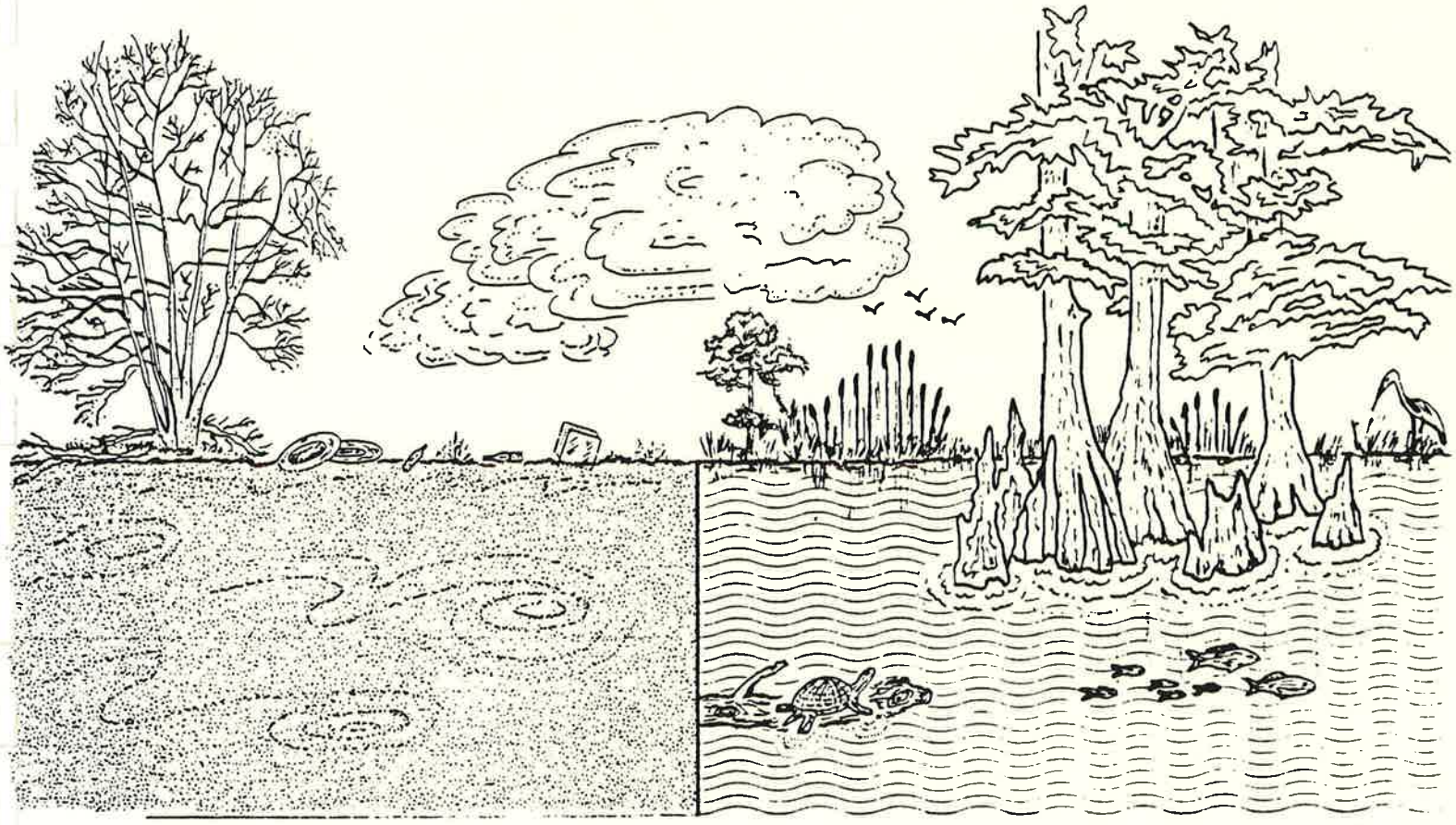
LAKE MUNSON ACTION PLAN

Restoring and Preserving for Future Generations

A REPORT WITH RECOMMENDATIONS

Produced by the Lake Munson Action Team
for the
Leon County Board of County Commissioners
and the
Citizens of Leon County

JANUARY, 1994



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EXECUTIVE SUMMARY

Lake Munson is the primary receiving waterbody for stormwater runoff from the majority of urbanized Tallahassee. For over sixty years, Lake Munson has been severely degraded by nutrient pollution and sedimentation. As a consequence, both the quality and volume of lake water has been measurably reduced. Although some essential remedial steps have been taken, the potential economic, recreational, and esthetic value of Lake Munson will only be realized through careful planning, creative funding strategies, and the persistent implementation of well coordinated restoration projects and maintenance programs.

After broad-based study and collaboration, the Lake Munson Action Team devised this Action Plan to effectively restore the lake and provide long term economic returns for the citizens of Leon County. Watershed Management, In-Lake Restoration, and Community Action provide the basis of a comprehensive and practical approach to redeeming this valuable natural resource.

A clearly defined Watershed Management program is critical to lake restoration and protection. The Action Team strongly endorses the City of Tallahassee-Leon County Lake Munson Stormwater Management Plan (Bartel et al, 1991). While the cost of this plan totals approximately $16,000,000, the projected reduction in the cost of flood damage alone is $1,000,000 per year, and creative approaches to funding projects and programs can ease the financial burden to any one funding source.

In-Lake Restoration hinges on removing a two-foot thick layer of nutrient-rich, organic sediment at a cost of $2,000,000. Without an in-lake source of excessive nutrients, Lake Munson will be able to thrive as an outstanding fishery and recreational area. The Action Team recommends creating parks with boat ramps on the lake as part of a proposed "greenway system" along watercourses in the area. Public access to the lake compliments a project now underway to develop the Tallahassee to Carrabelle "Rails-To-Trails" recreational corridor and could establish Lake Munson as the southern gateway to the coastal plains.

Under the heading of Community Action, a broad range of steps, including a community based "Adopt A Lakeshore" program, a white goods pickup program, public education programs on pollution abatement, regulatory standards on impervious surfaces, and fines for sewage spills are recommended.

Though Lake Munson is one of the most abused waterbodies in the region, it has tremendous potential and can be completely restored in ten years. Consider this Action Plan an investment portfolio, one which, if implemented, will pay dividends of a lasting and higher quality of life for the citizens of Leon County.

INTRODUCTION

If you avoid looking straight down, the view of cypress-ringed Lake Munson is one of the most beautiful in Leon County. Unfortunately, from 1934 to 1984, Munson's location made it the most convenient receiving waterbody for Tallahassee's municipal wastewater. As early as July of 1954, the "sewage problem [had] an adverse effect on the area, and many local people [would] not fish the lake because of it." (FG&FWFC Fish Management Bulletin #3, 1955). The lake currently receives stormwater runoff from approximately 57% of the Tallahassee urban area.

The long term pollution of Lake Munson has resulted in frequent algae blooms, fish kills, a thick layer of organic muck on the lake bottom, and tons of trash spread along the drainage ways. When $13.6 million was spent to divert treated sewage east to spray fields, the condition of the lake improved. Nevertheless, the pollution of Lake Munson continues with periodic accidental sewage spills and large frequent pulses of untreated stormwater from its urbanized watershed and sediment-filled drainage ways.

So it is not without some justification that Lake Munson is locally derided in the local media as being highly polluted. There is even a mind-set that the lake is beyond repair. To reverse this defeatist mentality and to prove that even the most polluted lake in the region can be carefully restored, the Lake Munson Action Team was created by the Leon County Board of County Commissioners.

The Action Team is comprised of twelve voting members. Seven members are state or local government technical staff with direct responsibilities associated with the lake. Staff appointments were made from the following agencies:

- Leon County Department of Public Works
- Leon County Department of Growth and Environmental Management
- Northwest Florida Water Management District
- Department of Environmental Protection
  (Formerly Departments of Environmental Regulation and Natural Resources)
- HRS/Leon County Public Health Unit
- Tallahassee-Leon County Planning Department

Five members are private citizens who are appointed by the County Commission and represent those who have demonstrated an interest in and concern for Lake Munson.

The Action Team's mission is to facilitate, but not assume, the roles and responsibilities held by other agencies; to recommend to the County Commission for approval a management plan and implementation schedule (Action Plan) that considers the plans and jurisdictions of other agencies; to recommend strategies for funding the management plan; to monitor the implementation of the plan; and to keep the County Commission, the public, and all those involved with the lake informed of the status of the plan's implementation. In short, the Action Team is to formulate and promote a realistic management plan to restore Lake Munson to a healthy aquatic system, one with excellent recreational, fish, and wildlife values.

After eighteen months of reviewing the well known problems with the lake and deliberating and ranking the possible solutions, the Lake Munson Action Team developed an overall strategy for restoring the lake: the Lake Munson Action Plan. If implemented, Lake Munson will be an enjoyable place to be again, even when one breathes deeply and looks straight down.

CHAPTER I: BACKGROUND

HISTORICAL LAKE USES

Perhaps one of the earliest documented uses of Lake Munson is by the Spanish Deputy Governor, Manuel Solana, of the then Province of Apalachee, who in 1704 wrote that he had ordered seven men to ascend the St. Marks and Wakulla Rivers by canoe to a landing place near the San Luis Fort. A description of a 1705 map and historical documents of the San Luis Region by Boyd, et al. (1951), suggests that the Wakulla River may have once arisen from the present day Lake Munson.

In an 1840 map of the West Territory of Florida, Lake Munson is referred to as Munson's Mill Pond. Since cypress was harvested in this area, a cypress mill may have been present on the lake. The name also suggests that a structure was used to impound the lake. In 1883, the lake was mapped as "Munson's Lake". In the 1943 U.S. Geological Survey Quadrangle of Tallahassee, the lake was called "Lake Munson" and had a shape and size nearly identical to its appearance on modern day maps. Munson Slough, to the south of the lake, was called Bradford Brook. Except for one main road, present day U.S. Highway 319, there were no paved roads and no indications of development on the lake.

In 1950, a dam structure was reportedly built at the outfall of the lake in an effort to alleviate downstream flooding problems (Bocz and Hand, 1985). However, a recent study of water surface profiles (Bartel, et al., 1991), indicates that this structure did little to reduce downstream flooding. Flooding also occurs upstream of and adjacent to the lake, partly as a result of the dam structure, but also as a result of a major roadway restriction in the channel of Munson Slough just south of the lake at the Crawfordville Highway (U.S. 319). The roadway berm and culvert system creates a backwater condition all the way to the Munson dam. This causes the dam structure to be submerged and upstream areas to flood during large storm events. Overall, the lake has not been very useful for flood control purposes because it does not have a large enough storage capacity, even if it were to be completely empty prior to flooding.

In 1954, one of the earliest surveys by the Florida Game and Fresh Water Fish Commission indicated that Lake Munson was a good waterfowl hunting area and a cracker fishing lake "in the best of Southern Style". However, even then, many people reportedly did not fish the lake because it received effluent from Tallahassee sewage treatment plants and lake esthetics were deteriorating as was evidenced by algal blooms.

Two sewage treatment facilities contributed effluent to Lake Munson: The Dale Mabry Treatment Plant, constructed during the 1930's, and the Lake Bradford Facility, built in the 1950's. In 1954, the lake was also reported to have two public landings and a private fish camp with nine boats. Currently, only one public landing exists.

From 1954 until the early seventies, data on the lake was very limited. An apparent resurgence to document lake conditions occurred in the State of Florida as fish management reports, provided by the Florida Game and Fresh Water Fish Commission, indicate that fish and wildlife assessments and surveys were completed in 1973, 1976, 1978, 1979, and 1986. The latest survey, taken in 1986, indicates an overall 75 percent decrease in fish biomass from the 1976 survey, which occurred just before a 1977 drawdown and a supplemental restocking program.

Historically, the lake served to attract real property owners and residential development. A pocket of residential development on the northeast side of the lake clearly extends outward from the lake. However, since the 1950's, the lake's esthetic condition has been quite variable. The heavy algal blooms, which occur in the warmer months, can cause severe odor problems. Street debris, including paper products, cans, bottles, toys, dead animals, and yard trash, is scattered throughout the lake's inflow delta and has been since the early 1970's. The overall effect has been to decrease market values for real estate around the lake and to provide highly visible evidence of less visible incipient pollutants which continuously enter the lake through the channelized Munson Slough.

Today's uses of Lake Munson are very limited. The degraded state of the lake and low fish productivity is highly publicized by local media and generally known by local residents. Although no surveys have been performed, the current average use rate for fishing the lake is estimated to be less than three people per day. Other occasional but very limited uses may include duck hunting, boating, and wildlife observation. In the winter months, the water can become a translucent brown color, and the lake provides a very pleasant view.

SYSTEM DESCRIPTION

Lake Munson

Lake Munson is located within the Lake Munson Sandhills Physiographic Region, which is composed of dry, sandy hills and ridges. The region contains many lakes, swamps and sinkholes, and high-quality upland communities. These areas provide habitat for a variety of threatened and endangered plants and animals. Lake Munson is a shallow, 255-acre, cypress-ringed lake, and is artificially impounded at the outflow. It is located in an area characterized by a relatively low, sandhill topography. Munson Slough, the lake's primary inflow and outflow stream, enters at the northwest corner and exits at the southeast corner of the lake.

Lake Munson receives surface water from most of the land area within the Lake Munson Drainage Basin. The Munson Basin encompasses approximately half of the Tallahassee urban area and contains numerous smaller subbasins. Many of the wetlands originally in the basin have been eliminated through development; though wetlands still remain in the western and southern parts of the basin. Because intense urban development and the loss of wetlands have increased stormwater runoff, much of the area in the basin is considered floodplain.

The land area immediately surrounding Lake Munson is developed at a low density, consisting of residential uses to the northeast, east, and southeast. The western lake shore, within the Apalachicola National Forest (ANF), is a high quality, mixed hardwood, floodplain forest. The area north of the lake includes several large sand pit operations interspersed with marginal quality, successional growth forest. **Figure 1** shows Lake Munson and vicinity.

Lake Munson Sandhills Physiographic Region

The Lake Munson Sandhills, located approximately between Silver Lake Road and Crawfordville Highway, extend southwest of Tallahassee to the Wakulla County line. The region is 47.3 square miles in area. The Lake Munson Sandhills region is an extensive area of dry hills and ridges composed of deep sands over limestone bedrock with a moderate amount of subsurface silt and clay in between. Hills rise up to 60 feet above their bases. Many small areas with ten to twenty percent grades are scattered throughout the region. Also, numerous sinkholes and karst-formed lakes are present.

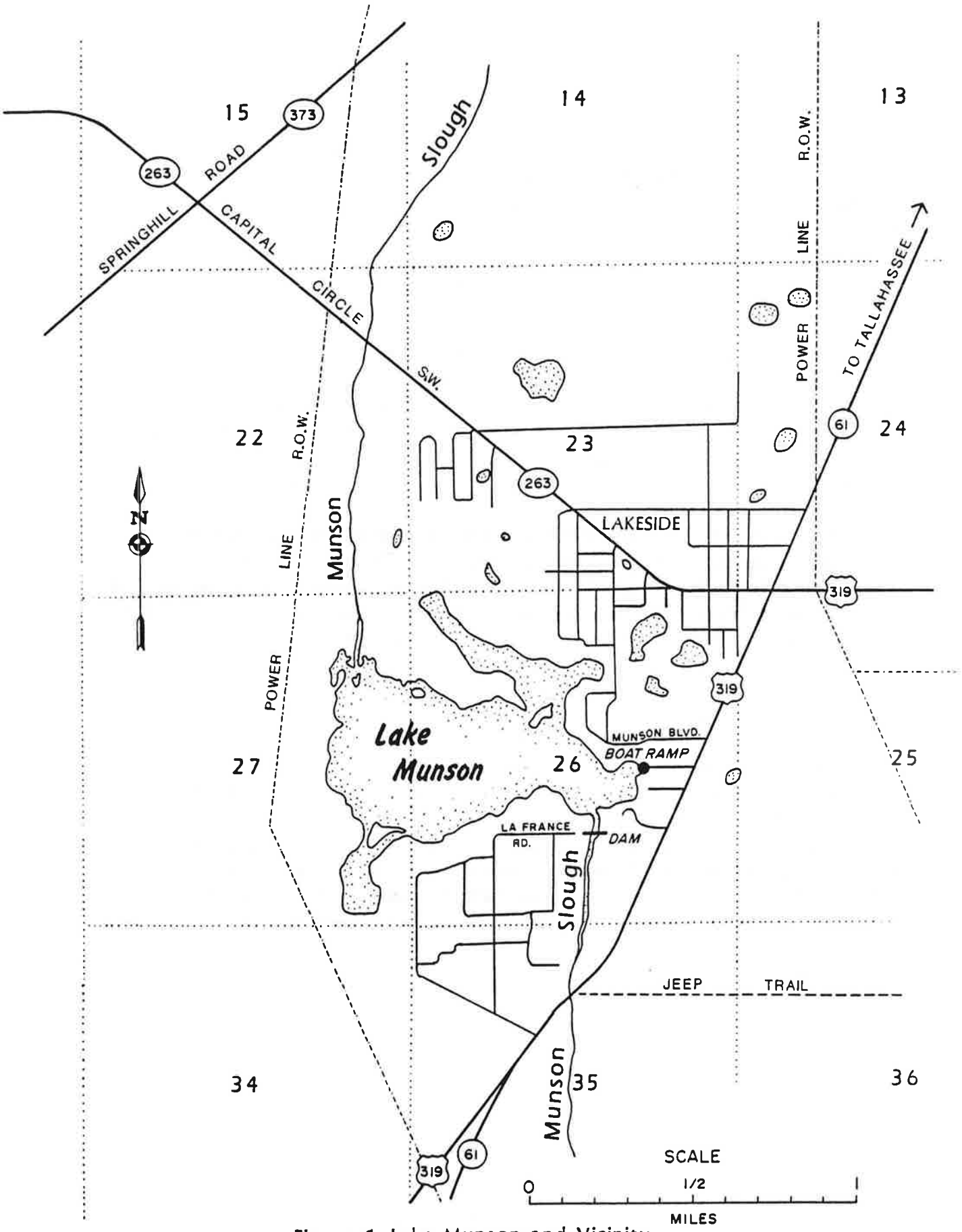

Figure 1. Lake Munson and Vicinity.

Soils of the Lake Munson Sandhills are generally of the Kershaw-Ortega-Alpin groups, which are characteristic of sand ridges. They range from nearly level to gently sloping, drain well, and typically are sandy to a depth of 80 inches or more, occasionally with a thin, loamy lamella below 45 inches. Being highly porous and permeable, these soils have a high absorption capacity, thus reducing surface water runoff. These types of well-drained soils have low erodibility. However, the potential for erosion increases in areas of steep slopes. Removal of vegetative cover on steep slopes further increases the risk of erosion.

The Lake Munson Sandhills Physiographic Region is bordered by five other physiographic regions (**Figure 2**), which includes:

- the Tallahassee Red Hills, to the northeast;
- the Cody Sandhills, to the east;
- the Woodville Karst Plain, to the southeast;
- the Apalachicola Flatwoods, to the west; and
- the Okefenokee Dunes, to the northwest.

Surface and Ground Water Features

Surface water runoff percolates easily into the sands of the Lake Munson Sandhills. Some of the resulting shallow groundwater feeds the regions many small lakes, including the Lake Bradford Chain-of-Lakes, Lake Munson, and Silver Lake. Many of the lakes in this region were formed from Karst (solution) activity, and some have a direct connection to the Floridan Aquifer. The Bradford Brook Chain-of-Lakes is a prime example of this geomorphological phenomenon. Only two stream systems are evident: Bradford Brook-Munson Slough and Fisher Creek. These streams receive most of their water from the adjoining Apalachicola Coastal Lowlands, Tallahassee Red Hills, and Okefenokee Dunes regions.

The Lake Bradford Chain-of-Lakes system is the last of the urban area lakes with good water quality. This is because of the supply of fresh, clean base flow from the system's headwaters in the Apalachicola National Forest and the relative absence of urban stormwater inflow.

Aquatic, Wetland, and Sinkhole Communities

Aquatic and wetland communities in the region are numerous. They include sandhill, swamp, and sinkhole lakes and many small temporary ponds. Also, cypress, gum, and bottomland hardwood swamps often occur at the edges of lakes and streams. Collapsed sinkholes often contain distinctive sinkhole communities where ground water seepage through vertical sidewalls is common. This ground water seepage results in a constantly cool, highly humid environment where ferns such as the southern maidenhair fern are abundant. Areas of exposed water table include aquatic caves, where the Woodville cave crayfish, blind and adapted to a dark aquatic environment, can often be found. Big Dismal Sink, in the Leon Sinks Geological Area, contains a high quality example of this unique sinkhole community.

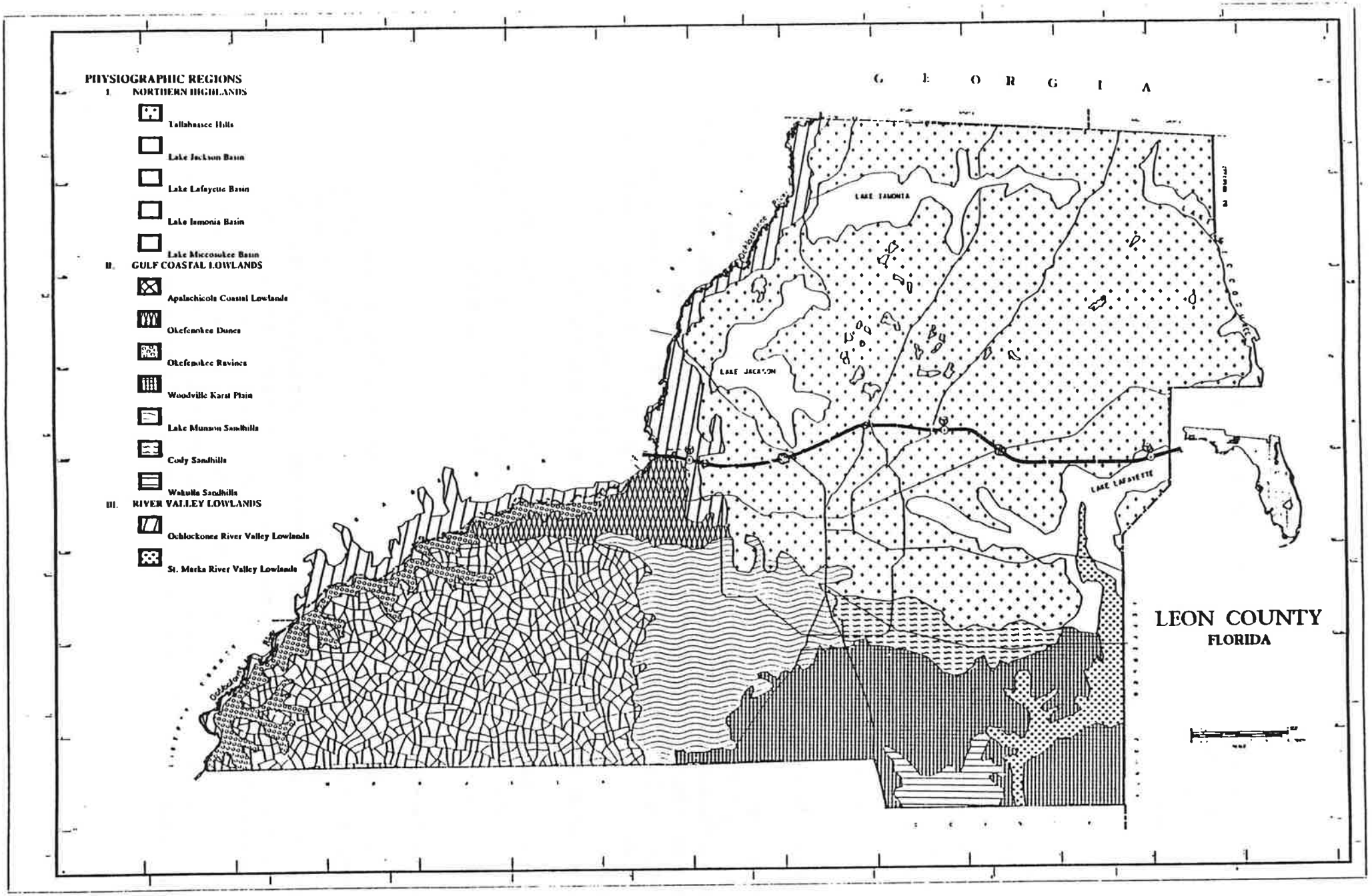

Figure 2. Lake Munson Sandhills Physiographic Region Map.

Typically, lakes are ringed with vegetation types which are tolerant of fluctuating water levels. Common wetland communities in this region of Leon County are dominated by cypress and blackgum trees and may include aquatic grasses such as maidencane, herbs such as lizards-tail and pickerelweed, and shrubs such as buttonbush and titi. Wildlife benefits of the lakes can be seen by the presence of wading birds such as herons, amphibians such as chorus frogs, and mammals including the round-tailed muskrat, which is currently being considered for legal protection by the U.S. Fish and Wildlife Service.

Numerous high quality natural communities exist in the region. Bradford Brook, above Lake Cascade, is a high quality blackwater stream. A mature pond-cypress forest, some of which appears to never have been cut, is located in the western arm of Lake Bradford. This community can be viewed from the boardwalk at the Tallahassee Junior Museum or along the Lake Bradford-Lake Cascade canoe trail via the lakes and connecting watercourses. Lake Amelia Davis, located south of Lonnie Gray Road, is a network of many high quality swamp lakes surrounded by pond-cypress forests. Some of these forests also appear to be pristine.

Longleaf pine-turkey oak forests occupy most of the uplands. The Lake Munson physiographic region appears to contain most of the remaining longleaf pine-sandhill community in Leon and six adjacent counties. However, substantial areas have been converted to pine plantation, including extensive silvicultural areas within the Apalachicola National Forest. High quality longleaf pine-wiregrass communities may be seen southwest of Lake Munson along Forest Road 305.

Rare Species

The region contains several rare species of plants and animals. The longleaf pine-wiregrass community is habitat for the bent golden aster (threatened) and the gopher tortoise (species of special concern). Gopher tortoises dig and spend much time in burrows that provide essential habitat for many other animal species. Also occurring within the Lake Munson Sandhills are eastern indigo snakes (threatened), which use gopher tortoise burrows for winter shelter and nesting, and gopher frogs (species of special concern), which occupy otherwise uninhabited burrows. Five of the six populations of gopher frogs known to exist in Leon County are located in the region. The panhandle meadowbeauty (C2, being considered for Federal protection) and karst pond xyris (endangered) are documented within lake margins of the region. The round-tailed muskrat (C2) is associated with area wetlands, and southern maidenhair fern (threatened) is associated with collapse sinkholes such as those located at the Leon Sinks Geologic Area. Bald Eagles (endangered) and Osprey (threatened) nest on Lake Munson's shore.

Land Use

Land use in the Lake Munson Sandhills is mixed. Scattered, residential areas are characteristic of the area, as are commercial and industrial uses which are heavily concentrated in the southwestern quadrant of Tallahassee's urban fringe. The western portions of the region extend into the timberlands and natural areas of the Apalachicola National Forest.

Land use can adversely affect some of the high quality natural features within the Lake Munson Sandhills Region. A Florida State University research project ranked the environmental features within the region that could be adversely affected by development. According to a consensus of rankings by a panel of local experts, the region's water quality, ground water, waterbodies and wetlands are top concerns for this region. These concerns suggest a development strategy that avoids proximity to sensitive features. In general, the sandhills region should be able to support high land use densities and intensities, provided they are carefully located and all site-generated impacts are properly managed.

Drainage Basin

The Lake Munson drainage basin is located in west-central Leon County. It encompasses approximately one-half of the developed Tallahassee urban area and includes a portion of the Apalachicola National Forest. It has a cumulative land area of approximately 44,360 acres, of which approximately 32,000 acres contributes surface water flow to Lake Munson. Surface water from the remaining area flows to closed basins and the Eight Mile Pond watershed south of the lake.

The Lake Munson drainage basin is bounded by Fred George and Lake Jackson drainage basins to the north; Lafayette, Woodville, and St. Marks drainage basins to the east; the Ochlockonee River drainage basin to the west; and Springhill and Fisher Creek drainage basins to the south (**Figure 3**).

The Munson basin contains many smaller watersheds or subbasins. These subbasins have been identified and mapped as part of the Leon County Environmentally Sensitive Areas study. **Appendix I** lists these subbasins and the environmentally sensitive areas they contain. Nineteen of these subbasins are closed basins and do not contribute surface water to Lake Munson. Water from the remaining subbasins flows into Munson basin's primary drainage ways: the East, Central and West Drainage Ditches, and Bradford Brook. The total length of these channelized drainage ways exceeds 56 miles. Munson Slough is formed by the confluence of these four major watercourses and flows into Lake Munson. Lake surface water discharges through a dam at the southern tip of the lake. From there, surface water flows through a continuation of Munson Slough to Eight Mile Pond and ultimately travels underground at Ames Sink and numerous karst features in the vicinity.

1. Ochlockonee River Basin
2. Lake Jackson Basin
3. Fred George Basin
4. Lake Munson Basin
5. Woodville Recharge Basin
6. St. Marks River Basin
7. Lake Lafayette Basin
8. Wood Basin Sink
9. Copeland Sink Basin
10. Lake Drain Sink Basin
11. Bird Sink Basin
12. Patty Sink Basin
13. Upper Moccasin Gap Basin
14. Lower Moccasin Gap Basin
15. Lake Miccosukee Basin
16. Lake Iamonia-Foshalee Slough

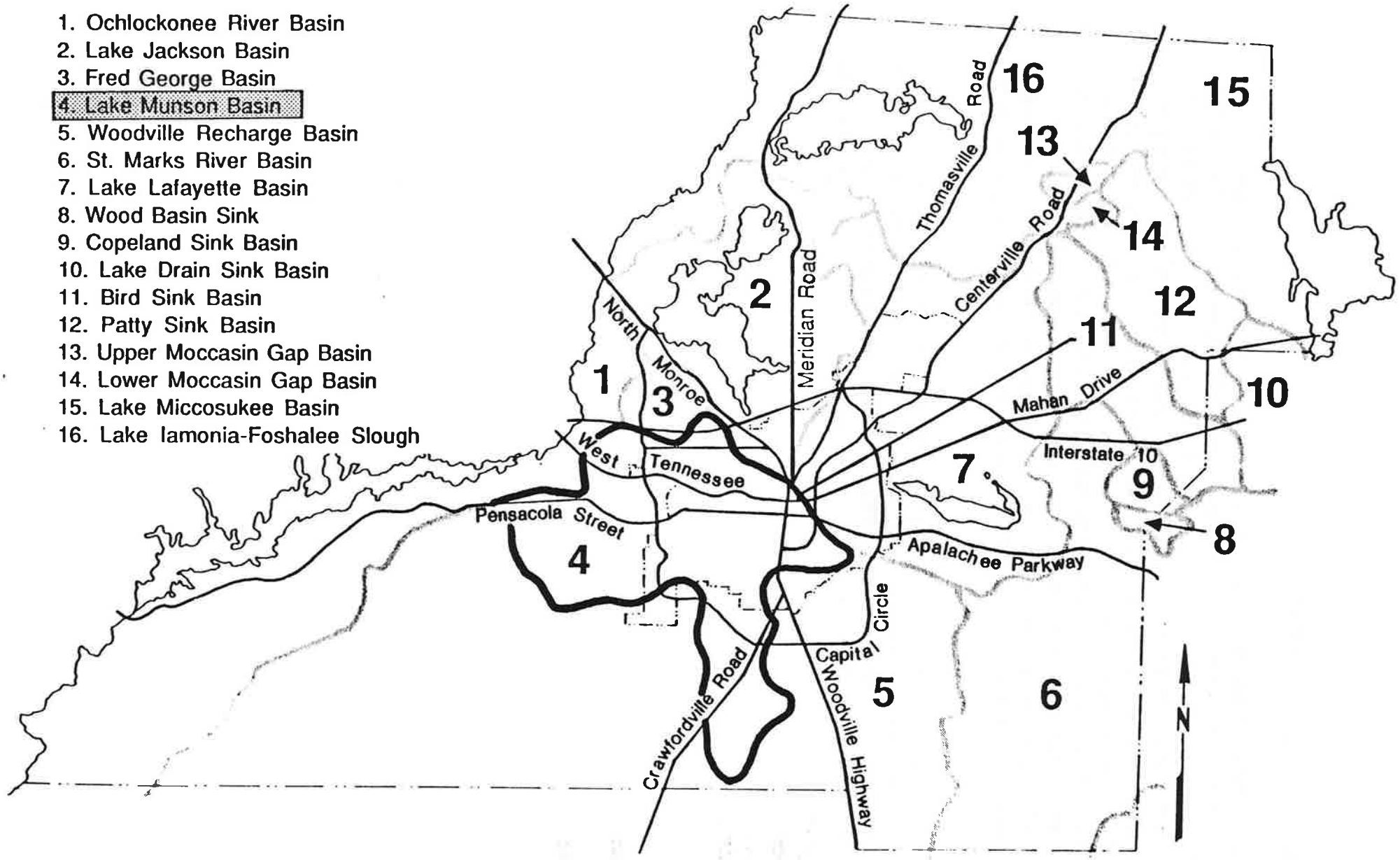

Figure 3. Surface Water Drainage Basins of Leon County, FL.

Flood Prone Areas and Wetlands

Total wetland areas within the Lake Munson drainage basin exceed 3,200 acres. They are concentrated, for the most part, in the western and southern portions of the basin along Bradford Brook in the Lake Bradford watershed. The headwaters of the Lake Bradford watershed arise within the Apalachicola National Forest. These wetlands include Black Swamp which is located between Lake Bradford and Lake Munson. The urbanization of Tallahassee in the northeastern half of the basin has resulted in the elimination of most wetlands and associated forested flood plains from that area. Wetlands still exist, however, in the North and West Gum Creek watersheds. The largest of these is Gum Swamp, an area previously channelized and encroached upon by development. Wetlands are also found adjacent to Lake Munson and Eightmile Pond and in the extreme southern portions of the basin.

Large, flood prone areas are found along the lower reaches of watercourses and drainage ditches within the basin. Flood prone areas also exist around Lake Munson, Eightmile Pond and areas between. Because extensive urbanization has increased the volume and velocity of stormwater runoff, nearly one-quarter of the area in the basin is now considered flood prone. **(Appendix I)**

CHAPTER II: PROBLEMS

SUMMARY OF PROBLEMS

Lake Munson has been adversely impacted by the discharge of both urban stormwater runoff from Tallahassee and effluent from municipal wastewater treatment plants in amounts vastly exceeding its natural assimilative capacity. As a result, the lake has experienced severe water quality and ecological problems including fish kills, algal blooms, floating aquatic vegetation, high nutrient and bacteria levels, low game fish productivity, and depressed oxygen levels. The first reports of massive algal blooms and fish kills date as early as 1954. Although the lake experienced significant improvements in water quality after the elimination of routine wastewater effluent discharges in 1984, it continues to receive large, untreated, stormwater discharges from the City of Tallahassee and urban areas in Leon County.

In 1988, Lake Munson was listed as ninth in priority of all the water bodies in the Northwest Florida Water Management District's Surface Water Improvement and Management Program and the only water body where restoration was listed as the major activity. Except for accidental sewage spills that occasionally discharge into Munson Slough, stormwater runoff now accounts for virtually all of the pollutant and sediment loads entering the lake.

The current status of Lake Munson problems may be summarized as follows:

1. The lake is currently classified as eutrophic, enriched with nutrients and organic matter. The lake's Trophic State Index (TSI), a water quality indicator, has improved from 89 to 66 since effluent discharges were diverted from Munson Slough. However, a lake with a TSI above 60 is still classified as a problem lake by the Florida Department of Environmental Protection.

2. Lake Munson receives all of its inflow from the channelized Munson Slough, which drains a large developed area that includes 57 percent of the area within the city limits of Tallahassee. Virtually all conveyances to Lake Munson are ditched and laden with polluted sediments. Development in the watershed has increased the volume and velocity of stormwater in these ditches.

3. Sediments on the lake bottom are enriched with nutrients which can be recycled back into the water. Nutrient recycling, in particular phosphorous, is apparent when stormwater inflows are minimal, lake temperatures begin to rise, and oxygen becomes depleted on the lake bottom. As long as nutrient-enriched sediments remain on the lake bottom, nutrients will continue to be recycled into the water.

4. An accumulation of organic material on the lake bottom has reduced average lake depth by approximately 2.4 feet. Poor sediment and water quality combined with shallow lake depths have resulted in a decrease in fish biomass of at least 75 percent, severely limiting sport fisheries in the lake.

5. Water hyacinth is an undesirable aquatic plant that grows on the surface of Lake Munson. At times it has choked the lake. Water hyacinth is currently controlled by herbicide applications directed by the Florida Department of Environmental Protection. The growth of submersed aquatic vegetation, however, is limited to some extent by poor water clarity and loose sediments. Still, the aggressive, exotic plant, hydrilla, has recently become established in the lake and could become very abundant if unchecked.

Water Quality

Water quality data for the period 1966 to 1980 indicated a lake in an advanced state of eutrophication. In a 1982 study of Florida lakes, Lake Munson was classified as hypereutrophic and ranked the seventh most degraded lake in the state. At the time, most of the nutrient loading into the lake originated from wastewater effluent. In 1978-1979, when wastewater treatment plants were discharging effluent into the lake at their peak historical rate, they were estimated to contribute at least 66 percent of the biochemical oxygen demand (BOD), 88 percent of the phosphorus, and 91 percent of the nitrogen loads into Lake Munson. Since effluent discharges were eliminated in 1984, the water quality in the lake has improved. As a result, the trophic status of the lake was reclassified from hypereutrophic to an advanced state of eutrophication.

Even though it has measurably improved, water quality continues to be poor. Water quality data collected from November 1986 to October 1987 by the Northwest Florida Water Management District indicated a lake with enriched nutrient levels, algal blooms, elevated pH levels, toxic concentrations of un-ionized ammonia, depressed oxygen levels, and radical diurnal fluctuations in dissolved oxygen. Several parameters were found to fail Class III water quality standards of the Florida Department of Environmental Protection. These included nutrients, dissolved oxygen, alkalinity, pH, un-ionized ammonia, total coliform, and fecal coliform.

An important indicator of a lake's water quality is the extent to which it supports algae growth. In 1988, the Florida Department of Environmental Protection conducted monthly tests on Lake Munson to measure algal growth rates and to determine the nutrients that limit algae growth. Algal Growth Potential (AGP) experiments indicated that the average yearly maximum standing crop of algae was 7.84 mg/l (dry wt). This is substantially lower than the extremely high AGP of 62.61 mg/l(dry wt) found in Lake Munson in 1977 when the lake received wastewater effluent discharge. Unfortunately, research indicates that southeastern lakes with maximum standing crops of algae that exceed 5 mg/l (dry wt) may be subject to nuisance algae blooms and fish kills (Rasche and Schultz, 1987).

To bring Lake Munson's AGP to an acceptable level, nutrient levels in the lake must be reduced. Algal growth depends on two key nutrients: nitrogen and phosphorus. Normally, the extent of algae growth will be limited by phosphorus because it is relatively scarce in the natural, fresh water environment. However, the 1988 AGP tests indicated that, because of the large amount of phosphorus present, algal growth in Lake Munson is limited instead by nitrogen, a relatively abundant nutrient. Because even atmospheric nitrogen is available to bluegreen algae, the key to halting algae blooms is to make phosphorus limiting again by greatly reducing its concentration in the water column.

The primary cause of the high AGP found in Lake Munson is likely to be urban stormwater runoff. **Table 1** shows the AGP values found in Lake Munson and other lakes in Leon County. Local waterbodies that receive large amounts of urban stormwater runoff include Lake Munson, Megginnis and Ford Arms of Lake Jackson, and Lake Talquin, which also receives large quantities of nutrients from agricultural areas. All show somewhat elevated AGP values. In contrast, Lake Bradford, which receives runoff from a relatively undisturbed portion of the Apalachicola National Forest, has a very low AGP. Lake Bradford has one of the lowest AGP values found in Florida lakes. Its condition probably represents that of Lake Munson before it received high amounts of urban stormwater runoff and wastewater effluent discharges.

Table 1

Ranking of Selected Florida Lakes From Highest to Lowest Algal Growth Potential

Waterbody	Mean AGP mg/1 (dry wt.)
Lake Munson (1977)	62.61
Lake Munson (1987)	7.84
Lake Talquin (Coe's Landing)	8.81
Lake Talquin (Blount Landing)	7.25
Lake Jackson (Ford's Arm)	2.27
Lake Jackson (Megginnis Arm)	1.77
Lake Jackson (Leon County)	0.41
Lake Bradford	0.33

Source: FDEP April, 1988

Stormwater Inflow

Much of the water coming into Lake Munson is stormwater coming from a heavily urbanized area. Stormwater discharges into Lake Munson originate from an area of 33,929 acres, which includes approximately 57% of the City of Tallahassee. Stormwater monitoring and rainfall data collected since 1990 document some of the recent inflows into the lake and the contributions from various portions of the watershed. The largest peak flow recorded upstream of the lake inflow, the result of a large storm in March, 1991, measured 1300 cubic feet per second (cfs).

The quality of stormwater coming into Lake Munson is poor. Monitoring data collected by the Northwest Florida Management District on six storms indicate average pollution loads to be 35,762 pounds per day (lbs/day) of suspended solids, 1,558 lbs/day of biochemical oxygen demand (BOD), 274 lbs/day of nitrogen, 156 lbs/day phosphorus, 7.8 lbs/day of lead, 2 lbs/day of copper, and 0.8 lbs/day of chromium. Of these incoming loads, the lake is estimated to retain 95 percent of the suspended solids, 20 percent of the BOD, 31 percent of the nitrogen, 64 percent of the phosphorus, 91 percent of the lead, 72 percent of the copper, and 78 percent of the chromium. Effluent from the lake discharges downstream into Eight Mile Pond and eventually into Ames Sink and the Florida Aquifer.

Livingston (1993) found that Lake Munson showed water quality characteristics indicative of reduced habitat value due to stormwater runoff. All data were consistent with nutrient loading during the winter and summer periods of high rainfall and extreme nutrient enrichment (hypereutrophication) during the spring and summer periods of high temperature. **Figure 4** is a "hot spot" map for Lake Munson, geographically depicting the areas of the lake with the greatest problems (Livingston and Swanson, 1993).

Bottom Sediments

Nutrients and other pollutants coming into Lake Munson accumulate in the bottom sediments and may adversely impact aquatic life. Several studies have been conducted of the bottom sediments in Lake Munson. They show that sediments in the main body of the lake contain higher metal concentrations than sediments in some of the more isolated areas which are not as heavily impacted by stormwater. Lake Munson's sediments contain pesticides and metal concentrations in quantities 10 to 100 times greater than amounts found in other local lakes, including Lake Miccosukee, Lake Iamonia, and Lake Jackson. Livingston (1993) has reported high concentrations of lead in sediments at the major stormwater inflow points. A biological assessment of Lake Munson's sediments documented a macroinvertebrate community typical of systems enriched with nutrients and organic matter.

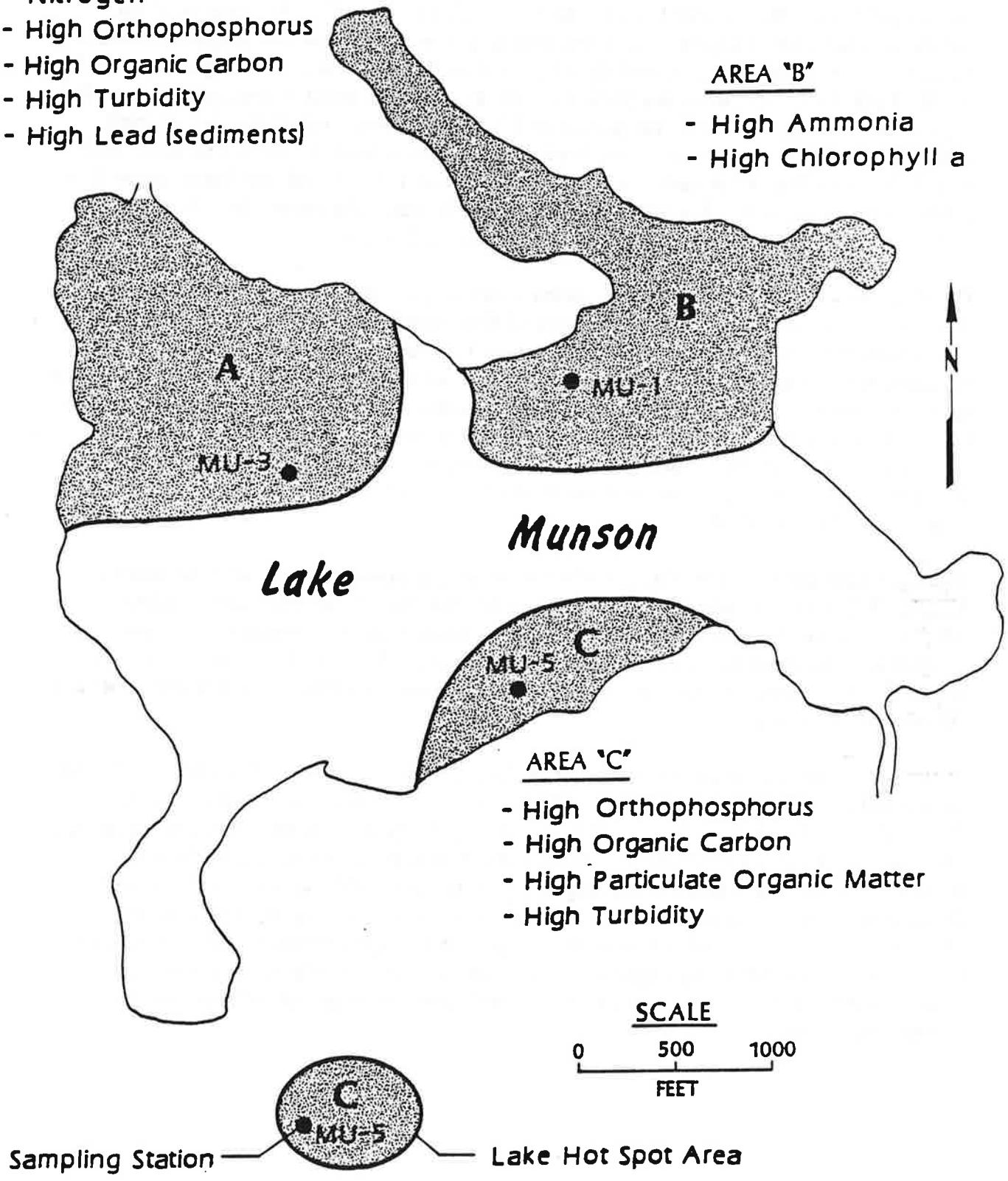

Figure 4. Lake Munson "Hot Spots" Based on Extent and Nature of Adverse Environmental Indicators.

To determine how much of the sediments have resulted from stormwater discharges, sample cores were taken from the lake bottom. Samples indicate that sediments comprise three distinct soil horizons or layers. The uppermost layer contains a brownish to grayish gel-like muck of silts and clays. Approximately 31 percent of this layer consists of organic materials, while 68 percent is fine, inorganic particles. The second layer contains mostly peat and other organic debris. Approximately 80 percent of this layer is comprised of organic materials, while 12 percent is fine particles. The lowest layer contains unconsolidated fine sands with very little silts, clays, or organic materials. The depth of the first sediment layer ranges from 5.5 to 13.5 inches, with a five station average of 9.3 inches. The second layer is much thicker, ranging from 1 inch to 4.25 feet, and averaging 2.4 feet.

Clearly, the two upper horizons were created under very different deposition environments. The top horizon, with a much higher content of fine particles relative to organic materials, seems to be the product of lake inflows laden with high suspended solids. Stormwater has been documented to have total suspended solids concentrations several times greater than those found in wastewater effluent. Therefore, the sediments in the uppermost layer have probably been deposited since 1940, when stormwater sediment loads began impacting the lake in a significant way. The thicker peat deposits underlying the surface layer must have been deposited prior to any significant stormwater discharges, most likely before the current outfall structure was built in 1950.

Since sediment removal is needed for lake restoration, sediment samples were collected in March, 1992, to obtain information on the potential toxicity of chemicals in the sediments. All three layers of the lake bottom were sampled. Using U.S. EPA methods, sediment samples were analyzed for toxicity of metals, pesticides, and herbicides. The sediments were also analyzed for total nitrogen, total phosphorus, petroleum hydrocarbons, volatile solids and organic solids content.

In all of the samples, the potential toxicity of the sediments that may be dredged from the lake were well below the EPA limits for classifying the sediments as a "toxic waste". Some elevated levels of petroleum hydrocarbons (2400 mg/kg dry weight) were noted in one sample taken near the boat ramp, which is probably a result of gasoline residues from boats or stormwater runoff from Munson Landing Road. Another possible source is asphalt residue from the road, which appeared to have been paved just prior to the tests. For sediment disposal purposes, the sediments with elevated petroleum hydrocarbons would be a very small fraction of the total amount dredged and do not appear to be a problem. However, the ecological effects of these sediments may well be detrimental to aquatic life and lake bottom dwellers in this area.

Sediment Accumulation

The sediments resulting from stormwater inflow into Lake Munson have decreased the depth of the lake. The first bathymetric map of Lake Munson was developed by the Water Management District in 1976. The map shows a large area in the central part of the lake with depths of about five feet. The lakewide average depth was calculated at 3.43 feet. A more recent contour map was developed by the Florida Game and Fresh Water Fish Commission in 1987. The 1987 map shows much shallower depths, as well as a larger delta at the mouth of the lake. The Florida Game and Fresh Water Fish Commission estimated the average lake depth at 3 feet. In the eleven years between 1976 and 1987, the difference in average depths shown in bathymetric surveys is 0.43 feet or 5.2 inches. This amounts to a sediment accumulation rate of 0.47 inches per year.

Fisheries and Wildlife

Poor water quality and shallow water depths in Lake Munson have adversely affected its fisheries. The Game and Fresh Water Fish Commission surveyed the fish populations present in Lake Munson in September 1986 (Young and Crew, 1987). Fish samples taken along the shoreline and in open water yielded only 80 to 90 pounds of fish per acre. The total weight of samples was extremely low considering the high fertility of the lake. The survey also showed a decline in the fish population over the previous ten years. Similar fish population studies in 1976 and 1979 yielded 351 and 286 pounds per acre respectively (Young and Crew, 1980). The 1986 study shows a 74 percent reduction in fish biomass since 1976, and a 69 percent reduction since 1979, and attributes the reductions to increased siltation and commensurate decreases in water depth over the past eight to ten years.

Species diversity was quite low, with only six species being collected in the 1986 samples. Species were largemouth bass, bluegill, black crappie, redear sunfish, golden shiner, and bowfin. Largemouth bass and bluegill were most numerous, and golden shiners and bowfin were least numerous. Low species diversity is typical of lakes with very limited habitats. The study indicated good to adequate reproductive rates for largemouth bass and black crappie, but limited reproduction of bluegill and redear sunfish. The only forage species collected was the golden shiner. The inadequate diversity of forage fish is adversely effecting the survival and growth of young largemouth bass. While numerous, harvestable-sized bass were collected, nearly all of these were taken in the small cove at the southwest corner of the lake. Few fish over ten inches in length were taken from the main body of the lake.

In 1984, the then Department of Environmental Regulation coordinated a statewide mercury survey. Largemouth bass were collected from 16 sites throughout Florida. Mercury concentrations ranged from 0.03 to 0.94 parts per million (ppm), with a mean concentration of 0.46 ppm. Mercury concentrations in fish from Lake Munson were within documented statewide limits. Smaller bass (200-300 mm total length, 300-500 g weight) had concentrations of about 0.06 ppm wet weight. Larger bass (400-450 mm TL, 1000-1600 g) averaged approximately 0.32 ppm. There is no health advisory on the consumption of bass below 0.50 ppm.

Vascular Plants

Almost the entire perimeter of Lake Munson consists of a dense ring of pond cypress festooned with spanish moss. Shading of the shoreline results in a somewhat limited emersed plant community. The exception is the sunny delta at the northwest corner of the lake where willow, cattail, smartweed, and other emersed species grow in profusion. This concentration of plants pales in comparison to the explosion of terrestrial annuals, up to ten feet in height, that covered 35% of the lake bottom during a drawdown in 1977. After reflooding, and the decomposition of those terrestrial species, the algae concentration in the water prevented the growth of submersed vegetation. A map prepared in 1986 by the Florida Department of Environmental Regulation shows the central, open water area of Lake Munson was essentially devoid of vegetation at that time. Since 1990, however, southern naiad has become increasingly abundant (**Table 2**). This native plant is consumed by waterfowl and is considered beneficial.

Exotic, aquatic plants may be a confounding factor in the restoration and management of Lake Munson. The prolific, floating, water hyacinth is currently the most problematic exotic plant in the lake. The DEP routinely suppresses the water hyacinth population by directing small, frequent applications of the herbicide 2,4-D. Hydrilla, however, is the exotic species that looms as the greatest challenge to plant managers. Though sparse when it was discovered in many parts of Lake Munson in 1993, hydrilla will be difficult to control. It could easily dominate the native southern naiad within the next several years and form dense, monotypic mats throughout the lake unless action is taken. One preventative measure being investigated is the use of triploid grass carp, a sterile, plant-eating fish.

Table 2
AQUATIC PLANT SURVEY SEPTEMBER 1990
Florida Department of Environmental Regulation

COMMON NAME	SPECIES	ACREAGE
alligator weed	Alternanthera philoxeroides	1.5
mosquito fern	Azolla caroliniana	3.0
swamp marigold	Bidens spp	0.5
coontail, hornwort	Ceratophyllum demersum	10.0
water hemlock	Cicuta mexicana	0.1
sedge	Cyperus spp	0.2
water millet	Echinochloa spp	0.1
Brazilian elodea	Egeria densa	0.1
waterhyacinth	Eichhornia crassipes	0.3
algae	Filamentous algae	1.5
water pennywort	Hydrocotyle spp	0.3
climbing hempvine	Mikania scandens	0.1
southern naiad	Najas guadalupensis	20.0
American lotus, lotus lily	Nelumbo lutea	12.0
maidencane	Panicum hemitomon	1.5
smartweeds	Polygonum spp	1.0
pickerelweed	Pontederia cordata	0.1
arrowhead	Sagittaria latifolia	0.1
water fern	Salvinia minima	10.0
lizard's tail	Saururus cernuus	0.5
duckweed	Spirodela spp	1.5
cattails	Typha spp	1.0
willows	Salix spp	8.0
TOTAL ALL SPECIES		73.4

Source: Florida Department of Environmental Regulation, Bureau of Aquatic Plant Management, unpublished data, 1990.

CHAPTER III: METHODOLOGY

PROCESS

Aside from a sincere concern about the future of Lake Munson, the diverse group of citizens, government officials, and technical experts that constitute the Lake Munson Action Team, also share a common desire to effectively use time. A process, or methodology, for satisfying the goals of the Action Team was the first item of discussion after the group was formed. Team members with experience in developing lake management plans introduced a previously successful process originally outlined in the EPA's Lake and Reservoir Guidance Manual, (Moore & Thornton, 1988). The method was modified to suit the particular needs of the Action Team and unanimously approved for use. The method outline includes the following:

1. Form representative group;
2. List problems;
3. Refine the problem statement;
4. Collect all pertinent information;
5. Describe lake and watershed;
6. List possible solutions;
7. Create "Lake Management Evaluation Matrix";
8. Refine list of solutions;
9. Write draft of management plan;
10. Seek broad review of draft;
11. Conduct a public hearing;
12. Write a final management plan;
13. Present management plan to Board of County Commissioners;
14. Acquire funding;
15. Implement management plan; and
16. Monitor and document results.

PROBLEM STATEMENT

Lake Munson certainly has no shortage of problems. By carefully defining problems before discussing solutions, the Action Team saved valuable time and was able to focus on the more serious problems. After listing, evaluating and discussing all identified problems, a concise problem statement was drafted:

Nutrient pollution and sedimentation from municipal wastewater effluent and stormwater input, extensive channelization of drainage systems and encroachments into wetlands and waterbodies throughout the drainage system, prolonged impoundment, and poor maintenance and water management practices have severely degraded the water quality, fisheries, and esthetics of Lake Munson.

COLLECT ALL PERTINENT INFORMATION

The next task involved the collection of all available information about Lake Munson into a written description of the lake and its watershed. Fortunately, Ron Bartel, an Action Team member and hydrologist with the Northwest Florida Water Management District, was already drafting a diagnostic feasibility report on Lake Munson for the Environmental Protection Agency's Clean Lakes Program. Much of the information on Munson's history, hydrology, basin, water quality, aquatic plants, fisheries and wildlife was gleaned from his report.

LIST POSSIBLE SOLUTIONS

The Action Team conducted brainstorming sessions to list as many solutions to Lake Munson's problems as possible. The most important principle in the sessions was to encourage all ideas, no matter how spontaneous or unrefined, in order to enhance creativity and broaden the scope of options. After two brainstorming sessions, the Team listed over fifty ideas for solving problems and grouped them into three major categories:

1. Community Action;
2. Watershed Management;
3. In-Lake Restoration.

LAKE MANAGEMENT EVALUATION MATRIX

A Lake Management Evaluation Matrix was developed to allow Team members to rate each solution according to seven different parameters:

1. Effectiveness: The degree to which a specific management practice is likely to meet its goal based on past experience.

2. Longevity: The probable duration of the beneficial results of a management action.

3. Confidence: The predictability of a positive response to a management action based on past experience.

4. Applicability: The degree to which a management practice directly affects the cause of a significant problem.

5. Potential Negative Impacts: The likelihood that a particular management action will adversely affect the lake, its basin, or its users.

6. Capital Costs: The initial expense of a specific management technique.

7. Operation And Maintenance Costs: The probable, long term expense of a management action per unit of time.

Prior to completing the matrix, the Action Team discussed each proposed solution and clarified the definitions of the parameters used to rate them. Each Team member completed the matrix and the resulting data was compiled in order to rank each solution according to an average score and standard deviation (**Table 3**). By considering the standard deviation of the scores for each option, the Team was able to ascertain the degree of disagreement on each one. To help form consensus and make certain that disagreements were not based on a lack of information, the possible solutions with the highest standard deviations were further discussed. In some instances, after clarification, scores for ranking specific solutions were changed and overall rankings were adjusted accordingly.

A final evaluation matrix, with the fifty-two possible solutions ranked according to total score, was completed. Approximately one-third of the options were rejected because of low scores. The remaining thirty-five options were consolidated into the three broad management strategies, Community Action, Watershed Management, and In-Lake Restoration, which comprise the Lake Munson Action Plan.

Table 3
FINAL RANKING OF POSSIBLE SOLUTIONS

RANK	POSSIBLE SOLUTION	AVERAGE	STD. DEV.
1.	Determine ownership of dam and responsibility for its operation and maintenance	25.50	3.24
2.	Increase funding for Stormwater Utility	24.89	2.18
3.	Place trash racks in proposed wet detention facilities	24.6	2.05
4.	Generate support for the implementation of the City/County Stormwater Management Plan	24.56	2.11
5.	Stop development in wetlands	24.50	3.54
6.	Repair dam structure	24.22	1.93
7.	Improve stormwater conveyance systems only after wet detention ponds are built	24.00	3.74
8.	Remove trash from lake bottom during drawdown	23.56	3.62
9.	Implement the NWFWMD's Stormwater Management Plan	23.22	1.03
10.	Create "greenways" next to floodplains	23.13	3.02
11.	Purchase important areas such as Black Swamp, etc.	23.00	2.11
12.	Restock lake with sports fish after restoration efforts	22.89	2.47
13.	Establish joint County/Federal park	22.83	2.34
14.	Assess fines for sewage spills	22.78	3.33
15.	Conduct winter drawdowns	22.78	3.54

RANK	POSSIBLE SOLUTION	AVERAGE	STD. DEV.
16.	Promote increased enforcement of County ordinances protecting wetlands	22.67	2.75
17.	Increase inspection/maintenance of stormwater facilities	22.67	4.08
18.	Endorse a bottle bill	22.56	3.56
19.	Re-examine the Local Comprehensive Plan for inclusion of carrying capacity of watershed for stormwater	22.38	4.47
20.	Educate the public on best management practices	22.22	3.49
21.	Discourage impervious surfaces	22.22	3.64
22.	Acquire lakefront land for access areas	22.14	2.75
23.	Continue aquatic plant control programs	21.78	2.70
24.	Educate the public on septic system maintenance	21.56	3.98
25.	Remove sediments from lake	21.44	2.01
26.	Initiate and coordinate "Adopt a Lake" litter campaigns	21.44	3.40
27.	Use alum once after sediment removal	21.25	3.15
28.	Draw down the lake for a period of one year	21.00	3.50
29.	Public education/awareness campaign	20.89	3.35
30.	Inspect all septic systems within 1000 ft. of lake	20.89	3.96
31.	Promote septic system pump-out	20.78	3.97
32.	Purchase certain residential areas which are subject to flooding	20.56	3.27
33.	Provide loans for septic system repair and maintenance	20.56	3.92

RANK	POSSIBLE SOLUTION	AVERAGE	STD. DEV.
34.	Work with nurseries, etc., to reduce fertilization	20.33	3.92
35.	Endorse a Countywide white goods pick-up	20.11	3.75
	NOT RECOMMENDED		
36.	Lower overflow at dam	19.89	3.70
37.	Mitigate sewage spills	19.88	2.98
38.	Improve water conservation measures	19.78	3.70
39.	Require sewer hook-up for new construction	19.44	3.74
40.	Use aeration in deep areas	19.43	3.70
41.	Require separate septic systems for gray water	19.25	3.93
42.	De-channelize Munson Slough	19.13	4.37
43.	Require sewer hook-up of all businesses and residences in watershed	19.00	4.08
44.	Promote composting toilets	18.78	3.97
45.	Restore certain wetlands	18.44	2.11
46.	Increase street sweeping	18.11	5.00
47.	Burn lake bottom	17.33	2.54
48.	Draw down the lake prior to flooding	17.11	3.21
49.	Decentralize sewage treatment	16.78	4.89
50.	Eliminate ditches	14.50	5.43
51.	Use alum injection system	14.13	5.49
52.	Divert water around Lake Munson	12.44	5.89

CHAPTER IV: LAKE MUNSON ACTION PLAN

ACTION PLAN

The Lake Munson Action Plan incorporates three major strategies to restore and protect Lake Munson: *watershed management, in-lake restoration, and community action.* The recommended sources of funding for the Plan's projects are the City and County stormwater utility programs. The Lake Munson Action Team recommends that serious consideration be given to increasing utility fees to cover anticipated costs.

WATERSHED MANAGEMENT

Implementation of the Lake Munson Stormwater Management Plan (Bartel et al, 1991) is absolutely crucial. This joint City of Tallahassee/Leon County plan, prepared by Northwest Florida Water Management District, calls for the construction of well-designed, strategically located, wet detention facilities (**Figure 5**). This type of stormwater treatment facility is the best available means of capturing a significant portion of nutrients and suspended solids, as well as metals, pesticides, and other toxic substances.

The Stormwater Management Plan also calls for the restoration and protection of important lakes and wetlands throughout the basin including Gum Swamp, Lake Bradford and Bradford Brook, Old Lake Henrietta, Grassy Lake, and Black Swamp (**Table 4**). Combined, the wetlands and treatment facilities will have an area almost twice the size of Lake Munson and are predicted to reduce the loading of sediment and phosphorus by 90% and 69%, respectively. Other significant benefits of implementing the plan are an annual reduction of over $1,000,000 in flood damage, and reduced street flooding, erosion, and channel maintenance.

For these reasons, the Lake Munson Action Team strongly recommends full implementation of the Stormwater Management Plan. Without it, all other restoration efforts will ultimately be futile. Construction of the proposed wet detention facilities will provide the highest cost effectiveness for structural improvements on a regional basis because they immediately reduce high peak flows and improve water quality. Facilities farthest upstream should be given higher priority since the design and performance of downstream alternatives would be adversely affected by a lack of upstream control. All wet detention facilities should be completed before stormwater conveyance systems are improved. Otherwise, the improved conveyance systems would only aggravate existing downstream flooding and increase erosion of sediments that degrade water quality. And finally, regular inspections and maintenance of the facilities will be required to assure proper functioning.

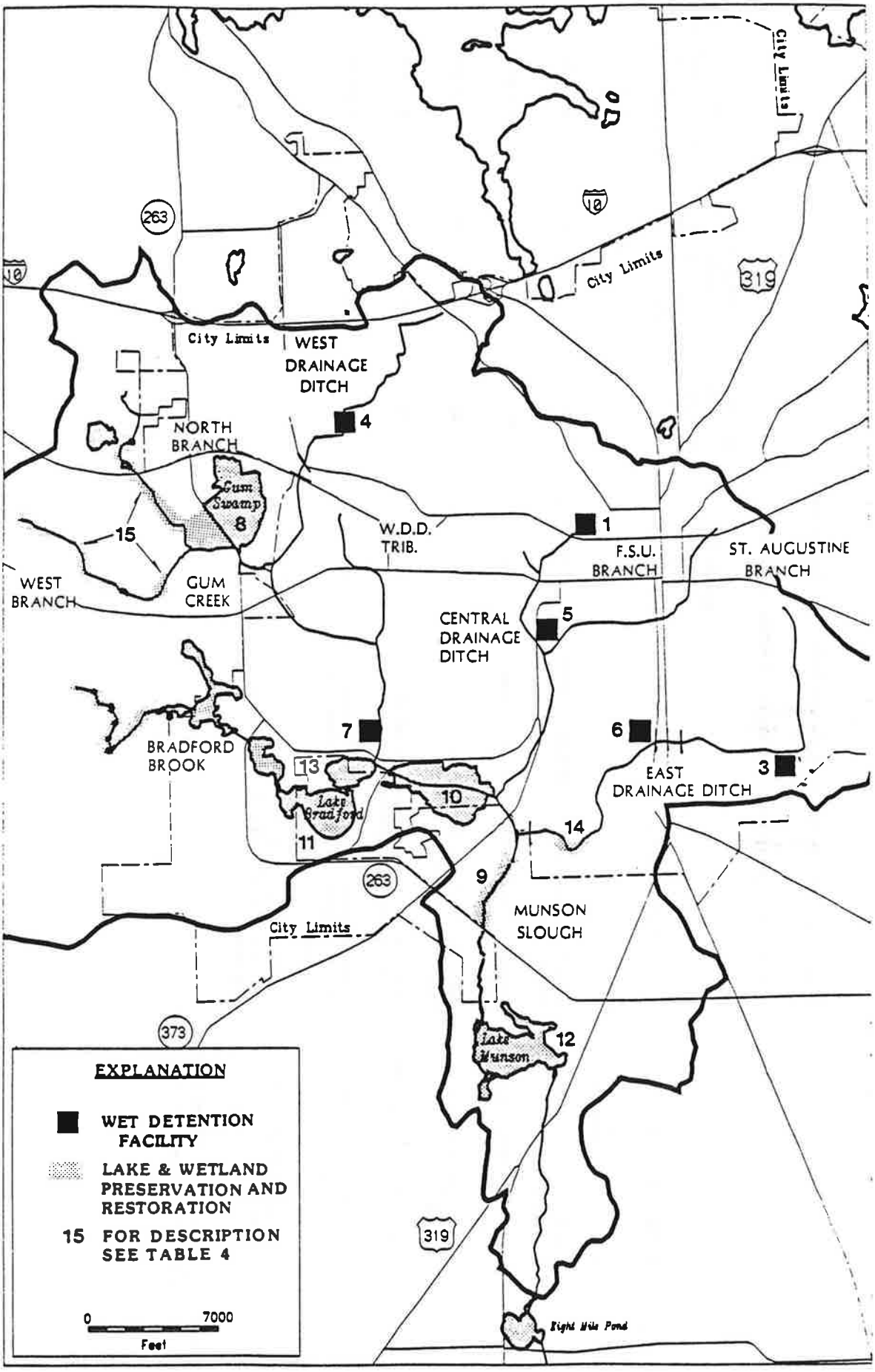

Figure 5. Lake Munson Basin Recommended Structural and Non-Structural Alternatives.

TABLE 4

LAKE MUNSON BASIN RECOMMENDED ALTERNATIVE PRIORITIES

STRUCTURAL ALTERNATIVES - WET DETENTION FACILITIES

MAP NUMBER[1]	FACILITY DESCRIPTION	ACTIVITIES TO IMPLEMENT	ESTIMATED CAPITAL COST ($/MILLIONS)	ANNUAL TREATED EFFLUENT COSTS ($/CU FT)	TREATMENT FACILITY EFFICIENCY TSS (%)	TP (%)	EXPECTED ANNUAL FLOOD DAMAGE REDUCTIONS $/YR
1	Frenchtown Pond at Headwaters of FSU Branch	Construction is complete		0.005	81	57	$ 10,190
2	East Branch Facility on East Drainage Ditch[2]	Acquire Land, Design and Construct Facility, Monitor Flows and Water Quality	1.300	0.005	85	79	$138,000
3	Jim Lee Road Pond on East Drainage Ditch	Design and Expand Current Facility, Monitor Flows and Water Quality	0.323	0.001	78	42	$ 51,577
4	Vega Drive Pond on West Drainage Ditch	Acquire Land for Facility, Design and Construct Facility. Monitor Flows and Water Quality	2.893	0.006	96	80	$290,890
5	FSU Pond on Central Drainage	Acquire Land for Facility, Design and Construct Facility. Monitor Flows and Water Quality	4.792	0.003	90	37	$181,430
6	Orange Avenue Pond on East Drainage Ditch	Negotiate Purchase of Land with State of Florida, Design and Construct Facility. Monitor Flows and Water Quality	5.054	0.001	88	58	$181,240
7	Eisenhower Avenue on West Drainage Ditch	Negotiate Purchase of Land with State of Florida, Design and Construct Facility. Monitor Flows and Water Quality	2.587	0.002	95	62	$ 50,000

1 See Figure 5 for approximate facility location

2 Facility location not determined at this time

TABLE 4
(continued)

LAKE MUNSON RECOMMENDED ALTERNATIVE PRIORITIES

NON-STRUCTURAL ALTERNATIVES - LAKE AND WETLAND RESTORATION AND PRESERVATION

MAP NUMBER[1]	ALTERNATIVE DESCRIPTION	ACTIVITIES TO IMPLEMENT
8	Gum Swamp on West Branch Gum Creek	Acquire Necessary Land, Restrict Further Encroachment Detailed Design, Construction, Restore Wetland
9	Lake Henrietta Restoration on Munson Slough	Restrict Further Encroachment, Detailed Study for Restoration, Acquire Land, Design and Construct Structure for Restoration
10	Black Swamp on Munson Slough	Restrict Further Encroachment, Preserve in Present Condition, Acquire Property, Divert Additional Flows Through Wetland
11	Lake Bradford and Bradford Brook	Restrict Development in Sensitive Areas, Impose Strict Development Requirements
12	Lake Munson	Detailed Design Plans for Lake Restoration, Follow Lake Plans, Maintain Dam, Water Quality Monitoring
13	Grassy Lake and Confluence Between Bradford Brook and West Drainage Ditch	Preserve Lake, Restrict Additional Development
14	North Ridge Road Wetland and Silver Lake on East Drainage Ditch	Restrict Encroachment, Acquire Land as Necessary, Detailed Restoration Study and Implementation
15	Gum Creek Wetlands	Restrict Development in Sensitive Areas, Preserve Wetlands, Acquire Land
	All Other Wetland Areas	Restrict Development in Sensitive Areas, Preserve Wetlands, Acquire Land

1 See Figure 5 for approximate location

Some important steps have already been taken by the City of Tallahassee and Leon County to implement the Stormwater Management Plan. These include the completion of the Frenchtown Pond north of Florida State University; land acquisition and engineering design for Gum Swamp restoration; and detailed engineering design and land acquisition for large stormwater storage and treatment facilities at Vega Drive on the Northwest Drainage Ditch, the Central Drainage Ditch downstream of Florida State University, the East Drainage Ditch on Jim Lee Road, and the St. Augustine Branch near Cascade Park. The City of Tallahassee proposed capital budget includes $8.4 million to be spent from 1994 to 1998 on stormwater projects in the Munson Basin (**Appendix II**). Leon County's proposed capital improvements budget includes $1,211,000 for Gum Swamp restoration and dam repairs (**Appendix V**).

As stormwater volume and rates increase, so too does the amount of debris being carried downstream. Tons of trash litter drainage ditches and Munson Slough. Another associated problem in the basin is the illegal dumping of appliances. Solutions to these problems include trash racks at wet detention facilities, as they catch much of the incoming debris and can be designed for easy maintenance and trash removal, a stormwater facility maintenance and trash removal program, a county-wide white goods pickup program, and a local government partnership with community action efforts to establish "Adopt a Shoreline" citizen's groups. The Action Team also endorses state-wide returnable bottle legislation and urges the County Commission to include it on their agenda with the local legislative delegation. Actions such as these would make a significant difference in the overall vitality and appearance of the Munson Basin drainage ways and Lake Munson.

Some stormwater treatment facilities recommended in the plan have been delayed by neighborhood protests. The Action Team recommends that City and County staff work closely with neighborhoods to better understand and address local issues in the siting of stormwater treatment facilities. In addition, to ensure that anticipated water quality benefits are realized, a systematic, on-going, water quality monitoring program should be developed and implemented in conjunction with research efforts already underway. Such a basin-wide program will allow critical adjustments to be made in a timely and effective manner.

IN-LAKE RESTORATION

Without in-lake restoration, water quality will remain poor, even if the quality of stormwater reaching Lake Munson is greatly improved. This is because lake bottom sediments are a significant reservoir of nutrients and other pollutants. In Lake Munson, the first foot of sediments is estimated to contain 900 tons of phosphorus! Internal phosphorus loading is adequate to maintain a eutrophic system regardless of the quality of incoming water. Therefore, the primary focus of in-lake restoration must be the removal of the upper muck layer of sediments. Selective removal of the upper two foot layer of sediments, or about 700,000 cubic yards of material, would expose approximately 100 acres of clean sandy substrate, about 115 acres of natural peat substrate, and would increase lake volume by 40%.

One of the most cost-effective, reliable, and environmentally acceptable methods of selectively removing organic sediments is hydraulic dredging. The two most common types of hydraulic dredges are cutterhead dredges and mudcats. The cutterhead dredge can typically move the largest volume of material, however, maneuverability and turbidity can be problems. Turbidity problems can be minimized by careful operation and cutterhead modification. Cutterheads also produce a slurry containing up to 80 percent water. This requires a disposal area with an adequate volume, preferably of cellular design, to permit settling of suspended materials and dewatering. In some cases, effluent is treated with alum to enhance settling.

Mudcats are specialized dredges designed to reduce turbidity problems and to pump a slurry with a high solids content. Although lower turbidity and higher solids content (30 to 40 percent) is preferred, the choice of equipment will likely depend on its capability to reduce disposal costs. Although costs can vary, both types of equipment can be cost effective. The cost of hydraulic dredging are estimated to range from $1.00 to $2.00 per cubic yard.

Though certainly the most important in-lake action, hydraulic dredging is not the only restoration method available. Extreme water level fluctuation, or "drawdown", is another, complimentary action. Exposing organic, bottom sediments to air and sunlight will oxidize and compact these materials. Laboratory tests indicate that, under optimal drying conditions, a maximum volume reduction of 67% could result. Any consolidation of the muck layer would facilitate hydraulic dredging.

In 1977, Lake Munson was drawn down approximately 5 feet from April to November. Unfortunately, because this drawdown was conducted during the growing season, terrestrial and semi-aquatic vegetation grew very rapidly on the bottom and reportedly grew to a height of ten feet. In addition, many fish died in the hot, oxygen-poor water that remained. Most of these problems, however, can be avoided by conducting drawdowns in the fall and winter. Fish kills are very rare in lakes drawn down in the fall and winter and, of course, prolific vegetation growth will not occur on bottom sediments exposed to hard freezes. Because of the potential to oxidize and compact organic sediments, because dam repairs and maintenance would be facilitated, and because previous problems could be avoided by timing, the Action Team recommends that fall and winter drawdowns be conducted on Lake Munson as part of a well-coordinated restoration plan. Coordination is the key. For instance, "Adopt-A-Lakeshore" litter cleanup campaigns could also be conducted during drawdowns.

As previously mentioned, a lake drawdown would facilitate dam repairs. Recognizing that refurbishment of the dam is an essential component of lake restoration, Leon County has allocated $80,000 to replace the metal gates on the outfall structure. A recent inspection by Leon County Public Works revealed that "the gates are obviously in dire need of replacement" but that the concrete dam, fixed crest spillway, and timber walkways are in good condition. The gate hoisting mechanisms were found to be operable, but in need of cleaning. All hoisting cables need to be replaced. Finally, a survey of the bottom contour near the face of the dam revealed scoured areas that need to be filled with concrete rubble, rip-rap, or sand bags to prevent undermining of the dam. These tasks are scheduled to be accomplished during a drawdown that began in November of 1993 and is scheduled to end in February of 1994.

A final, in-lake recommendation by the Action Team is to control noxious, exotic plants. One such plant is water hyacinth. Allowing water hyacinth to grow unchecked runs contrary to the goal of reducing organic matter in the substrate. Nutrient uptake by water hyacinth is short-lived, whereas the production of organic matter by this rapidly growing plant is enormous and has long term consequences. Also, the recent introduction of hydrilla into Lake Munson poses a different, perhaps more serious, problem. Therefore, the Action Team recommends the continued, judicious use of herbicides to suppress water hyacinth, and that control alternatives be implemented for hydrilla at the appropriate time.

COMMUNITY ACTION

The last major component of the Lake Munson Action Plan involves community and political action on a broad range of issues. As previously discussed, Lake Munson suffers from an image problem. To get past the mind-set that the lake is beyond salvage, to enlarge the constituency supporting its restoration, and to increase the pool of funding sources, the Action Team proposes that Lake Munson be viewed in a larger context. The Team suggests a "southern strategy" based on the area's unique, natural features.

Although it does not possess the traditional canopy road/hunting plantation image of northern Leon County, a strength of the southside is in its environmental diversity. The massive Apalachicola National Forest is home to many outstanding natural areas and rare biota. Its various recreation facilities include Lost Lake, Silver Lake, Trout Pond, Bradwell Bay Wilderness Area, the National Scenic Florida Trail, the St. Marks Trail, the FSU Lake Bradford Reservation, the Lake Bradford Canoe Trail, and the Leon Sinks Geological Area. A restored Lake Munson could become a fitting part of these outstanding, natural features.

The Action Team recommends the creation of lakefront parks with boat ramps, picnic areas, and adequate parking. Parks could be part of a greenway system of public land along watercourses that includes Black Swamp and Gum Swamp. Opportunities still exist to obtain undeveloped lakefront property with easy access. Partnerships with federal and state agencies, and private organizations and individuals should be assertively pursued by local government.

A proposal recently developed in context of a broader strategy is to establish a Tallahassee-Carrabelle Recreational Corridor. It follows the course of an abandoned G.F. & A. rail line along Springhill Road to the Bloxham cut-off and continues south to Sopchoppy and then to Carrabelle at the coast. The route passes through or near many of the natural areas and recreational features noted above. Staff discussions with the U.S. Forest Service, state agencies, and with officials and private individuals in Leon, Wakulla, and Franklin counties, have indicated a high degree of support and enthusiasm for such a joint initiative. Preliminary planning, and an environmental assessment of the corridor, which was both initiated and funded by Leon County, is now underway.

This corridor transects some of the most interesting environments in northern coastal Florida and puts Leon County's southside in touch with its forgotten geological and geographical coastal heritage. A similar concept has been suggested in the western reaches of the Lake Munson watershed, which encompasses Cascades Lake-Lake Bradford-Grassy Lake and associated aquatic forest domain of the northeastern A.N.F. (See Kasha, '90, "A Cypress Lakes Forest Preserve"). The Action Team believes a southern strategy that builds on the attributes of the area and promotes a positive image, one based on environmental education and natural area-based recreation, is economically and ecologically smart.

Public education goes hand in hand with effective community action. Assessable information about the proper design and maintenance of septic systems and best management practices for construction and lawncare allow professionals and individuals to take personal responsibility for reducing soil erosion and nutrient and other types of pollution. The Action Team is committed to public and professional education on environmental issues and will look to the County Commission for support. Brochures, public service announcements, workshops and community action days are being considered as effective ways to get information to the public. In addition, the Team is working with *Keep Tallahassee-Leon County Beautiful* to promote and establish Adopt-a Shoreline community groups to work on litter control.

SUMMARY

The restoration of Lake Munson hinges on the implementation of the City of Tallahassee-Leon County Stormwater Management Plan and other recommendations included in this Action Plan. Watershed management, in-lake restoration, and community action projects form the basis and include the details of a comprehensive solution to environmental problems in the Lake Munson Basin. More than $13,000,000 has been spent to divert wastewater discharges from Lake Munson, with approximately an additional $1,000,000 going to study and determine the restoration actions most likely to succeed. The return on these investments will only be fully realized by following through with the implementation of the Lake Munson Action Plan. The citizens of Leon County will benefit from improved flood control; healthy fisheries and wildlife habitat, and attractive recreational opportunities; conditions that lead to greater economic activity and increased property values. A beautiful, healthy Lake Munson is a realistic goal. We know how to get there; all we need is the will.

IMPLEMENTATION AND FUNDING STRATEGIES

(NOTE: TARGET DATES ARE NO LONGER VALID AS OF JULY 1994)

Introduction

The Lake Munson Action Team has identified twenty-four Lake Munson projects which, if implemented, represent a comprehensive approach to lake and watershed restoration and preservation. The Action Team recommends funding Lake Munson projects primarily from City and County stormwater utility fee revenues. Stormwater utility fees represent the core of a broader funding strategy, as outlined below, and should not be considered the sole source of project funding. Project evaluation, design, and management is to be provided by the appropriate operating agency. Project costs, percentage of cost shares or funding matches for joint projects, and design criteria and detail are not addressed here, but should be addressed in the recommended scoping papers and reports to be prepared by the appropriate implementing agencies. Proposed dates for implementing projects are included with the following funding and project recommendations and have been confirmed with officials of the implementing agencies. Further, the Action Team urges government agencies to collaborate with each other, and to cooperate and coordinate with each other on projects in order to make maximum use of human and capital resources.

Funding

Strategies for obtaining funds for lake restoration and preservation projects are listed in **Appendix IV** (Mason, 1993). Stormwater utilities fees can be used to fund all activities needed for lake restoration. Utility fees provide a predictable source of funds which reflect a communities commitment to restoring and protecting natural resources. As well, they provide a foundation of funds from which to build and attract other funds. An effective funding strategy should identify other funding sources, federal, state and private, that can augment stormwater utility fees. Other funding sources may provide a percentage match to local funds or may come as outright grants, and may be applied to a wide variety of projects. However, long-term management guidelines are needed to ensure that funding strategies meet their intended purposes.

The Lake Munson Action Team recommends the following funding strategy:

1. Evaluate and plan for stormwater utility fee increases needed to fully fund anticipated projects and land acquisition initiatives proposed for the Munson Basin. The estimated costs of projects should be based on conceptual designs. Conceptual designs should fully consider Best Management Practices (BMPs) and best available data.

   Public Works report to Board of County Commissioners, due March 1994.

2. Evaluate special utility assessment options which consider add-on fees for variables such as land use, extent of on-site green space, and permitted installation of on-site water management facilities. Specifically, there may be a scientific basis for assessing higher fees per unit of impervious area for industrial or high-intensity commercial land uses, since such land uses typically contribute higher pollution loads. Likewise, higher rates may be assessed to sites that have a higher percentage of impervious surfaces.

   Environmental Planning Section of Tallahassee-Leon County Planning Department in conjunction with Public Works, draft reports due by January, 1995. Drafts distributed for review and comment to Lake Munson Action Team.

   Final report to the Board of County Commissioners, due June, 1995.

3. Develop a standard procedure for coordination with State, Federal and regional agencies in order to pursue assistance grants and matching funds for stormwater management and lake restoration.

   Environmental Planning Section of Tallahassee-Leon County Planning Department, due August, 1994.

Project Activities

The Lake Munson Action Team recommends the following projects. For each alternative, a more detailed and thorough assessment of project design, analysis and cost, should be prepared by the implementing agency within the recommended timeframes.

1. Develop a Stormwater Utility Coordination Plan in conjunction with the city's counter-part program. The plan should address interagency review and comment procedures related to work plan development and proposed projects. A program level coordinating committee should be formed for project planning, monitoring, and evaluation. The scope of the coordination plan should include all proposed projects and strategies in the NWFWMD plan, and those recommended in this report.

   Public Works, due May, 1994.

2. Repair the Munson Slough outfall dam structure and prepare a management plan covering its operation and maintenance.

   Public Works, due March, 1994.

3. Amend the Environmental Management Act (EMA) to require trash racks and sediment sumps on all subsequently permitted water management facilities.

   Growth and Environmental Management, due June, 1994.

4. Develop a plan to retrofit current facilities and major inflow channels with trash racks.

   Public Works, due August, 1994.

5. Plan and conduct a series of Lake Munson watershed neighborhood meetings to present alternative and planned water management projects, including costs and future revenue needs estimates.

   Public Works, initiated by June, 1994.

6. Prepare annual status reports on the implementation of the NWFWMD Stormwater Management Plan.

   Public Works, initiated by May, 1994.

7. Develop a plan for trash removal in conjunction with the planned winter 1993/94 drawdown of the lake.

   Public Works, due January, 1994.

8. Develop a plan and timetable for in-lake sediment removal, including appropriate deposition methods and sites. Develop in conjunction with other proposed retrofit or restoration plans, including lake drawdown and stormwater management plans.

   Public Works, due June, 1995.

9. Initiate a land acquisition program funded from the stormwater utility and other available public and private resources. A plan should be developed considering all undeveloped property adjacent to Lake Munson, Munson Slough and Eight-Mile Pond.

   Tallahassee-Leon County Planning Department, due August, 1994.

10. Develop a concept plan and proposed interagency agreement, with regards to National Forest lands adjacent to the western shore of Lake Munson, for park management, passive recreation, and natural area preservation.

    Tallahassee-Leon County Planning Department, due July, 1994.

11. Develop an ordinance protecting the lake from pollutants, including sewage spills, failed septic tank systems, and point-source discharges. The ordinance should include fines and mitigation requirements.

    Growth and Environmental Management and HRS/Leon County Public Health Unit, due March, 1995.

12. Develop a periodic drawdown schedule for Lake Munson.

    Public Works, due March, 1994.

13. Write a budget request to fully fund stormwater facility maintenance inspections and operating permit enforcement within the Munson Slough basin.

    Growth and Environmental Management, due March, 1994.

14. Encourage State legislation for a Bottle Bill.

    Board of County Commission to Legislative Delegation, due October, 1994

15. Assess the feasibility of modifying the land use plan to determine maximum densities (build-out) based on geographical and ecological capabilities for the Munson Slough Basin and its associated waterbodies.

    Planning Department, due October, 1994

16. Develop a public education program on "best management practices" for Munson Basin residents and business owners.

    Lake Munson Action Team and the Cooperative Extension, due September, 1994

17. Continue the aquatic plant control programs.

    DEP, no report required

18. Develop outreach educational programs for septic tank maintenance.

    HRS/Leon County Public Health Unit, due June, 1994

19. Initiate an Adopt-a-Lakeshore litter program for Lake Munson.

    Lake Munson Action Team and Keep Tallahassee-Leon County Beautiful, June, 1994

20. Stock Lake Munson with juvenile largemouth bass and adult thread-fin shad or golden shiners.

    FGFWFC, March, 1994

21. Continue work with the intergovernmental task force, coordinated by DEP, on the Tallahassee to Carrabelle G.F. & A. "Rails To Trails" project.

    Growth and Environmental Management, Tallahassee-Leon County Planning Department, and Leon County Public Works, on-going

22. Accept donation of Ghazvini Parcel for use as a sediment disposal area subject to:
    A. Requisite legal and administrative issues resolution;
    B. Land use and permitting requirements for a sand mining operation;
    C. Establishment of a 100 ft. buffer to adjacent residential uses;
    D. Provision of appropriate security during excavation, including fencing;
    E. Restoration by Leon County as a recreation area.

    Growth and Environmental Management and County Attorney, due May, 1994

23. Continue the ecological study of Lake Munson currently a part of the Lakes Project, but expand the data collection and analysis component to include various waterbodies throughout the basin.

    Growth and Environmental Management, due February, 1995

24. Designate the areas surrounding Lake Munson and Munson Slough as Special Protection Zones in the Environmental Management Act.

    Growth and Environmental Management, due March, 1994

BIBLIOGRAPHY

Allen, Thomas W. and Wagner, Jeffry R., 1984. Hydrogeologic Evaluation of the Southwest Tallahassee Area. Northwest Florida Water Management District Technical File Report 84-1, Havana, Florida.

Bartel, R. L., Arteaga, R., Wooten, N., Ard, F.B., and Benoit, A.T., 1991. City of Tallahassee and Leon County Stormwater Management Plan, Volume I: Executive Summary. Northwest Florida Water Management District Water Resources Assessment 91-1, Tallahassee, Florida.

Bartel, R. L. and Ard, F.B., 1992. Diagnostic and Feasibility Report for Lake Munson. NWFWMD Water Resources Special Report 92-4. Tallahasee, Florida.

Bartel, R. L., Arteaga, R., Wooten, N., Ard, F.B., and Benoit, A. T., 1991. City of Tallahassee and Leon County Stormwater Management Plan, Volume VI: Technical Report. Northwest Florida Water Management District Water Resources Assessment 91-6, Tallahassee, Florida.

Beck, 1963, Conditions of Lake Munson; memorandum to the Florida Board of Health.

Boca, C. and Hand, Jr., 1985, Lake Munson: A Case Study for the Water Quality Effects of Sewage Diversion and Stormwater Cleanup Practices; Water Quality Monitoring Report #41, Department of Environmental Regulation, Tallahassee, Florida.

Boyd, Mark F., Smith, Hale G., and Griffin, John W., 1951. Here They Once Stood. University of Florida Press, Gainesville, Florida.

Camp, Dresser, and McKee, Inc., 1985. Stormwater Management Utility, Phase I Report; for the City of Tallahassee, Florida.

Cook, G. Dennis, et al., 1986. Lake and Reservoir Management. Butterworth Publ. Co., Boston, MA. 392 pp.

Dawdy, R. S. 1983. An Assessment of the Applicability of Hoyt's Sector Theory to Tallahassee, Florida. Institute of Science and Public Affairs. F.S.U.

Florida Department of Environmental Regulation, 1988, Lake Munson, Leon County, Florida: Biological Aspects of Water Quality; Biology Section, FDER, Tallahassee, Florida.

Florida Department of Natural Resources, Aquatic Plant Control Program, unpublished data, 1990.

Florida Department of Transportation, 1985. Florida Land Use, Cover and Forms Classification System. FDOT, State Topographic Bureau, Thematic Mapping Section, Tallahassee, Florida.

Florida Game and Freshwater Fish Commission, 1955. Fish and Fishing in Leon and Gadsden Counties, Florida. Fish Management Bulletin No. 3. Tallahassee, Florida.

Haney, 1963, Survey of Lake Munson - Tallahassee, Leon County, Memorandum to the Florida Board of Health.

Hendry, C. W., Jr., and Sproul, C. R., 1966, Geology and Groundwater Resources of Leon County, Florida: Florida Geological Survey Bulletin 47, 178 p.

Huber, W. C., Brezonik, P. L., and Heaney, J.P., 1982, A Classification of Florida Lakes; Department of Environmental Engineering, University of Florida, Gainesville, Florida.

Kasha, M., 1990, A Cypress Lakes Forest Preserve, Proposal for the Leon County Land Acquisition Program. Leon Lakes Scientific and Technical Panel.

Leon County, 1987. Stormwater Management Facility Maintenance Report; for The Leon County Board of County Commissioners, by the Department of Public Works Environmental Management Section, Leon County, Florida.

Leon County, 1989. Leon County Environmentally Sensitive Areas, Drainage Map Overlay, Lake Munson Drainage Basin. Leon County Department of Public Works, Tallahassee, Florida.

Leon County, 1989. Leon County Environmentally Sensitive Areas, Flood Prone Areas Map Overlay, Lake Munson Drainage Basin. Leon County Department of Public Works, Tallahassee, Florida.

Leon County, 1989. Leon County Environmentally Sensitive Areas, Physiographic Provinces Map Overlay, Lake Munson Drainage Basin. Leon County Department of Public Works, Tallahassee, Florida.

Leon County, 1989. Leon County Environmentally Sensitive Areas, Severe Grades Map Overlay, Lake Munson Drainage Basin. Leon County Department of Public Works, Tallahassee, Florida.

Leon County, 1989. Leon County Environmentally Sensitive Areas, Upland Native Forest Communities Map Overlay, Lake Munson Drainage Basin. Leon County Department of Public Works, Tallahassee, Florida.

Leon County, 1989. Leon County Environmentally Sensitive Areas, Wetland and Aquatic Communities Map Overlay, Lake Munson Drainage Basin. Leon County Department of Public Works, Tallahassee, Florida.

Leon County, 1991. Leon County Gum Swamp Restoration Plan. Leon County Division of Environmental Management, Department of Growth and Environmental Management, Leon County, Florida.

Livingston, Robert J. 1993. First Year Report: The Ecology of the Lake of Leon County, Florida. Center for Aquatic Research and Resource Management. Florida State University, Tallahassee, Florida.

Livingston, Robert J. and Helge Swanson. 1993. Project Overview: The Ecology of the Lakes of Leon County, Florida. Center for Aquatic Research and Resource Management. Florida State University, Tallahassee, Florida.

Maristany, A. E., Arteaga, R., Rodriguez, J. A., and Esry, D. H., 1988. City of Tallahassee and Leon County Stormwater Management Plan, Preliminary Report. Northwest Florida Water Management District Water Resources Assessment 88-2, Tallahassee, Florida.

Maristany, A. E., Bartel, R. L., Wiley, D., 1988. Water Quality Evaluation of Lake Munson, Leon County, Florida. Northwest Florida Water Management District Water Resources Assessment 88-1, Tallahassee, Florida.

North American Lake Management Society, 1988. Lake and Reservoir Restoration Guidance Manual. EPA 440/5-88-002.

Northwest Florida Water Management District, 1986, Quality Assurance Plan Submitted in reference to Water Quality Evaluation of Lake Munson to FDER, approved October 1986.

Procella, D.B., and Bishop, A. B., 1975,Comprehensive Management of Phosphorus Water Pollution; Ann Arbor Science, Ann Arbor, Michigan.

Raschke, R. L., and Schultz, D. A., 1987. The Use of Algal Growth Potential Test for Data Assessment. J. Water Poll. Control Fed 59(4).

Reid, G. K., and Wood, R. D., 1976, Ecology of Inland Waters and Estuaries; 2nd ed., D. Van Nostrand Co., NY, NY.
Swanson, Helge, Abdul Hatim, Tom Greene and Karen Kebart. 1992. Environmental Physiography of Leon County, Florida. Leon County Department of Growth and Environmental Management. Tallahassee, Florida.

Tallahassee-Leon County Planning Department, 1990. Mixed Use Overlay Map, Leon County; Tallahassee, Florida.

Tallahassee-Leon County Planning Department, 1990. Future Land Use Overlay Map, Leon County; Tallahassee, Florida.

U.S. Department of Agriculture, 1981, Soil Survey of Leon County, Florida.

U.S. Environmental Protection Agency, 1977, Report on Lake Munson, Leon County, Florida; National Eutrophication Survey Working Paper No. 268, EPA Region IV, Corvalis, Oregon.

U.S. Environmental Protection Agency, 1982, Methodology for Sampling and Sample Preservation of Water and Wastewater, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio.

Walker, William W., 1987, Phosphorus Removal by Urban Runoff Detention Basins; Lake and Reservoir Management: Volume III.

Williams, V., Moxley, D., and Rosegger, T., 1987, Lake Munson Benthic Contours and Sediment Depth Profiles; Florida Game and Fresh Water Fish Commission, Northwest Region, DeFuniak Springs, Florida.

Young, N. and Crew, J., 1980, 1979-80 Fish Management Report; Florida Game and Fresh Water Fish Commission, Northwest Region, DeFuniak Springs, Florida.

APPENDIX I
Lake Munson Drainage Basin

Sub-Basin/ Drainage Area	Closed Basin Y or N	Drainage Area (acres)	Water-body (acres)	Elevation of OHW (feet)	Wetland Area (acres)	Flood-Prone (acres)	Channel Length (miles)	Basin Relief (feet) Highest - Lowest		Severe Grades (acres) 10-20 %	>20%	Native Forest (acres)
Airport Basin	Y	610	0	-	0	1	0.0	102	29	1	0	246
Astoria Park	N	1209	27	200	21	104	6.0	246	46	375	29	183
AV Branch	N	626	5	48	20	132	1.7	124	42	18	0	0
Balkin Road	Y	275	8	27	0	17	0.0	75	27	0	0	69
Baseline Basin**	Y	195	28	77	1	28	0.0	153	77	25	6	53
Bethel Church	Y	42	4	146	0	7	0.0	162	146	0	0	38
Big Dog Basin	Y	735	0	-	0	2	0.0	103	27	79	4	476
Black Swamp	N	1671	262	35	98	575	2.7	110	28	102	4	396
Bradford Basin**	N	10570	807	36	1722	3091	9.1	173	28	538	60	4920
Campground Pond	Y	155	20	87	0	33	0.0	102	87	4	0	n/a
Eight Mile Pond**	N	8648	547	19	326	2587	5.4	84	10	43	0	3135
Empty Basin	Y	215	0	-	0	3	0.0	103	50	7	0	215
Forbes Basin	Y	820	2	68	3	18	0.0	121	39	2	0	815
Forest Square	Y	65	4	153	0	13	0.0	200	153	11	0	0
FSU	N	3040	5	49	27	228	3.9	222	39	725	10	38
Godby/San Luis	N	1053	8	81	7	67	1.7	243	62	494	17	295
Gum Swamp	N	1606	35	50	282	541	2.6	198	48	84	17	309
Indianhead Acres	N	3213	32	48	117	1007	5.3	212	38	489	39	438
Innovation Park	Y	65	1	54	2	5	0.1	101	56	0	0	15
Doger	N	916	14	95	53	107	2.4	213	72	252	10	169
Leon High	N	1463	0	-	1	256	3.0	215	65	578	27	90
Monday St.	Y	52	1	119	0	0	0.0	200	122	22	1	10
Moore Lake	Y	315	138	96	14	161	0.0	121	96	0	0	163
N. Gum Creek**	N	1865	193	90	115	394	2.5	170	52	91	6	293
Ocala Rd. Basin	Y	55	1	133	1	6	0.0	207	133	36	0	24
Poodle Basin	Y	36	0	-	0	0	0.0	82	38	0	0	40
Ruth	Y	35	2	156	0	8	0.0	200	155	18	1	0
Sylvan Lake	Y	80	3	155	0	7	0.0	210	155	17	3	0
Tharpe/Cap. Cir.	N	470	0	-	25	46	1.2	156	64	45	2	74
Trimble Rd. Basin	Y	190	1	78	1	3	0.0	212	78	78	0	0
West Drive Ditch	N	1066	0	-	31	352	3.2	155	48	0	0	106
W. Gum Creek**	N	1745	63	84	338	511	3.5	170	52	82	12	21
W. Tenn./Cactus Rd.	N	1202	0	-	29	92	2.0	204	46	82	0	89
W. Tenn./N.	Y	7	2	55	0	6	0.0	200	60	112	1	42
W. Tenn./S.	Y	50	3	53	0	9	0.0	102	53	0	0	4
TOTAL		44360	2216		3234	10417	56.3			4410	249	12766
Percent of Total			5.0%		7.3%	23.5%				9.9%	0.6%	28.8%

All acreages are estimates. *Denotes control drain outfall. **Limited data only for native forests.

Appendix II

PROPOSED CAPITAL BUDGET FOR STORMWATER MANAGEMENT IN THE LAKE MUNSON BASIN- CITY OF TALLAHASSEE FISCAL YEAR 1994 - 1998

PROJECT:	Prior Years	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998
Downtown Regional Stormwater Facility						
Construction of a treatment/attenvation facility and conveyance improvements along the central ditch to serve downtown and the FSU campus. **Total Funding:** 11,000,000	7,150,000	3,850,000				
Downtown Stormwater Outfall Conveyance						
Construct an outfall pipe to convey runoff from downtown through Stadium Drive. **Total Funding:** 2,350,000	100,000	2,250,000				
East Branch Stormwater Facility						
Solve flooding problems along Orange Avenue; to reduce peak flows entering that portion of the East Branch. **Total Funding:** 290,000	90,000	200,000				
Jackson Bluff Road Stormwater Improvements						
Lipona Road west to the outfall east essex Drive. FY 95 funding is to complete analysis and a conceptual design. **Total Funding:** 130,000			30,000	20,000	80,000	
Merritt/Carlton Drive Stormwater Improvements						
Rebuilds partially collapsed, deteriorated conveyance system from Stoutamire Drive to Merritt Drive; coordinated with the Magnolia Heights project. **Total Funding:** 250,000		30,000	120,000	100,000		
Mission-Trimble Stormwater Improvements						
Design and construction of structural improvements in Trimble/Mission Road drainage basin. **Total Funding:** 10,891,700	791,700	950,000	1,000,000	1,000,000	1,000,000	6,150,000
Orange Avenue Stormwater Facility						
Proposed for East Drainage Ditch near of Orange Avenue and Wahnish Way. **Total Funding:** 370,000			45,000		325,000	
Pepper Drive Stormwater Improvements						
Prevents flooding of residences along the lower portion of Pepper Drive near Lake Bradford Road. **Total Funding:** 545,000	15,000	60,000	20,000	100,000	350,000	

PROPOSED CAPITAL BUDGET FOR
STORMWATER MANAGEMENT IN THE LAKE MUNSON BASIN- CITY OF TALLAHASSEE
FISCAL YEAR 1994 - 1998

Putnam Drive Stormwater Improvements						
Project proposes enlarging the culvert under Putnam Drive and improving the channel upstream and downstream of the culvert. **Total Funding:** 230,000			30,000	200,000		
Rosedale Drive Stormwater Improvements						
Drainage basin is approximately 140 acres, bounded by Tharpe Street, Holly Street, Old Bainbridge Road, and Myrick Road; not possible to define what improvements are required until the conceptual engineering is completed. **Total Funding:** 1,005,000		25,000	100,000	200,000	680,000	

Source: Fiscal Year 1994 Proposed Capital Budget For Stormwater Management - City of Tallahassee. Implementation - October 1, 1993.

APPENDIX III

Excerpts from "The Ecology of the Lakes of Leon County, Florida" (Livingston, 1993)

RECOMMENDATIONS

1. Disseminate the First-Year Report results to all interested area scientists, agency officials and interested groups in order to maximize information exchange and resultant scientific dialog, as well as provide an opportunity for varying viewpoints and additional evidence. Consider sponsoring a lakes symposium to further disseminate results and generate interest and ideas for solutions and future actions. This symposium should incorporate "action teams" and other on-going groups (such as Dr. Michael Kasha's Leon Lands and Lakes Scientific Coalition) to gain as broad a participatory base as possible and to facilitate networking on these important questions.

2. Request personnel of the City's and County's Stormwater Utility Program to begin preliminary work on alternative management strategies and structural alternatives to address the geographical "hot spots" identified in this research, including retrofit program scope with specific targets for retrofit completion by watershed. The current Stormwater Utility Plans and Works Programs should be revised accordingly with a water quality focus and implementation actions undertaken as soon as practical.

3. Request immediate attention by the City's and County's Stormwater Utility Program and other units as appropriate for the evaluation, design and requisite implementation of the following specific water management needs.

   A. Implement a special management zone in the Environmental Management Act (E.M.A.) for Lake Munson encompassing the entire adjacent lowland physiographic region;

   B. Conduct a pilot study on a land planning methodology to designate "low density" zones based on stormwater and other environmentally sensitive feature constraint areas and "high density" zones or areas of major development potential, so that growth may be directed toward low impact areas and away from sensitive features and special management zones;

4. Design and conduct an experimental program as a part of The Lakes Project on more effective stormwater treatment alternatives, including distance setbacks from water bodies and watercourses and limitations to conventional water management; fund this new effort through the Stormwater Utility;

5. Explore inter-local agreement options to maximize coordination and mutual assistance between City and County stormwater utility research and environmental management programs; following conceptual approval by the appropriate Commissions, operating policies and procedures would be developed at the staff level.

6. Implement an updated Environmentally Sensitive Areas (E.S.A.) analysis of environmental features, paying particular attention to natural characteristics, or lack thereof, of watercourses, floodways, floodplains, wetlands and other surface water features.

7. Implement a land acquisition program, including such options as conservation easement set-asides, as soon as practical for preservation or remnant natural areas and "recovering" surface water features and adjacent forested flood plains.

8. Continue funding the Lake Project at the current level of $50,000 per year for a third and fourth year, after which, an on-going regular monitoring program should be incorporated into the County's Environmental Management Program.

APPENDIX IV

Alternative Strategies for Obtaining Resources Needed for Wetlands Acquisition, Restoration and Enhancement

Obtaining the resources needed for wetland acquisition, restoration and enhancement involves five strategies. These are listed in the order of their importance to program goals:

1. fees;
2. management through acquisition and agreement;
3. voluntary incentives;
4. tax benefits for protecting private property; and
5. regulatory development credits and rights transfers.

FEES

Stormwater Utility Fee

Stormwater utility fees are collected from every City and County resident to pay for stormwater-related Capital Improvement Projects.

The stormwater utility fee in the City of Tallahassee is $5.00 per residential household, based on the average amount of square feet of impervious surface per unit of 2,659, called the Single Family Equivalent Unit. In July 1993, the City Commission modified the rate structure to $4.75 based on the Equivalent Residential Unit (ERU) method resulting in 5% decreased cost to residential customers, but a 27% increase to non-residential customers.

County Stormwater Utility Fee

County residential property owners are currently paying a stormwater utility fee of $20.00 per year, based on a single family equivalent unit of 2,723 square feet.

Special Taxing District

Income could be generated from property owners within the Lake Munson Basin, through a Commission-created "special taxing district." The increased assessment funds would be returned to the basin district, to fund or co-fund capital improvement projects within the specific area targeted. The City's Stormwater Management Division estimates that it would cost approximately $13.98 per month (in stormwater utility fees) per Munson basin household, if basin residents were asked to fund all currently identified projects.

MANAGEMENT THROUGH ACQUISITION & AGREEMENT

Fee Simple Acquisition

Ecologically significant properties may be acquired outright. The City of Tallahassee's Greenspace and Environmentally Sensitive Land Acquisition Program is considering six parcels, totaling 465 acres, in the Lake Munson Basin:

PARCELS	ACRES
Apalachicola Forest near the airport terminal	335.00
Capital Circle near Gum Swamp	5.75
Capital Circle near Lake Cascade	100.00
Four Points	5.75
Ridge Road near Four Points	38.00
Area near Springsax Park & Springhill Road	15.40

Land Trusts

The Trust For Public Land, the Apalachee Land Conservancy and the Florida's Nature Conservancy are three local examples of land trusts established to protect areas of significant natural diversity, important recreational opportunities, or both. Land trusts hold land and other property rights for the benefit of the public and often undertake educational, recreational, and scientific activities. As private organizations, land trusts have considerable flexibility in the way they can acquire property, especially in their ability to take risks and to act quickly to buy land before it is sold for development.

Rights of First Refusal

An organization can receive a guarantee of the opportunity to purchase important properties, if the property owners grant the organization a right of first refusal. The property owner agrees to notify a prospective purchaser that the property is to be offered for sale and to give the purchaser the opportunity to match any *bona fide* offer, within a specified time period. This does not obligate the organization to purchase the property, but simply gives it the first opportunity to buy.

Option To Purchase

Option to purchase a property usually involves paying a landowner for the guarantee that the landowner will reserve a property at an agreed upon price for a set period of time. Even if an organization is unsure it can afford the purchase price, it might still consider purchasing the option if the option can be transferred to another buyer who is sympathetic to conservation. As with rights of first refusal, this technique does not obligate the organization to purchase the property.

Bargain Sale

Sometimes called a "donative sale," a bargain allows an organization to acquire a property partly as a purchase and partly as a gift. By this allowance, an organization may buy property at less than fair market value (the price the buyer pays a seller on the open market). The seller sets a price below the appraised value of the property and considers the difference to be a gift for which he or she can claim a charitable income tax deduction. The Seller's compensation, therefore, is a combination of cash and lower taxes.

VOLUNTARY INCENTIVES

Notification, Recognition and Non-binding Agreement Programs

Local government or nonprofit organizations can operate non- binding agreement programs for protecting natural features in association with recognition programs. Following an inventory of natural features, owners who are made aware of important resources on their properties. They are often willing to protect them once they learn of their existence and management needs. Notification generally consists of a brief letter describing why the property is significant and a follow-up visit to answer questions.

Property owners agree in writing to protect specified significant features on their properties and usually receive in return a plaque or certificate that acknowledges the special nature of the property and the owner's contributions to its protection. The owner's contribution is strictly voluntary. The agreements are based on mutual trust, pride of ownership, recognition and appreciation of the resource, commitment to conservation, and the personal satisfaction that participation brings.

TAX STRATEGIES FOR PROTECTING PRIVATE PROPERTY

Income and Estate Tax Benefits

Present federal tax law allows both individuals and corporations with large land holdings to take deductions from their taxable income for gifts of property, including easements, to a nonprofit organization designated as tax-exempt by the Internal Revenue Service, or to a government agency. Only gifts of perpetual easements, however, can qualify a donor for income and estate tax benefits. Individuals may deduct the value of the gift up to a certain percentage of their income and spread a sizable deduction over several years. If the gift can be divided into stages, it may be possible to spend deductions over many years. Donating a property can also reduce the value of the donor's estate at the time estate taxes must be paid.

Organizations using tax incentives to encourage gifts should realize that, while they may not have to "pay" for the gifts, when donors receive tax deductions the public forgoes tax receipts it might otherwise collect. Thus, an organization has a responsibility to local taxpayers to accept only high-quality gifts and to assure that the conservation values involved in those gifts will endure. For easements, a general kind of quality control is set forth in federal tax law (section 170(h) of the Internal Revenue Code. That section refers to a "qualified conservation contribution" that must meet one of several tests for *conservation purpose*. Under this law, conservation purposes include the preservation of land for outdoor recreation or education, protection of "relatively natural habitat," and preservation of historically significant properties. Also a conservation purpose is served if the preservation of open space, including farm and forested land, creates a "significant public benefit," either for the "scenic enjoyment of the general public" or "pursuant to a clearly delineated Federal, State or local governmental conservation policy."

REGULATORY DEVELOPMENT CREDITS AND RIGHTS TRANSFERS

Mitigation Banking

Mitigation banking is generally referred to as: "the creation, restoration, or enhancement of wetlands or other aquatic habitats expressly for the purpose of providing compensatory mitigation in advance of proposed discharges into waters of the United States, including wetlands, where generally complete and satisfactory mitigation cannot be achieved at the site of the impact. Where all the required mitigation cannot be achieved on site, bank credits may be used in lieu of, or in addition to, on-site mitigation to achieve appropriate compensation for the unavoidable adverse impacts ("Mitigation Banking Guidance, EPA, 1992)."

Local environmental ordinances *do not* permit off-site mitigation of development impacts in wetlands only through variance request to the Board of County Commissioners; however, the Florida legislature and several Federal and state agencies are beginning to encourage and allow mitigation banking where its appropriateness can be demonstrated. Federal guidelines and criteria incorporate a sequential approach to mitigation: first seek avoidance of aquatic impacts, then seek to minimize aquatic impacts, and finally seek compensatory mitigation for unavoidable impacts. The 1993 Florida Legislature established the potential for regional mitigation areas/banks to offset the adverse impacts of regulated activities. By January 1, 1994, FDEP and the Water Management Districts are directed by statute to adopt rules governing mitigation areas/banks and to participate in and encourage private and public regional mitigation efforts.

If it is determined that a project is suitable for mitigation banking, the next step may involve assessing the impacted area and determining the number of "credits" it will require from an eligible mitigation banking site in order to satisfy the mitigation requirements. Impacted area assessment involves consideration of a broad array of factors which are converted into numerical equivalents. Factors may include the total number of jurisdictional acres that are impacted; the geographic location of the impacted site; the condition of the particular jurisdictional wetlands; and most importantly, the *ecological functions* that are performed by the impacted wetlands.

APPENDIX V

LEON COUNTY
CAPITAL IMPROVEMENT PROGRAM
Adopted Budget FY 1993/94

PROJECT	1993/94	1994/95	1995/96	1996/97	1997/98
DRAINAGE IMPROVEMENT PROGRAM					
Stormwater Utility (123)					
1. Joint Stormwater Data Collection	34,500	34,500	37,000	37,000	40,000
2. I-10 Stormwater Monitoring	9,600	9,600	9,600	11,000	11,000
3. Stormwater Management Plan Study	196,000	61,000			
4. Surface Water Improvement/Management	33,666				
5. Gum Swamp	100,000	714,000	306,000	51,000	
6. Lake Munson Dam Repair	40,000				
7. Water Quality Monitoring	98,228	50,000	50,000	50,000	50,000
8. Yorktown Pond	260,500	24,000			
9. Cynthia Drive Stormwater Facility			45,900	91,800	
10 Lake Charles Stormwater Facility			191,760	204,000	
11 Meadows at Woodrun Dam Repair				40,800	
12 Killearn Acres Drainage				112,200	
13 Independence Court Drainage					51,000
Sub-Total	772,494	893,100	640,260	597,800	152,000
Grants Fund (125)					
1. Yorktown Pond (SWIM)	100,500	0	0	0	0
Sub-Total	872,994	0	0	0	0
TOTAL DRAINAGE IMPROVEMENT	872,994	893,100	640,260	597,800	152,000