.

Figure 16.

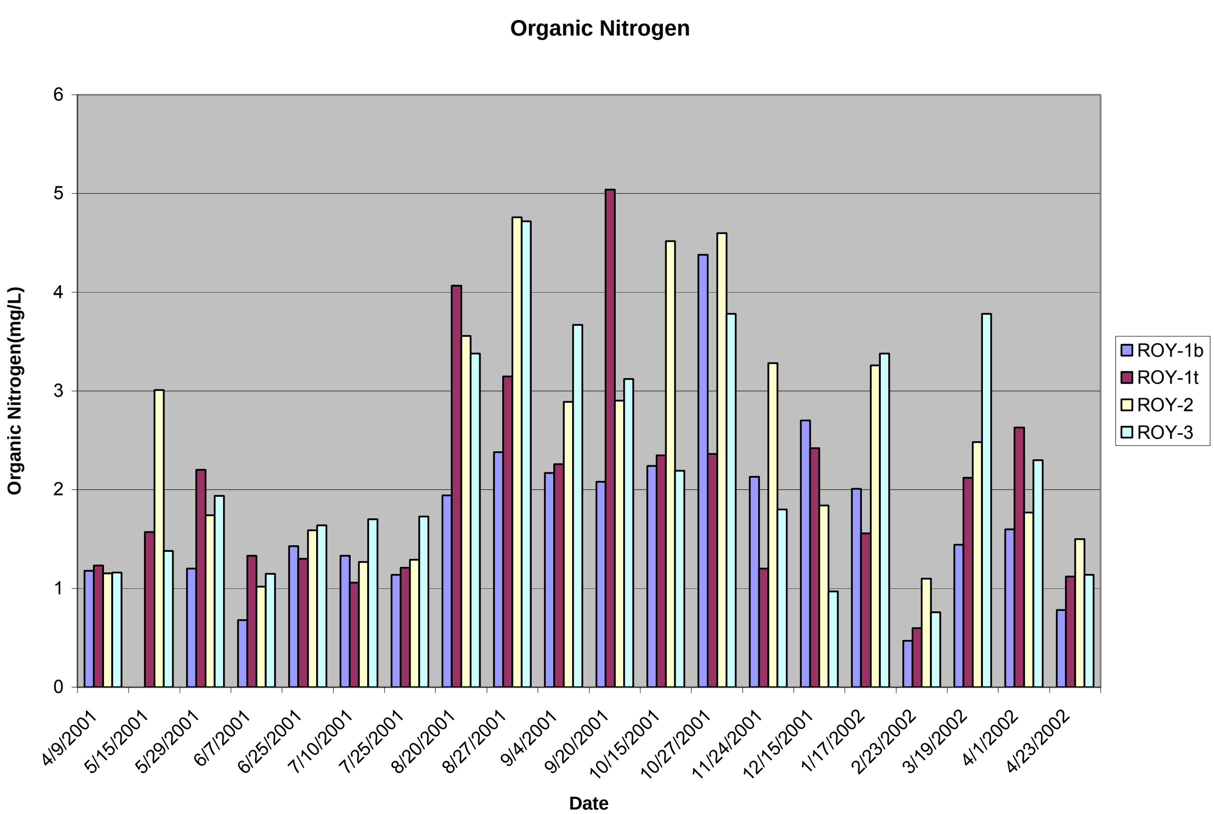


Organic Nitrogen

Organic nitrogen can enter a lake through decaying organic matter, septic systems, agricultural waste and waterfowl. On all but one sampling date (2/23/2002) levels in Patriot's Park Lake were above 1.1 mg/l. The overall average organic nitrogen level for 2001-2002 was 2.15mg/l. The 2001-2002 levels ranged from a low of 0.6mg/l at ROY-1b on 2/23/2002 to a peak of 5.04mg/l on 9/20/2001 at ROY-1t (Figure 17).

For all measures of Total Kjeldahl Nitrogen (mg/l) for which the analysis date is between May 2000 and July 2003, the reported value may not be accurate because the reported value failed to meet the established quality control criteria for precision or accuracy. Since organic nitrogen is calculated from Total Kjeldahl Nitrogen the results reported here may or may not be accurate.

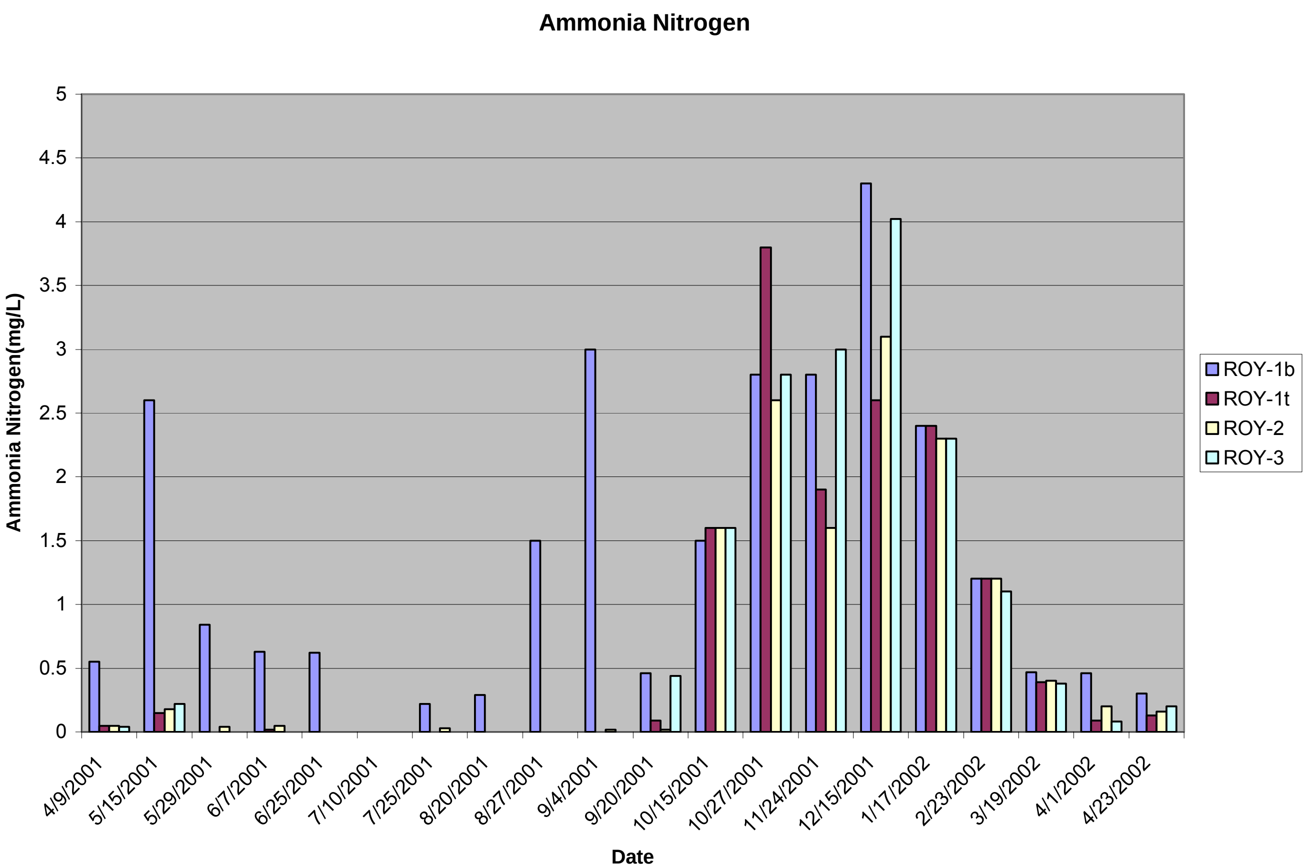
Figure 17.



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, found in the sediment at the bottom of the lake. The Illinois General Use Water Quality Standards for ammonia nitrogen vary according to pH and water temperature, with the allowable concentration of ammonia nitrogen decreasing as pH or temperature rise. Higher temperature and higher pH of the water increases the toxicity of ammonia nitrogen to fish and other aquatic organisms. The allowable concentration of ammonia nitrogen varies from 1.5 mg/l to 13.0 mg/l, depending on the variables of pH and temperature. From mid-October 2001 through mid-January 2002 the 1.5 mg/l level was exceeded al all sites (Figure 18). Proper interpretation of these results is not possible though because of a lack of pH data for these dates. The peak concentrations were found on 12/15/2001 at ROY-1b at the bottom of the lake. These peak concentrations are most commonly a result of bacterial decomposition processes.

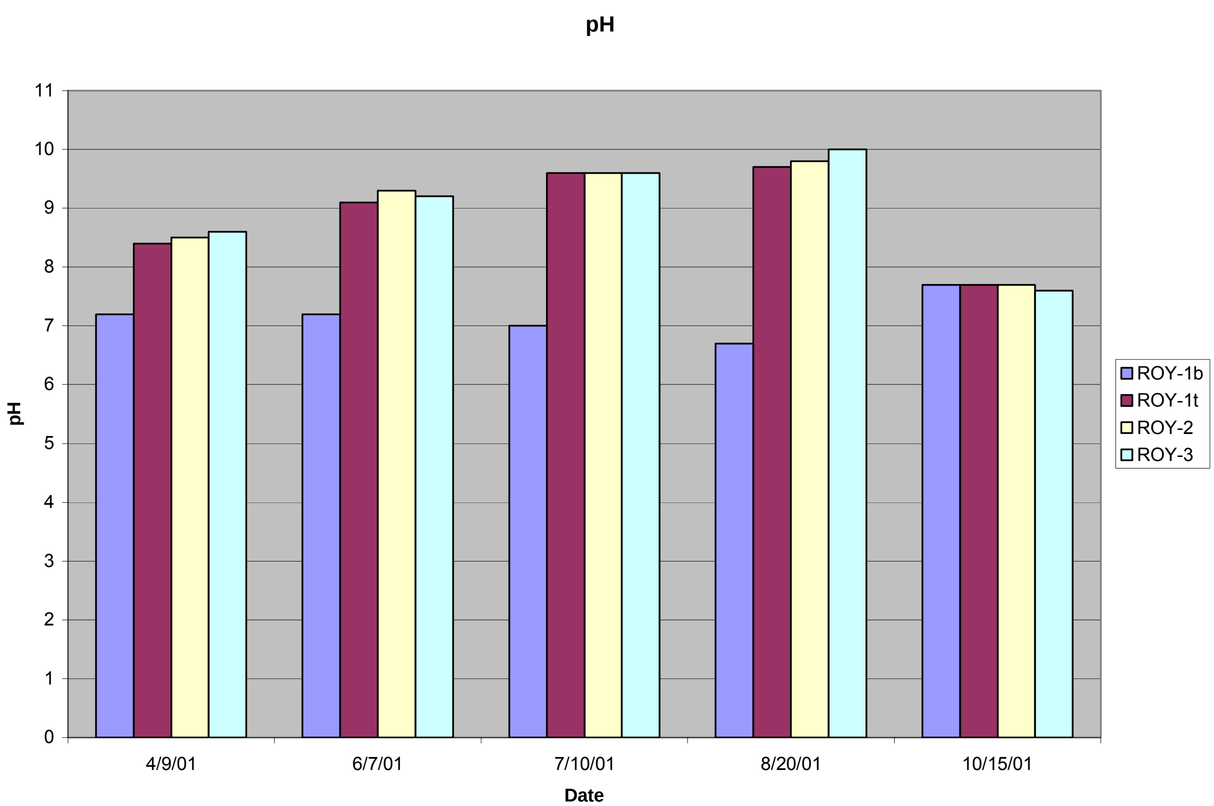
Figure 18.



pH

A lake's pH is a measure of the acidity of the water. The pH value is a measure of hydrogen ion concentration of a solution on a scale of 0-14. 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. The pH levels in the period June – August were extremely high and above the Illinois Water Quality Standard (Figure 19). High pH levels can have serious implications for aquatic life, especially fish. The tolerable range for most fish is 5.0 – 9.0 and the upper limit for good fishing waters is 8.7(Kentucky Water Watch, 2004). The synergistic effects of high pH levels may have an even greater impact on the system. One example is phosphorus, which can be released from the sediments at elevated pH levels (James, 1996). This may then lead to increased levels of algal growth resulting in a greater long – term demand for dissolved oxygen. All pH readings were collected by IEPA personnel.

Figure 19.



Dissolved Oxygen and Temperature

Dissolved oxygen is an important factor in the overall health of a lake. Oxygen levels are a key factor in fish health. Low oxygen levels can cause fish kills and limited oxygen levels can decrease the number 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. Wave action on the surface adds oxygen to the water. Microbial respiration, during decomposition of organic materials in the lake, uses oxygen.

Water temperature is an important influence on a variety of biological and chemical processes 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 dissolved oxygen levels continue to decline.

Regulations set by the IEPA and Illinois Pollution Control Board (IPCB) state that the dissolved oxygen (DO) level shall not fall below 6 mg/l for a 16 hour period and less than 5 mg/L at 1 foot depth (IPCB Part 302). Levels below 3 mg/l will likely cause fish kills. Since Patriot's Park Lake is a relatively shallow lake with a maximum depth of 16 feet, the temperature and DO readings were taken at the ROY-1 site, the area of greatest depth. The south end of Patriot's Park Lake demonstrated conditions found in a typically stratified lake. During the winter, the temperature was uniform throughout the lake and dissolved oxygen was well mixed at all depths. During the late spring and summer the lake stratified. The cold water sank to the bottom of the lake and warm water remained near the surface. Wind action and algae growth kept the upper levels oxygen rich while microbial decomposition processes near the bottom depleted the available oxygen. Chemical reactions take place under low oxygen conditions which release nutrients bound in the sediments. During the fall turnover as water temperature changed and the surface water became cooler this water sank to the bottom and the lake mixed. This mixing released nutrients from the bottom and resulted in internal nutrient loading.

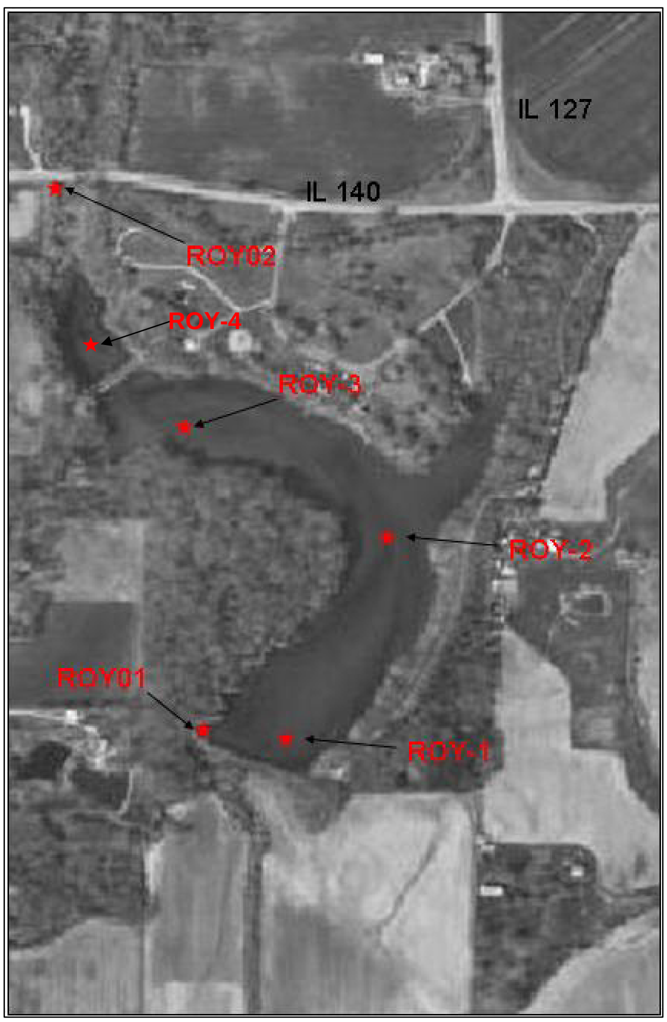
Dissolved oxygen readings were at supersaturated levels for much of the summer at all three sites. This was likely due to extensive algal blooms present in the lake at this time. These high daily readings likely coincided with very low dissolved oxygen levels at night as respiration was occurring. Very low levels of dissolved oxygen were recorded at all sites throughout the water column during the months of September, October and November. These low levels may be the result of the fall turnover producing a high organic load that depleted the oxygen and/or the Cutrine application that was made to the lake on October 4th. In spite of this there is no record of fish kills at this time. The north end of the lake, site ROY-3, had more uniform oxygen and temperature levels. This was most likely a result of the shallow depth at this end of the lake. The fact that this end of the lake is shallower allows mixing of the water from wind action so stratification would not occur over extended periods of time. In July there was one date when dissolved oxygen levels were low near the bottom at site ROY-3. This was most likely due to a lack of wind action mixing the waters. Appendix D provides temperature and DO profiles for the various seasons and at the three in-lake sampling sites during the study period.

TRIBUTARY MONITORING

In an effort to collect data on water and nutrients entering Patriot's Park Lake over the study period, a staff gauge was placed on the major tributary and at the spillway. A staff gauge is a measuring rod that allows relational water depths to be observed and recorded in tenths of a foot. A cross section of the tributary was measured. The relationship between the staff gauge reading and the cross-sectional area was used to determine volumes of water entering the lake. The tributary staff gauge was located just south of the bridge where Illinois Highway 140 crosses the tributary. It was designated ROY-02. Another staff gauge was located at the spillway and was used to determine the outflow. The spillway staff gauge was designated ROY-01(Figure 20).

KPD personnel recorded regular staff gauge readings at ROY-01 and ROY-02. During storm events park district personnel collected water samples from these sampling 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 (TSS), volatile suspended solids (VSS), phosphorus, nitrate-nitrogen, ammonia nitrogen, and Kjeldahl nitrogen. KPD staff also measured flow using a Global Water Works flow probe. The flow data was used to determine the sediment and nutrient loading to the lake.

Figure 20. In-Lake & Tributary Sampling Sites



Tributary Sampling

Samples were taken during ambient conditions and storm surge events in the principal in-flowing tributary to the lake, as well as in the area of the spillway or out-flow of the lake. This provided quantitative data on the quality as well as quantity of various pollutants flowing into and out of the lake. The difference between these two values is the assumed net amount of the pollutant retained in the lake itself.

In cases where the pollutant is non-degradable, such as sediments (in the form of non-volatile suspended solids) the actual net amount of the pollutant can be assumed to remain in the lake indefinitely. In cases of degradable substances (such as organics / volatile suspended solids, nutrients, some metals and synthetic organics) the pollutant may very well be “consumed” or change form. The quantity of those pollutants can degrade the lake in other ways, as further described below.

Table 19

TRIBUTARY SAMPLING DATES

Date	ROY - 01 Data Source Baseline	ROY - 01 Data Source Storm - event	ROY - 02 Data Source Baseline	ROY - 02 Data Source Storm - event
5/15/01	x		x	
5/19/01		x		x
5/21/01		x		x
5/29/01	x		x	
5/30/01		x		x
6/4/01		x		x
6/7/01	x		x	
6/15/01		x		x
6/25/01	x		x	
7/24/01		x		x
7/25/01	x		x	
10/12/01				x
10/24/01		x		x
10/27/01	x		x	
11/24/01		x	x	x
11/30/01		x		x
12/13/01		x		x
12/14/01		x		x
12/15/01	x		x	
12/16/01		x		x
12/17/01		x		x
1/17/02	x		x	
1/30/02		x		x
2/19/02		x		x
2/23/02	x		x	
3/2/02		x		
3/9/02				x
3/19/02	x		x	
4/1/02	x		x	
4/8/02		x		x
4/23/02	x		x	

Table 19 lists tributary sampling dates by storm event and baseline event.

Total Suspended Solids

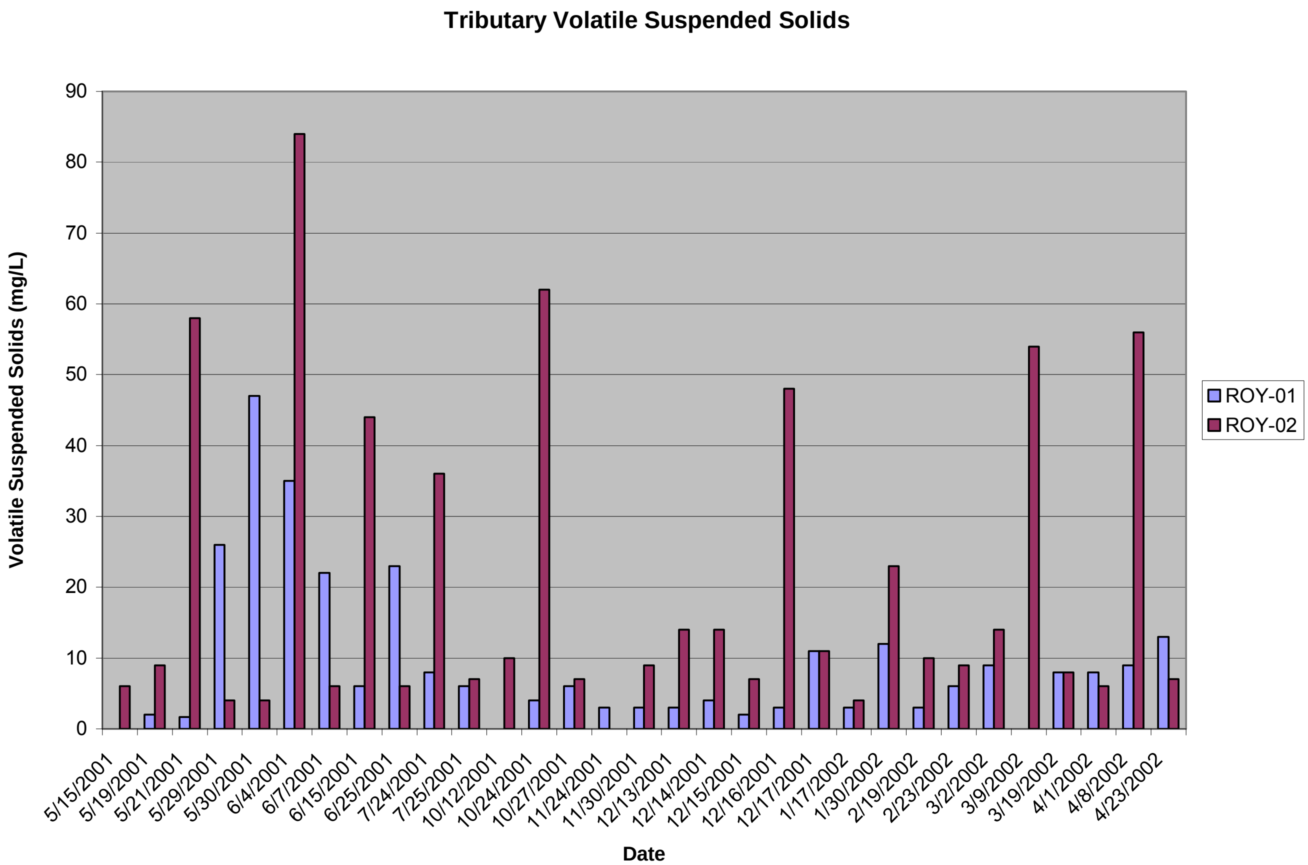
Total suspended solids (TSS) is a measurement of all suspended material in the water including both organic and inorganic materials. This would include materials such as algae, decaying plant materials, minerals, and soil particles. Peak levels of TSS corresponded with rain events. Values of TSS were used to calculate sediment loading. No data was available for the months of August and September as the tributary had zero or insignificant flow.

Figure 21.

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. Peak levels of VSS also coincided with rain events. No data was available for the months of August and September as the tributary had zero or insignificant flow.

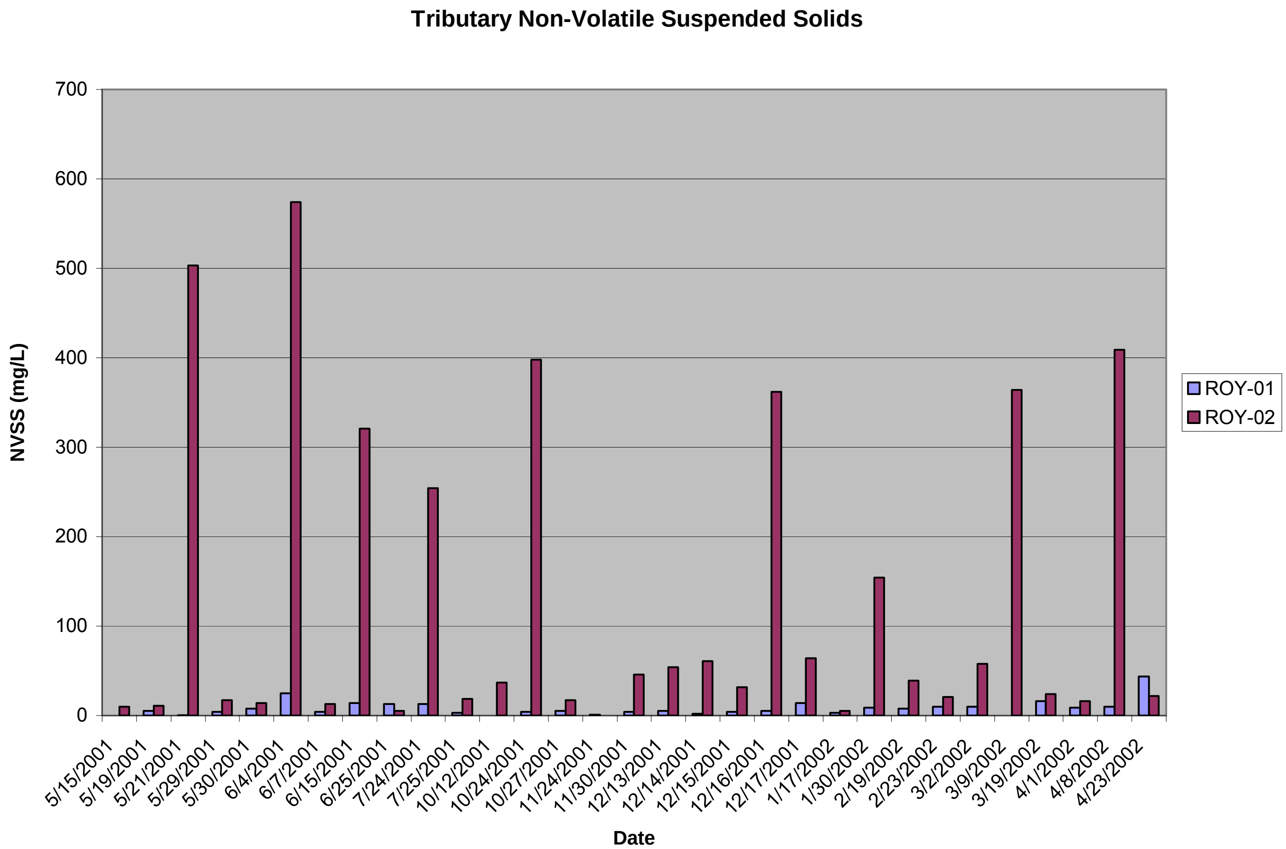
Figure 22.



Non-volatile suspended solids

Non-volatile suspended solids are the inorganic portion of the total suspended solids. NVSS consist of soil particles eroded and transported from the watershed into the stream. The concentration of NVSS is affected by the amount of rainfall on the watershed and the existing watershed land surfaces. Typically, 75%-80% of the TSS is composed of NVSS which is most likely eroded soil. All NVSS peak levels did coincide with rain events and the NVSS levels accounted for 70%-90% of TSS in each instance (Figure 23).

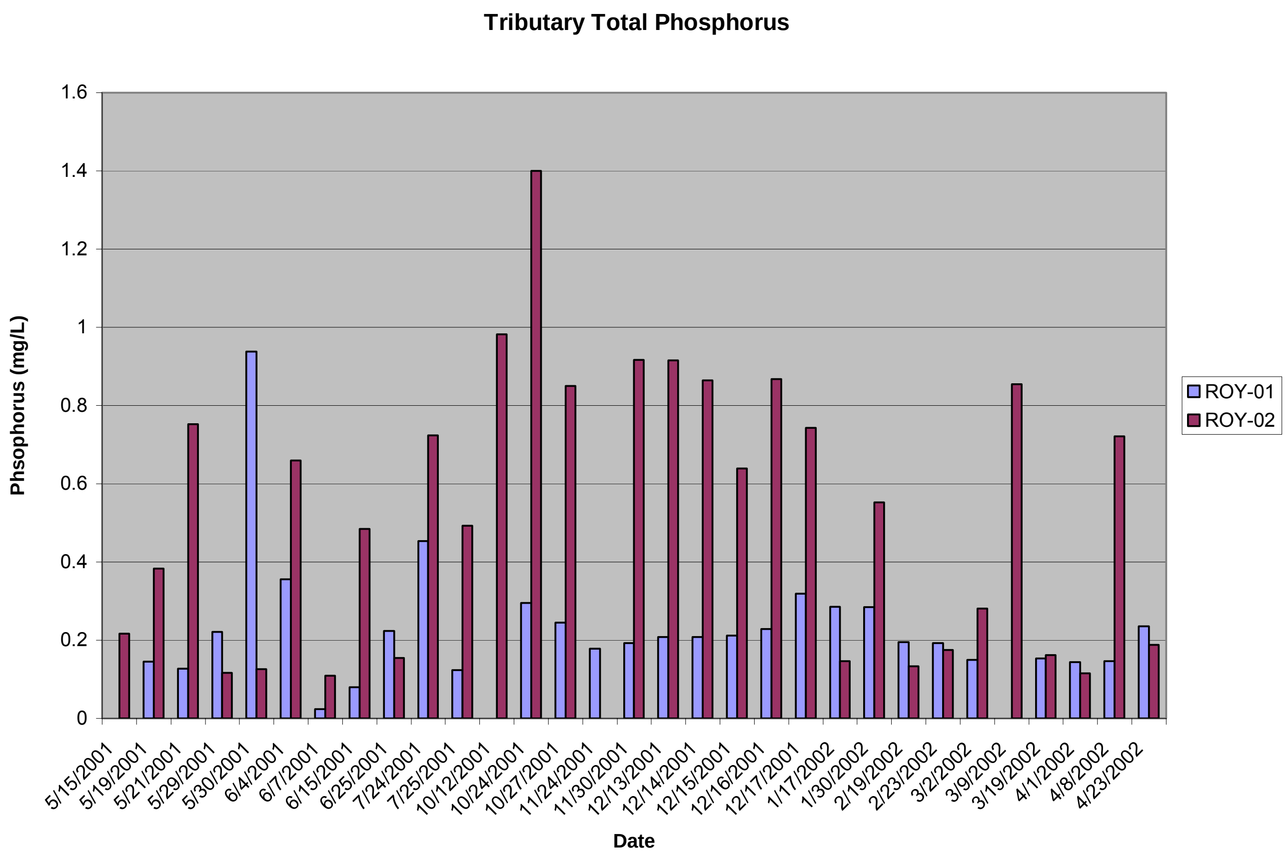
Figure 23.



Phosphorus

Phosphorus is a component found in both agricultural and residential fertilizer. It can also leach from septic systems and feed lots. High phosphorus levels can lead to algal blooms and poor water quality. Based on the Illinois General Use Water Quality Standard, in any reservoir or lake with a surface area greater than or equal to 20 acres (8 hectares) or any tributary stream where it enters the lake, the total phosphorus concentrations should not exceed 0.05 mg/l . When the concentrations of phosphorus begin to consistently surpass the 0.05 mg/l standard, lake eutrophication and primary plant production can be accelerated. The tributary exceeded this standard on virtually every date sampled. No data was available for the months of August and September as the tributary had zero or insignificant flow.

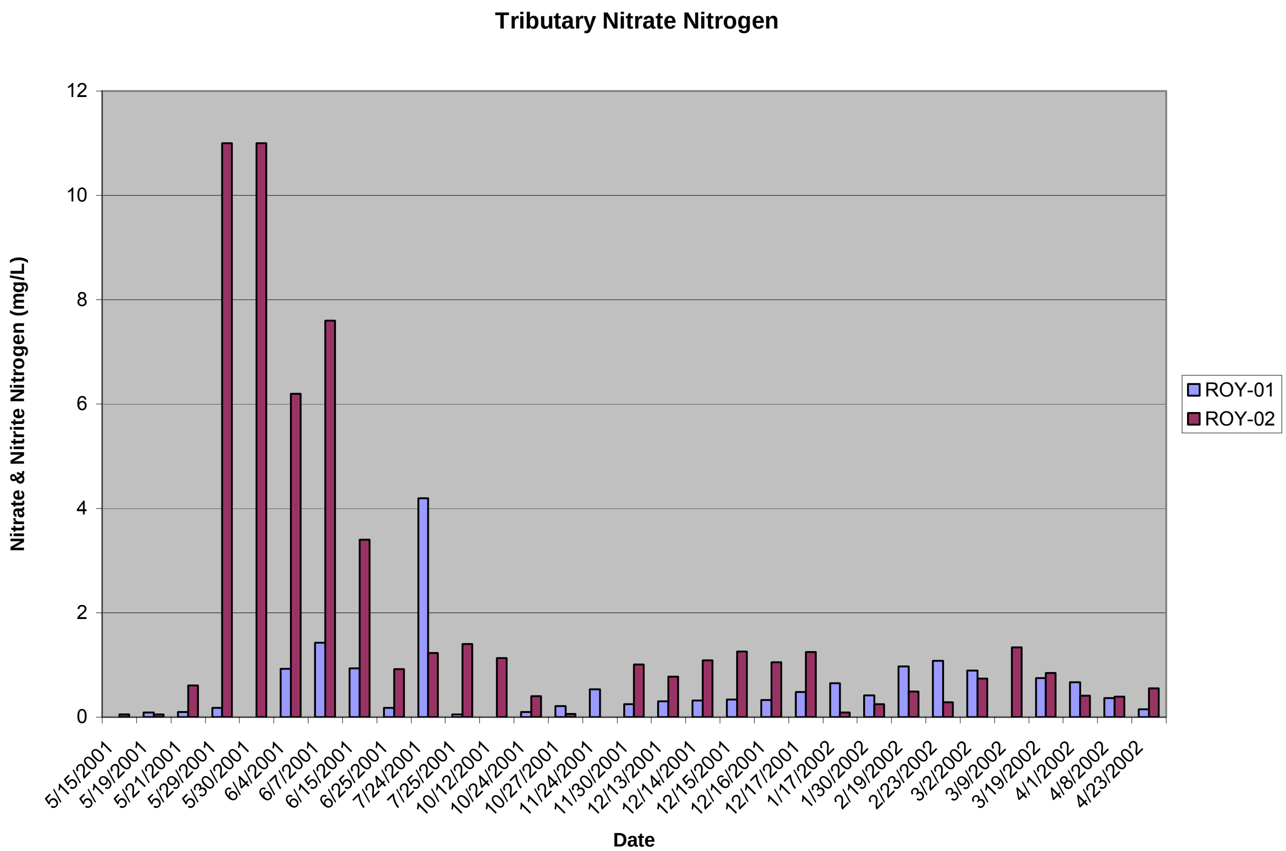
Figure 24.



Nitrate 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. The highest concentrations in tributary water samples were found in late May and June (Figure 25). These elevated levels of nitrate-nitrogen are probably attributable to the 3.88 inches of rainfall in the watershed during late May and early June when farmers begin applying nitrogen rich fertilizer to their fields. No data was available for the months of August and September as the tributary had zero or insignificant flow.

Figure 25.

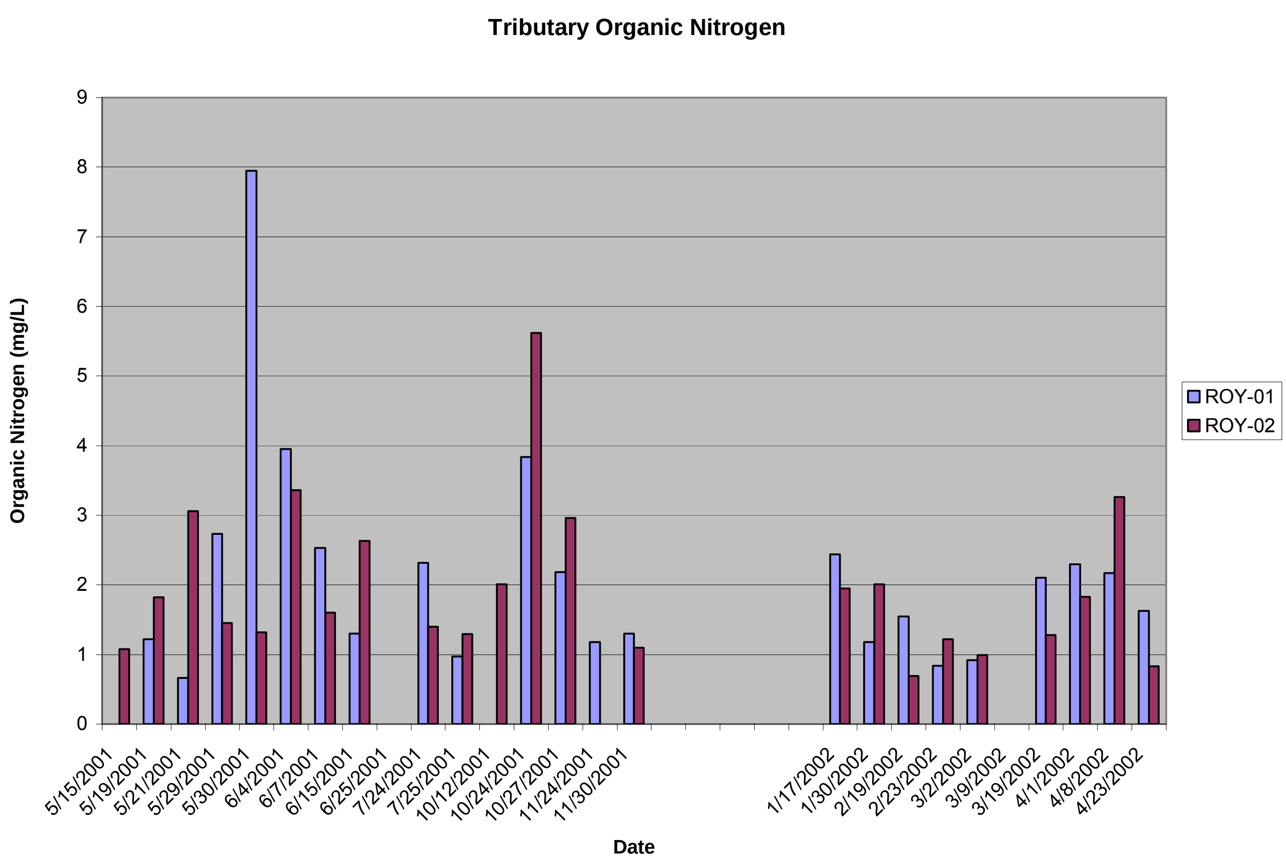


Organic Nitrogen

The Kjeldahl method is a widely used standard method of chemical analysis for determining protein nitrogen in biological materials. Kjeldahl nitrogen can be simplified as 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. Organic nitrogen peaked in the tributary in late May / early June and late October, and at the spillway in late October (Figure 26). No data was available for the months of August and September as the tributary had zero or insignificant flow.

For all measures of Total Kjeldahl Nitrogen (mg/l) for which the analysis date is between May 2000 and July 2003, the reported value may not be accurate because the reported value failed to meet the established quality control criteria for precision or accuracy. Since organic nitrogen is calculated from Total Kjeldahl Nitrogen the results reported here may or may not be accurate.

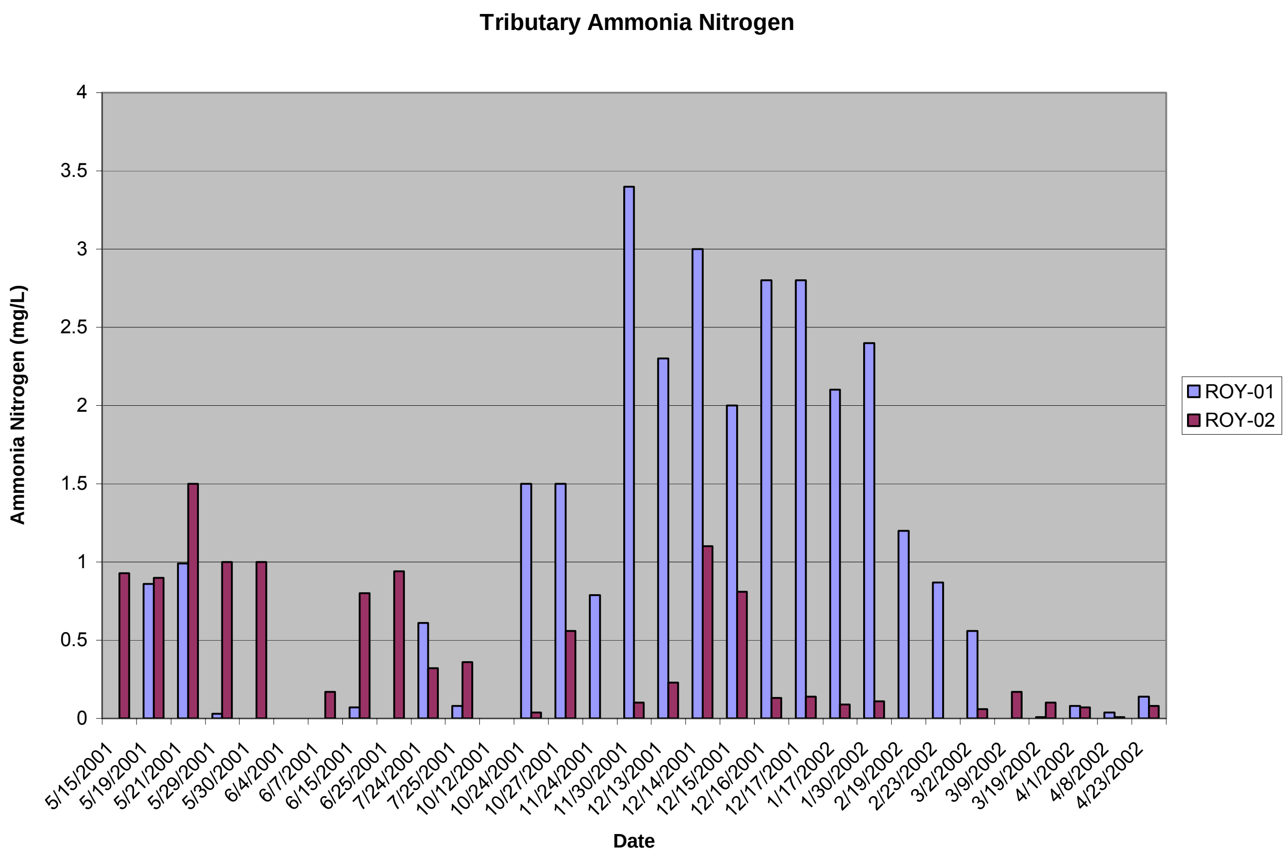
Figure 26.



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. The general use water quality standard states that total ammonia shall in no case exceed 15 mg/l. No tributary samples exceeded this standard. Ammonia nitrogen peaked at the spillway in December and January. No data was available for the months of August and September as the tributary had zero or insignificant flow.

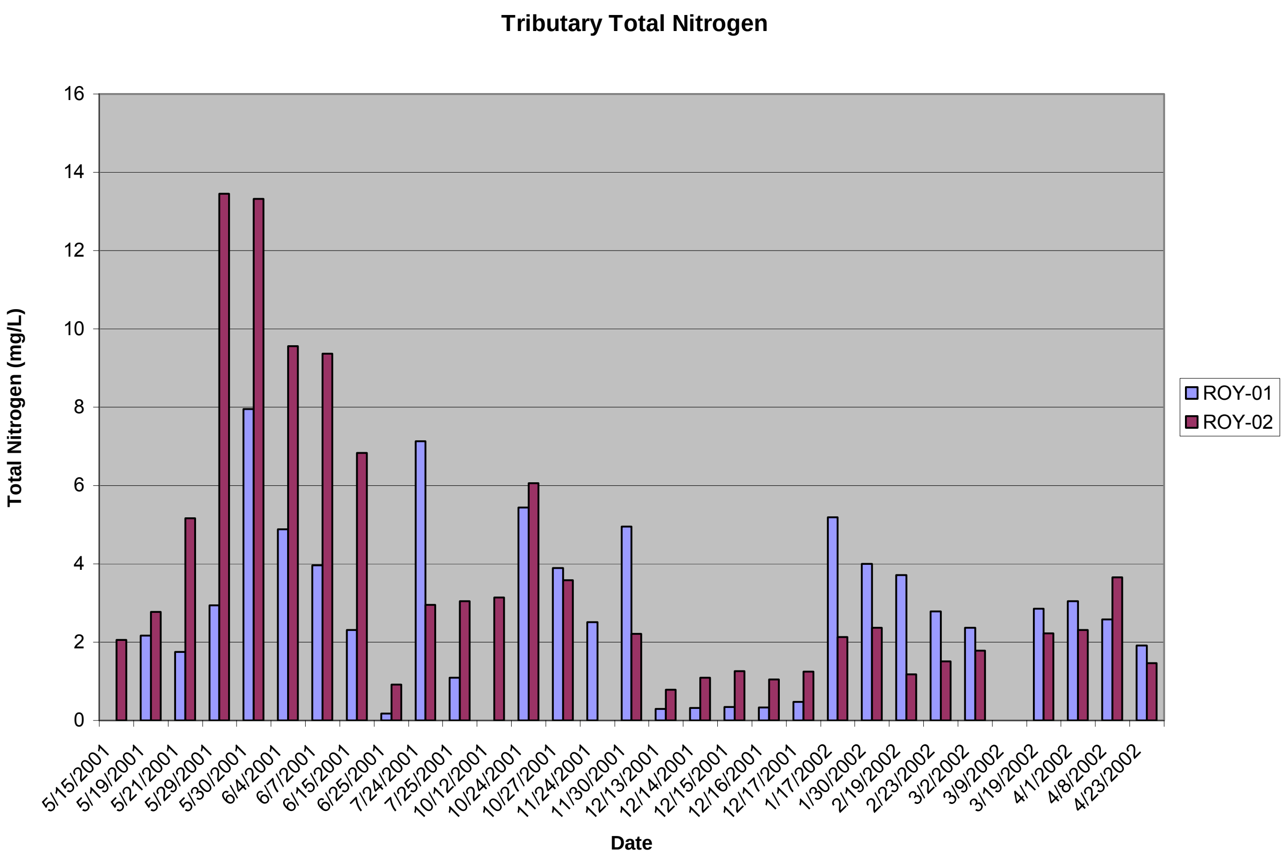
Figure 27.



Total Nitrogen

Total nitrogen is the sum of all nitrogen. It is calculated by adding Kjeldahl nitrogen and nitrate nitrogen. The highest concentrations were found in late May / early June and late October for the tributary site, and peaked sporadically for the spillway site (Figure 28). No data was available for the months of August and September as the tributary had zero or insignificant flow.

Figure 28.



Tributary pH

The Illinois general use water quality standard for pH is between 6.5 and 9.0 standard units. The pH of the lake is a measure of the hydrogen ion concentration in a substance, which ranges from very acidic (pH = 1) to very alkaline (pH = 14) (USEPA, 1988).

No tributary pH readings were taken as part of the lake study protocol, as KPD staff lacked the necessary equipment to measure this parameter. Samples taken by the IEPA on June 7th, 2001 indicated a pH of 9.5 at ROY-01, and a pH of 7.3 at ROY-02. This notable difference between the inflow and outflow point seem to support the in – lake data results and the high algal productivity within the lake. These samples were very close in pH range to those taken by IEPA on the same day from the lake (Figure 19). Projections of tributary pH during the study period could be made from the lake pH data.

SEDIMENT SURVEY

Surficial grab samples were taken of sediments and analyzed at IEPA laboratories. This data reveals the amounts of certain types of organic and metallic compounds that have been trapped in the sediment (Table 21). The sediment core samples collected by ZIES personnel were taken at lake sites ROY-3 at a total depth of six feet and ROY-4 (within the sediment basin) at a total depth of 2.5 feet. The IEPA collected samples at sites ROY-1 (13 ft) and ROY-3 (5ft) on 8/20/01. The information provides 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 affect the option to dredge.

Sediment organics analysis results indicate that all parameters were below detection limits at all three sites. Sediment metals analysis of ZIES collected samples indicates that at site ROY-3 all constituents were at or below normal levels while at site ROY-4 all constituents were normal or below normal except potassium which was at highly elevated levels at this site. Samples collected by the IEPA contained elevated to highly elevated levels of all constituents at ROY-1 except iron. Site ROY-3 results from the IEPA sample indicate elevated to highly elevated levels of all constituents with the exception of phosphorous, cadmium, arsenic, and manganese which were all at normal to low levels. Because of the significant difference between the results from these separate sampling events caution is advised when interpreting these findings. The lab results may require further investigation before a conclusion can be made. A sediment sample collected by the IEPA on 8/11/93 showed all constituents at normal levels except barium and phosphorous, which were at elevated levels on this date (Table 17). The statistical values (Mitzelfelt, 1996) against which the levels are compared are provided on the following page.

Table 20. Sediment Survey Results				
Patriots Park Lake Sediment Metals				
Collected by:	ZIES	ZIES	IEPA	IEPA
	ROY-3	ROY-4	ROY-1	ROY-3
Sample Depth	6	2.5	13	5
Phosphorus-P, Sed.	204	814	1550	490
Kjedahl-N, Sed	N/A	N/A	3520	3120
Solids, Vol, Sed.	6.5%	7.40%	15.3%	8.6%
Mercury, Sed.	0.10K	0.10K	0.10K	0.10K
Barium, Sed.	120	170	3100	470
Chromium, Sed.	13	14	200	130
Iron, Sed.	12000	13000	270000	49000
Manganese, Sed.	340	430	12000	1400
Silver, Sed.	0.5K	0.5K	6.2K	1.8K
Toc, Sed.	1.2%	1.90%	1.1%	2.1%
Solids, % Wet Sample	49.50%	52.70%	8.00%	27.70%
Arsenic, Sed.	3.6	4.4	77	5.9
Potassium, SE d/wt	720	9100	19000	4000
Cadmium, Sed.	0.5K	0.5K	6.2K	1.8K
Copper, Sed.	63	16	490	130
Lead, Sed.	18	17	260	68
Nickel, Sed.	11	11	160	40
Zinc, Sed.	50	54	570	200
Measured in Kg/mg				

Table 21. Sediment Classifications

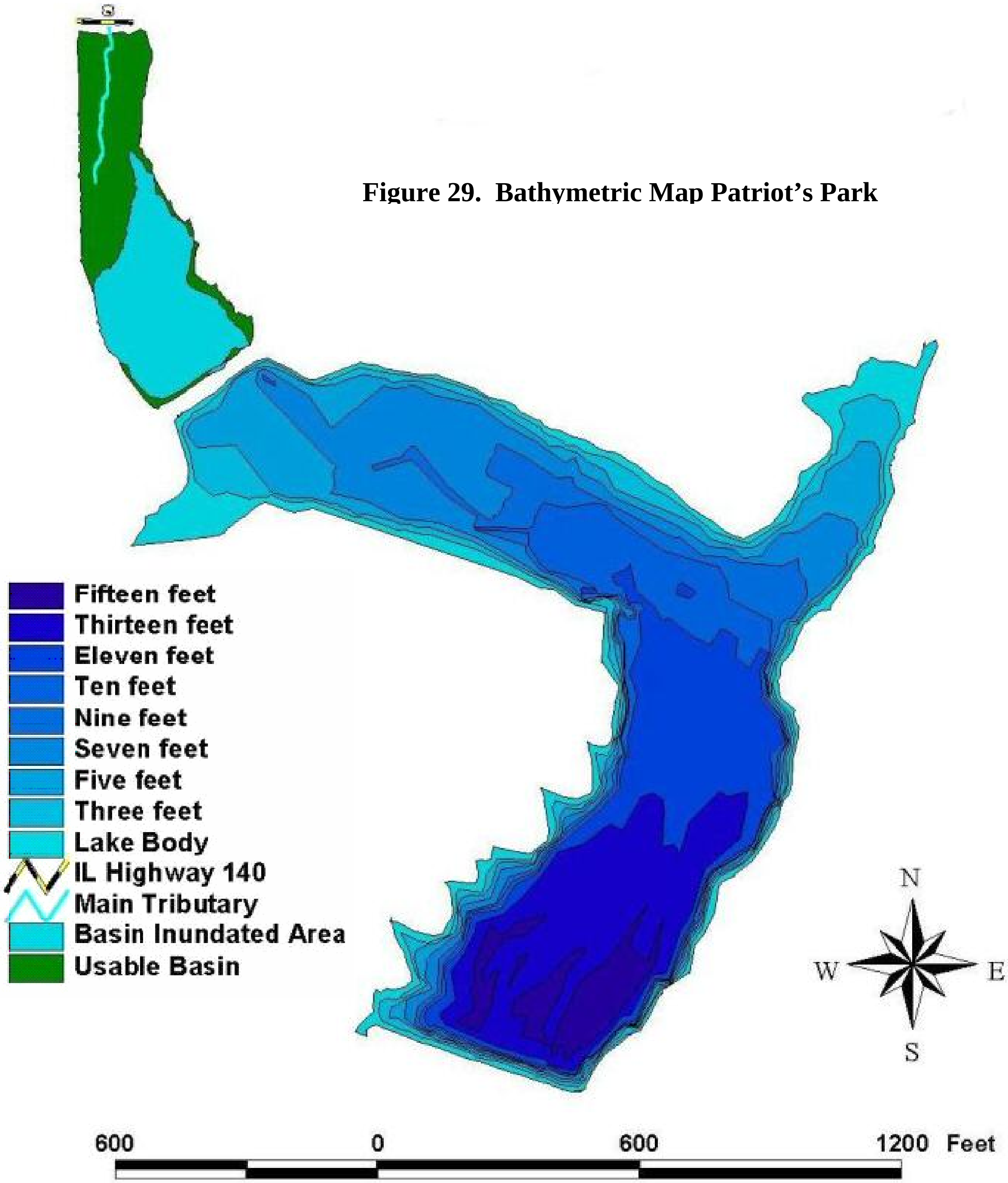
STANDARDS	Detection Limit	Low	Normal	Elevated	Highly Elevated
Phosphorus-P, Sed.	0.1mg/Kg	less than 394	394<1115	1115<2179	2179 or greater
Kjedahl-N, Sed	1.0mg/Kg	less than 1300	1300<5357	5357<11700	11700 or greater
Mercury, Sed.	0.1mg/Kg	n/a	less than 0.15	0.15<0.701	.701 or greater
Barium, Sed.	1.0mg/Kg	less than 94	94<271	271<397	397 or greater
Chromium, Sed.	10mg/Kg	less than 13	13<27	27<49	49 or greater
Iron, Sed.	10mg/Kg	less than 1600	1600<37000	37000<56000	56000 or greater
Manganese, Sed.	10mg/Kg	less than 500	500<1700	1700<5500	5500 or greater
Silver, Sed.	0.1mgKg	n/a	less than 0.1	0.1<1	1 or greater
Arsenic, Sed.	0.5mg/Kg	less than 4.1	4.1<14	14<95.5	95.5 or greater
Potassium, SE d/wt	10mg/Kg	lesss than 410	410<2100	2100<2797	2797 or greater
Cadmium, Sed.	0.1mg/Kg	n/a	less than 5	5<14	14 or greater
Copper, Sed.	10mg/Kg	less than 16.7	16.7<100	100<590	590 or greater
Lead, Sed.	0.1mg/Kg	less than 14	14<59	59<339	339 or greater
Nickel, Sed.	1.0mg/Kg	less than 14.3	14.3<31	31<43	43 or greater
Zinc, Sed.	10mg/Kg	less than 59	59<145	145<1100	1100 or greater

Table 22. Patriots Park Lake Sediments Organic				
Collected By:	ZIES	ZIES	IEPA	IEPA
	ROY-3	**ROY-4**	**ROY-1**	**ROY-3**
	UG/KG	UG/KG	UG/KG	UG/KG
Total PCBS	10K	10K	10K	10K
Hexachlorobenzene	1.0K	1.0K	1.0K	1.0K
Trifluralin	10K	10K	10K	10K
Alpha-BHC	1.0K	1.0K	1.0K	1.0K
Gamma-BHC (Lindane)	1.0K	1.0K	1.0K	1.0K
Atrazine	50K	50K	50K	50K
Heptachlor	1.0K	1.0K	1.0K	1.0K
Aldrin	1.0K	1.0K	1.0K	1.0K
Alachlor	10K	10K	10K	10K
Metribuzin	10K	10K	10K	10K
Metolachlor	25K	25K	25K	25K
Heptachlor Epoxide	1.0K	1.0K	1.0K	1.0K
Pendimethalin	10K	10K	10K	10K
Gamma-Chlordane	2.0K	2.0K	2.0K	2.0K
Alpha-Chlordane	2.0K	2.0K	2.0K	2.0K
Total Alpha and Gamma Chlordane	5.0K	5.0K	5.0K	5.0K
Dieldrin	1.0K	1.0K	1.0K	1.0K
Captan	10K	10K	10K	10K
Cyanazine	25K	25K	25K	25K
Endrin	1.0K	1.0K	1.0K	1.0K
P P'-DDE	2.5	1.0K	1.0K	1.0K
P P'-DDD	1.0K	1.0K	1.0K	1.0K
P P'-DDT	1.0K	1.0K	1.0K	1.0K
Total DDT	10K	10K	10K	10K
Methoxychlor	5.0K	5.0K	5.0K	5.0K
K - detection limit not exceeded				

BATHYMETRIC MAPPING

In order to develop an understanding of lake volume and possible loss of volume due to sedimentation a bathymetric map of the bottom contours of the lake was made (Figure 29). A Trimble Global Positioning System (GPS) and sonar depth finding equipment were used. GPS points were collected throughout the lake in a transect pattern. The GPS technology allowed staff to collect points with an exact knowledge of the location of these points. Depth at each GPS point was recorded from sonar equipment, at normal lake pool. The boundaries of the lake body, the sediment basin, the tributary, and other features were also recorded with the GPS unit. ArcView geographical information system (GIS) software was then used to create a map of the lake and its features.

Figure 29. Bathymetric Map Patriot's Park



Using ArcView, KPD staff measured the area of descending lake bottom contours in two-foot intervals (Figure 29). To calculate volume, each contour area was then multiplied by the depth associated with that contour. Slope / depth variation within each depth contour was corrected using the following method. All of the depth readings within a contour data set were tabulated, and the mean calculated. The mean of a contour data set was then used as the depth in calculating the volume of the contour. The volumes of all the contours were then summed to arrive at total lake volume. Using this method, the total volume of Patriot's Park Lake was determined to be 224.45 acre-feet (73,148,255 gallons).

Prior to the IEPA Clean Lakes Study, a study conducted by the Illinois Natural History Survey estimated the volume of the lake to be 185.7 acre-feet. Comparing this to the current volume estimated in this study would indicate a net gain of 38.75 acre-feet. The difference in volume may be accounted for by extensive spillway reconstruction that was performed in 1993-1994. Before reconstruction of the spillway, water flowing out of the lake was actually exiting the lake at a level below that of the original spillway. Over the years water had entered cracks in the concrete floor of the spillway and subsequent freeze/thaw cycles had caused the floor to heave until most of the water was exiting the lake underneath the spillway floor (Jerry Sauerwein, personal communication, 2003). Reconstruction of the spillway involved removing the old concrete floor, setting a sub-base and pouring a new floor. Additionally, a 9-inch concrete lip was added to the front of the spillway effectively raising the normal pool elevation. The Illinois Natural History Survey (INHS) bathymetric mapping was completed prior to the rebuilding of the spillway. It is unknown what the normal pool elevation would have been at the time of the INHS study but is likely that it was at least 9 inches and possibly as much as 18 inches lower than the current elevation. This spillway elevation difference would then account for the difference in volume between the two studies.

Because of the lack of baseline data prior to 1987, no estimations can be made of lake volume lost due to sedimentation since lake construction. However, as previously mentioned in this report, sedimentation has been shown to be a significant factor affecting lake health. NRCS investigations in 1996 revealed that within the upper sediment basin of the lake, the average depth of silt deposits was 61 inches. Given the 63-year time span between the construction of the lake and the NRCS study, the rate of volume loss in the sediment basin would be nearly an inch per year. Additionally, NRCS staff observed a reduction in sediment basin water surface area from an estimated 3.6 acres at its construction to approximately two acres at the time of the study. Recent global positioning system (GPS) data taken by KPD staff confirms the present surface area at normal pool. Within the remaining normally inundated area, depths have been reduced to an average of 1.15 feet. This loss of volume has a significant impact on the effectiveness of the sediment pond.

Hydraulically, it is likely that sedimentation rates have declined as retention time and storage capacity within the sediment basin has decreased. This has resulted in the sediment basin becoming a net exporter of sediments to the main body of the lake, a situation which cannot be allowed to continue.

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, stressed 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 habitat by reducing potential growing areas of plants and trees near the shoreline. Suspended sediments from erosion can reduce the photic zone, limit desired aquatic plant growth, displace benthic macro-invertebrate habitat, and have a negative aesthetic effect. Nutrients added to the lake from shoreline erosion can increase algae growth and lead to oxygen depletion. Increased turbidity can affect the ability of aquatic organisms to feed.

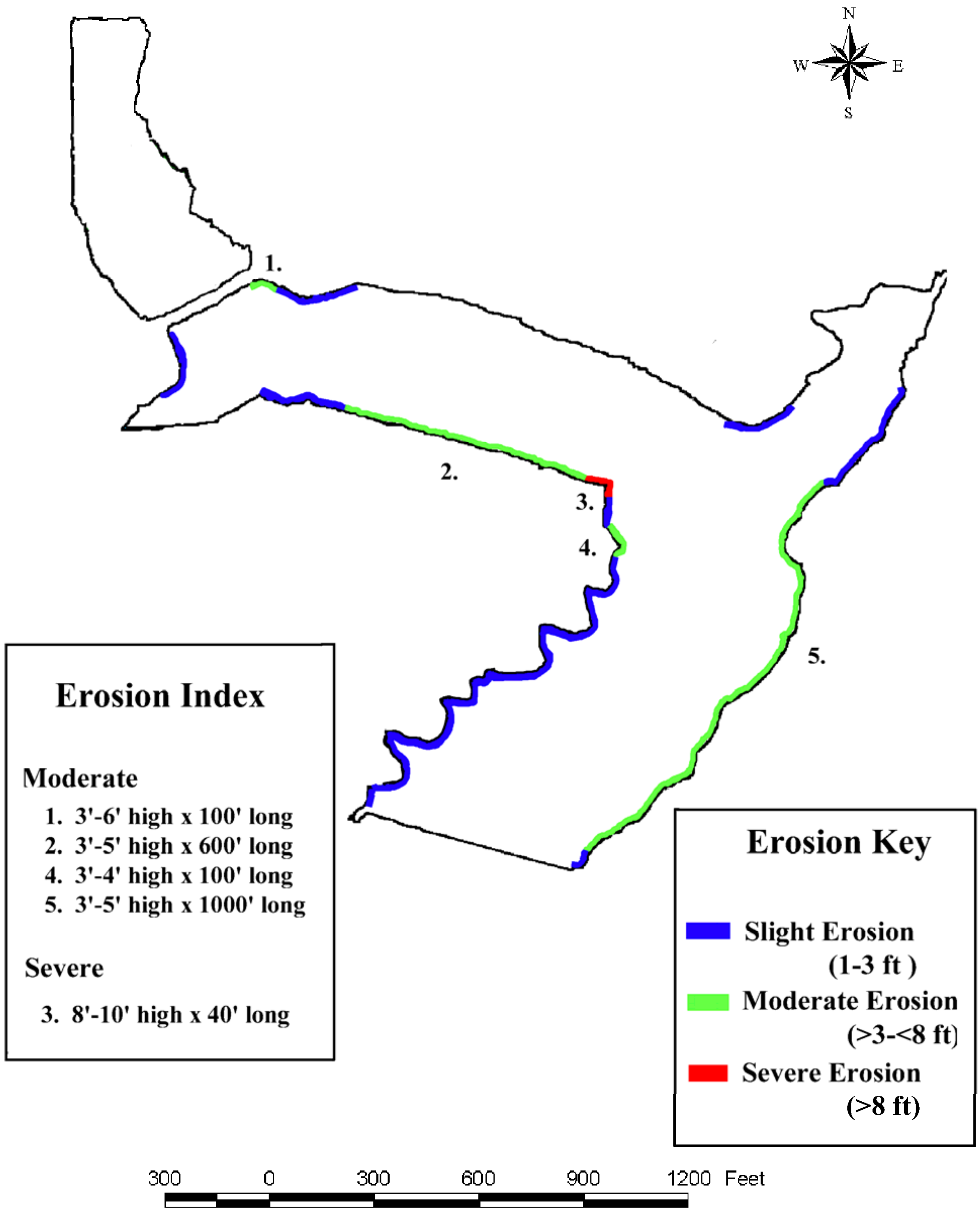
There are several causes for shoreline erosion - some of them are controllable and some of them are not. Some of the causes include loss of vegetation, powerboat waves, wind-generated waves and ice. The loss of vegetation on or near the shoreline makes the shoreline more susceptible to erosion. High-speed boats can increase the erosion on lakes. Patriot's Park Lake's trolling motor limitation will positively affect erosive action due to boats. (Fuller 1997).

To obtain a better understanding of the shoreline erosion situation, The Kingsbury Park District staff did a comprehensive survey of the shoreline around Patriot's Park Lake on August 2nd, 2001. The lake water level was one inch above normal pool. A map was generated in which areas of the shoreline were labeled in the following manner: slight erosion 1-3 ft, moderate erosion 3-8 ft and severe erosion 8 + ft.

The survey indicates that there are 40 linear feet of severe erosion and 1,800 linear feet of moderate erosion (Figure 30).

Shoreline erosion has exposed large segments of the concrete-rubble core within the causeway separating the silt pond and the lake body. Erosion of the silt pond causeway occurs from wave action and also when the basin fills and overflows during major (10-year) storm events. Several holes are beginning to appear in the top of the silt pond dam as a result of settling of sediment in the cavities of the concrete rubble core. An annual muskrat trapping program is in place to reduce breakdown of the silt pond causeway and the lake dam by muskrat burrowing activity.

Figure 30. Shoreline Erosion Survey Map and Key



TROPHIC STATUS

The trophic status of a lake is a phrase that refers to the current degree of eutrophication. Eutrophication is the process by which increased nutrient loads increase the productivity of phytoplankton and macrophytes in the lake. Increased levels of phytoplankton and macrophytes increase both turbidity and the biological oxygen demand (BOD) created by plant matter anaerobic decomposition. Increased BOD produces low dissolved oxygen and poor aquatic habitat. The trophic status gives an understanding of water quality problems and the biological aging of a lake. Lakes are classified by trophic state using the Trophic State Index (TSI) of Carlson (1977) which equates TSI to general ranges for Secchi transparency depth (SD), total phosphorous (TP) and Chlorophyll a (CHLA). Carlson's TSI is a commonly used, widely accepted method for classifying lakes by trophic condition. The TSI is calculated from TP (surface data only), CHLA, and SD data.

Trophic State	**TSI**	**SD (inches)**	**TP (mg/l)**	**CHLA (µg/l)**
Oligotrophic	<40	>145	<0.012	<2.5
Mesotrophic	≥40<50	>79≤145	≥0.012<0.025	≥2.5<7.5
Eutrophic	≥50>70	>18≤79	≥0.025<0.100	≥7.5<55
Hypereutrophic	≥70	≤18	≥0.100	≥55

The TSI uses a scale from 0 to 100, which is based on the log transformation of Secchi disk transparency; chlorophyll a corrected and total phosphorous concentrations. The trophic state of a lake is calculated by averaging the index numbers for Secchi disk transparency, chlorophyll a and TP.

The following are Carlson's TSI equations:

$$TSI = 60 - 14.41 \ln \text{Secchi disk (meters)}$$
$$TSI = 9.81 \ln \text{Chlorophyll } \underline{a} \text{ (corrected) in µg/l)} + 30.6$$
$$TSI = 14.42 \ln \text{Total phosphorous (µg/l)} + 4.15$$

Using the mean values of Secchi disk transparency, chlorophyll a (corrected) and TP concentrations, trophic state indices for the current baseline year were as follows:

	SD	CHLA	TP	Mean
TSI value	63	70	80	71

As shown by these results the trophic status of Patriot's Park Lake for the baseline year was in the eutrophic to hypereutrophic range. These results are also in agreement with those reported in the phytoplankton summary of Patriot's Park Lake.

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, a macrophyte survey, a fish survey, a bacteriological analysis and a waterfowl survey.

Phytoplankton

Phytoplankton are microscopic algae 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 sedimentation and filling of a lake.

Algae Genera Cell Density and Cell Volumes

As part of the IEPA's ALMP program, Kingsbury Park District staff collected water samples to be tested for genera, cell density and cell volumes. Phytoplankton analysis was conducted at the University of Illinois, Champaign-Urbana, IL. In the excerpted report that follows, table and graph references must be disregarded; a complete listing of taxa and summary & number of biovolumes of organisms can be found in Appendix A – Phytoplankton Data.

Lake Patriot's Park Report **June 14 2002**

Lake Patriot's Park was sampled at one site (Site 1) on 9 April, 7 June, 10 July, 20 August and 15 October, 2001 (Table: List of Taxa; Summary of Numbers and Biovolumes of Organisms). No record of sampling in earlier years was available. Blue-greens (Cyanophyta) dominated the phytoplankton totals on all dates except 9 April when cryptomonads (Cryptophyta) were the most numerous phytoplankters (Table: Phytoplankton Totals; Graphs: Total Phytoplankton; Cryptophyta; Cyanophyta).

Diatoms (**Bacillariophyta**) reached their peak density (245/mL) on 9 April and were in low densities (<100/mL) on the remaining dates. *Cyclotella meneghiniana* was responsible for a large part of the total density on 9 April (112/mL out of a total of 245/mL). Four other taxa were in the sample on that date. *Melosira varians* and *Navicula cryptocephala* var. *cryptocephala* were at 10/mL, *Nitzschia acicularis* at 20/mL and *N. palea* at 92/mL. All of these and the other diatoms seen in 2001 are those typical of eutrophic lakes. *N. palea* was in every sample taken and along with *N. acicularis* is tolerant of high levels of organic materials. These two species, *Navicula cryptocephala* and *Surirella ovata* (in the sample from 7 June) develop on the bottom in shallow areas of lakes or are washed into the lake from the bottom of streams entering the lake. In the lake, they continue to develop as part of the phytoplankton.

Green algae (**Chlorophyta**) were not in high (1000 or more/mL) densities on any date in 2001. They reached their peak in production on 20 August at 978/mL. Unlike the diatoms, however, they were in densities >100/mL on the remaining dates. The taxa seen in the samples from 2001 are those typical of eutrophic lakes. *Schroederia setigera* was the only green in the sample from 9 April and it formed all of the total density (112/mL) on that date. On 7 June, *Carteria multifilis* was responsible for most of the total (306/mL out of the total of 387/mL). On 10 July and 20 August, *Phacotus lenticularis* was the most numerous green. It was at 255/mL (out of a total of 489/mL) on the first date and at 632/mL (out of 978/mL) on the second. *Eudorina elegans* was second to *Phacotus* on 10 July at 102/mL and *C. multifilis* was second at 275/mL on 20 August. The latter formed most (92/mL) of the total (122/mL) on 15 October.

No chrysophytes (**Chrysophyta**) were seen in the samples from 2001. The 9 April date should have been earlier enough to have collected some of these algae. They characteristically develop in the phytoplankton during periods when temperatures are lower and competition from other algae is less.

As was noted, cryptomonads (**Cryptophyta**) were the most abundant (>1000/mL) algae on 9 April when they reached their peak of 11,527/mL. *Cryptomonas* sp. (No. 1) formed most (11,456/mL) of this peak (Table: Numbers and Biovolumes-Taxa). It was the only species present on 7 June and 15 October and was the most numerous on 10 July (173/mL out of a total of 183/mL), 20 August (143/mL out of a total of 204/mL). Characteristically, it is *C. erosa* that forms large densities in spring rather than the *C.* sp. The latter is more tolerant of high levels of organic materials and forms its major numbers after a heavy rain, an algicide treatment or in lakes with destratifiers in place.

Blue-greens (**Cyanophyta**) were most numerous organisms on every date after 9 April. They reached their peak on 20 August at 3261/mL and were abundant (>1000/mL) on 9 April (1885/mL), 10 July (1835/mL) and 15 October (2334/mL). They were numerous (866/mL) on 7 June. All three taxa indicative of eutrophic conditions in lakes were present in Lake Patriot's Park in 2001. Two of the three reached a "bloom" density of 1000 or more/mL (One Million or more/L). *Anabaena spiroides* var. *crassa* was at 1784/mL (1.784 Million/L) on 20 August and was the most abundant blue-green on that date. *Aphanizomenon flos-aquae* was at 1060/mL (1.06 Million/L) and was the most abundant blue-green on 10 July (Table: Numbers and Biovolumes-Taxa). *Microcystis aeruginosa* did not reach a bloom density, but was present on all dates except for 9 April (Table: List of Taxa). It reached its peak on 15 October at 214/mL and was at 31/mL on 7 June, 61/mL on 10 July and 41/mL on 20 August. Two innocuous blue-greens were responsible for most of the total production of blue-greens on dates other than those already mentioned. *Anacystis montana* and *Gomphosphaeria lacustris* are usually not of concern in lakes since they do not impart tastes or odors to the water or produce toxins. They do increase turbidity and may color the water. *Gomphosphaeria* was dominant on 9 April (1040/mL out of the total for blue-greens of 1885/mL), 7 June (673/mL out of 866/mL) and 15 October (1651/mL out of 2334/mL). The only other blue-greens not mentioned, *Schizothrix calcicola* and an *Oscillatoria* sp., were present but at low densities.

Euglenoids (**Euglenophyta**) were not important contributors to the phytoplankton in Lake Patriot's Park on any date in 2001. Their peak density of 795/mL occurred on 9 April. Most of this total (734/mL)was produced by *Colacium vesiculosum* which was attached to the copepod, *Cyclops* sp., and the cladoceran, *Bosmina longirostris*. This euglenoid is epizoic on these two organisms and legitimately is not part of the phytoplankton until it produces its *Euglena*-like zoospore. *Trachelomonas volvocina* was responsible for a majority of the total production on 7 June (82/mL out of a total of 92/mL) and all of it on 10 July (41/mL) and 20 August (51/mL). No euglenoids were in the sample from 15 October.

As was the case with the euglenoids, the dinoflagellates (**Pyrrhophyta**) were not responsible for much of the total phytoplankton production (Table: Phytoplankton Totals). *Ceratium hirundinella* was the only one present on 10 July. On 20 August, it and *Glenodinium gymnodinium* formed the total density of dinoflagellates with the former at 10/mL and the latter at 20/mL. Numbers and Biovolumes-Taxa). Both of these algae are typically found in eutrophic lakes.

Summary

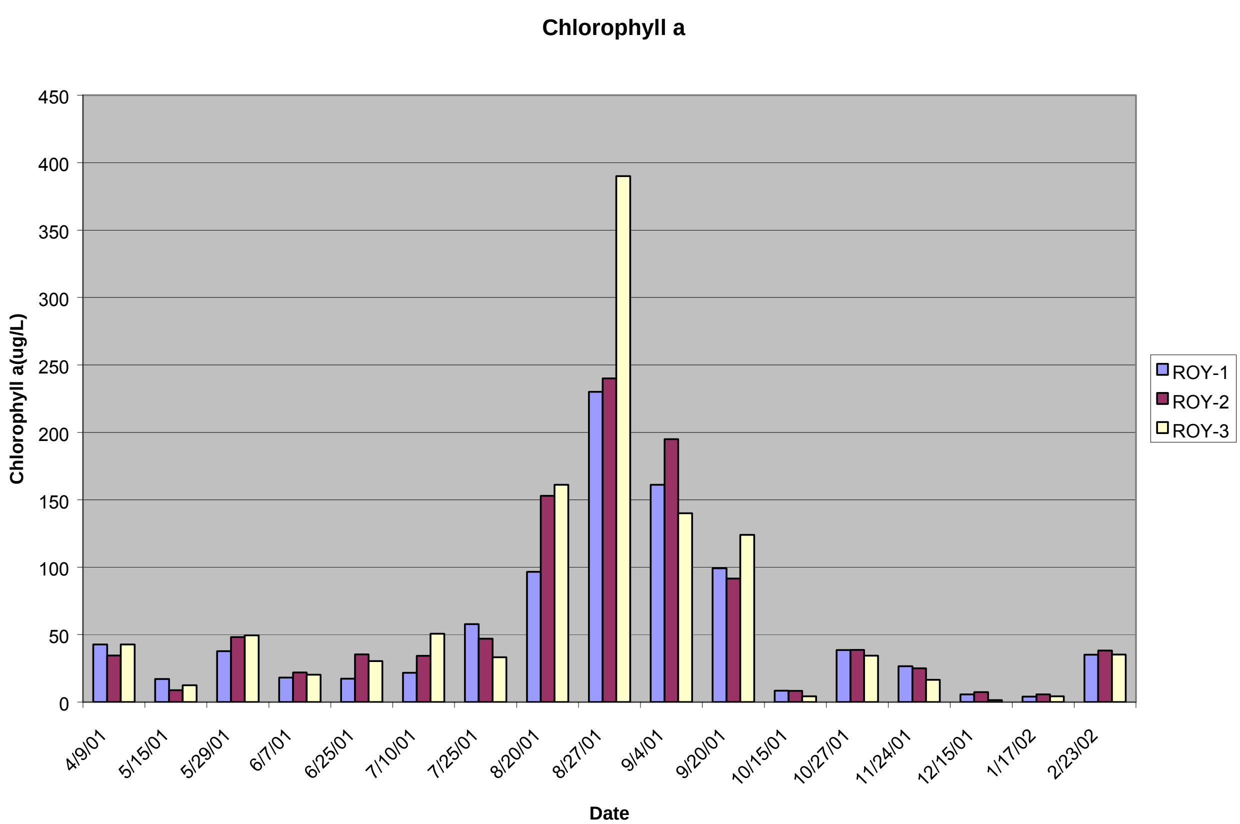
Patriot's Park Lake was eutrophic in 2001. This conclusion is based on the types of taxa composing the diatoms, greens, cryptomonads, euglenoids and the dinoflagellates. It is strongly supported by the presence of *Anabaena spiroides* var. *crassa*, *Aphanizomenon flos-aquae* and *Microcystis aeruginosa* and the "bloom" densities of the first two. Three positive features of the lake should be noted. First, total phytoplankton production was not extremely high on any date in 2001 except 9 April. Second, the lack of large densities of euglenoids and *Schizothrix calcicola* indicated that the lake had not developed extensive shallows by 2001. Finally, the water temperatures must not have been extremely high in 2001 since *Raphidiopsis curvata* was not present in the samples taken in July and August. This blue-green appears when water temperature reaches 25 C or higher.

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 a concentrations are also used as a variable in determining the degree of eutrophication and trophic status of a lake. Chlorophyll a samples were collected at three sites by the Kingsbury Park District staff and analyzed at IEPA laboratories. All sample values were corrected for pheophytin a. Pheophytin a is the breakdown product of chlorophyll a and is helpful in assessing the state of the algal population. A high concentration of pheophytin a may indicate an algal die-off or a stressed population. The corrected chlorophyll a values equal only the living chlorophyll a.

Chlorophyll a was found in the slightly elevated range on most dates. The highest levels occurred from late August through late September. This was also the time of the highest volatile suspended solid readings and the lowest Secchi readings during the study. Chlorophyll a levels peaked at all three sites on 8/27/01. ROY-1, 230 µg/l; ROY-2, 240 µg/l; ROY-3, 390 µg/l (Figure 31). A copper based algaecide, Cutrine, was applied to the lake in early October prior to trout stocking. This may have had some affect on the chlorophyll a count in mid-October.

Figure 31.



FISHERIES

Water quality can have a direct impact on the fish population in the lake and a healthy fishery is a major concern for Patriot's Park Lake. Fishing is one of the main recreational activities that take place on the lake, and it is known for its quality fishing. Sport fishers regularly come from areas as far away as the St. Louis metropolitan area for the bass, bluegill, and catfish. Rainbow trout are also stocked annually for the enjoyment of local fishermen as well as the youth fishing derby. Maintaining a quality fishery is an important component of overall lake management. The Illinois Department of Natural Resources has done a very good job managing the fisheries for Patriot's Park Lake, in part through the efforts of Charlie Marbut, IDNR Fisheries Manager (retired). Fish stocking records from 1992 through 2002 were provided by the Illinois Department of Natural Resources Division of Fisheries (Table 23).

Table 23. Patriot's Park Lake Fish Stocking Records

Species	Number	Size	Date
channel catfish	1176	8.8"	7-18-02
channel catfish	2500	5.0"	5-14-02
rainbow trout	1950	6-8"	10-10-02
channel catfish	7000	4.0"	8-27-02
channel catfish	1054	8.0"	8-31-01
largemouth bass	7000	3.5"	7-31-01
rainbow trout	2375	6-8"	10-11-01
channel catfish	723	8.0"	8-16-00
rainbow trout	2375	6-8"	10-9-00
channel catfish	720	10.0"	8-18-99
channel catfish	480	8.0"	11-2-99
rainbow trout	2050	8-10"	10-12-99
largemouth bass	12500	1.5"	6-3-98
rainbow trout	2500	8-12"	10-16-98
largemouth bass	257	16.5"	09-09-98
channel catfish	47	10"	10-9-97
channel catfish	1255	8.0"	08-12-97
rainbow trout	2500	10"	10-10-97
channel catfish	628	8.4"	09-19-97
rainbow trout	2400	8-10"	10-17-96
channel catfish	1255	8"	08-12-96
rainbow trout	2250	9.0"	10-12-95
largemouth bass	500	3.0"	09-25-95
largemouth bass	4260	4.0"	09-09-94
channel catfish	1255	9.0"	10-04-94
rainbow trout	1250	10-13"	10-13-94
channel catfish	1255	8.5"	07-29-93
channel catfish	1255	8.4"	07-08-92
Source: IDNR Fisheries			

The most recent Lake Management Status Report for Patriot's Park Lake was completed in 1998 (Appendix B). Fish were sampled by electro fishing and gill nets. Tissue samples were tested by the IEPA lab (Table 24). The IDNR in cooperation with the Park District sets fishing regulations including number and size limits in addition to developing a lake management plan which involves conducting regular fish surveys.

Table 24. IEPA Fish Tissue Samples

Collected by: DNR C. Marbut	Electrofishing & Gill Nets		
Date: 1/25/2002			
Species	Largemouth Small	Largemouth Large	Channelcat Large
# of fish	5	5	4
ALDRIN	.01K	.01K	.01K
TOTAL CHLORDANE	.02K	.02K	.02K
TOTAL DDT AND ANALOGS	0.02	0.01	.01K
DIELDRIN	.01K	.01K	.01K
TOTAL PCBS	0.1K	0.1K	0.1K
HEPTACHLOR	.01K	.01K	.01K
HEPTACHLOR EPOXIDE	.01K	.01K	.01K
TOXAPHENE	1.0K	1.0K	1.0K
METHOXYCHLOR	.05K	.05K	.05K
HEXACHLOROBENZENE	.01K	.01K	.01K
GAMMA-BHC (LINDANE)	.01K	.01K	.01K
ALPHA-BHC	.01K	.01K	.01K
MIREX	.01K	.01K	.01K
ENDRIN	.01K	.01K	.01K
LIPID CONTENT %	1.40%	0.89%	2.20%
SAMPLE WEIGHT Lbs	1.35A	3.07A	2.43A
FISH SPECIES CODE NUM	31	31	16
FISH SPECIES -ALPHA	LMB	LMB	CHC
ANATOMY (NUMERIC)	86	86	86
ANALYZING AGENCY	1	1	1
LENGTH (INCH)	0.93A	17.5A	20.14A
All chemicals in ug/g	Note: K = Less Than Value		

Fish tissue samples were below detectable limits for all constituents analyzed in all species.

MACROPHYTE SURVEY

Macrophytes are used by the IEPA as one determining factor of aquatic life health and as a recreational use impairment indicator (ALI, RUI). The quality of a lake can be impaired by an over abundance of aquatic and semi-aquatic plants. Macrophytes play an important role in the ecology of a lake. Macrophytes can provide shelter for fish, slow erosion, provide habitat for waterfowl, provide an oxygen source and absorb nutrients that are coming into the lake. The amount of aquatic or semi-aquatic macrophytes located in Patriot's Park Lake would be considered slight to minimal. This is likely a result of steep banks and water level fluctuations.

The Kingsbury Park District, Dan Marsch and Dr. James Lang of Greenville College did an extensive macrophyte survey on August 1, 2001. This survey consisted of collecting and mapping macrophytes throughout the lake. Thirty-two areas with significant macrophyte growth were identified. These were labeled 1-32. Plants in these areas were identified by their scientific name and common name when available (Steyermark 1999). The abundance of each type of plant was identified as sparse, moderate, or dense. This information was used to generate a map (Figure 32) and Tables 25 & 26.

On August 1, 2001, the lake was unusually transparent for the season, with extended Secchi readings:

ROY-1: 102 inches
ROY-2: 79 inches
ROY-3: 56 inches

The surface along the shoreline, extending 10-40 feet into the lake, consisted of a thick layer of *Lemna sp.* (duck weed), *Wolffia brasiliensis* (watermeal), and filamentous algae. Beneath this layer, beds of *Potamogeton sp.* (pondweed) and filamentous algae extend 10-20 feet from the shore, or to an approximate depth of five feet. Along heavily wooded / shaded areas macrophytes were either sparse or non-existent, whereby terrestrials resided at the waters edge.

Patriot's Park Lake contains many small coves throughout the main body of the lake. Several of the largest coves were considered separate areas for the macrophyte survey. The lake has steep banks around most of the shoreline leaving little room for aquatic macrophytes. However, many of the coves are densely occupied with *Taxodium distichum* (Bald Cypress), giving a distinct uniqueness to the lake's small area. Most of the plants found ranged from emergent to upland types of vegetation. All areas in the lake, except those found near the lakefront, were similar in nature with steep banks and moderate vegetation. The most common species in these areas were *Phalaris arundinacea* (reed canary grass), *Taxodium distichum* (bald cypress), and *Jussiaea repens* (water primrose). Areas #24 through #26 and #1, however, are located on the lakefront where the bank gradient is considerably less than the rest of the shoreline. These areas offered the most diverse sections of the lake with some species appearing only within them.

Figure 32. Macrophyte Survey Map and Key

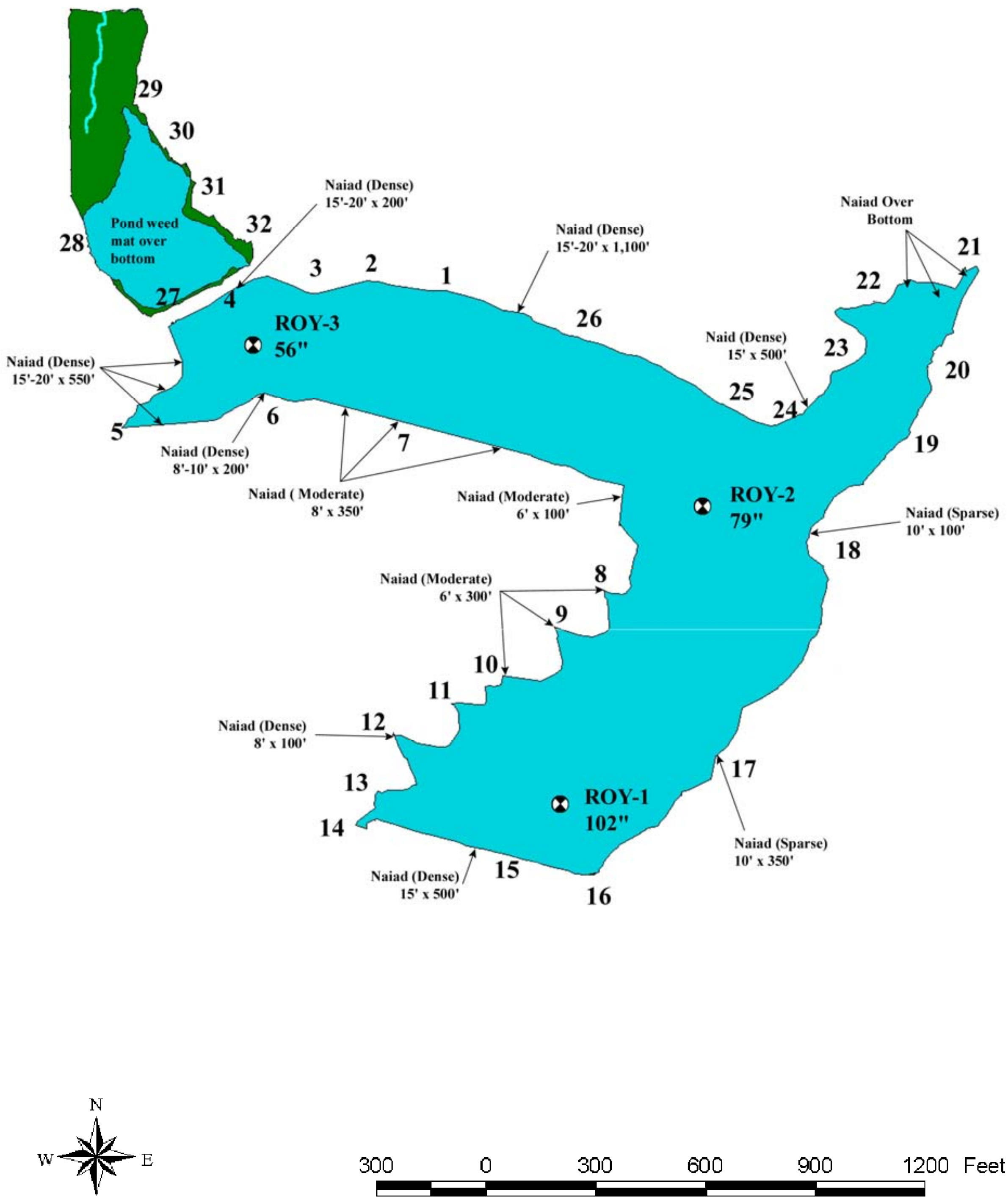


Table 25. Macrophyte Survey Areas 1-15

PLANT NAME	DENSITY and LOCATION														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Asclepias sp.		S				S				S					
Boehmeria cylindrica			M				S								
Cephalanthus occidentalis	S	S		S	S										
Cyperus croceus	S														
Cyperus sp.	M														
Cyperus strigosus	S														
Eclipta alba	S														
Eleocharis sp.	M														
Impatiens pallida	S	S			S		S								
Juncus effusus	S														
Jussiaea repens	S	S			M										
Phlaris arundinacea	D	M	D	D	D	D	S		M		S	M		D	D
Phyla lanceolata	M	S													S
Polygonum punctatum														S	
Polygonum hydropiper	M														S
Sagittaria sp.	S														
Taxodium distichum			S					S		M	D		D		

Table 26. Macrophyte Survey Areas 16-32

PLANT NAME	DENSITY and LOCATION																
	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Asclepias sp.																	
Boehmeria cylindrica																	
Cephalanthus occidentalis						S	S		S								
Cyperus croceus									M	M	M						
Cyperus sp.											D						
Cyperus strigosus									S	S	S						
Eclipta alba									M	S	S						
Echinochloa sp.											D						
Eleocharis sp.											S						
Impatiens pallida							M										
Juncus effusus									S		M						
Jussiaea repens	M									M		M	M	S	M	M	D
Phlaris arundinacea	D		M			D	M	M	M	D		D	S	D	M	S	D
Phyla lanceolata	S								D	D							
Polygonum punctatum											S						
Polygonum hydropiper																	
Sagittaria sp.																	
Taxodium distichum		S	S	M	D		S								M	D	

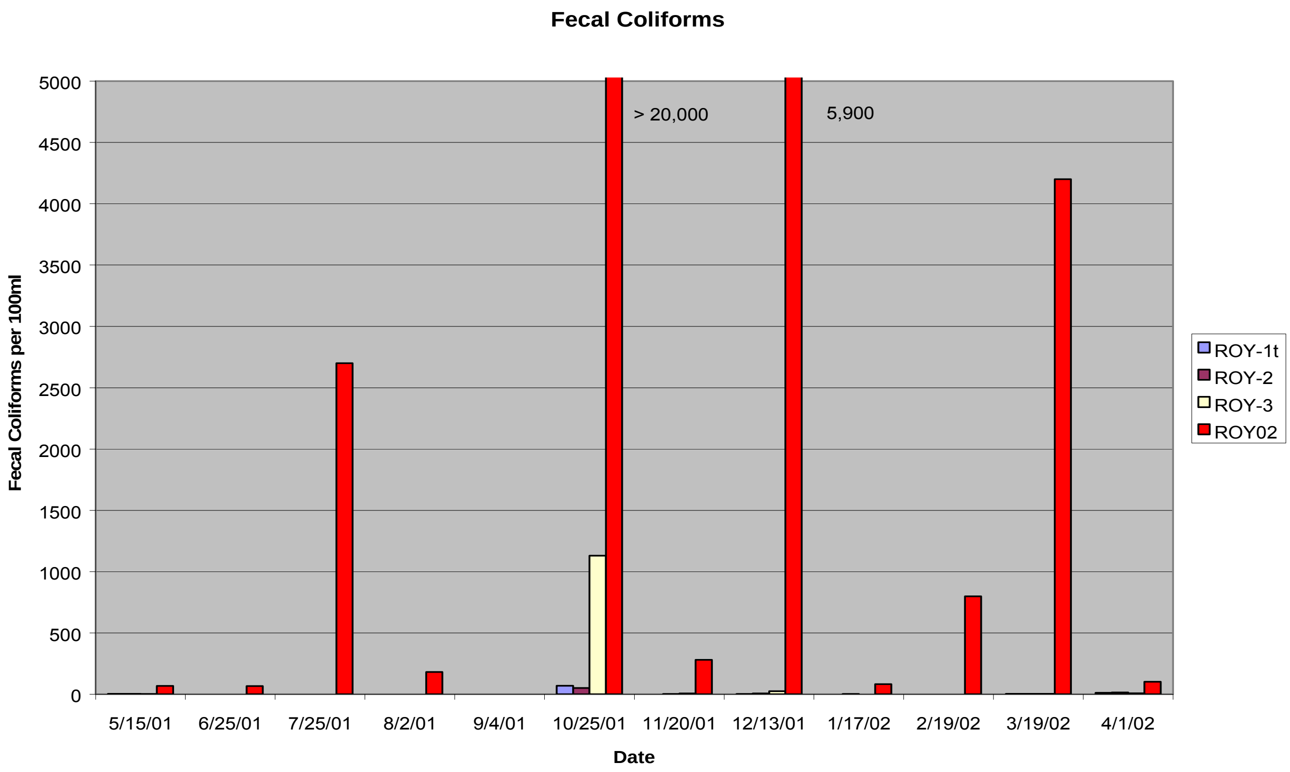
BACTERIOLOGY

Bacteriological samples were taken to check for coliform bacteria (Figure 33). Fecal coliforms are indicators of possible human and animal waste contamination. It is important for drinking and recreational waters 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. There are two potential sources of sewage effluent located on the park property. The caretaker's house is served by a septic tank and leach field that is greater than 25 years old and the new public restrooms completed in September 2002 are served by a septic tank and sand filter system. Both of these systems discharge onto the hillside on the north shore of the lake.

The Illinois general use 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 coliform samples is greater than or equal to 200 per100ml or 25% of all samples exceeds 400 per 100 ml.

Bacteriological samples were collected by Kingsbury Park District staff and analyzed at Madison County Environmental Laboratory in Edwardsville, Illinois.The highest concentration of coliforms were found at the northwest end of the lake (ROY-02), and usually after rain events. However, peak concentrations of coliforms did not correspond to significant rain events in all cases. During the month of October Kingsbury Park District staff observed livestock in the tributary prior to sampling at ROY-02. These incidents may have resulted in coliform spikes in October or additional months. Since five samples were never taken on a given date at a site it is not known if the high concentrations would have exceeded the IEPA standard. Regardless of the coliform levels, swimming has not been permitted in the lake for more than 25 years.

Figure 33.


Fecal Coliforms
Fecal Coliforms per 100ml
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
> 20,000
5,900
5/15/01
6/25/01
7/25/01
8/2/01
9/4/01
10/25/01
11/20/01
12/13/01
1/17/02
2/19/02
3/19/02
4/1/02
Date
ROY-1t
ROY-2
ROY-3
ROY02

WILDLIFE

Waterfowl and Bird Survey

To develop an understanding of the numbers and types of birds and waterfowl using the lake, Kingsbury Park District staff recorded bird observations while taking water samples throughout the year. This information was used to compile a table of the species of birds that were seen directly on or near the water (Table 27). Waterfowl can contribute significant amounts of pollution to a lake through fecal matter if they are found in large numbers throughout the year. There was not a large enough number of resident waterfowl observed to have a significant impact on the water quality, therefore nutrient loading from waterfowl is probably not a significant factor. Great blue herons were the only birds that were present during the survey in all months except when the lake was iced over. The other species were seasonal or in a migration pattern when they were observed on the lake. A summary of the greatest number of birds seen on any given day at the lake is illustrated in Figure 34.

Endangered Birds at Patriot's Park Lake

In October and November an osprey (*Pandion haliaetus*) was spotted at the lake on two different occasions. In 1952 the Osprey was listed as an extinct species in Illinois (Table 27). The osprey was not seen nesting again until 1986. Pied-billed grebes (*Podilymbus podiceps*), which are considered threatened in Illinois, were also spotted on Patriot's Park Lake. A total of six grebes were seen in the months of November and December. There are several endangered species that may potentially occur in Bond County; Table 28 shows this list.

Mammals

There is evidence of one type of mammal directly dependent on the aquatic system of Patriot's Park Lake. Muskrats (*Ondatra zibethicus*) tend to congregate within the silt basin at the lake. They are attracted to the area due to the thick stand of reed canary grass (*Phalaris spp.*) covering most of that area. Due to historical damage to the silt basin dam there is an active program to control the muskrat population in the lake.

There are many other mammals within the Patriot's Park Lake watershed but they are not entirely dependent on the lake to live. The watershed around the lake contains many different types of land uses. These range from agricultural crops and pasture to narrow riparian corridors and small blocks of oak-hickory dominated forests. These areas certainly provide habitat for a number of different mammals.

Table 27. Bird Count Estimates

Common Name	Scientific Name	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Canada Goose	*Branta Canadensis*	6		3	19							4	1
Mallard	*Anas platrynchus*	1											
Wood Duck	*Aix sponsa*	10					19						
American Coot	*Fulica Americana*											2	
Great Blue Heron	*Ardea herodias*	4	5	4	5	5	7	3				2	1
Osprey	*Pandion haliaetus*						1	1					
Belted Kingfisher	*Ceryle alcyon*		3				1					1	
Green Heron	*Butorides striatus*				2		3						
Common Merganser	*Mergus merganser*						3						
Blue-winged Teal	*Anas discors*							1					
Pied-billed Grebe	*Podilymbus podiceps*							5	1				
Ruddy Duck	*Oxyura jamaicensis*								3				
Lesser Scaup	*Athya affinis*											36	35
Bufflehead	*Bucephala islandica*												1

Figure 34.

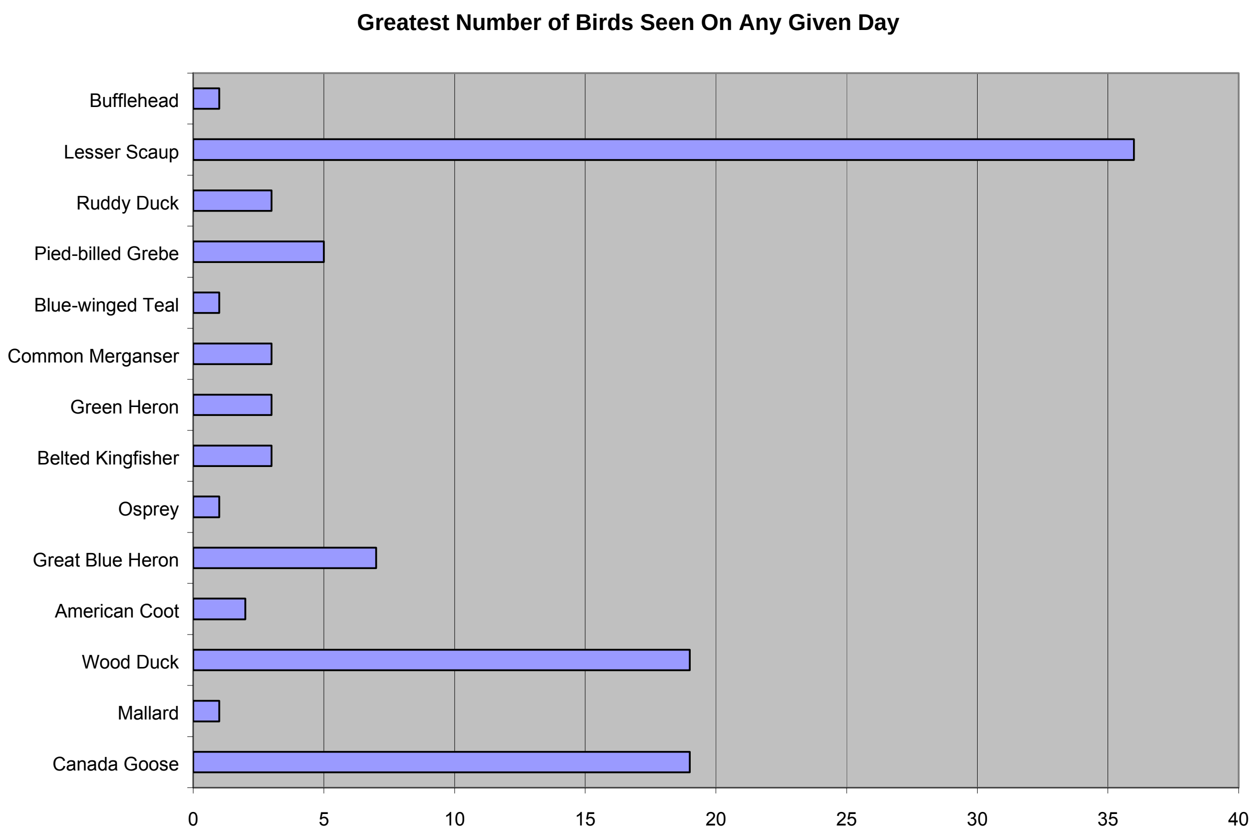

Greatest Number of Birds Seen On Any Given Day
Bufflehead
Lesser Scaup
Ruddy Duck
Pied-billed Grebe
Blue-winged Teal
Common Merganser
Green Heron
Belted Kingfisher
Osprey
Great Blue Heron
American Coot
Wood Duck
Mallard
Canada Goose
0
5
10
15
20
25
30
35
40

Table 28. Illinois Endangered and Extinct Species

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 Raven	*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 29. Currently listed species potentially occurring in Bond County

May occur as migrants 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	*Notropis boops*
Blacknose Shiner	*Notropis 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*

ECOLOGICAL RELATIONSHIPS

Macrophytes in the system provide an important base for the aquatic inhabitants of any aquatic ecosystem. Aquatic vegetation provides oxygen, cover, and food for many organisms. Along with microorganisms, the fish within the system take full advantage of the benefits of macrophytes. Predators use vegetation to ambush prey and the prey use the structure to escape from harm. Plants also provide food for muskrats that are normally concentrated in the silt basin, but most likely spend time in the main lake body as well.

Patriot's Park Lake has been stocked with channel catfish and rainbow trout every year for the past ten years. Largemouth bass have also been supplemented every few years when numbers from sampling showed the population slipping. The bluegill populations have been improving since the early 1990's (Appendix B). The breeding population of bluegill provides forage for the game species that are stocked and fished. A large number of channel catfish are harvested every year from the lake. The catfish creel limit is six fish per day for each person. Rainbow trout are annually stocked in the lake. These fish are not expected to survive the summers because of low oxygen levels and high water temperatures. However these fish probably have some effect on the baitfish populations in the lake.

Great blue herons are the main aquatic-dependent birds seen at Patriot's Park Lake. They are obviously taking advantage of the stable bluegill population and probably some of the smaller game fish. Some diving ducks, belted kingfishers and osprey have been seen feeding in the lake.

Aquatic ecosystems are extremely sensitive. Point and non-point source pollution can have a major effect on water quality. Surrounding land use has a large impact on sedimentation of the basin as well as the amount of nutrients present in the lake. Most of the organisms in an aquatic ecosystem have very specific tolerances to many water quality parameters.

REFERENCES

American Public Health Association. 1995. Standard Methods for the Examination of Water and Wastewater. 19th Edition. Washington D.C.

Brater, E. F. and H. W. King. 1976. Handbook of Hydraulics: For the Solution of Hydraulic Engineering Problems. 6th Edition. McGraw-Hill, New York.

Buchanan, T. J. and Somers, W. P. 1974, Stage Measurements at Gauging Stations, Techniques of Water-Resources Investigations of the United States Geological Survey, Book 3 Chapter A7.

Carlson, R.E. 1977. A trophic state index for lakes. Limnology and Oceanography 22(2): 361-69.

Carter, R. W. and Davidian, J, General Procedure for Gauging Streams, Techniques of Water-Resources Investigations of the United States Geological Survey, Book 3 Chapter A6.

Clark, G.M., Mueller, D.K., and Mast, M.A. 2000. Nutrient Concentrations and Yields in Undeveloped Streams Basins of the United States, Water Resource Association, v. 36 no. 4 p. 849-860.

Davidson William. 2003. Personal Communication (M. Shively) with Bill Davidson, 1st KPD Board President.

Fillos, J. and Swanson, W. R. 1975. The release rate of nutrients from river and lake sediments. V47(5):1032-1042. Journal of Water Pollution Control Federation.

Fuller, D. R. 1997. Understanding, Living with, and Controlling Shoreline Erosion: A Guidebook for Shoreline Property Owners. 2nd Edition. Tip of the Mitt Watershed Council. Conway, MI.

Galli, F. J. 1992. Analysis of the performance and longevity of urban BMP's installed in Prince Georges County, Maryland. Prince Georges County MD. For the MD Dept. of Environmental Resources. 136 pp.

Goldman, C. R. and A. J. Horne. 1983. Limnology. McGraw – Hill Publishing Co.

Haan, C.T., B.J. Barfield, J.C. Hayes. 1994. Design Hydrology and Sedimentology for Small Catchments. Academic Press San Diego, CA 588 p.

Hill, R. A., H.L. Hudson, J.J. Clark, T. R. Gray and R. J. Kirschner. 1994. Clean Lakes Program: Phase I Diagnostic Feasibility Study of Herrick Lake, Dupage County Illinois. Forest Preserve District DuPage County Planning and Development Department and The Northeastern Illinois Planning Commission Natural Resources Department.

Holland, T. 2004. Personal communication. Illinois Environmental Protection Agency, Springfield.

Illinois Environmental Protection Agency. 2000. Governor Bond Lake Phase I Diagnostic Feasibility Study - Report Submitted.

Illinois Pollution Control Board. 1990. Illinois Pollution Control Board Part 302 Water Quality Standards. Springfield Illinois.

Illinois State Geological Survey. 1990. Guide to the Geology of the Nashville Area, Washington. County. Champaign, Illinois.

James, W. F., J.W. Barko, and S.J. Field. 1996. Phosphorous mobilization from littoral sediments of an inlet region in Lake Delavan, Wis. Arch. Hydro. Biol. 138:245-257

Kentucky Water Watch. pH and water quality. [Online] Available http://kywater.org/ww/ramp/rmph.htm 2004.

Kirschner, R. J.1995. A Guide to Illinois Lake Management, Northeastern Illinois Planning Commission Chicago Illinois.

Lawrence, G. B., D. A. Goolsby and W. A. Battaglin. Atmospheric deposition of nitrogen in the Mississippi River Basin. [Online] Available http://toxics.usgs.gov/pubs/wri99-4018/Volume2/Sectionc/2413_Lawrence/pdf/2413_Lawrence.pdf 1999.

Litke, D. W. 1999. Review of Phosphorus Control Measures in the United States and their Effects on Water Quality. USGS WRI99-4007

Manny, B. A., W. C. Johnson and R. G. Wetzel. 1994. Nutrient additions by waterfowl to lakes and reservoirs: predicting their effects on productivity and water quality. Hydrobiologia. 279/280: 121-132.

Mitzelfelt, J. D., 1996. Sediment Classification for Illinois Inland Lakes (update). Illinois Environmental Protection Agency.

Nielsen, L. A. and Johnson, D.L. .1983. Fisheries Techniques, American Fisheries Society.

North American Lake Management Society. 1989. Management Guide for lakes and reservoirs. North American Lake Management Society. Washington D.C. 42 p.

North American Lake Management Society. 1990. The Lake and Reservoir Restoration Guidance Manual. 2nd Edition. EPA 440/4-90-006. U.S. Environmental Protection Agency, Washington D.C. 339 p.

North American Lake Management Society. 1990. Monitoring Lake and Reservoir Restoration: Technical Supplement to the Lake and Reservoir Restoration Guidance Manual. EPA 440/4-90-007. U.S. Environmental Protection Agency, Washington D.C.

Nürnberg, G.K. 1984. The Prediction of Internal Phosphorus Load in Lakes with Anoxic Hypolimnia. Journal of the American Society of Limnology and Oceanography: 29(1) 111-124.

Nürnberg, G. K. 1995. Quantifying anoxia in lakes. Limnology and Oceanography 40:1100 – 1111.

Oberts, G. L., P. J. Wotzka and J. A. Hartsoe. 1989. The water quality performance of select urban runoff treatment systems. Metropolitan Council of St. Paul, MN. For the Legislative Commission on MN Resources. 81 pp. plus appendices.

Pucket, L. J. 1993. Nonpoint and Point Sources of Nitrogen in Major Watersheds of the United States. USGS WRI94-4001

Rantz, S.E. 1982. Measurement and Computation of Streamflow. Geological Survey Water-Supply Paper 2175. U.S. Governmental Printing Office, Washington, D.C.

Riggs, H. C. and Hardison, C. H., 1989, Storage Analyses for Water Supply, Techniques of Water-Resources Investigations of the United States Geological Survey, Book 4 Chapter B2.

Roberts, W. J. and J. B. Stall. 1967. Lake Evaporation in Illinois. Report of Investigation 57 State of Illinois Department of Registration and Education. State Water Survey Division. Urbana, IL.

Sauerwein, J. 2003. Personal communication. Kingsbury Park District, Greenville.

Schueller, T.R. 1992. Design of stormwater wetland systems: Guidelines for creating diverse and effective stormwater wetlands in the mid-Atlantic region. Metropolitan Washington Council of Governments. 134 pp.

Steyermark, J.A. 1999, Steyermark Flora of Missouri. Iowa State University Press. Ames Iowa.

Strecker, W. E., J. M. Kersnar and E. D. Driscoll. 1992. The use of wetlands for controlling stormwater pollution. Prepared for the USEPA. 61 pp.

Taylor, W.D. 1979. Phytoplankton Water Quality Relationships in U.S. Lakes, Part VII: Comparison of Some New and Old Indices and Measurements of Trophic State. Environmental Monitoring and Support Laboratory Las Vegas, Nevada 51 p.
EPA 600/3-79-079

Terres, J. K. .1980. The Audubon Society Encyclopedia of North American Birds. Alfred A. Knopf New York.

Thornton, K.W., B. L. Kimmel and F. E. Payne, eds. In: Reservoir Limnology, Ecological Perspectives. John Wiley & Sons Inc. 1990. 256 pages.

U.S. Environmental Protection Agency. 1993. Fish and Fisheries Management in Lakes and Reservoirs: Technical Supplement to the Lake and Reservoir Restoration Guidance Manual. EPA 841-R-93-002. Environmental Protection Agency, Washington D.C. 321 p.

U.S. Environmental Protection Agency. 1982. Handbook for Sampling and Sample Preservation of Water and Wastewater. EPA 600/4-82-029. Environmental Monitoring and Support Laboratory Cincinnati, OH 401 p.

U.S. Environmental Protection Agency. 1984. Lake and Reservoir Management. EPA 440/5/84-001 Office of Water and Regulations and Standards Washington, D.C.

U.S. Department of Agriculture Soil Conservation Service. 1983. Soil Survey of Bond County, Illinois. Illinois Agricultural Experiment Station. Bond County, IL

U.S. Geological Survey. 1982. Measurement and Computation of Streamflow: Volume 2. Computation of Discharge, Geological Survey Water-Supply Paper 2175.

U.S. Geological Society. 1973. Storage Analyses for Water Supply: Techniques of Water-Resources Investigations of the United States Geological Survey Book 4 Chapter B2.

Winslow, L. 1995. Greenville Area Geology: The Geological Framework of Greenville, Illinois Guide 1995/A Greenville College.

Wisconsin Department of Natural Resources. 1974. Survey of Lake Rehabilitation Techniques and Experiences. Technical Bulletin No. 75. Department of Natural Resources. Madison, Wisconsin.

Yoo, K. H. and Boyd, C.E.. 1993. Hydrology and Water Supply for Pond Aquaculture. Chapman and Hall New York.

PART 2

FEASIBILITY STUDY OF PATRIOT'S PARK LAKE

INTRODUCTION

This study has identified many causes of impairment for Patriot's Park Lake. Restoration proposals will be directed at solving the most significant of these, including high sedimentation, high nutrient inputs from the watershed, and turbidity. Recommended methods for restoring and enhancing lake water quality can be sorted into several categories. These categories include watershed practices, in-lake practices and general or cultural practices.

The ultimate goal of this restoration program is the enhancement and protection of Patriot's Park Lake as a resource for the citizens of Bond County and beyond. The improvements proposed herein have the added benefit of providing significant benefit to the East Branch of Shoal Creek, and beyond that to Shoal Creek itself. Shoal Creek is among the largest secondary waterways in the state of Illinois, and is tributary to the Kaskaskia River. Both are impaired in several water quality categories, and improvements and protections at Patriot's Park Lake will have an incremental positive effect on these receiving waters.

As with any restoration program, it is important that all constituencies have ample opportunity for input. Using the information found in Part 1 of this Phase I Clean Lakes Study, the restoration proposals described in Part 2 have been reviewed in open meeting with the Kingsbury Park District (KPD) Board of Commissioners. Comments by all interested parties, and agreements made related to these restoration initiatives, are incorporated herein as support for Clean Lakes Phase II funding.

EXISTING LAKE QUALITY PROBLEMS AND THEIR CAUSES

Since the inception of this study, Patriot's Park Lake was removed from the 1998 IEPA Section 303(d) list of impaired waters for the state of Illinois. The reason being given by the 2002 Draft Section 303(d) List is "no data". The historical data which placed Patriot's Park Lake on the 1998 Section 303(d) List expired (older than 15 years) between 1998 and 2002. Presently, IEPA is reviewing data for the updated Section 303(d) list. Data from this study will provide the IEPA with water quality documentation needed to establish lake status. The established causes of impairment were found to be: nutrients, siltation, organic enrichment, and suspended solids.

High Levels of Nutrients Including Phosphorus

The nutrient budget estimates 13,401 Kg of nitrogen and 3,234 Kg of phosphorus entered the lake during the one-year study period. Phosphorus is of particular concern since it was identified as the limiting nutrient for the lake. Elevated phosphorus levels can lead to algal blooms which in turn cause increased turbidity and lower dissolved oxygen. These inputs are generally associated with watershed practices, which are dominated by agriculture (hay and grazing, as well as row crops).

Low Dissolved Oxygen and Internal Nutrient Release

During the summer months the lake stratifies and oxygen is depleted near the lake bottom. During the study period, this resulted in internal nutrient loading of 95 Kg/yr of phosphorus and 756 Kg/yr of nitrogen. The nutrient budget estimates this represents 5.6% of the total nitrogen load, and 2.5% of the total phosphorus load observed in the lake.

Sediment Entering the Lake from Watershed and Lake Shoreline

The sediment budget estimates 829,706 Kg/yr of suspended solids enter the lake from the watershed. High suspended solids are typically a result of a variety of different forms of erosion, including sheet, rill and gully erosion. The study also identified 55,600 Kg/yr of sediment entering the lake directly from the shoreline. This latter sediment load is attributed to shoreline erosion cause primarily by the soil type of this impoundment and wind/wave action.

OBJECTIVES FOR LAKE RESTORATION

Lake restoration involves the management of complex ecosystems, as well as the interests of a variety of stakeholders such as political jurisdictions, public interest groups and residents. Overall lake restoration and management can be designed to meet the majority of the desired outcomes and interests since improved water quality benefits quality of life for all stakeholders. This study examines the feasibility of restoring acceptable water quality to Patriot’s Park Lake in accordance with the following objectives:

- **Objective 1 - Reduce nutrient loading**
- **Objective 2 - Improve aquatic life in the lake**
- **Objective 3 - Reduce sedimentation**
- **Objective 4 - Improve the recreational use of the lake**
- **Objective 5 - Educate the public on the importance of good water quality**

WATERSHED INITIATIVES

Initiative 1 - Construction of Extended Detention (ED) Wetlands. *Meets objectives 1, 3*

In extended detention (ED) wetlands, water (from precipitation, groundwater seeps, etc.) runs off from the watershed and is captured and detained before entering the receiving waters (in this case, Patriot’s Park Lake). A storage basin is created either “on-line” (a dam in the flow-line of the creek) or “off-line” (beside the creek with an overflow or diversion structure). Extra storage is provided in a “forebay” above a shallow marsh which is created by this temporary detention of run-off (Figure 35). ED wetlands consume less space, as temporary vertical storage is partially substituted for shallow marsh storage. A new growing zone is created along the gentle slopes of the wetland that extends from the normal pool elevation to the maximum water surface elevation. ED wetlands slow the flow of water during storm events and act as a sediment catchment and filtering mechanism for runoff from the watershed; they also have the added benefits of providing improved wildlife habitat.

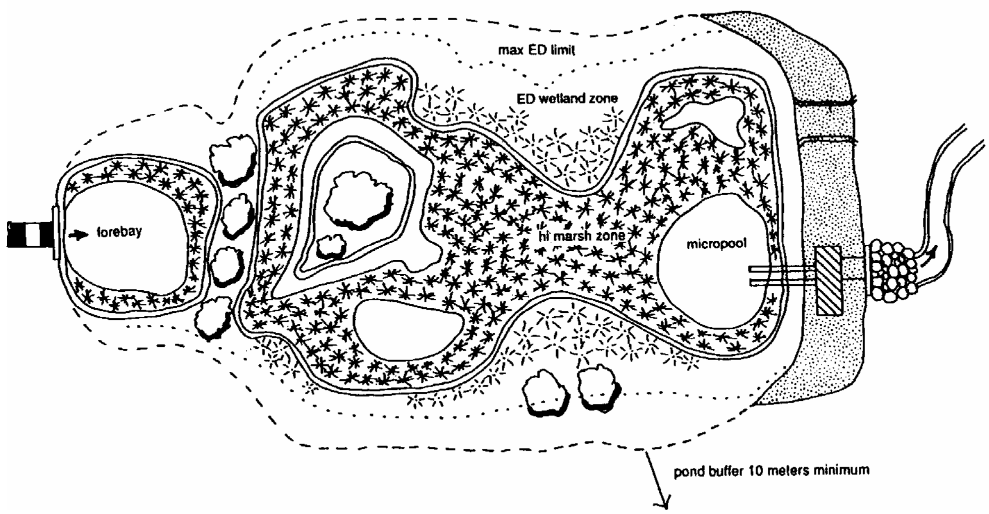


Figure 35. Extended detention stormwater wetland.

Figure 36. Location of ED wetlands.

Two ED wetlands are proposed in the watershed of Patriot's Park Lake, both on the principal in-flowing stream above the existing sediment basin of the lake (Figure 36). The estimated costs for these structures would be $160,000.00 and both would be constructed on permanent easement lands north of Illinois Route 140 (IL Rte 140).

Specifically, a larger, on-line facility would be installed on an in-flowing tributary approximately 1,800 feet north of IL Rte 140. This facility would be designed as a full-flow impoundment, with a low-level dam armored with cable stayed concrete block such as Armorflex™. The facility would have a clean-out cycle of 5 – 8 years.

The second facility would be a smaller, off-line facility located adjacent to the tributary immediately upstream of the IL Rte 140 crossing. This facility would be primarily designed to retain sediments and reduce velocities entering the upper sediment basin of Patriot's Park Lake, just to the south of the highway crossing.

These ED wetlands would be very effective at reducing the pollutants currently causing the impairments to the waterbody. The means for accomplishing this reduction are described below.

> REMOVAL PATHWAYS WITHIN STORMWATER WETLANDS - The basic intent of a stormwater wetland is to create a shallow matrix of sediment, plants, water and detritus that collectively removes multiple pollutants through a series of complementary physical, chemical and biological pathways, as follows. Some of the primary removal pathways operating within stormwater wetlands are described below:
>
> - Sedimentation
> - Physical Filtration of Runoff
> - Microbial Uptake/Transformation
> - Uptake by Wetland Plants
> - Uptake by Algae
> - Extra Detention and/or Retention
>
> *Sedimentation.* As with other conventional pond systems, sedimentation (or gravitational settling) is perhaps the dominant removal pathway for particulate pollutants operating within a stormwater wetland. The morphology and vegetation within stormwater wetlands create ideal settling characteristics, particularly in comparison to other pond systems. The sheet-flow conditions across the wetland, slower runoff velocities and hydraulic resistance afforded by the wetland vegetation, are all very effective at promoting settling. In addition, the root network of emergent plants helps to stabilize sediments, thereby reducing the potential for their re-suspension. Much of the sedimentation in wetlands (and ponds) will usually occur in the immediate vicinity of the inlet.
>
> *Adsorption to Sediment, Emergent Plants and Detritus.* The second primary removal pathway is the adsorption of pollutants to the surfaces of suspended sediments, bottom sediments, wetland vegetation and organic detritus. Adsorption is a key removal pathway

for phosphorus, trace metals and some hydrocarbons. The importance of adsorption as a removal pathway increases as the contact time with this complex of surfaces increases. Longer contact time in stormwater wetlands can be achieved by creating a high surface area to volume ratio. A number of techniques can be used to increase contact time:

- create a complex and variable micro-topography within the stormwater wetland,
- establish dense stands of emergent wetland vegetation,
- design for sheet flow or shallow flow conditions,
- incorporate organic soils into the bottom of the wetland, and
- allow wetland detritus to accumulate within the basin.

Physical Filtration by Plants. The dense network of emergent wetland plants acts as a filter for incoming stormwater as it passes through a stormwater wetland. In addition, the filtering action of the wetland plants reinforces the effectiveness of other removal pathways, such as sedimentation, adsorption and microbial removal.

Microbial Activity. The complex of surfaces within the stormwater wetlands provide favorable conditions for active microbial growth. Billions of microscopic bacteria consume carbon and nitrogen compounds within both the water column and the organic sediments of the wetland. Microbial processes are effective in removing nitrogen (via the nitrification / de-nitrification process) and organic matter (via aerobic decomposition). Microbial activity consumes oxygen, and often can completely deplete oxygen within the top layer marsh sediments. The combination of partially decomposed organic matter and low oxygen common to wetlands helps to immobilize many trace metals into less mobile sulfide, oxide or hydroxide compounds that are less likely to be released to the biota.

Uptake by Wetland Plants. Uptake of pollutants by emergent wetland plants is an indirect removal pathway for nutrients and metals. In nearly all cases, emergent wetland plants take up these substances through their roots, rather than from their leaves. Therefore, the influence of wetland plant uptake is primarily on pollutants that have been previously deposited in the sediments. Exceptions include some species of submerged or floating aquatic vegetation.

Although the uptake does not remove nutrients and metals from the water column, it does create new exchange sites within the sediment for future adsorption of pollutants. The nutrients and metals that are trans-located to the leaves and stems are not permanently retained, but can be released to the water column when the above-ground parts die back in the fall.

Uptake by Algae. Uptake by planktonic or benthic algae is an important removal pathway for soluble pollutants such as phosphate and ammonia within stormwater wetlands. The large volume of standing water within stormwater wetlands is an optimum environment for the growth of algae. Free-floating algae take up the nutrients and convert them into biomass which, in turn, settle out to the wetland sediments.

Contribution of algal uptake to the nutrient removal capability of wetlands is frequently overlooked. Galli (1992) surveyed over twenty wetlands and ponds in Maryland, and found that the wetlands as a group had a higher trophic index, which is a measure of system productivity. Algal mats are often observed on the sediment surface of shallow wetlands, and these mats are thought to be effective in removing nutrients as well.

Augmented Retention or Detention. Not all the removal pathways in a stormwater wetland are related to the wetland/plant/sediment matrix. In many designs, up to half of the total treatment volume is devoted to a permanent pool and/or temporary extended detention. These treatment volumes can augment sedimentation and algal uptake, and can increase the total contact time within the wetland for adsorption, filtration and microbial activity. These removal pathways take on added importance during the non-growing season, when marsh removal pathways are not as effective (Table 26).

Table 30. Projected long-term removal rates for stormwater wetlands 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 been 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. P removal of 65% and N removal of 40% are likely.*

The pollutant removal performance of nearly 25 stormwater wetland systems has been reported to date. Although the stormwater wetland systems monitored have differed greatly in their design and treatment volume, most have shown moderate to excellent pollutant removal capability under a range of environmental conditions. From a review of these studies, it is evident that:

- The removal rates for stormwater wetlands are similar to conventional ponds systems, such as dry extended detention and wet ponds. In many cases, suspended solid removal rates were higher than conventional ponds, which reflects the better settling conditions that are often found in wetland systems. Conversely, phosphorus removal rates in wetland systems were more variable and, and in some cases, slightly lower than wet ponds. The exact reason for the reduced phosphorus removal is not clear, but may reflect complex phosphorus cycling patterns often associated with wetlands. In fact, some wetlands actually exported ammonia nitrogen and phosphate at certain times of the year.

- Extended detention ponds with wetlands typically performed better than ED ponds without wetlands. Four performance studies of ED wetland systems have been reported, and these suggest a moderate to high capability to remove particulate pollutants, and a low to moderate capability to remove soluble pollutants. However, the four ED wetland systems investigated had inadequate treatment volumes (0.8 to 0.15 inches of runoff per contributing acre) which may have limited their ability to provide reliable levels of soluble pollutant removal.

- The most reliable overall performance was achieved by pond-wetland systems. In these systems, the permanent pool pre-treats runoff before entering a shallow marsh. The pool also reduces runoff velocities and provides considerable pollutant removal. Of particular note has been the demonstrated capability of these systems to provide consistently higher levels of phosphorus and nitrogen removal than other stormwater wetland designs.

- The performance of pocket wetlands has never been monitored. For a number of reasons, it is quite likely that the performance of pocket wetlands will not be as reliable as other stormwater wetland designs. First, most pocket wetlands are excavated to the groundwater, which means that much of the treatment volume capacity is used up by groundwater rather than stormwater. Second, pocket wetlands often lack forebays, are prone to re-suspension, and often lack the dense vegetative cover of larger wetland designs (Galli, 1992).

- Several studies indicate that the performance of stormwater wetlands declines slightly during the non-growing season, and more strongly when the wetland plants die back in the fall (releasing a portion of the nutrients stored in above-ground biomass). The lower performance can be attributed to the lack of wetland structure and lower temperatures that reduce microbial and algal activity.

- Performance also declines if stormwater wetlands are covered with ice or receive snowmelt runoff. Oberts et al (1989) reports that ice and snowmelt conditions experienced in Minnesota reduced average pollutant removal by about 25 to 50%. Nevertheless, good removal rates over the entire year were still observed at the site.

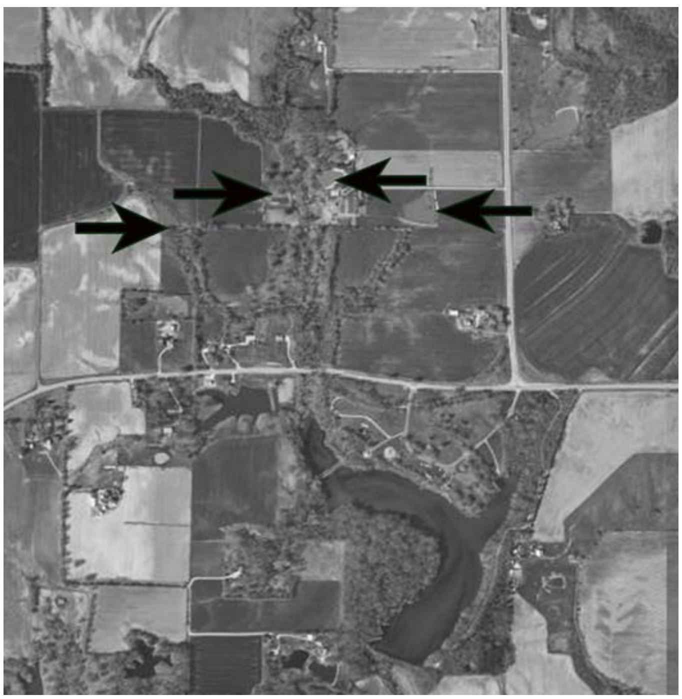
- Some evidence exists that stormwater wetland performance increases as the wetland ages at least in the first several years. This is attributed to the greater density of plants and organic materials that accumulate in the wetland over time. Initially, many stormwater wetlands do not posses much organic matter because they are excavated to depleted mineral subsoils. It is not clear whether performance continues to increase over the long term (i.e., decades) as nutrient exchange sites become fixed.

In general, it is apparent that stormwater wetlands outperform natural wetlands of similar size (Strecker et al, 1992). This undoubtedly reflects the longer detention and/or retention of runoff that is designed into constructed systems.

Initiative 2 – Maintenance of Existing Basins. *Meets objectives 1, 3*

The KPD has the good fortune of owning a lake for which the watershed already supports several sedimentation basins. Most have been constructed with private funds on private property, and are functioning very effectively to reduce sedimentation in the lake. It is clearly in the KPD's best interest to remove the sediment from these basins and regain the storage capacity they offer.

Figure 37. Basins to be cleaned out.



Four basins occur on lands owned by a single property owner (Figure 37). That landowner has offered to retain the sediments from those basins on the property, eliminating the need for expensive options of hauling and disposal. The estimated cost to clean out these basins is $15,000.00

Initiative 3 - Conservation Easements. *Meets objectives 1, 2, 3 and 4*

There are several areas in the watershed which generate runoff that could adversely affect the quality of the lake such as areas of row crop, grazing and confined livestock feeding areas. One of the most effective lake restoration initiatives is development of an incentive program for watershed landowners to develop conservation easements through existing government conservation programs such as the Conservation Reserve Program (CRP). Additional funds can provide assistance to landowners regarding the establishment of conservation cover and the best management practices (BMP) described below.

<u>CRP INCENTIVE PROGRAM</u> – The goal of this effort is to create an incentive for landowners to enroll their CRP eligible lands (generally highly erodible soils) into this USDA program. Specifically, landowners are directed to the USDA Farm Service Agency office during the general sign-up period for CRP; if accepted into the program, the landowner brings the CRP contract to the lake owner (in this case the KPD) and KPD uses Illinois EPA Phase II grant funds to provide a one-time, $100.00 per acre up-front

payment. The landowner signs an agreement with the KPD committing to remain in the CRP or return KPD funds, which could then be used for other landowners in the watershed eligible for such payments. The landowner also develops and establishes a conservation plan for the lands which provides the water quality benefits needed for lake restoration.

Figure 38. Potential CRP Incentive areas.

At present there are over 300 acres which would be ideally suited for this type of incentive program (Figure 38). Assuming 150 acres are signed up and accepted, the cost would be $15,000.00. When additional costs are included for administration of the program and development of the agreements and conservation easement language, the total cost for this effort would be $20,000.00.

CONSERVATION COVER INCENTIVE PROGRAM – There is significant benefit to the receiving waters of any watershed to have significant areas in a permanent cover crop such as improved pasture / hay fields. Within the watershed of Patriot's Park Lake there are almost 100 acres presently in hay production (Figure 39). This incentive program encourages these producers / landowners to commit to a 10 year contract for production of hay or allowing these acres to remain fallow (with twice annual mowing). There are also guidelines and limitations for applications of chemicals (herbicides and fertilizers). The overall soil conservation benefits can be significant for such a small watershed. The goal for this program would be to enroll 50 acres for 10 years at $100.00 per acre per year. The total cost, with administration and monitoring, would be $60,000.00.

Figure 39. Conservation Cover Incentive areas.

CONSERVATION EASEMENT AND RESTORATION PROJECT – This program would identify a specific parcel which represents a critical run-off area to the lake. The parcel selected would be a 10 to 15 acre area for which a conservation plan would be developed, to include planting of native warm-season grasses / prairie cover or native tree planting (mast producing species). A ten-year conservation easement would be developed which pays $100 per year; total costs, including administration and restoration (at an additional $10,000 to $15,000) are estimated at $25,000.00 (Figure 40.

Figure 40. Conservation Easement / Restoration areas.

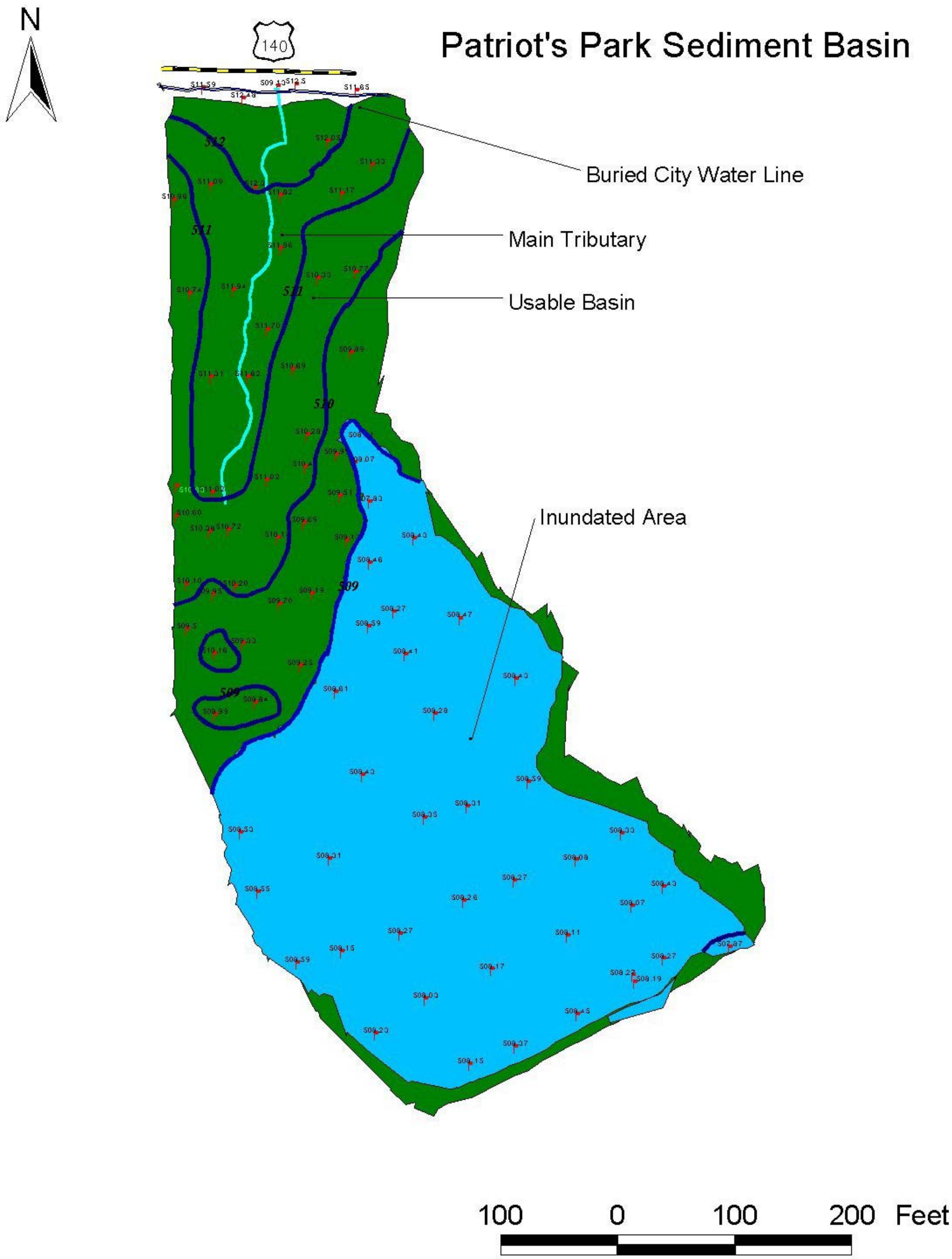
IN-LAKE INITIATIVES

Initiative 3 – Sediment Basin Dredging, Check-dam and Control Structure Rehabilitation.
Meets objectives 1, 2 and 3

Patriot's Park Lake has been well served over the years by the existence of a large forebay, or sediment basin, that has a "check dam" (intermediate causeway) and control structure (four 24-inch corrugated metal pipes). The sediment basin has trapped the majority of in-flowing sediments from the main tributary to the lake (the stream flowing under the IL Rte 140 bridge). During the preceding 70 years the sediment basin has become almost completely filled with sediments, creating a significant area of vegetated wetlands at the north end of the basin and an open water area with an unconsolidated bottom throughout the rest of the basin (Figure 41). The "usable basin" in the following figure defines the existing vegetation area which at present provides some filtering and nutrient assimilation from inflowing waters. The "inundated area" is the area which has no storage left (full of sediment) and has no vegetation; this is the area to be dredged. The culverts are more than 50% blocked with sediments.

The diagnostic portion of the study examined sediments from this settling basin and revealed no harmful pollutants which would require special handling during a dredging project. Dredged material, which is rich in nutrients and minerals, would be removed from the park district property a short distance to a confinement/consolidation and drying area in a neighboring field, allowing the material the time needed to promote handling and redistribution to those fields. Once dried the material would be spread, lightly tilled and ultimately planted again in row crop, pasture or hay.

Figure 41. Existing contours of sediment basin.



Dredging of this sediment basin would likely be done either with a track-hoe from a temporary causeway, with material being loaded onto trucks and removed from the park, or perhaps hydraulically dredged and pumped to a confinement area in an adjoining field for temporary storage and drying. The total material to be removed is estimated at 22,000 cubic yards (2.2 acres X 6 feet deep). The anticipated cost of either option is approximately the same at $135,000.00. For the excavation/removal scenario, this represents excavation of 22,000 cubic yards of material at $1.50/cu-yd and hauling at $3.50/cu-yd, plus design and administration. For the hydraulic dredging scenario, the $135,000.00 cost represents establishment of the temporary confinement area and hydraulic pumping of 22,000 cubic yards of slurry material at $5.00/cu-yd, plus design and administration.

The check dam and control structure for the basin also need to be rehabilitated. The check dam has been significantly damaged by muskrats and overflow of flood waters which exceed the diminished capacity of the control structure (four culverts). The culverts need to be replaced (with appropriate prior design to establish 25-year capacity, if possible, and control elevations) and the check dam re-constructed with appropriate materials (likely armoring with open-cell cable stayed concrete block). This armoring will allow for vegetative cover and the continued use of the check dam as part of the trail system in the park, while protecting the check dam during larger peak storm events that exceed the capacity of the culverts and over-top the dam.

The cost for this work is estimated at $100,000.00, based on the rehabilitation and reconstruction of 250 linear feet of causeway requiring the addition of 2,000 to 3,000 cubic yards of compacted fill, the addition of 9,000 square feet of Armorflex™ to protect the check dam, and the installation of culverts at pre-established elevations as control for the basin water elevation.

Initiative 4 - Shoreline Grading and Stabilization. *Meets objectives 2, 3 and 4*

The shoreline erosion survey conducted in this study indicated the erosion of 1,800 linear feet of moderate erosion and 40 linear feet of severe erosion (at one particular point on the lake). This study recommends approaching shoreline erosion problems using biostabilization and bioengineering, primarily using vegetative approaches for erosion control. It is proposed that moderately eroded areas be stabilized in the initial phase of lake restoration. Using an estimate of $35.00 per running foot for biostabilization for the 800 linear feet of moderately eroded shoreline, and including administration and design expenses, the project should have a total cost of $40,000.00.

In a future phase of lake restoration, the remaining 1,000 feet of moderately eroded shoreline should be biostabilized at a cost of $35.00 per running foot, plus design/administration expenses or a total cost of $40,000.00. Cost estimates for having the severely eroded point regraded and armored are harder to determine. Using estimates for regrading the point (which is difficult to access) and armoring the point with Class IV riprap of $35,000.00 and $10,000.00 respectively, and including costs for design/administration, it would cost $50,000.00 to be effective in the severely eroded area.

Initiative 5 - Reconstruction of Boat Ramp. *Meets objectives 3 and 4*

The existing boat ramp has deteriorated to the point of being nearly nonfunctional. The development of a new ramp will prevent the continuation of erosion currently occurring at the boat ramp site. It would also make the lake more accessible to potential users. This project would also help to accomplish the Kingsbury Park District long range plan for facilities repair and improvement. The cost estimate for the boat ramp reconstruction is $25,000.00.

GENERAL ALTERNATIVES

Initiative 6 - Rehabilitation of Septic System. *Meets objectives 1 and 4*

For the better part of 40 years a caretaker's house has been maintained in the park near the lake. The daylight basement of the house formerly served as the restroom facilities for the park; these have recently been replaced with a new public restroom facility constructed nearby. The new restroom is on a separate aeration system for wastewater disposal.

The existing septic system, which remains in use with reduced volume, is nevertheless in less than optimal condition and is likely a net exporter of nutrients and perhaps coliforms during certain periods. It is recommended the septic system be pumped and rehabilitated to a nominal condition to help reduce the nutrient load to the lake. The cost for this effort is estimated at $5,000.00.

Initiative 7 - Review and Update of Park District Policies. *Meets objectives 1, 2, 3, 4, and 5*

A review of current Park District policies related to the lake will be initiated by the KPD Board to assess changes which could improve lake water quality. Items of interest would include user numbers and frequency, park maintenance procedures (particularly related to chemical use), lake stocking with fish, on-going maintenance programs, etc.

Initiative 8 - Lake Educational Programs. *Meets objective 5*

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 during the Phase II restoration period is $1,000.00.

INITIATIVES BY OTHERS

The Illinois Department of Transportation (IDOT) will be solicited for assistance in removing the considerable silt load which currently blocks over 80% of the cross-sectional area of the IL Rte 140 box culvert at the in-fall of the lake's main tributary. Maintenance of this culvert is part of the routine maintenance performed by IDOT in such cases, and that agency will be encouraged to pursue the clean-out as part of this restoration program.

PHASE II 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 parameters, locations and frequency for sampling are described below. The cost for this post-implementation monitoring program is estimated at $15,000.00, assuming the IEPA lab performs sample analyses.

It is recommended the IEPA continue to monitor the lake under its ambient lake monitoring program. The Kingsbury Park District may also begin monitoring the lake under the IEPA's Volunteer Lake Monitoring Program to build on the one year of comprehensive monitoring conducted after the restoration program has been implemented. This long-term monitoring would include in-lake monitoring, similar to that in the ALMP. Using volunteer labor and equipment available from the IEPA, the cost for this effort should be minimal.

In-Lake Monitoring

Water Quality
1. Total Phosphorus
2. Nitrate + Nitrite Nitrogen
3. Ammonia Nitrogen
4. Total Suspended Solids
5. Non-Volatile Suspended Solids
6. Secchi Depth
7. Temperature and DO profiles
8. pH

Frequency
1. Once monthly at all historical sampling sites

SOURCES OF MATCHING FUNDS

Funding sources for this program include both state and federal agencies, as well as the Kingsbury Park District general revenue sources. Table 28 provides details regarding the potential funding sources for this program as it is implemented. Of the $841,000.00 in project work described herein, a portion of the sum could be provided as in-kind services from KPD. These in-kind services would include hours spent preparing permit applications, overseeing restoration and monitoring, and labor associated with implementing restoration.

Funding associated with larger projects, such as ED wetlands, dredging and rehabilitation of the sediment basin and check dam, and shoreline stabilization, are effectively financed by matching funds from the IEPA Clean Lakes Program Phase II grant (state funds) and Section 319 (federal funds) during the first two years of the implementation plan.

Table 31. Funding sources for restoration program

			TOTAL	IEPA PhII	PLWIP	Sec 319	KPD+
PROJECTS BY OTHERS							
SR 140 Culvert Clean-out							
KPD PROJECTS							
Stormwater Wetland Basins - NEW							
SWB #1	Young Property / North	25000 cy exc., 3-5 Ac, 15 Ac-ft, 6-ft berm, Armorflex	100000			100000	0
SWB #2	Young Property / South	15000 cy exc., <2 Ac, 10 Ac-ft, 3-ft berm, Armorflex	60000			60000	0
Stormwater Wetland Basins - Clean-out EXISTING							
Basin 1		Excavate existing detention basin	6000	6000			
Basin 2		Excavate existing detention basin	3000	3000			
Basin 3		Excavate existing detention basin	3000	3000			
Basin 4		Excavate existing detention basin	3000	3000			
Forebay and Control Structure/berm							
Rehab Control Structure and Berm		250 feet, fill to 4'x50', armorflex (15k sq ft), pipes	100000			100000	0
Dredge existing forebay		22,000 cy, $1.50/cy, hauled @ $35/10cy, + design/admin	135000	135000			
Conservation Practice Incentive Programs							
CRP Incentive		150 Ac at $100 / Ac plus admin	20000	20000			
Conservation Cover Incentive		50 Ac x $100/Ac x 10 yrs plus admin	60000	60000			
Conservation Easement & Restoration		Special project, easement plus design/restoration	25000	25000			
Shoreline Stabilization - 800 feet							
Bioengineering - Moderate Erosion		Shoreline stabilization with vegetation/bio-structure	40000		40000		
Rehab of Existing Septic System		Pump and rehab	5000	5000			
Boat Ramp Rehabilitation		Concrete & rock apron	25000	25000			
Policies and Education		IEPA Lake Education Grant	1000				
Phase II Monitoring		Contracted after Ph II implementation, at ROY 1 - 3	15000	15000			
			601000	**300000**	**40000**	**260000**	**0**
					YEAR 3		
ADDITIONAL PROJECTS - pursued in Years 3 & 4				C2000	PLWIP	Sec 319	KPD
Reconfigure infall channel / new forebay		New forebay at bridge, reconfigure to meandering channel	150000			90000	60000
Shoreline Grading / Armoring - 40 feet		Regrade and armor 40 linear ft of shoreline	50000		40000		10000
Shoreline Stabilization - 1000 feet		Shoreline stabilization with vegetation/bio-structure	40000	20000			20000
			240000	**20000**	**40000**	**90000**	**90000**

OPERATIONS AND MAINTENANCE PLAN

The Kingsbury Park District Board of Commissioners, as owner of Patriot's Park Lake, is primarily responsible for operation and maintenance of the lake and the various components of the restoration program. Each facility constructed and operated under this program will have a separate, detailed O & M Plan developed which will provide the guidelines for KPD labor efforts and funding in the coming years. For example, the forebay of each ED wetland will be sized to accommodate sediment load from its contributing watershed requiring a clean-out cycle no more often than every five years. In the case of the sediment basin / check dam in the lake itself, the current plan to dredge the basin and restore the check dam, in combination with construction of the aforementioned ED wetlands, should result in a virtually maintenance free facility (ie. no clean out should ever be required during the project lifespan of 25 years).

PERMITS FOR RESTORATION PLAN

Various permits will be required before implementation of several of the restoration proposals. It is the responsibility of the Kingsbury Park District to pursue the permits necessary to undertake restoration, and permits will be acquired before work has begun.

The US Army Corps of Engineers, under authority of Section 404 of the Clean Water Act, may require permits for construction of the ED wetlands described above. Authority to proceed under existing nationwide permits will be required for shoreline stabilization, and for dredging in the sediment basin and maintenance of the control structure. Applications will be submitted to the Illinois Department of Natural Resources for the ED wetland control structures, shoreline stabilization and other work in waters of the state. The Illinois Environmental Protection Agency, Division of Water Pollution Control require Section 401 Water Quality Certification for construction of the ED wetlands and for dredging, as well as shoreline stabilization.

ENVIRONMENTAL EVALUATION

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

2. *Defacement of Residential Areas*. The restoration plan will not deface any residential areas.

3. *Changes in Land Use Pattern*. The restoration plan will result in some positive changes to land use patterns. At present, livestock grazing is relatively common along and in the channel of the lake’s main tributary north of highway 140. The conservation easement initiatives described in this study will effectively eliminate the livestock grazing by creating a “greenway” corridor along the tributary (from the northernmost ED wetland south to highway 140).

4. *Impacts on Prime Agricultural Land*. There will be no negative changes to prime agricultural lands. Many of the conservation practices described in this study will improve the quality and value of prime agricultural lands 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 as 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*. Channel modifications are not included in this restoration program. Dredging which will occur in areas under jurisdiction of the United States Army Corps of Engineers under Section 404 of the Clean Water Act will be done in compliance with 404(b)(1) guidelines. Shoreline stabilization will be conducted in a manner consistent with the nationwide permit for such activities.

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 proposed is the best means to meet the objective set forth in this report. There are limited alternatives available to meet stringent guidelines for water quality standards. To effectively remove Patriot's Park Lake from "impaired" categories on the 305(b) list and meet anticipated Total Maximum Daily Load endpoints, the restoration plan as described should be implemented.

14. *Other Necessary Mitigation Measures*. There are not other mitigation measures necessary as part of this restoration program.

REFERENCES

References Cited

Galli, F. J. 1992. Analysis of the performance and longevity of urban BMPs installed in Prince George County, Maryland. Metropolitan Washington Council of Governments, Department of Environmental Resources technical report. 136 pp.

Oberts, G. L., P. J. Wotzka and J. A. Hartsoe. 1989. The water quality performance of select urban runoff treatment systems. Metropolitan Council of the Twin Cities, MN, Commission on Minnesota Resources, St. Paul, MN. 81 pp + appendices.

Schueller, T. R. 1992. Design of stormwater wetland systems: Guidelines for creating diverse and effective stormwater wetlands in the Mid-Atlantic region. Anacostia Restoration Team, Department of Environmental Programs, MWCOG. 134 pp.

Strecker, W. E., J. M. Kersnar, and E. D. Driscoll. 1992. The use of wetlands for controlling stormwater pollution. USEPA technical report. 61 pp. + appendices.

References Used but not Cited

Burton, G. A. and R. E. Pitt. 2002. Stormwater effects handbook: A toolbox for watershed managers, scientists and engineers. Lewis Publishers / CRC Press Company. 911 pp.

Haan, C. T., B. J. Barfield and J. C. Hayes. 1994. Design hydrology and sedimentology for small catchments. Academic Press / Harcourt Brace and Company. 588 pp.

Ritter, W. F. and A. Shirmohammadi (ed). 2001. Agricultural nonpoint source pollution: Watershed management and hydrology. Lewis Publishers / CRC Press Company. 342 pp.

Schueller, T. R., P. A Kumble and M. A. Heraty. 1992. A current assessment of urban best management practices: Techniques for reducing non-point source pollution in the coastal zone. Anacostia Restoration Team, Department of Environmental Programs, MWCOG. 127 pp.

APPENDIX A

PHYTOPLANKTON

LAKE Patriot's Park

DATE 4-9-01 SITE ROY-1

TAXA	SIZE (µm)	UNIT VOL. (μm^3)	No./mL	VOLUME
BACILLARIOPHYTA				
Cyclotella meneghiniana	11.2 (diam.)	198.8	112.112	22287.9
Melosira varians	15.0 x 20.0	3534.3	10.192	36021.6
Navicula cryptocephala var. *cryptocephala*	6.15 x 20.3	603.0	10.192	6145.8
Nitzschia				
N. acicularis	2.5 x 87.5	429.5	20.384	8754.9
N. palea	3.0 x 25.0	176.7	91.728	16208.3
CHLOROPHYTA				
Schroederia setigera	2.5 x 52.5	257.7	112.112	28891.3
CHRYSOPHYTA-None				
CRYPTOPHYTA				
Cryptomonas				
C. erosa	12.5 x 20.0	2454.4	71.344	175106.7
C. sp. (No. 1)	5.0 x 7.5	147.3	11455.808	1687440.5
CYANOPHYTA				
Anacystis montana	10.0 (col.-diam.)	523.6	825.552	432259.0
Gomphosphaeria lacustris	10.0 (col.-diam.)	523.6	1039.584	544326.2
Schizothrix calcicola	2.0 x 10.0	31.4	20.384	640.1
EUGLENOPHYTA				

LAKE Patriot's Park

DATE 4-9-01 SITE ROY-1

TAXA	SIZE (µm)	UNIT VOL. (µm^3)	No./mL	VOLUME
Colacium vesiculosum	10.0 x 15.0	1178.1	733.824	864518.0
Euglena sp.	15.0 x 37.5	6626.8	20.384	135080.7
Trachelomonas volvocina	11.2	735.6	40.768	29988.9

PYRRHOPHYTA-None

ANIMAL MATERIAL

ARTHROPODA-Class Crustacea-Sub-Class Copepoda-Order Eucopepoda-Family Cyclopidae

Cyclops				
C. sp. (Adult)	175.0 x 450.0	10823759.0	10.192	110315750.0
C. sp. (Nauplii)	175.0 x 400.0	9621119.3	10.192	98058447.0

-Sub-Class Oligobranchiopoda-Order Cladocera-
Family Bosminidae

Bosmina longirostris	175.0 x 275.0	6614519.4	10.192	67415181.0

LAKE Patriot's Park

DATE 6-7-01 SITE ROY-1

TAXA	SIZE (µm)	UNIT VOL. ($µm^3$)	No./mL	VOLUME
BACILLARIOPHYTA				
Cyclotella meneghiniana	11.2 (diam.)	198.8	10.192	2026.2
Melosira italica var. *tenuissima*	15.0 x 20.0	3534.3	Present	
Nitzschia palea	3.0 x 25.0	176.7	40.768	7203.7
Surirella ovata	35.0 x 45.0	43295.0	Present	
CHLOROPHYTA				
Carteria multifilis	7.5 (diam.)	220.9	305.760	67542.4
Oocystis borgei	12.5	1022.7	61.152	62540.2
Schroederia setigera	2.5 x 52.5	257.7	20.384	5253.0
CHRYSOPHYTA-None				
CRYPTOPHYTA				
Cryptomonas sp. (No. 1)	5.0 x 7.5	147.3	30.576	4503.3
CYANOPHYTA				
Anacystis montana	10.0 (col.-diam.)	523.6	163.072	85384.5
Gomphosphaeria lacustris	10.0 (col.-diam.)	523.6	672.672	352211.0
Microcystis aeruginosa	40.0 (col.-diam.)	33510.4	30.576	1024613.9
Schizothrix calcicola	2.0 x 10.0	31.4	Present	
EUGLENOPHYTA				

LAKE Patriot's Park

DATE 6-7-01 SITE ROY-1

TAXA	SIZE (μm)	UNIT VOL. (μm^3)	No./mL	VOLUME
Trachelomonas				
T. volvocina	11.2	735.6	81.536	59977.9
T. sp. (cyl.-smooth-collar)	20.0 x 25.0	7854.0	10.192	80048.0

PYRRHOPHYTA-None

ANIMAL MATERIAL

PROTOZOA-Sub-Phylum Ciliophora-Class Ciliata-Order Oligotrichida-Family Halteriidae

Halteria sp.	25.0	8181.2	10.192	83382.8

LAKE Patriot's Park

DATE 7-10-01 SITE ROY-1

TAXA	SIZE (µm)	UNIT VOL. (μm^3)	No./mL	VOLUME
BACILLARIOPHYTA				
Cyclotella meneghiniana	11.2 (diam.)	198.8	10.192	2026.2
Melosira italica var. *tenuissima*	15.0 x 20.0	3534.3	Present	
Nitzschia palea	3.0 x 25.0	176.7	10.192	1800.9
CHLOROPHYTA				
Carteria multifilis	7.5 (diam.)	220.9	30.576	6754.2
Eudorina elegans	50.0 (col.-diam.)	65450.0	101.920	6670664.0
Oocystis borgei	12.5	1022.7	30.576	31270.1
Phacotus lenicularis	7.5 x 12.5	552.2	254.800	140700.6
Schroederia setigera	2.5 x 52.5	257.7	71.344	18385.3
CHRYSOPHYTA-None				
CRYPTOPHYTA				
Cryptomonas				
C. erosa	12.5 x 20.0	2454.4	10.192	25015.2
C. sp. (No. 1)	5.0 x 7.5	147.3	173.264	25521.8
CYANOPHYTA				
Anabaena spiroides var. *crassa*	10.0 x 100.0	7854.0	Present	
Anacystis montana	10.0 (col.-diam.)	523.6	173.264	90721.0

LAKE Patriot's Park

DATE 7-10-01 SITE ROY-1

TAXA	SIZE (µm)	UNIT VOL. (µm^3)	No./mL	VOLUME
Aphanizomenon flos-aquae	5.0 x 50.0	981.7	1059.968	1040570.5
Gomphosphaeria lacustris	10.0 (col.-diam.)	523.6	540.176	282836.2
Microcystis aeruginosa	40.0 (col.-diam.)	33510.4	61.152	2049227.9
EUGLENOPHYTA				
Trachelomonas volvocina	11.2	735.6	40.768	29988.9
PYRRHOPHYTA				
Ceratium hirundinella	50.0 x 237.5	155414.1	10.192	1583980.5
ANIMAL MATERIAL				
PROTOZOA-Sub-Phylum Ciliophora-Class Ciliata-Order Oligotrichida-Family Halteriidae				
Halteria sp.	25.0	8181.2	10.192	83382.8

LAKE Patriot’s Park

DATE 8-20-01 SITE ROY-1

TAXA	SIZE (µm)	UNIT VOL. (μm^3)	No./mL	VOLUME
BACILLARIOPHYTA				
Melosira italica var. *tenuissima*	15.0 x 20.0	3534.3	Present	
Nitzschia palea	3.0 x 25.0	176.7	10.192	1800.9
CHLOROPHYTA				
Carteria				
C. multifilis	7.5 (diam.)	220.9	275.184	60788.1
C. sp. (No. 1)	15.0 x 20.0	3534.3	30.576	108064.8
Eudorina elegans	50.0 (col.-diam.)	65450.0	20.384	1334132.8
Oocystis borgei	12.5	1022.7	10.192	10423.4
Phacotus lenicularis	7.5 x 12.5	552.2	631.904	348937.4
Scenedesmus abundans	7.5 x 15.0	577.3	10.192	5883.8
CHRYSOPHYTA-None				
CRYPTOPHYTA				
Cryptomonas				
C. erosa	12.5 x 20.0	2454.4	61.152	150091.5
C. sp. (No. 1)	5.0 x 7.5	147.3	142.688	21017.9
CYANOPHYTA				
Anabaena spiroides var. *crassa*	10.0 x 100.0	7854.0	1783.600	14008394.0
Anacystis montana	10.0 (col.-diam.)	523.6	570.752	298845.7

LAKE Patriot's Park

DATE 8-20-01 SITE ROY-1

TAXA	SIZE (µm)	UNIT VOL. (μm^3)	No./mL	VOLUME
Aphanizomenon flos-aquae	5.0 x 50.0	981.7	40.768	40021.9
Gomphosphaeria lacustris	10.0 (col.-diam.)	523.6	744.016	389566.8
Microcystis aeruginosa	40.0 (col.-diam.)	33510.4	40.768	1366151.9
Oscillatoria sp.	7.5 x 50.0	2208.9	10.192	22513.1
Schizothrix calcicola	2.0 x 10.0	31.4	71.344	2240.2
EUGLENOPHYTA				
Trachelomonas volvocina	11.2	735.6	50.960	37486.2
PYRRHOPHYTA				
Ceratium hirundinella	50.0 x 237.5	155414.1	10.192	1583980.5
Glenodinium gymnodinium	32.5 x 35.0	29035.2	20.384	591853.5
ANIMAL MATERIAL				
PROTOZOA-Sub-Phylum Ciliophora-Class Ciliata-Order Oligotrichida-Family Halteriidae				
Halteria sp.	25.0	8181.2	30.576	250148.4
ROTATORIA-Class Monogonata-Order Flosculariacea-Family Testudinellidae				
Tetramastix opoliensis	13.3 x 126.5	5594.1	50.960	285075.3
-Order Ploma-Family Brachionidae				
Brachionus sp.	50.0 x 85.0	166897.0	Present	
-Family Trichoceridae				
Trichocerca sp.	15.0 x 133.0	23503.0	30.576	718627.7

LAKE Patriot's Park

DATE 10-15-01 SITE ROY-1

TAXA	SIZE (µm)	UNIT VOL. (μm^3)	No./mL	VOLUME
BACILLARIOPHYTA				
Cyclotella meneghiniana	11.2 (diam.)	198.8	30.576	6078.5
Nitzschia palea	3.0 x 25.0	176.7	30.576	5402.8
CHLOROPHYTA				
Ankistrodesmus falcatus var. *acicularis*	1.25 x 18.0	22.1	10.192	225.2
Carteria multifilis	7.5 (diam.)	220.9	91.728	20262.7
Oocystis borgei	12.5	1022.7	20.384	20846.7
CHRYSOPHYTA-None				
CRYPTOPHYTA				
Cryptomonas sp. (No. 1)	5.0 x 7.5	147.3	40.768	6005.1
CYANOPHYTA				
Anacystis montana	10.0 (col.-diam.)	523.6	468.832	245480.4
Gomphosphaeria lacustris	10.0 (col.-diam.)	523.6	1651.104	864518.0
Microcystis aeruginosa	40.0 (col.-diam.)	33510.4	214.032	7172297.9
EUGLENOPHYTA-None				
PYRRHOPHYTA-None				
ANIMAL MATERIAL				
PROTOZOA-Sub-Phylum Ciliophora-Class Ciliata-Order Oligotrichida-Family Halteriidae				
Halteria sp.	25.0	8181.2	61.152	500296.7

LAKE Patriot's Park

DATE 10-15-01 SITE ROY-1

TAXA	SIZE (μm)	UNIT VOL. (μm^3)	No./mL	VOLUME
ROTATORIA-Class Monogonata-Order Ploima				
Unknown Rotifer	45.0 x 70.0	111330.1	10.192	1134676.3

List of taxa found in samples from Lake Patriot's Park (ROY) at Site 1 during 2001.

Taxa	Date Found
BACILLARIOPHYTA	
Cyclotella meneghiniana Kuetz.	4-9, 6-7, 7-10, 10-15 (All C)
Melosira	
M. italica (Ehr.) Kuetz. var. *tenuissima* (Grun.) Muell.	6-7, 7-10, 8-20 (All C)
M. varians Ag.	4-9(C)
Navicula cryptocephala (Kuetz.) Wm. Sm. var. *cryptocephala*	4-9(C)
Nitzschia	
N. acicularis (Kuetz.) Wm. Sm.	4-9(C)
N. palea (Kuetz.) Wm. Sm.	4-9, 6-7, 7-10, 8-20, 10-15 (All Dates, All C)
Surirella ovata Kuetz.	6-7(C)
CHLOROPHYTA	
Ankistrodesmus falcatus (Corda) Ralfs var. *acicularis* (A. Br.) G. S. West	10-15(C)
Carteria	
C. multifilis (Fres.) Dill.	6-7, 7-10, 8-20, 10-15(All C)
C. sp. (No. 1)	8-20(C)
Eudorina elegans Ehr.	7-10, 8-20(Both C)
Oocystis borgei Snow	6-7, 7-10, 8-20, 10-15 (All C)
Phacotus lenticularis (Ehr.) Stein	7-10, 8-20 (Both C)
Scenedesmus abundans (Kirch.) Chod.	8-20(C)
Schroederia setigera (Schroed.) Lemm.	4-9, 6-7, 7-10 (All C)
CHRYSOPHYTA-None	

Taxa	Date Found
CRYPTOPHYTA	
Cryptomonas	
C. erosa Ehr.	4-9, 7-10, 8-20 (All C)
C. sp. (No. 1)	4-9, 6-7, 7-10, 8-20, 10-15 (All Dates, All C)
CYANOPHYTA	
Anabaena spiroides Kleb. var. *crassa* Lemm.	7-10, 8-20 (Both C)
Anacystis montana (Lightf.) Dr. & Daily	(All Dates, All C)
Aphanizomenon flos-aquae Born. *et* Flah.	7-10, 8-20 (Both C)
Gomphosphaeria lacustris Chod.	(All Dates, All C)
Microcystis aeruginosa Kuetz.	6-7, 7-10, 8-20, 10-15 (All C)
Oscillatoria sp.	8-20(C)
Schizothrix calcicola Gom.	4-9, 6-7, 8-20 (All C)
EUGLENOPHYTA	
Colacium vesiculosum Ehr.	4-9(C)
Euglena sp. (15.0 x 37.5 µm)	4-9(C)
Trachelomonas	
T. volvocina Ehr.	4-9, 6-7, 7-10, 8-20(All C)
T. sp. (cyl.-smooth-collar) (20.0 x 25.0 µm)	6-7(C)
PYRRHOPHYTA	
Ceratium hirundinella (O. F. Muell.) Duj.	7-10, 8-20 (Both C)
Glenodinium	
G. gymnodinium Penard	8-20(C)

Taxa	Date Found
ARTHROPODA-Class Crustacea-Sub-Class Copepoda-Order Eucopepoda-Family Cyclopidae	
Cyclops	
C. sp. (adult) (175.0 x 450.0 µm)	4-9(C)
C. sp. (nauplii) (175.0 x 400.0 µm)	4-9(C)
Sub-Class Oligobranchiopoda-Order Cladocera-Family Bosminidae	
Bosmina longirostris	4-9(C)
PROTOZOA-Sub-Phylum Ciliophora-Class Ciliata-Order Oligotrichida-Family Halteriidae	
Halteria	
H. sp. (25.0 µm)	6-7, 7-10, 8-20, 10-15 (All C)
ROTATORIA-Class Monogonata-Order Flosculariacea-Family Testudinellidae	
Tetramastix opoliensis	8-20(C)
Order Ploima-	
Unknown Rotifer	10-15(C)
Family Brachionidae	
Brachionus sp. (50.0 x 85.0 µm)	8-20(C)
Family Trichocercidae	
Trichocerca sp. (15.0 x 133.0 µm)	8-20(C)

(C) indicates taxon was found in counts.

Summary of numbers and biovolumes of organisms for Lake Patriot's Park (ROY) Site 1 in 2001.

Date	Phylum	No./mL	Volume
4-9-01	Bacillariophyta	244.608	89418.5
	Chlorophyta	112.112	28891.3
	Chrysophyta	0	0
	Cryptophyta	11527.152	1862547.2
	Cyanophyta	1885.520	977225.3
	Euglenophyta	794.976	1029587.6
	Pyrrhophyta	0	0
	Total	14564.368	3987669.6
	Arthropoda	30.578	275789378.0
	Protozoa	0	0
	Rotatoria	0	0
	Total	30.578	275789378.0
6-7-01	Bacillariophyta	50.960	9229.9
	Chlorophyta	387.296	135335.6
	Chrysophyta	0	0
	Cryptophyta	30.576	4503.8
	Cyanophyta	866.320	1462209.4
	Euglenophyta	91.728	140025.9
	Pyrrhophyta	0	0
	Total	1426.880	1751304.6
	Arthropoda	0	0
	Protozoa	10.192	83382.8
	Rotatoria	0	0
	Total	10.192	83382.8

Date	Phylum	No./mL	Volume
7-10-01	Bacillariophyta	20.384	3827.1
	Chlorophyta	489.216	6867774.2
	Chrysophyta	0	0
	Cryptophyta	183.456	50537.0
	Cyanophyta	1834.560	3463355.6
	Euglenophyta	40.768	29988.9
	Pyrrhophyta	10.192	1583980.5
	Total	2578.576	11999463.3
	Arthropoda	0	0
	Protozoa	10.192	83382.8
	Rotatoria	0	0
	Total	10.192	83382.8
8-20-01	Bacillariophyta	10.192	1800.9
	Chlorophyta	978.432	1868230.6
	Chrysophyta	0	0
	Cryptophyta	203.840	171109.4
	Cyanophyta	3261.260	16127733.6
	Euglenophyta	50.960	37486.2
	Pyrrhophyta	30.576	2175834.0
	Total	4535.260	20382194.4
	Arthropoda	0	0
	Protozoa	30.576	250148.4
	Rotatoria	81.536	1003703.0
	Total	112.112	1253851.4

Date	**Phylum**	**No./mL**	**Volume**
10-15-01	Bacillariophyta	61.152	11481.3
	Chlorophyta	122.304	41334.6
	Chrysophyta	0	0
	Cryptophyta	40.768	6005.l
	Cyanophyta	2333.968	8282296.3
	Euglenophyta	0	0
	Pyrrhophyta	0	0
	Total	2558.192	8341117.3
	Arthropoda	0	0
	Protozoa	61.152	500296.7
	Rotatoria	10.192	1134676.3
	Total	71.344	1634973.0

APPENDIX B:

FISHERIES DATA

The following is the Lake Management Status Report submitted by Charlie Marbut on February 18, 1999.

LAKE MANAGEMENT STATUS REPORT

Fisheries Date of Report: 02/18/99
Fisheries Manager: Charley Marbut
District No: 16
Lake Name: Greenville Old City Lake
County: Bond
Water No: 179
Ownership (S,PUC,PUO) PUC
ACREAGE: 25.1

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. All Fish - Two pole and line fishing only.
Channel catfish - six fish daily creel limit.
Trout - Fall closed season.

2.06/03/98 - LMB stocking 12,500 (1.5 inch)
06/10/98 - Population Survey
08/12/98 - CCF stocking (1255) (8 inch)
10/17/98 - Trout stocking (2500)

3. A. Lake was renovated and restocked in 1987-88.

BLG	LMP GOALS	1988	1994	1998
YAR	1 - 5	-	-	-
PSD	20 - 40	0	5	13
RSD-7	10 - 15	0	0	2
Wr	90 - 110	91	70	97
HARVEST (lbs/ac)	1 - 2	92	164	

The CPUE/hr in 1988 was 92, 164 in 1994, 258 in 1997, and 142 in 1998. The length frequency distribution remains poor. 13% of the bluegill were equal to or larger than 6.0 inches, 8% were less than 4.0 inches and 79% were between 4.0 and 6.0 inches in length. Wr improved from 91 in 1988 to 94 in 1994 and to 96 in 1998.

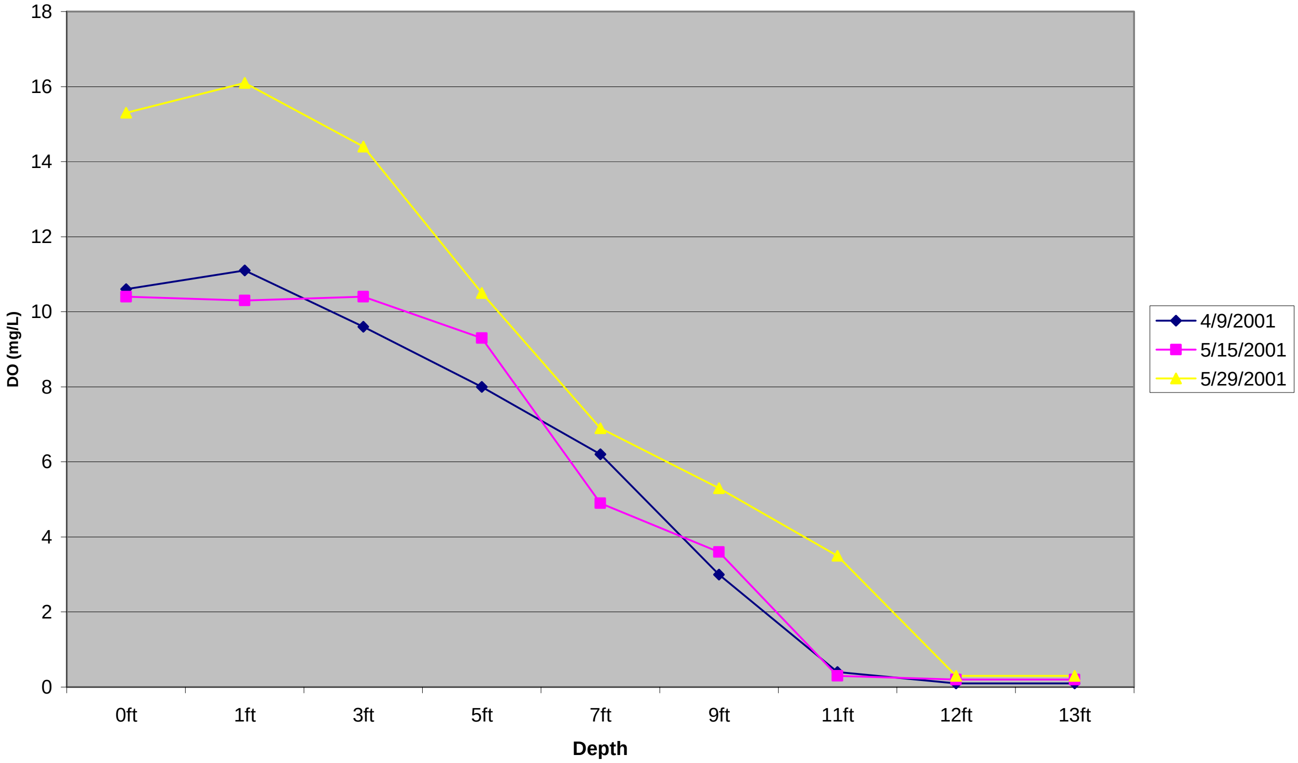
APPENDIX C:

DAM REPORT

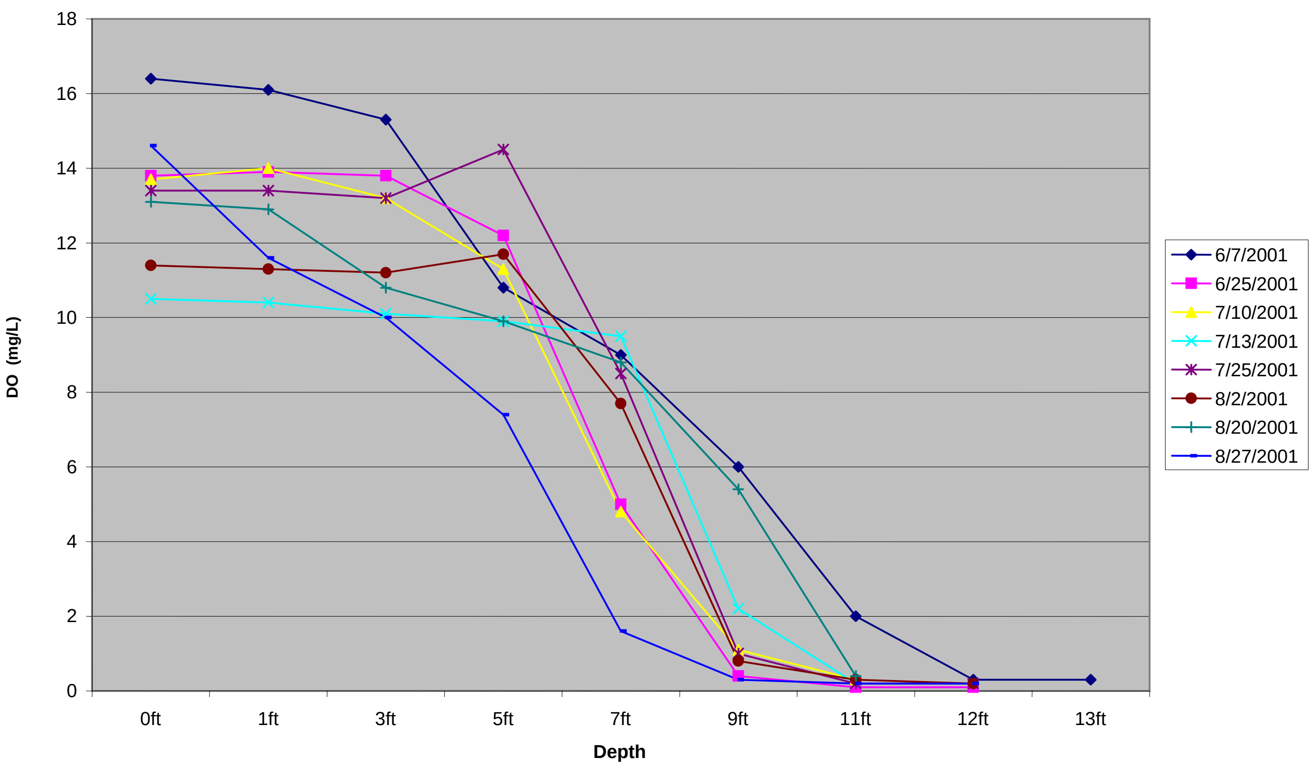
APPENDIX D:

DISSOLVED OXYGEN AND TEMPERATURE PROFILES

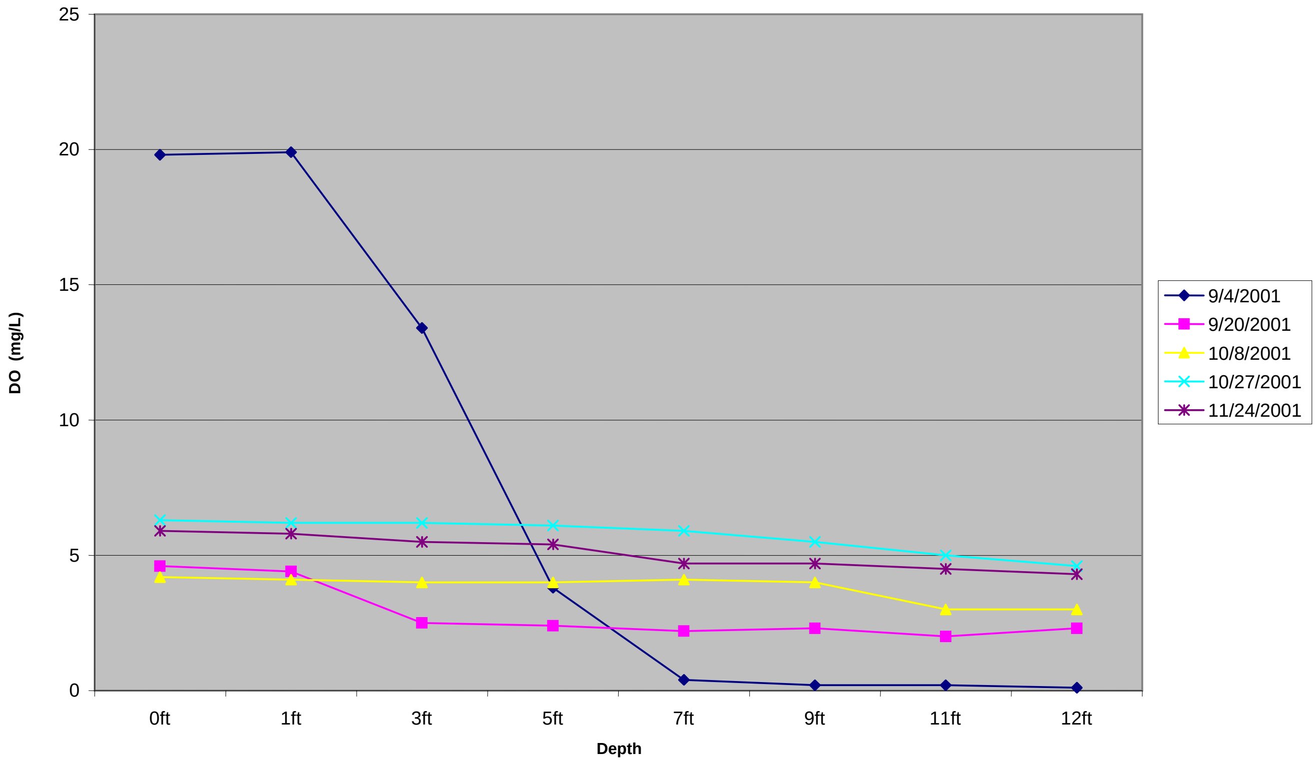
Dissolved Oxygen ROY - 1
Spring 2001



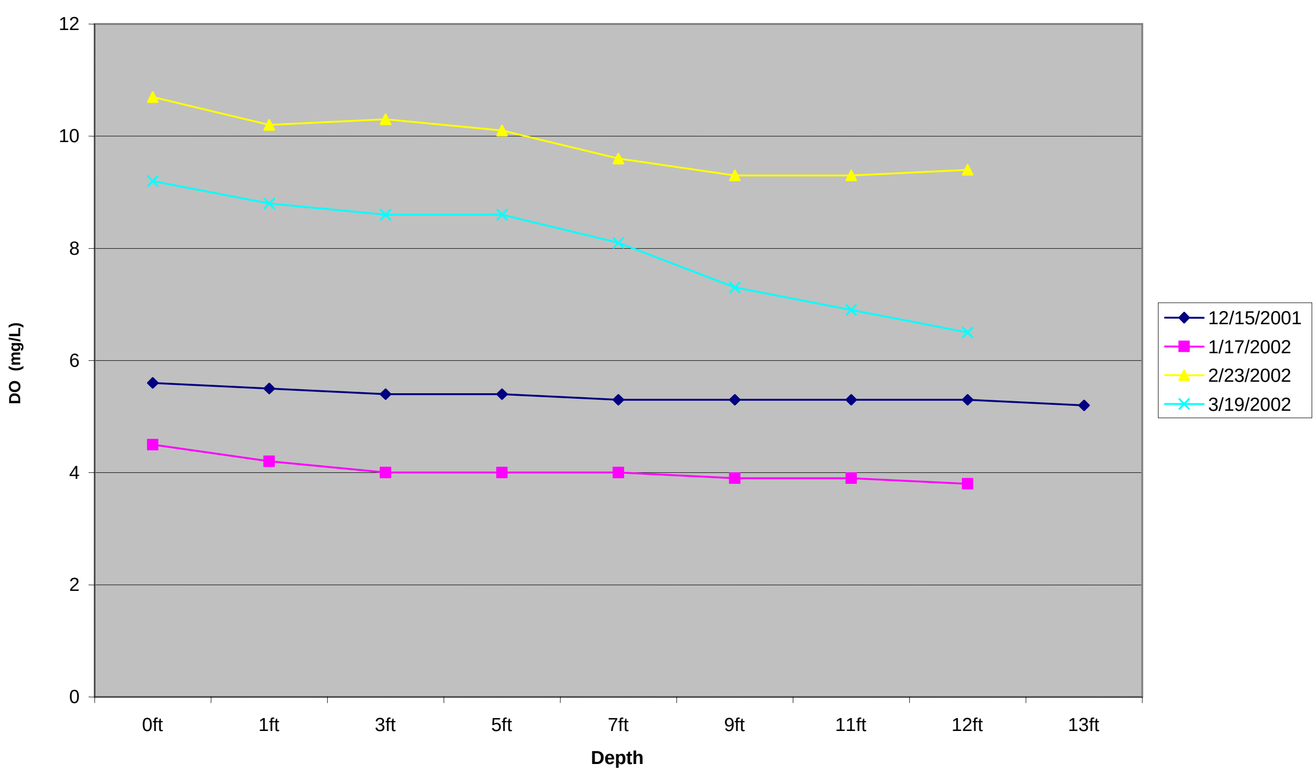
Dissolved Oxygen ROY - 1
Summer 2001

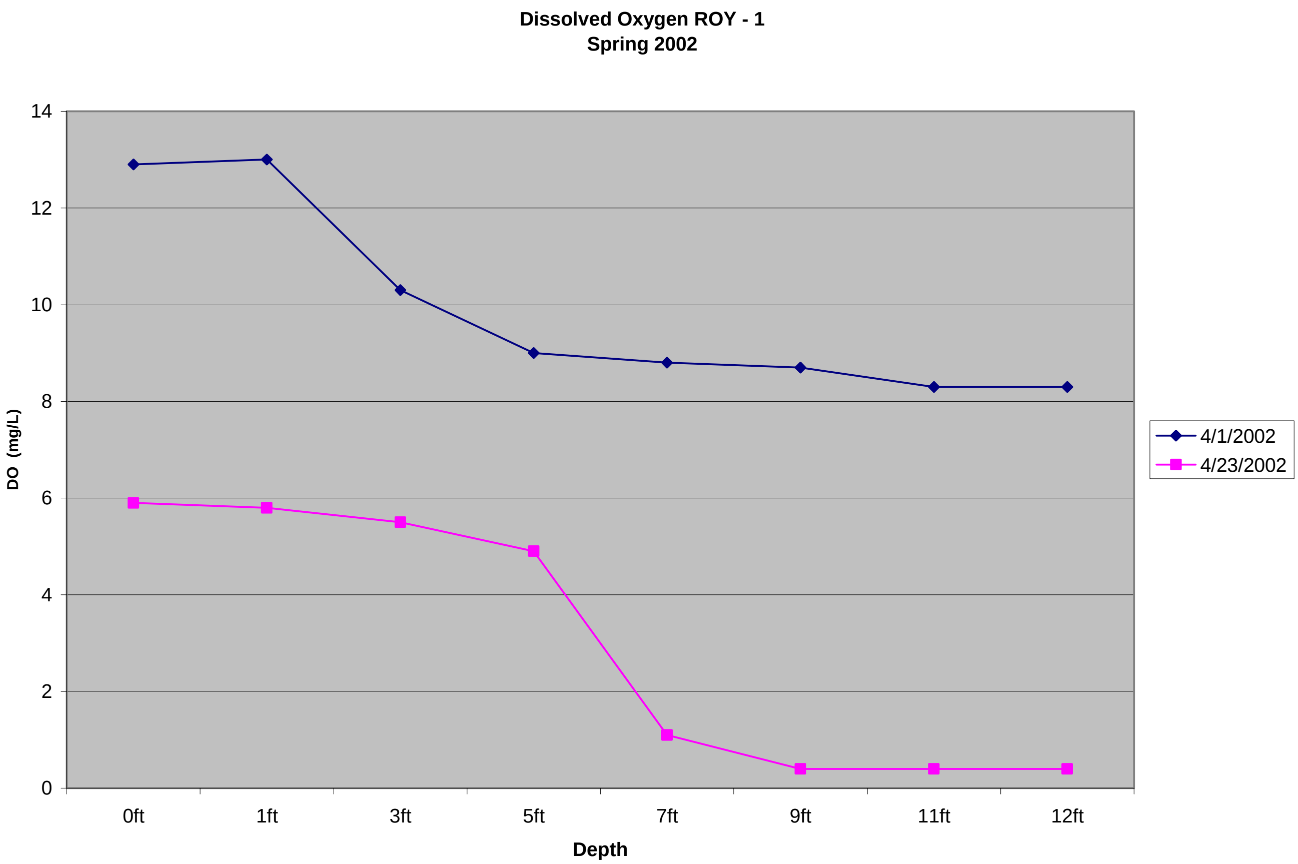


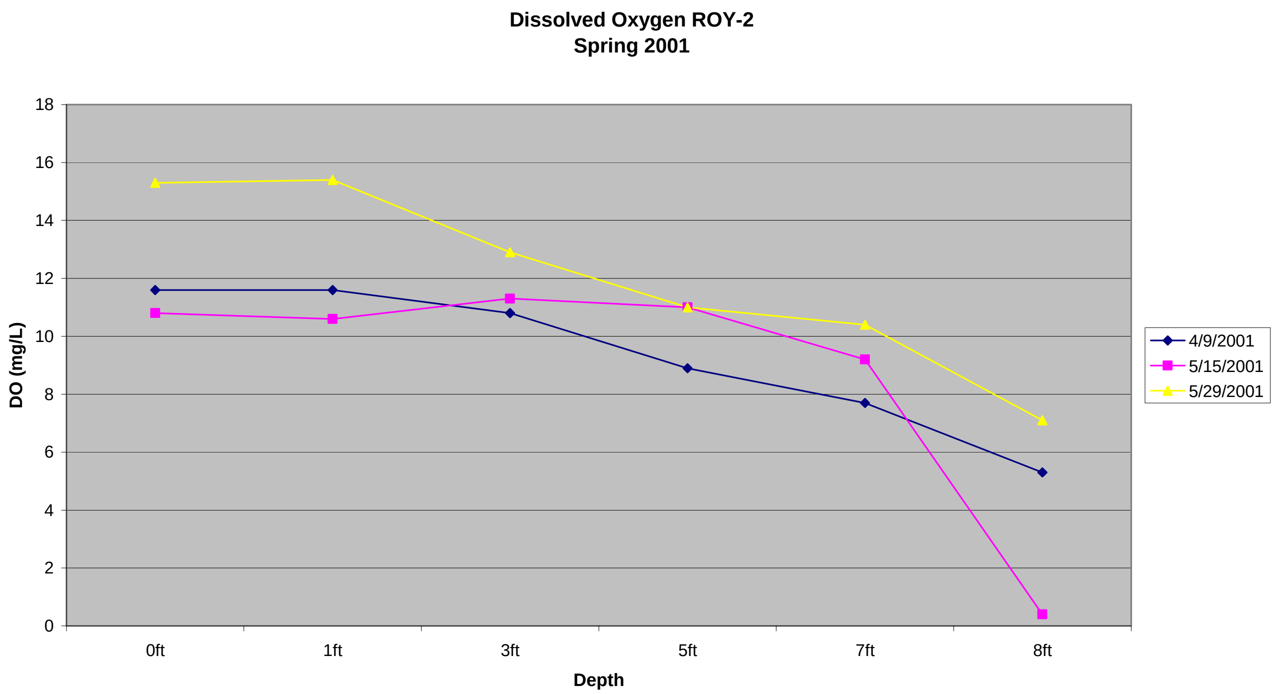
Dissolved Oxygen ROY - 1
Fall 2001

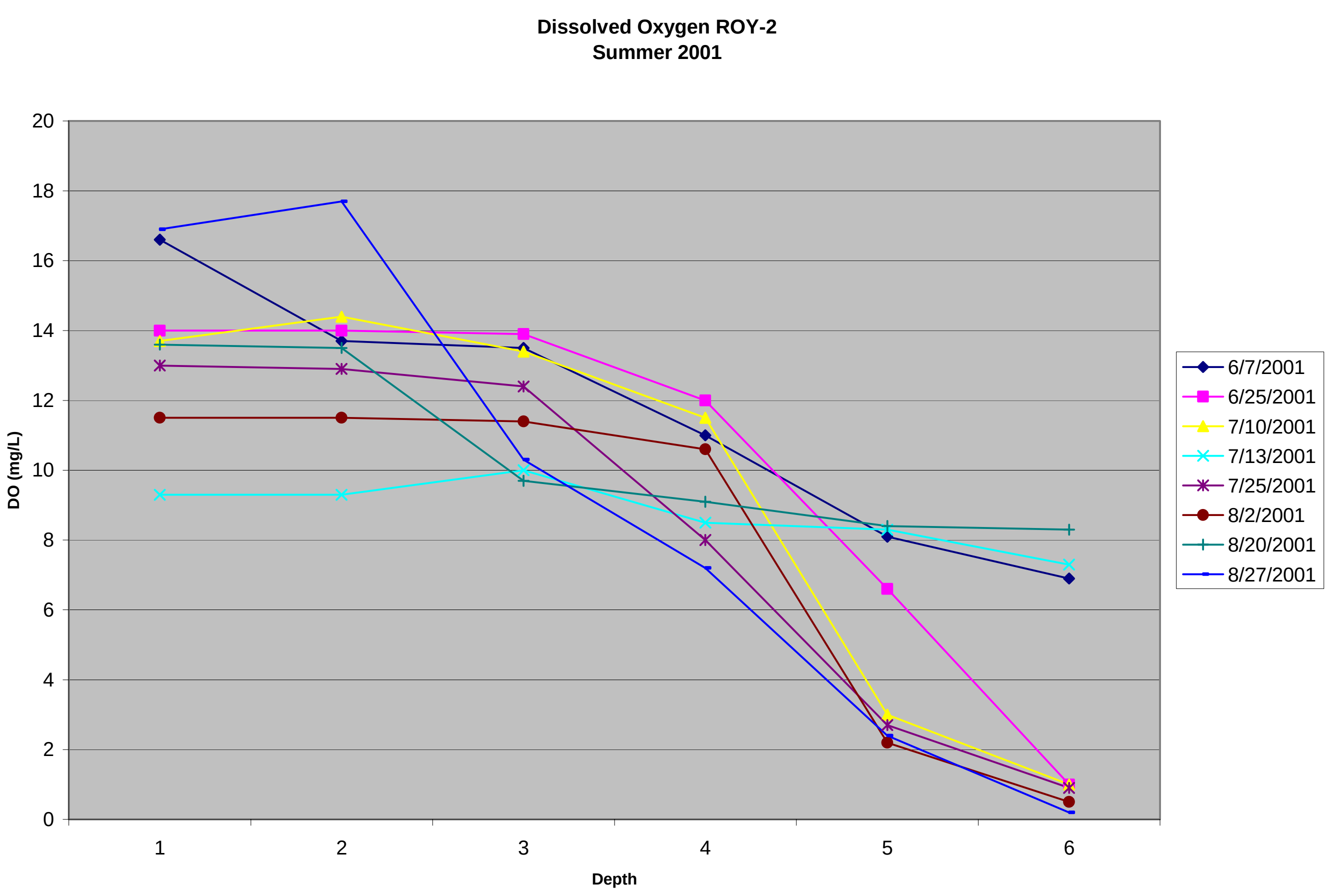


Dissolved Oxygen ROY - 1
Winter 2001 - 02

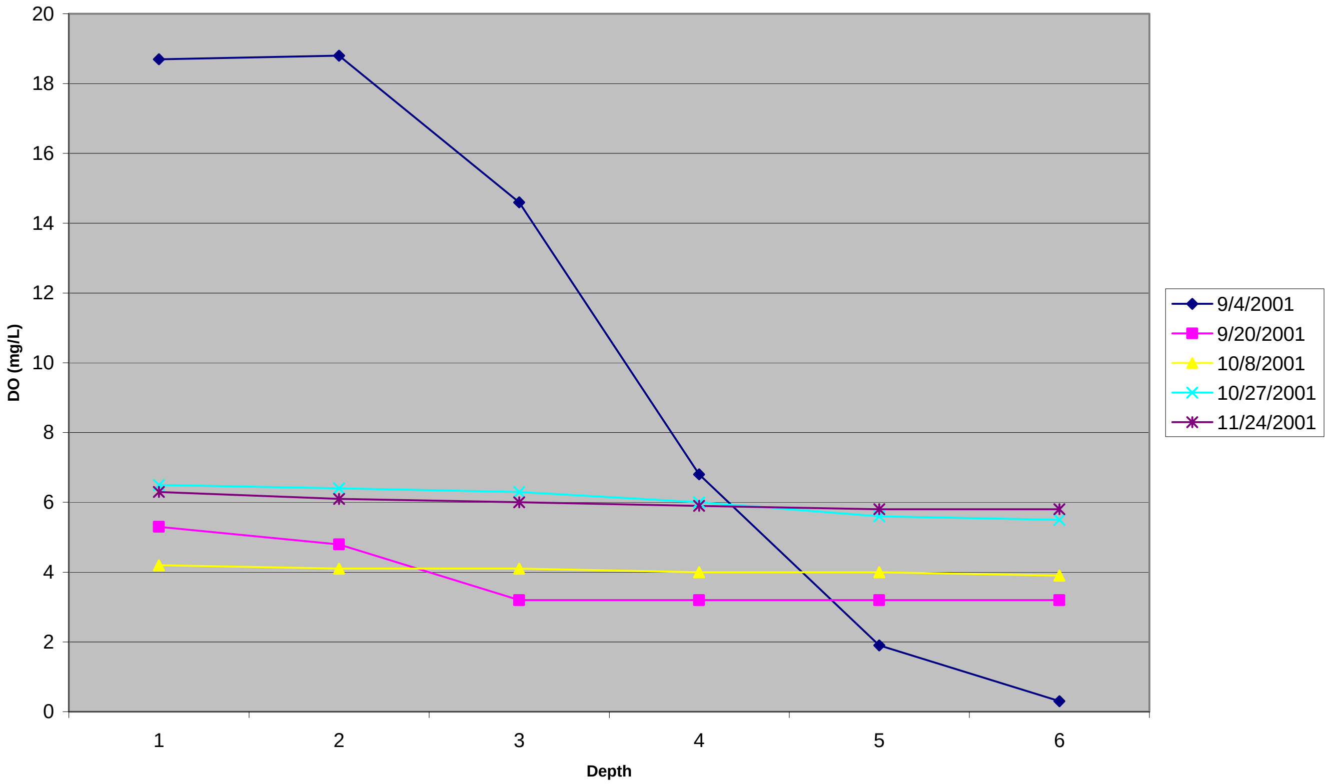



Dissolved Oxygen ROY - 1
Spring 2002
DO (mg/L)
14
12
10
8
6
4
2
0
0ft
1ft
3ft
5ft
7ft
9ft
11ft
12ft
Depth
4/1/2002
4/23/2002

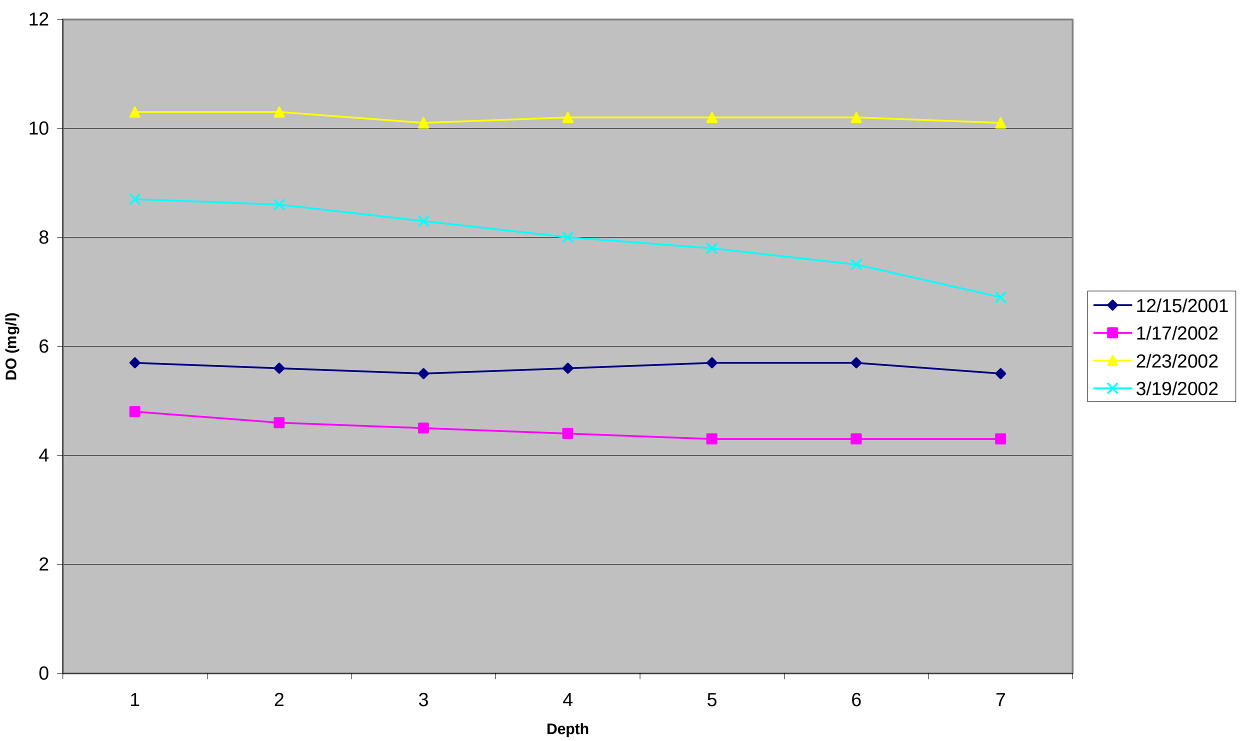

Dissolved Oxygen ROY-2
Spring 2001
DO (mg/L)
18
16
14
12
10
8
6
4
2
0
0ft
1ft
3ft
5ft
7ft
8ft
Depth
4/9/2001
5/15/2001
5/29/2001

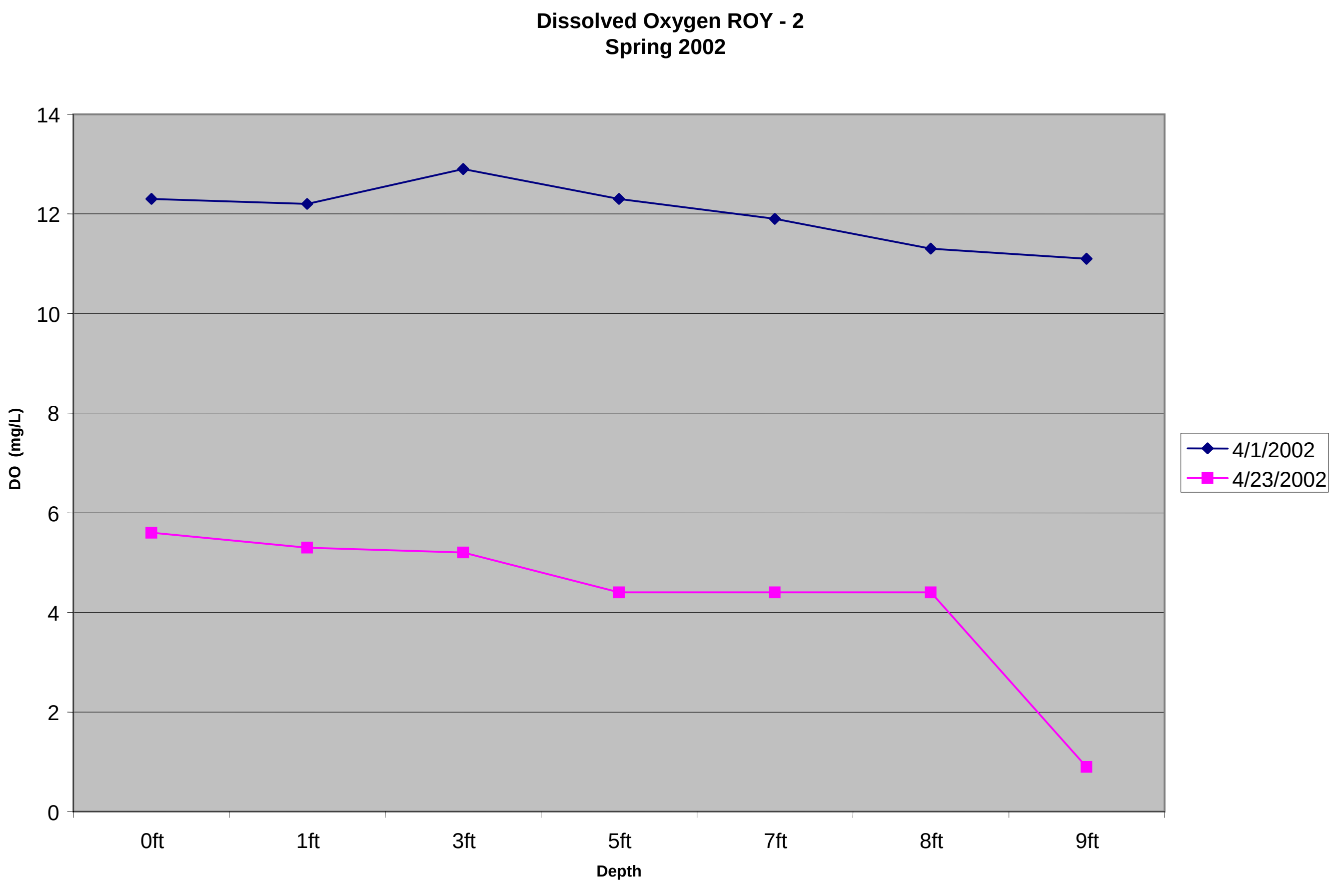

Dissolved Oxygen ROY-2
Summer 2001
DO (mg/L)
20
18
16
14
12
10
8
6
4
2
0
1
2
3
4
5
6
Depth
6/7/2001
6/25/2001
7/10/2001
7/13/2001
7/25/2001
8/2/2001
8/20/2001
8/27/2001

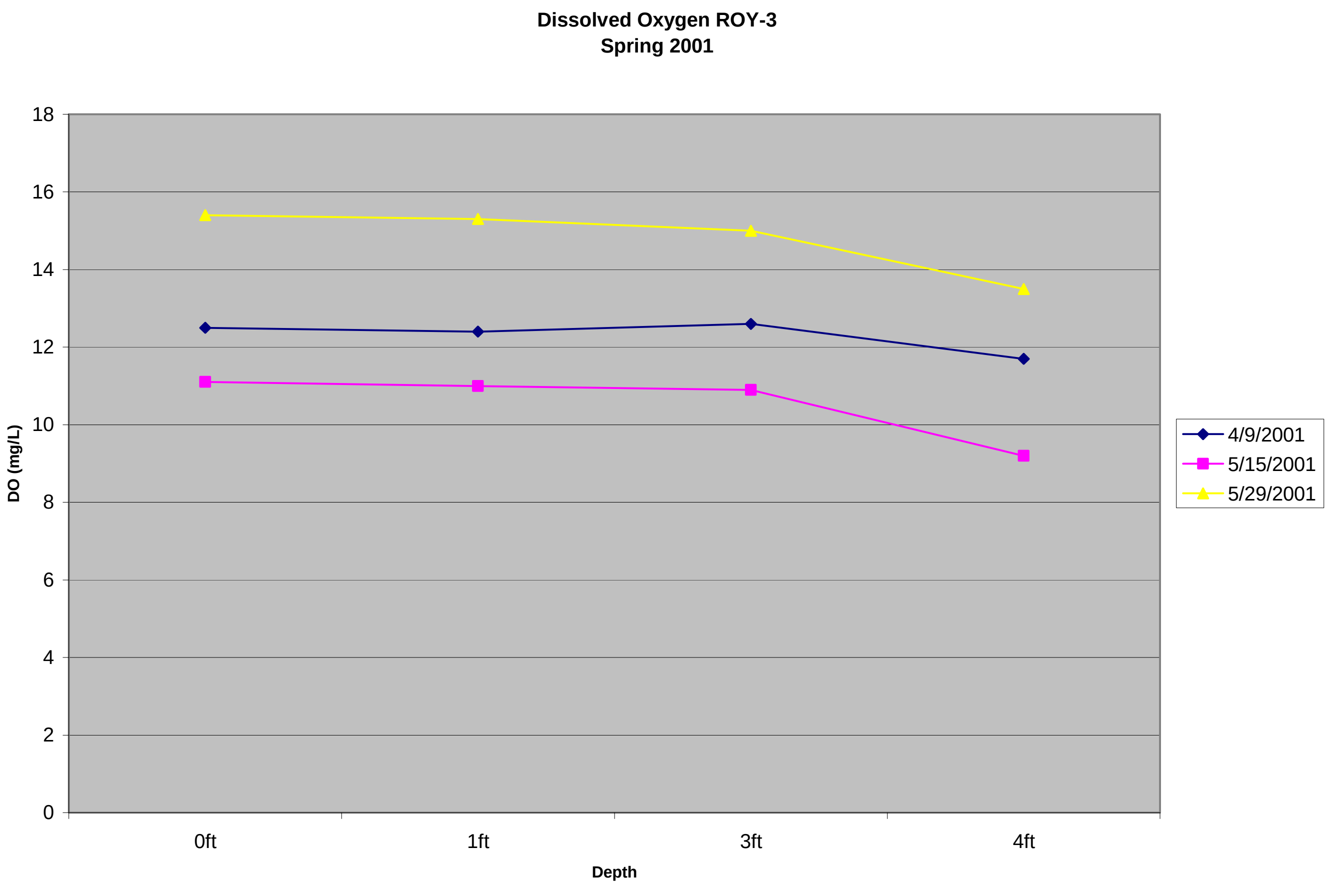
Dissolved Oxygen ROY-2
Fall 2001

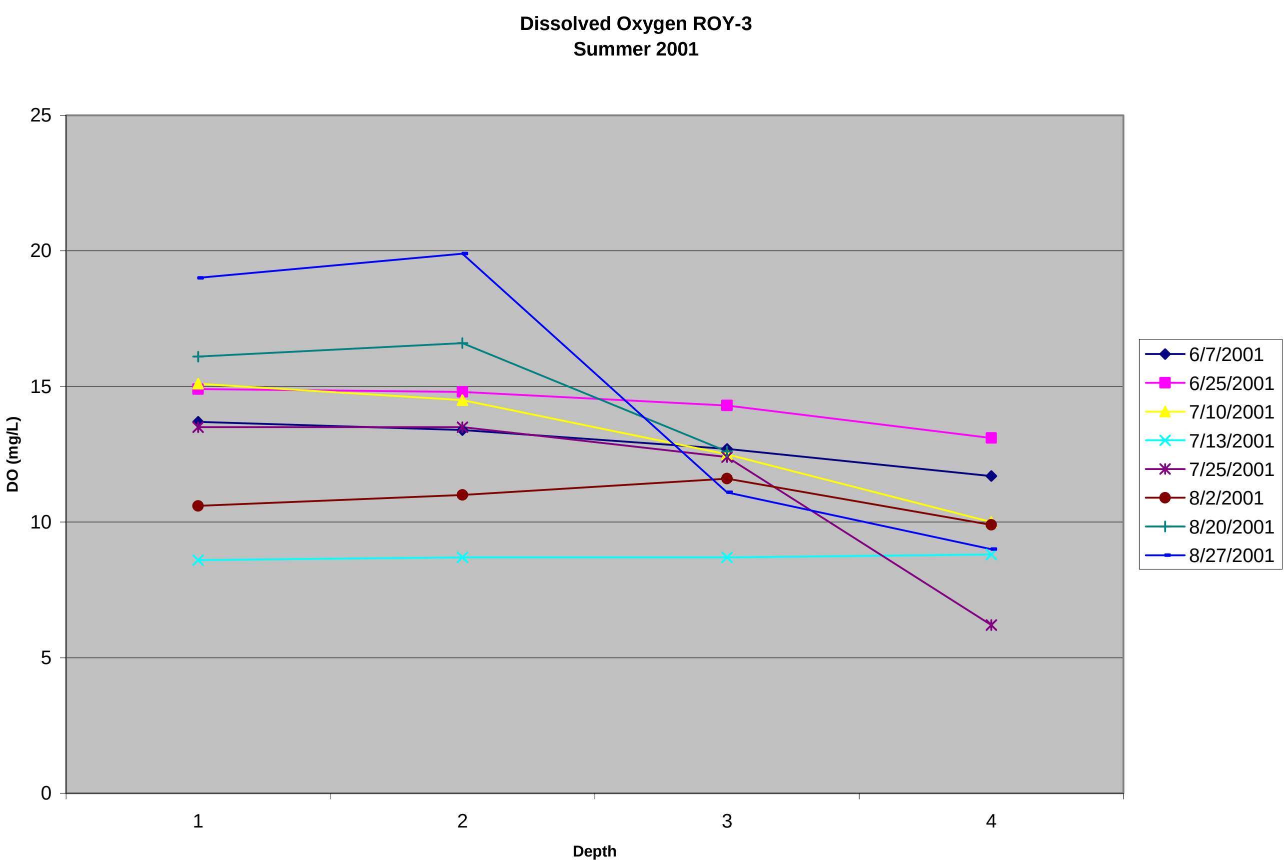


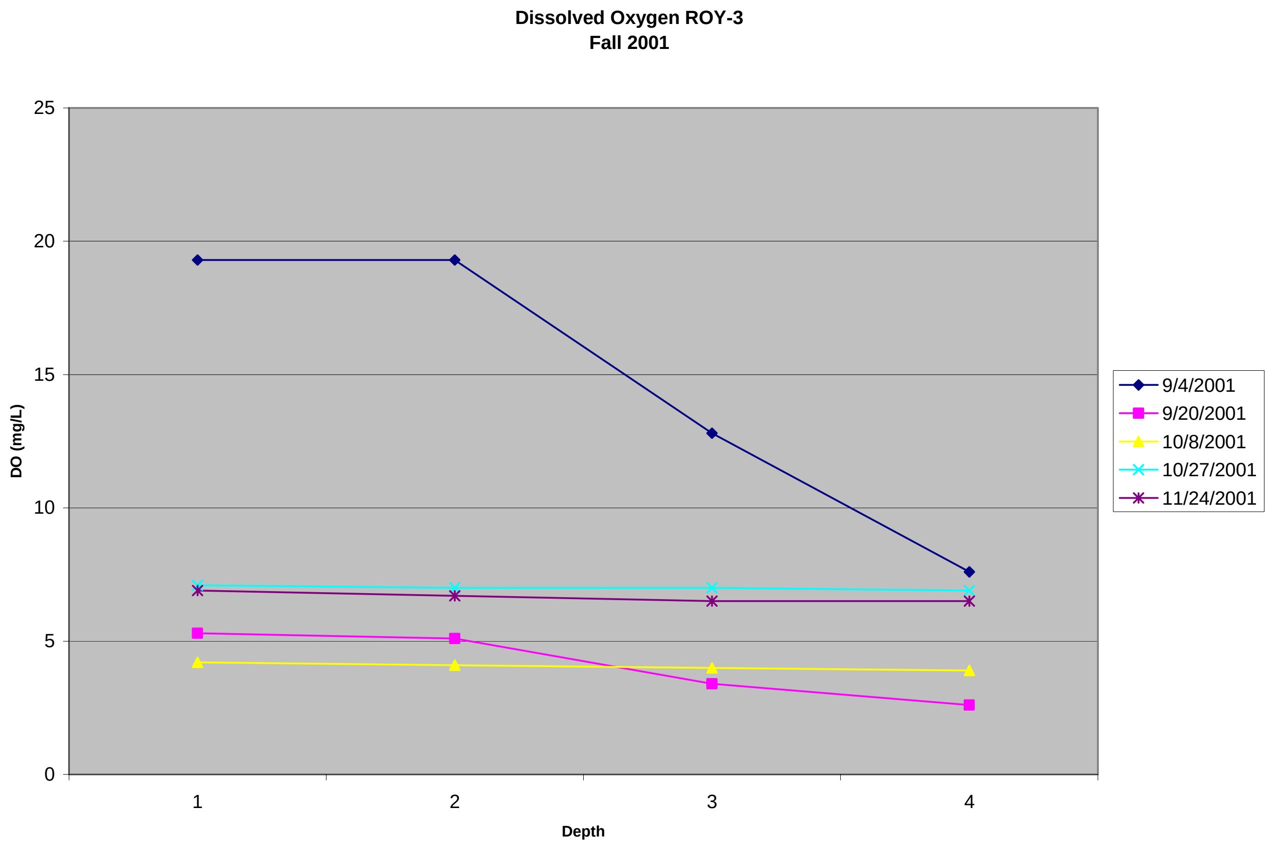
Dissolved Oxygen ROY-2
Winter 2001-02

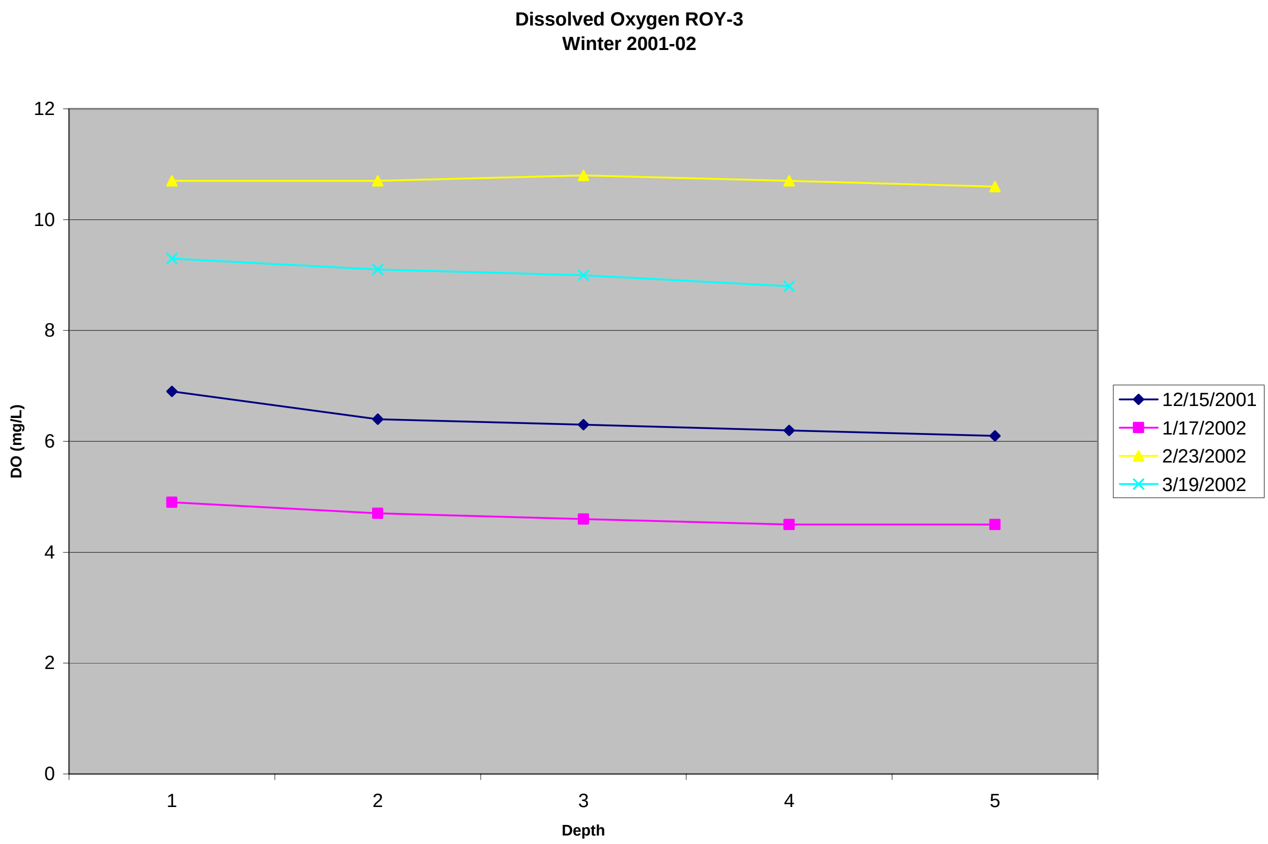


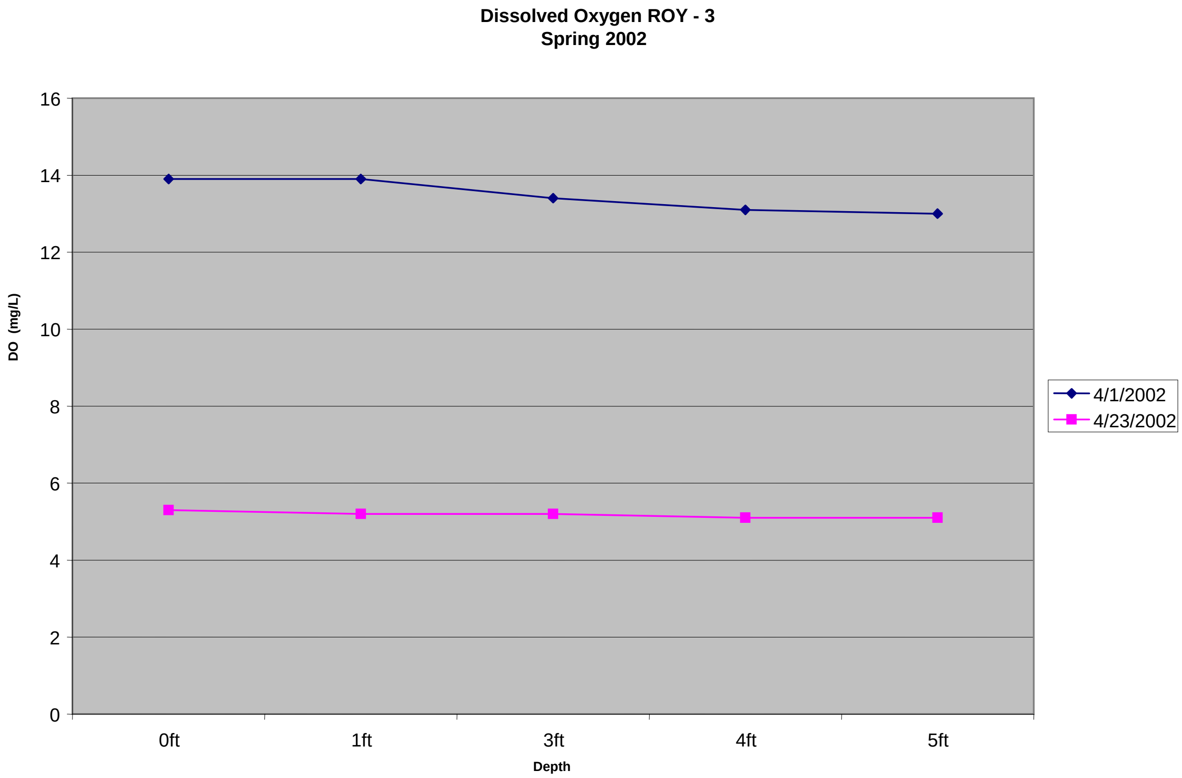

Dissolved Oxygen ROY - 2
Spring 2002
DO (mg/L)
14
12
10
8
6
4
2
0
0ft
1ft
3ft
5ft
7ft
8ft
9ft
Depth
4/1/2002
4/23/2002


Dissolved Oxygen ROY-3
Spring 2001
DO (mg/L)
0
2
4
6
8
10
12
14
16
18
0ft
1ft
3ft
4ft
Depth
4/9/2001
5/15/2001
5/29/2001

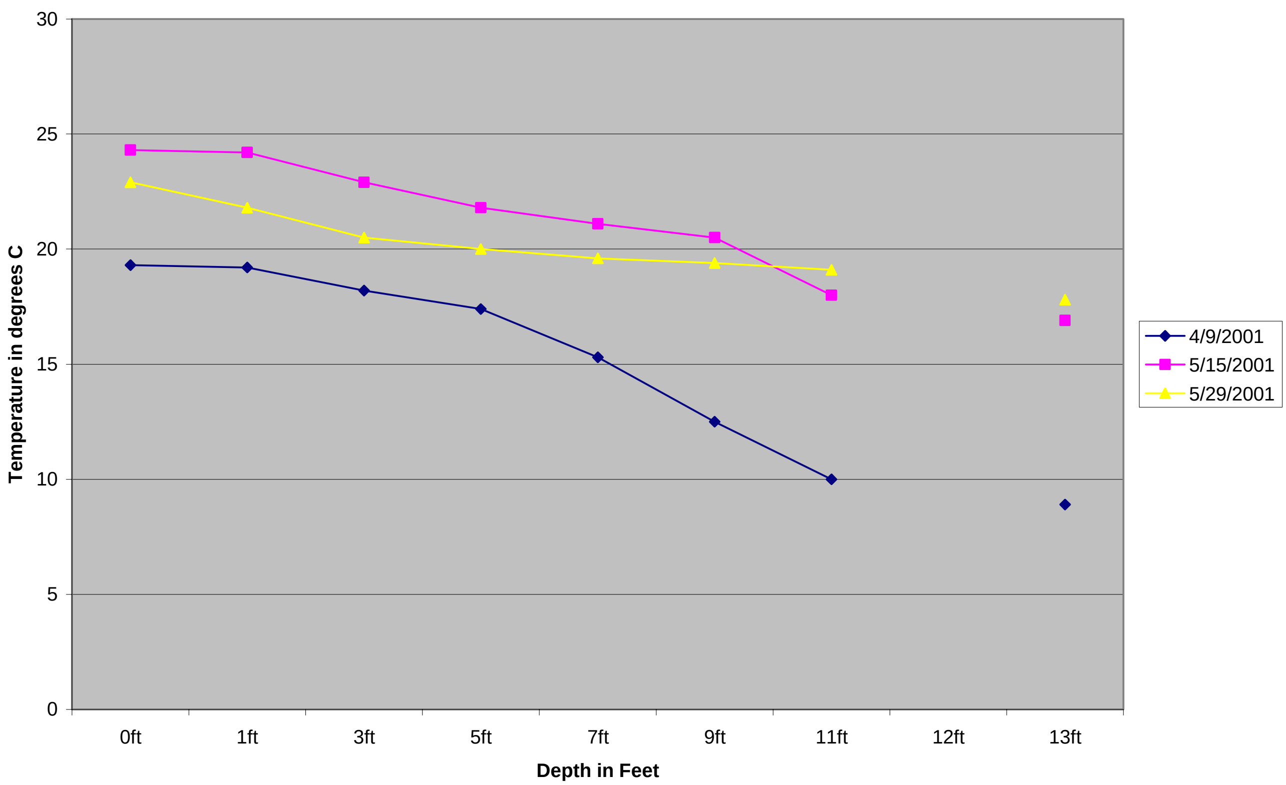

Dissolved Oxygen ROY-3
Summer 2001
DO (mg/L)
0
5
10
15
20
25
1
2
3
4
Depth
6/7/2001
6/25/2001
7/10/2001
7/13/2001
7/25/2001
8/2/2001
8/20/2001
8/27/2001


Dissolved Oxygen ROY-3
Fall 2001
DO (mg/L)
Depth
9/4/2001
9/20/2001
10/8/2001
10/27/2001
11/24/2001

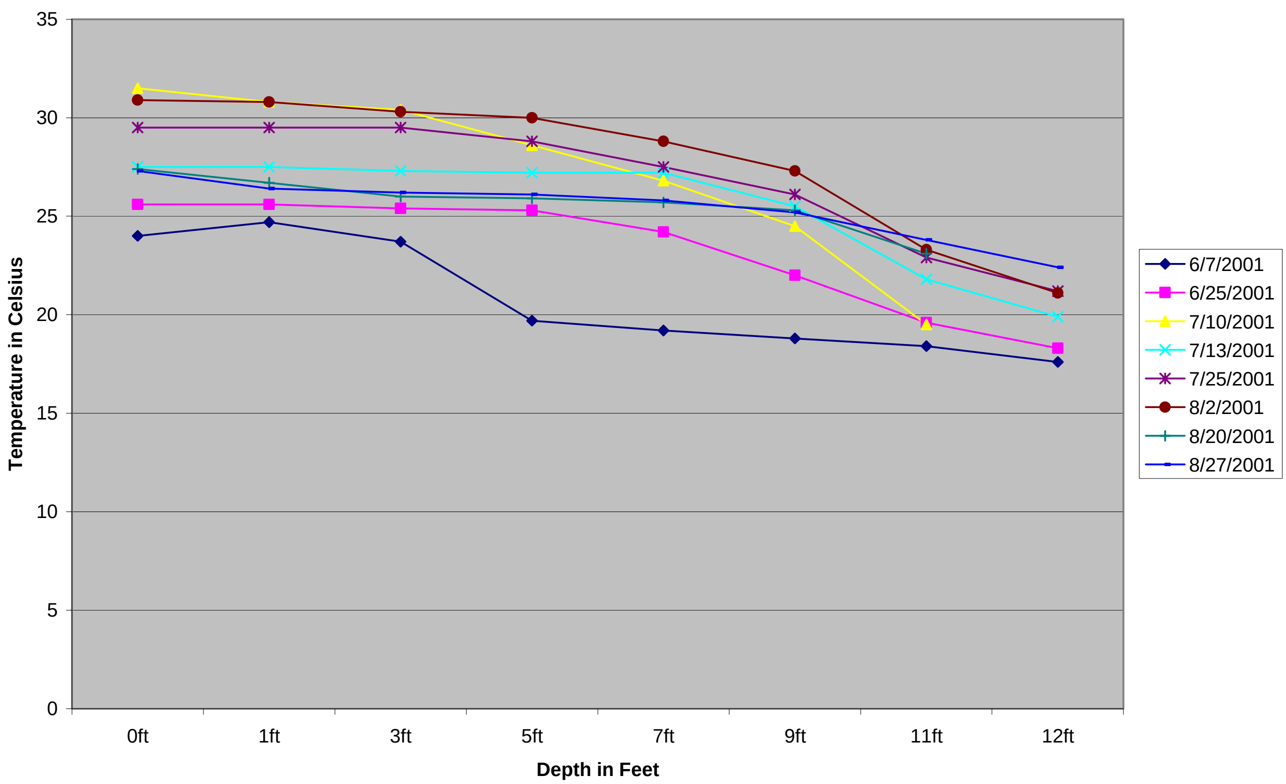

Dissolved Oxygen ROY-3
Winter 2001-02
DO (mg/L)
Depth
12/15/2001
1/17/2002
2/23/2002
3/19/2002

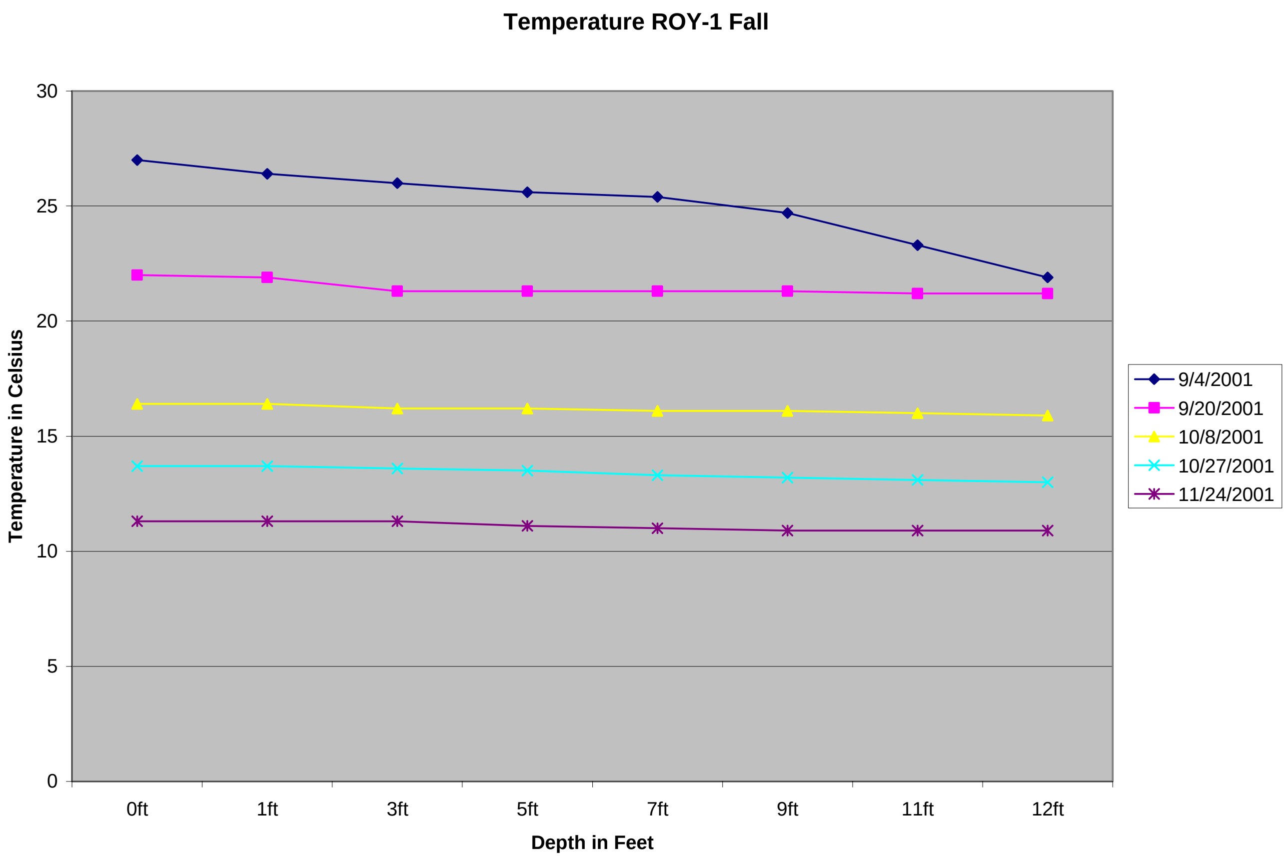

Dissolved Oxygen ROY - 3
Spring 2002
DO (mg/L)
16
14
12
10
8
6
4
2
0
0ft
1ft
3ft
4ft
5ft
Depth
4/1/2002
4/23/2002

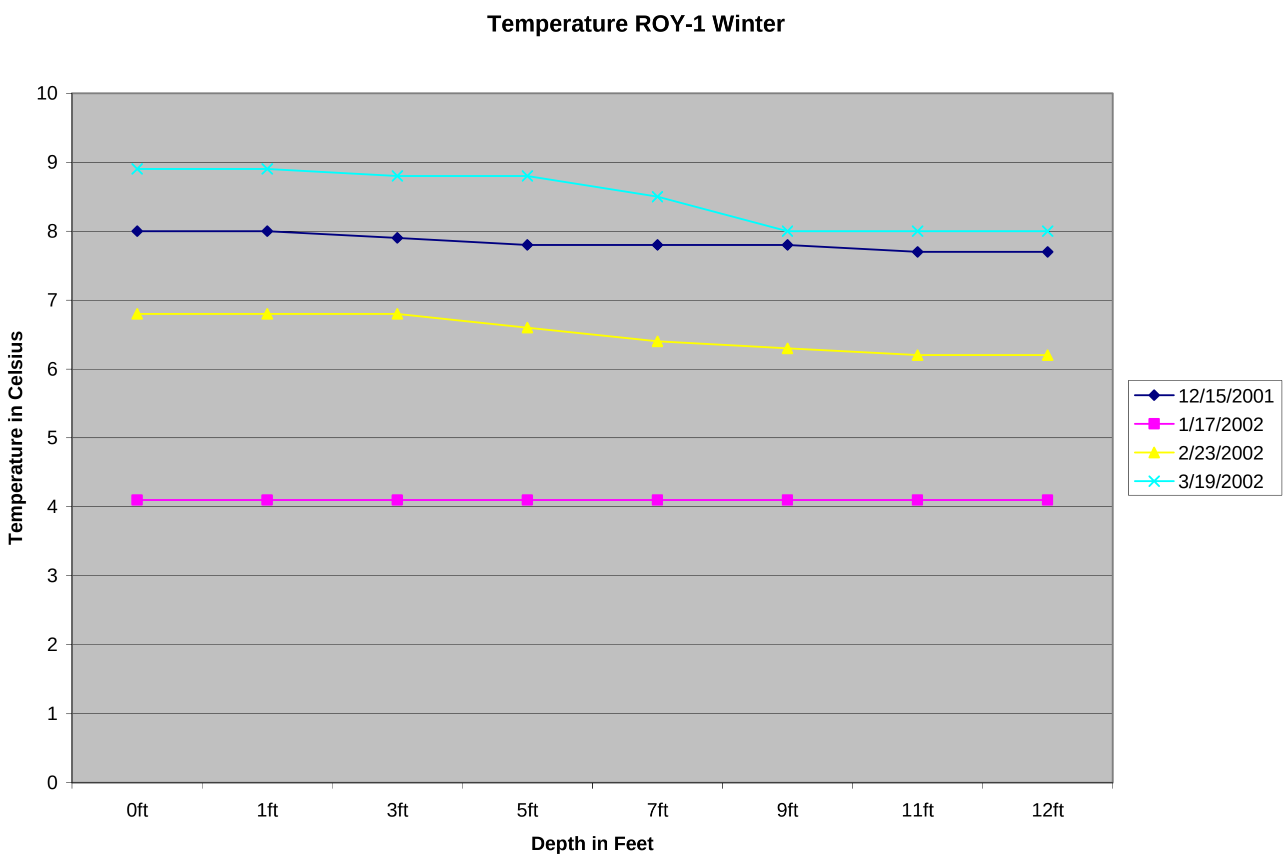
Temperature ROY-1 Spring 2001



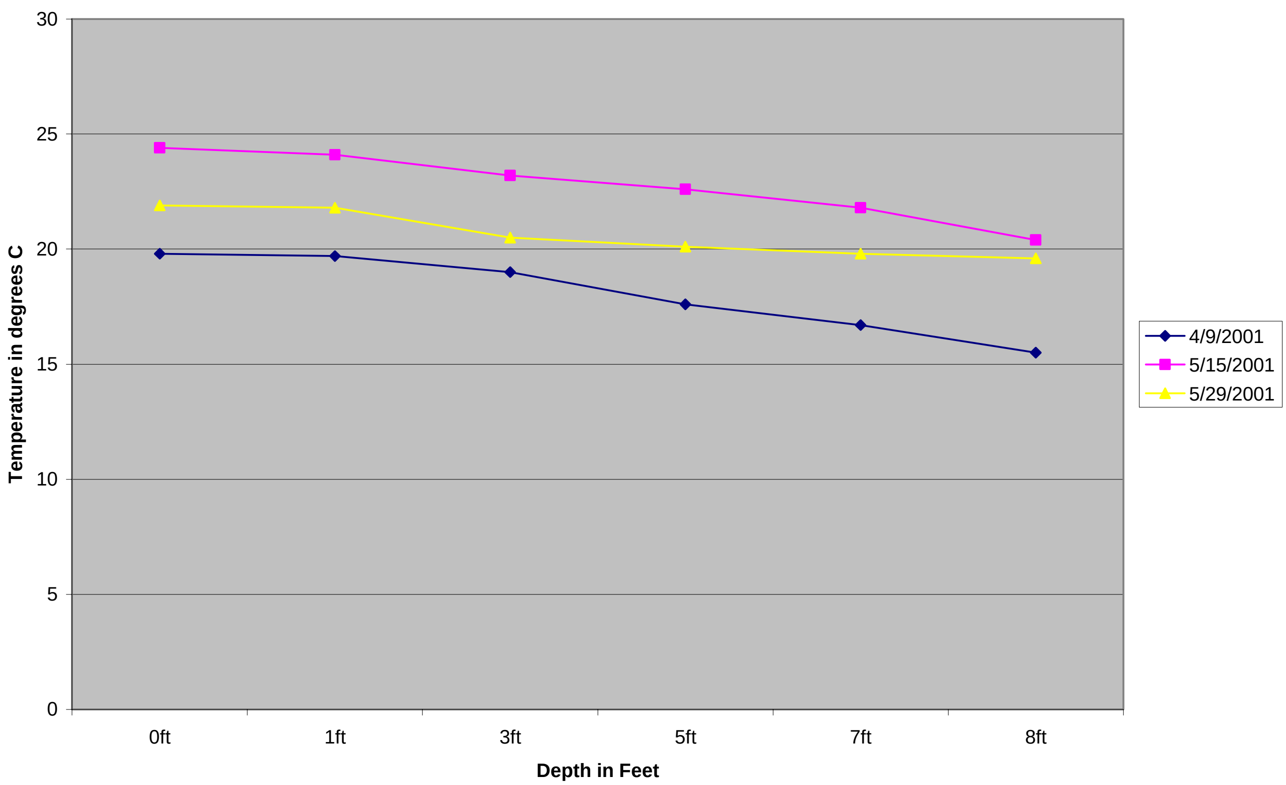
Temperature ROY-1 Summer



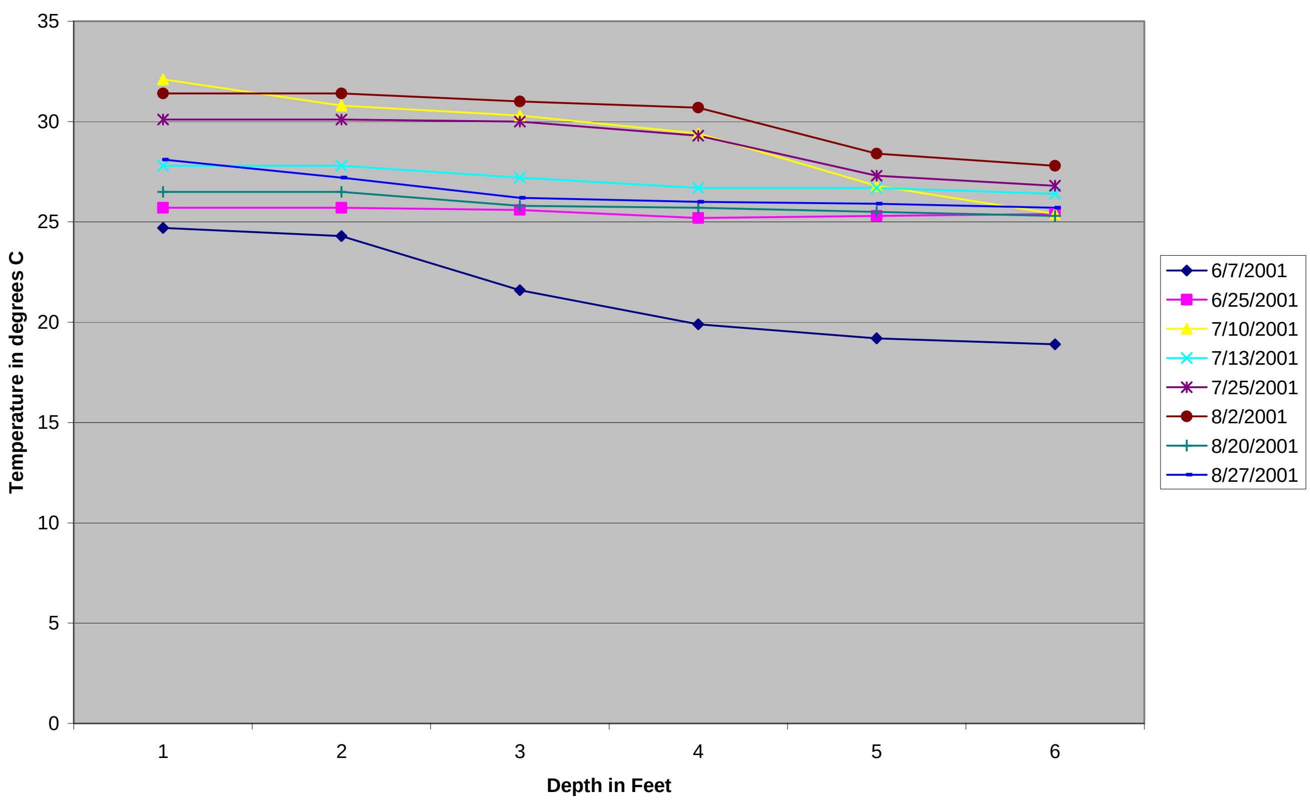

Temperature ROY-1 Fall
Temperature in Celsius
30
25
20
15
10
5
0
0ft
1ft
3ft
5ft
7ft
9ft
11ft
12ft
Depth in Feet
9/4/2001
9/20/2001
10/8/2001
10/27/2001
11/24/2001


Temperature ROY-1 Winter
Temperature in Celsius
10
9
8
7
6
5
4
3
2
1
0
0ft
1ft
3ft
5ft
7ft
9ft
11ft
12ft
Depth in Feet
12/15/2001
1/17/2002
2/23/2002
3/19/2002

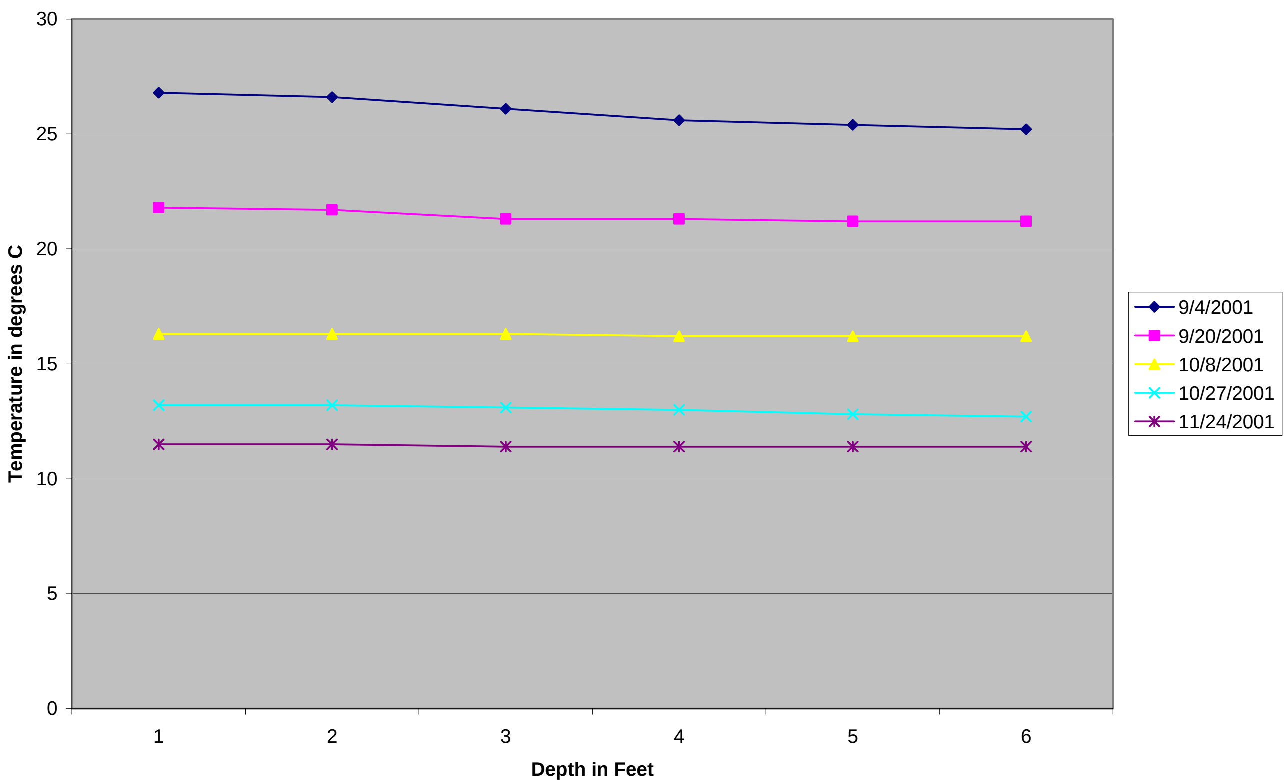
Temperature ROY-2 Spring



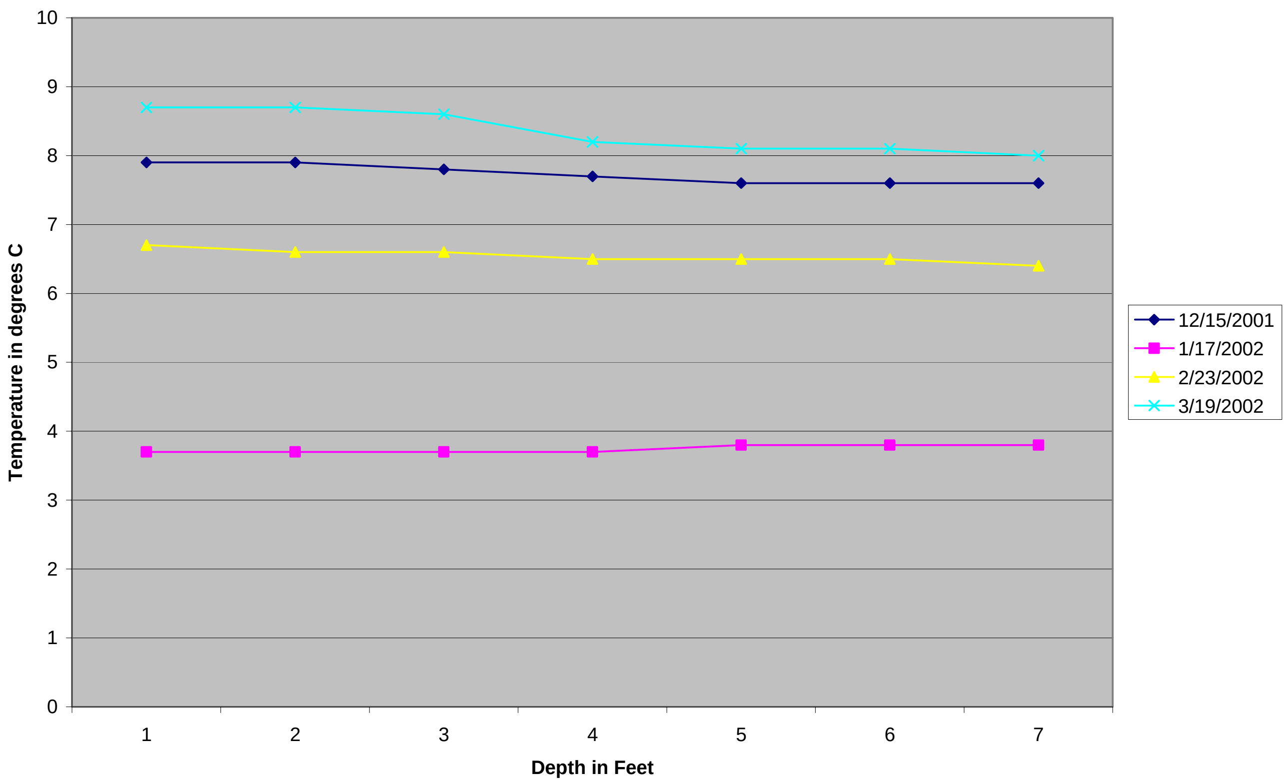
Temperature ROY-2 Summer 2001



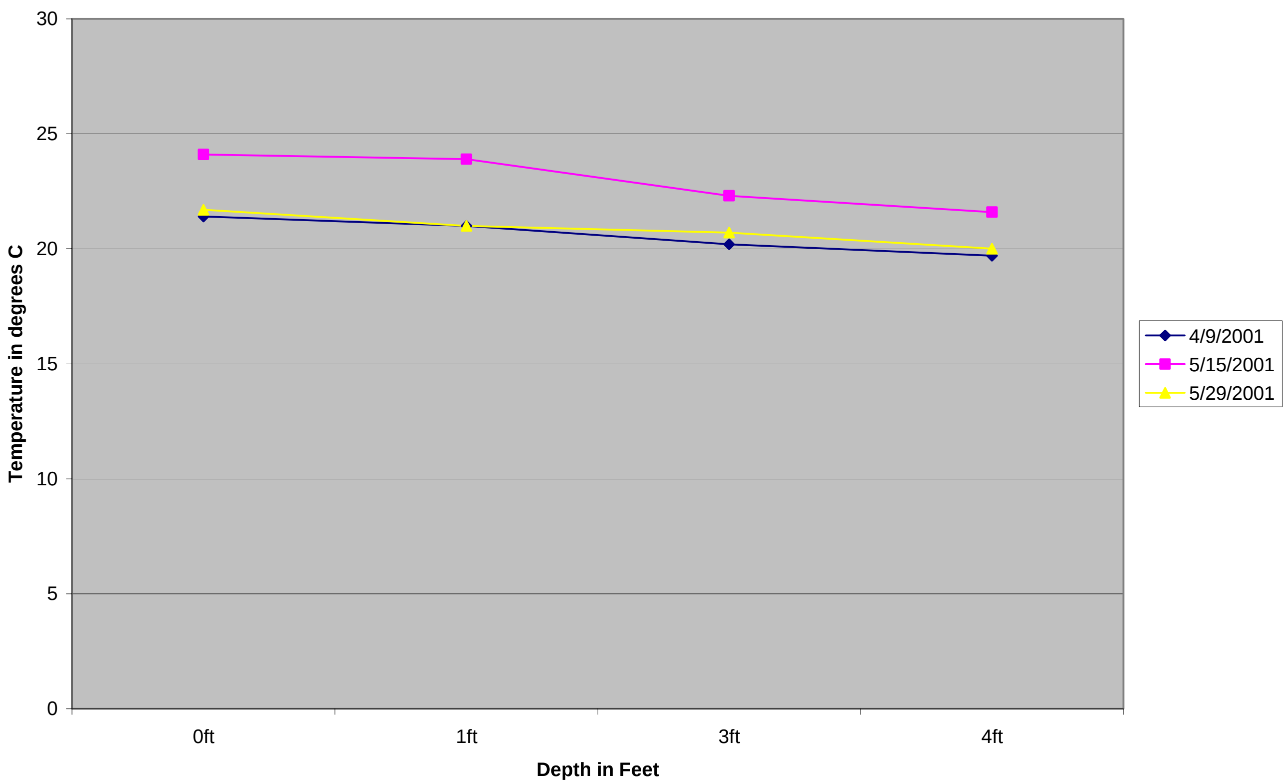
Temperature ROY-2 Fall 2001



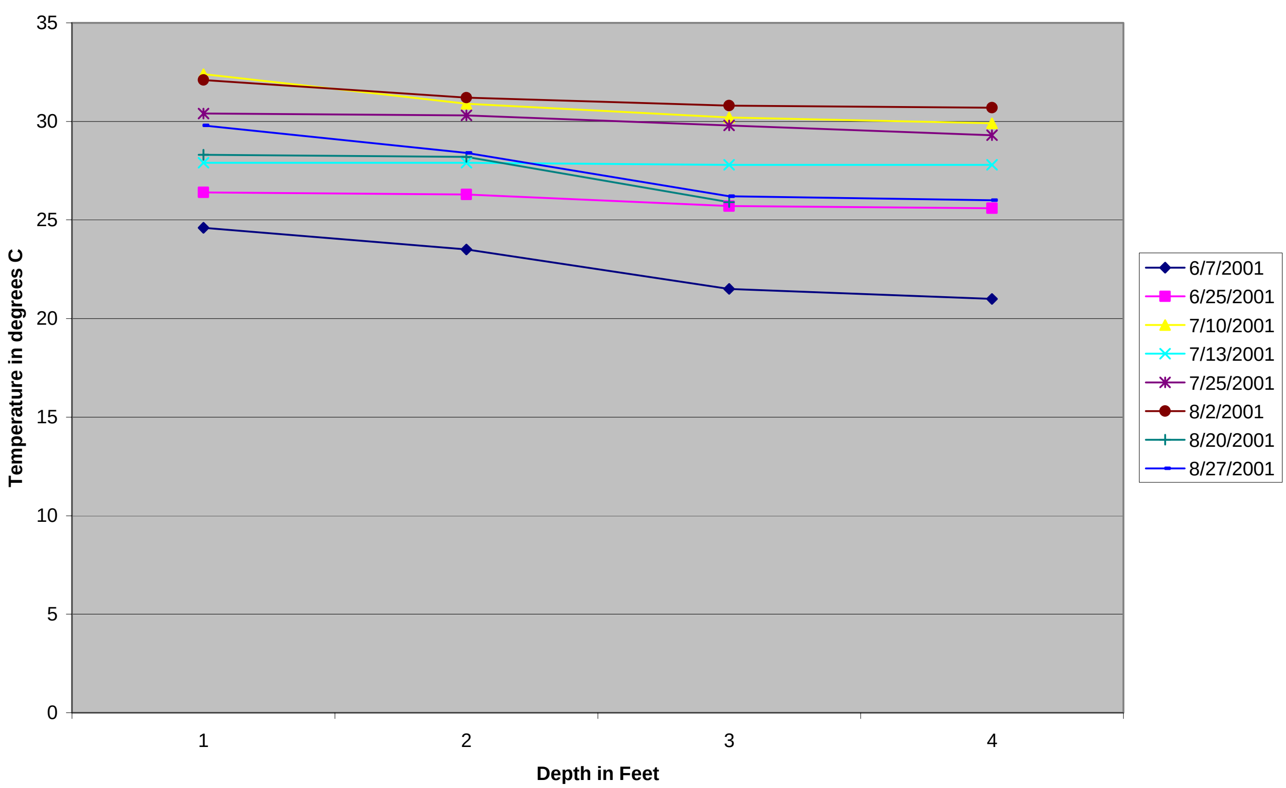
Temperature ROY-2 Winter 2001-02



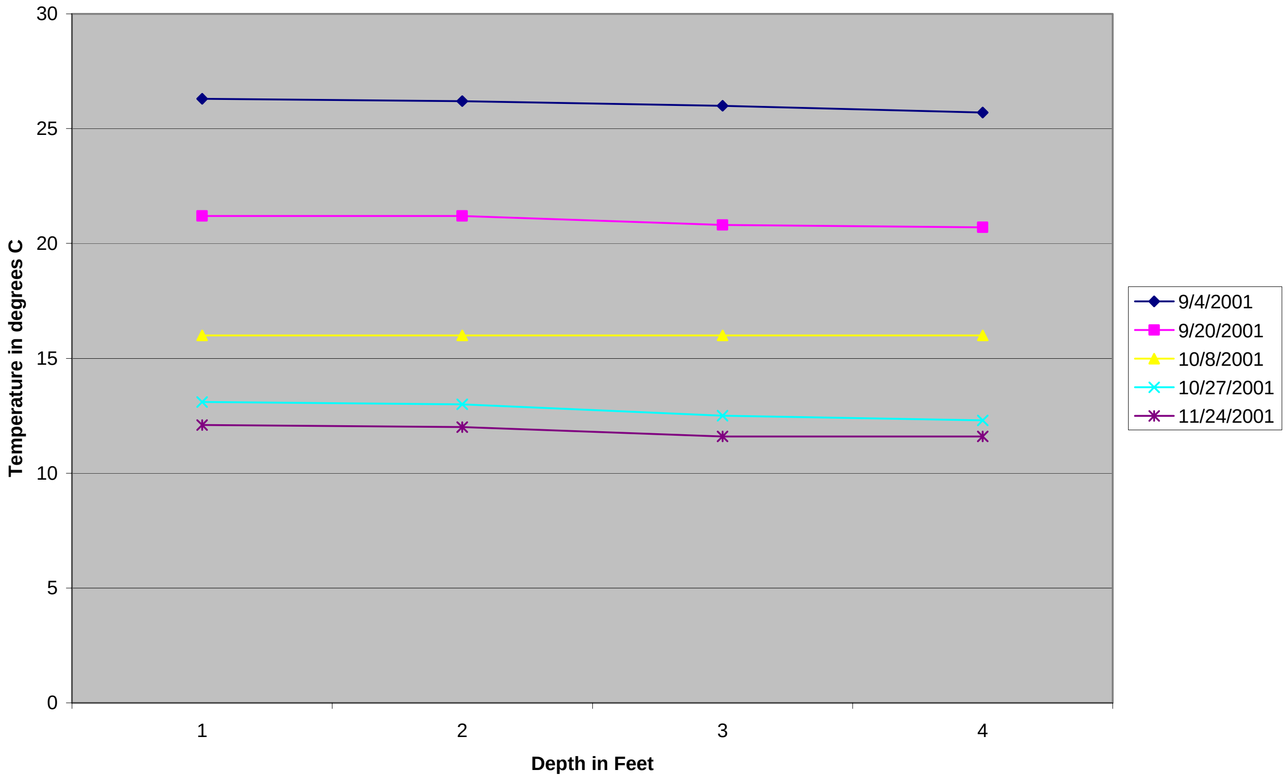
Temperature ROY-3 Spring



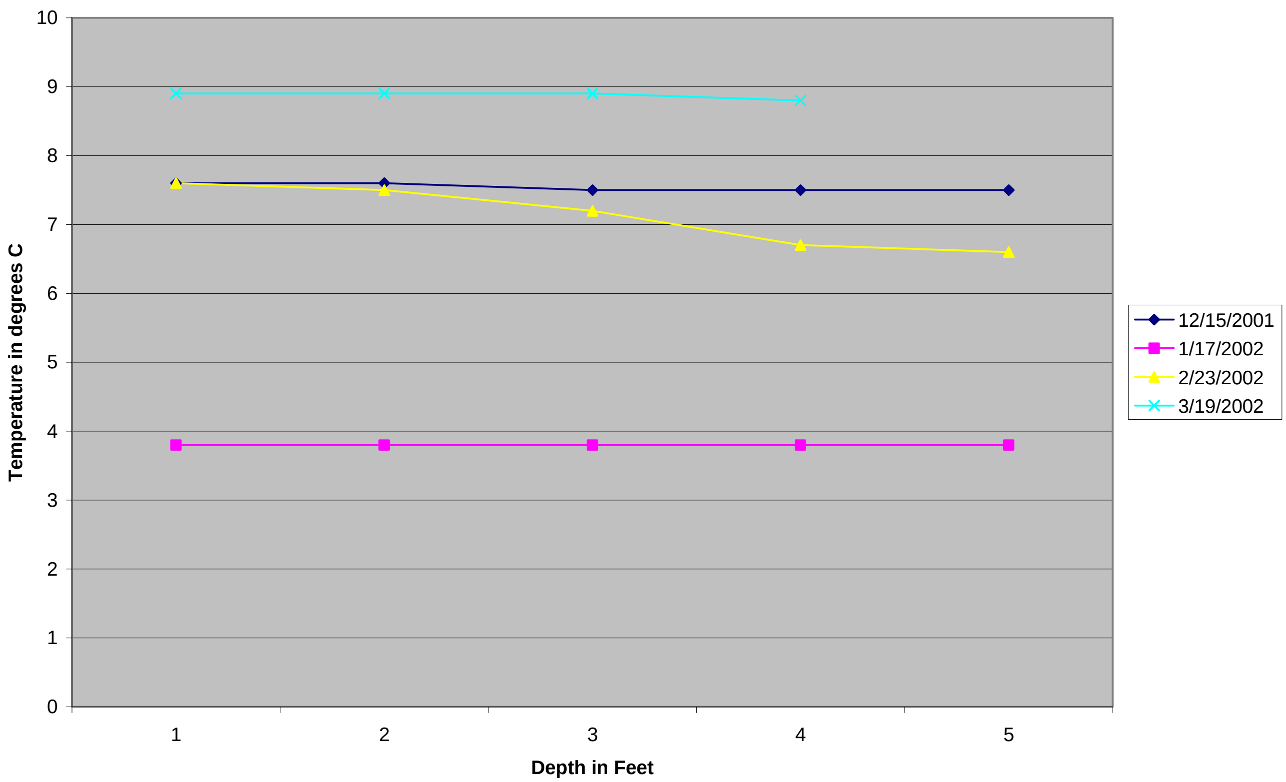
Temperature ROY-3 Fall 2001



Temperature ROY-3 Fall 2001



Temperature ROY-3 Winter 2001-02



APPENDIX E: DATA TABLES

Nutrients, pH, conductivity, fecal Coliforms, dissolved oxygen, temperature, chlorophyll, secchi

Patriots Park 4/01 - 4/02												
TSS Total suspended solids (mg/L)												
	4/9/01	5/15/01	5/29/01	6/7/01	6/25/01	7/10/01	7/25/01	8/20/01	8/27/01	9/4/01	9/20/01	10/15/01
ROY-1b	15	10	4	4	11	9	13	18	17	24	29	16
ROY-1t	8	5	10	8	10	8	8	23	23	20	30	10
ROY-2	7	8	10	6	21	8	12	26	29	22	29	12
ROY-3	7	10	13	8	13	11	15	25	16	17	30	9
VSS Volatile suspended solids (mg/L)												
	4/9/01	5/15/01	5/29/01	6/7/01	6/25/01	7/10/01	7/25/01	8/20/01	8/27/01	9/4/01	9/20/01	10/15/01
ROY-1b	8	6	2	2	6	8	12	15	12	22	23	9
ROY-1t	5	4	8	6	7	6	7	18	19	18	25	7
ROY-2	5	4	8	5	5	6	9	21	26	19	23	8
ROY-3	5	3	10	3	10	8	8	21	11	15	21	6
NVSS Non-volatile suspended solids (mg/L)												
	4/9/01	5/15/01	5/29/01	6/7/01	6/25/01	7/10/01	7/25/01	8/20/01	8/27/01	9/4/01	9/20/01	10/15/01
ROY-1b	7	4	2	2	5	1	1	3	5	2	6	7
ROY-1t	3	1	2	2	3	2	1	5	4	2	5	3
ROY-2	2	4	2	1	16	2	3	5	3	3	6	4
ROY-3	2	7	3	5	3	3	7	4	5	2	9	3
Phosphorus (mg/L)												
	4/9/01	5/15/01	5/29/01	6/7/01	6/25/01	7/10/01	7/25/01	8/20/01	8/27/01	9/4/01	9/20/01	10/15/01
ROY-1b	0.083	0.627	0.162	0.107	0.096	0.111	0.39	0.505	0.648	0.874	0.327	0.243
ROY-1t	0.09	0.067	0.113	0.079	0.061	0.081	0.123	0.297	0.256	0.196	0.36	0.309
ROY-2	0.073	0.073	0.127	0.075	0.062	0.081	0.137	0.321	0.328	0.227	0.321	0.317
ROY-3	0.062	0.056	0.137	0.069	0.082	0.107	0.141	0.274	0.352	0.196	0.304	0.307
Total Nitrogen Kjeldahl nitrogen + nitrate&nitrite nitrogen (mg/L)												
	4/9/01	5/15/01	5/29/01	6/7/01	6/25/01	7/10/01	7/25/01	8/20/01	8/27/01	9/4/01	9/20/01	10/15/01
ROY-1b	1.88	2.021	2.041	2.91	2.53	1.331	1.37	2.25	3.881	5.171	2.541	3.741
ROY-1t	1.44	1.73	2.34	2.86	1.46	1.061	1.211	4.15	3.151	2.261	5.131	3.951
ROY-2	1.36	3.25	1.96	2.55	1.74	1.271	1.321	3.561	4.761	2.911	2.921	6.121
ROY-3	1.36	1.601	2.1	3.11	1.641	1.701	1.731	3.381	4.721	3.671	3.561	3.82
Kjeldahl Nitrogen (mg/L)												
	4/9/01	5/15/01	5/29/01	6/7/01	6/25/01	7/10/01	7/25/01	8/20/01	8/27/01	9/4/01	9/20/01	10/15/01
ROY-1b	1.73	2.02	2.04	1.31	2.05	1.33	1.36	2.23	3.88	5.17	2.54	3.74
ROY-1t	1.28	1.72	2.2	1.35	1.3	1.06	1.21	4.07	3.15	2.26	5.13	3.95
ROY-2	1.2	3.19	1.78	1.07	1.59	1.27	1.32	3.56	4.76	2.91	2.92	6.12
ROY-3	1.2	1.6	1.94	1.15	1.64	1.7	1.73	3.38	4.72	3.67	3.56	3.79
Nitrate & Nitrite Nitrogen (mg/L)												
	4/9/01	5/15/01	5/29/01	6/7/01	6/25/01	7/10/01	7/25/01	8/20/01	8/27/01	9/4/01	9/20/01	10/15/01
ROY-1b	0.15	0.001	0.001	1.6	0.48	0.001	0.01	0.02	0.001	0.001	0.001	0.001
ROY-1t	0.16	0.01	0.14	1.51	0.16	0.001	0.001	0.08	0.001	0.001	0.001	0.001
ROY-2	0.16	0.06	0.18	1.48	0.15	0.001	0.001	0.001	0.001	0.001	0.001	0.001
ROY-3	0.16	0.001	0.16	1.96	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.03

IEPA sample date shaded gray

Patriots Park 4/01 - 4/02

	10/27/01	11/24/01	12/15/01	1/17/02	2/23/02	3/19/02	4/1/02	4/23/02
ROY-1b	18	7	6	7	11	23	20	12
ROY-1t	19	9	4	9	15	20	22	23
ROY-2	16	7	13	9	11	20	21	13
ROY-3	18	5	6	9	21	27	26	15

VSS Volatile suspended solids (mg/L)

	10/27/01	11/24/01	12/15/01	1/17/02	2/23/02	3/19/02	4/1/02	4/23/02
ROY-1b	8	5	4	4	4	6	7	5
ROY-1t	9	5	2	5	6	7	12	10
ROY-2	7	3	9	4	5	7	9	7
ROY-3	8	4	4	3	5	9	13	7

NVSS Non-volatile suspended solids (mg/L)

	10/27/01	11/24/01	12/15/01	1/17/02	2/23/02	3/19/02	4/1/02	4/23/02
ROY-1b	10	2	2	3	7	17	13	7
ROY-1t	10	4	2	4	9	13	10	13
ROY-2	9	4	4	5	6	13	12	6
ROY-3	10	1	2	6	16	18	13	8

Phosphorus (mg/L)

	10/27/01	11/24/01	12/15/01	1/17/02	2/23/02	3/19/02	4/1/02	4/23/02
ROY-1b	0.648	0.256	0.217	0.295	0.173	0.133	0.149	0.109
ROY-1t	0.347	0.249	0.214	0.303	0.189	0.145	0.185	0.221
ROY-2	0.343	0.245	0.211	0.276	0.179	0.157	0.146	0.201
ROY-3	0.345	0.226	0.275	0.272	0.184	0.168	0.196	0.197

Total Nitrogen Kjeldahl nitrogen + nitrate&nitrite nitrogen (mg/L)

	10/27/01	11/24/01	12/15/01	1/17/02	2/23/02	3/19/02	4/1/02	4/23/02
ROY-1b	7.22	5.08	7.32	4.91	2.55	2.65	2.68	1.32
ROY-1t	6.23	3.25	5.33	4.42	2.7	3.27	3.39	1.41
ROY-2	7.27	5.03	5.31	6.02	3.18	3.63	2.61	1.81
ROY-3	6.59	4.98	5.35	6.14	2.73	4.9	3.05	1.5

Kjeldahl Nitrogen (mg/L)

	10/27/01	11/24/01	12/15/01	1/17/02	2/23/02	3/19/02	4/1/02	4/23/02
ROY-1b	7.18	4.93	7	4.41	1.67	1.91	2.06	1.08
ROY-1t	6.16	3.1	5.02	3.96	1.8	2.51	2.72	1.25
ROY-2	7.2	4.88	4.94	5.56	2.3	2.88	1.97	1.66
ROY-3	6.58	4.8	4.99	5.68	1.86	4.16	2.38	1.34

Nitrate & Nitrite Nitrogen (mg/L)

	10/27/01	11/24/01	12/15/01	1/17/02	2/23/02	3/19/02	4/1/02	4/23/02
ROY-1b	0.04	0.15	0.32	0.5	0.88	0.74	0.62	0.24
ROY-1t	0.07	0.15	0.31	0.46	0.9	0.76	0.67	0.16
ROY-2	0.07	0.15	0.37	0.46	0.88	0.75	0.64	0.15
ROY-3	0.01	0.18	0.36	0.46	0.87	0.74	0.67	0.16

Patriots Park 4/01 - 4/02												
Organic Nitrogen Kjeldahl nitrogen - ammonia nitrogen (mg/L)												
	4/9/01	5/15/01	5/29/01	6/7/01	6/25/01	7/10/01	7/25/01	8/20/01	8/27/01	9/4/01	9/20/01	10/15/01
ROY-1b	1.18	0	1.2	0.68	1.43	1.329	1.14	1.94	2.38	2.17	2.08	2.24
ROY-1t	1.23	1.57	2.199	1.33	1.299	1.059	1.209	4.069	3.149	2.259	5.04	2.35
ROY-2	1.15	3.01	1.74	1.02	1.589	1.269	1.29	3.559	4.759	2.89	2.9	4.52
ROY-3	1.16	1.38	1.939	1.149	1.639	1.699	1.729	3.379	4.719	3.669	3.12	2.19

Organic Nitrogen Kjeldahl nitrogen - ammonia nitrogen (mg/L), (CONT.)								
	10/27/01	11/24/01	12/15/01	1/17/02	2/23/02	3/19/02	4/1/02	4/23/02
ROY-1b	4.38	2.13	2.7	2.01	0.47	1.44	1.6	0.78
ROY-1t	2.36	1.2	2.42	1.56	0.6	2.12	2.63	1.12
ROY-2	4.6	3.28	1.84	3.26	1.1	2.48	1.77	1.5
ROY-3	3.78	1.8	0.97	3.38	0.76	3.78	2.3	1.14

Ammonia Nitrogen (mg/L)												
	4/9/01	5/15/01	5/29/01	6/7/01	6/25/01	7/10/01	7/25/01	8/20/01	8/27/01	9/4/01	9/20/01	10/15/01
ROY-1b	0.55	2.6	0.84	0.63	0.62	0.001	0.22	0.29	1.5	3	0.46	1.5
ROY-1t	0.05	0.15	0.001	0.02	0.001	0.001	0.001	0.001	0.001	0.001	0.09	1.6
ROY-2	0.05	0.18	0.04	0.05	0.001	0.001	0.03	0.001	0.001	0.02	0.02	1.6
ROY-3	0.04	0.22	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.44	1.6

Ammonia Nitrogen (mg/L)								
	10/27/01	11/24/01	12/15/01	1/17/02	2/23/02	3/19/02	4/1/02	4/23/02
ROY-1b	2.8	2.8	4.3	2.4	1.2	0.47	0.46	0.3
ROY-1t	3.8	1.9	2.6	2.4	1.2	0.39	0.09	0.13
ROY-2	2.6	1.6	3.1	2.3	1.2	0.4	0.2	0.16
ROY-3	2.8	3	4.02	2.3	1.1	0.38	0.08	0.2

Dissolved Phosphorus (mg/L)					
	4/9/01	6/7/01	7/10/01	8/20/01	10/15/02
ROY-1b	0.028	0.067	0.031	0.383	0.322
ROY-1t	0.025	0.025	0.04	0.11	0.242
ROY-2	0.025	0.026	0.043	0.12	0.243
ROY-3	0.023	0.034	0.049	0.11	0.244

Fecal Coliforms (per 100 ml)												
	5/15/01	6/25/01	7/25/01	8/2/01	9/4/01	10/25/01	11/20/01	12/13/01	1/17/02	2/19/02	3/19/02	4/1/02
ROY-1t	4	0	0	0	0	70	0	2	0		4	12
ROY-2	4	0	0	0	0	52	2	6	2		4	16
ROY-3	2	0	0	0	0	1130	6	26	0		4	8
ROY02	68	66	2700	182		20000	280	5900	82	800	4200	102

Conductivity (um/cm)					
	4/9/01	6/7/01	7/10/01	8/20/01	10/15/02
ROY-1b	386	402	419	410	325
ROY-1t	386	344	310	312	325
ROY-2	386	341	309	311	325
ROY-3	385	341	309	319	326

pH					
	4/9/01	6/7/01	7/10/01	8/20/01	10/15/01
ROY-1b	7.2	7.2	7	6.7	7.7
ROY-1t	8.4	9.1	9.6	9.7	7.7
ROY-2	8.5	9.3	9.6	9.8	7.7
ROY-3	8.6	9.2	9.6	10	7.6

IEPA sample date shaded gray

APPENDIX F

Patriot's Park Lake Internal Regeneration Loading

PATRIOT'S PARK LAKE INTERNAL NUTRIENT LOADING

Anoxic P release

L_{int} = anoxic area (m^2) x anoxic period (days) x anoxic P release rate ($mg/m^2/day$)

Oxic P release

L_{int} = oxic area (m^2) x oxic period (days) x oxic P release rate ($mg/m^2/day$)

Anoxic N release

L_{int} = anoxic area (m^2) x anoxic period (days) x anoxic N release rate ($mg/m^2/day$)

Site 1 2001 - 02

	Depth	Area (ac)	Area (m2)	days anox	P rel rate	Int. load (kg)	Int. load (lb)	Anoxic factor
9-Apr	11	9.4	38040.45	15	12	6.8	15.3	570606.755
15-May	11	9.4	38040.45	15	12	6.8	15.3	570606.755
29-May	12	7.4	29946.738	16	12	5.7	12.8	479147.8
7-Jun	12	7.4	29946.738	15	12	5.4	12.0	449201.063
25-Jun	9	12.9	52204.448	15	12	9.4	21.0	783066.717
10-Jul	11	9.4	38040.45	10	12	4.6	10.2	380404.504
13-Jul	11	9.4	38040.45	10	12	4.6	10.2	380404.504
25-Jul	11	9.4	38040.45	11	12	5.0	11.2	418444.954
2-Aug	9	12.9	52204.448	10	12	6.3	14.0	522044.478
20-Aug	11	9.4	38040.45	10	12	4.6	10.2	380404.504
27-Aug	11	9.4	38040.45	11	12	5.0	11.2	418444.954
4-Sep	11	9.4	38040.45	15	12	6.8	15.3	570606.755
23-Apr	9	12.9	52204.448	15	12	9.4	21.0	783066.717
Anoxic P totals				168		80.5	179.5	6706450.46
Anoxic factor								66.9

Site 2 2001-02

	Depth	Area (ac)	Area (m2)	days anoxic	P rel rate	Int. load (kg)	Int. load (lb)	anoxic factor
15-May	8	14.4	58274.732	15	12	10.5	23.4	874120.987
25-Jul	8	14.4	58274.732	15	12	10.5	23.4	874120.987
2-Aug	8	14.4	58274.732	15	12	10.5	23.4	874120.987
27-Aug	8	14.4	58274.732	15	12	10.5	23.4	874120.987
4-Sep	8	14.4	58274.732	15	12	10.5	23.4	874120.987
23-Apr	9	12.9	52204.448	15	12	9.4	21.0	783066.717
Anoxic P totals				90		61.8	138.0	5153671.65
Anoxic factor								49

Oxic zone	area (ac)	area (m2)	days oxic	P rel rate	Int. load (kg)	Int. load (lb)
Jan	26	105218.27	31	0.3	1.0	2.2

Feb	26	105218.27	28	0.3	0.9	2.0
Mar	26	105218.27	31	0.3	1.0	2.2
Apr 1	26	105218.27	15	0.3	0.5	1.1
Apr 2	16.6	67177.817	15	0.3	0.3	0.7
May 1	16.6	67177.817	15	0.3	0.3	0.7
May 2	18.6	75271.529	16	0.3	0.4	0.8
Jun 1	18.6	75271.529	15	0.3	0.3	0.8
Jun 2	13.1	53013.819	15	0.3	0.2	0.5
Jul 1	16.6	67177.817	10	0.3	0.2	0.4
Jul 2	16.6	67177.817	10	0.3	0.2	0.4
Jul 3	16.6	67177.817	11	0.3	0.2	0.5
Aug 1	13.1	53013.819	10	0.3	0.2	0.4
Aug 2	16.6	67177.817	10	0.3	0.2	0.4
Aug 3	16.6	67177.817	11	0.3	0.2	0.5
Sep 1	16.6	67177.817	15	0.3	0.3	0.7
Sep 2	26	105218.27	15	0.3	0.5	1.1
Oct 1	26	105218.27	15	0.3	0.5	1.1
Oct 2	26	105218.27	16	0.3	0.5	1.1
Nov	26	105218.27	30	0.3	0.9	2.1
Dec	26	105218.27	31	0.3	1.0	2.2
Apr 1	13.1	53013.819	15	0.3	0.2	0.5
Oxic P totals			380		10.0	22.3
Anoxic + oxic P totals					152.3	339.8

Depth below which anoxic (<1mg/L)

Site 1 2001 - 02

	Depth	Area (ac)	Area (m2)	days anoxic	N rel rate	Int. load (kg)	Int. load (lb)
9-Apr	11	9.4	38040.45	15	120	68.5	152.8
15-May	11	9.4	38040.45	15	120	68.5	152.8
29-May	12	7.4	29946.738	16	120	57.5	128.3
7-Jun	12	7.4	29946.738	15	120	53.9	120.3
25-Jun	9	12.9	52204.448	15	120	94.0	209.6
10-Jul	11	9.4	38040.45	10	120	45.6	101.8
13-Jul	11	9.4	38040.45	10	120	45.6	101.8
25-Jul	11	9.4	38040.45	11	120	50.2	112.0
2-Aug	9	12.9	52204.448	10	120	62.6	139.8
20-Aug	11	9.4	38040.45	10	120	45.6	101.8
27-Aug	11	9.4	38040.45	11	120	50.2	112.0
4-Sep	11	9.4	38040.45	15	120	68.5	152.8
23-Apr	9	12.9	52204.448	15	120	94.0	209.6
Anoxic N totals				168		804.8	1795.5

APPENDIX G

PROJECT SCHEDULE

Watershed and Lake Restoration Program

SCHEDULE: 2004 (A M J J A S O N D) · 2005 (J F M A M J J A S O N D) · 2006 (J F M A M J J A S O N D) · 2007 (J F M A M J J A S O N D)

	PROJECT TYPE	DETAILS
First Phase	Conservation Practice Incentive Programs	
	CRP Incentive	150 Ac at $100 / Ac plus admin
	Conservation Cover Incentive	50 Ac x $100/Ac x 10 yrs plus admin
	Conservation Easement & Restoration	Special project, easement plus design/restoration
	Rehab of Existing Septic System	Pump and rehab
	Boat Ramp Rehabilitation	Concrete & rock apron
	Policies and Education	IEPA Lake Education Assistance Program
Second Phase	Stormwater Wetland Basins - NEW	
	SWB #1 Young Property / South	15000 cy exc., <2 Ac, 10 Ac-ft, 3-ft berm, Armorflex
	SWB #2 Young Property / North	25000 cy exc., 3-5 Ac, 15 Ac-ft, 6-ft berm, Armorflex
	Stormwater Wetland Basins - Clean-out EXISTING	
	Basin 1	Excavate existing detention basin
	Basin 2	Excavate existing detention basin
	Basin 3	Excavate existing detention basin
	Basin 4	Excavate existing detention basin
	Forebay and Control Structure/berm	
	Rehab Control Structure and Berm	250 feet, fill to 4'x50', armorflex (15k sq ft), pipes
	Dredge existing forebay	22,000 cy, $1.50/cy, hauled @ $35/10cy, + design/admin
	Shoreline Grading / Armoring - 40 feet	Regrade and armor 40 linear ft of shoreline
	Shoreline Stabilization - 800 feet	Shoreline stabilization with vegetation/bio-structure
	Shoreline Stabilization - 1000 feet	Shoreline stabilization with vegetation/bio-structure
	Phase II Monitoring	Contracted after Ph II implementation, at ROY 1 - 3

319 Application

Projects