LAKE LAFAYETTE MANAGEMENT:

A Report Outlining Lake Shore, In-Lake and Land Use Management Proposals

Helge R. Swanson
Mellini Sloan
and
Natalya Chernets

A report prepared at the request of the Leon County Board of County Commissioners and in conjunction with Robert J. Livingston, Center for Aquatic Research and Resource Management

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Department of Growth and Environmental Management
Gary W. Johnson, Director

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ACKNOWLEDGMENTS

Special thanks for the preparation of this publication are given to Tammy Jessup and Rhonda Tucker for word processing, Joe Noble for G.I.S. and research assistance, and to Robert J. Livingston of Florida State University for Scientific review and reference materials.

EXECUTIVE SUMMARY

Lake Lafayette has been degraded by urban stormwater and point source discharge. Due to long-term, unmitigated urban and structural abuse it has been brought to the edge of complete ecological collapse. The continuously degrading ecological condition of the lake, presenting a disturbing environmental problem *per se*, also threatens the federal, state and locally protected Woodstork population at the rookery site in Lower Lake Lafayette. It may also adversely affect the St. Marks River system, one of the state's designated "Outstanding Florida Water", and strongly suggests adverse groundwater impacts due to stormwater discharge through the Upper Lafayette sink.

An extensive examination of the up-land geographical areas contributing surface water runoff to the various lake "hot spots" has been completed, with attention given to land uses and drainage system characteristics within these associated watersheds. Significant adverse impacts directly associated with these urban water inflow points, have been documented (Livingston 93, and Swanson, 95). Lower Lafayette reflects particularly acute water quality problems, the result of long-term non-point source stormwater inflow through Alford Arm, and point-source discharges from adjacent, high intensity facilities.

An immediate and comprehensive management program for Lake Lafayette is necessary in order to provide the lake with a chance of avoiding complete ecological collapse. The offered management program consists of strategies for land use controls, in-lake management and

clean-up, and subsequent research and monitoring. As a starting point for management and consistent with the current requirements of the Leon County Land Development Regulations, this report advocates the designation of selected areas of the Lake Lafayette drainage basin as a special development zone with the specific proposed restrictions. It is also recommended that stormwater retrofit should be given a top priority, with necessary funding provided through the County's Stormwater Utility and negotiated cost sharing initiatives with the City of Tallahassee and other willing agencies of the state or federal government.

INTRODUCTION

Lake Lafayette has been degraded by urban stormwater and point source discharges. The lake reflects considerable and long-standing abuse from a variety of geographical and anthropogenic sources which have affected many elements of the lake's natural environment. Additional, and as yet unquantified, groundwater impact at the upper Lafayette sink is suspected, and should be investigated further. There is also concern for the federal, state and locally protected Woodstork population at the rookery site in lower Lafayette (Brakhage, et al.1994). Similarly, a potential for adverse impact exists concerning the St. Marks River system, a state designated "Outstanding Florida Water." In short, this lake is a disturbing case study in the destructive potential of long-term, unmitigated urban and structural abuse. Although this situation has occurred in such close proximity to Florida's capitol, and in the area under the jurisdiction of numerous state, federal and local agencies, no studies previous to Livingston (1993) even hint at the lake's degraded condition.

An immediate and comprehensive management program for Lake Lafayette is necessary in order to provide the lake with a chance of avoiding complete ecological collapse. As a starting point for management and in conformity with section 10-192 of the Leon County Land Development Regulations, this report advocates the designation of a special development zone around the lake and its primary tributaries, as a first step toward

such a management program. Specifically, the referenced special development zone enabling legislation provides that:

> The Board of County Commissioners may designate special development standards for environmentally sensitive zones adjacent to watercourses or receiving water bodies and in other environmentally sensitive areas within any watershed where additional or more stringent minimum design and development standards shall apply.
>
> Design and development standards shall be established to minimize the adverse environmental impacts associated with both the extent of development activity and the type of land uses permitted within or adjacent to sensitive environmental features such as watercourses, water bodies, wetlands, and areas subject to periodic flooding. (Environmental Management Act, 1992, Section 10-192).

This strategy, while preserving the critical littoral and floodplain ecotone, is not, by itself, sufficient to address the larger management needs of Lafayette. A full scale, basin-wide water quality retrofit, along with a flood plain restoration initiative and a revised land development scenario are also needed as components of the county's and city's stormwater utility program and comprehensive plan land use designations.

The analytical section of this report presents an overview of the relevant scientific and technical findings which support this call for action. Details of the management program address land use controls; in-lake clean-up strategies; and specifically targeted, subsequent research for consideration of implementation by the Leon County Board of County Commissioners and other governmental entities as appropriate. Selected terms

and concepts which may not be common knowledge are explained in the glossary at the end of this report.

The following section contains material summarized from the report, "The Ecology of the Lakes of Leon County, Florida" (Livingston and Swanson, 1993) which, along with the five volume set, "First Year Report: The Ecology of the Lakes of Leon County, Florida" (Livingston, 1993), are the principle scientific and technical basis supporting the conclusions and recommendations offered in this report. Wherever additional references have been used, they are noted accordingly. Other general materials used in the preparation of this report are listed in the bibliography.

ANALYSIS

The Lake Lafayette Lowlands physiographic region includes all of Lake Lafayette itself, as well as its associated, adjacent wetlands and floodplains (Swanson et el.,1992). The region extends westward to Weems Road, northward around Alford Arm, and southeasterly to the junction of the St. Marks River Lowlands region. The lowland region encompasses 19.7 square miles; the lake itself is the receiving waterbody for a 79.7 square mile (51,000 acre) drainage basin (Figure 1).

Lake Lafayette is essentially four interconnected lakes, the result of several structural alterations to the lake system over a number of years. This is important in

evaluating the ecological response of the lake to various stressors, given that upland pollution contributions and in-lake responses vary from area to area more extensively than otherwise might be the case. The lowlands, created over time by the widespread solution of the underlying limestone, receive surface water from the adjacent, higher Tallahassee Hills physiographic region. During the Pleistocene period, the lake area was probably an estuary associated with the ancient Wicomico shoreline. Within the lake lowlands various sinks are still present through which there is interaction with the groundwater.

Lake Lafayette's geographical problem areas include: (1) the Alford Arm watershed, a receiving area for surface water drainage from approximately 24,000 acres extending northward through the recently incorporated area of Welaunee Plantation; the mixed use Killearn Estates development, and neighboring residential subdivisions up to and including the Lake McBride watershed near the intersection of Thomasville, Bradfordville and Bannerman Roads; (2) Upper Lake Lafayette and its contributing watersheds, including the heavily urbanized West Basins of the city of Tallahassee; (3) the artificially impounded Piney Z Lake, cut from the middle of the historical lake bed; and, (4) Lower Lafayette and its contributing watersheds, a large pond cypress lake. Figure 2 is a reference map for the Lake Lafayette Drainage Basin. Figure 3 shows the watersheds and closed basins contained within the Lake Lafayette Basin; Table 1 is an index of basin names.

FIGURE 1
LOCATION OF THE LAKE
LAFAYETTE DRAINAGE BASIN

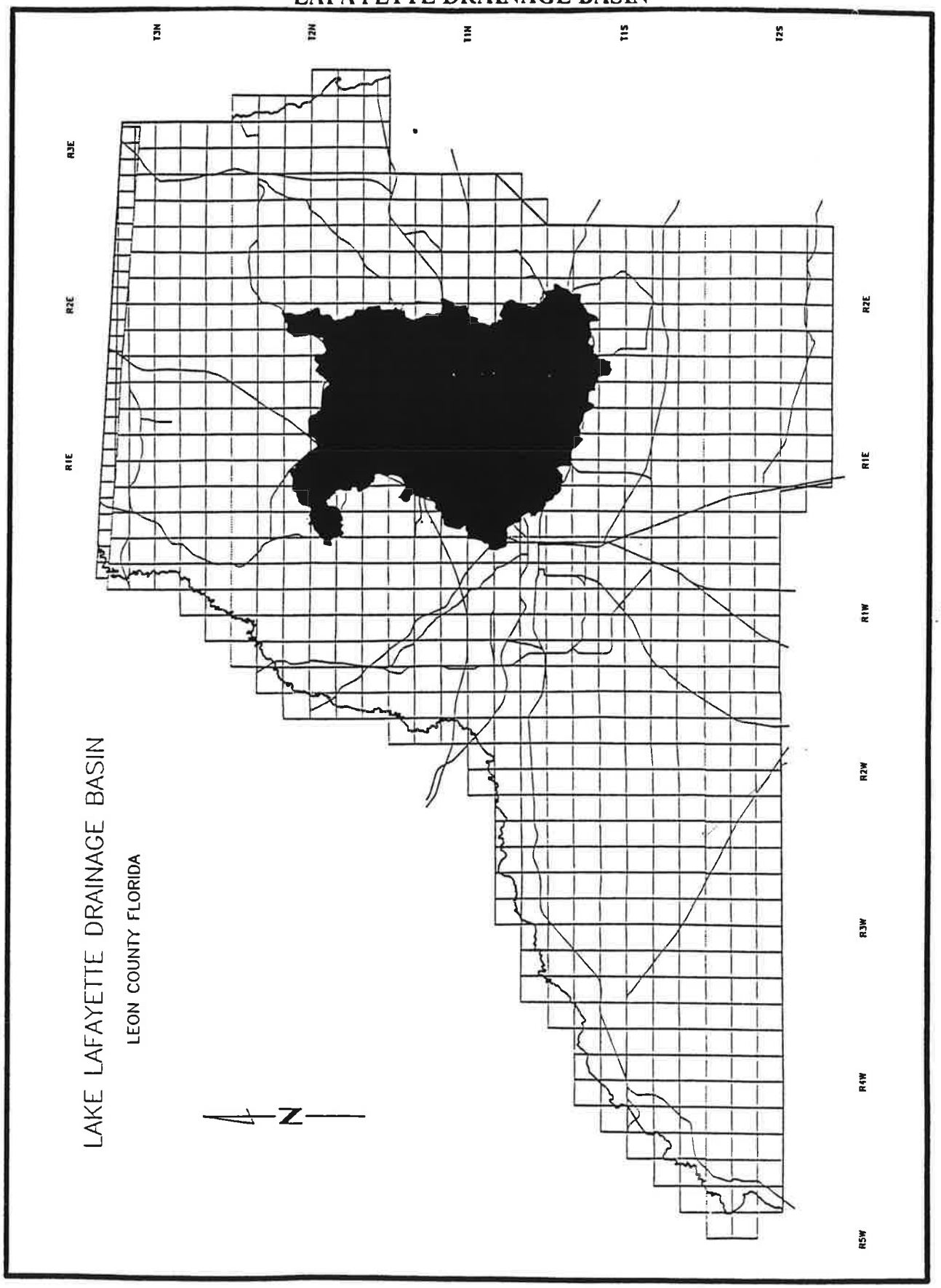


FIGURE 2

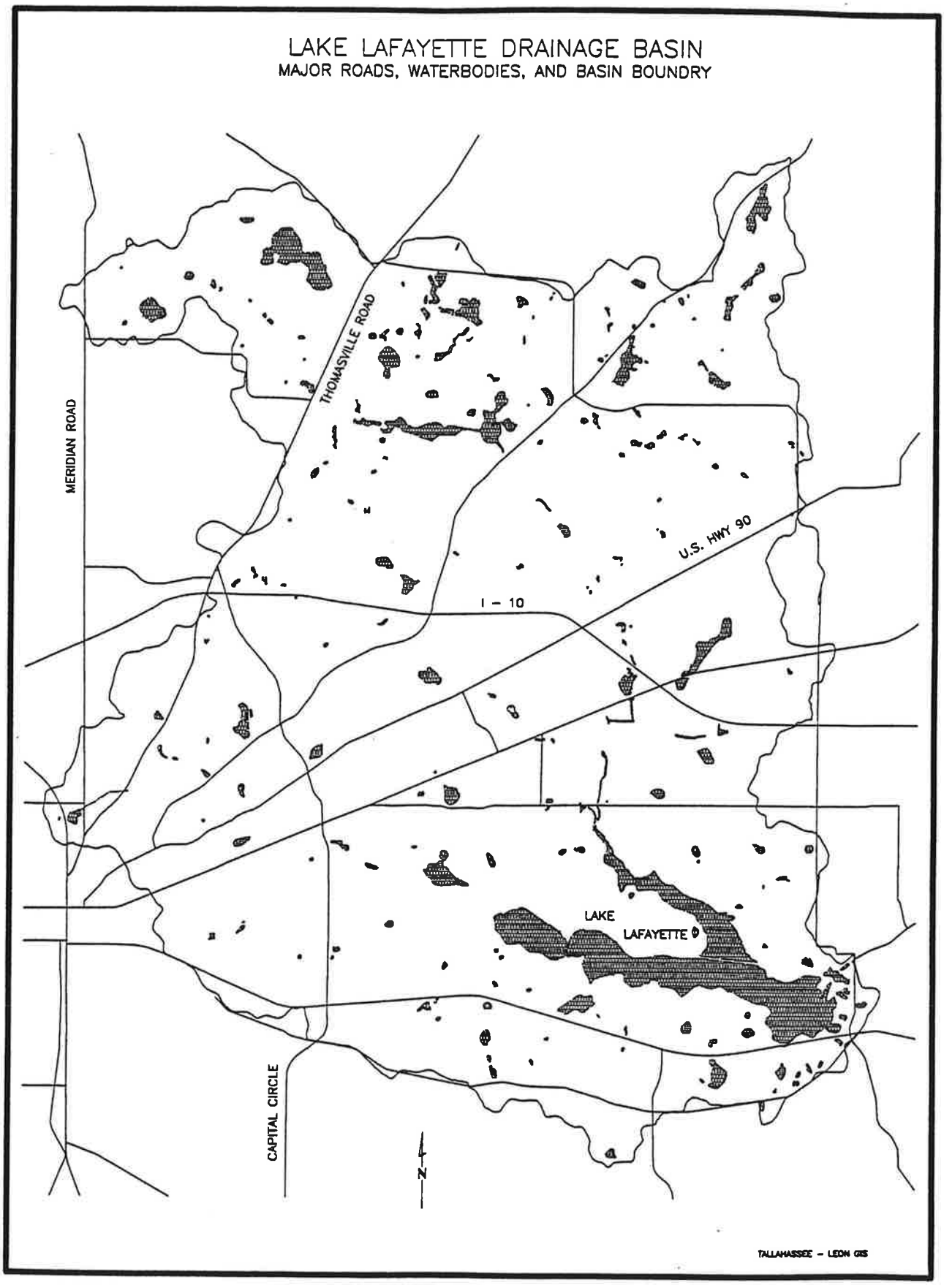

LAKE LAFAYETTE DRAINAGE BASIN
MAJOR ROADS, WATERBODIES, AND BASIN BOUNDRY
MERIDIAN ROAD
THOMASVILLE ROAD
U.S. HWY 90
I – 10
LAKE
LAFAYETTE
CAPITAL CIRCLE
N
TALLAHASSEE – LEON GIS

FIGURE 3
LAKE LAFAYETTE DRAINAGE BASINS
WATERSHEDS AND CLOSED BASIN BOUNDARIES

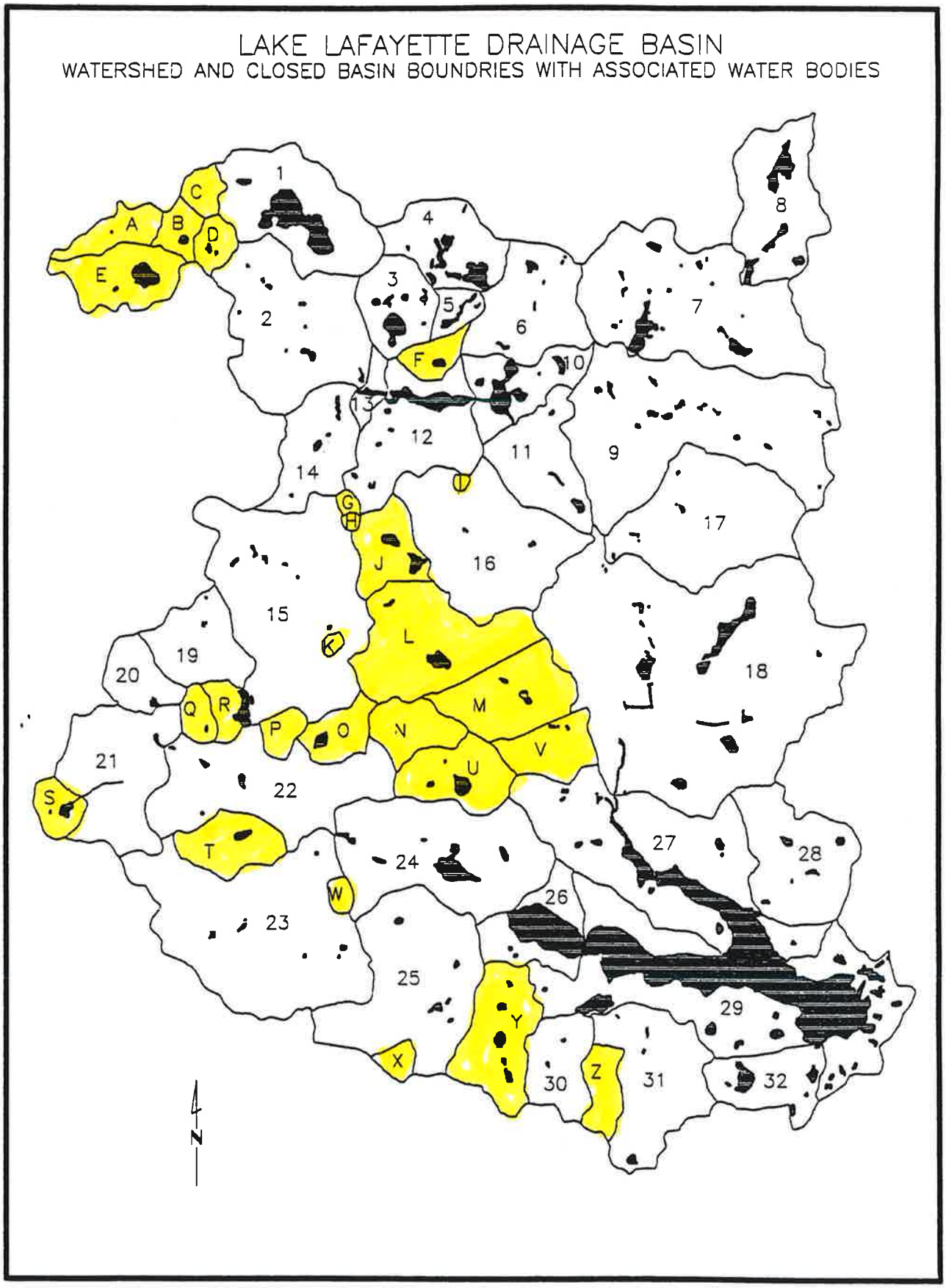


TABLE ONE

LAKE LAFAYETTE WATERSHEDS AND CLOSED BASINS

INDEX

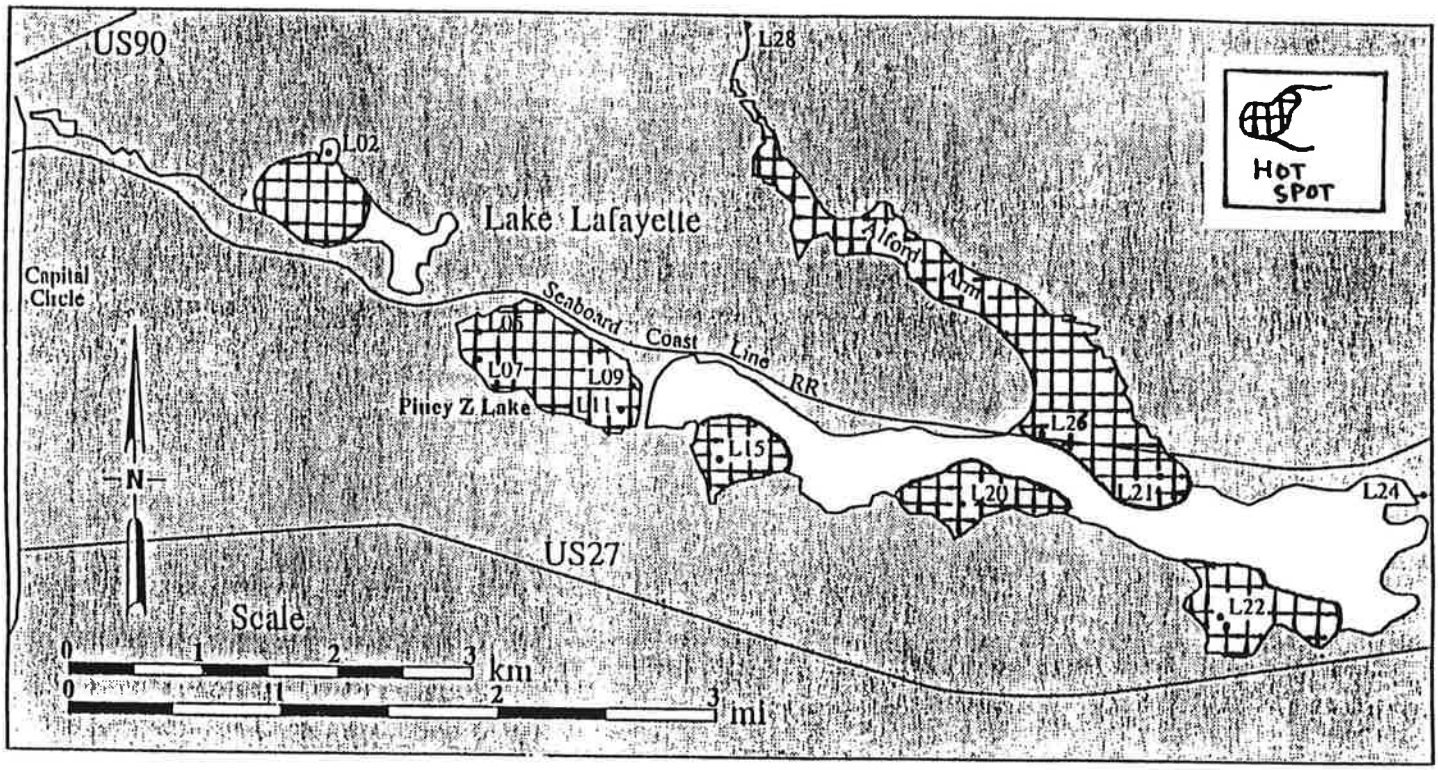
CLOSED BASINS	ACREAGE	%	WATERSHEDS	ACREAGE	%
A - SMITH # 1	287	0.54	1 - LAKE McBRIDE	1286	2.42
B - SMITH # 2	182	0.34	2 - MILLSTONE CR.	1647	3.10
C - SMITH # 3	153	0.29	3 - LAKE TOM JOHN	621	1.17
D - SMITH # 4	179	0.34	4 - GILBERT POND	725	1.37
E - MOORE POND	587	1.11	5 - LAKE KILLKEE	169	0.32
F - LAKE SHEELIN	204	0.38	6 - LAKE SARATOGA	955	1.87
G KILLENEY PLAZA	39	0.07	7 - ROBERTS PONDS	2175	4.10
H - FOLEY DRIVE	40	0.07	8 - DESOTO LAKES	1046	1.97
I - CELEB. BAPT. CH.	20	0.04	9 - MARTINEZ	2701	5.09
J - WITFIELD PLAN.	450	0.85	10 - LAKE KANTURK/BEL.	603	1.14
K - ST. PETERS	32	0.06	11 - LOWER KANTURK	695	1.31
L - WELAUNEE	1214	2.29	12 - LAKE KILLARNEY	1120	2.11
M - LAFAYETTE OAKS	590	1.11	13 - LAKE KINSALE	125	0.23
N - MAYLOR	350	0.66	14 - ROYAL OAK CR.	704	1.33
O - CMC	330	0.62	15 - GOOSE POND	2187	4.12
P - MELODY HILLS	152	0.29	16 - MT. HORNBEM CH.	1724	3.25
Q - FLEISMAN RD.	163	0.30	17 - MILES	1543	2.91
R - HARRIMAN CIR.	157	0.29	18 - I - 10 / 90	3200	6.03
S - LAKE ELLA	206	0.39	19 - PIEDMONT	675	1.27
T - PHILLIPS ROAD	413	0.78	20 - WAVERLY	376	0.71
U - BUCK LAKE	530	1.00	21 - McCORD PARK	998	1.89
V - PEDRICK	440	0.83	22 - BETTON WOODS	1781	3.36
W - FCI	76	0.14	23 - E. PARK AVE	2560	4.82
X - SOUTHWOOD PLAN. RD.	109	0.20	24 - UPPER LAKE LAFAYETTE	1527	2.88
Y - MOM AND DAD'S	768	1.45	25 - LINCOLN HIGH	1903	3.59
Z - EAST PARKWAY	261	0.49	26 - PINEY Z	627	1.18
			27 - ALFORD ARM	3683	6.94
			28 - E. SPRING CHURCH	1053	1.98
			29 - LOWER LAKE LAFAYETTE	3200	6.03
			30 - MT. SINAI	519	0.98
			31 - VERDURA II	1018	1.92
			32 - LAKE HERITAGE	519	0.98

In general, Lake Lafayette has indications of severe adverse ecological impacts in the upper, central and lower portions. Information presented in Figure 4 indicates the Lake Lafayette's "hot spots", based on the geographical distribution of adverse water quality indicators given by Livingston (1993) (Table 2). No empirical evidence of water quality impacts or ecological conditions of the lake existed prior to that study. It had been generally assumed that only Upper Lake Lafayette and Alford Arm were vulnerable to degradation. This assumption was based on known stormwater inflows from urban areas to these lake segments, but it was also assumed that they, in turn, buffered the Lower Lafayette area.

An examination of the "hot spots" map indicates that this assumption was false. In fact, significant adverse impacts, directly associated with urban stormwater inflow points, are evident in all lake segments. The following adverse indicators from Livingston (1993) support this conclusion: high conductivity, low dissolved oxygen, minimum Secchi readings, extreme hypoxia, high color, high chlorophyll a, periodic hypereutrophication, high bottom organic nitrogen, high nitrogen compounds, high ammonia, high total kjeldahl nitrogen (T.K.N.), high total phosphorus, high orthophosphorus, high organic carbon, high particulate organic matter (P.O.M)., high turbidity and high total suspended solids (TSS).

An examination of the geographical areas contributing surface water runoff to the various "hot spots" of Lake Lafayette has been completed. This examination focused on land uses and drainage system characteristics within the associated watersheds. Field

FIGURE 4
LAKE LAFAYETTE "HOT SPOTS"
Areas of Adverse Ecological Conditions



Based on Livingston and Swanson (1993)

TABLE 2:

Summarized Adverse Water Quality Indicators for Lake Lafayette "Hot Spots"

UPPER LAFAYETTE	PINEY Z	LOWER LAFAYETTE	ALFORD ARM
Station L02	Station L05	Station L15	Station L26
Very high ammonia	High concentrations of	Extreme hypoxia	Periodically hypereutrophic
High chlorophyll a	submerged aquatic	High ammonia	High organic carbon
High conductivity	vegetation	High bottom organic nitrogen	High chlorophyll a
High T.K.N.	High chlorophyll a	Station L20	High particulate organic
High nitrogen compounds	High nitrogen compounds	Extreme hypoxia	matter
High orthophosphorous	Station L07	Periodically hypereutrophic	High bottom organic nitrogen
High silica	High concentrations of	High organic carbon	High total suspended solids
High turbidity	submerged aquatic	High chlorophyll a	Station L28
	vegetation	High color	Periodically hypereutrophic
	Station L09	Station L21	High chlorophyll a
	High concentrations of	Extreme hypoxia	High bottom organic nitrogen
	submerged aquatic	High color	High total phosphorous
	vegetation	Station L22	
	High particulate organic	Extreme hypoxia	
	matter	Periodically hypereutrophic	
	Station L11	High organic carbon	
	High concentrations of	High ammonia	
	submerged aquatic	High chlorophyll a	
	vegetation	High color	
	High particulate organic	High conductivity	
	matter	High T.K.N.	
		High nitrogen compounds	
		High orthophosphorous	
		Low dissolved oxygen	
		High turbidity	
		High bottom organic nitrogen	
		High total phosphorous	
		High total suspended solids	
		Minimum secchi readings	
		Station L24	
		Extreme hypoxia	
		High color	
		High bottom organic nitrogen	

checks and in some cases, detailed studies were completed for selected areas of high density or intensity land use..

Historic anthropogenic alterations to the Lake Lafayette drainage basin and to the lake itself have been extensive and pervasive. Virtually all of the western, northwestern and southern tributaries to the lake have been ditched or have had storm sewers installed. Marshes, sloughs and wetlands have been drained and filled. Unmitigated (pre-ordinance) urban development now fills much of the adjacent upland area, replacing virtually all natural ecosystems and native plant communities. The lake itself has been dissected by impoundments, and a ditched outfall lowering normal pool elevations was installed to facilitate flow to the St. Marks drainage basin. In short, all elements of the lake's natural hydrocycle have been affected, resulting in an aquatic ecosystem radically different from its original, homeostatic condition. These factors, in combination with lack of public access and awareness, governmental ambivalence, and no previous scientific attention have brought the lake to the edge of collapse.

Upper Lake Lafayette

During most of the Florida State University sampling period, Upper Lake Lafayette (the western section of the historic lake bed) was dry, except for the small pond adjacent to Upper Lafayette Sink. It was evident that this lake bottom area, including a large sinkhole and a small perennial pond, received stormwater of relatively poor quality from upland commercial and industrial areas. "Hot spots" associated with Upper Lake Lafayette are directly related to inflows from urbanized, eastern Tallahassee and its channelized watercourses. Some of the highest conductivity levels in the entire survey were noted in this area during the fall of 1991, a finding consistent with the massive inflows of stormwater. Secchi depths were minimal and dissolved oxygen was low even during winter periods. The westernmost sampling station, L02 was characterized at the surface level by high color and turbidity, moderately high chlorophyll a, and high ammonia, total nitrogen, and total phosphorus concentrations. At depth, ammonia levels were even higher, along with relatively high total nitrogen and total phosphorus. Nutrient loading was typically highest during summer-fall months. Of critical concern, is the fact that these adverse indicators are in the backwater pool associated with the Upper Lafayette Sink, a direct conduit into the groundwater. For example, sediment cores taken at 80 feet into the sink were found to contain PAH's, potentially dangerous pollutants associated with stormwater runoff.

Although the Upper Lafayette watershed (1,527 acres) adjacent to the lake is sparsely developed, the area contains the large, currently pending, Falls Chase Development (Figure 5). The expansive Lincoln High watershed (1,903 acres) to the south of the lake contains a mixture of both widely scattered and selectively concentrated urban development, including residential, commercial, industrial, institutional and transportation land uses. The 2,560 acre East Park Avenue watershed contains extensive urban development, including major commercial activity areas along U.S. 27 South (Apalachee Parkway), and numerous single family neighborhoods, multi-family apartment complexes and single family attached units throughout the Park Avenue vicinity area. Closed basins include Southwood Plantation (109 acres) and the Federal Correctional Institute (F.C.I.). basin (76 acres).

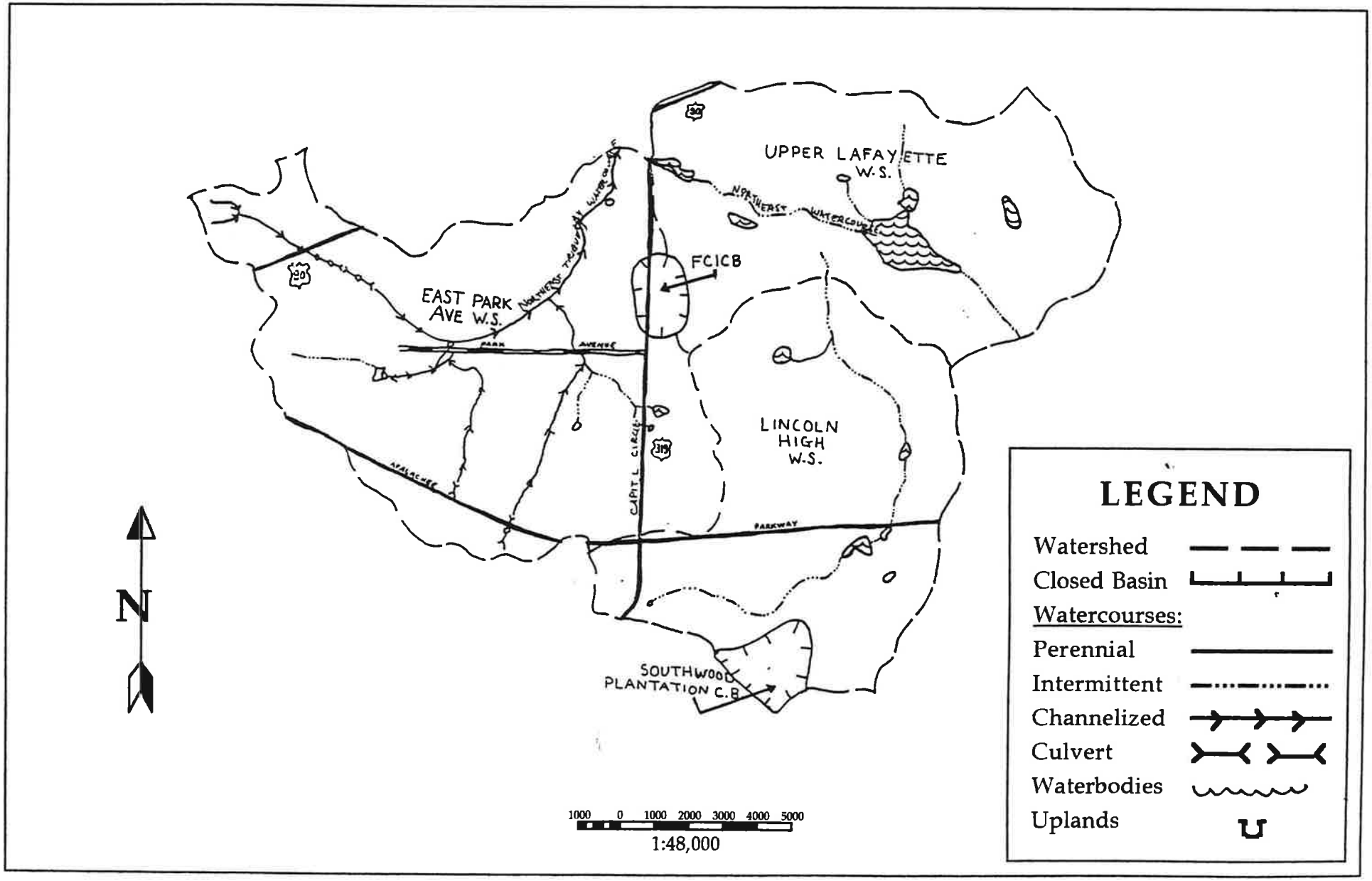
An asphalt plant straddles the lower reach of the watercourse entering Upper Lafayette. A large office and warehouse complex straddles the confluence of the other watercourse immediately upstream of the heavily traveled Capital Circle N.W., at a point 1000 feet south of the U.S. 90 East intersection. A concrete plant borders the watercourse at Weems Road.

All primary and secondary watercourses throughout this heavily urbanized area are channelized or have storm sewers installed. Most historic wetlands, sloughs or marshes have been drained and filled prior to their protection by local, state or federal environmental codes. Such system alterations tend to alter natural hydrocycles substantially, causing increased peaks, rates and volumes of runoff, along with degraded

FIGURE 5

Upper Lake Lafayette- Southwestern Watersheds & Closed Basins:

Upper Lafayette WS, Lincoln High WS, East Park Avenue WS, Federal Correctional Institution CB & Southwood Plantation CB.



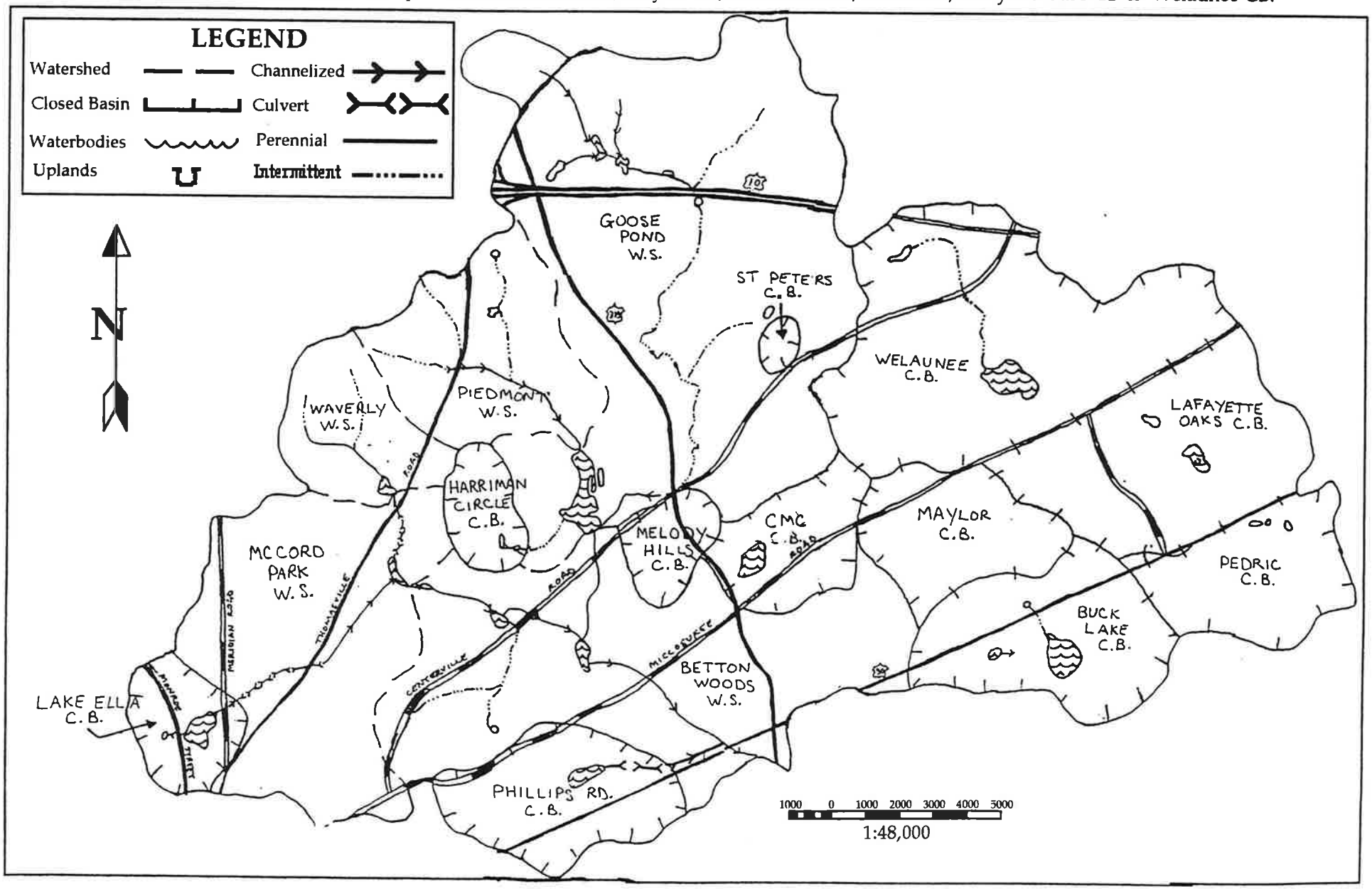
water quality due to sedimentation and reduced nutrient uptake and adverse impacts to associated natural aquatic habitats.

Figure 6 is a map of the urban watersheds and associated watercourses of northeastern Tallahassee. These watersheds extend as far north and west as the old K-mart shopping center on North Monroe Street at Tharpe Street to the uphill portion of the Lake Ella watershed. Included in these upper basins are: the 413 acre Phillips Road Closed Basin, artificially drained through an overflow pipe installed as a result of a law suit settlement; the 1000 acre McCord Park watershed; the 206 acre Lake Ella Closed Basin, a reconstructed and artificially operated waterbody, draining through an overflow pipe; the 157 acre Harriman Circle Closed Basin, artificially drained through an overflow pipe; the 376 acre Waverly Closed Basin, artificially drained through an overflow pipe; Piedmont watershed (675 acres), Goose Pond watershed (2,187 acres), and the Betton Woods watershed (1,781 acres). Also contained in this area are a number of closed basins with no natural surface water connections. They include the 152 acre Melody Hills Basin (pop-off discharge proposed), St. Peters (32 acres), Capital Medical Center (330 acres with a pop-off discharge proposed), Maylor (350 acres), Buck Lake (530 acres), Pedric (440 acres), Lafayette Oaks (590 acres), and Welaunee (1214 acres) closed basins. These areas comprise a small portion of a larger group of closed basins collectively referred to as the "eastern sinks regions". Many of these basins have experienced extensive and damaging flooding as a result of the July-August 1994 extreme rainfall volumes.

FIGURE 6

Upper Lake Lafayette- Urban Northeastern Tallahassee Watersheds & Closed Basins:

Lake Ella CB, Phillips Road CB, McCord Park WS, Harriman Circle CB, Waverly CB, Piedmont WS, Goose Pond WS, Betton Woods WS, Melody Hills CB, St. Peters CB, Capital Medical Center CB, Maylor CB, Buck Lake CB, Pedric CB, Lafayette Oaks CB & Welaunee CB.



These numerous, adjacent closed basin areas, along with several more east of the Jefferson County line, are karst-dominated, closed basins drained to the groundwater by numerous sinkhole depressions. As a result of new development, closed basins are problematic from both the water quality perspective, including potential ground-water contamination and surface water degradation in concentrated stormwater receiving areas. From a water quantity perspective, closed basins often experience higher flood elevations due to volume increases from development or high rainfall volume as evidenced by recent floods. Development in these small closed basins can produce extensive and, in some cases, dramatic changes to the basin hydrocycle, ecological elements and water quality characteristics. Examples of where problems have already manifested themselves include Lake Ella (flooding, severe water quality degradation), the Capital Medical Center (CMC) (flooding), Phillips Road (flooding, legal battles), Lafayette Oaks (severe flooding and extensive property damages), Pedric Road (flooding), and Maylor (flooding) basins.

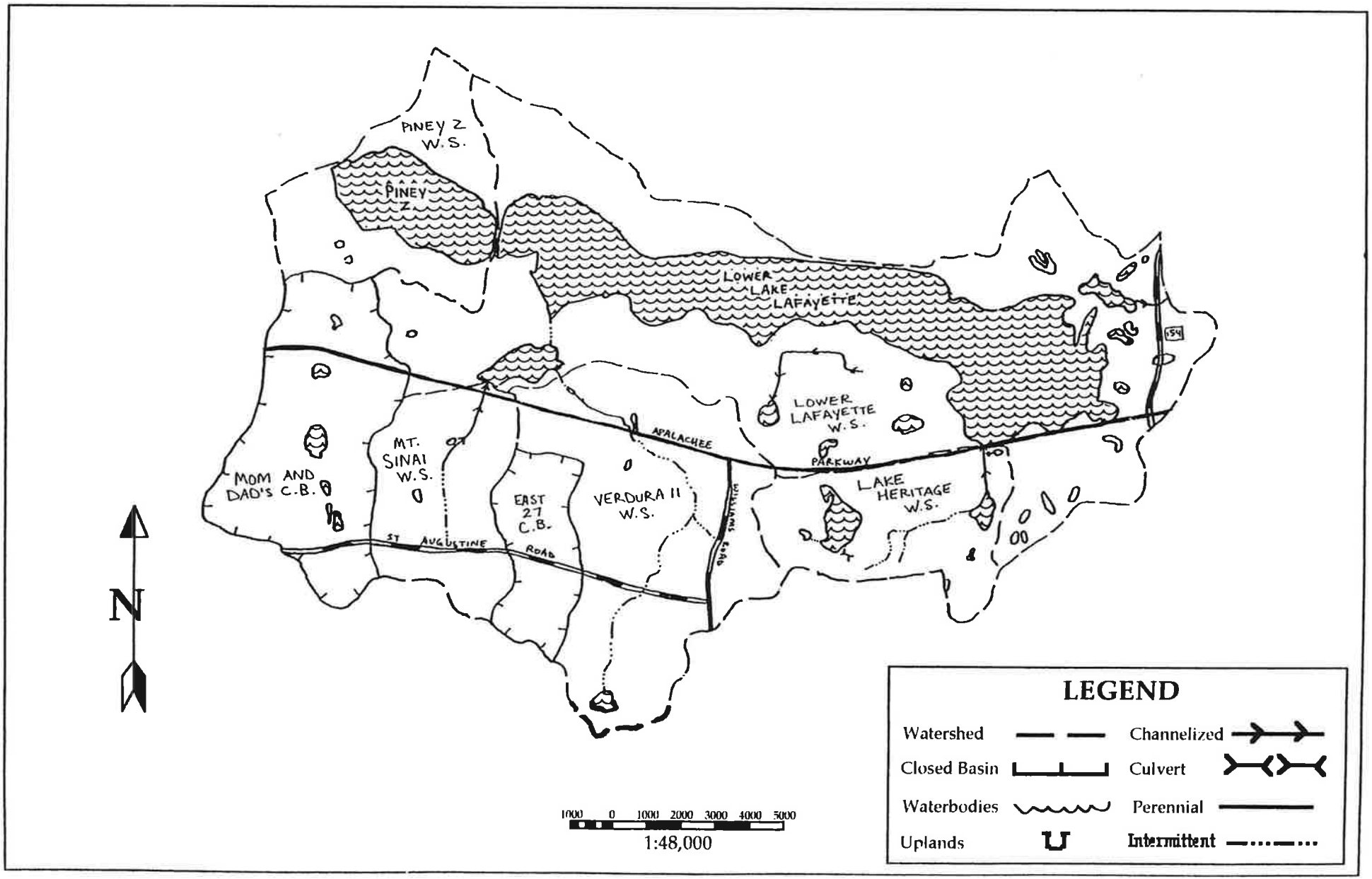
Piney Z Lake

This artificially impounded lake is relatively shallow, and has limited surface water interactions with other formerly contiguous water bodies. Figure 7 shows the Piney Z and its associated watersheds and watercourses. The long-standing management practice of maintaining an artificially high water elevation in the Piney Z has accelerated its eutrophication. Fortunately, this portion of the lake receives relatively little direct stormwater runoff from developed areas, although plans for extensive upland development are being considered at this time.

FIGURE 7

Piney Z- Watersheds & Closed Basins:

Lower Lafayette WS, Verdura WS & Lake Heritage WS, East 27 CB, Mom & Dad's CB & Mt. Sinai CB.



Piney Z Lake water was characterized by very high summer temperatures, relatively high dissolved oxygen concentrations, and relatively low conductivity. Dissolved oxygen during the daytime was relatively high throughout the year, although there had been hypoxic intrusions at depth during early summer. Piney Z is defined by generally high total nitrogen and by moderate total phosphorus. Mean chlorophyll concentrations have been extremely high in Piney Z. The high water column productivity is not unexpected in a closed system. Total organic carbon levels are moderate. Given its current condition, this portion of the lake must be considered to be highly vulnerable to further urban encroachments and resultant stormwater discharges. Land use activity in the Piney Z watershed is growing in intensity. A new school has been constructed in the lowlands region along the lake's north shore, and a major, mixed-use development is proposed for the former Piney Z Plantation. On a positive note, a large conservation area along the lake's littoral zone and associated ecotone extending eastward to the south shore of lower Lake Lafayette has been sold to the City of Tallahassee.

Lower Lake Lafayette

Lower Lafayette reflects particularly acute water quality problems, the result of long-term, non-point source stormwater inflow through Alford Arm and point-source discharges from adjacent, high intensity facilities (Figure 7). Conductivity has been relatively low in lower Lake Lafayette, with the exception of the extreme southeasterly portion of the lake, at research station L22, (Figure 4). Water quality conditions in the vicinity of station L22 were among the worst observed in a county-wide study (Livingston

1993). This area is part of the habitat utilized by the endangered woodstork as a feeding and nesting site. Very high conductivity levels, together with seasonally low dissolved oxygen concentrations and minimal Secchi readings, indicate serious water quality problems in this portion of the Lafayette system. Overall, during the entire twelve month period of observation by Livingston, the easternmost sections of Lake Lafayette showed extremely high and sustained conditions of hypoxia at both the surface and the bottom. Eastern sections of Lake Lafayette have been denoted by shallow depths and relatively low dissolved oxygen. Carbon compounds and chlorophyll a have been high in this section of the lake. Total nitrogen, ammonia, and total phosphorus concentrations have been extremely high at stations L22 and L24. Water from station L24 drains at high-water into the St. Marks River system through a mosquito control ditch built in the 1940's. In the Lake itself, there were indications of hypereutrophication, widespread hypoxia, enhanced nutrient levels, high conductivity, high concentrations of orthophosphate, color, and turbidity. Ammonia levels were high enough in some areas to suggest possible toxic effects.

Figure 7 shows the Lower Lake Lafayette region and its contributing watersheds and watercourses, including the Lake Heritage (519 acres), Vendura II (1018 acres) East Spring Church (1,053 acres) and Lower Lafayette watersheds (3200 acres). The Lake Heritage watershed contributes runoff to the area immediately adjacent to station L22. Major land uses within this watershed include the 600 acre Leon County Solid Waste Facility, portions of which encroach into the floodplain ecotone and fall within 100 feet of

the waters edge. A 70,000 gallon per day package sewage treatment plant, owned and operated by Talquin Electric Cooperative, is located immediately adjacent to the lake and proximal to station L22. Several surface water connections from the landfill to the lake were observed and documented through field analysis. These included two major, long-term sediment breaches from upland drainage areas contributing runoff from intensive-use areas. Subsequent water quality testing at additional sampling sites indicated that both the landfill and the sewage treatment plant were associated with water quality degradation in eastern Lake Lafayette. Chemical analysis of sediment plumes and associated overflows indicated pollutant deposition into the lake. Examination of data gradients provided evidence of pollution sources (Livingston 1994). Estimated volume for the sediment loading into the lake exceeded 2000 cubic yards (Greene, 1993). Extensive seepage areas were also found adjacent to the downslope of two of the three settling ponds on the Talquin sewage treatment plant. These findings were verified by the Leon County Solid Waste Facility Task Force, appointed by the County Administrator, Parwez Alam, as a follow-up to these initial results. Recommendations were offered in a final report (Leon County Solid Waste Facility Task Force, 1994) to address these and other issues. Required improvements have been completed at the landfill site; resolution is still pending at the sewage treatment plant.

Additional stormwater flows into the lake near station L22 from a segment of U.S. 27 South. This 4-lane highway transects the lower end of the watershed, passing directly adjacent to the lake at one point. On the south side of U.S. 27, there are several small

commercial and institutional land uses, which include the Meadows at Woodrun residential subdivision, along with other smaller residential subdivisions. Stormwater flows into Lake Lafayette from such sources. Adjacent, to the east of Lower Lake Lafayette, is the St. Marks River Lowlands Physiographic Region, an area interconnected with the lake at times of high water through the previously referenced drainage ditch. This area and the adjacent low lying areas around Chaires are subject to extensive and regular flooding. The St. Marks River is a state designated "Outstanding Florida Water" (OFW), thus, granting the river an extra measure of protection from degradation.

Alford Arm

Alford Arm is the stormwater receiving area for various developments, including Killearn Estates and neighboring residential areas of the City of Tallahassee and Leon County. Figure 8 and 9 show portions of the Alford Arm drainage area along with its associated watersheds and watercourses. Closed basins within the area include Witfield Plantation (450 acres), Celebration Baptist Church (20 acres), Foley Drive (40 acres) and Killearney Plaza (39 acres).

Runoff from highly concentrated urban developments including commercial and industrial areas has seriously affected the western watershed areas and Alford Arm. High concentrations of total nitrogen, ammonia, and total phosphorus were found at station L28 (Table 2). The 3,680 acre Alford Arm watershed extends northward to Buck Lake Road, encompassing low intensity agricultural/silvicultural and low density residential land

FIGURE 8
Alford Arm-Southern Watersheds & Closed Basins:
I-10/US 90 WS, Alford Arm WS & East Spring Church WS.

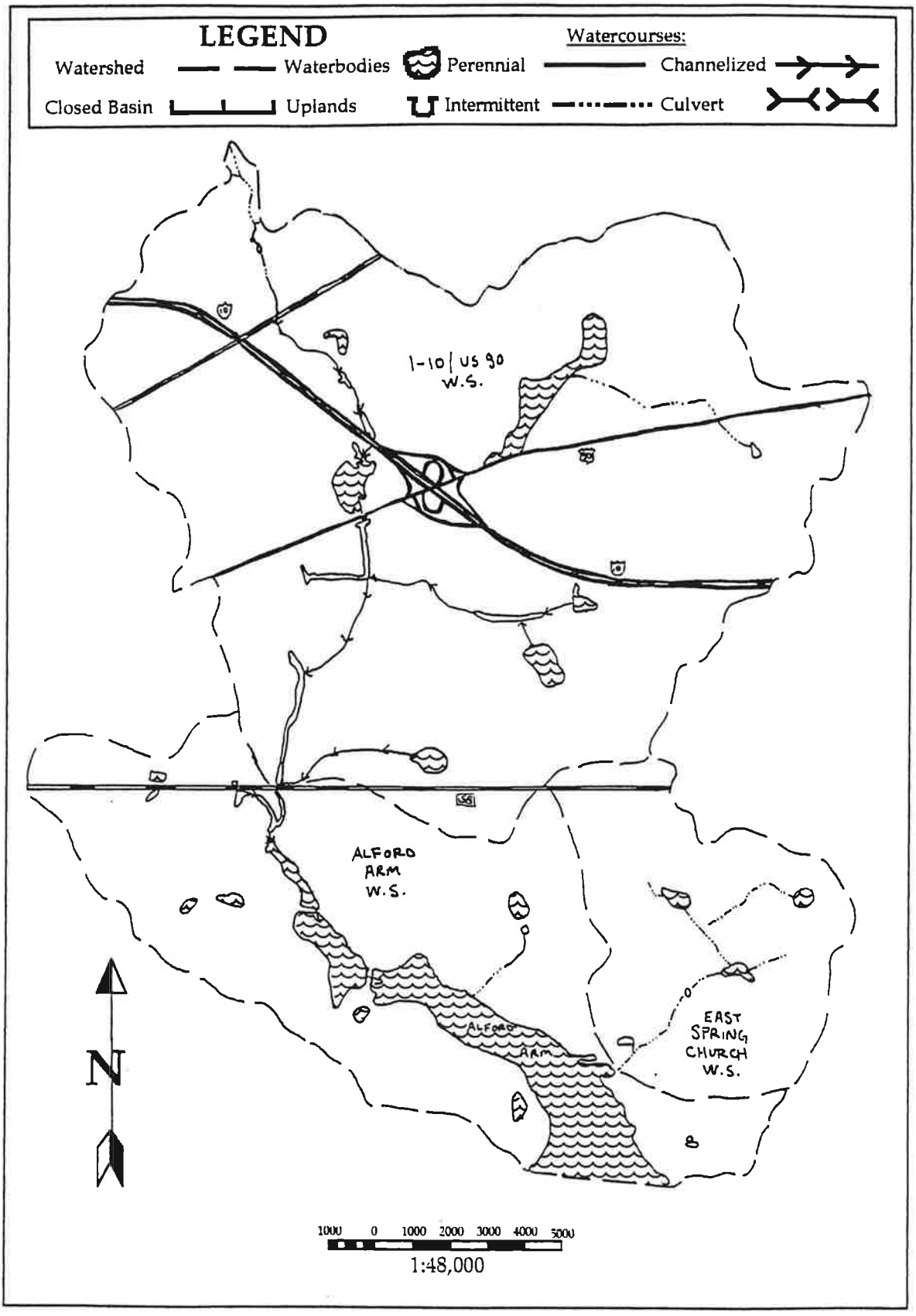
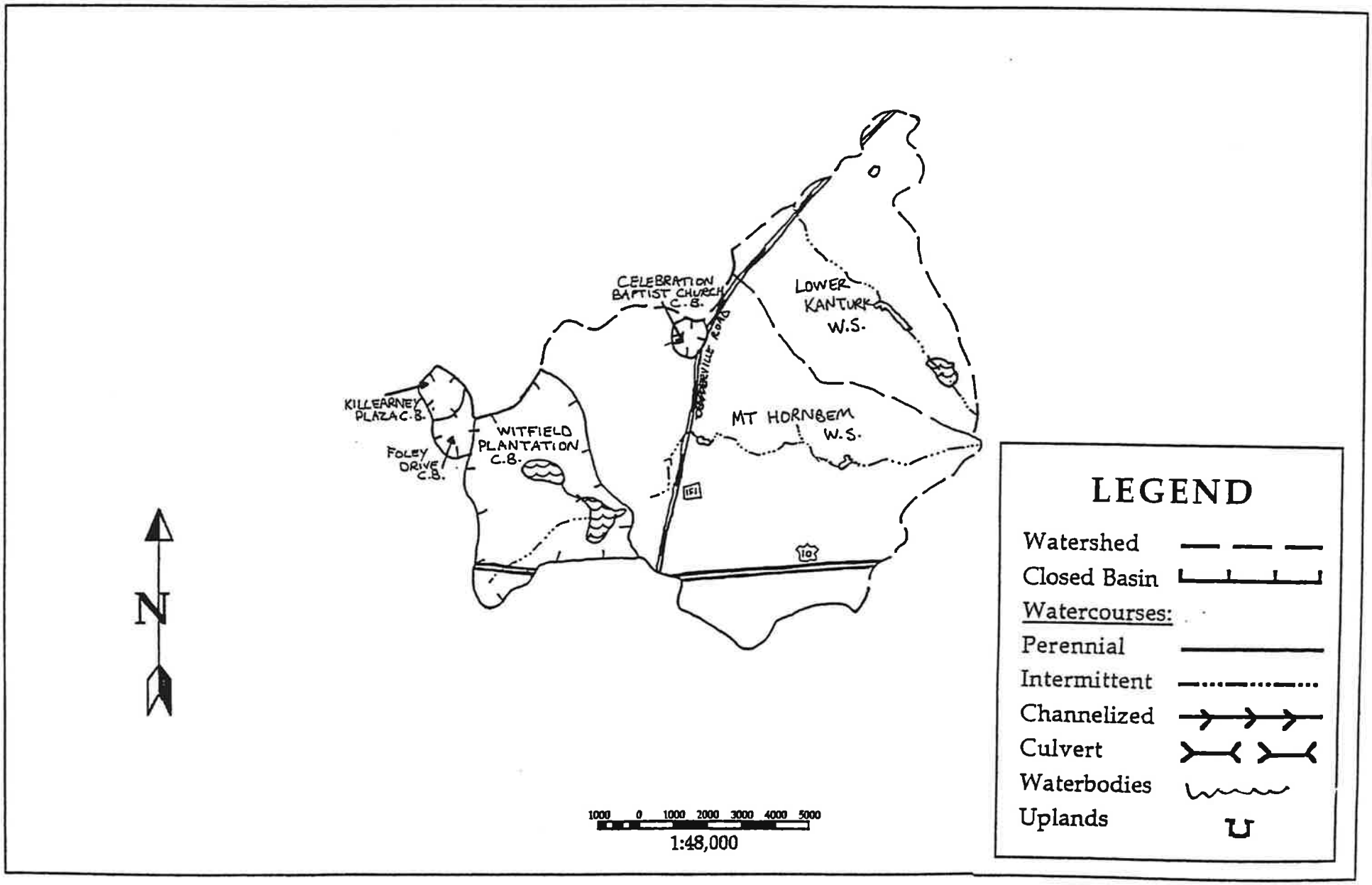


FIGURE 9

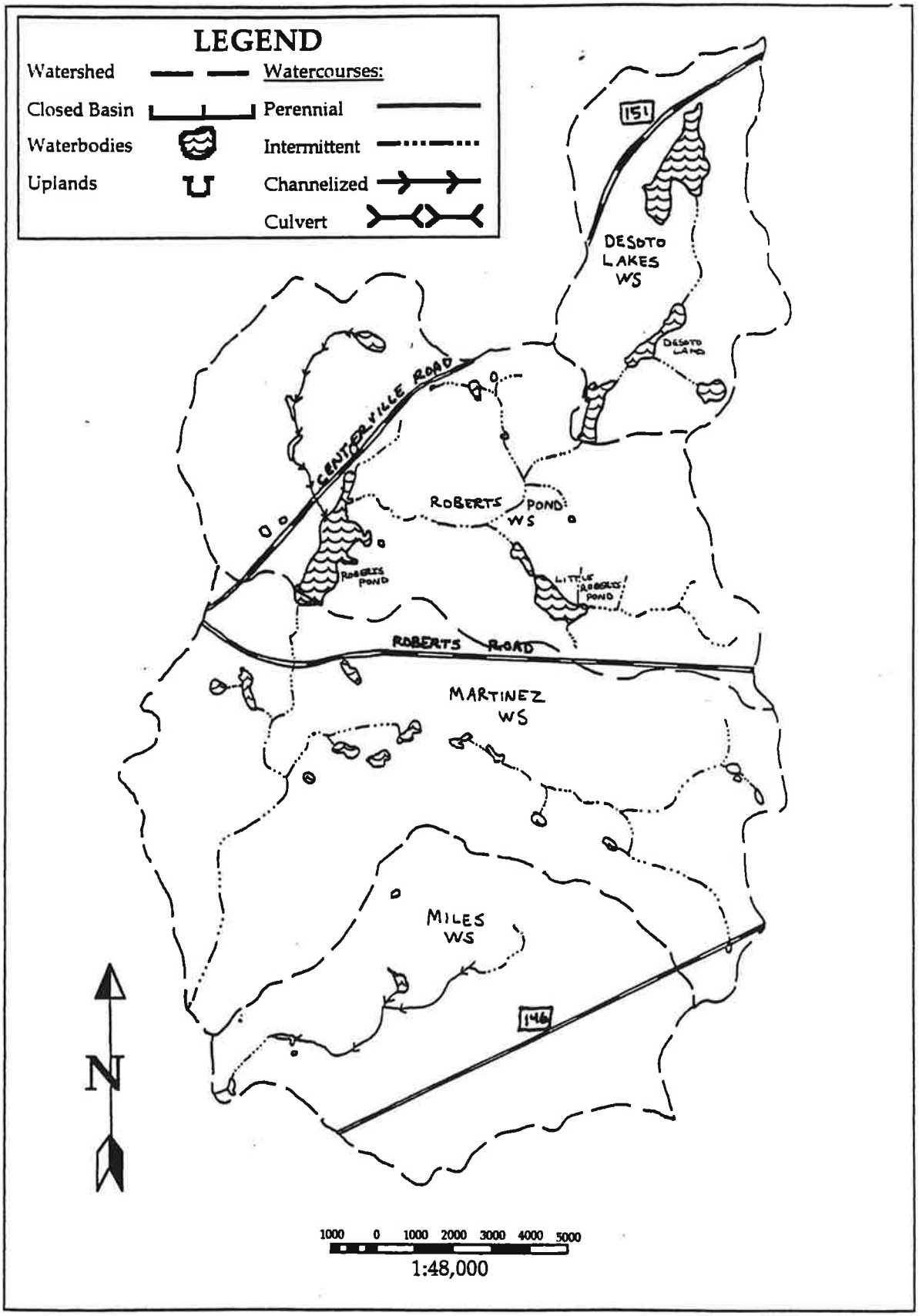
Alford Arm- Western Welaunee Region Watersheds & Closed Basins:

Mt. Hornbem WS, Lower Kanturk WS, Celebration Baptist Church CB, Foley Drive CB & Killearney Plaza CB.



uses. At the lower end of Alford Arm, the Seaboard Coastline Railroad crosses the lake on a causeway. Two 48" crossdrain pipes allow surface water flow to pass into Lower Lake Lafayette, and have the inadvertent hydrologic effect of turning the Alford Arm into a nutrient and sediment sump. Field observations in the area report evidence of past adverse practices by the railroad, including the dumping of hundreds of treated (creosote) railroad cross ties and timbers into the lake. This has the potential for a significant long-term, point source for pollution in both Alford Arm and Lower Lake Lafayette. North of Buck Lake Road, the large I-10/U.S. 90 watershed (3,200 acres) contains a cloverleaf interchange, along with limited adjacent commercial development. Relative to the other Tallahassee Interstate exits (such as U.S. 319 North and U.S. 27 North), this interchange has been slow to commercialize, due, in large measure, to the absence of central sewer services in the area. Immediately to the north of this interchange is the massive Welaunee Plantation, a recent annexation by the City of Tallahassee, which extends northward all the way to Centerville Road and the southern terminus of Killearn Estates. This newly incorporated area is the largest land area annexation in Tallahassee's history. From a spatial distribution standpoint, it is a substantial addition toward infilling the northeastern growth quadrant. However, future development plans for the plantation and the associated proposed Northeast Parkway are unknown. Throughout the Welaunee region, there are numerous surface water junctions with contributing watersheds including Mount Hornbem (1724 acres), Lower Kanturk (695 acres), Miles (1543 acres), Martinez (2700 acres), Roberts Pond (2175 acres), and DeSoto lakes (1064 acres) watersheds. The above watersheds are shown in Figure 10. These rural areas contain variable densities of

FIGURE 10
Alford Arm-Eastern Welaunee Region Watersheds & Closed Basins:
Miles WS, Martinez WS, Roberts Pond WS & Desoto Lakes WS.



residential land uses, from residential subdivisions to large-tract individual parcels, along with widely disturbed, light agricultural and silvicultural uses.

North and west of Centerville Road is the urbanized Killearn Estates mixed use development, with its range of single-family, multi-family, recreational, greenspace, commercial and office areas. Surface water from these sites enter the Killearn chain of lakes: Lakes Kanturk, Killearney and Kinsale. These constructed lakes have broad associated floodplains within a well defined valley, and a well-documented history of extensive episodic flooding to structures and roads that have encroached into the floodplain. Dating back to the original W.H. Coloney study in 1970 which predicted the threat of flooding should development proceed the downstream conveyance enlargements, numerous studies have been completed on this artificial lake chain. Currently, a project is underway to enlarge the downstream flow capacity to reduce flooding around the chain of lakes. Downstream water quality and quantity impacts are intended to be absorbed by an in-line wetland downstream of the project.

Contributing watersheds, as shown in Figure 11, include: Lake Kanturk (603 acres), Lake Killearney (1120 acres), Lake Kinsale (125 acres), Royal Oaks Creek (704 acres), Lake Tom John (621 acres), Gilbert Pond (725 acres), Lake Killkee (169 acres) and the Lake Saratoga (955 acres) watersheds. Also included is the Lake Sheelin closed basin (204 acres). Development throughout this area is dense, contained in numerous residential neighborhoods and clustered commercial centers.

FIGURE 11

Alford Arm- Killearn Estates Region Watersheds & Closed Basins:

Lake Kanturk WS, Lake Killarney WS, Lake Kinsale WS, Royal Oaks Creek WS, Lake Tom John WS, Gilbert Pond WS, Lake Saratoga WS & Lake Sheelin CB.

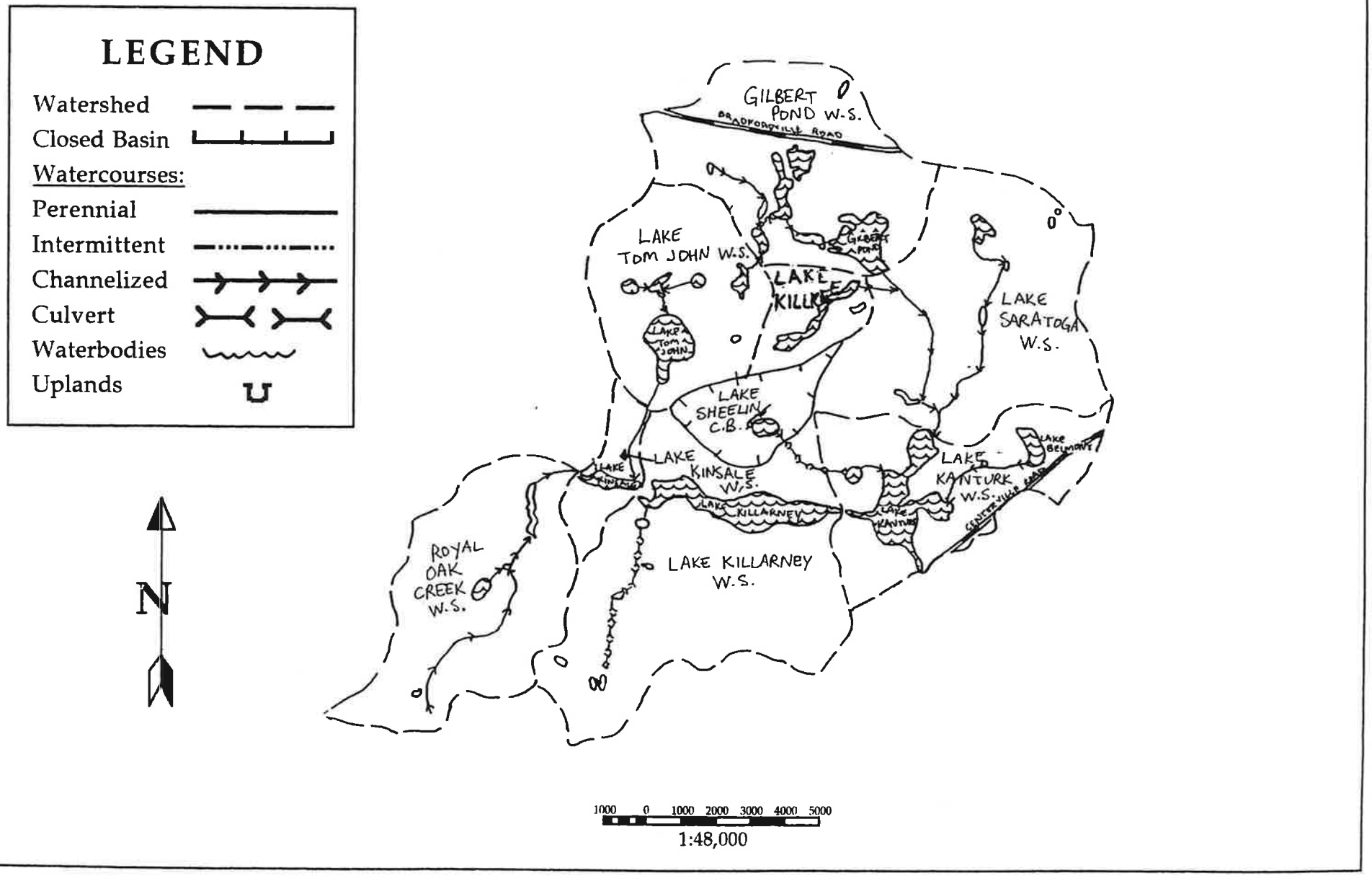
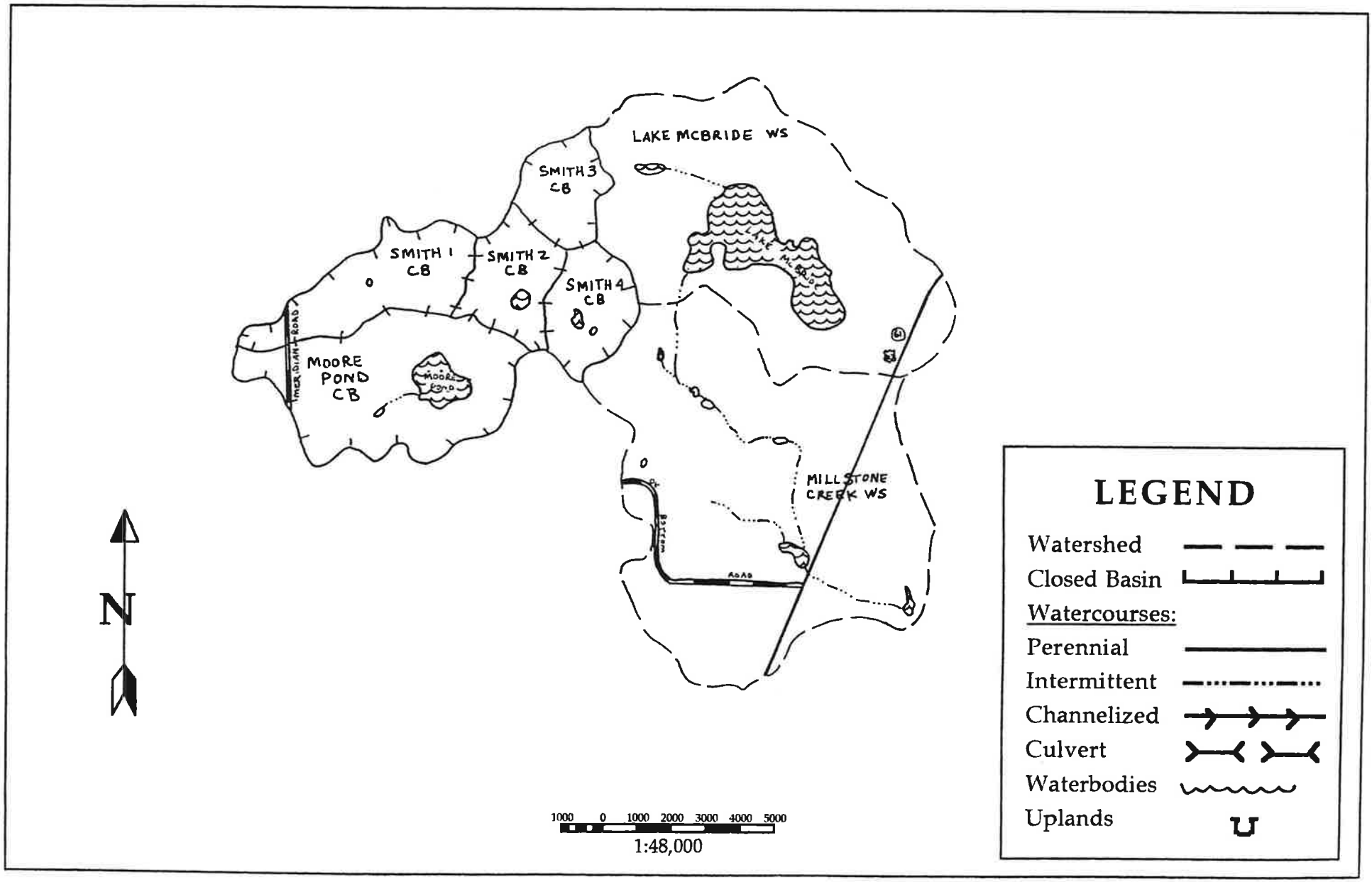


FIGURE 12

Alford Arm- Northeastern Region Watersheds & Closed Basins:

Lake McBride WS, Millstone Creek WS, Smith 1 CB, Smith 2 CB, Smith 3 CB, Smith 4 CB & Moore Pond CB.



The Northhampton P.U.D., a large multi-use development located north of Velda Dairy Road, drains into Lake Kinsale, and, upon several occasions, contributed extensive sedimentation to the downstream lake chain during its construction phases.

The sparsely developed 1,647 acre Millstone Creek and the 1286 acre Lake McBride watersheds lie to the west of Thomasville Road, U.S. 319, Figure 12. These two watersheds contain a variety of good to high quality successional forests and numerous surface water features including wetlands, waterbodies, creeks and sloughs. Major archeological and historical features are scattered throughout these areas, consistent with both historic and pre-historic settlement patterns. Also included are the Smith 1 (287 acres), Smith 2 (182 acres), Smith 3 (153 acres), Smith 4 (179 acres), and Moore Pond (587 acres) closed basins. Development in these basins is scattered: low density residential development along with light agricultural and silvicultural uses. Thus, numerous high quality natural areas, including both upland and wetland systems, still remain in the region, along with a rich and varied archeological history. The Lake McBride and Millstone Creek Watersheds constitute the northernmost extent and headwaters of the Lake Lafayette basin.

The Lake McBride watershed is adjacent to the large, rapidly growing Killearn Lakes development. This large mixed-use development is located just over the drainage divide, in the Lake Iamonia drainage basin to the north.

The urbanizing Bradfordville Road intersection is also immediately adjacent to the northeast. This intersection has been the scene of several intense land use battles over future shopping and school center sites. Currently planned road expansions and intersection improvements will intensify real estate interest in this already booming area, continuing to threaten the beautiful and fragile Lake McBride aquatic ecosystem.

RECOMMENDED MANAGEMENT PROGRAM

The following recommended management program is offered to address Lake Lafayette's problems. The program consists of strategies for land use control, in-lake management and clean-up, and for subsequent research and monitoring. It is recommended that necessary funding be provided through the County's Stormwater Utility and through negotiated cost sharing initiatives with the City of Tallahassee or other agencies of the state or federal government as appropriate.

Land Use Controls

1. Special protection zone restrictions should be implemented around the lake and its primary and secondary tributaries consistent with the current requirements of Leon County Code (Section 10-192), Special Development Standards for Environmentally Sensitive Zones. The recommended geographical boundary for the Special Protection Zone A is the higher of the ESA, FEMA or USGS delineated 100 year flood plain adjacent to the lake and its primary and secondary drainage tributaries. Zone A protection is also recommended for the pristine and sensitive Lake McBride and Millstone Plantation Watersheds. Recommended restrictions within this zone include the following:

   Land uses limited to existing uses, passive recreational and open space uses, water management or to single family residential structures on existing parcels, provided that the total construction area of the site and within the special

protection zone is limited to 5% of the surface area within the zone or to 4000 square feet, whichever is greater.

Unlike the special protection zones for Lakes Jackson, Iamonia, Bradford and Fred George, the recommended Lake Lafayette zone is to be inclusive of the flood plain adjacent to the contributing primary and secondary watercourses, and the main elements of its dendritic tributaries to the lake. The purpose of this recommendation is to protect the ecological integrity of these tributaries, thus allowing them to perform the requisite periodic flood storage and water quality enhancement, and to provide the associated wildlife and forest habitat functions characteristic of forested flood plains.

Additionally, a recommended Zone B green belt buffer is proposed for the area 500 feet landward of the Zone A boundary. The purpose of this zone is to ensure a green belt remains between more intensely developed adjacent upland land uses and the sensitive Zone A area. Two restrictions are proposed for Zone B:

a. land uses are limited to single family residential at applicable comprehensive plan densities; and,

b. limits of clearing are restricted to no more than 50% of the parcel.

Figure 13 (page) shows the recommended Zones A & B and protected watersheds areas.

In order to address the portion of the recommended Lafayette Special Protection Zone within the incorporated area of the City of Tallahassee, it is recommended that the Board pass a resolution requesting adoption of a comparable ordinance by the City Commission.

2. A request should be forwarded to the City of Tallahassee to review the land use designations for the incorporated area of the Welaunee annexation to ensure the following:

    a. overall land use densities are maintained at an appropriate low level;

    b. higher density commercial and institutional areas should remain decentralized to avoid high density sprawl and large concentrations of contiguous impervious surfaces;

    c. all higher density development should be located as far away from the special protection zone and from primary, secondary and tertiary drainage ways as practical; and,

    d. the entire floodway (Zone A) and its associated greenbelt (Zone B) through the annexation area, including the confluence of the various watershed tributaries coming together in this region, should be preserved in a natural and unaltered condition.

3. Additional special protection zone designations should be given to the Lake McBride and the Millstone Creek Watersheds, limiting all future development to low density, residential land uses (minimum lot size of one acre) consistent with the high quality natural areas and environmental sensitivities of these areas.

4. A hydraulic and environmental features study should be undertaken of each closed basin contained with the Lake Lafayette drainage basin region, with

recommendations for future land use restrictions including special protection zones, development distribution and density, flood control and water quality protection measures, as necessary.

5. The proposed Eastern Sector Study should be reviewed and given priority consideration, as it is an environmentally sensitive land use based methodology designed to address the special protection needs of the Lake Lafayette Basin and vicinity. The results of the Eastern Sector Study should be coordinated with the review of development plans for the Welaunee Plantation annexation.

6. A master plan for full water quality retrofit of all urbanizing watersheds within the basin should be developed jointly by the City and County stormwater programs. Implementation should be completed on a priority basis (within 5 years for example). Facilities should be sized at 2% of the contributing watersheds. Annual progress should be given to the Board and to the City Commission.

7. The Board of County Commissioners should request a review of Lake Lafayette basin water quality issues to be completed by the Leon County Science Advisory Committee. Consideration should be given to the appropriateness of a development monitoring as recommended by the SAC for Lake Jackson, pending implementation of a water quality master plan.

POINT SOURCE POLLUTION ABATEMENT

(NOTE: Items one through four have also been recommended by the Leon County Solid Waste Facility Task Force. Implementation status notes are included).

1. Revised management plans should be developed and submitted to ensure that no further surface water discharges from the Leon County Landfill are allowed to enter Lake Lafayette or its associated floodplain or tributary watercourses. Such assurance should include design consideration for events up to and including the 100 year flood event. The plans should be reviewed and approved by Leon County Environmental Permitting, and an annual compliance report should be submitted in conjunction with the state and county inspection program. [Completed, construction underway]

2. A thorough analysis should be undertaken to determine the feasibility and desirability of removing sediment and other pollutants from the various plumes associated with stormwater runoff discharges from the landfill to the lake. The study should include removal methods, if appropriate, to minimize contamination from resuspended sediments and other pollutants. On completion of the study and as conditioned by review and approval by Leon County Environmental permitting, the requisite management and mitigation options should be implemented as soon as practical. [Underway]

3. A study should be undertaken by an independent consultant for future management options for the Talquin Electric Cooperative Sewage Treatment Plant, including, if necessary, the removal of the facility and relocation to an area less proximal to the lake and its associated watercourses. On completion of the study and conditioned on review and approval by Leon County Environmental Permitting, the necessary management and mitigation should be implemented as soon as practical. [Underway]

4. A study should be undertaken by an independent consultant, funded by the Seaboard Coastline Railroad, of the removal and management options for the discarded railroad ties and other construction materials. On completion of the study and conditioned on review and approval by Leon County Environmental Permitting, the necessary management and mitigation should be implemented as soon as practical. [No action has been taken]

5. A study should be undertaken to evaluate other potential point source inputs of pollution to Lake Lafayette and its associated primary watercourses. For example, a concrete plant and an asphalt plant both are immediately adjacent to the primary tributary into upper Lafayette. Both these facilities are pre-ordinance and, therefore, have no water quality or other required on-site management facilities.

6. A priority retrofit initiative in conjunction with the City of Tallahassee should be undertaken for the watersheds contributing to upper Lake Lafayette where severely degraded stormwater discharge is entering the upper Lafayette sinks in vast quantities. Upon completion of this plan, consideration should be given to a voter referendum initiative to fund the long-term restoration of the lake.

Other Research Needs

1. A study by an appropriate entity should be undertaken as soon as practical to evaluate impacts from pollution upon the individuals and habitat of the protected Woodstork and their rookery located in southeastern Lake Lafayette. [note: This need has been communicated to the Florida Game and Freshwater Fish Commission and they are supportive of this idea].

2. An evaluation and monitoring study should be undertaken in conjunction with the City of Tallahassee, as soon as practical, to evaluate actual or potential impacts to the groundwater, including any drinking water hazards from polluted stormwater discharge into the Upper Lafayette Sink and other Lafayette Basin sink holes. [note: The City Of Tallahassee Water Quality Lab has been advised of this condition but no reports of subsequent actions have been received].

3. The implementation status of the Lake Lafayette Basin Master Plan prepared by the Northwest Florida Water Management District should be reviewed and results

priorities and funding needs should be recommended in coordination with Number 6, point source abatement.

GLOSSARY OF SELECTED TERMS AND CONCEPTS

General terms:

Eutrophication: The process of nutrient enrichment (usually by nitrates and phosphates) in aquatic systems such that the productivity of the system ceases to be limited by the availability of nutrients. It occurs naturally over geological time, but is commonly accelerated by human activities such as sewage disposal, stormwater runoff or soil erosion and sedimentation. The increase in nutrient levels stimulates algal blooms, which seriously deplete the lake's oxygen levels. The result may be the death of fish, creating further oxygen demand and hence more deaths (Concise Oxford Dictionary of Ecology).

Littoral Zone: The Concise Oxford Dictionary of Ecology defines the littoral zone as the area in shallow, fresh water and around lake shores where light penetration extends to the bottom sediments, giving a zone colonized by rooted plants.

The following water quality factors are considered good indicators of how a waterbody is responding to stresses from urban stormwater runoff and what might be expected in the future as a result:

Chlorophyll a: Concentrations of chlorophyll a are an indicator of phytoplankton productivity.

Color: (Method Number 204, *Standard Methods for the Examination of Water and Wastewater*, Fourteenth Edition, 1976.) Color may be the result of the presence of natural

metallic ions (iron and manganese), humus and peat materials, plankton, weeds, and industrial wastes.

Conductivity: (Method Number 205, *Standard Methods for the Examination of Water and Wastewater,* Sixteenth Edition, 1985.) Conductivity or specific conductance is a measure of the dissolved ions in water. It is measured in terms of micromhos per centimeter at a specific temperature as a test of the flow of electrons across 1 cm of water in a charged environment. The concentration of salts and organic residue in water is called the total dissolved solids (TDS). This factor can be estimated from the measure of specific conductance. The total dissolved solids or filterable residue is related to osmotic regulation of freshwater organisms. Salts and organic residue, if too high, can have an adverse effect on organisms.

Dissolved Oxygen: (Method Number 421, *Standard Methods for the Examination of Water and Wastewater,* Sixteenth Edition, 1985.) Dissolved oxygen (measured in mg/per liter), is present in low concentrations in water. This factor is basic to the life of animals in lakes, since most metabolic functions utilize dissolved oxygen in the water. The metabolic process of plants consume oxygen during the evening periods at which time there is a net loss of dissolved oxygen due to the combined respiratory needs of plants and animals. Dissolved oxygen concentration undergoes diurnal (day and night cycle) changes, with the lowest levels usually occurring during the early morning hours just before dawn. Anoxia or severe hypoxia occurs when dissolved oxygen (DO) levels are at or below 2mg per liter. This level is actively detrimental to most aquatic populations. Hypoxia involves DO

levels between 2 and 4mg per liter, and is considered stressful to more sensitive organisms and thus can be associated with loss of certain populations.

Nutrient loading: The process and rate at which nutrients, such as phoshorous and nitrogen,are discharged via surface water systems into receiving water bodies.

pH: (Method Number 423, *Standard Methods for the Examination of Water and Wastewater,* Sixteenth Edition, 1985.) The pH of water is the result of various complex interrelationships that include the concentration of buffering substances (carbonates, bicarbonates, borates, etc.), processes involving primary productivity and respiration (primary production reduces carbon dioxide thus having a tendency to increase the pH, whereas respiration releases carbon dioxide thus having a tendency to reduce the pH), and the interacting forces of the input of different forms of organic matter to a given lake system. A range of 6-9 is considered biologically neutral.

Secchi depths: A Psych. disk is a simple instrument designed to determine the depth of penetration of visible light in water. It reflects the amount of color (light effects due to dissolved substances) and turbidity (light effects due to the particulate matter in water) in a body of water. The Psych. disk is lowered into the water slowly until the characteristic black and white pattern can no longer be distinguished. The disk is then raised until the pattern is again apparent. This process is repeated and the two depths noted. The average of these two depths is recorded as the Psych. reading.

Water depths: Water depth is an important variable in terms of stratification potential, the relationships of productivity (production of organic carbon matter from inorganic

substances) to mineralization (breakdown of organic matter), and the levels of secondary water quality values such as pH and dissolved oxygen.

Water Temperature: (Method Number 212, *Standard Methods for the Examination of Water and Wastewater,* Sixteenth Edition, 1985.) Water temperature is an important variable, as most of the rate functions in a body of water (respiration, primary productivity, Biochemical Oxygen Demand, Chemical Oxygen Demand) depend on this variable. Most of the organisms in lakes are poikilotherms, so called "cold blooded organisms", so that temperature is a major determinant of various physiological and behavioral characteristics of the various species.

Turbidity: (Method Number 214, *Standard Methods for the Examination of Water and Wastewater,* Fourteenth Edition, 1976.) Turbidity is caused by the presence of suspended matter, such as clay, silt, finely divided organic and inorganic matter, plankton and other microscopic organisms. It is an expression of the optical property which causes light to be scattered and absorbed rather than transmitted in straight lines through the sample.

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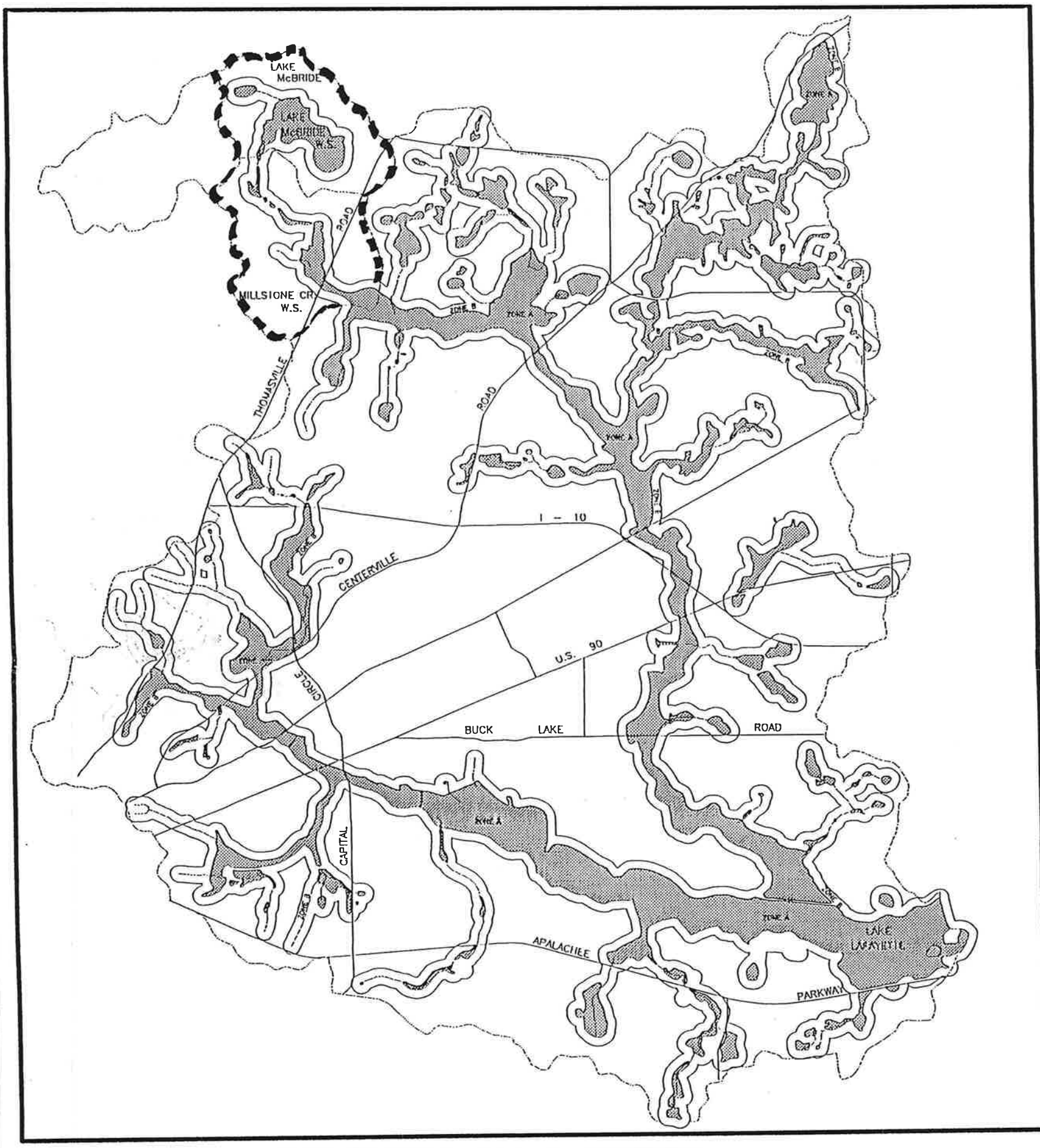
FIGURE 13

LAKE LAFAYETTE SPECIAL DEVELOPMENT ZONES



**THIS PRODUCT IS INTENDED TO BE USED FOR PLANNING AND REFERENCE PURPOSES ONLY

ZONE A — ZONE A INCLUDES ALL CONTIGIOUS E.S.A. FLOODPRONE AREAS ASSOCIATED WITH LAKE LAFAYETTE PROPER

ZONE B — ZONE B IS THE 500' BUFFER SURROUNDING E.S.A. FLOODPRONE AREAS AND CONNECTING WATERCOURSES

ZONE C — ZONE C INCLUDES ALL OF THE LAKE MCBRIDE AND MILLSTONE CREEK WATERSHEDS.