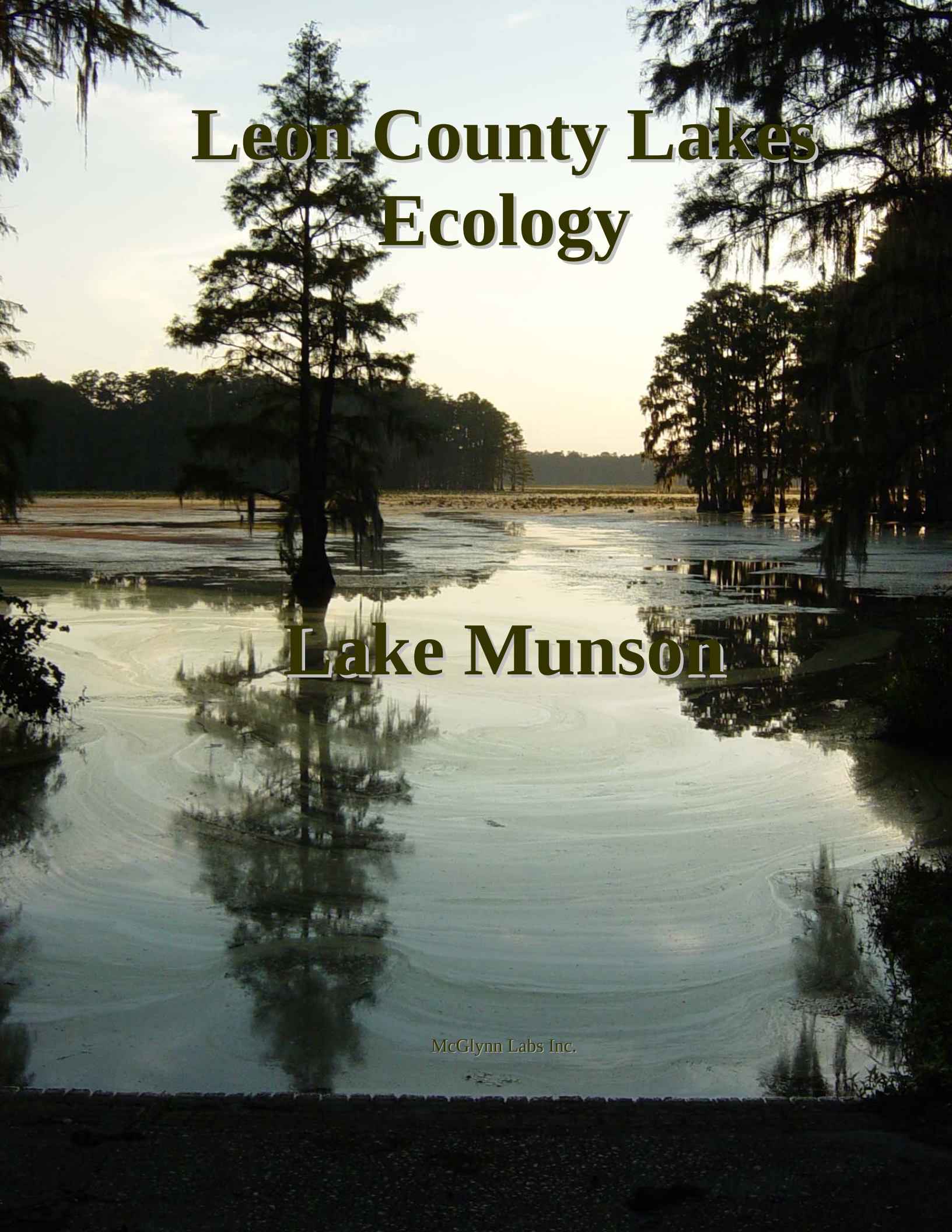

Leon County Lakes Ecology

Lake Munson

McGlynn Labs Inc.

7.3.2: Lake Munson

Surface Area: 255 acres
Drainage basin: 44,360 acres
Classification: Hypereutrophic
Location: Lake Munson Sandhills
Number of Stations: 3
Duration of Monitoring: 09/91-06/06

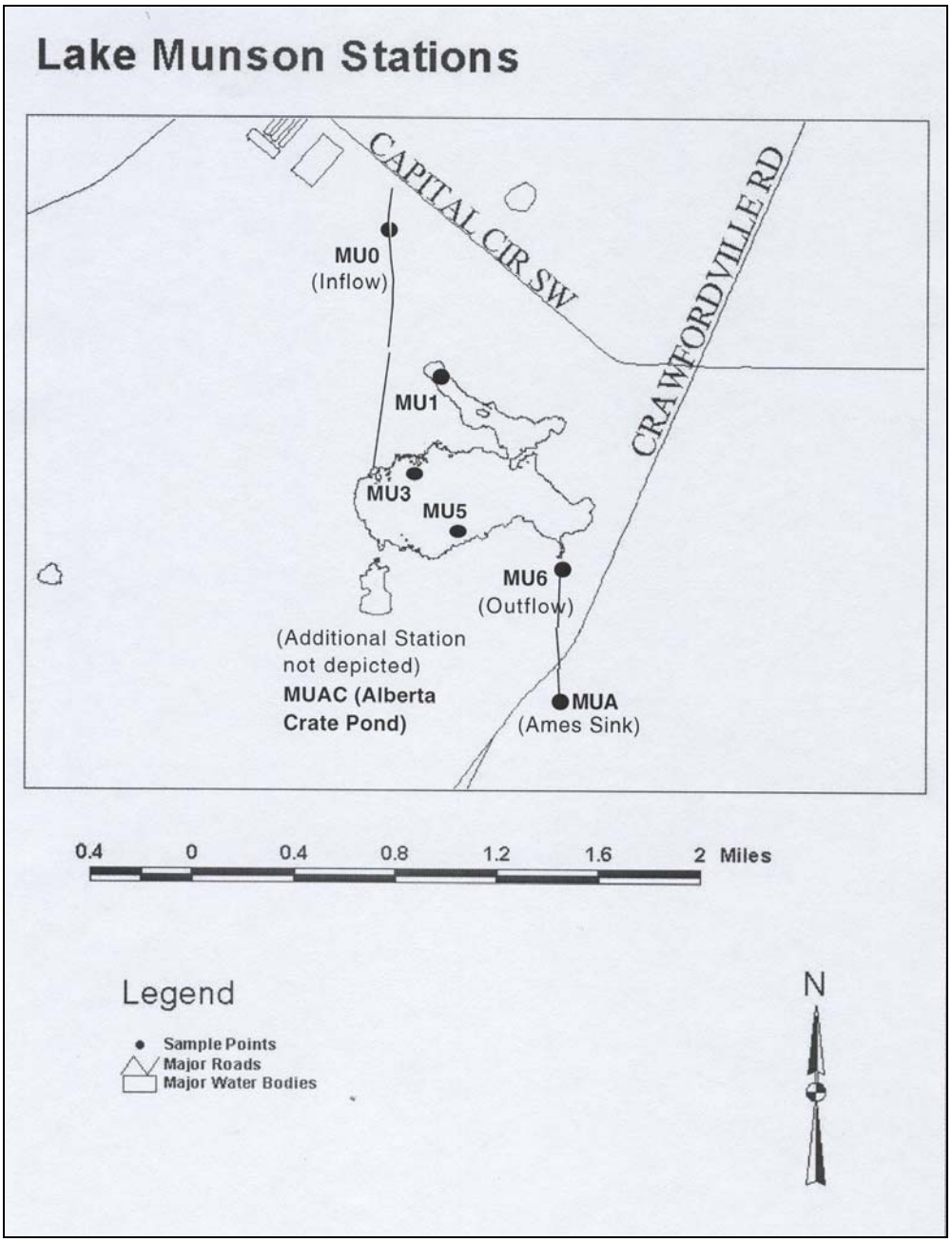

Figure 5.3.2.1: Lake Munson sampling stations

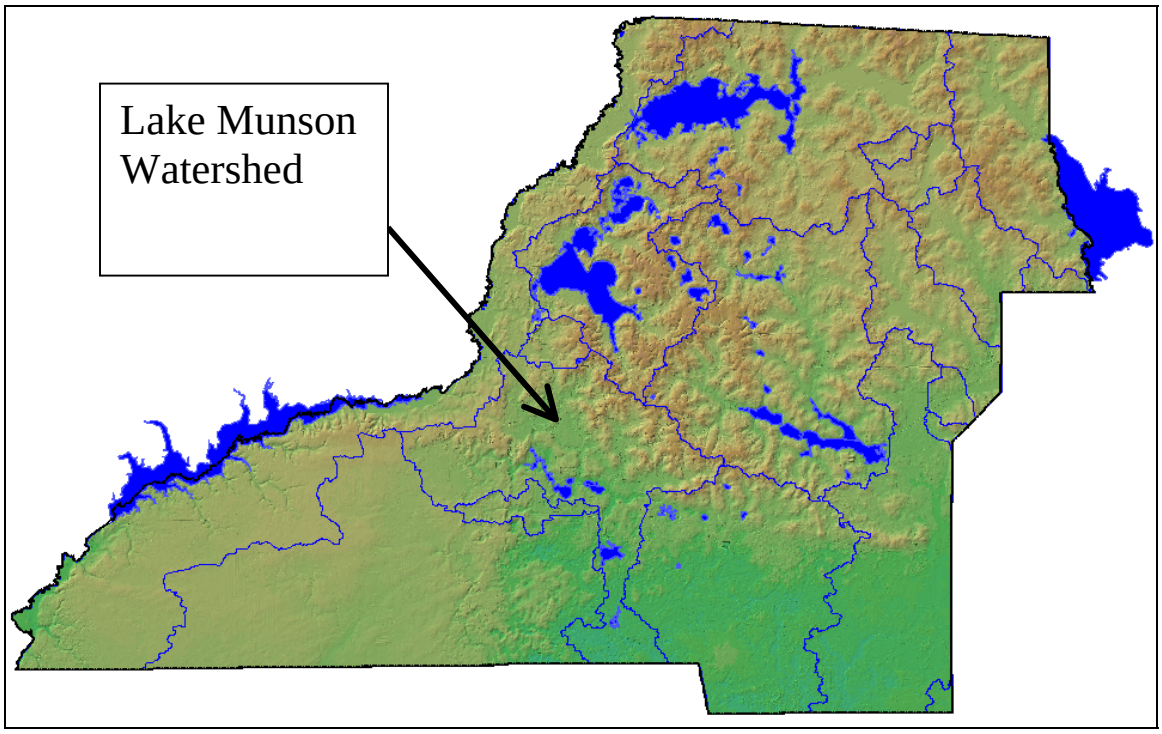

Figure 5.3.2.2: Map by Greg Mauldin, Tallahassee-Leon County GIS

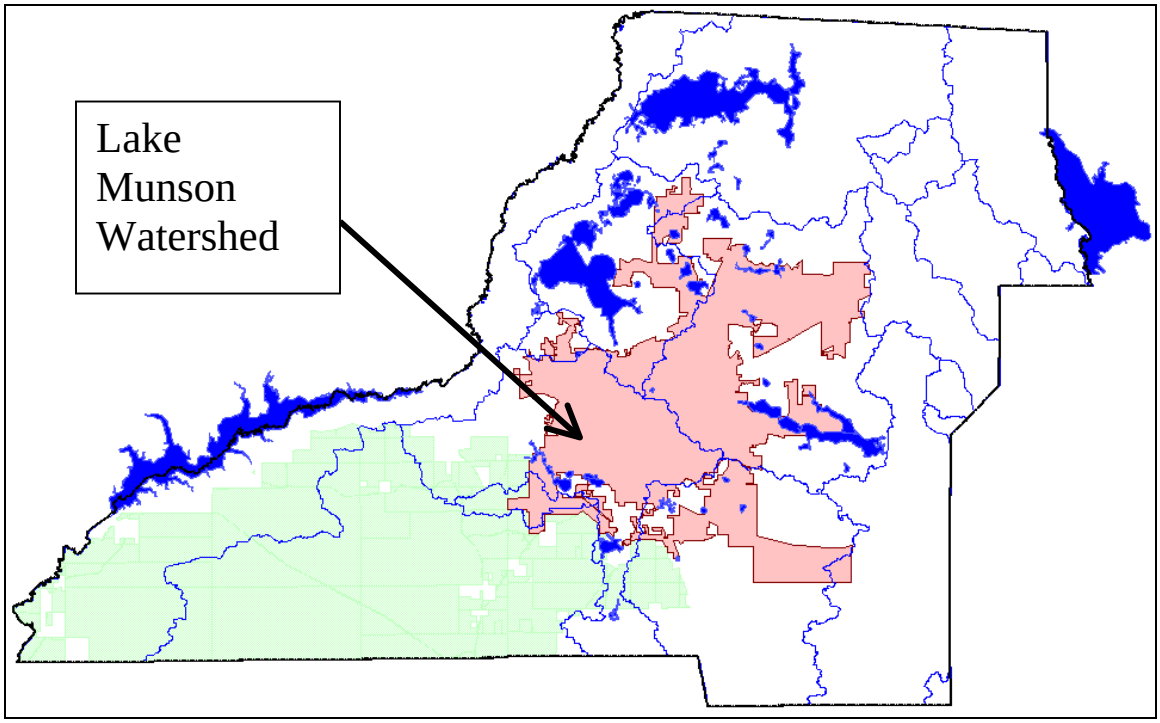

Figure 5.3.2.3: Map by Greg Mauldin, Tallahassee-Leon County GIS

Lake Munson remains one of the more impaired lakes in our region. This lake's water comes from densely developed regions in the City of Tallahassee. Over a third of the urban stormwater from Tallahassee flows into Lake Munson. In addition, sewage from the City of Tallahassee once flowed into this lake.

Leon County and Florida Wildlife Commission have committed substantial resources to restoring Lake Munson. Improvements have been made on the drainage into the lake which includes Lake Henrietta and Munson Slough. The nutrient rich delta of Munson Slough, has been removed. The delta was formed by decades of sewage discharge and tons of trash that had accumulated from frequent pulses of extremely poor quality untreated urban stormwater (Lehman, 1994). Also, a lake wide sediment removal project by Leon County and the Florida Wildlife Commission is about to begin.

Water quality has improved in this lake, once called one of the most polluted lakes in the State of Florida (FDEP). Two large holding ponds have been built on Munson Slough to relieve flooding and water quality issues (Alberta Crate and Lake Henrietta). A chain of ponds is proposed, starting at the site of the former Cascade Sink and extending between the FAMU and FSU campuses to the Alberta Crate Pond (Blueprint 2000). Recent action by the Metropolitan Planning Commission has led to a greater commitment to improve water quality. The last segment of Blueprint 2000, the segment with the most water quality improvement capacity, the south side of town, was moved from unfunded to funded as a high priority.

Nutrient loading from urban stormwater is still a problem in Lake Munson, which is scheduled for a TMDL. This TMDL could enforce further improvements in the quality of water that drains into Lake Munson. Recent dye studies have shown that Aimes Sink, which eventually swallows the murky waters of Lake Munson, has caverns that take this tainted water to the Wakulla Springs cave system. As they say, "Lake Munson is a beautiful lake as long as you do not look at the water". Hopefully this common epitaph will become a thing of the past with continuing improvements.

Early Spanish records from 1705 indicate that Lake Munson once flowed into the Wakulla/St Marks System (Boyd, 1951). The Ochlockonee River seems to have flowed through the Bradford Brooks chain of lakes, into Lake Munson, on past Aimes Sink, through Woodville, to the Wakulla/St. Marks Rivers, and out to the Gulf of Mexico. The waters of Lake Munson may still reach the Wakulla River through a series of subterranean conduits in 8 mile pond and Aimes Sink, located just to the south of the lake.

Maps from 1840 refer to Munson's Mill Pond, probably a cypress mill. This is the first historical reference to an impoundment, although there is an oral tradition that beaver dams have historically maintained Lake Munson as a natural impoundment. In 1950 a permanent dam was built at the outfall of the lake (Bocz and Hand, 1985). Wildlife surveys by the Florida Fish and Wildlife Conservation Commission (FFWCC, 1954) praised the excellent fishing and hunting, although it was noted that some Tallahasseans

at that time had already decided not to eat fish from Lake Munson since the lake was receiving effluent from the Tallahassee Sewage Treatment Plant (FFWCC, 1954). The lake is still completely encircled by immense Cypress trees whose tall trunks ring the Lake like a palisade of columns. Indeed, it is a beautiful lake if only you don't look too closely at the water.

Figure 5.3.2.4: Lake Munson in winter colors. Looking north from Munson Landing off South Monroe Street.

From 1934 to1984, Lake Munson was the receiving water body for Tallahassee's Municipal Waste Water discharges (Lehman, 1994). In 1982 FDEP classified Lake Munson as hypereutrophic and ranked it as the seventh most degraded lake in the State of Florida. The construction of a Spray field in 1984 for Tallahassee's Municipal Waste Water greatly improved the water quality in Lake Munson, but it still receives stormwater runoff from 57% of Tallahassee's urban area.

Lake Munson has a history of frequent fish kills, infestation with invasive exotic plants and animals, such as *Hydrilla verticillata* and *Pomacea canaliculata*. A thick layer of organic muck coats its bottom. The duck hunting has continued to be good in Lake Munson but the fishing has not fared as well. A major fish kill in 1999 showed that the lake still had a few trophy bass, even though there has been a 70% reduction in fish biomass. The problem is pollution from urban storm water. Testing by FDEP showed that this urban stormwater runoff carries a pollutant load of 35,762 lbs/day Total Suspended Solids, 1,558 lbs/day Biochemical Oxygen Demand, 274 lbs/day Nitrogen 156 lbs/day Phosphorus, 7.8 lbs/day Lead and 2 lbs/day Copper (Bocz and Hand, 1985), and stormwater pollutant loading has increased according the City of Tallahassee.

Figure 5.3.2.5: A young boy fishing in Lake Munson, Charles Barron, 1954.

The outflow from Lake Munson disappears into the aquifer through in a series of sinkholes. Urban stormwater flows into these sinkholes south of Lake Munson, flowing off from one to the other as they are overwhelmed by the flow of stormwater. Under most circumstances this water goes directly into the sinks, but during major floods events it breaches the sinks and fills low lying areas like the slough system, flooding many homes in the Woodville Recharge Basin. An effort is currently underway in Leon County to purchase this flood prone area.

The first major sinkhole south of Lake Munson is in 8 Mile Pond (approximately eight miles north of Wakulla Springs). Rumors were heard that a gazebo built on a bed of discarded automobile tires had collapsed into the sink. The flow of water from Lake Munson to Ames Sink (MLI, 1999) was not diminished as it passed through Eight Mile

Pond, which indicates that the sink was not open. On most occasions Aimes Sink swallows most of the outflow from Lake Munson.

Figure 5.3.2.6: Ames Sink, approximately 5 miles north of Wakulla Springs, is where the outflow from Lake Munson goes underground. A Largemouth Bass (*Micropterus salmoides*) from Lake Munson.

During the drought in 2000, Lake Munson was the recipient of 13.3 million dollars for restoration projects. Thirty nine acres of sediments from the delta at the inflow of Lake Munson and Lake Henrietta were removed. Lake Henrietta, just upstream, was reconstructed to increase water capacity (Tallahassee Democrat, July 2, 2001). Willow trees became established throughout the center of Lake Munson during the drought; in 2005 these trees began to die, allowing improved circulation within the lake. An additional six million will be used to complete removal of sediments from the lake bottom.

Thirteen years of data show that Lake Munson always exceeds the natural background values for good water quality. Midwater and surface values of Dissolved Oxygen in Lake Munson are usually adequate to sustain fish populations; however, the preponderance of high values where the Dissolved oxygen is supersaturated is a sign that the vegetation is out of control. The abundance of aquatic algae in the lake contributes to diurnal fluctuation of dissolved oxygen concentrations. Fish kills occur when the dissolved oxygen concentrations bottom out. The majority of the chlorophyll values in Lake Munson exceed eutrophic values.

Typical of lakes impacted by stormwater runoff, pulses of nitrate and phosphate occur regularly; high concentrations of ammonia within Lake Munson occur regularly (this indicates anaerobic decay); high concentrations of phosphate within Lake Munson have

occurred -regularly. These conditions fuel plant growth and elevate the trophic status of the lake.

The thirteen-year average TSI values for Lake Munson are just below the impairment level. This is misleading however, because Lake Munson is a flow through system. The older water in the lake disappears into the aquifer. The lake's water does not stay there and may not have the necessary residence time to develop algal growth used to measure TSI.

Since the drought there has been improving water quality trends in Lake Munson. This is due to restoration activities begun by Leon County and the Florida Wildlife Commission, such as removing sediments, treating stormwater, and creating a condition of constant flow through the lake.

In late 2005 invasive exotic Channeled Apple Snails appear to have eaten most of the aquatic vegetation in Lake Munson. Before this it was almost impossible to get a boat through Lake Munson. Now it is easy to get a boat across Lake Munson but the water has had a persistent algal bloom since September 2005. This algal bloom is composed of Microcystis, a species of bluegreen algae that are known to produce algal toxins. These toxins are hepatotoxins, teratogens, neurotoxins and tumor promoters. Unfortunately these toxins are present in the waters of Lake Munson and have been detected at significant levels with the lake several times over the past year. Since the algal bloom has been persistent over that time the toxins have probably been there too. The water from Lake Munson flows into a sinkhole (Aimes Sink), which flows to Wakulla Springs in about a week's time.

Figure 5.3.2.7: Invasive exotic Channeled Apple Snails, *Pomacea canaliculata*, have been found in Lake Munson. First picture depicts a snail on a lily the second pictures shows the characteristic pink egg clusters on a bottle floating in Lake Munson.

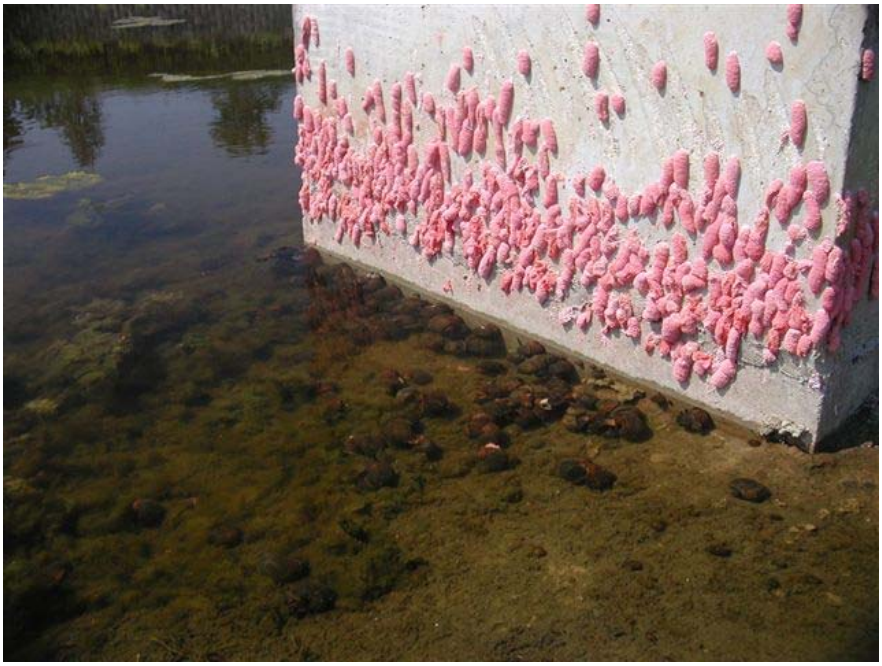

Figure 5.3.2.8: Invasive Exotic Channeled Apple Snail eggs on a control structure

Figure 5.3.2.9: Invasive Exotic Channeled Apple Snail eggs on a cypress knee (photo by Mike Ewen, Tallahassee Democrat, 05/06)

Figure 5.3.2.10: Aerial View of Lake Munson before the snails, looking north up Munson's Slough

Figure 5.3.2.11: Aerial view of Lake Munson looking north, after the snails. Note the difference in the aquatic vegetation. The invasive exotic Snails have consumed most of the macrophytes, which have been replaced by a toxic algal bloom (see green algal scum in lower right corner of lake) 11/05.

Algal toxin analysis (Lake Munson) – The drinking water threshold effects level for the cyanobacterial toxin microcystin, as defined by the World Health Organization (WHO), is 1.0 µg/L MCLR. No other Algal toxin standard exists. Algal blooms were sampled in Lake Munson on 9/23/05 and 5/1/06 and they contained harmful algae and exceeded the WHO standard. Microcysitis algae was found. Microcystin, an algal toxin, was assayed at 54.4 ug/L on 9/23/05 at and 26 ug/L on 5/1/06. There have been problems associated with incidental contact with water containing algal toxins and these blooms are properly termed Harmful Algal Blooms (HAB). The waters of Lakes Munson are connected to the aquifer by sinks and could potentially impact drinking water. The algal toxin analytical results from Green Water Labs and a poster from the Florida Department of Health are included (suggested for use in affected waters).

Figure 5.3.2.12: Lake Munson Algal Bloom at old boat ramp (photo by Mike Ewen, Tallahassee Democrat, 05/06).

Figure 5.3.2.13: Lake Munson Algal Bloom at new boat ramp. Note the Channeled Apple Snail eggs on the cypress trees (photo by Michael Hill, FWC 05/06).

Figure 5.3.2.14: Poster recommended for use in affected waters by FDOH.

GreenWater laboratories — aquatic analysis ... research ... consulting

Microcystin Analysis Report

Project: McGlynn Laboratory

Sample Identification	Sample Collection Date
LPZ1-North	060501
Lake Jackson	060501
Lake Munson	060501

Sample Prep – The samples were sonicated, filtered and diluted (when appropriate) prior to analysis. All samples were run in duplicate. In addition, a spiked (1.0 µg/L MCLR) sample of Lake Jackson and a 1.0 µg/L MCLR standard were also run for both qualitative and quantitative assurance.

Analytical Methodology – A microcystins enzyme linked immunosorbent assay (ELISA) was utilized for the quantitative and sensitive congener-independent detection of MCs. The current ELISA kit is sensitive to all MCs (LR, LA, RR, YR, etc.) down to a detection/quantification limit of 0.15 µg/L. The MCLR standard and Lake Jackson spike recoveries averaged 90% and 115%, respectively.

Results Summary

Sample	Date of Collection	MC levels (µg/L)
LPZ1-North	060501	≈ 10.0
Lake Jackson	060501	≈ 0.5
Lake Munson	060501	≈ 26.0

Cyano LAB

205 Zeagler Drive, Suite 302 • Palatka, FL 32177
info@greenwaterlab.com • www.greenwaterlab.com
386.328.0882.voice • 386.328.9646.fax
cyanomail@cyanolab.com • www.cyanolab.com

Figure 5.3.2.15: Algal toxin analysis results from Greenwater Labs in Palatka.

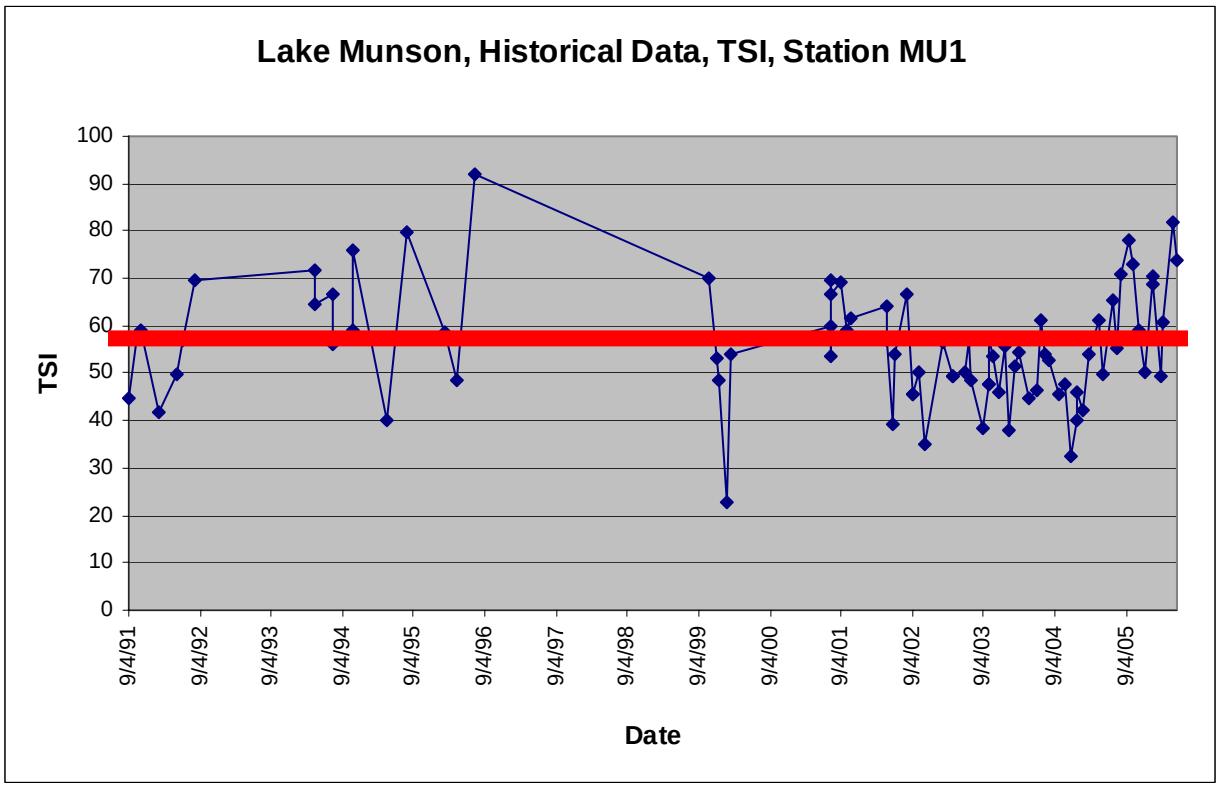

Figure 5.3.2.16: Lake Munson,
Station MU1,
Tannic lake,
According to FDEP criteria this lake would be impaired at TSIs greater than 60 units,
Data duration:09/91-06/06,
Data source LCL Data (McGlynn Laboratories Inc), data from before 1997 LCL Data (CARRMa).

*** Result: possibly impaired and getting worse.**

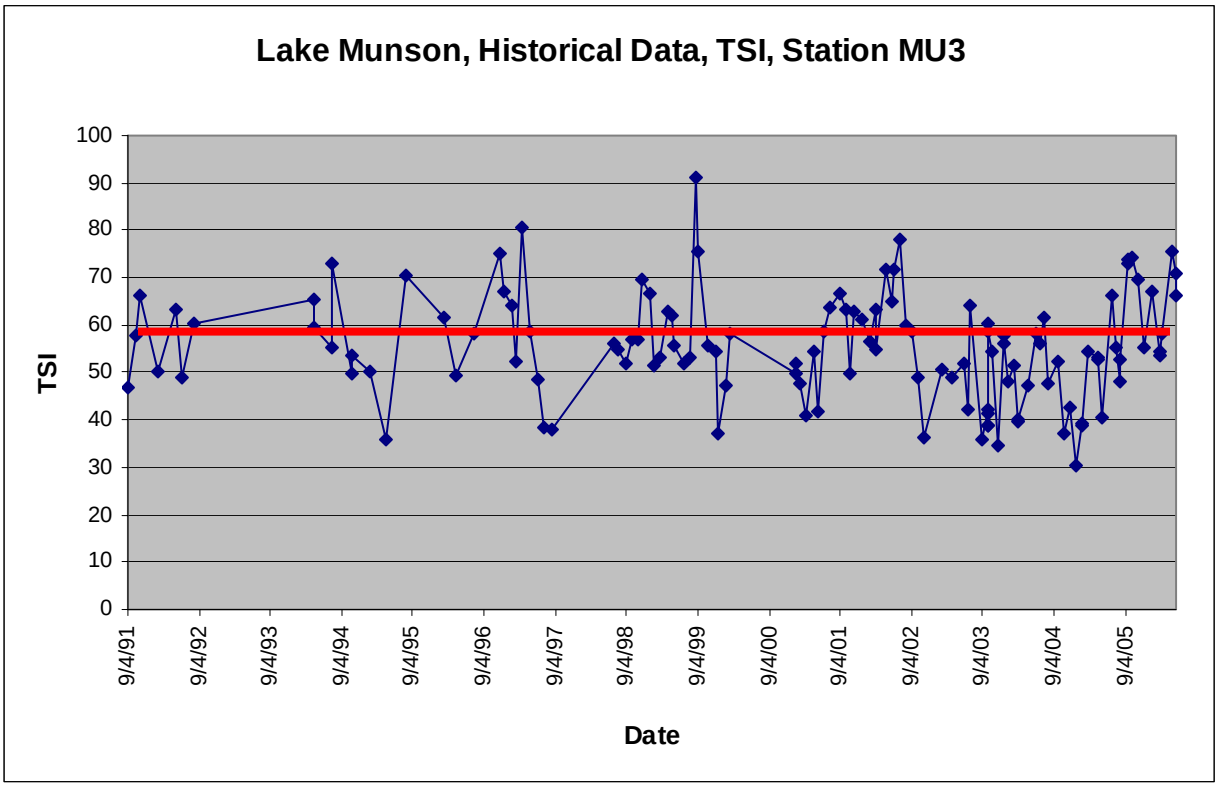

Figure 5.3.2.17: Lake Munson,
Station MU3,
Tannic lake,
According to FDEP criteria this lake would be impaired at TSIs greater than 60 units,
Data duration:09/91-06/06,
Data source LCL Data (McGlynn Laboratories Inc), data from before 1997 LCL Data (CARRMa).

*** Result: possibly impaired and getting worse.**

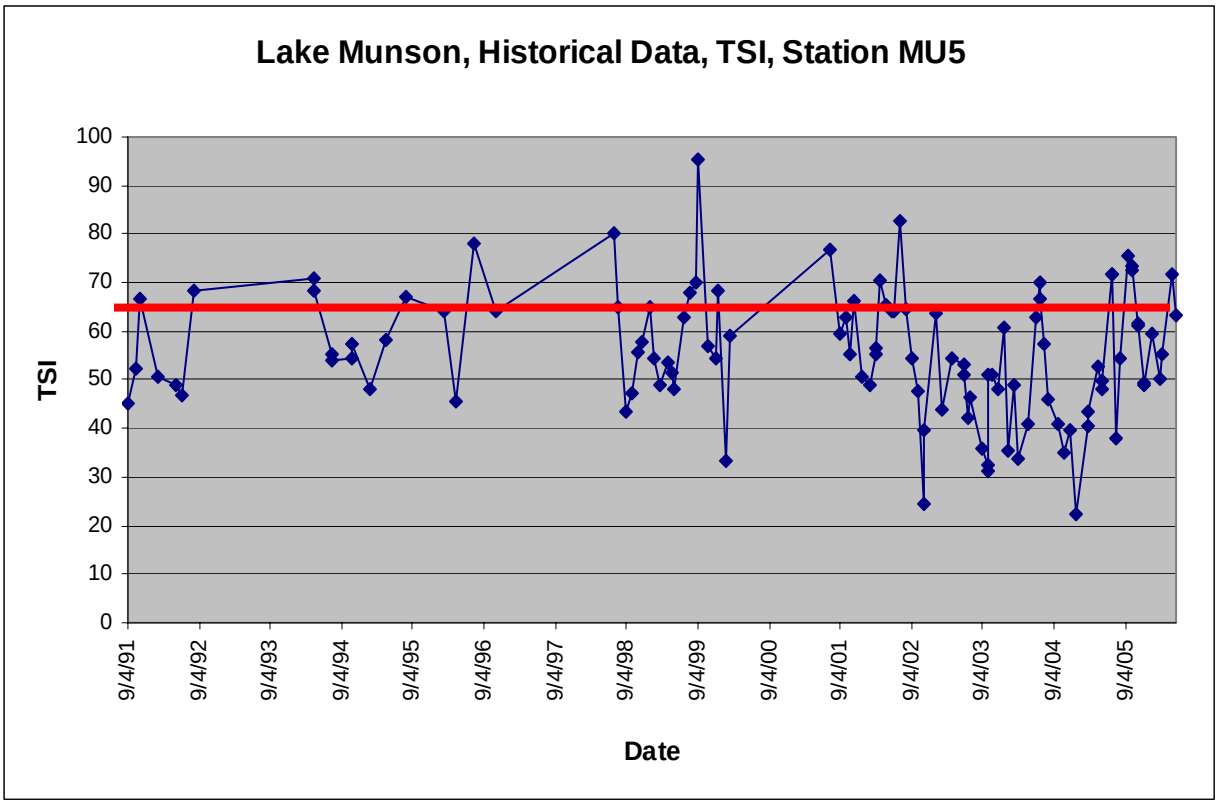

Figure 5.3.2.18: Lake Munson,
Station MU5,
Tannic lake,
According to FDEP criteria this lake would be impaired at TSIs greater than 60 units,
Data duration:09/91-06/06,
Data source LCL Data (McGlynn Laboratories Inc), data from before 1997 LCL Data (CARRMa).

*** Result: borderline potentially impaired and possibly getting worse.**

5.3.2A: Cleaning up the Stormwater

The St. Augustine Branch and Munson Slough

The following is an early account of the upper portion of the Lake Munson Watershed. "It might well be the land of the fairies: to the southward and westward, the country opens like a magnificent park, gently undulating and studded with beautiful basins of limpid water, at their feet a crystal fountain, gushing from a declivity of a hill… falling over a ledge of rocks into a deep glen, which forms almost a circle of about seventy yards in diameter, and disappears at the bottom of the same ledge of rocks, very near the cascade (Pensacola Gazette, Sept., 1825)."

The St. Augustine Branch arose from several springs; one was located on at the site of Leon High School. One was the source of water for the Apalachee Indian village and was near the site of the Parkway Shopping Center. One was located in Myers Park. The only surviving spring is located off Call Street in Magnolia Ravine. The spring fed waters of the St. Augustine Branch fell in the waterfall or cascade into a sink near the Capitol Building. This area was known as the 'County Club' area where several of our early Governors lived (Governors Broward and Duval). The falls were destroyed in the 1860's by the railroad when they discarded used railroad ties in the sink, clogging it.

Figure 5.3.2A.1: An early drawing of the Cascade Sink and waterfall (~1820).

The Cascades Sink became a small lake and a popular swimming hole off the east side of South Monroe where the railroad overpass was constructed. It was even the site of a high diving competition, off the bluffs, and a suicide. Eventually as the little lake began to fill in with trash and sediment it became marshy and being near the railroad attracted vagrants. The City Dump and a Coal Tar Gasification Plant were located here. By 1959 the little lake was completely filled in (Lammers, 2000).

Figure 5.3.2A.2: This postcard, probably from around 1910, depicts two ladies enjoying an afternoon at Cascade Sink, a popular swimming hole.

Once the Cascade Sink filled in the St. Augustine Branch began to flow on to Lake Munson since it no longer disappeared into the ground. Two sites on this watercourse were contaminated with toxics. The Coal Gasification Plant, on the site of the sink caused the soils to be contaminated with petroleum hydrocarbons like Polynuclear Aromatic Hydrocarbons. The site of the Elberta Crate Factory was contaminated with creosote. The St. Augustine Branch is now filled with urban storm water that flows into Lake Munson. Two holding ponds have been built to relieve flooding and water quality issues (Elberta Crate and Lake Henrietta). The excavation of the pond at Elberta Crate also removed the contaminated soils. Both these ponds had trouble with sinkholes opening in them. Elberta Crate Pond has had over 30 sinks open in it since it was built. A large sinkhole also opened in Lake Henrietta during construction in 2001.

A chain of ponds is proposed in the Blueprint 2000 program for the old St. Augustine Branch starting at the site of the former Cascade Sink and extending between the FAMU and FSU campuses to the Alberta Crate Pond. The last segment (downstream near Springhill Road) has the greatest opportunity for treatment. The furthest upstream pond they proposed is a 50 foot deep pond at the site of the Cascade Sink. This will be constructed to remove soil contaminated by a coal tar gasification plant that once occupied the site. There is a high probability that sinkholes will form in this area. According to the project engineers there will be no water quality treatment upstream from the Cascade Pond. The water quality in this pond will be very bad unless a high maintenance treatment system is added. The problems with the drainage, most to the north of Tennessee Street need to be addressed or this project will be no more than a bandage, a temporary fix to a long standing problem in the heart of Tallahassee that needs to be addressed if future growth is anticipated. Burying the St. Augustine Branch, as planned in the downtown area, will remove all water quality considerations since the Branch will no longer exist as surface water and will be an underground pipe (box culvert). This is not a solution since it merely transports the stormwater water elsewhere.

Figure 5.3.2A.3: The Coal Gasification Plant, seen here just behind Centennial Field in the early 1960's. The plant contaminated the soils at the site of the old Cascade Sink.

Figure 5.3.2A.4: Elberta Crate in the 1930's, where the soils were contaminated with creosote.

Figure 5.3.2A.5: Sinkholes in Elberta Crate Pond, 2002, when the contaminated soils were removed the resulting pond was developed over 30 sinkholes. These numerous sinks were filled with grout. Lime rock pinnacles weakened the clay liner. Similar conditions exist beneath the Civic Center and the Seminole Stadium. This is implies caverns.

Figure 5.3.2A.6: The inflow to the Elbrta Crate Stormwater Pond. This water comes from a recently completed box culvert in which a creek (Budweiser Creek) that once flowed through the FSU campus was buried.

Figure 5.3.2A.7: The cypress trees in Lake Henrietta were cut down and it was modified into a stormwater facility. A large sinkhole that opened during construction is visible to the upper left

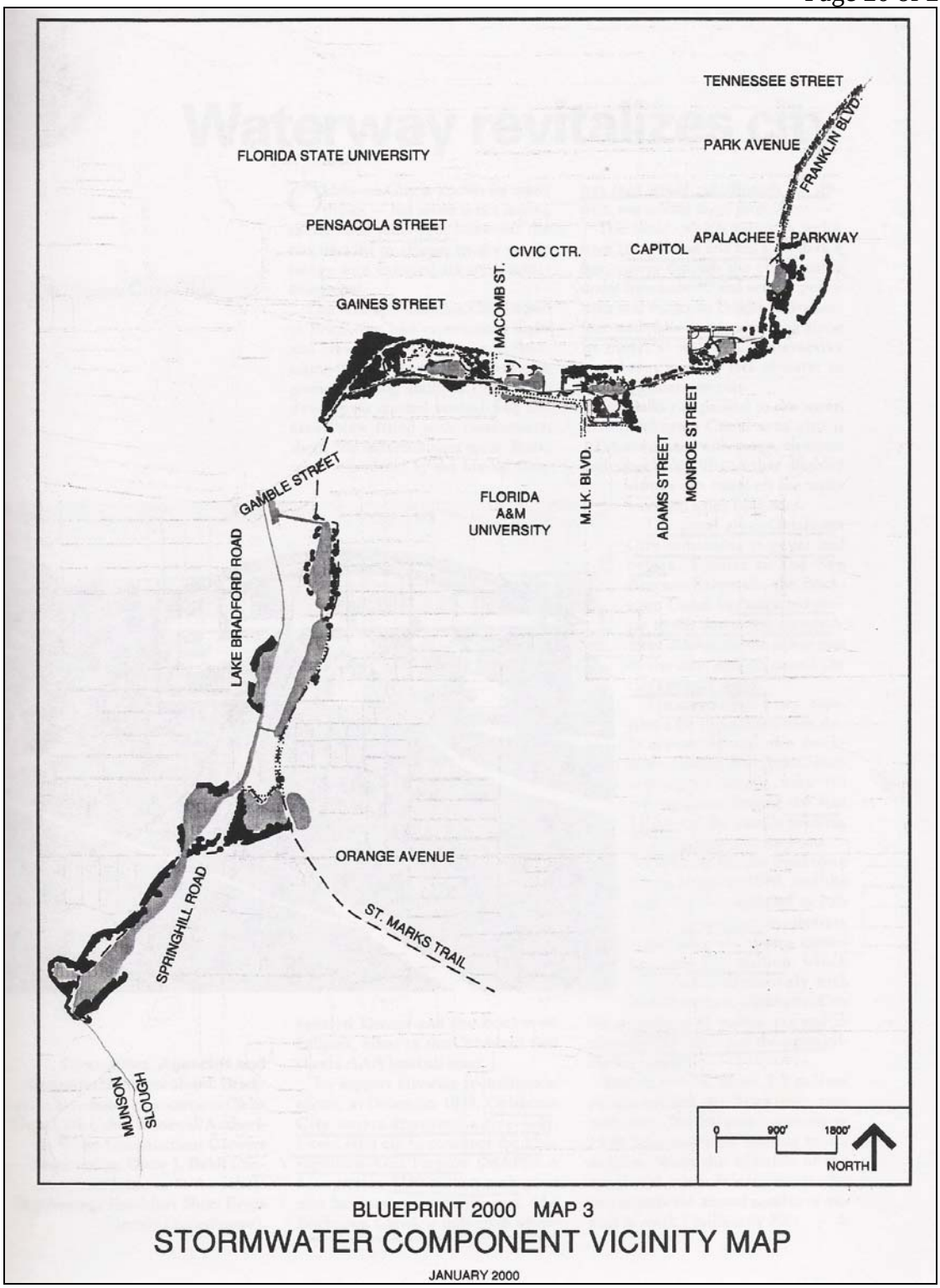

Figure 5.3.2A.8: The original proposed Blueprint stormwater map depicts the drainage and sequence of ponds. This will be revised many times before the project is completed. Hopefully the final designs will maximize water quality treatment.