SOUTH FLORIDA WATER MANAGEMENT DISTRICT

THE 2000-2001 DROUGHT IN SOUTH FLORIDA

PART II: WATER MANAGEMENT

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PART II: Water Management During the 2000–2001 Drought in South Florida

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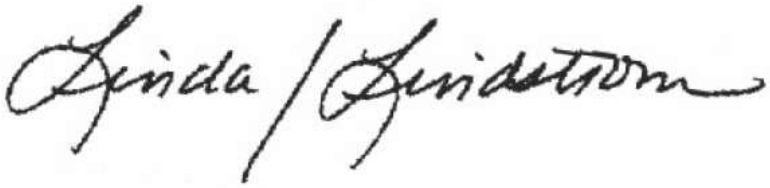
PREFACE

The 2000–2001 drought in Central and South Florida was a significant hydrologic and water management event. During this period, a critical water supply shortage was experienced by all sectors of water users. The continual monthly rainfall deficit compounded the decline in storage volume, forcing the South Florida Water Management District to declare a drought emergency and implement water use restrictions. Water quality and biological monitoring were expanded, and daily, weekly and monthly reports were generated to assist water management decision making and inform the public about the status of the hydrologic system. The South Florida Water Management District took the lead in facilitating a multi-agency response to this event, coordinating a series of decisions and actions to protect the public interest to the maximum extent possible.

Documentation of such an event is necessary to preserve the experience for the benefit of future managers of such events. Thus, the District is producing the *2000–2001 Drought Report*. The report is divided into three parts. *Part I: Hydrologic Analysis of the 2000–2001 Drought in South Florida* summarizes the hydrologic and water resources conditions from October 1, 1999 through September 30, 2001. Historical hydrologic analysis is also provided for a comparative understanding of the magnitude of the drought. *Part II: Water Management During the 2000–2001 Drought in South Florida* addresses water management during this period of record-low rainfall and highly restricted water supply. It provides a record and overview of the drought management process, including valuable information for future drought monitoring and drought management. Finally, the Executive Summary contains a synopsis of the major findings.

Many staff members worked to make the Drought Report a reality. Special thanks go to the editorial team, chapter authors and support staff. Their assistance was invaluable.

Sincerely,



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Chapter 1: Introduction and Overview

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INTRODUCTION TO THE WATER MANAGEMENT REPORT

Part II of the report on the 2000–2001 drought in South Florida addresses water management during this period of record low rainfall and highly restricted water supply. The South Florida Water Management District took the lead in facilitating a multi-agency response to this event, coordinating a series of decisions and actions to protect the public interest to the maximum extent possible. This water management report chronicles and evaluates these responses as an after-action assessment of the drought event.

The fundamental purpose of *Part II: Water Management During the 2000–2001 Drought in South Florida* is to provide a permanent record and a synoptic view of management actions and their context during the drought, as well as a vehicle for communicating lessons learned for use during future droughts. The report begins with a brief summary of Part I, the essential hydrology of the event, and then presents general management philosophies applied across the many activities associated with the period. The chronicle continues with a summary of system operations and District-wide efforts to manage water demand and supply. The second half of Part II provides a synthesis of data and findings on issues of water demand and supply at the regional level, and then records the many impacts resulting from the drought. The report also includes a detailed account of the far-reaching actions taken in outreach and communications.

HYDROLOGIC BACKGROUND OF THE 2000–2001 DROUGHT

The 2000–2001 drought was a significant hydrologic and water management event in Central and South Florida. A detailed evaluation of hydrological data and findings is presented in *Part I: Hydrological Analysis of the 2000–2001 Drought in South Florida.* This section of Chapter 1 highlights key aspects of Part II to provide context for the management analysis being done in the chapters of the water management report.

According to the Palmer Drought Severity Index, the 2000–2001 drought was one of the few extreme drought events in the Upper Kissimmee, Lower Kissimmee and Lake Okeechobee areas of the District (**Figure 1-1**).

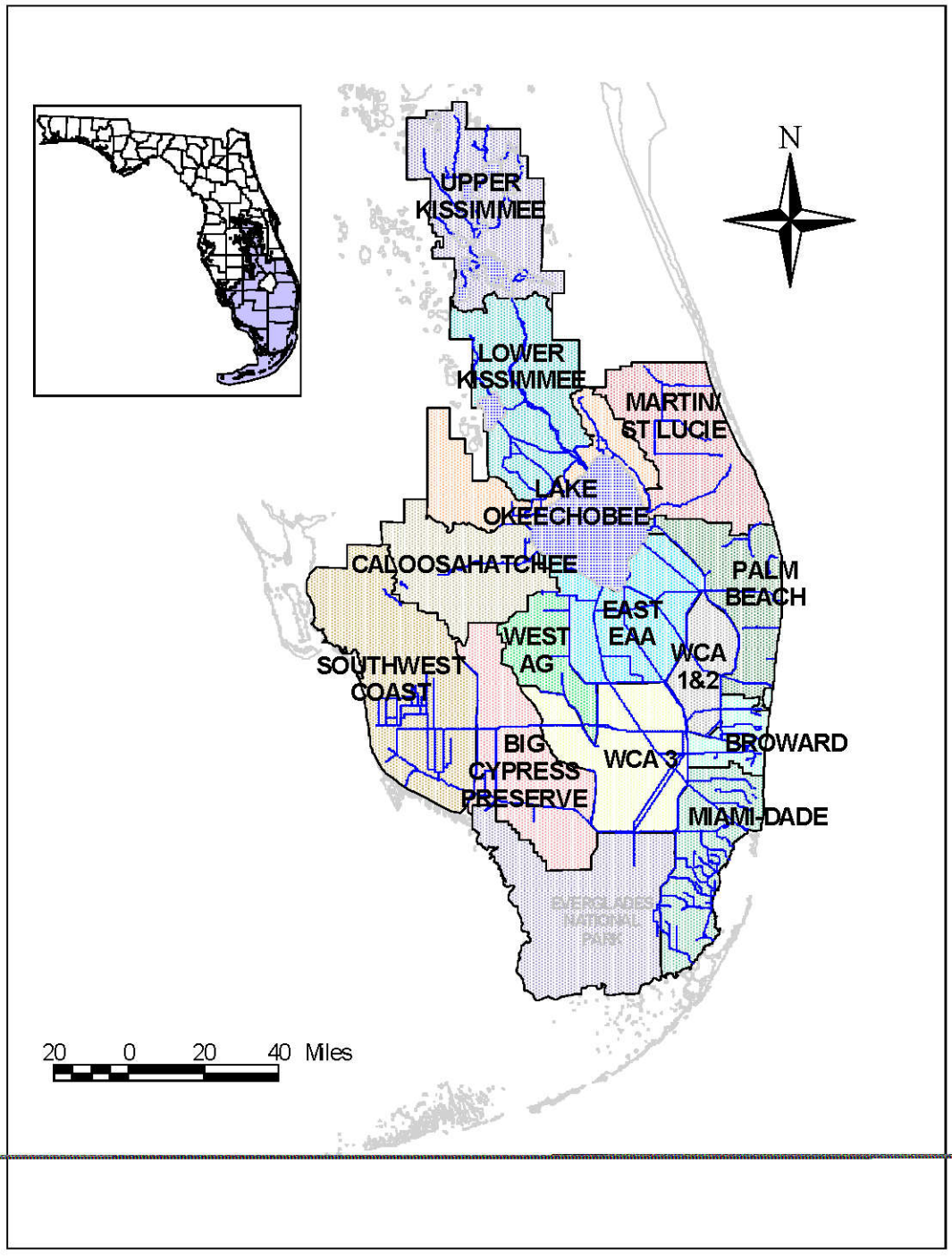


Figure 1-1. South Florida Water Management District rain areas

These are the watersheds that contribute most of the inflows to Lake Okeechobee. The 2000 annual rainfall for the three areas had a dry frequency of 1-in-100 years. Annual rainfall deficit for the three areas was 35 percent. The 2000 District-wide annual rainfall deficit was 25 percent of the historical mean. The drought persisted in most areas through August 2001. Hurricane Gabrielle passed through Central Florida in the middle of September 2001 and resulted in significant rainfall over a large area, contributing to drought relief.

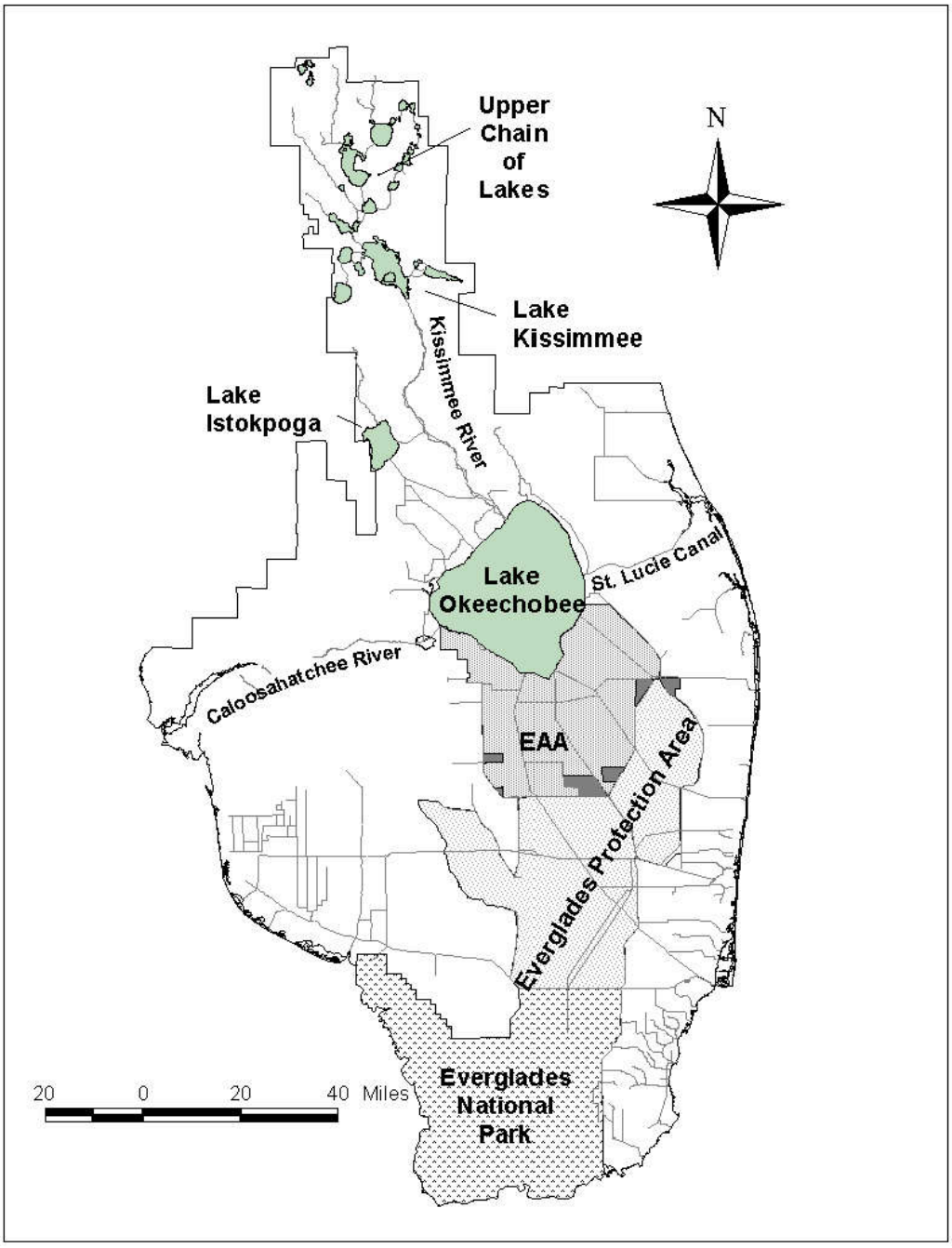
The cascading effects of the drought were demonstrated by significant reductions in inflow and outflow to the major lakes in the District (**Figure 1-2**). There was no outflow from Lake Kissimmee for eight consecutive months (November 2000 to June 2001). Lake Istokpoga was similarly affected, recording the second-lowest annual discharge during the 2000–2001 drought.

The drought's effect on Lake Okeechobee inflows and outflows was significant. From December 1999 to June 2001 there were 19 consecutive monthly inflows below the historical average. The significant increase in lake inflow from July to September 2001 corresponds with an increase in rainfall and a decrease in drought effect. During the same period, backflow into the lake through pumping and gravity was 32 percent of the total. The remaining inflow of 68 percent was from the north. The maximum annual backflow occurred in nine months of 2001 (679,157 ac-ft). The total backflow to the lake for the period of October 1999 to September 2001 was 1,017,224 ac-ft, of which 420,701 ac-ft were back pumped through the S-2 and S-3 pump stations. Based on flow data from January 1, 1972 to September 30, 2001, major surface inflows to Lake Okeechobee showed an annual average volume of 1,999,000 ac-ft with an annual minimum of 675,000 ac-ft occurring during the 2000 drought.

Outflows from the lake are mainly through the south, southeast, and southwest structures. The average historical (1972 to 2001) annual outflow was 1,282,000 ac-ft. For the period of October 1999 to September 2001, 16 months of outflows from the lake were below the historical average. A significant portion of the discharge during the lake recession occurred in May 2000. When the lake stage reached 10.1 ft referenced to the National Geodetic Vertical Datum (NGVD), temporary forward pumps were activated at the S-351, S-352, and S-354 structures to discharge water to the south. The pumps were operated irregularly from March 28, 2001 to July 3, 2001 for a total discharge of 92,904 ac-ft.

The effects of the drought were also felt south of the lake in the Stormwater Treatment Areas (STAs) and Water Conservation Areas (WCAs). Many of the inflows and outflows to the STAs were reduced by the drought. STA 6 and a portion of STA 5 dried out during the most severe period of the drought. All the STAs began to receive significant inflow beginning in June and July 2001, aiding their recovery from the drought. Inflow and outflow volumes for WCAs showed significant drought related reductions from November 2000 through June 2001. The ability to release water from the WCAs for water supply purposes was severely restricted during 2001. Inflow and outflow volumes increased progressively from July through September 2001 and led to a recovery of water levels by the end of September 2001. The same overall pattern was observed in outflow volumes from coastal structures. Total outflows through coastal structures to tide were negligible during the height of the drought in the first several months of 2001. Further south, inflow volumes to Everglades National Park (ENP) from October 1999 to September 2001 showed the drought effects dramatically. Park inflows were minimal from January 2001 through June 2001 and increased starting in August 2001.

Figure 1-2. Major hydrologic components of the South Florida Water Management District



Water levels in lakes and reservoirs are gages for drought and water shortage conditions. Water level data for Lake Okeechobee are available beginning in 1931. The minimum lake level for the period of record, 8.97 ft NGVD, occurred on May 24, 2001. Lake water level was at or below 11 ft NGVD for only 3 percent of the period since 1931, with the longest consecutive period, 194 days, occurring in 2001. In fact, Lake Okeechobee's water level declined 7.56 ft. NGVD, from 16.53 NGVD on October 1, 1999 to 8.97 ft NGVD on May 24, 2001. Decreased inflow and rainfall, with increased discharge and evaporation, corresponded to the lake water level decline, while increased inflow from the north, backflow to the lake, and reduced discharge from the lake corresponded to gain in water level.

Lake Kissimmee, with an area of 35,520 acres, has been regulated by the S-65 structure since 1964, with slightly more than a three-foot fluctuation. The mean historical lake level is 50.38 ft NGVD. For the period of October 1, 1999 to September 30, 2001, Lake Kissimmee fluctuated between 52.57 and 48.28 ft NGVD, with the minimum level occurring on April 29, 2001. Lake Istokpoga, with an area of 28,160 acres, has been regulated by the S-68 structure since the early 1960s within a three-foot fluctuation. The average historical lake level is 38.59 ft NGVD. Lake Istokpoga fluctuated between 39.55 and 35.88 ft NGVD, with the minimum occurring on June 19, 2001.

The Water Conservation Areas are shallow impoundments, with a total area of about 736,640 acres. WCA-1 (Loxahatchee National Wildlife Refuge) is 140,800 acres in area, with a daily average water level of 15.55 ft NGVD. WCA-2A is 105,408 acres in area, with an average water level of 12.59 ft NGVD. WCA-3A is 491,072 acres in area, with an average water level of 9.46 ft NGVD. Daily water level fluctuations for the three WCAs during the most recent drought period reached minimum water levels of 12.06, 10.49, and 8.07 ft NGVD at WCA-1, WCA-2A, and WCA-3A, respectively, in May 2001.

During the 2000–2001 drought, groundwater levels declined and there were periods when below-average levels were reached in most regions of the District in the various aquifers. The Upper Floridan Aquifer in the Upper Kissimmee region dropped below its average level for more than a year. At one point, it was approximately 4.0 ft below normal level at the Boggy Creek well. The Surficial Aquifer System in the Upper East Coast planning area exhibited low groundwater levels for two extended periods, as did the Surficial Aquifer in Palm Beach County. Groundwater levels approached the 100-year low water level (lower values occur less than 1 percent of the time in the historical record) in summer 2000 and spring 2001. The water level in the Biscayne Aquifer exhibited different trends in different areas during the drought period. Excluding well water levels in Southern Miami-Dade County, northern and interior wells showed declines during various periods. Water levels in the Surficial Aquifer, the Lower Tamiami aquifer and the Sandstone aquifer in the Lower West Coast planning area declined with decreased rainfall and increased pumping and demonstrated a recovery after water use restrictions were imposed and with increased rainfall and recharge. All of the aquifers in the Lower West Coast planning area approached the 100-yr (1 percent) low groundwater level in summer 2000 and spring 2001.

DROUGHT MANAGEMENT PHILOSOPHY

To understand the water management responses to the extreme drought conditions described in section B, the fundamental legal and administrative framework for agency activities must be explained. This section summarizes Florida's system for equitable distribution of available water resources during the 2000–2001 drought event. The review will summarize theoretical underpinnings, associated laws, implementation of rules concerning water shortages, and linkages to the certainty concept.

CERTAINTY CONCEPT

Water users seek certainty, a reduction in risk of the water supply being interrupted for any reason, including drought. Water law systems attempt to resolve the issues of legal, tenure, and physical certainty (Maloney et al., *A Model Water Code 158,*1972). The latter is relevant to water shortages. Physical certainty concepts in water law address the status of water rights in changing weather conditions, particularly droughts. Common law rights in western prior-appropriation states reduced uncertainties associated with drought events by granting priority to the "first in time" user. The senior user's full water rights were preserved, while those of subsequent users were eliminated (*A Model Water Code 158*, and *Waters and Water Rights, Volume 2*, s. 12.03(e) 118). Conversely, Florida's system of addressing water shortages is based on equitable distribution of available supplies among all users. This equitable distribution of water in light of drought events begins in the permitting scheme and is further implemented in water shortage plans.

In the permitting realm, water is allocated to users based on its physical availability in a specified level of drought. The permitting system makes assumptions about the severity of rainfall deficit to allocate sufficient "make-up" water to satisfy demands. For example, a drought that has a rainfall deficit so extreme that, statistically, it can be expected to occur only once every 100 years is more severe than a drought whose rainfall deficit would occur once every 10 years. Supplemental water allocations to meet demands in extreme, 100-year drought events would involve huge quantities. If permitted, these quantities of water would become the protected water right of existing legal users. If users acquired rights to such large quantities of water to insulate themselves from the impacts of extreme drought events, their physical certainty of supply would be assured. However, few users would be able to access water, since Florida law prohibits unmitigated impacts to legally existing users (F.S. 373.223(1)(b)). A balance between user desire for certainty of supply, risk of impacts from drought events, and the number of water users who can acquire water rights is achieved via the assumptions relating to drought contemplated in the permitting scheme. Once a significant drought event occurs, Florida's Water Shortage Plan provisions may be triggered.

THEORIES BEHIND FLORIDA'S EQUITABLE SCHEME OF WATER SHORTAGE ALLOCATION

In 1972, during a severe drought, the Florida Legislature adopted F.S. Chapter 373, creating a unique and innovative means of allocating water resources. Water resource planning is a key theme of this landmark statute, by which the legislature requires the state's water management districts to adopt water shortage plans as an integral part of Florida's water allocation scheme (F.S. 373.246). A companion statute, F.S. 373.175, was also adopted.

User Knowledge: First, F.S. 373.246 requires the water management districts to adopt Water Shortage Plans, found in Chapters 40-A, C, D, and E of the Florida Administrative Code; the districts generally use consistent numbering for the rules contained within the various plans. Users are able to refer to the Water Shortage Plan provisions that will apply to their use class to determine the level of restriction in a given drought condition. Knowledge of potential restrictions enables users to prepare themselves for such circumstances, thereby increasing their physical certainty. For example, citrus growers who refer to the restrictions might notice that highly efficient irrigation systems are not restricted (e.g., FL Admin. Code Rule 40E-21.551). Thus, a grower may opt for installation of a highly efficient irrigation system to avoid or minimize drought restrictions.

Equitable Distribution of Available Water: Implementation of water shortage plans enables the districts to equitably apportion available supplies among all legal users, while also protecting

the water resources. Equal treatment of all users also mediates the economic implications of use restrictions.

Minimizing Economic Impact: The Water Shortage Plans identify use classes (e.g., FL Admin. Code Rule 40D-21.511) so each permitted user is classified with similar users. Restriction of an entire class of users is anticipated. Individual projects are generally not singled out. A given project may be restricted, particularly via the emergency water shortage order provision found at F.S. 373.246(7). The restrictions of the Water Shortage Plans impact all use classes: domestic self-supply, irrigation, golf course, public water supply, agricultural, dewatering, etc. Even users who are exempt from permitting (domestic self-supply) are subject to water shortage restrictions. Specific restrictions consider the unique needs of each use class in an attempt to equitably minimize the economic, social, and health-related impacts of drought cutbacks.

FLORIDA'S WATER SHORTAGE PLANS

Classification System: As noted above, each user is classified according to use type. Further, each user's source and method of withdrawal are classified. Source classes are divided into surface and groundwater. District rules identify the location of surface water use basins and groundwater sources. Method of withdrawal classes is also established by rule (e.g., FL Admin. Code Rule 40D-21.531, .541, and .571). For example, surface water users are classified by identification of pump usage or gravity inflow. In this manner, like users are grouped for equitable implementation of restrictions.

Evaluating Water Conditions: The water management districts monitor and evaluate water conditions. Comparisons between current and historical data help judge whether estimated present and anticipated available water supply within a source class will be sufficient to meet users' estimated present and anticipated demands from the source and whether serious harm to the water resource may occur. A series of technical factors help evaluate both the supply and demand components (e.g., FL Admin. Code Rule 40C-21.221).

Water Shortage Declaration and Restrictions: If a district governing board expects that sufficient water is not or will not be available to meet demands it may declare a water shortage for the affected source class. Estimates of the percent reduction in demand required to match available supply are used to identify which phase of drought restriction is implemented (e.g., FL Admin. Code Rule 40C-21.251). For example, phase one restrictions require golf course managers to restrict irrigation of fairways and roughs on the first nine holes of the course to the hours of 12:01 a.m. to 8:00 a.m. on Mondays, Wednesdays, and Saturdays. Phase two restrictions cut back the available irrigation days to Wednesdays and Saturdays (e.g., FL Admin. Code Rules 40E-21.521(3)(e) 2 and .531(3)(e)2). Thus, a gradual progression in severity of restriction is implemented through increasing phases. Once declared, the districts must both notify permitted users by mail of the restrictions and publish them in area newspapers (e.g., FL Admin. Code Rule 40E-21.291).

Monitoring of Conditions and Enforcement of Water Shortage Restrictions: Continuous assessment of supply, demand, and resource impacts is to occur through assessment of resource data. Restrictions may be modified or lifted as conditions warrant (e.g., Fla. Admin. Code Rule 40C-21.291(4)).

Generally, the water management districts seek the cooperation and assistance of state and local government resources in the enforcement of water shortage restrictions. Law enforcement officers are asked to ticket violators. (F.S. 373.609). Some districts, in an effort to enhance coordination, have encouraged local government adoption of water shortage ordinances that parallel district restrictions. Many local governments have implemented such ordinances.

Variances: The water shortage plans universally provide an opportunity for particular users to make a request to the district executive director and governing board for a variance. Application contents and conditions for issuance of a variance from water shortage restrictions are stated in water management district rules. Procedures for review of variance applications are expedited. Generally, the rules provide for a 10-day review period, after which staff must make their recommended agency action. If the application requires immediate action, staff may present the application to the Executive Director for temporary action, with governing board concurrence to follow. Otherwise, the variance applications are presented at the District monthly meetings. (e.g., FL Admin. Code Rules 28-104 and 40E-21.275).

CHRONOLOGY OF THE DROUGHT AND ASSOCIATED DECISIONS

The combination of drought hydrology and the legal framework described in previous sections of this chapter resulted in a series of water management actions and other drought-related activities. The remaining chapters of Part II will detail this management. The chronology and summary of management actions shown in **Figure 1-3** will help guide the reader through drought management and represents an organizational tool for this water management report.

Conditions During 2000

In April 2000, it appeared that a normal wet season weather pattern was beginning. In response to six years of high water levels, a managed recession was planned and implemented for Lake Okeechobee, primarily during May and June of 2000. However, May 2000 was the driest month statewide in more than 100 years and the summer of 2000 saw the development and implementation of a water supply contingency plan, highlighted in the next section of the chapter. Drought conditions during 2000 got progressively more severe as the rainfall deficit continued throughout the South Florida Water Management District area. Many other signs of the emerging drought appeared in the fall of 2000, including high salinity levels in the Caloosahatchee River, increased navigational problems in Lake Okeechobee, construction of temporary forward pumping facilities to move water from the lake at low stages, and imposed water restrictions in 11 of 16 counties in the District. By the close of 2000, lake levels were causing widespread concern as water restrictions were being implemented by the District's governing board.

Conditions During 2001

The first half of 2001 produced the worst drought conditions seen in many decades, and phases I and II water restrictions were imposed over most of the District early in 2001. Levels in Lake Okeechobee continued to fall, and the lowest level since record keeping began was recorded in May 2001. Nevertheless, early in 2001 the lake began to display a number of positive impacts from the low water levels, including growth of submerged plant beds, expansion of bulrush stands, very clear water with low phosphorus concentrations, and oxidation and consolidation of lake sediments. The Lower West Coast was being impacted by falling groundwater levels, and there was an increasing risk of saltwater intrusion. As the summer wet season approached, pumping was stopped on lake canals, and backpumping into the lake began for water supply purposes. Deviations from Water Conservation Area floor elevations were implemented in late spring affecting the amount of water available to the Lower East Coast, as modified phase II water restrictions were imposed on the Lower East and West Coast service areas.

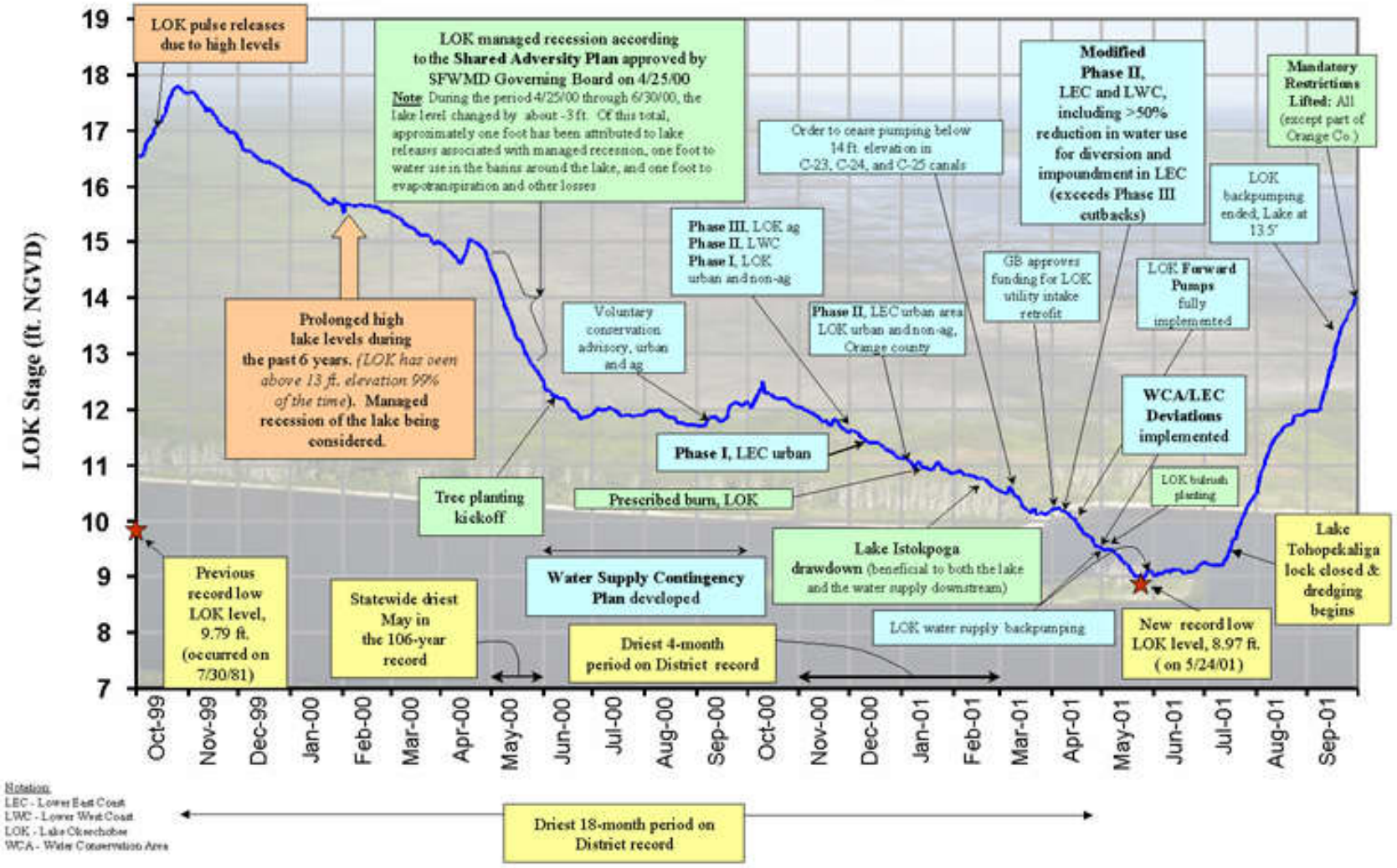


Figure 1-3. Chronology of the 2000-2001 drought

The wet season began in June and brought gradual relief from drought conditions. During the summer of 2001, water levels increased in District lakes and Water Conservation Areas. Both coastal discharges and releases into Everglades National Park increased sharply in August and September, accompanied by renewed inflows and outflows to the Stormwater Treatment Areas. Most specific responses to drought conditions were not necessary after September 2001 and the District resumed routine, seasonal water management activities.

WATER SUPPLY CONTINGENCY PLAN

During the summer of 2000 the District developed a Water Supply Contingency Plan that described measures that could be taken in response to the emerging drought. The plan was a compilation of short-term water management options that could be implemented at the advent of emergency water shortage conditions. This plan was implemented during the 2000–2001 dry season.

During the summer of 2001 the District began updating the Water Supply Contingency Plan for implementation during the 2001-2002 dry season. The list of water shortage management options was updated based on lessons learned over the previous year. Each option was then described and analyzed with respect to implementation factors, costs, and benefits. Before the plan could be finalized, normal rainfall returned and the water supply situation improved significantly. The second iteration of the Water Supply Contingency Plan was never finalized, and remains in draft form. It is available to serve as a starting point for future water shortage situations. Some of the major features of the draft plan are described below.

Option Implementation Matrix

The matrix (**Table 1-1**) was developed to show relationships among factors that are considered during the water shortage management decision process. The matrix contains information on the water shortage severity that should exist, the appropriate time of year, costs and benefits, and other considerations associated with each option. Each option was evaluated on this basis and placed into one or more of four categories, based on whether the option could be appropriately implemented during moderate, severe, extreme, or critical water shortage conditions. The implementation process reflected in this matrix was based on existing policies adopted by the South Florida Water Management District governing board over the course of the drought.

Severity: The severity of water shortage, as incorporated within the Option Implementation Matrix, is defined based on consideration of the following factors:

Lake Okeechobee stage/storage

Water Conservation Areas stage/storage

Local groundwater and surface water conditions

Timing: The appropriate time to implement the option, for maximum effectiveness, was also determined. Some options can be implemented year-round, while others can only be effective when water levels are above or below certain levels.

Costs and Benefits: Relative benefits and costs of options vary widely. Costs are defined to include environmental effects, as well as monetary expenses. The amount of water supply benefit that can be realized from any given option also varies and, in some cases, cannot be quantified in advance.

Table 1-1. Water supply contingency options implementation matrix

Option	Water Shortage Severity[2]			Season to Implement[1]		Costs	Benefits	Other Considerations
	Lake Okeechobee	Water Conservation Areas	Local GW/SW Conditions	wet	dry			
1. Lake Okeechobee Backpump & Augmentation	M, S, E, C	N/A	N/A	x		$855K	371K ac-ft	WQ impacts
2. Water Conservation Area Schedule Deviations	S, E, C	S, E, C	S, E, C		x	Staff time	(34-38% less demand on LO)	MFL violation environ. impacts
3. Upper Chain of Lakes Operational Flexibility	M, S, E, C.	M, S, E, C	N/A	x	x	Staff time	Environ., WQ improve.	Recreation loss environ. benefits
4. Cloud Seeding	C	C	C	o	x	Yr 1: $950K Yr 2: $750K	30-60% rain-fall increase	Ancillary WQ, environ. + flooding
5. Modified Supply Side Management (yellow book)	M, S, E, C	N/A	N/A	o	x	Staff time	More equitable restrictions	MFL violation
6. Revise BMP Makeup Water Deliveries	M, S, E, C	M, S, E, C	M, S, E, C		x	Staff time	160K ac-ft	STA, WQ impacts
7. Water Shortage Triggers	M, S, E, C	M, S, E, C	M, S, E, C	x	x	$80K admin	Resource-based trigger	Changes in value of water; user impacts
8. Minimize Deliveries to Maintain LEC Canal Levels	S, E, C	S, E, C	M	o	x	Lower op. cost; High poss. impact	40K ac-ft + environ. benefits	MFL violation SW intrusion
9. Diversion and Impoundment Operations	S, E, C	S, E, C	S, E, C	o	x	Poss. local ag impacts	12K ac-ft/day + environ. benefits	
10. Southern Istokpoga Basin Operations	M, S, E, C	N/A	M, S, E, C	o	x	$48K pump costs	4K ac-ft	
11. STA Operations	M, S, E, C	M, S, E, C	M, S, E, C	o	x	(saves money)	35K ac-ft	STA vegetation, WQ impacts
12. Water Conservation BMPs For Water Shortage	M, S, E, C	M, S, E, C	M, S, E, C	x	x	varies	Up to 50% of demand	
13. Water Shortage Restrictions	M, S, E, C	M, S, E, C	M, S, E, C	x	x	$300-15000 per ac-ft	10-50 % reduction	Local Government responsibility
14. Forward Pumping	S, E, C	S, E, C	S, E, C	o	x	$2.5M+op and maintenance	266K ac-ft	Lower lake levels
15. Compr. Water Shortage Public Education Program	M, S, E, C	M, S, E, C	M, S, E, C	o	x	$1M	10-50% of PWS demand	
16. C-23, C-24, & C-25 Water Shortage Operations	N/A	N/A	E, C	o	x	Varies	.5 to .8K ac ft	Time to Implement
17. Caloosahatchee River At-Risk Utilities	S, E, C	N/A	M, S, E, C	o	x	$ 32 M to local utilities	Less frequent restrictions	Caloosahatchee WQ, MFL violation
18. Lake Okeechobee At-Risk Utilities	E, C	N/A	N/A	o	x	$2M	Reliability to 6 ft	
19. Ground Water At-Risk Utilities	M, S, E, C	M, S, E, C	S, E, C	o	x	Admin, monitor and report costs	Minimize local SW intrus. risk	
20. Water Supply Improvements for C-40 and C-41 Canals	S, E	N/A	N/A	o	x	$450K	34K acre-ft	
21. Local Government Enforcement	M, S, E, C	M, S, E, C	M, S, E, C	x	x	Staff time	Reduced water use	Local Government responsibility
22. District Enforcement	M, S, E, C	M, S, E, C	M, S, E, C	x	x	Staff time	$ collected; red. In water use	

[1] x= preferred; o =optional; [2] Severity is classified s follows: C = critical, E = extreme, S = severe, M = moderate

Other Considerations: Other conditions, issues, or events may play a role in the decision process, such as water quality or environmental effects, economic considerations, violations of Minimum Flow and Level (MFL) criteria, local government or other agency actions or participation, etc.

How Options are Implemented

Depending on the extent and nature of a drought, actions may be taken either regionally or locally. Regional actions involve operation of the canals, structures, and reservoirs of the primary water management system. Local options involve area-specific water use restrictions, or changes to local drainage, district, or utility operations.

An example of how the process of balancing timing, cost/benefit, and drought severity considerations worked during the period from October 1999 to June 2001 is presented in this report. The initial Water Supply Contingency Plan was developed beginning in June 2000. Due to conditions in Lake Okeechobee, implementation of features of this plan began immediately, even before the final document was completed.

Recommendations for implementation of available options are based on monthly Lake Okeechobee position analyses, which are computer simulations of projected lake levels under various rainfall scenarios, and projections of other relevant water conditions. The entire range of options is continually evaluated for implementation in an iterative fashion, based on existing water conditions, projected water conditions, current severity of water shortage and demand characteristics, option cost, environmental impact, and water supply benefit.

Water Shortage Team

The District established a water shortage team under the auspices of the Emergency Operations Center (EOC) to develop and implement the plan. As emergency situations threatened or occurred, Emergency Management activated the EOC to facilitate evaluation and incident planning, as well as implementation of emergency functions and resources.

FUNDING

Many of the options identified in the 2000 contingency plan were costly to implement and were also unbudgeted. The District governing board authorized $10,134,026 in emergency drought expenditures through August 2001. Since these expenditures were unbudgeted, a number of funding options was identified to support water shortage operations. The next iteration of the Water Supply Contingency Plan identified additional expenditures of $6,159,014, which were incorporated into the FY02 budget.

Chapter 2: Emergency Management

Olivia McClean

The South Florida Water Management District's (District's) Comprehensive Emergency Management Plan establishes the policies and procedures the District will use to prepare for, respond to, and recover from any and all emergencies. The plan is developed from an "all hazards" approach and is designed to address the management of District resources assigned to an emergency event, such as the water shortage. A nationally recognized management system known as the Incident Command System is used to organize the District's Emergency Operations Center (EOC) whenever it is activated.

In September 2000, the water shortage was becoming a threat to agricultural, environmental, and utilities' needs. Based on their concerns and on the precipitation forecast, the District's Executive Director activated the EOC under the direction of the deputy Executive Director for Water Resource Operations. The director of emergency management was charged with securing the appropriate District resources to effectively respond to the emergency situations. The Water Shortage Team, consisting of directors from impacted departments, was organized under the Incident Command System. Key staff members from various departments and with diverse expertise were organized under the EOC sections of water operations, response, logistics, finance, legal, and public information. Assignments to the water shortage emergency were made from the director of emergency management to the department directors for a specific length of time, depending on the assignment. Many duties required full-time dedication to the water shortage situation, and regular duties were re-assigned within the impacted department.

The EOC was activated at level 2 (partial activation). It operated approximately 12 hours a day and remained activated until July 2001.

The District's EOC served as the information clearinghouse, event coordination center, records management area, and central working area for the management team. This allowed for quick decision making and the necessary coordination among the various groups involved in the operation.

The EOC conducted daily briefings, at which time each section reported on its areas of responsibility. A weekly briefing was held for the executive management group. Weekly situation reports summarizing key actions taken by the District were distributed to the governing board, the state EOC, the Florida Department of Environmental Protection (FDEP), the Florida Department of Agriculture and Consumer Services (FDACS), and the Florida governor.

A weekly action plan for the upcoming operational period was developed during a planning meeting that outlined specific assignments for each section.

COORDINATION WITH THE STATE EOC

The District's EOC remained in constant contact with the state EOC during the water shortage emergency. The state EOC continued to monitor the situation and prepared contingency plans for delivery of emergency water supplies in case a utility become inoperable. Statewide conference calls were held weekly with water management districts, the FDEP, the Florida

Department of Emergency Management (FDEM), FDACS, and Federal Emergency Management Agency (FEMA). In addition, the District's EOC provided both a weekly and a biweekly situation report to the state EOC.

Chapter 3: System Operations

Susan Gray, Paul McGinnes, Gary Goforth and Tom Kosier

SUMMARY

Management of the Water Conservation Areas (WCA) and the South Dade Conveyance System (SDCS) during the drought involved operating according to approved schedules. Temporary deviations from approved schedules were sought and obtained to maximize operational flexibility while protecting environmental resources. To a large extent, the successes in obtaining temporary deviations to the minimum water level regulation schedule relied on the timely hydrodynamic predictive modeling and ecological assessment reports prepared by District staff. This information was provided to the U.S. Army Corps of Engineers (USACE) and the U.S. Fish and Wildlife Service (USFWS). These reports revealed no significant ecological impacts due to the temporary deviations. Water levels in the Loxahatchee National Wildlife Refuge (WCA-1) fell below the normal minimum water level regulation schedule for approximately four weeks (May 2001). During this time the WCA was operated in accordance with the approved temporary minimum water level regulation schedule, thereby avoiding the need to bring water into the WCA from Lake Okeechobee or other sources while making water supply releases to the Lower East Coast Services Area – 1 (LECSA-1). Rains that began in mid-May returned the WCA to non-critical water levels by mid-June 2001. Water levels within WCA-2 were already below both the normal and approved lower minimum water level when a temporary deviation was approved in late April 2001. With the May rains, water levels returned to normal in WCA-2 by mid-June 2001.

LAKE OKEECHOBEE MANAGEMENT

Lake Okeechobee water levels fell to historic lows because of the drought. Initially the 2001 rainy season generated only average rainfall, hampering the lake's recovery and raising the possibility of even more severe water shortages during the approaching dry season.

In anticipation of these historic lows the South Florida Water Management District secured a pump vendor and several contractors to manufacture and install a temporary pumping system at structures S-351, S-352, and S-354. The system was designed so all components could be installed, operated, and removed at each structure without modifications. In March 2001, as the lake levels approached 10 feet, a total of 14 100-cfs pumps and system components were installed at a cost of $2.3 million. The pumps were operated an average of three days a week and provided needed irrigation to the surrounding farm communities. The pumps delivered 92,904 ac-ft during this period, as the lake reached an all-time low of 8.97 feet. They were removed in August 2001. Several of these pumps have been designated for permanent installation in new District structures.

The water intakes for the City of Fort Myers and Lee County potable water supply plants are located on the C-43 canal at Olga, approximately one mile upstream of the W.P. Franklin Lock and Dam (S-79). During periods of negligible discharge at S-79, saltwater intrudes up the estuary to the lock and dam and eventually upstream of S-79 and into C-43. As a result, chloride concentrations at the water plant intakes can reach unacceptable levels (>200 ppm). In response, water supply releases are made from Lake Okeechobee to flush chlorides from the system. Two such releases occurred during the drought. The first occurred as a pulsed release over a five-day period in November 2000 (November 22 through 26) and peaked at 1,563 cfs on November 23,

2000. The release totaled about 9,100 ac-ft. The second release occurred as a pulsed release over a six-day period in January 2001 (January 4 through 9) and peaked at 1,968 cfs on January 7, 2001. The release totaled about 9,100 ac-ft. Both releases successfully flushed chlorides from the top five meters of the seven meter water column. Use of bubble curtains at the lock, as well as limited lockage, helped retard further saltwater intrusion. A minor rain event in early April resulted in 1,900 ac-ft of discharge at S-79, which helped keep chloride levels low at the plant intakes. Rains began in late May, and high chloride ceased to be a problem.

As a result of these and other effects of the drought, the District's Executive Director declared a water emergency on March 27, 2001. The District governing board subsequently concurred with the decision in an emergency board meeting that same day. In response to the declared water emergency, the Florida Department of Environmental Protection (FDEP) issued the first Emergency Final Order (OGC no. 01-0715) on April 27, 2001. This order authorized the District to initiate water supply backpumping into the lake through the existing structures at S-2 and S-3 at the south end of Lake Okeechobee. In the ensuing months, as the drought continued and concerns escalated regarding the impending dry season, the FDEP issued a second Emergency Final Order (OGC no. 01-1202) on August 3, 2001. This order authorized the District to continue water supply backpumping and also allowed augmentation of the pumping and gravity flows of water into the lake through the structures at S-4, S-77, S-308, S-352, and culvert 10-A. In addition, the District was authorized to install temporary pumps to backpump supplemental water as necessary. Operation of the temporary pumps did not occur, however, because increased rainfall during the latter part of the rainy season, as well as gravity inflow through key structures, sufficiently raised lake water levels before the pumps became operational.

During the backpumping and recession period from June 1 through September 21, 2001, augmentation activities contributed 575,726 ac-ft, or approximately 39 percent of the total inflow, to Lake Okeechobee (**Table 3-1**). From June 1 to September 21, 2001, the lake's contributing basins received 26 to 37 inches of rainfall as the lake's stage rose from 9.0 to 13.5 feet, with the largest increase occurring in September (**Table 3-2**). Flow augmentation and backpumping operations, coupled with the increased rainfall during the latter part of August and early September, sufficiently raised Lake Okeechobee water levels to allow the discontinuation of the activities authorized by the Emergency Final Orders on September 21, 2001. The full report detailing the Lake Okeechobee backpumping and augmentation activities is included as **Appendix 3A-1.**

Table 3-1. Summary of inflows for June 1, 2001 through September 21, 2001, water supply backpumping and water supply augmentation sites and total inflow for all lakewide sites

STATION	Total Inflow		% of lake-wide inflow total
	Cfs-days	Acre-feet	
S-2	98,882	196,129	13%
S-3	65,324	129,569	9%
CULV10A (L-8)	37,753	74,881	5%
S-77	34,916	69,255	5%
S-308	45,860	90,962	6%
S-4	6,072	12,044	1%
S-352	1,455	2,886	<1%
Total for above sites	**290,262**	**575,726**	**39%**
% lake-wide of all inflow	**39%**	**39%**	**39%**
Lake-wide inflow total	**741,275**	**1,470,298**	**100%**

Table 3-2. Lake stage and rainfall for Lake Okeechobee and vicinity

Month/Date	USACE STAGE Data. Daily Lake Average in ft (NGVD)		Monthly total of SFWMD provisional 24-hour rainfall (inches), starting on the first of each month and ending at 7:00 a.m. EST on the indicated date							
	Beginning	Ending	EAA West	EAA East	Lake Okee-chobee	Upper Kissimmee	Lower Kissimmee	East Caloos.	Martin, St. Lucie County	Palm Beach County
June / 30	9.01	9.27	6.51	6.12	5.69	8.04	6.58	6.56	7.44	6.56
July / 31	9.26	10.53	7.14	8.24	9.07	8.44	8.89	13.44	11.71	9.41
August / 31	10.61	11.98	4.53	5.78	6.19	6.67	4.53	8.48	8.18	7.95
September / 21	11.96	13.56	8.21	6.24	7.80	9.87	8.47	9.04	7.31	9.86
Total	**9.01**	**13.56**	**26.39**	**26.38**	**28.75**	**33.02**	**28.47**	**37.52**	**34.64**	**33.78**

STORMWATER TREATMENT AREA MANAGEMENT

BACKGROUND

The Stormwater Treatment Areas (STAs) are large constructed wetlands designed to reduce the levels of phosphorus entering the Everglades Protection Area. Four of the six STAs that comprise the Everglades Construction Project (ECP) are fully operational and total over 18,000 acres. The remaining two are under construction and should be completed by October 2003. A schematic of the STAs is presented in **Figure 3-1**. The STAs will reduce phosphorus levels from stormwater originating from the Everglades Agricultural Area (EAA), the C-139 and C-51 West basins, and Lake Okeechobee releases prior to discharging into the Water Conservation Areas. The long-term phosphorus removal mechanism for the STAs is the growth and subsequent deposition of organic matter as new sediment, or accumulation of peat.

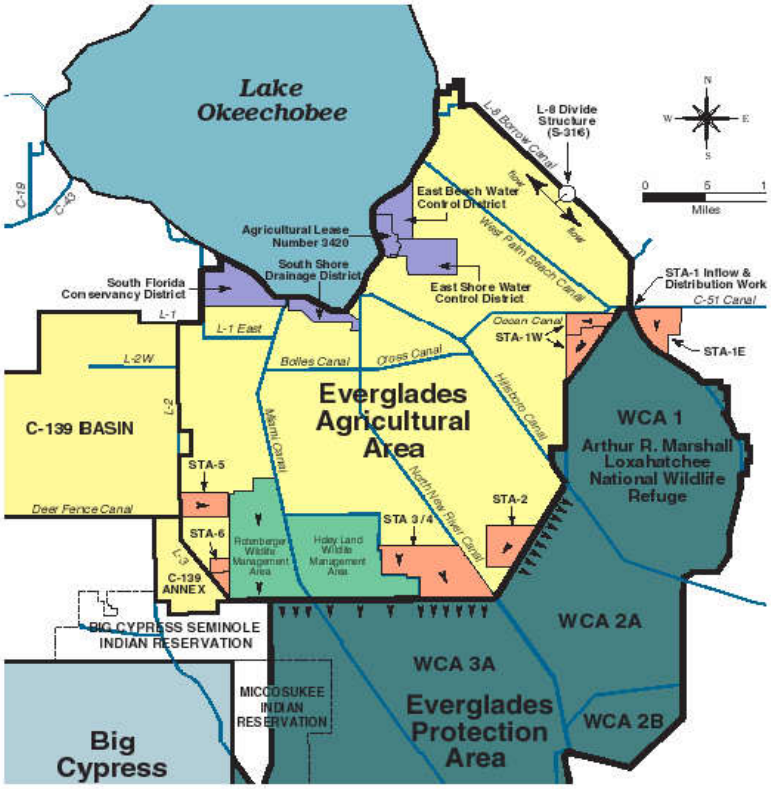


Figure 3-1. Overview of the Everglades Construction Project

The success of the STAs in removing phosphorus is directly linked to the health and viability of the vegetated communities within the STAs and the soil's ability to retain phosphorus. Even during dry weather (including drought conditions) it is important that these vegetated communities receive enough water to ensure they can effectively remove phosphorus during future storm events. Three critical water depth thresholds are used in operating the STAs for vegetative health:

1. Optimal performance. Three general types of vegetated communities are used in the STAs: cattail; sawgrass and other mixed-marsh species; and submerged aquatic vegetation (SAV).

For optimal phosphorus removal performance it is necessary to maintain normal operating depths of 18 to 24 inches above average ground level.

2. Net improvement. To ensure that the organic sediment within the STAs does not release phosphorus when exposed to the air, the operational target for the STAs is to maintain a minimum depth of six inches above average ground level.
3. Vegetation viability. Based on the best available scientific information, the three vegetation communities have unique minimum-depth requirements for keeping the vegetation alive and healthy. For cattail, the stress threshold is approximately six inches below the ground. For sawgrass and other mixed-marsh species, there apparently is no mortality threshold. For SAV, the mortality threshold is approximately six inches above the ground.

The potential impacts of dryout within the STAs will vary depending on site-specific soil, vegetation, and hydrology.

Death of wetland vegetation due to dehydration is a major factor in STA operation related to drought conditions. The growth of undesirable vegetation (exotics, dog fennel, and other terrestrial species) as the organic soil is exposed to the air is another STA issue. Following a low-water period, resuspension and release of phosphorus from the soil into surface waters upon re-wetting can impair the wetland's ability to retain phosphorus. Once the area is re-flooded, there may be a period of a year or more during which phosphorus reduction may be greatly decreased, depending on the severity of the drought and the health of the vegetation upon re-wetting. It may be necessary to take individual treatment cells offline as the STA vegetation re-grows before the cell produces a net reduction in phosphorus, as required by permit.

Finally, there is evidence that dryout and subsequent re-wetting of these systems may stimulate the mercury methylation process, which may result in potential risks to wildlife both at the site and downstream in the Everglades.

In addition to the biological basis for maintaining minimum depths within the STAs, there are also relevant legal and regulatory concerns. The District is party to a federal Everglades Settlement Agreement that establishes STA performance targets. To the extent that drydowns adversely affect the STAs' ability to achieve performance targets, there may be legal consequences. The STAs are subject to state and federal operation permits that establish minimum performance targets and operational requirements to ensure that performance targets are met. Non-compliance could potentially result in enforcement action against the District.

STA Operations

STA operations during the 2000–2001 drought were based on the philosophy of "shared adversity" with other water users. Due to extreme drought conditions, water levels dropped below the optimal water levels for phosphorus reduction within the STAs. In addition, the drought's severity resulted in water levels dropping below the minimum operational target of six inches in all the cells, a level typically associated with maintaining a net reduction of phosphorus. The shared adversity philosophy was manifested in an operations strategy designed to supply just enough water to keep the vegetation alive. In STA-5, during the drought cattail cells fell below the assumed stress threshold of six inches below ground for a period that did not exceed 90 days. STA-6 is predominantly mixed marsh and sawgrass. It was believed that both community species could remain viable during and following dryout, so no supplemental water was delivered.

STA-1 WEST

STA-1 West contains five treatment cells and more than 6,670 acres of wetland vegetation. Treatment cells 5A, 1, 2, and 3 are comprised predominantly of cattail and other emergent vegetation, with significant quantities of SAV. Treatment cells 4 and 5B are dominated primarily

by SAV. During the 2000–2001 drought approximately 830 ac-ft of water were delivered to STA-1W to maintain viability of the vegetation. Water deliveries also were made to cells 4 and 5 to ensure SAV viability.

STA-2

STA-2 contains three treatment cells and more than 6,430 acres of wetland vegetation. Treatment cells 1 and 2 are comprised predominantly of sawgrass and other emergent vegetation. Treatment cell 3 is dominated by SAV. During the 2000–2001 drought approximately 400 ac-ft of water were delivered to STA-2 to maintain the viability of vegetation in cell 3.

STA-5

STA-5 contains four treatment cells and more than 4,100 acres of wetland vegetation. Treatment cells 1A, 2A, and 2B are comprised predominantly of cattail and other emergent vegetation. Treatment cell 1B is dominated by SAV. During the 2000–2001 drought approximately 3,027 ac-ft of water were delivered to STA-5 to maintain viability of the SAV in the downstream cells. Initially the operations relied on the existing water supply and seepage return pumps that delivered water to the STA's upstream (cattail vegetation) portion. However, after observing the small amount of water that traversed the cattail community from the upstream to the downstream cells, future water supply deliveries were made via a leased, portable pump installed on the levee directly into cell 1B. During the drought the cattail cells fell below the assumed stress threshold of six inches below ground for a period that did not exceed 90 days. Water quality and limited biological data collected subsequent to the drought were evaluated to determine the 2000–2001 drought's impact on the STA's performance.

STA-6

STA-6 contains two treatment cells and approximately 870 acres of wetland vegetation. Both treatment cells are comprised predominantly of grasses and other emergent vegetation. During the 2000–2001 drought, no supplemental water was delivered to STA-6. Water quality and limited biological data collected subsequent to the drought were evaluated to determine the drought's influence on the STA's performance.

WATER CONSERVATION AREA MANAGEMENT

INTRODUCTION

The five Water Conservation Areas (see **Figure 3-1**) were constructed as part of the Central and South Florida Project (C&SF Project). Collectively, these areas provide a detention reservoir for excess water from the Everglades Agricultural Area, parts of the Lower East Coast (LEC) planning area, and flood discharge from Lake Okeechobee. The WCA levees prevent Everglades floodwaters from inundating East Coast urban areas and retain water that can later be supplied to East Coast areas and Everglades National Park. In addition, these levees help maintain higher water levels that provide recharge to surficial aquifers, ameliorate saltwater intrusion in coastal basins, reduce seepage, and benefit Everglades fish and wildlife.

In general the WCAs provide water during the dry season to three Lower East Coast service areas. Lower East Coast Service Area 1 (LECSA-1) includes that part of Palm Beach County east of WCA-1 and a small part of Broward County. Lower East Coast Service Area 2 (LECSA-2) includes that part of Broward County east of the WCAs and south of the Hillsboro Canal basin and the C-9 Canal basin in northern Miami-Dade County. Lower East Coast Service Area 3 (LECSA-3) includes that portion of Miami-Dade County east of WCA-3B and Everglades National Park, as well as the Florida Keys. All three service areas are heavily urbanized and have experienced rapid growth for several decades.

Water levels within the WCAs are managed according to schedules established by the U.S. Army Corps of Engineers (USACE). The WCA regulation schedules represent seasonal and monthly limits of storage. This seasonal range permits the storage of runoff during the wet season for use by the Lower East Coast service areas and Everglades National Park during the dry season. In addition, the regulation schedules help maintain and preserve native plant communities, which are essential to fish and wildlife.

The regulation schedules establish minimum water levels below which water releases are not permitted due to anticipated adverse environmental impacts. However, the schedules permit water to be "passed through" the WCAs. This can be accomplished by sending water to the WCAs from another source (Lake Okeechobee, for example), and then releasing it to the service areas on an equal-volume-in/equal-volume-out basis.

REQUEST FOR TEMPORARY DEVIATION

In December 2000 the District determined that, because of then-current water levels within the WCAs and Lake Okeechobee, and in anticipation of the coming dry season, water levels within the WCAs had the potential to fall below the regulation schedules' minimum water levels. In addition, the District recognized that the ability to "pass through" water from the lake to the Lower East Coast service areas could be compromised due to an inability to move water from Lake Okeechobee to the WCAs. As Lake Okeechobee levels decreased to stages of 10.0 ft-NGVD and lower, it was virtually impossible to move water south from Lake Okeechobee into the WCAs. One option the District considered was that of seeking "temporary deviations."

On March 29, 2001, as lake levels continued to decline toward record lows, the District formally requested a temporary deviation from the minimum water level schedule for WCA-1 from the USACE. The request to lower the schedule for the minimum water level from 14.0 ft-NGVD to 11.0 ft-NGVD was made to "protect the public water supply wellfields in Service Area 1 from saltwater intrusion." The temporary deviation allowed releases to be made to the LECSA-1 from the WCA without the need to "pass through" water from Lake Okeechobee or other sources. The releases from WCA-1 to the LECSA-1 occurred until the temporary minimum water level schedule was reached.

On April 4, 2001 the District made a similar, formal request to the USACE for a temporary deviation to the minimum water level regulation schedule for WCA-2. The request temporarily lowered the minimum water level from 11.0 ft-NGVD to 10.0 ft-NGVD and limited water releases to the South Dade Conveyance System (SDCS) through SFWMD structure G-211. This allowed water supply releases to be made from WCA-2 to the LECSA-2 until the temporary minimum water level schedule was reached without the need to "pass through" water from Lake Okeechobee or other sources. Restricting the releases to the SDCS through the G-211 structure would conserve water in WCA-3.

On April 9, 2001, District staff members were invited to attend an "informal consultation" with the USACE and the USFWS. Under section 7 of the Endangered Species Act of 1973, the USACE was required to consult with the USFWS on the two formal requests for temporary deviations, described above, that the USACE had received from the SFWMD. In essence, the USFWS was charged with determining whether the requested deviations would have a "significant impact" on any endangered species living in or near WCA-1 and WCA-2. At this informal consultation, SFWMD staff presented hydrodynamic modeling information and the draft of a report on then-current ecological conditions (*Ecological Impacts of Drought in the Water Conservation Areas*) to assist the USFWS in making its determination.

As a result of this meeting, the District modified its requests for the two temporary deviations. The original requests were for lowering the minimum water level schedule abruptly

from the normal level to the lower level. However, at the meeting it was agreed that lowering the levels gradually over a period of several weeks would be more environmentally sound and would provide nearly the same water conservation benefits as the originally requested deviations.

On April 25, 2001 the District hosted a USACE-sponsored "public meeting" describing the District's modified requests. The USACE gathered additional comments and suggestions from the public to assist in reaching a decision on the two District requests.

On April 26 the District made a similar, formal request to the USACE for a temporary deviation to the minimum water level regulation schedule for WCA-3. The request sought to temporarily lower the minimum water level schedule to 6.5 ft-NGVD from the normal 7.5 ft-NGVD. Although not granted, the temporary deviation would have allowed water supply releases to be made from WCA-3 to the LECSA-3 until the temporary minimum water level schedule was reached without the need to "pass through" water from Lake Okeechobee or other sources.

Additionally, on April 26 the District received a copy of a letter from the USFWS to the USACE. In summary the USFWS found "no significant impacts" from the modified requests for temporary deviations to the schedules for WCA-1 and WCA-2.

On April 30, 2001 the District received approval from the USACE for the modified requested temporary deviations to the minimum water level schedules for WCA-1 and WCA-2.

On May 4, 2001 the District received a letter from the USACE clarifying its position on the operation of structure G-211 referenced in the District's request dated April 4 (described above). In summary, the USACE concluded that "termination of the water supply deliveries to the SDCS is in accordance with approved water control plans and, therefore, does not require a deviation."

On May 10, 2001 the District received a copy of a letter to the USACE from the USFWS concerning the District's request for a temporary deviation to the minimum water schedule for WCA-3 (described above in the April 26 letter). In this letter, the USFWS was concerned that approving the requested deviation to the minimum water level schedule would "lead to adverse impacts." This finding led the USACE to begin discussions with the District on the USACE's responsibility to conduct a full "Environmental Impact Statement" (EIS) on the potential effects of the deviation request. The two agencies informally agreed that in the time it would have taken to complete an EIS (six months), the wet season would by that time already have begun and the need for a temporary deviation would have passed. For this reason, an EIS in support of the requested deviation was not initiated.

Chapter 4: Water Demand Management

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Robert M. Brown and Patricia Walker

SUMMARY

The South Florida Water Management District (District) has a long history of promoting voluntary water conservation under normal rainfall conditions and routine water management activities. During times of drought, the District may declare mandatory water use restrictions to prevent serious harm to the region's water resources. During the 2000–2001 drought, the District imposed phase II and phase III mandatory water use restrictions over a large portion of the area under its jurisdiction. Local governments enforced the restrictions on small-volume water users that were not required to obtain a water use permit from the District. The District enforced restrictions on larger-volume water users that were required to obtain a water use permit from the District. The District also processed variance requests from water users seeking relief from the provisions of the mandatory water use restrictions.

INTRODUCTION

This section describes the menu of options that the District may use to reduce water demand. These options range from routine water conservation to mandatory water use restrictions imposed during time of serious water shortage. The District's Water Shortage Plan describes four phases (I-IV) of mandatory water use restrictions designed to obtain 15 percent, 30 percent, 45 percent, and 60 percent reductions in water use. The plan also provides provisions for obtaining a variance from the restrictions under certain circumstances.

WATER CONSERVATION

The District has a long history of promoting voluntary water conservation. The water conservation program is aimed at educating the public to reduce water usage for each type of use to the lowest level economically feasible. This program is geared to normal rainfall years and routine hydrologic circumstances. When deficit rainfall periods occur, the techniques involved in wise water use often become the components of mandatory water use restrictions. Those behaviors practiced voluntarily during non-drought periods become required behaviors during a water shortage crisis. All wise water use practices within the District's water conservation program can be applied during a drought, thereby reducing the need to impose mandatory water use behavior. Water users who practice a true water conservation ethic rarely feel the impacts of drought and should not be overly impacted in their water use by the imposition of mandatory water shortage restrictions. Mandatory restrictions are aimed at bringing water users who waste the resource to a level of use similar to that of those who practice water conservation as a way of life.

MANDATORY WATER USE RESTRICTIONS

The South Florida Water Management District governing board issues water shortage declarations requiring mandatory water use restrictions only when the physical impacts of drought threaten serious harm to the region's water resources. In contrast to the routine water conservation efforts discussed above, mandatory restrictions are imposed as emergency water management actions in response to extreme hydrologic conditions. In November 2000, after a general call for water conservation, District staff and the governing board determined a need to impose mandatory water use restrictions on South Florida residents because of a pending threat of serious harm to the region's water resources. To lessen the drought's impact and corresponding disruption to the regional economy and residents' lifestyles, the District decided to ease South Florida into water use restrictions by first declaring a phase I, or moderate, water shortage in most of the District.

On November 29, 2000, the District's executive director declared a water shortage emergency for non-agricultural uses from Lake Okeechobee and connected surface waters within the Everglades Agricultural Area water use basin, the lakeshore perimeter water use basin, the Caloosahatchee River water use basin, portions of the Indian Prairie water use basin, and the St. Lucie River water use basin and imposed phase I water use restrictions in these areas. A water shortage emergency was also declared for agricultural uses in these same water use basins and phase III water use restrictions were imposed. A water shortage emergency and phase II water use restrictions were imposed within the Caloosahatchee River water use basin, the Caloosahatchee River Watershed North, the Caloosahatchee River Watershed South, the western-most portion of the South Hendry County/L-28 Gap water use basins, the Fakahatchee North water use basin, the Fakahatchee South water use basin, the Big Cypress water use basin and the coastal Collier County water use basin on November 29, 2000. On December 8, 2000, phase I water use restrictions were imposed for the South Dade Water Conservation Area/Everglades National Park, Water Conservation Area 3, Water Conservation Area 2, Water Conservation Area 1/C-51, the M Canal, C-18, the Loxahatchee River, the North Palm Beach County and the interior Palm Beach County water use basins. These water emergency declarations were approved by the District's governing board at its meeting on December 14, 2000.

After about a month of phase I restrictions, it became apparent that to protect the region's water resource from the potential impact of saltwater intrusion into public water supply aquifers, a phase II, or severe, water shortage declaration was necessary. Lake Okeechobee is the reserve water supply for most of the Lower East Coast and parts of the Lower West Coast and Upper East Coast. Because of record-low water levels in the lake, this potential recharge source was in jeopardy. Reducing water demand on the coasts lessened the need to recharge coastal well fields from the lake. On January 11, 2001, the District's governing board declared a phase II water shortage for both the Lower East Coast region and water use basins in the EAA, Indian Prairie, St. Lucie River and Lake Okeechobee areas. Modified phase II restrictions were also imposed in the Orlando metropolitan area based on the threat of sinkhole formation from record-low Floridan aquifer levels. The District received a significant amount of input from the major water use industries and public water suppliers regarding the potential economic impact to the region under a prolonged phase II declaration. The District did not anticipate relief from drought conditions until June, when the South Florida rainy season typically begins.

In March 2001, with no rainfall projected, the District was faced with declaring a phase III or extreme water shortage emergency. At the March governing board meeting, the District's executive director asked the governing board to declare a phase III water shortage emergency, an action never before taken on "demand management" restrictions. Previous water shortages had included phase III "supply-side" restrictions on water users taking water directly from Lake Okeechobee. The governing board approved a motion to impose phase III restrictions at its

regular meeting on March 15, 2001, but the negative response to the board's action was strong and vocal. Consequently, the governing board directed District staff to analyze the economic threat/water-saving relationship and meet with concerned industries to devise an alternative. At a public meeting with District managers on March 21, 2001, many business owners expressed concern over the potential economic impact on their businesses and clients relative to the projected water savings in implementing phase III restrictions.

Protestors showed up at the District's special board meeting on March 27, 2001, and picketers gathered outside the District auditorium. At the meeting, District staff presented an alternative plan calling for a modified phase II declaration for the Lower East Coast and Lower West Coast regions. This plan met three criteria: reduce economic impact; meet or exceed the water saving potential of the existing phase III restrictions; and make the alternative restrictions enforceable to encourage compliance. Subsequent to this action, District staff continued to meet with the industry work groups to forge proposed changes to the other three phases of water shortage restrictions that would also meet the above criteria.

In September 2001, the governing board voted to rescind restrictions for those public water suppliers using at least 20 percent alternative water supply technologies, including water re-use and aquifer storage and recovery (ASR).

At its October 10, 2001 meeting, the governing board voted to rescind all water use restrictions and orders except those in place for the Orlando area (coordinating with the St. John's River Water Management District's modified phase II restrictions, which remained in effect).

LOCAL GOVERNMENT ENFORCEMENT

The District and the local governments within its jurisdiction shared responsibility for enforcing water shortage restrictions. Local governments were responsible for enforcing water use restrictions imposed on small-volume residential and commercial water users that do not use enough water to be required to obtain a water use permit from the District. The District was responsible for enforcing water use restrictions on larger-volume water users required to obtain a water use permit from the District.

County sheriffs' offices, local police departments and municipal and county code enforcement officials are typically responsible for enforcing water shortage restrictions at the local level of government. The local government departments and agencies provided the funds for staff time to enforce water shortage restrictions. The District supplied warning tickets, water shortage violation tickets, and water shortage publications for distribution to assist in enforcement activities. When the District officially declared the water shortage in effect and subsequently imposed restrictions, members of the District's water shortage team and the District's regional service centers held a series of compliance/enforcement workshops. These workshops, or "cop shop" meetings, were held in those counties affected by water use restrictions to coordinate water shortage enforcement between cities and counties.

The District printed warning tickets (nicknamed "scarlet letters") and violation tickets and made them available to local sheriffs' offices and police and code enforcement departments. In addition, District staff worked closely with the court system and the local state attorney's office to develop a program that was enforceable and effective.

To track the effectiveness of utility water conservation programs and water supply delivery reductions during water shortages, the District's Water Supply Permitting Department produced monthly utility pumpage reports. The reports were produced each Friday before the next regularly scheduled governing board meeting to provide up-to-date information for the monthly Water Shortage Conditions Report presented to the governing board.

Complaint calls from the District's phone bank were mapped, and analyses of the calls indicated which communities had potential enforcement problems. In addition, service center staff compiled information from local governments within the county or area served by the service center. At the beginning of each week, local governments reported to the service centers regarding enforcement activities within their jurisdiction, providing details regarding the numbers of water shortage warnings, water shortage violations, and citations issued, as well as the number of fines imposed. District service centers held weekly teleconferences to monitor local governments' level of restriction enforcement. This forum made regional information available that located problem areas and assisted in the prompt identification and coordination of solutions. Local government enforcement information is provided in **Table 4-1**.

Table 4-1. Number of warnings and tickets issued, by county, during the water shortage

County	Warnings	Tickets
Broward	7985	2579
Charlotte[1]	N/R[2]	N/R[2]
Collier	778	1498
Glades	N/R[2]	N/R[2]
Hendry	N/R[2]	N/R[2]
Highlands	N/R[2]	N/R[2]
Lee	510	2345
Martin	N/R[2]	N/R[2]
Miami-Dade	358	234
Monroe	304	3
Okeechobee	27	0
Orange	393	0
Osceola	N/R[2]	N/R[2]
Palm Beach	8268	969
Polk[1]	N/R[2]	N/R[2]
St. Lucie	N/R[2]	N/R[2]
Total	18623	7628

[1] Part of county within District boundary
[2] N/R = No report

Smaller communities can quickly exhaust their staff resources when a water shortage is declared because of the additional compliance enforcement responsibilities. During the 2000–2001 drought in South Florida, the District provided funds to help these smaller communities augment their enforcement staff resources to ensure enforcement of water shortage restrictions.

Water shortage restriction enforcement occurred in every region within the South Florida Water Management District that was declared to be under a water shortage, and the water resource management benefits accrued locally and regionally.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT ENFORCEMENT

Due to the severity of the water shortage, as well as the possibility of imposing phase III water restrictions in the urban areas, the District implemented a compliance/enforcement program to address potential water shortage violations by water users that are required to have a water use permit from the District. At the March 2001 governing board meeting, District staff presented an overview of the plan for implementing water shortage enforcement in both the agricultural and urban areas (see **Appendix 4A-1**, Exhibit 1), including proposed fines. Following the presentation, the District aggressively pursued compliance in accordance with the various water shortage orders. The agriculture component was comprised of inspections conducted both by air and on the ground. Compliance of this initiative was pursuant to Water Shortage Order number 2000-172 DAO-WS. The urban component was conducted primarily on the ground. Compliance with this initiative was pursuant to Water Shortage Order numbers 2001-04 DAO-WS and 2001-048 (modified phase II). The effort involved the use of more than 50 staff members from various divisions within the District. Compliance sweeps were conducted in shifts on non-watering days, including weekends, and after hours, with a shift commencing at midnight.

Overall, the District identified 708 violations during the water shortage effort, and had collected approximately $300,000 in penalties and costs. Largely because of internal training and the dissemination of detailed guidelines for properly documenting enforcement cases, the District was able to successfully resolve the majority of the enforcement actions taken.

URBAN ENFORCEMENT

District staff from numerous departments conducted compliance inspections, also known as "sweeps." The locations of the sweeps were determined both randomly and through complaints received by the District's phone bank. Using a field report form specifically designed for the water shortage (see **Appendix 4A-1**, Exhibit 2), District staff documented unauthorized uses of water and District right-of-way. The District trained all compliance enforcement staff regarding the use of the forms, as well as how to properly document a violation (i.e., photographs, time, date, and the inspector's name). All field reports were submitted to the Water Use Division's Compliance Section and were reviewed and compared with permit files regarding unauthorized use of water. The Water Use Division maintained an updated ledger for those projects receiving variances, as well as those on reuse/mix, so that those projects were not inadvertently issued violation notices. For alleged violations in which it appeared that a structure (i.e., pump) had been placed on a District right-of-way, the District's Right-of-Way Division reviewed the field report and confirmed ownership. Once the field report was reviewed and the alleged violation was confirmed, the file was sent to the Environmental Resource Compliance Division's enforcement supervisor.

Based on the volume of water permitted for the project (extent of deviation), the number of previous offenses, and whether the water user had a valid permit, a penalty was assigned using a schedule that had been developed specifically for the water shortage (see **Appendix 4A-1**, exhibits 3 and 4). If the violation involved a District right-of-way, an additional fine was imposed for the infraction. A standardized "Notice of Violation/Short-Form consent agreement," which included the assigned penalty and any provisions the permit holder was required to implement to resolve the violation, was sent to the respondent (see **Appendix 4A-1**, exhibits 5 through 7). The permittee then had the option to either agree to the provisions of the consent agreement or refuse. If the permittee/respondent agreed to the consent agreement (by his or her signature), the District's governing board approved it at the next regular meeting. If the permittee/respondent refused to sign the consent agreement, staff referred the file to the District's Office of Counsel and requested litigation authority from the governing board to resolve the matter in court. If a

permittee/respondent violated the provisions of the water shortage on more than one occasion or refused to cease, an increased penalty was imposed.

The District documented 708 alleged water shortage violations, of which 676 occurred in the urban area. Section 373.129, Florida Statutes, authorizes the District to collect civil penalties and costs associated with an enforcement action. The District deposited all civil penalties that were collected as the result of enforcement actions into the water management lands trust fund. Recovered staff costs were deposited into the District's general revenue fund. Because of significant staff time and resources involved with the water shortage, all civil penalties and costs were split on an even 50/50 basis.

AGRICULTURAL ENFORCEMENT

Immediately after implementation of phase III water restrictions in the Lake Okeechobee Service Area, Indian Prairie Basin, and the Upper East Coast, field maps were produced that contained the aerial coverage of the established sub-basins, boundaries of District-issued consumptive use permits (CUPs), and associated permit numbers. In addition, these maps contained locations of District structures, permitted pump locations and, later, the locations of those pumps that had approved variances. All maps were drawn to scale and were sized for field activities. An index referencing the permit numbers, the property name, and the general location of the permitted withdrawal point accompanied the sub-basin maps. The aerial photography base for the maps was extremely useful when pinpointing locations in the field, especially during helicopter fly-overs or when violations were discovered on properties that had no CUP.

Prior to implementing enforcement activities, public meetings were held with permittees in the sub-basins to discuss the restrictions, the variance process, and enforcement. The District encouraged each sub-basin to delegate a basin coordinator, but only the sub-basins within the Everglades Agricultural Area (EAA), and the C-44 basin did so. The EAA basin coordinator conducted meetings with stakeholders within those areas, while the District held meetings with the remaining permittees in other sub-basins. In those areas where no sub-basin coordinator was selected, the District established toll-free telephone information lines that allowed permittees to call for daily updates on water conditions in their area and inform them if pumping would be allowed that day. These information lines were updated daily by 6:00 a.m.

The District established enforcement teams to patrol the agricultural areas by land-based vehicles and helicopter. Team members were selected to enforce those areas with which they were most familiar. Normal business activities were coupled with enforcement during the week. A kickoff meeting was held with the selected team members, and the District provided information about water restrictions, the enforcement process, field documentation, scheduling, and lines of communication. Each Monday, team members were contacted to discuss the week's enforcement strategies and convey pertinent information regarding water conditions, operations, and approved variances. Weekend enforcement trips were scheduled on Wednesdays. The District's flight department was notified when flyovers were necessary.

Enforcement was typically performed in pairs, with each team possessing a hand-held Global Positioning System (GPS), a camera (film or digital), a cell phone, and appropriate maps and forms.

A separate enforcement form was prepared for the agricultural areas (see **Appendix 4A-1**, Exhibit 8). The agricultural form contained pertinent permit information, as well as space for listing the crop type and the specific violation observed. Field inspectors also obtained GPS coordinates for each violation, and this information was included on the enforcement form. In addition, several photographs depicting the violation were attached to the form, which was stamped with the time and date that the violation was observed. The location of the violation, as

well as information about the inspector, was provided on the back of each form. The field enforcement forms were designed to keep violation information thorough, yet concise. The photographs and GPS coordinates proved crucial when assessed violations were challenged by water restrictions violators.

Enforcement was primarily conducted on "no pumping" days established by rule (i.e., canal stages), Supply Side Management operations, and/or water supply delivery schedules. However, overhead irrigation violations were documented throughout the week as team members were performing routine business activities in the field. Therefore, agricultural enforcement was consistently a five-day-a-week operation, with weekend trips being most frequent during February, March, and April. Weekend surveillance was conducted by land-based vehicle and by helicopter. Several weekend trips were also conducted during the evening (from 7 p.m. to 11 p.m.) by land-based vehicle, when canal stages monitored by Operations Department staff appeared to drop significantly during times when pumping was prohibited.

Enforcement teams were instructed to document violations, complete the required paperwork, and submit the information to the Environmental Resource Compliance Division (ERC) for processing and permittee/owner notification. Water shortage enforcement staff notified the property owners/operators directly only when immediate action was necessary. During the drought, two such events occurred when water supply deliveries were being made to the Water Conservation Areas, and the illegal pumping was documented. During those events it was crucial that no withdrawals occur from the canals conveying water to the target areas; therefore, immediate notification and action was necessary. All other notifications were handled through ERC staff. Of the 708 alleged water shortage violations documented by District staff, 32 occurred in the agricultural area.

VARIANCE REQUESTS

Both permitted and exempt water users are provided with the opportunity to request relief from the provisions of a water shortage declared under Chapter 40E-21, Florida Administrative Code (F.A.C.). Applicants must provide reasonable assurances that the variance will not otherwise be harmful to the District's water resources and must affirmatively demonstrate that one or more of the following circumstances exist:

4. The variance is essential to protect the public health or safety.
5. Compliance will require measures which, because of their extent or cost, cannot be accomplished within the anticipated duration of the water shortage.
6. Alternative restrictions that achieve the same level of demand reduction as the restriction from which a variance is sought are available, binding, and enforceable.
7. The applicant is a public or private utility that demonstrates that special circumstances exist that necessitate issuing a variance.
8. The applicant's water source includes an approved aquifer storage and recovery installation or a water reclamation project.

The District examines each variance petition individually to determine its applicability to one or more of the above criteria, and may issue relief for the designated restrictions within a single, specific governing board order. The variance expires simultaneously with the expiration of the board's order. The board may, at its discretion, extend a variance into another phase of a water shortage by a declaratory statement within the subsequent board order.

Variance petitions that request relief from restrictions due to the extent or cost of compliance within the anticipated duration of a water shortage (criterion 2) account for the majority of the variance petitions the District receives. These variances may be issued for the duration of a single

water shortage event only and do not extend to future water shortage events. Rather, the petitioner is expected to exercise due diligence by modifying or repairing the water use system so it will meet the requirements of subsequent water shortage events.

The District may consider variance petitions from entities that hold valid water use permits or that obtain water from a public water supply (PWS) utility, and from individuals who are exempt from water use permitting (single-family homes and duplexes) pursuant to Chapter 40E-2.051, F.A.C. The District's governing board may not consider variance petitions for illegal uses of water. Variance petitions for uses that were not exempted by rule and were not supplied by a PWS, yet were withdrawing water without the benefit of a water use permit, were closed without action. Those variance petitions were returned to the senders, along with a set of permit application forms and a letter of instruction to obtain a water use permit.

During the 2000–2001 drought, District staff in West Palm Beach and at the Ft. Myers Service Center reviewed 1,052 variance petitions. The West Palm Beach Service Center received and reviewed 85 percent of the petitions, while the Fort Myers Service Center received and reviewed 15 percent of the petitions. The disposition of these reviews is shown in **Table 4-2** (also shown by percentage in **Figure 4-1**).

Four of the most common use types for which a variance was requested (community/ governmental/commercial landscape, 38 percent; single-family landscape, 29 percent; new landscape, 4 percent; and washing of vehicles and non-pervious surfaces, 11 percent) represented 82 percent of the total number of variance petitions received. Agricultural users seeking relief from the day/time Supply Side Management requirements comprised 6 percent of variance requests. Public water supply utilities (1 percent) requested enhancement of water main pressure and sought authorization to conduct water main flushing for safety purposes. Four motion picture crews working within the Lower East Coast requested permission to irrigate landscaping and to "slick down" roads for film production (< 1 percent) (**Figure 4-2**).

Table 4-2. Petition breakdown, West Palm Beach and Fort Myers

Approved	610
Denied	243
Withdrawn	71
Closed Without Action	128
Total	1052

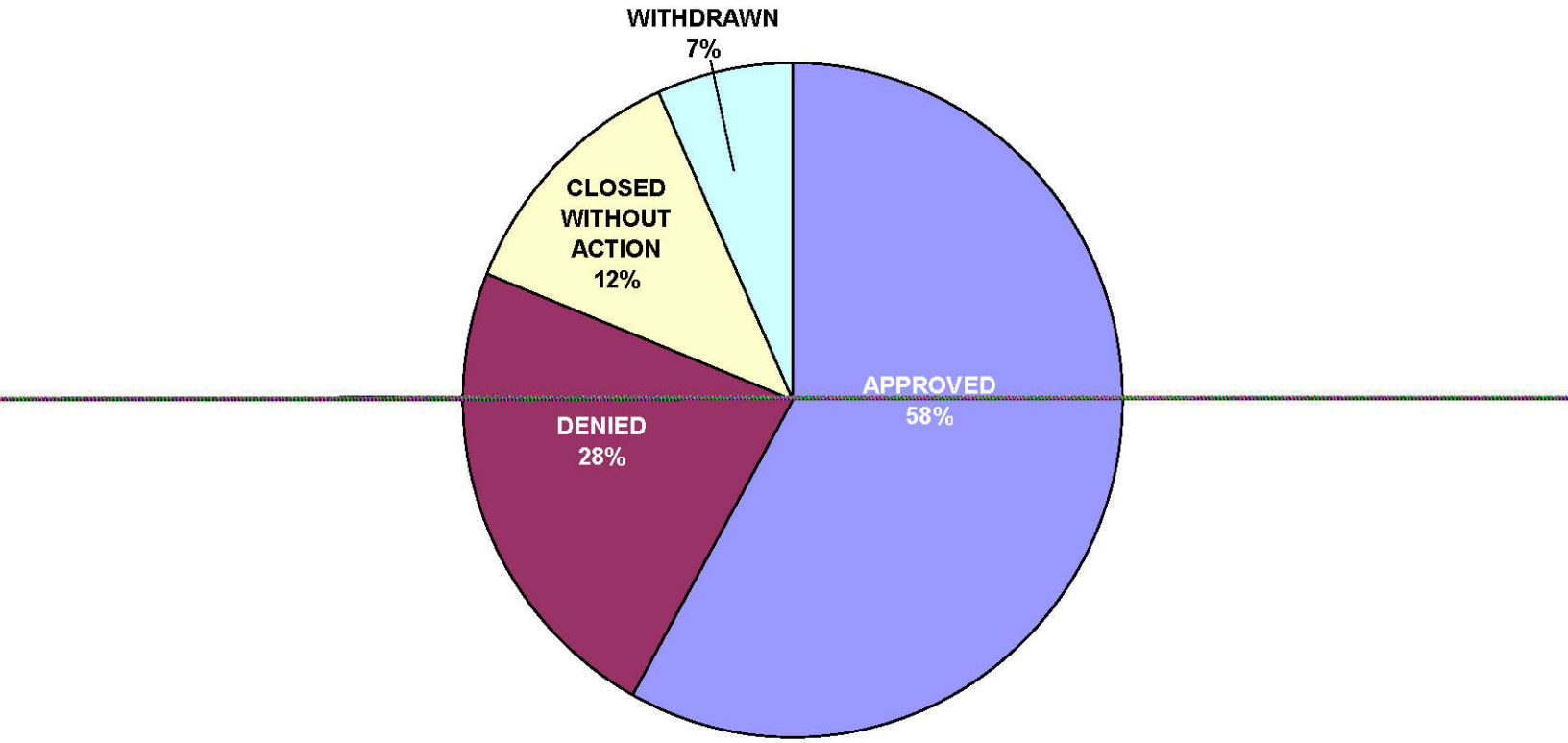

Figure 4-1. Variance requests by disposition

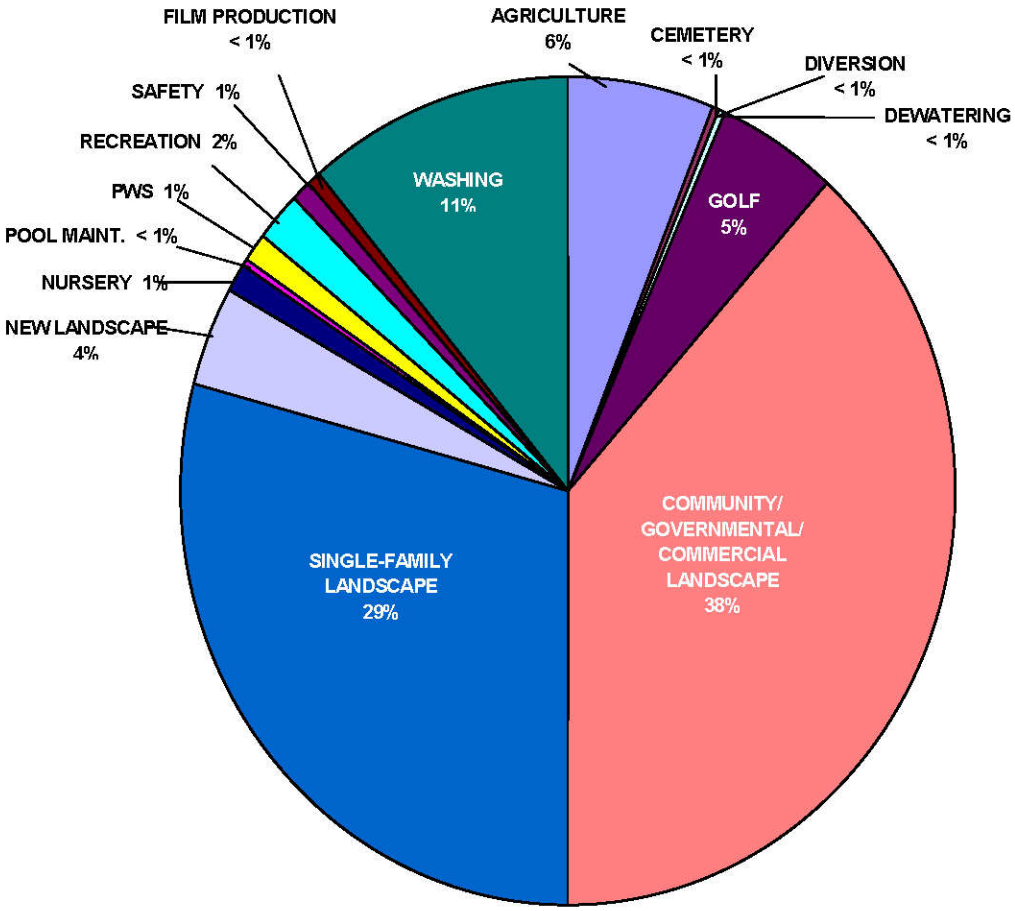

Figure 4-2. Variance requests by use type

Chapter 5: Lake Okeechobee Water Supply Management

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SUMMARY

The Supply Side Management documentation produced after the 1990–1991 drought (SSM1991) was used extensively again during the 2000–2001 drought. This chapter describes how the SSM1991 was used in the most recent drought and the modifications or variations that were required. It provides a summary of Lake Okeechobee allocation volumes, tabular histories of the allocation factors, and required changes to the reference stage. Finally, this chapter provides a brief description of the communication process between the South Florida Water Management District (District) and Lake Okeechobee water users.

INTRODUCTION

The South Florida Water Management District protocols for responding to a drought include careful management of available water supplies to extend the reasonable, beneficial use of the resource until rains return and replenish regional and local supplies. The 2000–2001 drought presented a special challenge because the low water levels extended well into the wet season. Existing drought management strategies, which addressed only dry-season shortages contained in the Supply Side Management Plan, had to be quickly modified to include wet-season conditions. This chapter details the Supply Side Management Plan and its application during the 2000–2001 drought.

SUPPLY SIDE MANAGEMENT

As part of the overall Water Shortage Plan (SFWMD, 1991) the Supply Side Management (SSM) protocol was designed as a guide for implementing water use restrictions and management alternatives associated with Lake Okeechobee during declared water shortages. Written in 1991, the Supply Side Management policy document (Hall, 1991) is commonly known as the "yellow book," or SSM1991. The document states that at any point during the dry season "the amount of water available for use…is a function of the anticipated rainfall, lake evaporation, and water needs for the balance of the dry season in relation to the amount currently in storage. Supply Side Management was designed to complement the District Water Shortage Plan by providing a means for the prudent management of surface water storage in Lake Okeechobee." (Hall, 1991). During the dry season (October through May), the District can declare water restrictions for Lake Okeechobee water users when the lake stage falls below a critical water level (an indicator of drought conditions), which can vary depending on the time of year. The time series of these water levels is referred to as the Supply Side Management line (SSM line). The computation procedures outlined in the SSM1991 document may be used to determine allocation volumes for agricultural users in the Lake Okeechobee Service Area (LOSA). The original SSM line (Hall, 1991) was defined in terms of normal rainfall and evapotranspiration (ET) over the lake and average lake water uses expected over the balance or remainder of the dry season. It was lowered by half a foot as a result of the recent Lower East Coast Regional Water Supply Plan development process

(SFWMD, 2000). The line was lowered, effectively increasing the amount of available lake water, for the purpose of maintaining the same level of service for the Lake Okeechobee Service Area over the next 5 to 10 years while water resource projects are under development.

The SSM1991 protocol called for implementation of supply-side management on the first day of the 2000–2001 dry season (October 1, 2000). However, water shortage restrictions were not declared until November 29, 2000. The South Florida Water Management District deemed this delay necessary to provide relief to water users dependent upon the lake, which was experiencing unusually low levels due to the ongoing severe drought and to the April-May 2000 Lake Okeechobee managed recession. Likewise, SSM1991 only addressed a single dry season implementation of supply side management. Due to the severity and prolonged nature of the drought, water restrictions remained in effect through the following wet season (June-September 2001) and into the beginning of the subsequent dry season until their suspension on October 10, 2001.

Ten LOSA sub-basins were identified during the 2000–2001 implementation of SSM (**Figure 5-1** and **Table 5-1**). Allocations for agricultural users in each of these sub-basins were calculated weekly throughout the 45-week period of SSM implementation (**Figure 5-2)**.

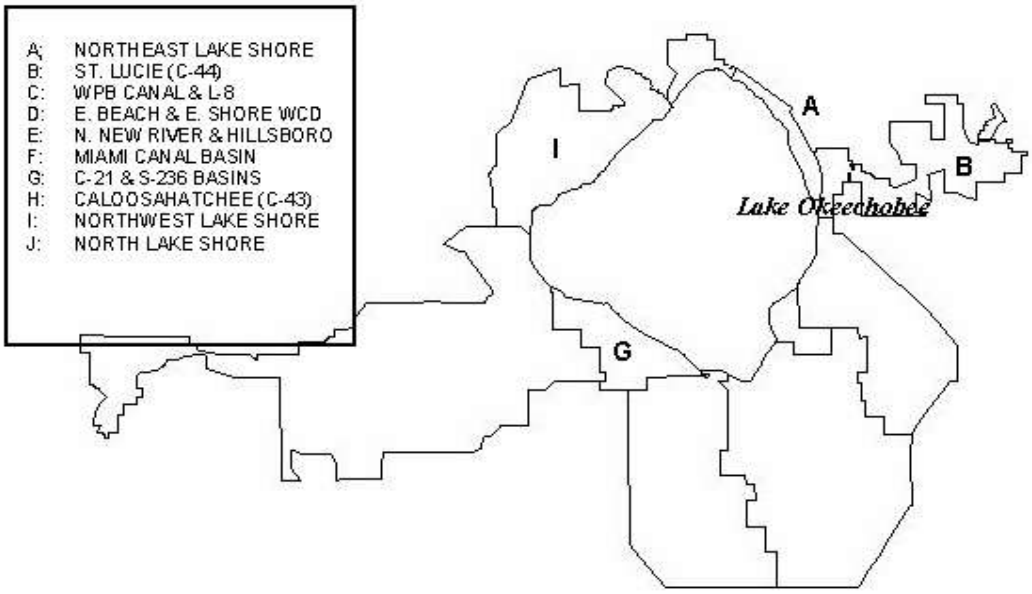

Figure 5-1. Identification of Lake Okeechobee service area sub-basin boundaries as used in supply side management

Table 5-1. Lake Okeechobee Service Area sub-basins used for SSM implementation during the 2000–2001 drought

Sub-basin Name	Controlling Structure(s)	Crop Type	Water Use Permit Irrigated Area (ac)*
Northeast Lake Shore	S-135 and G-36	Citrus	420
		Other	7,289
St. Lucie (C-44)	S-308	Citrus	47,575
		Other	8,776
WPB Canal and L-8	S-352, C-10A, C-13 and C-16	Citrus	7,590
		Other	123,537
E. Beach and E. Shore WCD	C-12 and C-10	Citrus	0
		Other	13,054
N. New River and Hillsboro	S-351 and C-4A	Citrus	234
		Other	230,146
Miami Canal Basin	S-354	Citrus	2,426
		Other	113,325
C-21 and S-236 Basins	S-310 and S-169	Citrus	0
		Other	34,122
Caloosahatchee (C-43)	S-77 and C-5A	Citrus	68,219
		Other	58,311
Northwest Lake Shore	S-131, S-129, S-127, G-207 and G-208	Citrus	4,362
		Other	2,101
North Lake Shore	S-193	Citrus	117
		Other	1,060

Total: 722,664 acres *As of October 2001

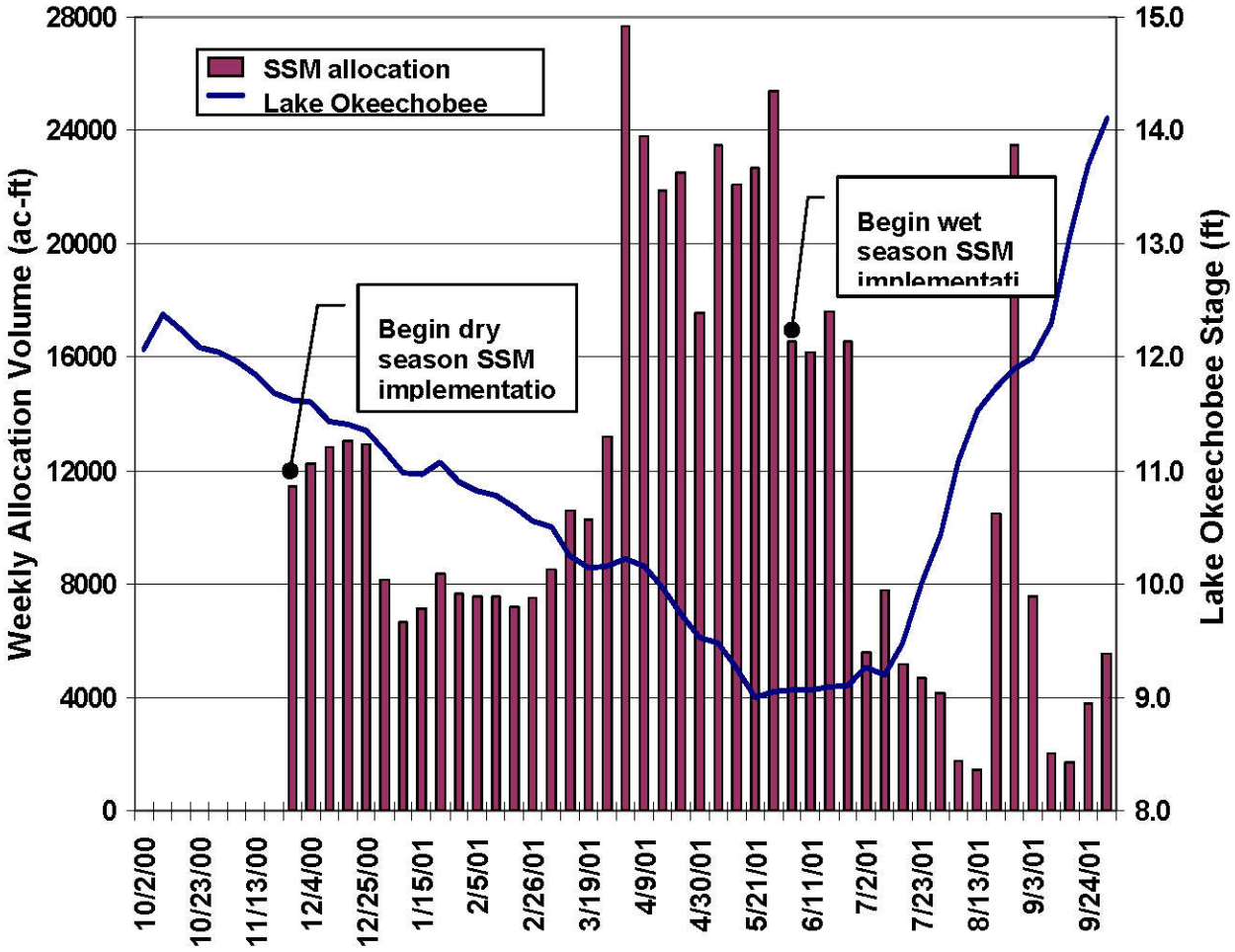

Figure 5-2. Lake Okeechobee stage and Lake Okeechobee Service Area allocation during the 2000–2001 drought

Lake Okeechobee stage and weekly allocation volumes for the period of the 2000–2001 water shortage restrictions are shown in **Figure 5-2**. Water shortage cutbacks for the Seminole Indian tribal lands are not calculated in the normal SSM procedure, but are included in the Water Rights Compact. Similarly, SSM calculations do not explicitly determine lake water allocation for non-agricultural uses, e.g., public water supply to the Lower East Coast (LEC) service areas, releases to navigational lockages, and environmental deliveries to the Stormwater Treatment Areas (STAs). However, the SSM calculations do take into consideration the amount of water consumed by these users in determining lake water allocations for agricultural users within the LOSA. No water was specifically provided from Lake Okeechobee for pasture irrigation during the drought (SFWMD, 2001).

During the 2000–2001 dry-season implementation of the SSM, a total volume of approximately 380,000 ac-ft was allocated to the Lake Okeechobee Service Area using the calculation procedure for the LOSA outlined in SSM1991. The largest weekly allocation was 27,697 ac-ft for the week of April 1, 2001; the smallest was 6,663 ac-ft for the week of January 8, 2001. On average, approximately 14,070 ac-ft were allocated weekly to the entire LOSA. **Table 5-2**, adapted from Hall (1991), shows some of the data associated with calculations of allocation during the 2000–2001 SSM implementation.

The allocation for any week during the dry season is equal to the weekly allocation factor multiplied by the allocable volume of water from the lake for that particular week. The allocation factor distributes allocable volume in time and is patterned after the historical distribution of demands (LOSA water use). For a given week the allocation factor is derived as the water use for that week divided by the projected cumulative water use for the remainder of the dry season, based on historical information. For example, the allocation factor for May 16, 2001 is equal to 30,193 (30,193 + 30,193 + 17,253) or 0.389. The allocable volume is also determined on a weekly basis. It is calculated as the storage above a lake reference stage associated with the ending date of the dry season (May 31), and adjusted for expected average net rainfall (rainfall minus evapotranspiration) on the lake for the remainder of the dry season.

Table 5-2. Data used for SSM implementation during the 2000–2001 dry season (adapted from Hall, 1991)

Week Starting	Lake Okeechobee Rainfall (ac-ft)	Lake Okeechobee ET (ac-ft)	LOSA Water Use (ac-ft)	Weekly Allocation Factor*
10/04/00	20203	28614	11833	0.017883
10/11/00	20203	28614	11833	0.018209
10/18/00	20203	28614	11833	0.018547
10/25/00	20203	28614	11833	0.018897
11/01/00	16925	27876	14737	0.023988
11/08/00	15614	27581	15898	0.026515
11/15/00	15614	27581	15898	0.027237
11/22/00	15614	27581	15898	0.028000
11/29/00	16345	25147	16202	0.029357
12/06/00	17320	21903	16608	0.031002
12/13/00	17320	21903	16608	0.031994
12/20/00	17320	21903	16608	0.033051
12/27/00	17320	21903	16608	0.034181
01/03/01	20004	23619	11994	0.025558
01/10/01	20004	23619	11994	0.026229
01/17/01	20004	23619	11994	0.026935
01/24/01	20004	23619	11994	0.027681
01/31/01	23702	27201	12962	0.030767
02/07/01	26475	29888	13688	0.033521
02/14/01	26475	29888	13688	0.034684

Table 5-2. Continued

Week Starting	Lake Okeechobee Rainfall (ac-ft)	Lake Okeechobee ET (ac-ft)	LOSA Water Use (ac-ft)	Weekly Allocation Factor*
02/21/01	26475	29888	13688	0.035930
02/28/01	26958	34962	16780	0.045689
03/07/01	27321	38768	19099	0.054493
03/14/01	27321	38768	19099	0.057633
03/21/01	27321	38768	19099	0.061158
03/28/01	26681	40138	21141	0.072106
04/04/01	22843	48360	33392	0.122742
04/11/01	22843	48360	33392	0.139916
04/18/01	22843	48360	33392	0.162677
04/25/01	22843	48360	33392	0.194282
05/02/01	48220	52615	30650	0.221328
05/09/01	52450	53324	30193	0.280000
05/16/01	52450	53324	30193	0.388889
05/23/01	52450	53324	30193	0.636364
05/30/01	29971	30471	17253	1.000000

*Allocation factor is derived as the water use for the week, divided by the projected cumulative water use for the remainder of the dry season. It is used to distribute the total allocation among the remaining weeks of the dry season.

The reference stage used on the first week of SSM implementation during the 2000–2001 dry season was 9.80 ft-NGVD. This was lower than the 10.50 ft-NGVD recommended in the LEC plan (SFWMD, 2000), resulting in an increased allocable volume. Data supporting the SSM1991 calculations (Lake Okeechobee rainfall and ET, and LOSA water use) were based on average dry season conditions. However, the 2000–2001 drought conditions were more severe than what was assumed in SSM1991. In fact, it was necessary for the reference stage to be altered on several occasions during the entire 2000–2001 drought to:

1. Account for the difference between actual rainfall during the 2000–2001 drought and what was assumed in SSM1991; and
2. Maintain a minimum level of supply to all users of lake water (i.e., public water supply in LOSA, water supply deliveries to the LEC service areas, provide minimum levels for stormwater treatment areas, and/or maintenance of navigational depths in the C-43 and C-44 canals). This guideline was approximated by meeting 40 to 50 percent of the 1-in-10 LOSA supplemental irrigation demand on Lake Okeechobee as estimated by the South Florida Water Management Model or SFWMM (SFWMD, 1999).

A summary of adjustments to the reference stage during the 2000–2001 drought is listed in **Table 5-3**. The SSM1991 methodology defines a dry season reference stage on June 1, 2001 only. An extension of the methodology into the following wet season required a July 1, 2001 reference stage.

To distribute the total allocation volume as calculated by the SSM1991 procedure to each of the ten individual LOSA sub-basins during the dry season, a separate methodology was developed that uses evapotranspiration models. The method estimates the relative demand for a particular LOSA sub-basin compared to the total demand for all ten sub-basins. This spatial distribution method was dependent on the characteristics of each sub-basin, including its predominant crop and soil type, and was conducted weekly.

SSM1991 did not include a procedure for SSM implementation during the wet season. However, the persistence of low Lake Okeechobee stages beyond May 2001 resulted in the extension of SSM implementation and water restrictions from June through October 2001. Since drought conditions in June were expected to be similar to those experienced in May, the methodology associated with dry season Supply Side Management was extended to include the month of June 2001. Beginning on June 6, weekly allocations were computed using a July 1 reference stage. Rainfall and ET data used in the SSM implementation for June 2001 came from the SFWMM. Sub-basin distribution of allocation was also accomplished in a manner similar to the procedure used during the dry season. The corresponding data for computing allocation factors, extracted from the SFWMM, is presented in **Table 5-4**. Definitions for the data in **Table 5-4** are identical to the definitions in **Table 5-2**.

Table 5-3. Summary of reference stage changes

Reference Stage #	Date of Change	New Reference Stage	Comments
Dry Season Adjustments (June 1 Reference Stage)			
1	11/29/00	9.80	SSM Implementation Begins
2	12/13/00	9.60	Drought Management Decision (based on below-normal rainfall relative to SSM1991)
3	01/17/01	9.57	Adjust for release to control saltwater intrusion in Caloosahatchee River (9449 ac-ft)
4	02/21/01	9.53	All non-LOSA releases prior to 2/13 including releases to the STAs, except the previously accounted (9449 ac-ft)
5	03/07/01	9.52	Non-LOSA releases 2/14 to 2/27 including releases to the STAs, and data revisions back to 11/29
6	03/14/01	9.20	Drought Management Decision (based on below-normal rainfall relative to SSM1991)
7	03/21/01	9.17	Non-LOSA releases 2/28 to 3/13
8	04/04/01	9.15	Non-LOSA release 3/14 to 3/27 including releases to the STAs, and data revisions back to 2/28
9	04/11/01	9.35	Maintain minimum level of supply: 40% to 50% of the 1-in-10 LOSA demand estimated from the SFWMM.
10	04/25/01	9.25	
11	05/09/01	9.20	
12	05/16/01	9.07	
13	05/23/01	8.87	
14	05/30/01	9.00	
Wet Season Adjustments (July 1 Reference Stage)			
15	06/06/01	8.89	Maintain minimum level of supply: 40% to 50% of the 1-in-10 LOSA demand estimated from the SFWMM.
16	06/13/01	8.94	
17	06/20/01	9.00	
18	06/27/01	9.07	

Table 5-4. Data used for SSM implementation during June 2001 (based on SFWMM)

Week Starting	Lake Okeechobee Rainfall (ac-ft)	Lake Okeechobee ET (ac-ft)	LOSA Water Use (ac-ft)	Weekly Allocation Factor*
06/06/01	58528	55990	35904	0.259259
06/13/01	58528	55990	35904	0.350000
06/20/01	58528	55990	35904	0.538462
06/27/01	50167	47992	30775	1.000000

*Allocation factor is derived as the water use for the week divided by the cumulative water use for the remainder of the dry season.

During the wet-season months of July through September 2001, and continuing until the suspension of SSM on October 10, 2001, a methodology was used for allocation of water to the LOSA that represented a departure from the traditional "reference stage"-type calculations, as outlined for the dry season in SSM1991. During this period the supplemental irrigation demands on Lake Okeechobee were relatively small due to rainfall in the service area. The changes in supply due to rainfall and other sources were inestimable. As a result, the implementation of an allocation procedure based on the concept of reference stage would have been difficult. Instead, the methodology allocated a predetermined quantity for each week computed using the results from the SFWMM. The predetermined volume was chosen to represent approximately 40 to 50 percent of the 1-in-10 LOSA supplemental irrigation demand volume on Lake Okeechobee as simulated in the SFWMM. The selection of this level of service is consistent with the procedures used in previous months. This methodology was adequate for the majority of the period. There were, however, several consecutive weeks of dry conditions in late August and early September that resulted in higher-than-expected demand in the LOSA. As a result, temporary deviations were made from the predetermined volumes to provide increased allocations for the weeks of August 20 to September 9, 2001 and maintain the minimum level of service. The District's drought management team deemed these measures appropriate, considering that lake stages had already begun to recover and revised allocation volumes were still small relative to typical late dry season demand volumes. A total of approximately 152,000 ac-ft of Lake Okeechobee water was allocated to the LOSA from June through October 2001.

The previously mentioned uncertainty associated with projected rainfall during the wet season also created a challenge for sub-basin distribution. The evapotranspiration models used during the dry season were deemed unresponsive to antecedent rainfall conditions. To help determine the real-time relative spatial distribution of demand for LOSA agricultural users during this wet season period, more complete models that include antecedent conditions, soil type, crop type, soil moisture accounting, and real-time monitoring of rainfall and evapotranspiration were used to compute weekly irrigation requirements for each sub-basin. As before, the total allocation volume was distributed to each sub-basin based on its corresponding fraction of the total projected demand.

EXTERNAL COMMUNICATION

The Supply Side Management calculations were performed weekly on Mondays and were posted/communicated for users on Tuesdays for implementation on Wednesdays. Most of the users accessed the information posted on the SFWMD Website. The 298 Districts and the majority of the users in the Lake Okeechobee Service Area hired a basin coordinator to use the Website information and calculate the number of hours each farm could operate their pumps. The basin coordinator communicated this pumping information directly to clients. If questions arose regarding the SSM information posted on the SFWMD Website, the basin coordinator would contact assigned personnel in the District's Operations (OPS) and Hydrologic Systems Modeling (HSM) divisions.

The southern Lake Istokpoga-Indian Prairie basin did not have a basin coordinator; clients had to be contacted individually. Assigned personnel in the District's Operations Division informed clients via phone, e-mail, or fax regarding the SSM allocation and weekly pumpages for specific farms and the Brighton Reservation. In addition, individual farms pumped on different days than the Brighton Reservation to eliminate direct competition of water resources and to better ensure water allocations were delivered to the appropriate user.

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Chapter 6: Regional Water Supply and Demand Management Issues

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SUMMARY

The District is divided into four planning areas within which water supply planning and other activities are focused: Lower East Coast (LEC), Lower West Coast (LWC), Upper East Coast (UEC), and Kissimmee Basin. **Figure 6-1** illustrates the four planning areas.

LOWER EAST COAST PLANNING AREA

The LEC planning area includes Palm Beach, Broward, and Miami-Dade counties and portions of Monroe, Hendry, and Collier counties. The LEC planning area encompasses a sprawling, fast-growing urban complex along the coast; extensive agricultural lands, including the EAA; critical environmental resources, such as the Everglades ecosystem; and important estuaries, including Biscayne Bay and Florida Bay. The existing population is concentrated in the coastal areas of Miami-Dade, Broward, and Palm Beach counties, which are expected to remain the area's population centers.

LOWER WEST COAST PLANNING AREA

This area includes all of Lee County and parts of Charlotte, Collier, Glades, Hendry, and Monroe counties. Rapid growth in population and irrigated agricultural acreage within the LWC planning area has caused demands for water to increase significantly. The existing population is concentrated in the coastal areas of Lee and Collier counties. These areas are expected to remain the population centers for the area.

UPPER EAST COAST PLANNING AREA

The UEC planning area is comprised of St. Lucie and Martin counties and eastern Okeechobee County. The existing population is concentrated in the coastal areas of Martin and St. Lucie counties. These areas are expected to remain the population centers for the area.

KISSIMMEE BASIN PLANNING AREA

The Kissimmee Basin planning area includes parts of Orange, Osceola, Polk, Highlands, Okeechobee, and Glades counties. The majority of the basin drains to the Kissimmee River, though some areas drain into Fisheating Creek, the canal system within the Indian Prairie Basin, or a few landlocked lakes within the basin. A few fringe areas drain to either the Southwest Florida or the St. Johns River water management districts. Urban growth is anticipated to be concentrated in Orange and northern Osceola counties, while irrigated agricultural acreage is anticipated to increase to the south in Highlands, Okeechobee, and Glades counties. Most of the area is rural/agricultural, and this pattern is projected to continue through 2020.

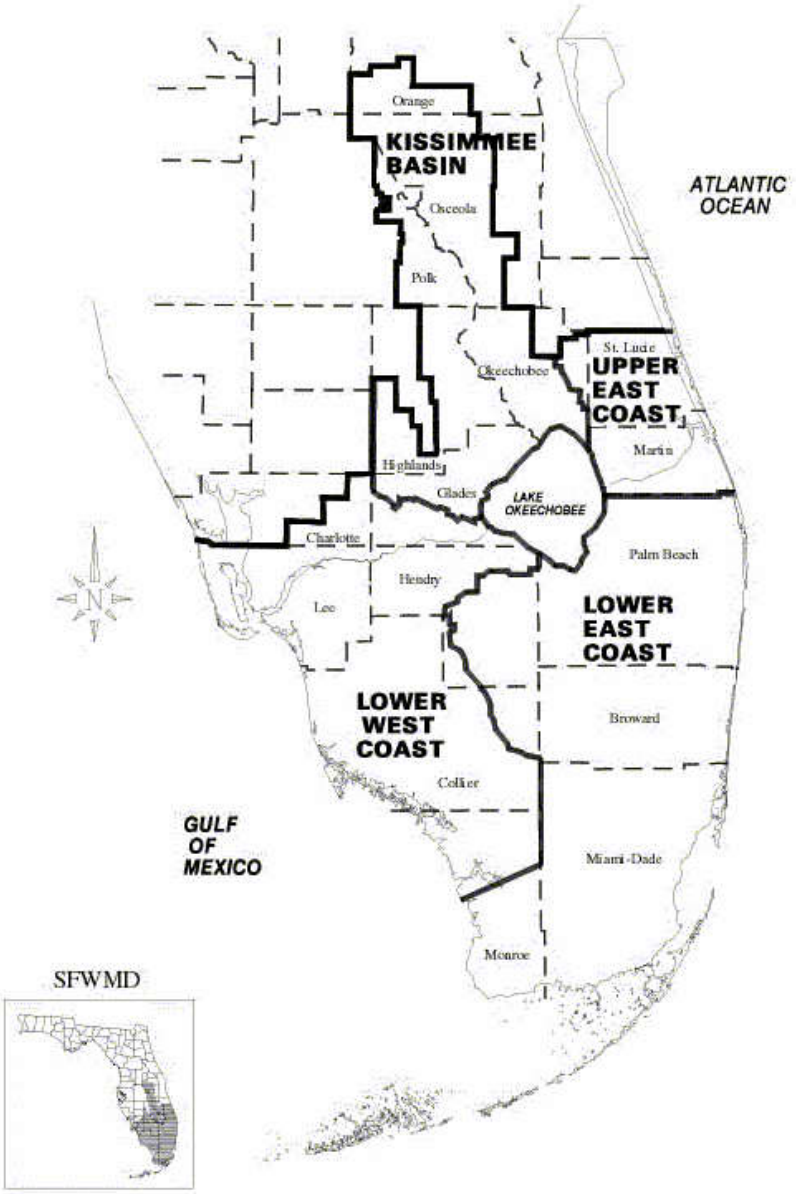

Figure 6.1 The four planning areas used by the District in managing water and related resources

KISSIMMEE BASIN

DESCRIPTION OF THE AREA AND ASSOCIATED WATER RESOURCES

The Kissimmee Basin water supply planning area (**Figure 6-2**) covers approximately 3,500 square miles and is divided at the outlet of Lake Kissimmee into upper and lower basins. These two sub-regions have distinctly different current and projected water demand and source patterns and are described separately below.

The upper Kissimmee River basin stretches into the heart of Orlando, where urban development continues to expand the boundaries of the Orlando metropolitan area. The SFWMD has jurisdiction in approximately a third of Orange County. That region includes a large portion, though less than a third, of the Orlando metro area. Also within the District's jurisdiction in Orange County are the Outstanding Florida Waters of the Windermere or Butler Chain of Lakes, the intense development in the Disney resort area, the growing urban corridor connecting Orlando to Kissimmee, and the Orlando International Airport.

Most of the population of the Orlando metro area reside in the St. Johns River Water Management District (SJRWMD), which is not significant from a groundwater perspective; the resource serves the entire region. However, the SJRWMD presence in Central Florida is significant to the discussion of how the drought was handled and how the districts worked together to develop both a consistent message to the public and nearly identical water use restrictions.

In the SFWMD, the local governments encompassing the areas under water use restrictions included the city of Orlando, Orange County, the town of Windermere, and the Reedy Creek Improvement District (the political subdivision that supports the Disney parks and resorts).

The Floridan aquifer is the region's primary groundwater resource. Concern about sinkhole development brought on by declining Floridan aquifer levels drove the decision to impose water use restrictions. Three years of drought have dropped the Floridan to historic lows. Though the region received normal levels of rainfall during 2001 to the present in 2002, the Floridan has not recovered completely. As a policy decision, the SFWMD has agreed to allow the St. Johns River WMD to determine the time span to pursue mandatory restrictions. Since the Floridan does not respond quickly to normal rainfall, the SJRWMD has concluded that the restrictions will remain in place as long as the Floridan continues to hover near record lows.

The area also supports a productive surficial aquifer that yields a sizable amount of water, but this shallow aquifer is almost entirely used for home lawn irrigation and other needs that do not require a source of consistently high-quality water. The surficial aquifer does not contribute to the sinkhole threat, and therefore was not a concern in the decision making process that led to mandatory water use restrictions.

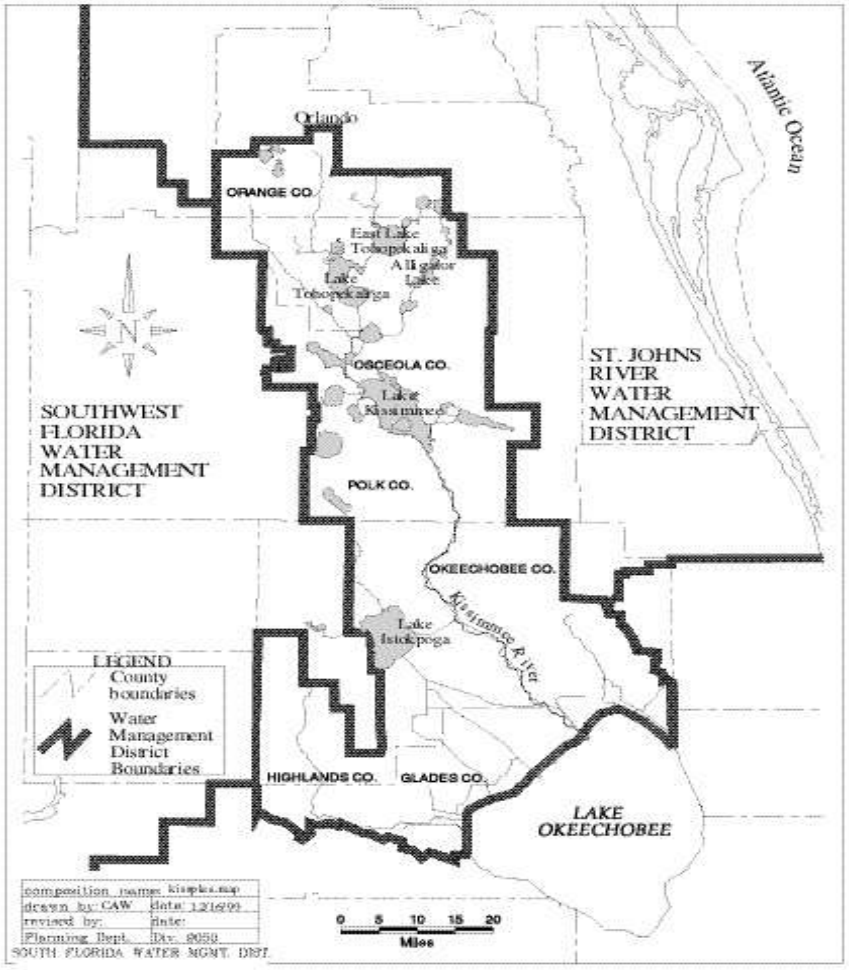

Figure 6-2. Kissimmee Basin water supply planning area

The area is dotted with hundreds of lakes and a number of springs are located to the north of the SFWMD in the SJRWMD. Sinkhole activity has also been more prevalent in the SJRWMD in the northern portion of the Orlando Metro Area. A relatively small area of the SFWMD in Central Florida is prone to sinkhole development, primarily in and around the Butler Chain of Lakes in west Orange County.

The Lake Istokpoga-Indian Prairie Basin, further south in the Kissimmee Basin planning area, encompasses 575 square miles of Polk and Highlands counties. The Brighton Seminole Reservation is located in the southern portion of this basin. Lake Istokpoga is a shallow lake with an average bottom elevation of 33.5 ft-NGVD and a surface area of 43 square miles. It is the fifth-largest lake in Florida.

Control structure S-68 discharges water from Lake Istokpoga into associated downstream canals in accordance with an established regulation schedule. Based on this schedule, water surface elevations in Lake Istokpoga are regulated between 37.5 and 39.5 ft-NGVD. This regulation schedule was adopted as part of the District's water shortage rule (40E-22, F.A.C.).

District canals that provide both drainage and water supply deliveries in the Istokpoga-Indian Prairie Basin are as follows:

Northern basin area

C-41A, situated between S-68, S-82, S-83, and S-83 to S-84

C-39A, situated between S-82, S-75, and S-70

Southern basin area

C-40, (Indian Prairie canal) situated between S-75 and S-72/G-208

C-41, (Harney Pond canal) situated between S-70 and S-71/G-207

L-59, situated between G-34 and S-72/G-208

L-60, situated between S-72/G-208 and S-71/G-207

L-61, situated between S-71/G-207 and the intersection of the L-50

Land use in the area is predominantly agricultural, with citrus, vegetables, sugar cane, and ornamentals being the most common crops. Beef cattle production is also a significant industry in the basin. Agricultural areas within the basin and south of Lake Istokpoga depend on the lake for their primary irrigation supply.

Groundwater is not used extensively in the Lake Istokpoga basin. Some groundwater is used to irrigate citrus in the northern part of this basin, but availability is limited in the south. Wells located south of the Glades-Highlands county line show elevated concentrations of chlorides, a situation that worsens further south. Consequently, surface water is the primary source for irrigation and other agricultural demands in the basin's southern portion.

Due to periodic water shortages in the Indian Prairie Basin, the District determined that additional water should be released from Lake Istokpoga for water supply, lowering the lake's water level. The District also installed two pump stations, G-207 and G-208, in the early 1990s to pump water from Lake Okeechobee into the southern portion of the basin during drought periods. The Kissimmee Basin Water Supply Plan evaluated the basin's water use problems. One recommendation, implemented during the 2000–2001 drought, was that of shifting the primary source of surface water in the southern basin from Lake Istokpoga to Lake Okeechobee.

The operational strategy for G-207 and G-208 during water shortage conditions is established by Agreement C-4121. Based on the Water Rights Compact, the Seminole Tribe is entitled to 15 percent of the total amount of water that can be withdrawn from SFWMD canals and SFWMD borrow canals by all surface water users within the Lake Istokpoga basin. Lake Istokpoga water availability estimates for the reservation are 26,872 ac-ft during the wet season (June through October) and 16,997 ac-ft during the dry season (November through May). If water is unavailable from Lake Istokpoga because lake stages are below the regulation schedule, G-207 and G-208 will provide water to the Brighton Reservation from Lake Okeechobee based on the Lake Okeechobee Supply Side Management criteria.

DROUGHT-RELATED THREATS TO THE RESOURCE

In the northern Kissimmee Basin planning area, sinkhole development was the primary concern driving the decision to impose water use restrictions. A decline in Floridan aquifer levels was a related concern.

Water supply planning efforts in both the SFWMD and the SJRWMD have identified long-term concerns about the Floridan aquifer's ability to satisfy future demands for a rapidly growing population without negatively impacting wetlands and spring flows or hastening the migration of saltwater into the freshwater Floridan.

These threats, coupled with the decision to keep water use restrictions simple and unambiguous in a region with thousands of new residents potentially unfamiliar with water management district boundaries, led to the decision to impose mandatory water use restrictions within the SFWMD in conjunction with those imposed by SJRWMD.

The District's primary concern in the Istokpoga-Indian Prairie Basin during the 2000–2001 drought was whether water levels in Lake Okeechobee would fall so low as to prohibit pumping of G-207 and G-208. The invert elevations of the pump intakes are set to pump water to an elevation of 7.0 ft-NGVD. During the 2000–2001 dry season, these pumps were successfully operated to supply water to the Brighton Reservation and other permitted surface water users in the southern basin area until Lake Okeechobee levels dropped to below 9.2 ft-NGVD in May 2001. At this elevation the lake bottom was exposed and water from Lake Okeechobee could not flow into the C-40 and C-41 canals. Consequently, the District was unable to pump G-207 and G-208 and deliver water to the Brighton Reservation and other permitted users in the southern basin area.

MANAGEMENT ACTIONS TAKEN TO PROTECT THE RESOURCE

After nearly two months of weekly conference calls that included SFWMD and SJRWMD officials, a modified phase II set of restrictions was developed. The modified restrictions departed from the standard set in that they allowed watering any time of the day during the two-days-a-week schedule, except between the hours of 10 a.m. and 4 p.m.

The SFWMD rules limited their focus to sinkhole development so that only Floridan aquifer sources were identified for restrictions. In the SJRWMD, all sources were restricted, which

created some confusion. However, the confusion was not so great as to require additional governing board action to make the rules in the two districts more consistent.

The SFWMD area affected by the restrictions was limited to that district's jurisdiction in Orange County. The SJRWMD, however, imposed restrictions in Lake, Marion, Brevard, Volusia, and Seminole counties and in the SJRWMD's portion of Orange County. Because the media market for the region is centered in Orange County, the restrictions created some confusion in Osceola County, where the county commission enacted voluntary restrictions. Regional media perpetuated this confusion by reporting that the SFWMD restrictions extended into Osceola County.

In February 2001 in the southern Kissimmee Basin planning area's Istokpoga basin, the Florida Fish and Wildlife Conservation Commission (FFWCC) in partnership with the District took advantage of low surface water elevations in Lake Istokpoga and expedited the drawdown of the lake's water level to facilitate tussock removal. The drawdown was already being planned prior to the drought, and the schedule was accelerated after the drought began. The District worked closely with the FFWCC to coordinate the drawdown activities so the basin could benefit from the additional water being released from Lake Istokpoga. The District coordinated and held meetings to inform the public of the drawdown schedule and the lake environmental enhancement activities. An Emergency Order (No. 2001-17-DAO-WS) was issued enabling surface water permittees within the Istokpoga basin to store as much of the water released from Lake Istokpoga as possible within stated time frames. These withdrawals were allowed during the time when S-68 was releasing water and basin canals were above their minimum levels. Once the releases ceased, the District encouraged permitted users to use the stored water to minimize demand on the basin canals and maintain high stages in the canals for the longest period possible.

The Lake Istokpoga drawdown occurred at a crucial point in the drought and provided necessary relief to permitted users in the basin. For several weeks all canals in the Lake Istokpoga basin were above the minimum levels established in 40E-22, F.A.C., allowing permitted users to withdraw their allocations. The District encouraged water conservation during this time and, for the most part, water users complied with the request.

After the drawdown, and as the Istokpoga Basin canals again began dropping, a drought information hotline was established at the District's Okeechobee Service Center for consumptive use permittees with a surface water source. This hotline was updated prior to 6:00 a.m. daily to provide permitted users with current canal stages and inform them whether surface water was available for withdrawals on a given day. It was the permittees' responsibility to access this information and make use of available water from basin canals, as allowed. This information was also posted on the District's Website as an alternative means of conveying the information to permitted users. The hotline remained fully operational until water restrictions were rescinded for the Istokpoga basin.

In addition to the hotline, the SFWMD Operations Department issued the "Operational Intent of Supply Side Management Implementation" weekly for those permittees located within the boundaries of the Lake Okeechobee Service Area. Since the southern portion of the Lake Istokpoga basin was heavily dependent on the operation of G-207 and G-208, the District e-mailed the preliminary operating plan and schedule for the upcoming week to permitted users in the area. The operating plan provided the pumping schedule for G-207 and G-208 and designated "allocation days" among the Seminole Tribe and other users in the area. These designated allocation days were established so the tribe could receive its allocation without competing with other users. Typically, the tribe's allocation was delivered on Thursdays. The non-tribe allocations were delivered on Fridays.

RESULTS AND OUTCOMES

In the northern Kissimmee Basin planning area, all consumptive use permit holders reported dramatic drops in pumpage. On average, the declines in water use hovered between 20 and 25 percent, which is substantial considering the District's stated objective of a 15-percent reduction. Central Florida has not experienced such a situation for many years; therefore, water use that predates the restrictions likely includes a substantial amount of waste. Nevertheless, most water users took the restrictions seriously. Some of the largest water users, by volume, took impressive actions to conserve water resources. Disney, for example, greatly expanded its water re-use systems, employed separate systems for fire protection to allow pressure reductions for potable uses, and maintained regular contact with the SFWMD to ensure compliance with the rules.

Enforcement of the restrictions was not substantial. Just a handful of violators were fined, though hundreds of water users received warning tickets. Enforcement was handled by code enforcement sections of the city of Orlando and Orange County and the town of Windermere Police Department. Orange County also contracted with an outside vendor, which organized enforcement teams. However, those workers were only allowed to hand out informational literature and warning tickets. The enforcement teams also followed up to determine if warnings led to compliance. When warnings were repeatedly ignored, those violators were turned over to code enforcement officers. Water use reductions in excess of the target 15 percent tempered the call to seek a greater response by local governments, so ultimately the SFWMD did not challenge the local decision not to impose stricter enforcement of restrictions. Furthermore, the strategy at the SJRWMD also supported a "softer" enforcement strategy. In the future, water managers may want to consider drawing up an enforcement plan and having it in place long before enactment of any Central Florida water use restrictions.

Further south, drought conditions within the Lake Istokpoga basin were severe. The District worked diligently with permittees to minimize the loss of crops and livestock in the area by scheduling public meetings and site visits, establishing the drought hotline, and issuing various emergency orders for the Istokpoga basin. When unforeseen opportunities, such as the Lake Istokpoga drawdown, arose, the District enabled permitted users to maximize their ability to capture and store the additional available water. Without the additional water from the lake drawdown in February 2001, it is possible that the Istokpoga basin could have suffered tremendous losses of both agricultural and livestock. The importance of cooperation and daily communication between permitted users and District staff during this time was evident.

Considering the severity of the drought, the number of water use violations encountered was not as high as it could have been. Many violations came from users who did not have a consumptive use permit.

A significant discovery during the drought was the inability of G-207 and G-208 to operate when Lake Okeechobee reached 9.2 ft-NGVD, the result of lake-bottom shoaling at the terminus of the C-40 and C-41, which prohibited lake water from flowing into these canals. This situation occurred in mid-May 2001, when G-207 and G-208 could not be operated to provide water to the Brighton Reservation and other permitted users until Lake Okeechobee water levels rose above the 9.2 ft-NGVD threshold. SFWMD and USACE employees discussed at length the possibility of dredging each canal to re-establish a physical connection with the lake. Ultimately, however, the District and USACE determined that such a project would be time-prohibitive. Should drought conditions similar to those experienced in 2000 and 2001 appear likely in the future, the shoaling problem at the terminus of the C-40 and C-41 canals must be considered early on to allow time for corrective action, particularly if dredging is the selected method of remediation.

UPPER EAST COAST

DESCRIPTION OF THE AREA AND ASSOCIATED WATER RESOURCES

The Upper East Coast (UEC) planning area encompasses Martin and St. Lucie counties in their entirety, as well as an eastern portion of Okeechobee County (**Figure 6-3**), and covers approximately 1,200 square miles. The majority of water supply and flood protection is achieved through four major canals located throughout the area. The C-44 basin, which is part of the UEC, is connected to Lake Okeechobee, while most of the remaining area (the C-23, C-24 and C-25 basins) are independent of the lake. As a result, the UEC was under three different Water Shortage Orders during the drought. Specifically, the C-44 basin, located entirely in Martin County, was under water shortage restrictions imposed by the Lake Okeechobee Supply Side Management Plan. Water was allocated to the C-44 basin three times a week, depending on Lake Okeechobee's stage, canal stage, and permitted water use allocations. The C-23, C-24, and C-25 are a network of canals independent of the Lake Okeechobee watershed that discharge into the St. Lucie Estuary and the southern Indian River Lagoon. This portion of the UEC is often referred to as the St. Lucie Agricultural Area. Water shortage restrictions were implemented when these canal stages fell below 14.0 ft-NGVD. Water users were allowed to pump daily from 6:00 a.m. until noon, as long as canal stages remained above the threshold of 14.0 ft-NGVD. If canal stages did not rebound above 14.0 ft-NGVD, then water withdrawals from the canals for that day were not permitted. The C-23 and C-24 basins dropped below the 14 ft-NGVD threshold in April 2001. As a result, daily canal stage notices (posted at 6:00 a.m.) were provided to agricultural stakeholders via e-mail or the water shortage hotline at the District's Martin/St. Lucie Service Center. The C-25 canal did not drop below the threshold of 14.0 ft-NGVD; therefore, water shortage restrictions were not imposed for the C-25 basin. The third water shortage restriction implemented within the UEC was imposed by Martin County Utilities due to infrastructure problems and water use permitting issues. These pertained only to those residents who got water from Martin County Utilities. The District's phase II water shortage restriction guidelines were implemented by Martin County Utilities.

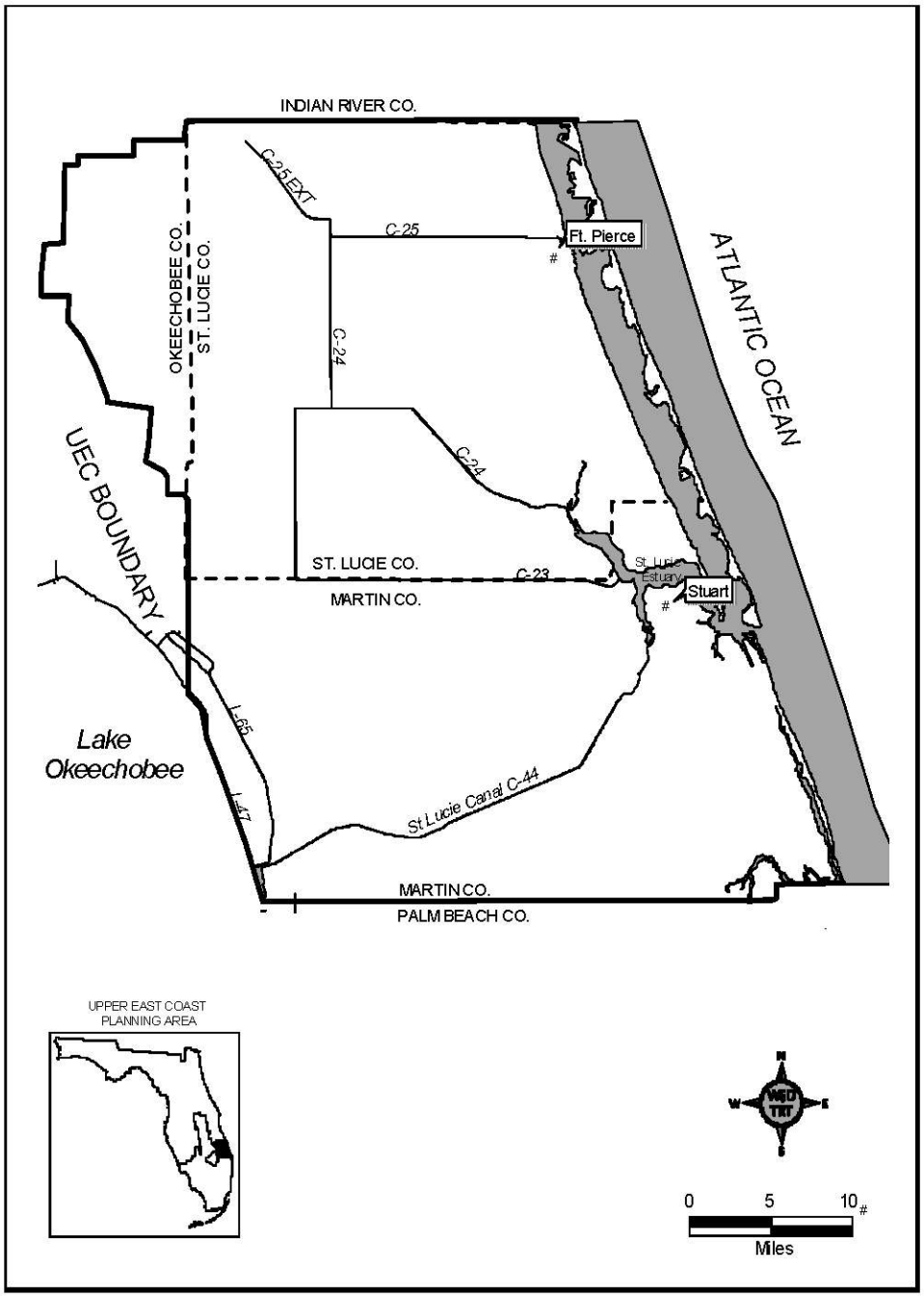

Figure 6-3. Map of Upper East Coast planning area

RESOURCE IMPACTS

As a result of water shortage conditions in the C-44 basin, increased canal-side bank sloughing was noticed along several areas of canal reach. Low stage levels in the C-44 canal made it problematic for several agricultural users to withdrawal their permitted allocation due to pump cavitation. In addition, low canal and Lake Okeechobee stages obstructed navigation.

The C-23 and C-24 basins also showed signs of increased canal-side bank sloughing, as well as pump cavitation, resulting in reduced water withdrawals for several agricultural users. Consequently, some citrus growers experienced a smaller percentage of fruit "setting," which resulted in a significantly smaller citrus harvest and a negative economic impact on the industry.

RESOURCE PROTECTION

Water users in the C-44 basin were allocated water three times a week, as prescribed under the Lake Okeechobee Supply Side Management Plan. Allocated pumping withdrawals were allowed on Wednesday, Friday, and Monday, depending on canal and Lake Okeechobee stages. In addition, compliance sweeps were made during non-pumping times in an effort to ensure appropriate use of available water resources. Citrus growers requested that they be allowed to reduce allocated pumping for older growth groves in exchange for increased pumping allocation for young (one to two years old) groves. This gave grove managers the flexibility to provide more water to younger trees in an attempt to decrease the risk of tree mortality.

To protect and maximize water resources in the C-23 and C-24 basins, real-time water level readings were communicated daily to basin stakeholders via e-mail or the water shortage hotline. Messages were updated daily at 6:00 a.m. to inform stakeholders whether pumping was allowed for that day and, if so, the scheduled times for allocated pumping. In May 2001, the C-25 basin was getting some relief from isolated local rainfall events. As a result, canal stages in the C-25 were approximately six feet higher than in the C-23 and C-24. This provided the District with a management option to transfer water from the C-25 basin to the C-24 and, to a lesser extent, the C-23 basin.

RESULTS AND OUTCOMES

The UEC planning area did not experience the significant water resource impacts that affected the majority of the District during the drought, primarily because C-23, C-24, and C-25 were independent of the water shortage requirements associated with Lake Okeechobee. Continuous and open communication between the District and local stakeholder groups proved beneficial in managing the region's water resources.

Due to increased water levels in C-25, in May 2001 the District was able to transfer water from C-25 to C-24 and, to a lesser extent, C-23. As a result, it became apparent that infrastructure improvements will need to be made between G-78 (C-23) and G-79 (C-24) to increase the conveyance capacity between C-23, C-24 and C-25. With respect to increasing the District's ability to move water between C-23 and C-24, a partnership between the District and the City of Port St. Lucie may provide an avenue of increased conveyance. The City of Port St. Lucie has a conveyance system of canals and ditches that run perpendicular to the C-24 and C-23 canals. These facilities could potentially be utilized to transfer water between the two basins.

LOWER EAST COAST

DESCRIPTION OF THE AREA AND ASSOCIATED WATER RESOURCES

The Lower East Coast (LEC) planning area covers approximately 9,000 square miles and includes Palm Beach, Broward, and Miami-Dade counties as well as portions of Monroe, Hendry, and Collier counties. Land use within the LEC ranges from urban in the east to undeveloped natural landscapes in the west, with significant agricultural areas south of Lake Okeechobee and in south Miami-Dade County. The area includes world-renowned environmental resources, such as the Everglades ecosystem and Lake Okeechobee, the largest freshwater lake in the southern United States. In addition to the LEC, the entire Lake Okeechobee Service Area, which includes parts of Martin, Okeechobee, Glades, and Lee counties, relies on Lake Okeechobee for a portion of its water supply. Highly productive coastal estuaries, such as Biscayne Bay and Florida Bay, exist along the area's shores.

Groundwater resources are the principal source of urban water supply for most of the LEC. These resources consist of the Surficial Aquifer System, which includes the Biscayne aquifer, and the Floridan aquifer system. The Biscayne aquifer is unconfined and is one of the most productive aquifers in the world. In contrast, areas around Lake Okeechobee rely on the lake as a surface water source for potable water supply.

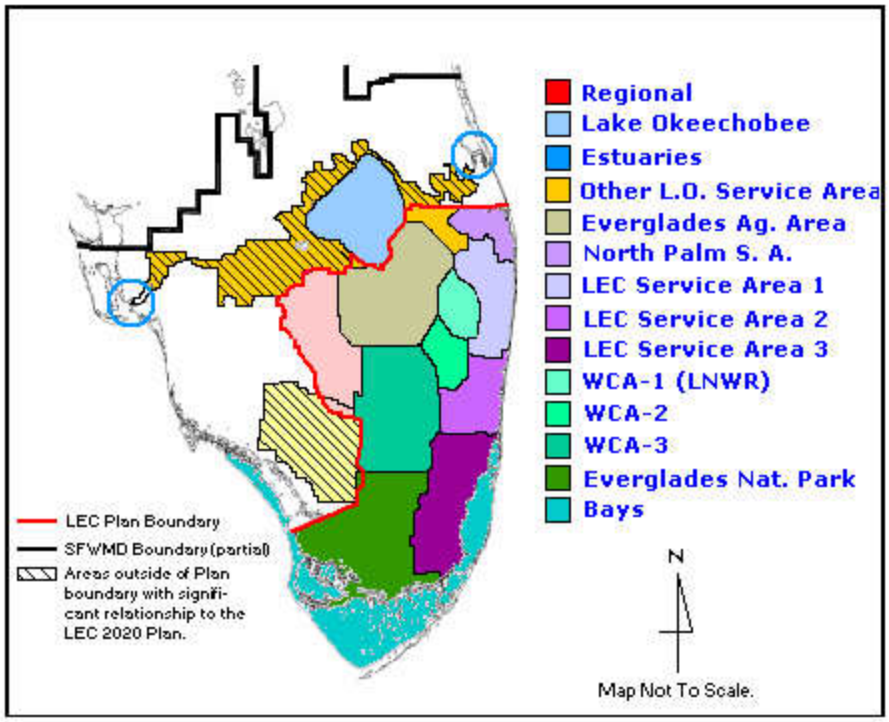

Figure 6-4. Lower East Coast map

LAKE OKEECHOBEE UTILITIES: RAW WATER INTAKE

During the 2000–2001 drought, Lake Okeechobee was at an extremely low level and no rainfall was expected in the foreseeable future. Projections of lake levels indicated that Lake Okeechobee would reach record lows within a few months. A survey of the public water supply utilities that depend on withdrawal of water from the lake indicated that existing intake configurations would not be able to furnish water with Lake Okeechobee levels at or below 10 ft-NGVD. Lack of funding and resources prevented the utilities from responding; therefore, the District, in coordination with the state Emergency Operations Center (EOC), took the engineering, contracting, and construction lead to ensure dependable intake capacity designed for lake levels as low as 6 ft-NGVD. The District reviewed the configurations for each of the utilities' intake facilities and determined that temporary fixes were not feasible. With the expectation that the low-level conditions would last for some time and would likely recur in the near future, the District determined that more permanent retrofits were necessary.

PROJECT PURPOSE AND OBJECTIVES

The purpose of the project was to ensure that existing utilities would have a continuous and uninterrupted water supply from Lake Okeechobee surface water sources. In addition, the forecast was for below-average rainfall for the upcoming wet season, which had the potential to result in multi-year-low lake stages. The project design assumed a need for lengthy and continuous service, with the potential to last well into the following wet season and the subsequent dry season. It should also be noted that the affected utilities had less than 24 hours of available water storage in their systems. Given the possibility that the proposed facility would need to have a long service period and would likely be exposed to severe weather or open-water conditions, the following design objectives and desired features were established:

1. Reliability by use of redundant systems
2. Reliability because of a robust design
3. Designed for future high lake stages
4. Designed for continuous, long-term service to address the potential of a multi-year drought
5. Designed to address vandalism and public safety concerns
6. Operate to a low lake level of 6.0 ft-NGVD
7. Sixty-day implementation
8. Minimal risk of delay
9. Design addresses major maintenance
10. Structure is operational in less than 24 hours
11. Pump capacity satisfies plant demand

IMPLEMENTATION PLAN CONSIDERATIONS

The following considerations were incorporated in the design and contract package development:

1. Incorporate resources of cities, including use of consulting firms under contract, to develop conceptual and detailed design
2. Develop, design, and build strategies that have the shortest implementation schedule
3. Designs shall minimize permit requirements to expedite implementation schedule
4. Use District resources to expedite implementation schedules

City of Pahokee

EXISTING FACILITIES

The intake consisted of a single, 14-inch diameter ductile iron supply line with a screened intake tee outside the marina channel 825 feet west of the water plant. The lake bottom at the intake was an approximate elevation of 6.2 ft-NGVD. Modification of the intake was considered effective to a lake stage of 9.0 ft-NGVD. The two intake pumps were located in the treatment plant south of the levee. These supply pumps had a capacity of 1,200 gpm and 45 feet of total dynamic head (TDH). They were Aurora centrifugal pumps, model no. 411 BF, driven by 60-hp, 1,180-rpm, 240/480-volt three-phase motors. Aurora is a division of Simonds Pump Co. The pump is classified as a horizontal, split-case, electrically driven fire pump.

DISCUSSION

The intake was considered at risk of failure with a lake level below elevation 9.0 ft-NGVD. Wind setup and wave action provided the opportunity for the entrance of air in the line. Because of the shallow depth of the line at the intake, further modification to increase submergence was not possible. An alternative for modification of the intake required the cutting of the suction line near shore and construction of a headwall. The existing intake drew water from the lake outside the influence of the poorer water quality of the marina. The city wished to keep the existing intake for future use because of this preferred water quality.

The pump's required net positive suction head (NPSH), as well as the system characteristics, were not known. The centrifugal pumps within the plant were primed with a vacuum system. The pump's name plate rating indicated that the pumps, at the time of inspection, were operating below their rated design points, with a meter reading of 900 gpm. With the lake at approximately 9.5 ft-NGVD, the pumps were incapable of being primed. With the observed decreasing output and increased difficulty in priming the pumps, it was assumed that a lake level of 9.5 ft-NGVD would result in pump shutdown.

There was no backup system for the supply pumps. The operator's emergency plan, given the inability to prime the Aurora pumps, was to connect a portable pump unit to an existing clean-out tee in the suction line near the water's edge to supply the existing pumps. The city had a mobile pump with a small, attached fuel tank that had been used on numerous occasions for this purpose. However, because of the receding shoreline the city lacked the sufficient 8-inch diameter suction/discharge line. Therefore, the SFWMD rented sufficient line, a 150-gallon, skid-mounted fuel tank and a backup diesel-driven, skid-mounted pump for the city's use until the selected alternative was constructed and tested.

The plant's 1950s-era emergency 125-kW generator was not operational for some time, and because of its age, replacement parts were not available. The District had two surplus, 125-kW generators from the modification of pump station S-331 and offered one of them to the City of Pahokee as a replacement. The District transferred the unit, and the city accepted it.

ALTERNATIVE EVALUATION

Design efforts initially focused on a turbine pump station mounted on a structural steel platform that utilized the existing concrete piles of the fishing platform. However, upon review of the preliminary drawings, the utility voiced concerns about vandalism and public safety. The design of an enclosure for the pumps was initiated but was subsequently dropped for being too costly due to wind load and possible wave impact considerations. There was also a concern regarding storm effects on the wood platform superstructure of the fishing pier and the possibility of its failure, as well as loss of access to the pumps. As a result, an alternative design was proposed that included installing a wetwell and valve box with duplex electric submersible pumps located adjacent to the fishing pier. The pumps were sized to supply the plant demand of 1,200

gpm at a total head of 44 feet. A 220-foot, 24-inch diameter HDPE intake line with a grated intake supplied water to the well from deep water located near the north end of the fishing pier. A 14-inch diameter discharge line connected to the existing suction line. At the plant manager's request, the intake pumps were sized to discharge directly to the plant treatment tank. The plant supplied electrical service and control. The bid price for the project was $465,000. Total construction cost was $532,361.

City of Belle Glade

EXISTING FACILITIES

The current intake pump station was formerly a booster station and has undergone several modifications, including the abandonment of the Torry Island intake and the conversion of the booster station to the intake. The original station had two 18-inch diameter, 4,600-gpm, 200-hp turbine pumps in 36-inch diameter cans. A third variable-speed, 250-hp pump was added and was connected to the intake and discharge piping. The 36-inch diameter steel intake pipe had an invert elevation of 2.6 ft-NGVD.

DISCUSSION

The two original pumps were out of service because of cavitation problems that occurred with the lake stage at approximately 10.5 ft-NGVD. The performance characteristics of these pumps were not known. Because of a modification to facilitate the drawing of water from a gravity intake line in lieu of water supplied from the original intake station, it was suspected that the original pump design was significantly changed. Therefore, the variable-speed pump was operated at a greatly reduced speed to reduce the submergence and NPSH required.

The City of Belle Glade had just completed construction of a new submersible pump intake withdrawing from a rock pit on Torry Island, with its discharge line connected to the old supply line to the booster station. The purpose of this intake was to provide water of good quality that would be blended with the water of the rim canal at the current intake. The performance testing of the new campground station indicated that a significant amount of time would be necessary to recharge the pit. Therefore, this station was not considered to be a continuous source of water supply but would provide approximately one day of available storage given the shutdown of the rim canal station.

The emergency plan required the mobilization of a portable pump at the existing rim canal intake. This portable pump was connected to an existing, 8-inch diameter bypass line to supply water directed to the intake pumps. Because of a concern about the failure of the last remaining pump, the District decided to mobilize, test, and keep the portable unit hooked up and ready until the new facility was constructed, tested, and operational.

ALTERNATIVE EVALUATION

The initial design focused on a wetwell and valve box with two submersible electric pumps constructed adjacent to the existing raw water pump station. The wetwell was supplied by gravity through a 30-inch diameter HDPE supply line with a grated, pre-cast concrete intake. The discharge line connected to the existing 20-inch diameter supply line, which connected to the plant approximately 13,000 feet to the south. The pump rating point was 4,000 gpm and 90 feet of total head. On the initial pricing of the job, it was disclosed that the cost and delivery time for this relatively large unit exceeded the initial estimate. Additionally, construction of the deep wetwell required significant sheeting. The District decided to design an alternative unit consisting of two turbine pumps mounted on a pre-cast, concrete, pile-supported platform with an access ramp. The pumps would use the current service from the existing station. Quotes for both alternatives were requested because the city wanted the wetwell alternative.

After the bid, the city expressed a concern about navigation with regard to the platform's proximity to the channel. The U.S. Army Corps of Engineers (USACE) expressed the same concern after the bid. Consequently, the District relocated the platform more than 60 feet to the north, farther from the Torry Island bridge restriction. However, the USACE did not want the platform any further out in the channel than the bulkhead of the existing intake. Therefore, a steel, sheet-pile bulkhead was designed to allow the platform to be located in the canal bank. The additional cost was addressed in change order number 1.

Turbine pumps/platform mounted: $305,000 + C/O No.1 for bulkhead, estimated $40,000

Wetwell: $385,000

Construction cost: $446,828

City of South Bay

EXISTING FACILITIES

The intake consisted of an elevated pump house on concrete pile located in the rim canal. The canal bottom elevation at the intake was 1.0 ft-NGVD. Three vertical pumps and three 750-gpm turbine pumps with 15 hp motor drivers were manifolded to one 12-inch and one 8-inch ductile iron supply pipe. The bottoms of the pump bells were estimated at elevation 7.0 ft-NGVD. One pump was sufficient to meet the plant's demand; one pump was inoperable due to a mechanical problem. The flow rate of one of the pumps appeared to vary proportionately with the lake stage, especially when the upper stage bowl was exposed. From the design drawings produced by the firm Barker, Osha & Anderson Inc., the following table indicates the original design parameters:

Pump	Suction	Discharge	GPM	TDH	Efficiency percent	RPM	Power
1	8 inch	8 inch	750	60	80	1200	240/480
2	8 inch	8 inch	750	60	80	1200	240/480
3	8 inch	8 inch	750	60	80	1200	240/480

DISCUSSION

The pumps were apparently not operating at maximum efficiency, resulting in an increase in the NPSH required. There were no records available on the low stage assumed in the pump design rating.

During the subsequent pump installation by District personnel, platform movement was noted with wave action within the rim canal. Because of stability concerns, District staff evaluated the pump platform to determine the need for structural improvements.

ALTERNATIVE EVALUATION

Since the canal bottom beneath the platform had sufficient depth, District staff decided that the most cost-effective solution would be to replace the pumps. Because of a significant risk of pump failure, District personnel also decided to immediately replace each of three turbine pumps with pumps that satisfied the design requirements for a projected low lake stage of 6.0 ft-NGVD. The total cost of the new equipment was $30,000, at a total construction cost of $111,945 (including structural modifications to the platform).

City of Okeechobee

EXISTING FACILITIES

The City of Okeechobee's intake was located in the Government Cut channel, with a 30-inch diameter supply pipe at an invert of 6.2 ft-NGVD to 6.4 ft-NGVD at the pump station. The intake was approximately 600 feet south of the pump station. The pump station had two 10-inch, 3,000-gpm, and one 8-inch, 2,000-gpm, mixed-flow pumps. The 24-inch diameter discharge line from the station extended 650 feet under the rim canal and over the dike to the plant. The plant supplied electric service. The city also used a well to supply 17.5 mg/month. The plant demand was indicated to be 3,800 gpm, which required the city to operate two pumps simultaneously to meet this requirement. The intake station appeared to be in good condition.

DISCUSSION

District staff believed that the pumping system of the existing intake was capable of operating to a low lake stage of 8.5 ft-NGVD based on the assumed submergence of the mixed-flow pumps. It was unknown at what elevation the pumps would begin to experience performance problems. There was no backup to the existing intake. The District's emergency plan was to mobilize a portable centrifugal pump at the water's edge to pump water into the intake until the permanent replacement station was completed and operational.

The city had a planned plant improvement within the succeeding 18 months that included the replacement of the existing raw water intake. The city requested that the new intake be designed to satisfy the new plant design.

ALTERNATIVE DISCUSSION

A portable pump installation would have significantly exposed equipment, piping, etc. to severe weather and open-water conditions. Therefore, the District did not consider such an installation secure or reliable, nor would it have satisfied the project's objectives. Therefore, the District determined that the sole alternative was a new wetwell and valve box with duplex electric submersible pumps. Use of platform-mounted pumps was not considered because of the lengthy distance required for an access walkway and the exposure of such a platform to severe wind and open-water conditions. The plan was for the wetwell to be adjacent to the existing station to limit the distance to the connection to the existing discharge piping. The quoted design sized the pumps at 2,800 gpm at a total head of 35 feet to make use of existing electric service. Both pumps were necessary to meet demand. The city objected and requested that 3,800-gpm pumps be installed to provide redundancy. However, this proposed design required a significant upgrade of the electrical service to the station and resulted in increased equipment costs. The design was completed after the quote day and, subsequently, a price was obtained from the contractor with the lowest quote, who recommended the installation of larger pumps and a larger-capacity electrical system.

The new facility included a 450-foot, 36-inch diameter intake line with a screened intake for gravity feed to the well. The regulatory agencies were consulted regarding a channel approach to the wetwell and elimination of a significant portion of the intake line. The USACE has specific language in its regulations prohibiting permit exemptions following modification of lake-bottom topography. Consequently, because the mandatory permit process for this design would have taken several months, it was not pursued. The bid price for the project was $457,144, plus $116,580 for pump and electrical upgrades. Projected construction costs were $652,298.

City of Clewiston

EXISTING FACILITIES

The primary intake and pump station for the City of Clewiston was located approximately four miles northeast of the city. It was built in 1943 and was presumably located out in the lake for water quality reasons. The station consisted of a 40-foot diameter reinforced concrete dry/wetwell intake structure, with three 14-inch centrifugal pumps (two electric-driven pumps at 2,100 gpm and one diesel-driven pump at 5,600 gpm). The water entered the wetwell through a five-foot-square gated opening with a sill elevation of 5.3 ft-NGVD. The pump discharges were manifolded to one of three 24-inch supply lines. The treatment plant had a backup intake on the rim canal that consisted of a 12-inch diameter, 5000-gpm, 125-hp, variable-speed, electric motor-driven turbine pump. The 14-inch diameter intake to the pump had an invert of 4.3 ft-NGVD.

DISCUSSION

The city of Clewiston has contracted with U.S. Sugar Corporation for operation of their water treatment plant. U.S. Sugar considered both the primary station in the lake and the backup pump at the rim canal to be at risk below a lake stage of 8.5 ft-NGVD. The performance characteristics and the system curves for the stations and discharge lines were not provided. The lake bottom in front of the primary intake was more or less at elevation 5.0 ft-NGVD. Therefore, with extremely low water it appeared that the lake site required that a channel be excavated to deeper water. Soundings found no existing channels within several hundred feet. The rim canal station was the focus of emergency action, both because of the obvious convenience and the deeper water found in the rim canal.

One disadvantage to the rim canal site was the lack of a dedicated emergency power supply. There was a 175-kW generator located south of the levee that could have provided electric power to the 125-hp motor of the rim canal pump. However, U.S. Sugar indicated that this generator was not for use solely at this site and could potentially be relocated in the case of a higher priority. The District had two 125-kW surplus generators available from the automation of pump station S-331 and offered one unit to U.S. Sugar to ensure the rim canal generator could be dedicated solely for use as an emergency backup for this water supply station. U.S. Sugar agreed and the District transferred the unit.

ALTERNATIVE EVALUATION

There was some discussion of the use of a portable, diesel-driven pump to supply water to the lake intake by sandbagging the wetwell opening and piping water over the plug. The duration of this operation, as well as the difficulty of supplying fuel and/or emergency service, eliminated this alternative from further discussion. Also, with the assumption of an extremely low lake stage of 6.0 ft-NGVD, this site was not feasible.

A portable hookup to the rim canal pump was possible with the removal of the intake line strainer and connection of the pump's discharge to the 14-inch diameter intake line at the tee. The portable pump would be sized and operated to feed the existing pump. This was the then-current emergency plan since both stations were shut down. In lieu of pumping into the intake, the District decided to install the piping for the selected alternative from the connection to the existing 12-inch supply line to a point where a connection could be left for the portable pump.

The initial proposed design was that of a wetwell with a duplex submersible pump system. However, after reviewing the cost of such a system, a platform-mounted turbine pump was designed as an alternative. U.S. Sugar Corp wanted a diesel engine-driven pump, so two alternatives were prepared: one with an electric motor and another with a diesel motor. The platform was designed for one pump, with U.S. Sugar eventually agreeing to a single, installed

unit with one backup pump. U.S. Sugar indicated it could easily and quickly replace the pump, if necessary.

The proposed drawings failed to indicate the need for a spare pump for the diesel-driven alternative, while the electric motor alternative had a second pump as a backup. The diesel-driven alternative quoted was $20,000 less than the electric motor-driven alternative. U.S. Sugar was given the choice of either the diesel engine without the backup pump, or the electric engine with the second pump. U.S. Sugar selected the latter, which consisted of one electric motor-driven turbine pump rated at 4,800 gpm at 70 feet of total head with a backup pump. The pump was mounted on a reinforced, concrete pile-supported platform with an access ramp and operated off the electrical service to the existing rim canal intake pump.

- Electric motor-driven turbine pump alternative - $340,000
- Diesel engine-driven turbine pump alternative - $320,000 + $40,000 for spare pump not quoted
- Wetwell/submersible pump alternative - $474,000
- Construction cost - $345,300

Table 6-1. Lake Okeechobee Water Utility expenditures (replace or restore raw water intakes and pump stations)

Water Utility	Expenditures*
Pahokee	$ 532,361
Belle Glade	$ 446,828
South Bay	$ 111,945
Okeechobee	$ 652,298
Clewiston	$ 345,300
Total	$2,088,732

9/28/01

* The above expenditures do not include the reimbursement paid to the cities of Belle Glade, South Bay, and Pahokee for increased treatment expenses during Lake Okeechobee water supply back pumping.

DROUGHT-RELATED THREATS TO THE RESOURCE

A primary concern during the 2000–2001 drought was the threat of saltwater intrusion into water supply wells, especially those used by public utilities along the coastal margin. Local rainfall is the primary source of recharge for the Biscayne aquifer. Seepage from the Water Conservation Areas to the west and recharge from Lake Okeechobee through canals are important sources of recharge, especially during a drought. Consequently, the extent to which water levels in Lake Okeechobee would fall to an elevation that would prohibit withdrawals was an especially important consideration. The Lake Okeechobee water level dropped to below 9.2 ft-NGVD in May 2001. At this level, significant portions of the lake bottom were exposed, and gravity flows to the WCAs and canal system were not possible. Therefore, the District installed pumps that were capable of "forward pumping" water to the LEC.

MANAGEMENT ACTIONS TAKEN TO PROTECT THE RESOURCE

The South Florida Water Management District took numerous actions to protect Lower East Coast water resources. These actions, documented in weekly reports, included closely monitoring

Lake Okeechobee water levels, as well as groundwater levels, public water supply wells (especially for utilities at risk), and diversions by special districts.

The Operations Department issued the "Operational Intent of Supply Side Management Implementation" weekly for those permittees located within the boundaries of the Lake Okeechobee Service Area. All flows out of Lake Okeechobee were monitored and compared against the Lake Okeechobee Service Area weekly allocation. Actions taken concerning the Everglades Agricultural Area, including supply side management and deliveries of water, were discussed in the previous chapter.

To monitor saltwater intrusion, specific wells were selected and data from them were collected weekly. Pumpage information from selected public water supply wells was also collected and analyzed weekly.

The following public water supplies had coastal wellfields that were monitored especially closely, since they were considered "at risk" due to saltwater intrusion: Hollywood, Pompano, Deerfield, Hillsboro, Hallandale, Dania, Broward County 3A, Florida Keys Aqueduct Authority, Florida City, Miami-Dade County-Rex, Homestead, Lake Worth, Highland Beach, Riviera Beach, Manalapan, and Lantana.

In addition, six utilities withdraw surface water directly from Lake Okeechobee: Clewiston, U.S. Sugar-Bryant, Okeechobee, South Bay, Belle Glade, and Pahokee. These utilities were considered "at risk" and were closely monitored due to all-time-low lake levels that threatened to drop below the intakes. Lee County Utilities and Ft. Myers were monitored extremely closely and were considered "at imminent risk" of saline intrusion into their intake structures due to their inability to release water from Lake Okeechobee to offset salinity coming into the Caloosahatchee River. Information on pumpage from the Old Plantation, Broward County, Sunshine, Acme, and Lake Worth special districts were collected and analyzed weekly.

RESULTS AND OUTCOMES

While the drought conditions within the LEC during the 2000–2001 drought were severe, actions taken by the District to decrease pumpage prevented permanent damage to public water supplies. The extremely low water levels recorded by Lake Okeechobee proved that the District may need to consider alternative water supplies and treatment for those utilities that currently withdraw water directly from the lake and along the coastal margin.

LOWER WEST COAST

DESCRIPTION OF THE AREA AND ASSOCIATED WATER RESOURCES

The Lower West Coast (LWC) consists of Charlotte, Collier, Glades, Hendry and Lee counties (**Figure 6-5**). During the drought, there were several areas of concern within the five counties, including saline movement within the Caloosahatchee River and groundwater levels within the lower Tamiami, Sandstone and mid-Hawthorn aquifers.

DROUGHT-RELATED THREATS TO THE AREA

The over-use of the mid-Hawthorn aquifer in the western half of Charlotte County, and the Sandstone aquifer in the eastern half of the county (near the Four Corners area), was a primary concern. Single-family homes that utilize centrifugal pumps to withdraw water from potable wells competed for water from both aquifers for agricultural and domestic use. Lack of rainfall,

combined with the continual and increased use of the aquifers, lowered the water levels beyond a point that the centrifugal pumps worked.

In Collier County, over-use of the lower Tamiami aquifer was a primary concern. Within the western and northern sections of the county, there was also a major concern about saline movement within the aquifer. The aquifer was only used for potable water supply from the county line south to Pine Ridge Road and from the Gulf of Mexico east to I-75. Outside those boundaries, there were competing uses for water from the aquifer by both self-supplied commercial users and single-family homes. The potential was greater for saline water movement when water levels within the lower Tamiami aquifer dropped below 0.0 ft-NGVD. U.S. Geological Survey (USGS) water resource investigation number FL-66200 indicated that there were areas within the lower Tamiami aquifer that had annual average water levels below 0.0 ft-NGVD.

In Glades and Hendry counties, a concern existed for competing uses of the Sandstone aquifer from both agricultural and domestic use by single-family homes. These homes utilize centrifugal pumps that are also affected by groundwater levels. Additional concerns regarding the Caloosahatchee River included low water levels and the possibility of saline intrusion from the Gulf of Mexico towards Lake Okeechobee beginning in Lee County at the W.P. Franklin Lock and Dam (S79).

In Lee County, there was concern for competing water uses. The Caloosahatchee River on the east side of the W.P. Franklin Lock and Dam (S-79) supplied water to the City of Ft. Myers and also to Lee County. Two utilities – the City of Ft. Myers and Lee County – withdrew water from the Caloosahatchee River. The City of Ft. Myers pumped water from the Caloosahatchee to its wellfield located 10 miles to the south. The water flooded a 543-acre project, seeped into the surficial aquifer, and then was withdrawn using screened surficial aquifer wells. Once withdrawn from the wells, the water was pumped to a reverse osmosis plant, sanitized with chlorine gas, and distributed to customers. Lee County had a water plant adjacent to the City of Ft. Myers' withdrawal point on the river. The Lee County plant was an older plant that used aeration methods to process water. In addition, as noted above, it used chlorine gas to sanitize treated water. Lee County had installed an Aquifer Storage and Recovery (ASR) well at the Olga Water Plant. The county was testing the structure to determine its performance. Lee County depended on the District to maintain a fresh water supply on the east side of the W.P. Franklin Lock and Dam (S-79) because the plant had no way to reduce chlorides in the water. The maximum total chloride level was 200 parts per million.

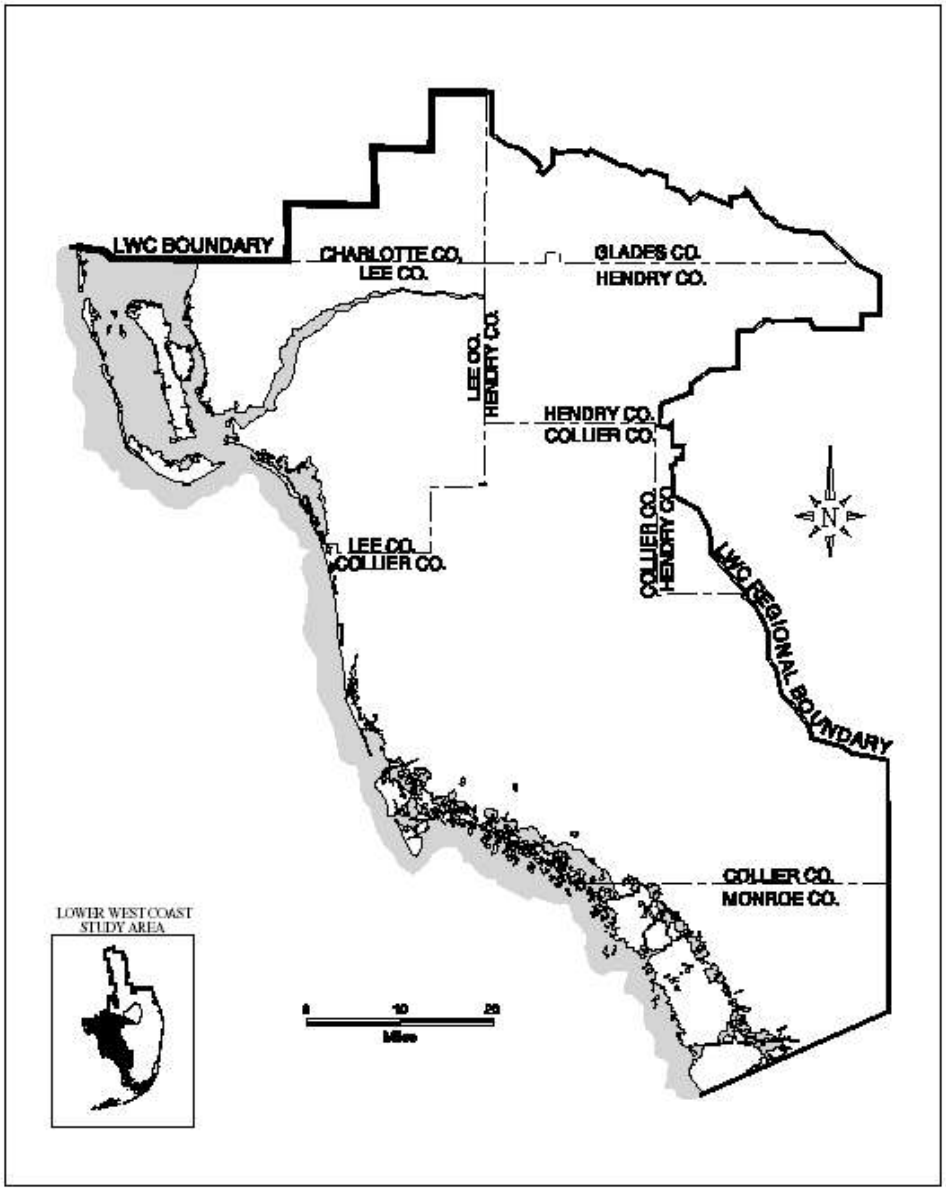

Figure 6-5. Lower West Coast planning area

The Lehigh Acres section of Lee County depends on the Sandstone aquifer for its water supply. Demand in the northern section of Lehigh Acres is predominantly from single-family homes and commercial landscape use. Demand in the southern section is for both agricultural purposes and domestic use by single-family homes. The homes use centrifugal pumps that were affected by groundwater levels.

Cape Coral, South Ft. Myers, the Iona area, and Estero still use the mid Hawthorn aquifer, which has a very low transmissivity. Lack of rainfall results in continual use of the aquifer and lowers water levels to a point below which centrifugal, and some submersible, pumps can withdraw.

The primary concern in Bonita Springs north to Coconut Road is over-use of the lower Tamiami aquifer. Within the southwestern section of the county, there is a major concern regarding saline movement within the aquifer.

MANAGEMENT ACTIONS TAKEN TO PROTECT THE RESOURCE

On November 29, 2000 the District issued phase II water restrictions for the LWC and phase III water restrictions for all uses of the Caloosahatchee River east of the W.P. Franklin Lock and Dam (S-79). By instituting the phase II restrictions for the Surficial, lower Tamiami, Sandstone and mid Hawthorn aquifers, the District was able to help stabilize groundwater levels. This was achieved by limiting groundwater use for irrigation to two days a week.

In addition, District staff from the Ft. Myers Service Center created a group that met weekly to discuss any issues of concern to local utilities that withdraw water from the Caloosahatchee River on the east side of the W.P. Franklin Lock and Dam. A primary concern was the saline wedge that penetrated the W.P. Franklin Lock and Dam and headed eastward towards Lake Okeechobee. The group continues to meet quarterly to discuss the status of both utilities.

RESULTS AND OUTCOMES

A positive result achieved by both instituting groundwater irrigation restrictions and restricting the use of the Caloosahatchee River was a significant reduction in the number of "out-of-water" complaints from single-family homes. Additionally, the Caloosahatchee River utilities group that met weekly to assess the availability of fresh water in the river helped to promote the District's commitment to preserve the resource.

Chapter 7: Environmental and Economic Impacts

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SUMMARY

As the drought progressed, South Florida's varied ecosystems were monitored for drought conditions to attempt to predict areas of concern. The South Florida Water Management District (District) conducted ecological assessments for the Kissimmee River basin, Lake Istokpoga, Lake Okeechobee, the coastal estuaries, the water conservation areas, Everglades National Park, and Florida Bay. In addition, the District monitored water quality conditions in Lake Okeechobee, the water conservation areas, and Everglades National Park. Because the natural system normally experiences wide variation in weather conditions, not all the observed effects from the drought were negative. However if the drought had continued, greater impacts would likely have been observed.

Although quantitative data are limited, the drought resulted in significant economic impacts to user groups throughout the District. Public water supply utilities experienced unanticipated revenue losses associated with reduced pumpage, and, in some cases, higher production costs resulting from increased use of alternative water sources. Agriculture, plant nurseries, and the landscaping and golf course industries also experienced significant negative economic impacts. Small recreational and tourism businesses surrounding Lake Okeechobee were especially hard-hit by the drought. The drought emergency took an unanticipated economic toll on the District, as well. By the end of the fiscal year in September 2001, the District had spent $9.7 million of its unbudgeted funds on drought-related expenditures.

ENVIRONMENTAL RESPONSES, WATER QUALITY, AND ENVIRONMENTAL IMPACTS

During the 2000–2001 drought, there was a critical need to provide up-to-date ecological and environmental science to decision makers for both short-term and long-term water management. The drought affected all of South Florida and created unprecedented low water level conditions in some Everglades sub-regions. Under these conditions, Everglades water levels had the potential to be drawn down below preferred levels for the ecosystem's biological components. Drought conditions during 2000 and 2001 created situations that necessitated striking a balance between water supply and environmental needs, which required protecting wellfields and conserving critical water supplies while minimizing and mitigating adverse impacts to the environment.

KISSIMMEE RIVER BASIN

No long-term impacts of drought were observed in the Kissimmee Basin, though water levels in the Upper Chain of Lakes were between 0.5 feet and 1.0 foot below regulation schedules. However, impediments to navigation as a result of low water levels during the drought were encountered.

Despite the drought, continuous discharge from Lake Kissimmee to the Kissimmee River for environmental restoration was re-established in June 2001. As a result, numerous initial positive responses were documented within the river/floodplain ecosystem, including:

Historic river channel substrate and sandbar characteristics were re-established.

The cover of nuisance aquatic plants decreased in the river channel, and levels of dissolved oxygen increased.

Broadleaf marsh was re-established over portions of the re-inundated floodplain, with increased utilization of floodplain habitats by river channel fishes.

Four species of waterfowl, including hundreds of blue-winged teal and eight species of shorebirds using floodplain and river channel habitats, returned to the revitalized wetlands.

There has been an increased occurrence of the endangered bald eagle and wood stork in the restored area.

Lake Istokpoga Environmental Enhancement

As a result of the drought, a three-month muck and tussock removal project was initiated to capitalize on the already low lake stages and obviate the need to discharge excessive quantities of water to Lake Okeechobee in the future. The Florida Fish and Wildlife Conservation Commission (FFWCC) was scheduled to conduct a Lake Istokpoga drawdown and muck removal project during 2002 and 2003. Since the District expected the lake to naturally drop to a level that would allow muck removal to occur, and because lake users were already being impacted, the District lowered the lake's water level by approximately one foot in February 2001 to allow the work to proceed during the dry season. By the time the lake started to refill in June 2001, 1,300 acres, or two-thirds, of the perimeter shoreline had been scraped and harvested and 2.4 million cubic yards of material were removed. Two-thirds of the material were consolidated on wildlife islands along 21 miles of shoreline; the remaining third was transported to upland disposal. The muck and sand islands will become covered with weeds, brush, red maple trees and, eventually, cypress in conjunction with future FFWCC efforts. The FFWCC conducted additional cleanup efforts using an aquatic weed harvester to enhance areas along the shoreline that could not be completed during the drawdown. The FFWCC also planned to conduct some revegetation work in the enhanced areas. But for the most part the lake's response to the completed work was beneficial for fishing interests because of the re-establishment of desirable native plant communities.

LAKE OKEECHOBEE

Positive Changes to the Lake

Lake Okeechobee experienced a number of positive ecological changes in response to the low lake stages, reflecting the ecosystem's recovery after years of damage from high water levels. These positive responses included:

Renewed growth of submerged plant beds in regions of the lake where no plants grew in the late 1990s, and widespread growth of bulrush, spikerush, and other emergent marsh plants in shoreline regions

Very clear water in the shoreline regions, with dense submerged and emergent plants; there was heavy utilization of the lake by wading birds, ducks, and shore birds

Fishing in the shoreline area was reported to be excellent, with evidence of good recruitment of young-of-year bass, according to recent information from the Fish and Wildlife Conservation Commission (FFWCC)

Widespread oxidation and compaction of organic muck that had accumulated in the lake's shallow shoreline areas

Large-scale littoral zone fires, either purposely set by management agencies or due to unknown causes, burned tens of thousands of acres of dense cattail, melaleuca, and torpedo grass during the drought, opening up the habitat for potential re-colonization by native plants

The opportunity for physical removal of an organic berm along the western lakeshore, a project carried out by the FFWCC, with funding from the District and the U.S. Army Corps of Engineers (USACE).

Impacts to the Lake

One significant negative ecological consequence of the extreme low lake stage was that torpedo grass expansion into native plant communities in the interior littoral zone was more rapid than in earlier years. However, the District and the Florida Department of Environmental Protection (FDEP) are working together to treat these areas of expansion with herbicide, in addition to the ongoing program to eradicate torpedo grass from larger areas where it had already become established. The District is also screening a variety of herbicides to determine if there is a control agent that offers more selectivity (not harmful to native plants) than chemicals currently being used.

Another adverse impact to the lake's ecology resulted from a decision to backpump water into Lake Okeechobee. As the drought progressed during the spring of 2001 the District's Executive Director declared a water emergency on March 27, 2001. The governing board subsequently concurred with that decision during an emergency meeting on the same date. In response, the FDEP issued the first Emergency Final Order (OGC no. 01-0715) on April 27, 2001 authorizing the District to initiate water supply backpumping into the lake through the structures at S-2 and S-3 at the south end of Lake Okeechobee. In the ensuing months, as the drought continued and as concerns escalated about the impending dry season, the FDEP authorized the District in a second Emergency Final Order (OGC no. 01-1202) dated and issued on August 3, 2001 to continue water supply backpumping and allow augmentation of the pumping and gravity flows of water into the lake through the structures at S-4, S-77, S-308, S-352, and culvert 10-A. As part of those permitted operations, the orders mandated intensive water quality and biological monitoring programs, the implementation of certain operational constraints, and activities required to offset potential negative impacts of the backpumping events. These activities included planting bulrush in previously denuded areas and removing an organic berm in the lake.

Water Quality Monitoring

In general, the water entering the lake through the augmentation structures contained lower total phosphorus concentrations than water entering the lake from other sources. All sampling and analyses were conducted in accordance with the conditions detailed in the emergency final orders of April 27, 2001 and August 3, 2001.

During the period from June 1 through September 21, 2001, backpumping from S-2 and S-3 contributed 22 percent, or approximately 325,000 ac-ft, of the total water inflow into the lake, but only 9 percent, or 37.9 metric tons, of the total phosphorus (TP) contribution to the lake (**Table 7-1**). Flows from all augmentation sources addressed in the second Emergency Final Order, including backpumping and gravity flow, contributed 39 percent of the flow and 25

percent of the TP when compared to all water sources contributing to the lake at that time. These relative contributions resulted in an average flow-weighted mean concentration (FWMC) of TP from all backpumping and augmentation sources of 146 parts per billion (ppb); the FWMC of TP entering the lake from all sources, including the backpumping and augmentation flows, averaged 228 ppb.

Calculated loads for total nitrogen (TN) indicate that the load entering the lake for the augmentation period and coming from the augmentation structures represented 46 percent of the total nitrogen load from all sources. The FWMC of TN entering the lake from all sources during the period was 2.53 mg/l (2,532 ppb), whereas the FWMC of TN from the flows coming through the structures being used for water supply backpumping and augmentation was 2.99 mg/l.

The monitoring programs specified by the emergency final orders also required additional water quality monitoring of the inflows into the lake for parameters other than nutrients, including pesticides, trace level mercury, and general water quality parameters. Though trace levels of pesticides were found in some samples, no pesticide concentrations exceeded class I water quality standards. Trace level mercury monitoring for all structures involved in augmentation flows to Lake Okeechobee indicated that no analyzed and reported water sample exceeded the state criterion of 12 ng/l total mercury.

Analyses of general water quality parameters indicated that there were no significant violations of class I water quality standards at any location, except for variations from the dissolved oxygen (DO) standard and a few exceedances of the standard for iron. Concentrations below the 5 mg/l DO standard are common in ambient South Florida surface waters and do not necessarily indicate an adversely impacted water quality. The FDEP is reviewing this standard, and it is anticipated that it will be revised to more accurately reflect naturally occurring conditions in South Florida. The exceedances observed for iron that were in excess of the class I standard were still within the class III standard. Since the water samples were collected on the upstream, or canal side, of the structures and, therefore, were collected in class III waters, there is a question as to which standard should apply. Furthermore, iron in concentrations greater than the class I standard of 0.3 mg/l in surface water is generally in the form of particulate iron associated with suspended sediments and should settle out in the lake. This would allow the water to meet class I standards in that water body before the water reaches any public water supply intake point. A detailed tabulation of all water quality analyses can be found in the full report on the Lake Okeechobee backpumping and augmentation activities in **Appendix 3A-1**.

Table 7-1. Summary: June 1, 2001 through September 21, 2001 water supply backpumping and augmentation sites compared to all lake inflows

Total Phosphorus (TP)			
STATION	**Total Phosphorus (TP)**		**% of total lake-wide inflow**
	loads (metric tons)	**FWMC (ppb)**	
S2	23.96	99.0	6%
S3	13.95	87.3	3%
CULV10A (L8)	9.52	103.0	2%
S77	13.13	153.8	3%
S308	40.09	357.3	10%
S4	2.29	153.9	1%
S352	0.82	229.2	<1%
Sum of above sites	**103.76**	**146.1**	**25%**
% of all lake-wide inflow	**25%**		
Lake-wide total inflow	**413.52**	**228.0**	
Total Nitrogen (TN)			
STATION	**Total Nitrogen (TN)**		**% of total lake-wide inflow**
	Loads (metric tons)	**FWMC (ppb)**	
S2	894	3,697	19%
S3	559	3,499	12%
CULV10A (L8)	206	2,227	4%
S77	169	1,977	4%
S308	238	2,118	5%
S4	40	2,669	1%
S352	24	6,752	1%
Sum of above sites	**2,129**	**2,999**	**46%**
% of all lake-wide inflow	**46%**		
Lake-wide total inflow	**4,592**	**2,532**	

Biological Monitoring

The FDEP required the District to expand its biological monitoring program in the lake in an effort to identify any negative ecological impacts resulting from backpumping. The District had the benefit of nearly two years of biological monitoring background data to assist in the identification of potential effects. The focus of the monitoring, as detailed in the two emergency final orders (OGC no. 01-0715 and OGC no. 01-1202) provided by the FDEP, was on submerged aquatic vegetation (SAV) and water transparency. The lake's SAV is a valued ecosystem component that provides habitat for fish and other aquatic biota. Submerged aquatic vegetation is a sensitive indicator of water quality because its aboveground tissues are in direct contact with the lake water. Documented research on Lake Okeechobee and other shallow, freshwater ecosystems has shown that underwater light availability is a prime determinant of SAV growth. Therefore, the biological monitoring program also included a detailed analysis of underwater light in the southern region of the lake in proximity to the S-2 and S-3 pump stations, as well as at other stations that could be used as "reference" locations for comparison.

In summary, biological monitoring indicated no negative impacts of the backpumping operations on SAV or water transparency. There were typical seasonal and location variations in SAV occurrence similar to those that have been previously documented for Lake Okeechobee. There were also changes in water transparency associated with increased water depths, lake-wide effects from wind, and lake-wide changes in dissolved organic color. However, none of these changes was associated with the emergency water supply backpumping operations. These results do not indicate that backpumping will never have negative ecological impacts on the lake; rather, only that such effects were not observed during the 2000–2001 drought.

The full report on the Lake Okeechobee backpumping and augmentation activities (**Appendix 3A-1**) provides detailed discussions of all biological data.

DROUGHT IMPACTS ON THE EVERGLADES CONSTRUCTION PROJECT

STA-1W

Drought impacts on STA-1W were minimal despite record low stages in all treatment cells. Seepage inflow from WCA-1 almost eliminated the need for emergency water deliveries to STA-1W. In May 2001, however, the District diverted 830 ac-ft of water into the project to protect more than 2,000 acres of SAV from dryout. Because the District kept STA-1W flooded throughout the drought, the underlying peat soils were protected from oxidation. No significant long-term impacts on treatment performance or the vegetation communities are anticipated.

STA-2

The sawgrass and woody plant communities of the former Brown's Farm Wildlife Management Area make up most of the treatment area within STA-2 and are naturally drought tolerant. Consequently, no drought impacts were evident in either cell 1 or cell 2. When water depth in cell 3 dropped below six inches in March 2001, the District made emergency water deliveries totaling approximately 1,600 ac-ft to that cell to protect the developing SAV community from drying out. Significant long-term impacts from the drought are not expected on treatment performance or the vegetation communities.

STA-5

Despite extremely low water levels in STA-5, the drought's impact on vegetation communities was minimal. To protect the developing SAV community in cell 1B, the District

diverted roughly 3,000 ac-ft of water into that cell to maintain a minimum depth of six inches, as directed by permit. No plant mortality was observed in the SAV cell. There was a net gain of cattail in the remaining three cells despite having water levels that fell below the average ground surface elevation. While some isolated mortality occurred in cattail stands located at the highest ground elevation, the plants recovered quickly when the cells were reflooded. Water quality was monitored closely at STA-5 to determine if the drought was having any adverse influence on treatment performance.

STA-6

Because STA-6 usually experiences an annual dryout, the 2000–2001 drought did not adversely impact the wetland's ecological integrity. Both treatment cells experienced two separate dryout events and, subsequently, two re-flood periods. No emergency water deliveries were required for STA-6 because the mixed grass and sawgrass plant communities are drought tolerant. In fact, re-growth of the SAV and periphyton communities in cell 5 seemed to follow a predictable annual pattern once the wetland reflooded. Pre- and post-drought phosphorus removal did not differ significantly, which indicated that the drought had minimal, if any impact on treatment performance.

DROUGHT IMPACTS ON WATER CONSERVATION AREAS AND EVERGLADES NATIONAL PARK

To assist water managers in evaluating drought conditions, District staff created a series of indices that formalized knowledge of the effects of drought on ecosystem attributes. Water level, muck fire, wading bird habitat, and general ecological risk assessment models were developed as tools for assessing then-current, as well as predicted, 2000–2001 drought effects within the WCAs, wildlife management areas, and Everglades National Park. District staff created formulae using the Environmental Protection Agency's REMAP data and the South Florida Water Management District's Stormwater Treatment Area receiving areas' Monitoring and Research and Threshold Program data. SFWMD staff used these formulae to estimate the then-current, as well as predicted, ecological conditions in the Everglades that might have occurred as a result of the drought. The indices were compiled in Drought Ecological Impact reports. The April 2001 report contains background information on how the ecological risk assessment models were specifically developed. In addition, a draft manuscript for publication, "Assessing Drought Related Ecological Risk in the Florida Everglades" (Smith et al., 2002), has been developed.

The output from these models in the form of system-wide maps provided a qualitative tool for understanding the spatial and temporal variability of ecological risk during the 2000–2001 drought. This proved valuable in developing piecemeal water management plans in this highly compartmentalized system, where each component functions differently and can differ substantially in terms of risk. Overall it was a good year for the Everglades ecosystems when evaluating the ending, dry-season conditions of May 2001. Several marsh sites identified by the muck fire hazard index exceeded the critical water level threshold of one foot below ground elevation. Fortunately, the numerous fires that occurred throughout the Everglades during this time were restricted to healthy surface burns and did not result in damaging muck fires. All the wading bird colonies successfully fledged young this nesting season, though some colonies were more successful than others were.

In addition to providing continuous, updated assessments throughout the drought period, the models were linked with position analyses (predictions of future stages) to evaluate the ways various water management alternatives might exacerbate or alleviate ecological stress. Assessments were completed for various operational schemes, all of which sought to lower the

minimum allowable stages for the WCAs in various ways for the benefit of water supply. The assessments revealed that such deviations in the regulation of WCAs 1 and 2A, for example, would result in little or no increase in ecological risk, but that deviations in WCA-3A would be unwise. The assessments also revealed that parts of northern WCA-3A were already in the high-risk category for peat fire and the spatial extent of suitable wading bird habitat.

Water Quality Monitoring

Potential effects of the drought on water quality were evaluated for the Loxahatchee National Wildlife Refuge (Refuge), Water Conservation Area 2 (WCA-2), Water Conservation Area 3 (WCA-3), and Everglades National Park (Park). Water quality samples were collected at 111 routinely monitored stations (**Figure 7-1**). Monitoring stations located within each region were divided into sub-regions as inflow, interior, or outflow sites. Inflow sites were defined as those stations that convey water into a region. Marsh and canal stations, as well as those structures that convey water within each region, are defined as interior sites. Outflow sites are defined as those that convey water from a region. In addition, the Refuge has a rim canal component for analysis of inflows being conveyed in rim canals that border the east and west Refuge levees and discharge into outflow structures in the south levee. This classification scheme is presented in the *2000*, *2001*, and *2002 Everglades Consolidated Report* (ECR) (Bechtel et al., 1999; Weaver et. al., 2000; Weaver et al., 2001).

Changes in water quality and compliance with Class III criteria were used to evaluate any potential effects of the drought for the period from May 2000 through September 2001. This evaluation was limited to the following parameters:

water temperature	dissolved oxygen*
specific conductance*	pH*
alkalinity*	total suspended solids
turbidity*	total nitrogen
total phosphorus	

* Numeric criteria pursuant to Chapter 62-302, F.A.C.

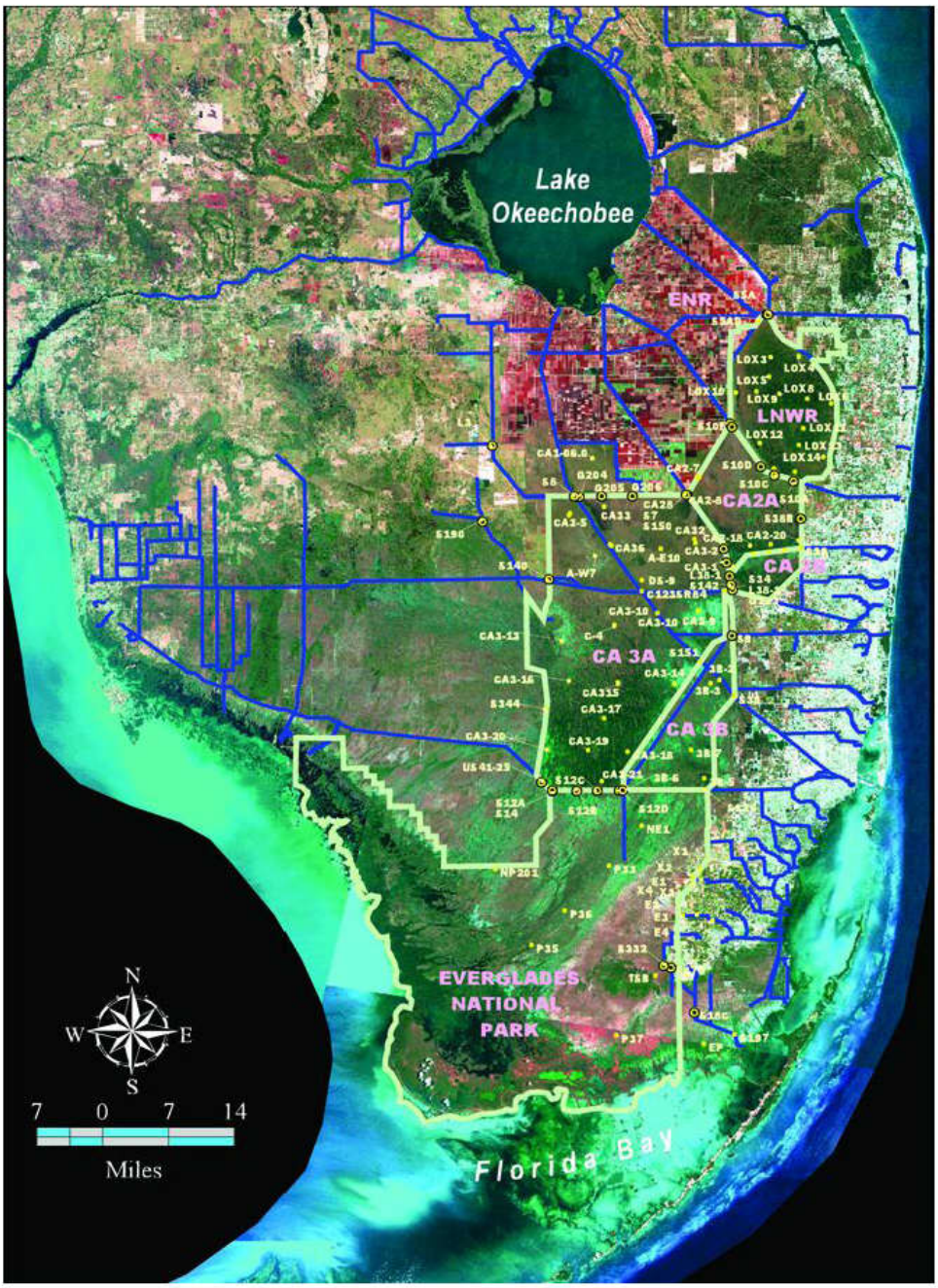

Figure 7-1. Location of monitoring sites in the Loxahatchee National Wildlife Refuge, Water Conservation Areas, and Everglades National Park

Loxahatchee National Wildlife Refuge

A summary of water quality data for the drought period is presented in **Table 7-2**. In addition, a graphical presentation of the data is presented in **Figures 7A-1-1** through **7A-1-16** in **Appendix 7A-1** for each parameter. These plots show: (a) the total number of samples collected per month by parameter at each sub-region, as well as the number of excursions from class III standards; and (b) the average monthly level for each parameter in the specified sub-regions.

Specific conductivity, dissolved oxygen, alkalinity, turbidity, and pH levels in the Refuge did not meet the class III criteria during the drought period. Of these parameters, only dissolved oxygen and pH had a greater percent of excursions during the drought than during previous years of monitoring. The remaining parameters (alkalinity and turbidity) had percent excursions similar to or below previous years of monitoring.

Approximately 91 percent of dissolved oxygen measurements at the interior sites were below the 5.0 mg/L limit compared with 76 percent for the historic period (1978 through 1999) and 77 percent for the 2000 Water Year (Weaver et. al., 2001). The percent excursion for the 2001 Water Year was similar to the drought period because the first 12 months of the drought period are represented in the 2001 Water Year.

One of the more obvious effects of the drought was the number of stations that were dry. Bechtel et al., (2002) reported that approximately 33 percent fewer samples were collected for total phosphorus from January through September of 2001 than for the same period in 2000 at interior sites. This trend was also observed for other parameters at interior sites.

The interior sites of the Refuge had monthly mean dissolved oxygen concentrations below the class III criteria during the drought period. Outflow structures exhibited a slightly greater percentage of dissolved oxygen excursions (2 to 3 percent) during the drought than in previous periods (Weaver et al., 2001).

Dissolved oxygen concentrations are typically depressed in macrophyte-dominated marsh environments, such as interior sites in the Refuge, due to natural processes of photosynthesis and respiration (Belanger and Platko, 1986; McCormick et al., 1997). These low dissolved oxygen concentrations represent the natural variability in this type of ecosystem. Therefore, the class III criterion of 5.0 mg/L is not believed to be appropriate for the Everglades system (Weaver et al., 2000; Weaver et al., 2001). However, an increase in the percent excursions may be indicative of drought effects within the interior of the Refuge.

Overall, the mean dissolved oxygen concentration reported for the drought period (**Table 7-2**) in the Refuge was comparable to the average reported for the 2001 Water Year (Weaver et al., 2001) and lower than that reported for the 2000 Water Year (Weaver et al., 2000). As stated previously, the majority of the data reported for the drought period (except for May 2001 through September 2001) was reported for the 2001 Water Year in the ECR. Therefore, similarities between these two data sets are not surprising. However, any deviations observed between the drought period data and the 2001 Water Year summarization (as reported by Weaver et al., 2001) can be attributed to the last five months of the drought.

Table 7-2. Summary of water quality data collected at monitoring sites in the Loxahatchee National Wildlife Refuge during the drought period from May 2000 through September 2001

Parameter	No. of Samples	Min.	Median	Max.	Mean	Standard Deviation	Class III Criteria
Inflow Structures							
Physical							
Temperature (°C)	316	15.0	26.9	32.6	25.4	4.1	Not Applicable
Dissolved Oxygen (mg/L)	316 (230)	0.08	3.46	13.51	3.73	2.24	Not less than 5.0 mg/L
Specific Conductance (µmhos/cm)	316 (23)	313	1059	1461	984.8	259.9	Not greater than 50% above background or to 1,275 µmhos/cm
Water pH	316 (2)	5.15	7.42	8.57	7.47	0.30	Not less than 6.0 or greater than 8.5
Alkalinity (as $CaCO_3$ mg/L)	154	108.1	221.4	390.7	228.7	65.8	Not less than 20 mg/L
Total Suspended Solids (mg/L)	125	<1.0	4.4	40.0	7.2	7.8	Not Applicable
Turbidity (NTU)	154 (1)	0.6	4.2	46.4	6.6	6.6	Less than or equal to 29 NTU above background
Nutrients							
Total Nitrogen (mg/L)	221	<0.50	2.43	7.09	2.57	1.07	
Total Phosphorus (µg/L)	413	14	49	356	68	56	
Rim Canal							
Physical							
Temperature (°C)	70	7.4	25.6	30.7	24.8	4.7	Not Applicable
Dissolved Oxygen (mg/L)	84 (58)	0.55	3.68	8.46	4.04	1.83	Not less than 5.0 mg/L
Specific Conductance (µmhos/cm)	94 (3)	444	931	1420	908.6	210.1	Not greater than 50% above background or to 1,275 µmhos/cm
Water pH	60	7.01	7.43	8.15	7.47	0.23	Not less than 6.0 or greater than 8.5
Alkalinity (as $CaCO_3$ mg/L)	65	116.0	240.0	346.0	237.9	54.9	Not less than 20 mg/L
Total Suspended Solids (mg/L)	41	4.0	6.0	77.0	10.0	12.8	Not Applicable
Turbidity (NTU)	29 (2)	1.6	7.2	35.0	10.1	8.9	Less than or equal to 29 NTU above background
Nutrients							
Total Nitrogen (mg/L)	65	0.68	2.40	5.60	2.51	0.88	
Total Phosphorus (µg/L)	70	19	59	263	75	45	
Interior Sites							
Physical							
Temperature (°C)	313	11.3	25.4	33.2	24.2	4.2	Not Applicable
Dissolved Oxygen (mg/L)	350 (318)	0.19	2.35	9.68	2.60	1.65	Not less than 5.0 mg/L
Specific Conductance (µmhos/cm)	384 (1)	8	277	1412	418.7	322.4	Not greater than 50% above background or to 1,275 µmhos/cm
Water pH	289 (65)	5.43	6.81	7.66	6.71	0.54	Not less than 6.0 or greater than 8.5
Alkalinity (as $CaCO_3$ mg/L)	210 (25)	10.0	128.5	345.0	133.7	87.8	Not less than 20 mg/L
Total Suspended Solids (mg/L)	126	2.1	4.0	29.0	4.6	2.5	Not Applicable
Turbidity (NTU)	92	0.4	0.7	3.5	0.9	0.6	Less than or equal to 29 NTU above background
Nutrients							
Total Nitrogen (mg/L)	210	<0.50	1.71	4.76	1.76	0.67	
Total Phosphorus (µg/L)	312	<4	11	120	14	14	
Outflow Structures							
Physical							
Temperature (°C)	96	14.5	28.1	32.3	26.6	3.8	Not Applicable
Dissolved Oxygen (mg/L)	96 (68)	0.21	3.69	9.73	3.94	2.11	Not less than 5.0 mg/L
Specific Conductance (µmhos/cm)	95 (1)	168	718	1287	743.1	252.1	Not greater than 50% above background or to 1,275 µmhos/cm
Water pH	96	6.79	7.45	8.34	7.46	0.31	Not less than 6.0 or greater than 8.5
Alkalinity (as $CaCO_3$ mg/L)	83	62.5	185.4	380.7	198.7	76.0	Not less than 20 mg/L
Total Suspended Solids (mg/L)	80	<1.0	3.1	39.6	5.6	7.0	Not Applicable
Turbidity (NTU)	83 (1)	0.8	2.7	36.7	4.8	5.4	Less than or equal to 29 NTU above background
Nutrients							

Alkalinity excursions were only observed at interior sites of the Refuge (**Table 7-2**). Approximately 12 percent of alkalinity measurements were below the 20-mg/L standard specified in Section 62-302.530, F.A.C. During previous years, the percent of samples with alkalinity levels below this criterion ranged from 15 to 30 percent (Weaver et al., 2001). This sub-region receives most of its hydrologic load through rainfall, which results in lower alkalinities compared with the other sub-regions of the Refuge. For the drought period, alkalinity at the interior sites of the Refuge averaged 133.7 mg/L (**Table 7-2**) compared with 44 to 136 mg/L for previous years. The higher alkalinities observed during the drought at these sites (as well as the lower percent excursions) suggest that the water quality for interior sites may have been affected by the drier conditions.

Generally, the other parameters (including total nitrogen and total phosphorus) exhibited similar levels to those reported in previous years. Only mean specific conductance at the interior sites of the Refuge was higher than in previous years. This apparent increase in specific conductance may have resulted from the drought.

Water Conservation Area 2

Water quality in WCA-2 for selected parameters collected during the drought are summarized in **Table 7-3** by sub-region. The total number of monthly samples collected for each parameter, as well as the number of excursions from class III criteria, are depicted in **Figures 7A-1-17** through **7A-1-32** in **Appendix 7A-1**. These figures also show mean monthly concentrations by parameter in the sub-regions of WCA-2.

Excursions from the class III dissolved oxygen standard were observed for the three sub-regions of WCA-2 (**Table 7-3**). Inflow structures and interior sites exhibited higher percent excursions during the drought than for previous periods (Weaver et al., 2001). However, mean dissolved oxygen concentrations in WCA-2 were higher during the drought at inflow and outflow structures, and lower at interior sites, than that reported for previous periods (Bechtel et al., 1999; Weaver et al., 2000; Weaver et al., 2001).

In addition, specific conductance levels at inflow and interior sites and turbidity levels at inflow sites exceeded the class III criterion for these parameters (**Table 7-3**). The percent of samples with these excursions was similar to that reported in previous periods (Weaver et al., 2001).

The mean specific conductance for the drought period was comparable to that reported previously (Bechtel et al., 1999; Weaver et al., 2000; Weaver et al., 2001). However, turbidity levels generally averaged slightly higher than those previously reported (Bechtel et al., 1999; Weaver et al., 2000; Weaver et al., 2001). No apparent changes in average nutrient concentrations during the drought period were observed from those reported in previous reports.

Table 7-3. Summary of water quality data collected at monitoring sites in Water Conservation Area 2 during the drought period from May 2000 through September 2001

Parameter	No. of Samples	Min.	Median	Max.	Mean	Standard Deviation	Class III Criteria
Inflow Structures							
Physical							
Temperature (°C)	95	14.2	27.7	31.4	26.1	4.2	Not Applicable
Dissolved Oxygen (mg/L)	95 (67)	0.21	3.75	9.73	3.98	2.06	Not less than 5.0 mg/L
Specific Conductance (µmhos/cm)	94 (2)	388	837	1466	836.7	229.4	Not greater than 50% above background or to 1,275 µmhos/cm
Water pH	95	6.91	7.46	8.34	7.52	0.29	Not less than 6.0 or greater than 8.5
Alkalinity (as $CaCO_3$ mg/L)	79	102.4	222.9	380.7	230.3	69.3	Not less than 20 mg/L
Total Suspended Solids (mg/L)	57	<1.0	3.0	39.6	6.3	7.9	Not Applicable
Turbidity (NTU)	78 (1)	0.5	2.8	36.7	5.7	6.4	Less than or equal to 29 NTU above background
Nutrients							
Total Nitrogen (mg/L)	102	<0.50	2.11	5.13	2.16	0.94	
Total Phosphorus (µg/L)	113	9	47	306	58	46	
Interior Sites							
Physical							
Temperature (°C)	312	10.6	26.2	31.9	25.4	3.9	Not Applicable
Dissolved Oxygen (mg/L)	326 (273)	0.13	2.91	9.44	3.12	1.90	Not less than 5.0 mg/L
Specific Conductance (µmhos/cm)	334 (13)	159	843	2525	805.9	282.3	Not greater than 50% above background or to 1,275 µmhos/cm
Water pH	261	6.43	7.41	8.18	7.39	0.27	Not less than 6.0 or greater than 8.5
Alkalinity (as $CaCO_3$ mg/L)	259	78.0	213.0	462.0	217.3	62.9	Not less than 20 mg/L
Total Suspended Solids (mg/L)	234	<1.0	4.0	36.0	4.2	3.2	Not Applicable
Turbidity (NTU)	78	0.3	0.7	7.2	1.1	1.2	Less than or equal to 29 NTU above background
Nutrients							
Total Nitrogen (mg/L)	259	<0.50	2.10	5.70	2.19	0.82	
Total Phosphorus (µg/L)	331	<4	13	240	29	36	
Outflow Structures							
Physical							
Temperature (°C)	86	14.6	27.1	32.0	25.7	3.9	Not Applicable
Dissolved Oxygen (mg/L)	86 (46)	0.90	4.38	8.58	4.41	2.12	Not less than 5.0 mg/L
Specific Conductance (µmhos/cm)	84	300	728	1114	746.0	159.6	Not greater than 50% above background or to 1,275 µmhos/cm
Water pH	86	6.70	7.47	8.42	7.54	0.36	Not less than 6.0 or greater than 8.5
Alkalinity (as $CaCO_3$ mg/L)	86	83.8	194.8	304.4	191.4	40.1	Not less than 20 mg/L
Total Suspended Solids (mg/L)	84	<1.0	1.5	13.0	2.2	2.2	Not Applicable
Turbidity (NTU)	86	0.3	1.3	12.4	1.9	1.9	Less than or equal to 29 NTU above background
Nutrients							
Total Nitrogen (mg/L)	86	0.76	1.56	2.90	1.61	0.42	
Total Phosphorus (µg/L)	86	4	18	87	25	19	

Values in parenthesis indicate number of samples that exceeded the Class III standard

WATER CONSERVATION AREA 3

A summary of water quality data for selected parameters monitored in WCA-3 during the drought period is provided in **Table 7-4**. The total number of monthly samples collected by parameter, as well as the number of excursions from class III criteria, are depicted in **Figures 7A-1-33** through **7A-1-48** in **Appendix 7A-1**. Mean monthly concentrations for each parameter in the sub-regions of WCA-3 are also depicted in these figures.

The number of excursions from class III standards observed for dissolved oxygen, specific conductance and turbidity during the drought period are presented in **Table 7-4**. The percent of samples with excursions for these parameters were similar to those previously reported in Weaver et al., 2001. Excursions for specific conductance were only observed at inflow stations while turbidity excursions occurred at both the inflow and interior sites (**Table 7-4**). Conversely, dissolved oxygen excursions were observed throughout WCA-3 (**Table 7-4**).

Mean nutrient concentrations at inflow structures were lower during the drought period than reported in the previous periods while concentrations at interior and outflow sites were similar to previously reported values (Weaver et al., 2001).

Table 7-4. Summary of water quality data collected at monitoring sites in Water Conservation Area 3 (the Refuge) during the drought period from May 2000 through September 2001

Parameter	No. of Samples	Min.	Median	Max.	Mean	Standard Deviation	Class III Criteria
Inflow Structures							
Physical							
Temperature (°C)	333	13.1	27.2	32.0	26.0	3.7	Not Applicable
Dissolved Oxygen (mg/L)	331 (67)	0.52	3.82	11.02	4.12	2.16	Not less than 5.0 mg/L
Specific Conductance (µmhos/cm)	331 (2)	9	728	1558	724.6	160.8	Not greater than 50% above background or to 1,275 µmhos/cm
Water pH	333	6.12	7.43	8.61	7.49	0.36	Not less than 6.0 or greater than 8.5
Alkalinity (as $CaCO_3$ mg/L)	201	106.1	222.9	366.1	221.4	48.9	Not less than 20 mg/L
Total Suspended Solids (mg/L)	179	<1.0	2.4	20.8	3.0	2.7	Not Applicable
Turbidity (NTU)	201 (1)	0.4	2.1	32.9	3.0	3.3	Less than or equal to 29 NTU above background
Nutrients							
Total Nitrogen (mg/L)	297	<0.50	1.49	5.18	1.68	0.62	
Total Phosphorus (µg/L)	574	8	26	289	39	38	
Interior Sites							
Physical							
Temperature (°C)	177	9.7	26.6	34.7	25.6	4.0	Not Applicable
Dissolved Oxygen (mg/L)	195 (273)	0.29	2.84	10.32	3.25	1.94	Not less than 5.0 mg/L
Specific Conductance (µmhos/cm)	220 (13)	149	437	1160	495.2	215.9	Not greater than 50% above background or to 1,275 µmhos/cm
Water pH	177	6.54	7.21	8.29	7.23	0.24	Not less than 6.0 or greater than 8.5
Alkalinity (as $CaCO_3$ mg/L)	92	71.0	188.3	347.3	185.0	62.9	Not less than 20 mg/L
Total Suspended Solids (mg/L)	47	<1.0	3.6	38.0	4.7	5.8	Not Applicable
Turbidity (NTU)	92	0.3	1.1	32.5	2.3	3.6	Less than or equal to 29 NTU above background
Nutrients							
Total Nitrogen (mg/L)	93	<0.50	1.43	2.90	1.44	0.47	
Total Phosphorus (µg/L)	175	4	11	310	20	30	
Outflow Structures							
Physical							
Temperature (°C)	281	14.6	27.4	32.1	26.3	3.7	Not Applicable
Dissolved Oxygen (mg/L)	280 (46)	0.66	3.13	8.94	3.53	1.68	Not less than 5.0 mg/L
Specific Conductance (µmhos/cm)	281	211	403	819	443.6	132.6	Not greater than 50% above background or to 1,275 µmhos/cm
Water pH	281	6.16	7.33	8.27	7.35	0.23	Not less than 6.0 or greater than 8.5
Alkalinity (as $CaCO_3$ mg/L)	169	90.7	166.2	288.1	170.0	42.0	Not less than 20 mg/L
Total Suspended Solids (mg/L)	165	<1.0	1.5	23.6	2.7	3.2	Not Applicable
Turbidity (NTU)	169	0.4	1.5	8.0	2.0	1.4	Less than or equal to 29 NTU above background
Nutrients							
Total Nitrogen (mg/L)	179	<0.50	1.15	2.14	1.16	0.27	
Total Phosphorus (µg/L)	279	6	19	90	23	15	

Values in parenthesis indicate number of samples that exceeded the Class III standard

EVERGLADES NATIONAL PARK

Of the five parameters with class III criteria, only dissolved oxygen levels did not comply with the class III standard. Approximately 76 percent of samples at the inflow stations and 60 percent of samples at interior sites had dissolved oxygen concentrations below the 5.0-mg/L criteria (**Table 7-5**). During the drought, mean dissolved oxygen concentrations at inflow stations were slightly higher than previously reported for this region (Bechtel et al., 1999; Weaver et al., 2000; Weaver et al., 2001). However, the mean dissolved oxygen concentration at interior sites during the drought was similar to averages reported in previous reports (Bechtel et. al. 1999; Weaver et. al., 2000; Weaver et al., 2001).

During the drought, the average total phosphorus concentration at inflow sites was slightly higher than the mean annual concentrations reported for previous years of monitoring (Weaver et al., 2001). Otherwise, mean nutrient concentrations at other sub-regions of the Park were similar to those reported previously (Weaver et al., 2001).

A graphical presentation of the selected water quality parameters examined for the drought period are presented in **Figures 7A-1-49** through **7A-1-64** in **Appendix 7A-1**. These figures include the number of samples collected monthly for each parameter (including the number of excursions from class III criteria) and monthly mean concentrations for each parameter.

Table 7-5. Summary of water quality data collected at monitoring sites in Everglades National Park during the drought from May 2000 through September 2001

Parameter	No. of Samples	Min.	Median	Max.	Mean	Standard Deviation	Class III Criteria
Inflow Structures							
Physical							
Temperature (°C)	357	14.6	26.9	32.1	26.2	3.4	Not Applicable
Dissolved Oxygen (mg/L)	357 (67)	0.30	3.76	8.67	3.87	1.70	Not less than 5.0 mg/L
Specific Conductance (µmhos/cm)	357 (2)	227	465	697	457.4	112.3	Not greater than 50% above background or to 1,275 µmhos/cm
Water pH	357	6.16	7.35	8.12	7.41	0.24	Not less than 6.0 or greater than 8.5
Alkalinity (as $CaCO_3$ mg/L)	190	101.5	184.7	258.1	174.9	36.7	Not less than 20 mg/L
Total Suspended Solids (mg/L)	187	<1.0	1.5	22.0	2.0	2.3	Not Applicable
Turbidity (NTU)	190 (1)	0.4	1.5	9.0	1.9	1.3	Less than or equal to 29 NTU above background
Nutrients							
Total Nitrogen (mg/L)	203	<0.50	0.98	2.14	0.98	0.38	
Total Phosphorus (µg/L)	356	4	13	81	18	14	
Interior Sites							
Physical							
Temperature (°C)	108	10.7	28.2	36.4	27.1	5.5	Not Applicable
Dissolved Oxygen (mg/L)	109 (273)	0.27	4.55	12.02	5.03	2.65	Not less than 5.0 mg/L
Specific Conductance (µmhos/cm)	108 (13)	216	424	1156	448.3	153.9	Not greater than 50% above background or to 1,275 µmhos/cm
Water pH	109	6.98	7.55	8.42	7.61	0.29	Not less than 6.0 or greater than 8.5
Alkalinity (as $CaCO_3$ mg/L)	109	75.6	154.4	264.2	154.9	36.8	Not less than 20 mg/L
Total Suspended Solids (mg/L)	101	<1.0	1.5	25.0	2.2	3.2	Not Applicable
Turbidity (NTU)	109	0.4	1.0	13.4	1.8	2.1	Less than or equal to 29 NTU above background
Nutrients							
Total Nitrogen (mg/L)	109	<0.50	1.06	3.97	1.18	0.71	
Total Phosphorus (µg/L)	109	<4	6	68	9	11	

Values in parenthesis indicate number of samples that exceeded the Class III standard

DROUGHT IMPACTS IN THE CALOOSAHATCHEE AND ST. LUCIE ESTUARIES AND FLORIDA BAY

The long-term impacts of drought or lack of freshwater on estuarine systems may be summarized from studies of Florida's Apalachicola Bay and other estuaries throughout the world. At the beginning of a drought, when land-derived nutrients are still plentiful, the increased water clarity and light penetration lead to an increase in estuarine productivity. For example, a short-term increase in the production of oysters and clams may occur, as has been observed in San Francisco Bay and Apalachicola Bay. Over time the supply of nutrients is exhausted, and productivity declines. Multi-year droughts seem to cause a shift from highly productive food webs in the water column to low-productivity communities dominated by bottom-dwelling plants and animals.

Salinity in both the Caloosahatchee and St. Lucie estuary increased until mid-June 2001. Enhanced water clarity and reduced turbidity accompanied this increase. Although salinity was relatively high in the St. Lucie Estuary, it reached critical levels (25 ppt at the Roosevelt Bridge) only during the last few weeks of the drought. By contrast, salinity in the Caloosahatchee River at Fort Myers exceeded critical levels (30-day average >10 ppt) from mid-November 2000 to mid-July 2001. Tape grass beds in the upper Caloosahatchee were virtually wiped out by the drought, with the last specimens being recorded in January 2001. Re-growth of the beds, presumably from seed, was first recorded in November 2001. The more marine regions of the Caloosahatchee did not appear to be negatively affected by the drought. In the lower Caloosahatchee River the drought probably hastened the recovery of shoal grass beds damaged during the managed recession of Lake Okeechobee.

As the drought persisted into the spring and summer of 2001, Florida Bay experienced hyper-saline conditions. No negative impacts were noted, however, due to the relatively short duration of these conditions.

REPORTED EXTERNAL ECONOMIC IMPACTS

The record drought of 2000 and 2001 had tremendous impacts in the area around and north of Lake Okeechobee, where agriculture and recreation are the driving forces of the local economy. With water levels in Lake Okeechobee dropping to record lows, navigation on Lake Okeechobee, Lake Istokpoga, and the Kissimmee River was severely impeded. Eventually, navigation was only possible by airboat. Agriculture, the largest water user in the area north of Lake Okeechobee, also was adversely impacted by water supply restrictions necessitated by low surface water levels.

This section describes and, when possible, quantifies impacts on agriculture, irrigation users (golf courses and nurseries), businesses, recreation, public water supply utilities, and other water users, particularly around Lake Okeechobee.

The SFWMD region experienced numerous impacts during and shortly after the 2000–2001 drought. The Everglades Agricultural Area (EAA) and recreation businesses around Lake Okeechobee were among the most severely impacted sectors. However, published data series for the drought period are not yet available to ascertain quantifiable impacts on agriculture and employment. *County Business Patterns*, a U.S. Census Bureau publication, shows employment and payroll data by type of establishment. The 2000 edition is not yet available. Florida Agricultural Statistics Service (FASS) provides crop yield information, but data on yields for the growing season of interest have not been published.

PUBLIC WATER SUPPLY

Public water supply utilities within the SFWMD reduced pumpage during the time period of water use restrictions by 15 percent weekly overall, according to the District's Regulation Department. The actual percentage by reporting utility varied weekly.

For some utilities the reduction in pumpage resulted in an unanticipated revenue reduction with which they had to contend during and after the drought. In addition, shortly after the District rescinded drought restrictions, there was a significant rainfall event during which no irrigation took place and some utilities again experienced significant revenue reductions. Some utilities reported revenue reductions as great as 10 percent. In response, some utilities lowered water pressure to cope with the drop in revenues. For most utilities, fixed costs constitute the bulk of their rate base; consequently, any revenue shortfall has a significant effect on water utility operations.

In certain cases, some water utilities had already scheduled for automatic rate increases to go into effect once drought restrictions were implemented. In such cases, the temporary rate increase corresponds to the percentage cutback, goes into effect automatically, and remains in place for the duration of water use restrictions, increasing as cutback levels increase.

Some utilities added a flat-rate surcharge to customers' water bills to recover revenue shortfalls brought on by water use reductions. The surcharge, while crude, makes up for revenue shortfalls without sending an inappropriate economic signal to customers. Utilities that levied the surcharge did so for all their customers, whether or not they cooperated in the cutbacks. In this way, the surcharge was also regressive, that is, charging a higher rate at the lower levels and becoming a smaller percentage of the additional amount of water used as the customer uses more water.

Utilities using alternative water supplies experienced additional impacts. Such utilities' production costs and fixed costs tend to be higher than utilities using conventional water sources. Therefore, revenue impacts for utilities using alternative water supplies can be more severe. In such cases, water restrictions were imposed uniformly without regard to the water source or the use of alternative water supplies.

One Palm Beach County utility using desalinization reported monthly losses of more than $200,000 during the period of water restrictions. Production costs of desalinization are 35 percent more than conventional treatment, and desalination was used at a higher percentage to avoid withdrawal of water from the Biscayne aquifer. This, along with revenue reductions due to water use cutbacks, combined to create a negative revenue impact for the utility.

One way to evaluate the impact of water restrictions on an area is to review the variances that were issued to individuals, organizations, and businesses and which allowed for deviations in water use restrictions so those entities could avoid economic and other losses associated with restricted water use. Types of variance requests may mirror the impacts to an area. The District received more than 1,000 requests for nonagricultural variances, with 85 percent of those requests coming from the Lower East Coast and Kissimmee Basin regions. Nearly 40 percent of the variance requests involved irrigation systems, for either estate-sized lawns or condominium landscapes. A significant number of the requests were necessitated by the inadequacy of irrigation systems, representing an inefficient use of water. Interestingly, the District occasionally granted variances for religious reasons. For example, in some cases Orthodox Jews, who are not permitted to work on the Sabbath ("work" would include turning on sprinklers), requested a variance to change their irrigation day from Saturdays (the Jewish Sabbath) to Sundays. Similarly, some church groups requested a variance to change their watering day from Sundays, when many congregations meet, to Saturdays. The District routinely granted such requests.

AGRICULTURE

Yield data for the sugar crop in 2002 are not yet available from FASS. The *Sugar and Sweetener Situation and Outlook* report from the USDA made a preliminary projection of the 2002 sugarcane harvest. The most recently published report indicates Florida sugarcane production (**Table 7-6**) is projected at 1.990 million STRV (short tons raw value). The National Agricultural Statistics Service (NASS) estimates Florida sugarcane acreage harvested at 446,000 acres, an increase of 19,000 from the previous year. NASS estimates sugarcane for sugar yield at 35.3 tons per acre, down from 37.5 tons realized the previous year. Sugarcane for sugar production is estimated at 15,744 million tons. Sugar recovery through early January was good, implying a season average recovery rate of approximately 12.65 percent.

Table 7-6. Florida sugarcane for acreage, production, yield and prices (1996-2002)

Year	Sugarcane for sugar	Sugarcane for sugar	Production	Yield	Price
	Sugarcane for Sugar Acreage Florida	Acreage Martin and P.B. county	(short tons)	short tons/acre	$/ton
1996	417,000	328,000	13,803,000	33.3	$29.40
1997	421,000	352,000	15,535,000	36.9	$28.70
1998	426,000	356,000	17,083,000	40.3	$29.50
1999	443,000	370,000	12,996,000	35.1	$27.20
2000	427,000	357,000	15,505,000	38.3	#N/A
2001 N/A					
2002	446,000		15,743,800	35.3	$0.2145

Sources:

http://www.ers.usda.gov/publications/agoutlook/sep2000/ao274e.pdf

http://www.nass.usda.gov/fl/rtoc0cr.htm

Reduction in yield: 38.3 to 35.3 = 3 tons per acre

3 tons per acre

446,000 acres

$27.20 per ton

Value of reduced production = $36,393,600

(Yield data on citrus and vegetables are not yet available).

Statewide, Florida citrus production was down from 297,660,000 boxes from 1999 through 2000, to 278,290,000 boxes in 2000 through 2001, a decline of approximately 6.5 percent. Attributing the total reduction in production to the drought, at a weighted-average 2000 price of $2.79 per bushel, the value of reduced citrus output statewide was approximately $54,000,000 based on 2000 FASS data. The data showed that approximately 66 percent of Florida citrus production occurred in a 16-county area. Apportioning statewide damages in proportion to acreage, an initial estimate is a loss of $36 million.

A realistic assessment of drought losses must await more accurate county-level price, acreage, and yield data. Future yield data will also be necessary to determine if any long-term citrus tree damage occurred.

LAKE OKEECHOBEE REGION AGRICULTURE

Farmers in both the upper and lower Indian Prairie Basin between Lake Okeechobee and Lake Istokpoga were required to cut their water consumption nearly by half during the most severe period of the drought. Though farmers and District staff worked together to lessen the impacts as much as possible, some impacts were unavoidable due to low surface water conditions. Particularly notable was the loss of several hundred acres of sugar cane on the Brighton Seminole Reservation when low canal levels prevented irrigation during a freeze. Farmers also were required to move cattle to areas in close proximity to canals or provide watering by alternative means, including increasing the depth and size of watering ponds, installation of wells, and/or trucking water into the area. The District assisted farmers in these efforts by easing permit restrictions and fast-tracking permit applications through an emergency order approved by the District governing board. Still, some cattle ranchers were forced to sell yearling cattle prior to the optimal time, resulting in an economic loss that has not yet been measured.

NURSERIES AND LANDSCAPING

The University of Florida's Institute of Food and Agricultural Sciences (IFAS) conducted an economic impact study of Florida's environmental horticulture industry in 2000 via a telephone survey of more than 2,200 businesses and households. Economic impact estimates were developed separately for six Florida regions and 13 counties that have significant nursery industry production: Miami-Dade, Broward, Palm Beach, Orange, Lake, Lee, Hillsborough, Manatee, Duval, Volusia, Alachua, Marion, and Gadsden. The IFAS study evaluated the effect of the ongoing severe drought and water use restrictions in Florida and found that nurseries and landscape firms experienced a net decrease in sales of $245 million. Retailers, on the other hand, reported increased sales, particularly for large-volume outlets.

Anecdotal evidence indicated that many horticulture businesses suffered severely because of the drought because of the limited availability of water for irrigation, the impact of water use restrictions, and loss of sales resulting from a lower demand for plants. However, the drought also had the potential to benefit some horticultural businesses as a result of the demand for replacement plants and water-conserving equipment or supplies. The IFAS study attempted to document the drought's economic impact by asking respondents whether, during the last four years, the drought had affected sales or purchases of plants. A majority of nurseries, landscape firms, and institutional consumers indicated that sales had been affected by the drought, while somewhat less than 50 percent of retailers and households expressed this opinion. Among those respondents who indicated that they had been affected, more than three-quarters said sales or purchases had decreased rather than increased. Moreover, for every group the magnitude of change was more negative than positive. The percentage change in sales or purchases was multiplied against the estimated total sales or purchases for each respondent, and was then expanded and added to reflect the net change in total industry sales or purchases. The net impact of the drought for all groups, with the exception of retailers, was negative.

Nurseries and landscapers were estimated to have suffered a net decrease in sales of $61 million and $184 million, respectively, while households and institutions reduced their purchases by $109 million and $3 million, respectively. The retail sector had a somewhat different outcome, with a net increase in sales of $80 million due mainly to sales growth reported by large-volume retail chains. The total economic impact to the horticulture industry, and the net change in sales of horticultural products, due to the drought were estimated for Florida's five water management districts, which have varying water supply conditions and policies for water use restrictions. The St. Johns, South Florida, and Southwest Florida Water Management districts had horticulture industry sales exceeding $2 billion. The net change in horticulture industry sales was negative in

all the water management districts. The largest change in sales as a result of the drought occurred in the Southwest Florida Water Management District, which experienced a loss of $155 million. In the SWFWMD the loss of sales represented approximately 7 percent of total industry sales. Horticulture businesses in the South Florida Water Management District and St. Johns River Water Management District also experienced significant losses in the nursery and landscape sectors, but the losses were offset by positive net changes for retailers.

(1) Source: Economic Impacts of the Florida Environmental Horticulture Industry, 2000. Alan W. Hodges, Ph.D., and John J. Haydu, Ph.D., University of Florida Institute of Food and Agricultural Sciences, Food and Resource Economics Department, and Mid-Florida Research and Education Center, P.O. Box 110240, Gainesville, FL. Telephone: 352-392-1881, x312; fax: 352-392-3646; e-mail: AWHodges@ufl.edu.

GOLF INDUSTRY

A similar economic impact study was performed by the two IFAS researchers on the golf course industry. Of over 1,300 golf operations surveyed throughout the state, 225 operations responded. Multiple courses were covered in both the mail-out and response, covering the over 1,600 existing courses in Florida. Results of this survey are to be published in the near future and were unavailable at the time of this report.

Source: Economic Impacts of the Florida Golf Industry, 2000 by John J. Haydu, Ph.D. and Alan W. Hodges, Ph.D., University of Florida Institute of Food and Agricultural Sciences

Food and Resource Economics Department and Mid-Florida Research and Education Center, P.O. Box 110240, Gainesville, FL. Telephone: 352-392-1881, x312; fax: 352-392-3646; e-mail: AWHodges@ufl.edu.

LAKE OKEECHOBEE REGION BUSINESS AND RECREATION

The Lake Okeechobee-area tourism and recreation industries suffered significant economic losses as a result of the drought. With navigation on most of the waterways virtually impossible, the recreational fishing industry suffered the worst losses. Motels, bait-and-tackle shops, fishing guides, ecotour operators, marina operators, boat sales, and other retail outlets reported significant losses of revenue. Many of these businesses are small and are unable to withstand sustained periods of low activity, which typically result in employee layoffs throughout the region. The Lake Okeechobee communities suffered additional losses when seasonal tourists, who would normally increase the population of the lake communities by two-to-three times during the winter months, avoided the area because of poor fishing conditions. Subsequently, the lake communities lost seasonal revenues associated with cottage and cabin rentals in the area, resulting in a corresponding loss in retail sales, with a resulting impact to the State of Florida in lost state sales tax revenue.

The District participated in many activities to lessen the negative economic impact of the drought on the lake communities while simultaneously capitalizing on the low water levels in Lake Okeechobee. For example, the District mobilized volunteers to re-vegetate native plants in the lake that had been harmed by several years of extraordinarily high water levels immediately preceding the drought. The District also sponsored sediment removal projects to improve navigation in some canals and marinas and provided funding – two years ahead of schedule – for a Florida Fish and Wildlife Conservation Commission project on Lake Istokpoga. Other District projects included:

Lake Okeechobee Watershed Phosphorus Control Program Navigational Sediment Removal Projects: The South Florida Water Management District appropriated $1 million to cooperatively fund three navigational sediment removal projects along the southern shore of Lake Okeechobee.

These projects included removal of sediment accumulation to regain the original design capacity of the Industrial Canal in Clewiston, the Belle Glade Marina in Belle Glade, and the Pahokee Harbor in Pahokee. Due dates for individual project completion vary, but all should be completed by September 2002. The Belle Glade project will be fully funded by the SFWMD, while the Pahokee project will be approximately 50 percent funded by the SFWMD. Both cities are providing in-kind management services at a minimum cost. Hendry County provided $100,000 for the Industrial Canal project. In addition to enhancing the navigational aspects of these major Lake Okeechobee recreational sites, this project should reduce the amount of phosphorus-laden sediments that could potentially be redeposited into Lake Okeechobee or transported downstream into the Everglades system.

Lake Okeechobee Utilities Assistance Projects: The District undertook various capital projects to mitigate the impact of severe drought conditions on public drinking water supplies taken from Lake Okeechobee. Examples included extending intake pipes further into Lake Okeechobee, building new pump station platforms, and purchasing and repairing pumps. In addition, the District reimbursed the city of Belle Glade for additional treatment chemicals and filters. These capital expenditures were unbudgeted emergency measures to ensure the continued ability of the lake utilities to operate during the drought. The lake communities did not have adequate funds or staffing resources to undertake these emergency measures, and the SFWMD stepped in to provide this assistance. The capital projects expenditure by community is detailed in Chapter 6.

Lake Istokpoga environmental enhancement project: The SFWMD was able to provide $2.75 million in funds to the Florida Fish and Wildlife Conservation Commission (FWC) to entirely fund an environmental enhancement project on Lake Istokpoga. To take advantage of low water levels resulting from drought conditions, this project commenced two years ahead of schedule. It had been planned for FY2003 by the FWC. By completing this project during a time of naturally occurring low water, the state was able to forego the need to artificially drawdown the lake a second time in two years, providing a much needed water supply for downstream agricultural users and avoiding future economic hardship to recreation-based businesses around Lake Istokpoga. The FWC is expected to reimburse the SFWMD for these expenses in FY 2003. Highlands County provided in-kind services but was not required to provide matching funds.

Lake Okeechobee berm removal project: During the extraordinarily wet years preceding the drought in 2001, vegetation that was dislodged from the floor of Lake Okeechobee gathered at the edge of the lake's northwest marsh area, creating a berm that was nearly seven miles long. The FFWCC became concerned that this berm would prohibit fish from moving into the lake's spawning areas and would harm the Lake Okeechobee commercial and recreational fishing industry. The SFWMD, FFWCC and the USACE contributed funding to remove a majority of the berm. Rising water levels in the lake during the rainy season prevented complete removal.

Assistance with development of a regional water supply for communities south of Lake Okeechobee: The SFWMD worked with the Florida Department of Environmental Protection (FDEP), Palm Beach County, and the cities of Pahokee, Belle Glade and South Bay to find solutions to problems with drinking water quality for Palm Beach County's western communities. Though a number of options were suggested, the group identified the creation of a single water plant featuring membrane or reverse osmosis technology as the best long-term solution for these communities.

ECONOMIC IMPACTS OF DROUGHT MANAGEMENT TO THE DISTRICT

FUNDING FY00-01 DROUGHT-RELATED EXPENDITURES

During Fiscal Year 2000-01 (FY00-01), the South Florida Water Management District governing board, facing one of the most severe droughts on record, authorized more than $10.8 million of emergency drought-related expenditures. As the fiscal year came to a close the District had expended $9.7 million of the total $10.8 million authorized.

Funding these emergency related needs proved challenging because they were neither budgeted nor anticipated when the District adopted its annual FY00-01 budget. To identify the funds to meet these unbudgeted needs, the District employed three basic strategies. First, the District tapped into its budgeted contingency reserves. The District, in accordance with adopted financial management policies, annually appropriates specific reserve amounts to meet unanticipated or emergency needs. Second, the District redirected staff, available resources, and budgeted appropriations to higher-priority, drought-related needs. Certain contracts, staff resources, and expenditures were reviewed in context of the pending emergency and were redirected and/or deferred to the next fiscal year. Third, the District re-examined projected fund balances and remaining contract encumbrances/balances and redirected those resources to emergency drought-related needs. Through the use of these three approaches and with the cooperation of project managers throughout the agency, the District was able to identify the resources required by the drought.

STREAMLINED PROCUREMENT PROCESS

The District governing board delegated authority to the executive director through a series of motions for "Waivers of Competition" for the procurement of goods and services that were a direct result of immediate needs due to severe drought conditions. The District's Engineering and Procurement divisions worked together with the water shortage team using the following process for expediting the procurement process:

1. **Understand a specific drought need**. The water shortage team described a condition requiring an immediate District maintenance and/or construction response.
2. **Define the project**. The Engineering Division analyzed a situation and defined a project based on immediate needs and long-term solutions.
3. **Propose a solution**. The Engineering Division proposed a solution or solutions to correct the immediate situation using District inhouse resources, external vendor resources, or a combination of both to best meet a project's challenges.
4. **Obtain management approval**. The proposed plan was presented to the water shortage team and to management for their input and approval to proceed with an action plan.
5. **Release a solicitation**. The Engineering and Procurement divisions created an RFQ (Request for Quotations) solicitation specifying project requirements and the expected completion date.
6. **Award the project**. Upon recommendation by Engineering, Procurement awarded the solicitation to the vendor submitting the quote that met the RFQ's requirements at the lowest cost.
7. **Manage the construction**. The Engineering Division assigned a project manager to each project to supervise project activity and monitor the awarded vendor's progress.
8. **Pay the invoice**. The Engineering and Procurement divisions reviewed the project's progress and requested payment for work accomplished.

Upon granting the executive director authority to approve Waivers of Competition, the water shortage team sought competition among those vendors having the capability to meet a project's requirements within expected parameters of work quality, time, and price. The normal solicitation timeframe to procure goods and services using the Request for Bid and Request for Proposal did not fit the District's immediate needs as driven by the drought situation. Therefore, a modified Request for Quotation (RFQ) solicitation format was used to meet the more immediate timeframe demanded by the ongoing drought (see **Appendix 7A-2**). The Procurement Department supplied the RFQ document to recognized manufacturing and industry leaders and a pool of vendors listed in the District's financial system vendor database. After an onsite pre-solicitation meeting with vendors, the Procurement Department opened and awarded the solicitation to vendor(s) meeting a project's Statement of Work (SOW) requirements at the lowest cost. Upon award and receipt of the required bonds and certificate of insurance, the vendor(s) and the District executed a contract (see **Appendix 7A-2**).

DROUGHT EXPENDITURE SUMMARY

A Drought Expenditure Summary kept track of the expenditures throughout the drought period, detailing the governing board waiver authority and current expended/obligated amounts (see **Appendix 7A-2**). The Procurement Department maintained all purchase orders, contracts, and supporting documentation at one location, supporting the drought-related transactions listed in the Drought Expenditure Summary. After six governing board motions, the board delegated $8,685,159 to the executive director, who then designated the funds for drought-related expenditures. District staff payroll and benefits directly associated with the drought are estimated at $2,118,133. Combined drought expenditures and staffing costs amounted to $10,803,292.

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Chapter 8: Outreach and Communications

Jo Ann Hyres and Aneta Sewell

SUMMARY

This chapter provides an overview of the South Florida Water Management District's (District's or SFWMD's) Office of Media Relations (OMR) and Department of Public Information (DPI) functions during the 2000–2001 drought. During the drought, the goal of both departments was to increase public awareness of the drought, facilitate public understanding of drought-related issues and actions, develop the public's trust in how these issues and actions were being handled, and increase overall awareness of the SFWMD's mission. To achieve these goals, the Office of Media Relations and the Department of Public Information used many communication tools, including water shortage team meetings; press releases and news briefings; daily media contact; media buys and media campaigns; fact sheets; a citizen information hotline (phone bank); a water shortage Website; and other drought-related public information tools and services.

MEDIA RELATIONS

The 2000–2001 drought was a consuming issue for area media covering the South Florida Water Management District. The press saw the drought as a major story and covered it with zeal. The District saw the drought as a primary challenge in its goal to manage the region's water resources. News reporters kept in constant contact with the District's Office of Media Relations, examining various angles of the drought. Television meteorologists reported frequently on the ongoing drought conditions and on area and regional water use restrictions. The extensive media coverage of the drought gave the District a high profile as the primary agency handling the emergency. When Florida Governor Jeb Bush began speaking about the drought the issue was elevated to a statewide media platform, and media interest became even more intense. District staff worked daily, including weekends, to respond to the intense interest the story generated from all branches of the media, including television and radio stations, newspapers, and magazines. Area media became a valued partner in lifting the District's water conservation message to a higher level of awareness and understanding among South Florida residents. That, in conjunction with a multi-tiered approach to communication, gave the general public a better understanding of the South Florida Water Management District and its mission.

The team approach was crucial in organizing and communicating District strategies for handling drought-related issues, water restrictions enforcement, media interest, and public awareness. Daily media interest was so intense that from May 4 through June 29, 2001 the District held daily and weekly media briefings. Some of the topics covered in the briefings included the latest Lake Okeechobee water levels, water restrictions enforcement, local government coordination, drought signage, drought publications, water conservation tips and conservation information. These daily and weekly briefings kept local news reporters interested in covering the story of the drought.

The Office of Media Relations also contributed to media awareness through regular press releases and proactive phone calls. Since the challenges of the drought varied depending on their

location within the District, SFWMD regional service centers were particularly helpful in spreading the word and calming the public's fears about the drought and water conservation.

The Office of Media Relations had to respond quickly and effectively to rumors, public criticism, or new problems that arose as a result of the drought. The OMR responded daily to incorrect information and/or rumors generated by misinformed citizens or area media. The Office of Media Relations also worked closely with District Operations Division staff to ensure that drought information remained as updated and accurate as possible.

The District's water shortage team relied on a series of four drought-themed campaigns for its radio and television "spots." The campaigns were coordinated according to the severity of the drought. The first campaign theme began in September 2000 and included television, radio, and print materials revolving around the theme "*Turn it Off*," a familiar campaign theme used in previous droughts and which asked for voluntary water conservation by South Florida residents. The "*Turn it Off*" campaign helped educate the public about South Florida's water shortage crisis and encouraged residents to respond by conserving water.

In response to worsening drought conditions, the District's second drought-themed campaign was more emphatic. Titled "*Wasting Water is a Crime*," the second campaign began in April 2001.

During the rainy season, beginning in June 2001 the SFWMD implemented a drought-themed campaign having a more sensitive, less urgent message and theme. Titled "*It's Just a Drop in the Bucket*," the campaign's central emphasis was a reminder that "It may be raining now, but it's just a drop in the bucket so we should continue to conserve water." During summer and through fall 2001, as drought conditions continued to improve, the District's water conservation theme became "*Save water now, we'll need it later*." This theme helped keep the public thinking about lowering their water consumption and set the stage for the development of a year-round water conservation campaign by the District.

PROACTIVE MEDIA STRATEGIES

From the inception of the water shortage team to the end of the drought, an OMR representative attended and participated in each Emergency Operations Center (EOC) water shortage meeting. This enabled media relations staff to obtain drought information first-hand and to quickly discuss issues and develop and disseminate an appropriate message. OMR representatives also gave the water shortage team guidance regarding strategies for communicating the District's message to the public and the media.

As the drought persisted, OMR representatives responded daily to questions from news reporters, talking to them in person or by telephone, fax, or e-mail; arranging interviews with key District staff for newspaper, television, and radio reporters; and issuing more than 100 press releases (see **Appendix 8A-1**). OMR staff also wrote editorials and letters to the editor to clarify inaccurate information on backpumping, water use restrictions enforcement, and the lowering of Lake Okeechobee (see **Appendix 8A-2**).

The Office of Media Relations held daily and weekly live and teleconferenced "Water Shortage News" briefings supplemented with priority points. The news briefings were extremely popular with reporters and were well attended. (see **Appendix 8A-3**).

In addition, OMR staff worked with local television meteorologists to incorporate water restrictions reminders, as well as information on the latest Lake Okeechobee water levels, into their daily weather forecasts to further emphasize the seriousness of the drought situation (see **Appendix 8A-5**).

OMR staff also used press releases, interviews, and follow-up (see **Appendix 8A-4**) to increase the public's understanding about how the regional water supply system is ultimately connected to Lake Okeechobee. OMR staff facilitated media buys (see **Appendix 8A-6**) to distribute radio and television public service announcements (PSAs) and inform the public about water restrictions and the importance of water conservation. Details are discussed in the "Media Placement, Public Poll Summary" section of this chapter (see **Appendix 8A-9**).

Strong internal communication was crucial to ensuring accurate and timely dissemination of drought information to news reporters. OMR staff had direct, 24-hour-a-day access to designated District experts and water shortage team members as resources for media questions. OMR staff working at SFWMD service centers were regularly updated on current drought conditions and worked closely with Department of Public Information staff to develop public outreach tools and strategies, including PSAs, flyers, signage, and the District's water shortage Website. Outreach tools and strategies are discussed in more detail in the "Public Information" section of this chapter.

Other functions facilitated by OMR staff included the preparation of responses to the Department of Environmental Protection's (DEP's) periodic requests for overall drought management status reports (see **Appendix 8A-7**). The OMR also facilitated requests for additional drought management coordination information.

MEDIA PLACEMENT, PUBLIC POLLS

Following the implementation of water use restrictions in November 2000, the SFWMD realized the necessity of reaching a large and diverse South Florida audience with a water conservation message and specific information on mandatory water restrictions. The District determined that the best way to reach this large audience was to use broadcast media (radio and television). Because of the severity of the drought conditions, the District concluded that the use of free public service airtime alone would be insufficient. Therefore, the SFWMD sought emergency funding, which was authorized to pay for drought-themed PSAs, with the stipulation that free public service airtime would augment the paid ad schedule.

To best optimize the emergency funding for a media campaign, the District solicited bids from media planners and buyers in the Miami/Fort Lauderdale, West Palm Beach, and Fort Myers media markets. Proposals were received and contracts with two vendors were executed in January 2001. Each contractor agreed to reimburse the District for at least 50 percent of the commission paid. This provided additional revenue to the emergency spending fund.

After the proposed media plans were approved, District-produced radio and television announcements began to air throughout South Florida. The announcements were produced in English, Spanish, and Creole. Media vendors were instructed to place media buys for ads that would reach a target audience of adults over the age of 25 through the use of various program formats to reach the largest segment possible of the region's multi-ethnic, multi-cultural population. A sample of the media buys is included with this report as **Appendix 8A-8**.

The contractors provided analyses on campaign efficiency by reporting the number of spots aired, the percentage of a target audience reached, how often an audience was reached, and the total cost of reaching an audience. Updates on drought-themed media campaign achievements were presented monthly to the District's governing board. Through the first quarter of 2001 the District was able to reach more than 90 percent of its target audience approximately 10 times. Additionally, the District contracted an independent study to measure the media campaign's effectiveness. The study is included in this report as **Appendix 8A-9**.

Ongoing drought conditions demanded that the District continue to provide information to South Florida residents about water conditions and mandatory water use restrictions into the

second quarter of 2001. Therefore, the Office of Media Relations made a decision to continue to use a media planner/buyer to place media announcements. To streamline this process, one contractor was selected to continue media planning and placement through two succeeding quarters. In addition to the District's radio and television campaign, OMR added Internet advertising to its drought strategy, and the campaign continued to reach a multi-ethnic, multi-cultural audience via varied program formats. Monthly campaign reports to the District's governing board also continued, and audience "reach" and "frequency" numbers remained high.

The media campaign continued through the fourth quarter of 2001, with minor variations to the campaign strategy. During the quarter, in addition to using a media planner to place announcements throughout the District, part of the media budget was used to contract with minority vendors to specifically place ads on minority-formatted radio stations throughout Central and South Florida.

During the course of the campaign thousands of drought-themed ads were broadcast. Consequently, the District effectively promoted water conservation and adherence to mandatory water use restrictions using broadcast media at a fraction of what it would have cost to reach such a large audience via other methods.

A second research survey was completed at the conclusion of the OMR's drought and water conservation information campaign. The primary purpose of the second poll was to evaluate the public's awareness of the campaign at a second point in time, as well as to follow up on some of the issues identified in the first poll. The results of the second poll are included in this report as **Appendix 8A-10**.

PUBLIC INFORMATION DURING THE DROUGHT

The need to keep up-to-date drought information in front of the public became apparent during the 2000–2001 drought. Initially, the District's Department of Public Information (DPI) used existing informational materials to quickly disseminate information. In September 2000 the District's governing board authorized $400,000 for television and radio airtime. Subsequently, DPI purchased airtime to broadcast public service announcements originally produced in the early 1990s (during a previous drought). During the 2000–2001 drought, DPI staff revised and re-edited the PSAs with updated contact information and tag lines. The theme of the first series of PSAs was "Turn it Off!"

DPI also began producing printed materials, called "splashes," based on templates that could be used to create a series of quick-turn-around fact sheets. The splashes were used to print flyers indicating the latest regional water restrictions and other, related topics, such as *Xeriscape Principles*, *Sensible Sprinkling*, and *50 Ways to Save Water*. DPI also developed a 10-minute presentation, titled, *Water, a Precious Commodity*, which included an accompanying brochure. District staff conducted the public presentations at meetings of area homeowner and civic groups.

As the drought became more serious, so did the District's message to area and regional water users. In response, DPI developed new television and radio PSAs and accompanying materials, with the theme, "Wasting Water is a Crime." The District printed color-coded fact sheets listing the latest commercial and residential water restrictions information. When water use restrictions changed (that is, with the implementation of phase I, phase II, and modified phase II restrictions), DPI updated, reprinted and posted the information on the District's water shortage Website for the duration of the drought.

Other public information initiatives by DPI included notices in South Florida residents' water bills, as well as working with townships and utilities to erect signage announcing the latest water use restrictions at city boundaries. The District also contacted the Publix supermarket chain and arranged to place flyers reminding residents of the latest water use restrictions in shoppers'

grocery bags. In addition, countertop "tent" cards listing water conservation tips, for use in hotel restrooms, were developed and distributed with the assistance of the District's Lower East Coast service centers.

Three workshops were also held to train District employees as outreach ambassadors for water conservation throughout the District community. The employees were armed with signs, brochures, videos, and enthusiasm and were encouraged to take the conservation message into their own neighborhoods, schools and clubs.

As drought conditions eased, the District changed its water conservation theme from "Wasting Water is a Crime" to "Be Water Smart." Water conservation materials, including new television and radio PSAs, were distributed. Promotional items, including buttons, sponges, magnets, and stickers, with the new theme were mailed to all elementary and middle schools in Palm Beach, Broward, Miami-Dade, Monroe, Collier, and Lee counties. The culmination of this outreach effort was a hugely successful competition in which students in the counties developed water conservation-themed posters and audio and video PSAs. Winners from the six counties were recognized and rewarded for their efforts at the District's April and May governing board meetings.

The District's Public Information Department handled thousands of telephone calls and responded to e-mail throughout the many months of the drought. When necessary, DPI located knowledgeable District staff to answer the occasionally complicated questions from the public and from municipalities and various locations throughout the 16 counties the District serves. The District's citizen information hotline and the water shortage Website proved important tools in facilitating communication with the public. Drought conditions became a daily part of local television weather reports that also displayed the citizen information hotline number on TV screens.

The Water Conservation Creative Team, composed of graphic artists and writers, as well as marketing, Web, video, and media specialists, met weekly to craft messages and develop appropriate outreach tools to disseminate those messages. Over a seven-month period, the SFWMD governing board authorized $1,231,000 for the District's water conservation campaign. Of that amount, the District spent a total of $971,360.

PUBLICATIONS TO PROMOTE WATER CONSERVATION

Initially, updated water conservation materials were used for fast distribution. The "splash" fact sheets were invaluable for quick-turn-around production and frequent changes. Printing was out-sourced for materials requiring more than 10,000 pieces because it is more cost-effective to produce larger quantities. In contrast, all photocopying was done in-house.

Distribution was a large initiative. The Department of Public Information used all established avenues and invented more. District service center and headquarters employees distributed materials to public building lobbies, schools, community libraries, video rental stores, bookstores, community festivals, retail stores, and parks. Listed below are the types and numbers of materials DPI developed and distributed. Copies of these materials are archived in the South Florida Water Management District Reference Center located at 3301 Gun Club Road in West Palm Beach.

Printed through outside contract

The "*Below the Surface*" series, an in-depth look at:

"*Water–A Precious Commodity.*" 35,000 copies (also in video format)

"Water Conservation." 10,000 copies

"*Water Drops*," a student educational booklet for insertion in newspapers. 30,000 copies

Fact sheet (splash) on conserving water. In English. 95,000 copies

Fact sheet (splash) on conserving water. In Spanish. 95,000 copies

"Neighborhood Water Restrictions." In English. 520,000 copies

"Neighborhood Water Restrictions." In Spanish. 20,000 copies

Fact sheet (splash), *"Phase II."* 3,000 copies

Fact sheet (splash), "*Collier County Phase II*." 25,000 copies

Flyer, "Residential Water Restrictions-Phase II." 125,000 copies

Flyer, "Commercial Water Restrictions-Phase II." 125,000 copies

Brochure, "*Be Water Smart*." 10,000 copies

Brochure, "*Share the Resource*." 5,000 copies

Fact sheet (splash) for Broward County water conservation campaign. 80,000 copies

Fact sheet (splash), "*Water Conservation.*" In English. 30,000 copies

Fact sheet (splash), "*Water Conservation.*" In Spanish. 30,000 copies

Fact sheet (splash), "*Xeriscape*." In Spanish. 15,000 copies

Fact sheet (splash), "*Sensible Sprinkling*." 12,000 copies

"Freddy the Alligator Skateboard Coloring Sheets" for schools. 40,000 copies

Printed in-house:

Various "splash" fact sheets explaining each phase of commercial and residential water use restrictions (phase I, phase II, modified phase II) for the East Coast, West Coast, and Orlando; 500,000 copies.

URL Web cards, "*Who to Call at SFWMD*." In English. 10,000 copies

URL Web cards, "*Who to Call at SFWMD*." In Spanish. 10,000 copies

PROMOTIONAL ITEMS

The District used its staff and was in constant contact with its regional service centers to employ all contacts and community connections for distribution of water conservation and water restrictions materials. Extensive mailouts to schools encouraged public interest in water conservation and drought awareness. District staff contacted regional directors of large retail chains for permission to send flyers and posters for distribution and posting. Tent cards were mailed to hotel chains or, in some areas, were hand delivered. The District's Miami-Dade, Broward, and Monroe county service centers worked particularly hard to disseminate these materials. Other service centers were erratic in their outreach efforts. District staff had difficulty meeting demand for printed materials that were ordered and re-ordered.

The District kept a large supply of signs, posters, and flyers in the B-1 lobby for the duration of the drought for employees to obtain and distribute. Consequently, the ready availability of these materials encouraged others to assist with distribution.

Drought-related promotional items

District poster that was part of the "*Be Water Smart*" campaign: 15,000 copies

District poster "*Water Conservation*": 10,000 copies

Corrugated plastic signs for posting in public places: 2,500 copies

Tent cards for hotel bathrooms: 10,000 pieces

Spanish-language tent cards for restaurant tables: 40,000 pieces

Tent cards for hotels: 150,000 pieces

Creole-language tent cards for restaurant tables: 2,000 pieces

English/Creole-language tent cards: 10,000 pieces

Sponges for the "*Be Water Smart*" campaign: 35,000 pieces

"Water drop" magnets for the water conservation campaign: 30,000 pieces

Celluloid buttons promoting water conservation: 15,000

Flyers for stuffing in Publix grocery bags: 50,000 pieces

Violation warning signs, East Coast: 4,000 copies

Violation warning signs, West Coast: 6,000 copies

Tickets for violating water use restrictions: 285,000 copies

31 Television Spots, 3 Languages (Public Service Announcements)

Drought-themed television "spots" (public service announcements, or PSAs) ran in all 16 counties within the District's jurisdiction. The District bought TV airtime and also solicited free airtime. These media buys helped ensure that the District's message to the public to conserve water was being disseminated. The effort proved effective in creating interest in and awareness of the drought (the frequency of PSAs had a direct correlation to the number of calls to the phone bank). Copies of the following television PSAs are archived on CD distributed with the executive summary of this report.

Television PSAs

"*Water Follies*": three versions

"*Turn It Off*": four versions, in English, Spanish, and Creole

"*Wasting Water Is A Crime*": two versions, in English, Spanish, and Creole

"Guy Harvey, Citizen/Fisherman": one version

"David Viker, Loxahatchee Refuge Deputy Manager": one version

"*Just A Drop In The Bucket*": one version, in English, Spanish and Creole

"*Rainy Season*": one version, in English and Spanish

"*Faucet*," "*Shower Head*," "*Sprinkler*," and "*Hose*": one version each

"Your Way Of Life": one version

Seven spots, in Spanish only

Six spots, in Creole only

Public Announcements in Public Places

Several ideas generated by Office of Media Relations and Department of Public Information staff were disseminated at no cost to the District. The ideas included a message on an electronic billboard and an announcement at Pro Player Stadium in Broward County prior to a Florida

Marlins baseball game and during the radio broadcast of the game; an announcement at Roger Dean Stadium in Jupiter during a Florida Hammerheads baseball game; and large signs at town and city boundaries reminding residents about current water use restrictions.

Radio Public Service Announcements

As with television spots, some radio spots were provided free of charge, but the District also purchased some airtime to guarantee prime exposure. Radio public service announcements included:

A series of 16 spots that were a revised "*Turn It Off*" series – two spots included 15-, 30-, and 60-second versions in English, and 30- and 60-second versions in Spanish and Creole

A series of two spots, titled, "*Why restrictions*?" 30 and 60 seconds, English only

A series of nine spots, titled, "*Wasting Water is a Crime.*" One spot in 15-, 30- and 60-second versions. In three languages

A series of nine spots, titled, "*A Drop in the Bucket.*" One spot, in 15-, 30- and 60-second versions in three languages

A series of nine spots, titled, "*Summer: It's Raining.*" One spot, in 15-, 30- and 60-second versions in three languages

A series of nine spots, titled, "*Conserve All Year.*" One spot, in 15-, 30- and 60-second versions in three languages

Copies of the radio PSAs are archived on CD available with the executive summary of this report.

Billboards

The District placed billboards, with the hard-hitting message "Wasting Water is a Crime," in six counties. Spanish-language billboards bearing the same message were placed in Miami-Dade. Photos of the billboards are archived in the South Florida Water Management District's Reference Center at SFWMD headquarters in West Palm Beach.

Speakers Bureau

The SFWMD speakers bureau was formed to disseminate information about the South Florida Water Management District. In 2001 nearly every presentation the speakers bureau made was to relay information about the drought, to define water restrictions, and to explain what the District was doing to alleviate the impacts of the drought. The speakers bureau made 41 offsite presentations on these subjects during the 2000–2001 drought. This compares with an annual average of 26 presentations made during the previous five years.

Water Ambassadors Program for District Employees

The SFWMD conducted three workshops for its employees, training them as water conservation ambassadors who could spread the District's message of conserving water. A total of 600 employees participated in the workshops, out of which came many creative ideas regarding how the District could best disseminate its water conservation message. The training educated employees about historical and current water conditions in the South Florida region, and employees were provided with District materials and publications to distribute among communities, civic groups, clubs, and schools. As part of their message, water conservation ambassadors added a humorous touch to a serious situation by employing a Jeopardy-style skit to

teach the public about water conservation. The skit was popular and useful in encouraging public participation.

Citizen Information Line

The District trained more than 500 employees to handle the more than 31,000 telephone calls received from the public requesting information about the drought and water restrictions. A phone bank was set up in the District's Emergency Operations Center (EOC) at District headquarters in West Palm Beach. Employees had to learn how and where to obtain current and pertinent drought-related information, the process of activating the telephone system, and protocols for speaking with sometimes demanding and distraught callers. In addition, employees were instructed on the latest water use restrictions to keep callers informed.

By the end of April 2001, the phone bank had received 23,000 calls, with nearly 1,000 calls coming in on a single day. The number jumped dramatically on days when water use restrictions were changed. At the height of the drought the phone bank was receiving up to 900 calls each day; at one point, 10 employees were assisting callers, while 31 more callers were put on hold. In addition, an administrative person was added to the phone bank staff to compile daily and weekly reports and to mail out copies of current water use restrictions and other information to callers who requested it. Many callers were also referred to the District's water shortage Website.

Calls were received throughout the night and day, and it became necessary to answer them long after the drought had eased. The District also hired temporary staff and trained them to answer the hundreds of calls about water use restrictions. The District has since established a special, permanently staffed telephone line for answering questions and providing information on water use restrictions and water conservation.

Water Shortage Website

The SFWMD's water shortage Website was redesigned at the beginning of the drought to meet the public's need for drought-related information. The water shortage Website began as a small site, with less than 50 Web pages providing primarily technical information and links to maps, weather and water-storage conditions, and "live" data on water levels. However, the site quickly grew to several hundred pages, including "Top of the Page" newsbrief updates on the Website's homepage. In a few sentences, updates of greatest interest to the general public and the media could be highlighted (see **Appendix 8A-11**).

A less high-profile version of the water shortage Website had existed for about three years prior to the 2000–2001 drought. The Website was originally created to post information related to specific geographic areas that were historically prone to drought. Prior to the 2000–2001 drought, the Website had featured numerous links to data about wells and weather forecasts and depicted areas where potential water shortages might occur or where restrictions had been in place as normal, seasonal wet-dry periods affected the water supply in limited areas throughout the District.

Subsequently, at the beginning of the 2000–2001 drought, the Website was revised and was continuously updated to handle the vast amounts of information necessary to communicate drought-related information to the public during this period.

The water shortage Website homepage was supplemented with links to electronic copies of all print materials created to educate the public and the media about the drought. An FAQ (frequently asked questions) page was created and updated daily or weekly, based on questions posed by site visitors and those calling the citizen's information telephone line. Nearly 3,000 e-mails were sent to the Website and included requests for drought-related information, as well as comments on the drought or local water restrictions enforcement or SFWMD operations. Each

e-mail received a response within one to three days. The Website also provided links to District news releases, Office of Media Relations news briefings and news conferences, updated maps and brochures with more detailed drought information, technical and legal documents, and current and historic water data. In addition, the Website included links to materials for specialized audiences, such as seasoned "SFWMD beat" reporters, commercial businesses, farms, and other drought-impacted local and state governments. Much of the information on the Website was available in English, Creole, and Spanish.

The water shortage Website's high-priority pages were updated regularly, often several times a day. Some lower-priority pages were also updated frequently (some daily and others weekly). As information was requested, or, based on the developing needs of the public or affected groups, new or updated information and links, and even new pages within the main Website, were quickly added. Callers to the citizens information line regularly were directed to the Website for immediate access to online versions of all printed documents. On the Website, the District urged residents to download and print out information and share it with their neighbors, friends, and family. The site also encouraged residents to insert the printed information in the doors of neighbors who appeared to be violating restrictions.

Media and police enforcement officials promoted the Website as a source for the latest information on the water shortage. The Website was also promoted in all educational and promotional materials for the water shortage – in television and radio PSAs, in all printed materials, and in special community signage. Many local governments and enforcement agencies used the Website as a resource for drought-related information. In addition, the District posted reports tallying the latest numbers of enforcement actions taken by local governments, as well as by the District (reporting on non-compliance) on the Website.

Staff from the Office of Media Relations and the Department of Public Information co-managed the water shortage Website. The Department of Public Information managed the site's high-priority pages, as well as pages and files linking to materials designed for the general public or specialized audiences. DPI staff also answered most of the incoming e-mail from the public.

Staff from several District technical departments updated and continuously added links to "live" data in demand by special audiences. Area news media, the general public, and several special interest groups expressed an interest in daily changes in water levels in Lake Okeechobee, for example. The groups were also interested in information concerning their local area. Staff from District technical departments answered the more technical questions received via e-mail. Information about changing trends in the types of information visitors were seeking was forwarded to the DPI's Website team members. Having this information available on the Website allowed technical experts and Office of Media Relations staff to focus on more in-depth, unusual, or very specific information requests.

The OMR and DPI teams worked together to reconfigure the water shortage Website a number of times, especially the top-level (high-priority) pages in response to feedback from those site visitors seeking specific types of information. Website staff from the Public Information Department, as well as several Webmasters from the District's Water Supply, Operations, Lake Okeechobee, GIS, Emergency Management, and Environmental Monitoring departments and divisions met regularly to ensure that the various groups that were part of the water shortage team were satisfied with the Website. Their collaboration helped ensure that all existing and new drought-related information would be included within a structure that was comprehensive and easy to navigate.

The "Be Water Smart" School Education Campaign on Water Conservation

As part of the South Florida Water Management District's efforts to inform area residents about the drought, 45 schools in six South Florida counties competed for cash awards in a campaign to educate students about the need for water conservation. The District awarded 58 cash prizes to winners among the elementary (best posters), middle (best verses or jingles) and high (best audio or video PSA) schools of Miami-Dade, Broward, Palm Beach, Lee, Monroe, and Collier counties.

The District sent water information packets to each elementary, middle, and high school in the six counties. The District recognized the winners at its April (East Coast winners) and May (West Coast winners) governing board meeting. By order of the executive director, and to encourage widespread contest participation within a short period of time, nearly $56,000 was spent on competition awards, certificates and mail-outs.

CONCLUSIONS: PUBLIC INFORMATION

It is difficult to ascertain the most effective outreach tool employed during the 2000–2001 drought. The volume of calls to the citizen information hotline indicates that local weather reports that included the hotline number and information on regional drought conditions were highly successful. Many members of the general public also telephoned or wrote to the District in praise of many of the PSAs. Visitors to the water shortage Website, including the more specialized users, appreciated the volume and the timeliness of information made available there. Area schoolteachers incorporated District materials on water conservation into their lesson plans, and those materials have continued to generate interest.

The 2000–2001 drought provided the South Florida Water Management District with an opportunity to newly educate the many South Florida residents who, prior to the drought, knew little, if anything, about the District and its mission.

The District continued its water conservation campaign, attempting to instill a year-round water conservation ethic among South Florida residents. The SFWMD collaborated with the St. John's River Water Management District (SJRWMD) and the Southwest Florida Water Management District (SWFWMD) in a statewide 2002 water conservation campaign titled, *Florida's Water: It's Worth Saving*. Campaign materials included brochures, PSAs, display boards and other promotional items, including bookmarks based on the winning elementary school poster from the 2000–2001 drought. The water shortage Website continued to receive regular visitors even though the SFWMD lifted water use restrictions. The Website's message included the theme, *Florida's Water: It's Worth Saving*. The District also created an Earth Day poster that included Everglades photos and a poem by Maya Angelou as part of its design. The poster was distributed at area schools and community festivals. During April 2002, for Earth Day and during Water Conservation Month, District volunteers participated in 27 community events to continue to tout the District's water conservation message.

CHALLENGES: WHAT CAN BE DONE BETTER NEXT TIME

Office of Media Relations (OMR) staff encountered many challenges while facilitating reporters' requests for drought-related information. Some of the items most-requested by the public included maps and documents, such as legal papers (letters and orders), water restrictions fact sheets, and rainfall charts. During the next water shortage emergency, better coordination between District GIS experts and graphic designers in providing material in a more timely manner is recommended, as various maps, publications, and other information had to be created quickly in response to the worsening drought conditions.

Another challenge OMR staff faced was that of comprehending the many accompanying scientific, technical, and complicated legal issues that arose as a result of the drought. It was crucial for OMR staff to fully understand these issues to provide the public with accurate and timely information about the drought. During future droughts, drought managers could help improve the media's understanding of highly technical information by designating a "translator" or point person to help with simplifying technical and legal issues for lay people.

Because the Office of Media Relations has no control over what news the media ultimately choose to report, OMR staff, despite their best proactive efforts, must respond to area news reporters' requests for information with the best information available. During future droughts, the District might want to consider whether it should rely as heavily on the external news media to communicate the District's message to the public. While the print media can be an important tool for publicizing a message, future drought managers might want to consider investing in and relying more heavily on other methods of communicating with the public, modes in which the District has more control over the message. Examples include direct mail, greater use of newspaper inserts and print advertisements, special events, Web page promotion, billboards, signage, television and radio public service announcements, and joint partnerships with water utilities. Combined with area-wide news coverage, these broad-based communication tools, while more costly for the District to implement, could potentially yield greater, more accurate outreach results.

LESSONS LEARNED: MEDIA RELATIONS

One lesson the Office of Media Relations learned as a result of the drought-themed media outreach is that the District must have an aggressive and involved media relations team in place for future droughts to ensure that area and regional media, as well as the general public, understand and support the District's water supply protection actions during a drought.

Secondly, the District must acknowledge that it will have to invest a considerable amount of money in mass media campaigns. For the 2000–2001 drought, the District spent $971,360, primarily in purchasing broadcast time on television and radio for public service announcements and targeted outreach campaigns. Those campaigns were very effective in reaching a large percentage of the population, including those who might not regularly read newspapers or watch or listen to broadcast news. Use of a variety of media is recommended to get the District's message to the greatest percentage of the public during future droughts.

Thirdly, early coordination is needed among the District, county governments, public utility departments, municipalities, and law enforcement agencies in preparing for effective campaigns that promote public awareness of a drought and corresponding positive actions to conserve water.

Fourthly, regarding any media outreach strategy, the District must take a decisive approach to a drought emergency. While the District is highly vulnerable to criticism as the primary handler of a drought emergency, it is also in a position to capitalize on more widespread recognition of its abilities if it handles such an emergency openly and with competence and professionalism. Because of the District's size and level of public exposure, it is important for drought managers to work to gain and maintain the public's trust and respect and to handle drought emergencies with competence and intelligence.

Finally, the 2000–2001 drought elevated the public's awareness of the District through its role in managing the area's water resources. The District hopes to build from this base an even more knowledgeable public that truly understands the SFWMD's mission. One effective strategy the Office of Media Relations staff used to build public awareness from the drought's outset was

patient, and competent professionals. The OMR designated specific spokespersons who gained the trust of reporters who covered the drought story for many months. The District's drought spokespersons helped the media clarify drought-related facts and information for the public.

Appendix 3A-1: Lake Okeechobee Water Supply Backpumping and Water Supply Augmentation after Action Report

[Note: This report was previously issued by the South Florida Water Management District on December 14, 2001.]

LAKE OKEECHOBEE WATER SUPPLY BACKPUMPING AND WATER SUPPLY AUGMENTATION AFTER ACTION REPORT

FINAL REPORT

December 14, 2001

Prepared for

Florida Department of Environmental Protection

by

South Florida Water Management District

DISCLAIMER

The information in this report is derived from a variety of sources, including but not limited to the U.S. Army Corps of Engineers, the U.S. Geological Survey, the National Weather Service and other federal, state and local government agencies. Different reporting formats and methods are used by contributors and may result in minor variations in data. ~ The District does not warrant, guarantee, or make any representations regarding the use, or the results of the use of information provided to you by the District -- in terms of correctness, accuracy, reliability, completeness, usefulness, timeliness or other similar terms. ~ The user recognizes that the information, data, apparatus, products, processes and materials are dynamic, and may change over time without notice. However, the District makes no commitment to update these items. ~ The disclaimer applies to individual use of the data and aggregate use with other data.

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INTRODUCTION AND BACKGROUND

This report has been prepared in compliance with and as a fulfillment of the requirements of the Emergency Final Order (O G C No. 01-1202) issued by the Florida Department of Environmental Protection (Department) on August 3, 2001. The order made provisions for allowing the South Florida Water Management District (District) to take specific necessary action or actions to augment flows to Lake Okeechobee to mitigate the effects of the severe drought conditions experienced across much of the State of Florida during 2001. These actions were intended to increase the stage of Lake Okeechobee, an essential and critical source of water for South Florida.

During the first half of 2001, Florida experienced one of the most severe droughts in recorded history. In spite of the imposition of Phase II (severe) and Phase III (extreme) water restrictions by the District's governing board, water supplies were severely impacted in South Florida. These impacts included water levels in Lake Okeechobee falling to historic lows. Since the early portion of the 2001 rainy season experienced rainfalls that were only of average intensity, the Lake was recovering slowly, raising the possibility of even more severe water shortages during the approaching dry season. As a direct result of the drought, the Executive Director of the District declared a Water Emergency on March 27, 2001 which the governing board subsequently concurred with in an emergency meeting of the Board on that same date. In response to the declared Water Emergency, the Department found that an emergency existed that required immediate action.

As a result of those findings, the Department issued the first Emergency Final Order (OGC No. 01-0715) on April 27, 2001, in which the District was authorized by the Department to initiate backpumping into the lake through the existing structures at S-2 and S-3 at the south end of Lake Okeechobee. As part of those permitted operations, the order required intensive water quality and biological monitoring programs, the implementation of certain operational constraints, and activities required to offset the potential impacts of the backpumping events which included planting bulrush plants in previously denuded areas and removal of an organic berm in the lake. In addition, the District was directed to work with the agricultural interests in the EAA and the Department of Agricultural and Consumer Services (DACS) to enhance the effective management of the use of pesticides and herbicides.

In the ensuing months, as the drought continued and concerns escalated regarding the impending dry season, the District was authorized by the Department in a second Emergency Final Order (OGC No. 01-1202) dated and issued on August 3, 2001 to continue backpumping as well as allow augmentation of the pumping and gravity flows of water into the lake through the structures at S4, S77, S308, S352, and Culvert 10A. In addition, the District was authorized to install temporary pumps to backpump additional water as required. Operation of the temporary pumps did not occur, however, because increased rainfall during the latter part of the rainy season and gravity inflow through key structures sufficiently raised lake water levels before the pumps became operational. Flow augmentation and backpumping operations, coupled with the increased rainfall during the latter part of August and early September, sufficiently raised Lake Okeechobee water levels to allow the discontinuance of the activities authorized by the Emergency Final Orders on September 21, 2001.

It should also be noted that several isolated heavy rainstorms resulted in operation of the pumps to mitigate flooding during the Spring and the month of September. Although these events

resulted in backpumping water into the lake, these operations were required for flood protection and carried out in accordance with established flood protection pumping criteria. These pumping events were not considered part of the water supply augmentation efforts covered in this report.

WATER QUALITY REPORT

Water quality data obtained during the backpumping and augmentation period are presented in the accompanying tables. In general, the quality of the water entering the lake through the augmentation structures contained lower total phosphorus concentrations than the water entering the lake from other sources. All sampling and analyses were conducted in accordance with the conditions detailed in the Emergency Final Orders of April 27, 2001, and August 3, 2001. All results are summaries or compilations of data previously reported to the Department by the District in prior monthly After Action Reports.

During the period from June 1 through September 21, 2001, backpumping from S2 and S3 contributed 22%, or approximately 325,000 acre-feet of water, of the total inflow into the lake, but only 9%, or 37.9 metric tons, of the total phosphorus (TP) contribution to the lake (Table 1). Flows from all augmentation sources covered in the second Emergency Final Order, including both backpumping and gravity flow, contributed 39% of the flow and 25% of the TP when compared to all water sources contributing to the lake during that time period. These relative contributions resulted in a flow weighted mean concentration of TP from all backpumping and augmentation sources that averaged 146 ppb, whereas the flow weighted mean concentration of TP entering the lake from all sources, including the backpumping and augmentation flows, averaged 228 ppb.

Calculated loads for Total Nitrogen (TN) indicate that the load of nitrogen entering the lake for the augmentation period coming from the augmentation structures represented 46% of the total load from all sources. The flow weighted mean concentration of TN entering the lake from all sources during the period was 2.53 mg/l (2,532 ppb), whereas the flow weighted mean concentration of TN from the flows coming through the structures being used for water supply backpumping and augmentation was 2.99 mg/l.

Table 2 reiterates flow and load data for each structure broken down into monthly intervals for the total augmentation and backpumping period.

The data summarized in Tables 1 and 2 are graphically put into perspective for the lake as a whole by the figures shown in Figure 1 through Figure 4. Figure 1 indicates the flow weighted concentration of TP from each inflow into the lake including those presented in Tables 1 and 2. The concentrations indicated in Figure 1 are then multiplied by the total flow to calculate the load of TP entering the lake from each source. Those loads are shown in Figure 2. Figure 3 likewise indicates the flow weighted concentration of TN entering the lake from each source, and Figure 4 shows the load of TN based on the flow weighted concentration and the total flow from each source.

A monthly summary of lake stage and rainfall reported by tributary basins is provided in Table 3. Individual daily flow and pump operation logs have been provided in the monthly After Action Reports previously submitted. A graphical representation of lake stage and regulation limits for the period from January 1, 2000 to the termination of the backpumping and flow augmentation activities on September 21, 2001, is provided in Figure 5.

The monitoring programs specified by the Emergency Final Orders also required additional water quality monitoring of the inflows into the lake for parameters other than nutrients. Sampling

stations used to collect water quality monitoring samples are indicated on the map in Figure 6. The results of those monitoring activities are reported in Tables 4 through 23.

Tables 4 through 9 specify the pesticides detected at each structure during the sampling period. Any pesticide that had a positive value reported at any time at any location during the monitoring program are reported for each sampling event at each sampling point, even if the pesticide was not found at that particular sampling point. The pesticide results were reported in this manner to enable easier cross comparisons between sampling events and locations. Tables 4 through 9 list only those pesticides for which at least one positive value was obtained during the monitoring required for the backpumping and augmentation operations, whereas Table 10 provides a complete list of all the pesticides for which analyses were performed. A BDL value in Tables 4 through 9 indicates that the concentration of the pesticide was below the analytical detection limit for that specific pesticide at that sampling event. No pesticide concentrations found exceeded Class I water quality standards.

Trace level mercury monitoring for all structures involved in augmentation flows to Lake Okeechobee are reported in Table 11. In no case was the state criterion of 12 ng/l total mercury exceeded for any water sample analyzed and reported. A "ND" value in Table 10 indicates that no data are available for that sample due to quality control issues with that particular datum. A value proceeded by a less-than symbol (<) for a sample indicates that the results for that analysis were below the method detection limit for that analyte; the value reported for those analyses is the detection limit for that particular determination.

Summaries of the water quality data for each sampling station are presented in tables 12 through 23. These summaries indicate that there were no significant violations of class I water quality standards at any location except for variations from the Dissolved Oxygen (DO) standard and a few exceedances of the standard for iron. Concentrations below the 5 mg/l DO standard are common in ambient South Florida surface waters and do not necessarily indicate adversely impacted water quality. This standard is currently under review by the Department and it is anticipated that it will be revised to more accurately reflect naturally occurring conditions in South Florida. The exceedances observed for iron were in excess of the Class I standard but were still within the Class III standard. Since the water samples were collected on the up-stream or canal side of the structures, and thus were collected in Class III waters, there is a question about which standard should apply. Furthermore, iron in concentrations greater than the Class I standard of 0.3 mg/l in surface water are generally in the form of particulate iron associated with suspended sediments and should settle out in the lake, allowing the water to meet Class I standards in that water body before the water reaches any public water supply intake point. A value proceeded by a less-than symbol (<) for a sample indicates that the results for that analysis were below the method detection limit for that analyte; the value reported for those analyses is the detection limit for that particular determination.

BIOLOGICAL MONITORING REPORT

OVERVIEW

The Department required that the District expand its existing program of biological monitoring in the lake in order to identify any ecological impacts of backpumping. The District had the benefit of nearly two years of biological monitoring background data to assist in the identification of potential effects. The focus of the monitoring, as detailed in the two Emergency Final Orders (OGC No. 01-0715 and OGC No. 01-1202) provided by the Department, was on submerged aquatic vegetation (SAV) and water transparency. The lake's SAV is a valued ecosystem component that provides habitat for fish and other aquatic biota. Submerged aquatic vegetation is a sensitive indicator of water quality because its aboveground tissues are in direct contact with the lake water. Research on Lake Okeechobee and in other shallow freshwater ecosystems has documented that underwater light availability is a prime determinant of SAV growth. Therefore, the biological monitoring program also included a detailed analysis of underwater light in the southern region of the lake in the proximity of the S2 and S3 pump stations, as well as other stations that could be used as "reference" locations for comparative purposes.

In summary, biological monitoring indicated no negative impacts of the backpumping operations on SAV or water transparency. There were typical variations in SAV occurrence with season and location, similar to what has previously been documented in Lake Okeechobee, and changes in water transparency associated with increased water depths, lake-wide effects of wind, and lake-wide changes in dissolved organic color. However, none of these changes were associated with the emergency water supply backpumping operations. These results do not indicate that backpumping will never have negative ecological impacts on the Lake, just that in this particular case such effects were not observed as of the date of this report.

METHODS

The District, in a document dated August 1, 2001 previously supplied the Department with a detailed description of the biological monitoring program. Therefore only a brief overview is included here. Biological monitoring included monthly assessment of the biomass, spatial extent, and taxonomic composition of SAV at over 50 sites around the south, west, and north perimeter of the lake, and reporting of this information in the form of GIS maps. The monitoring also included weekly measurements of water transparency with a Secchi disk; these measurements were restricted to locations at the lake's southern end. The primary aim of transparency monitoring was to have an "early warning" of impacts on light conditions that might give rise to future declines in plant growth. As indicated above, no such early warnings ever arose.

MONITORING THE STATUS OF SAV

To evaluate SAV status over the period when water supply backpumping and augmentation occurred and when the second Emergency Final Order (OGC No. 01-1202) was in effect (August and September 2001), the District increased the frequency of its SAV sampling program from quarterly to monthly. The sampling sites occur in the south, west, and north near-shore areas that are shallow enough to support plants when conditions are favorable for their growth. The sampling sites occur along transects from shoreline out to deeper water, with three sites per transect and a total of 45 sites (depending on lake stage).

EVALUATION OF UNDERWATER LIGHT AVAILABILITY

The SAV monitoring was accompanied by more frequent (weekly) sampling of underwater light availability at locations that were expected to experience inputs of water from backpumping and augmentation (i.e., the 21 stations around the south and southwest edge of the lake, from Pelican Bay to Mayaca Cut). This sub-network includes transects extending outward into both South Bay and the shallow bay to the west of Ritta Island, lakeward of the S2 and S3 pump stations, respectively. At the 21 sites, District staff carried out sampling during morning hours (to minimize the influence of afternoon thunderstorms and associated wind-induced mixing and sediment resuspension) on a weekly basis in August and September. The sampling method was based on past experience that the simplest and most useful approach is to measure Secchi disk transparency and total depth. The ratio of Secchi / total depth then is an indicator of underwater light conditions for plant growth. Sites with ratios in excess of 0.5 typically have well above the critical irradiance needed for plant growth, while sites with ratios below 0.25 might be considered "stressed" from the perspective of plant growth.

AUGUST RESULTS

SUBMERGED AQUATIC VEGETATION

The SAV community was sampled on August 21 (Figure B1). A total of 21 sites had SAV and 14 sites did not. Sites with SAV occurred in shallower water closer to the shore. The plants were responding to increased lake stages with the appearance of small *Chara* (shrimp-grass) plants around the shoreline at many of the sites that previously were dry (Figure B4). Two sites along the southwest shore also had a high biomass of *Vallisneria* (eelgrass). The pattern of SAV occurrence at this time was very similar to what was observed at the start of the growing season last year and it did not indicate any effects of water supply backpumping.

TRANSPARENCY

Transparency was measured on August 7, 14, and 21 at sites located along 7 transects parallel to the lake shore (Figures B2-B4), including Pelican Bay (one transect), South Bay (three transects), and three transects west of Ritta Island. On all three occasions, percent Secchi depth was greater than 75% (high light for plant growth) at most sites that were sampled. Of the 51 measurements (one transect in South Bay was dry and not sampled, and the innermost station along the transect near the Mayaca Cut also was dry), there were only 4 cases of percent Secchi below 50% (two each on August 14 and 21). Field crew reported that these lower values were associated with wind-driven mixing of the water column and sediments at exposed locations. The percent Secchi data do not indicate any particular influences of backpumping on water quality during the month of August. It is noteworthy that the lake has displayed a high degree of color in the water, probably reflecting the presence of humic materials. However, this color was observed system-wide (as far north as the Okeechobee pier), as opposed to just the southern region of the lake.

SEPTEMBER RESULTS

SUBMERGED AQUATIC VEGETATION

The SAV community was sampled again in the 3rd week of September (Figure B5). At that time 26 sites had sparse SAV (<100 g/m^2 dry weight), one site had dense SAV (>100 g/m^2 dry weight), and 27 sites had no SAV. Dominant types of SAV were *Chara* spp. (shrimpgrass) and *Vallisneria americana* (eelgrass). The number of sites with SAV in September was somewhat higher than in August (when 21 out of 35 sampled sites had plants), but the number of sites with dense SAV decreased from 3 in August to 1 in September. The results of SAV sampling did not indicate any causal relationships between plant distribution or biomass and water supply backpumping.

TRANSPARENCY

During September, water transparency (Figures B6-B9) continued to be monitored using the Secchi disk method at stations located along 7 transects perpendicular to the lake shore in Pelican Bay (one transect), South Bay (three transects), and west of Ritta Island (three transects). A total of 19 stations were monitored on September 4, 11, 18, and 25. Dense emergent vegetation prevented sampling with the Secchi disk at certain locations / dates. On September 4, 13 of 16 sampled sites had good or fair conditions for plant growth and three sites had insufficient light for plant growth, based on the Secchi to total depth ratios. This was very similar to the condition observed on August 21. Nearly identical results were obtained on September 11. On September 18, conditions changed – only 8 of 17 sites had fair to good light conditions, and 10 sites had insufficient light for plant growth. Similar results persisted to September 25. The decrease in light availability for plant growth was observed at other locations in the lake during late September, and was attributed to rising lake stage, coupled with a generally high level of dissolved organic material in the water. The data collected here do not indicate any causal linkage between the reduced light availability for plants and water supply backpumping.

WATER QUALITY AND ECOSYSTEM ENHANCEMENT/RESTORATION

As part of the conditions of the Emergency Final Order, several enhancement projects have been accomplished in the lake. Prior to the initiation of backpumping, approximately 12,000 bulrush plants had been planted in the lake as specified in Emergency Final Order 01-0715. In addition, the District has budgeted funds to plant approximately 50,000 additional bulrush plants but has not yet done so due to the return to normal lake stages. The planting work is anticipated to commence when water levels in the lake recede sufficiently to allow the proposed activity.

Additionally, the District was directed to contribute $200,000 to the Florida Fish and Wildlife Conservation Commission's project to remove the organic berm in the western portion of the lake and transfer the material to several wildlife islands. In actuality, the District has contributed $400,000 to the enhancement project and it has now been completed.

The District continues to actively work with the agricultural interests in the EAA in cooperation with DACS to promote and more closely manage the use of pesticides and herbicides. These activities are partially conducted as enhancements of the active Best Management Practices program the District promulgates in the EAA.

Emergency Final Order No. 01-1202 directed that the District reimburse the City of Belle Glade and the City of South Bay public water supply utilities for any monthly incremental increases in water treatment costs directly attributable to District operation of the S-2 and S-3 pump stations during the duration of the backpumping operations. As of this date, the City of Belle Glade has supplied the District with the necessary documentation of additional costs and treatment and has been reimbursed by the District. The Cities of South Bay and Pahokee are still in the process of providing the necessary documentation required to receive reimbursement which will be forthcoming upon the District's review and acceptance of that documentation.

During the Spring of 2000, the District performed a lake recession that removed approximately 150 metric tons of TP from the lake (Table 24). The backpumping and augmentation operations performed under the emergency action order contributed 38 metric tons of TP, resulting in a net loss of 112 metric tons of TP from the lake when the two actions are compared.

In addition, although not required by the Emergency Final Orders, the District is financially participating in cooperation with other governmental entities in the maintenance dredging of the Industrial Canal, which is currently in progress, and the planned dredging of three marinas in the southern part of the lake. It is anticipated that these dredging operations will remove significant quantities of nutrient containing sediments resulting in a net reduction of nutrient loads. This reduction should have an eventual beneficial effect on the water quality in the lake.

CONCLUSION

Analysis of the data collected in the Water Quality and Biological Monitoring programs associated with the Emergency Final Orders did not indicate adverse impacts to Lake Okeechobee attributable to the emergency water supply backpumping and flow augmentation operations.

The District, in partnership with the Department of Environmental Protection and the Department of Agricultural and Consumer Services, is continuing to implement water quality improvement and lake restoration projects consistent with the Lake Okeechobee Protection Act and the Lake Okeechobee SWIM Plan.

Table 1. Final Summary for June 1, 2001 through September 21, 2001 Water Supply Backpumping and Water Supply Augmentation Sites and for Lake-wide All Inflow.

Flow

STATION	Total Inflow		% of lake-wide inflow total
	cfs	acre-feet	
S2	98,882	196,129	13%
S3	65,324	129,569	9%
CULV10A (L8)	37,753	74,881	5%
S77	34,916	69,255	5%
S308	45,860	90,962	6%
S4	6,072	12,044	1%
S352	1,455	2,886	0%
Sum for above sites	**290,262**	**575,726**	39%
% of lake-wide all inflow	**39%**	**39%**	
(Lake-wide all inflow total)	**741,275**	**1,470,298**	100%

Total Phosphorus (TP)

STATION	Total Phosporus (TP)		% of lake-wide inflow total
	loads (metric tons)	FWMC (ppb)	
S2	23.96	99.0	6%
S3	13.95	87.3	3%
CULV10A (L8)	9.52	103.0	2%
S77	13.13	153.8	3%
S308	40.09	357.3	10%
S4	2.29	153.9	1%
S352	0.82	229.2	0%
Sum for above sites	**103.76**	**146.1**	25%
% of lake-wide all inflow	**25%**		
(Lake-wide all inflow total)	**413.52**	**228.0**	100%

Total Nitrogen (TN)

STATION	Total Nitrogen (TN)		% of lake-wide inflow total
	loads (metric tons)	FWMC (ppb)	
S2	894	3,697	19%
S3	559	3,499	12%
CULV10A (L8)	206	2,227	4%
S77	169	1,977	4%
S308	238	2,118	5%
S4	40	2,669	1%
S352	24	6,752	1%
Sum for above sites	**2,129**	**2,999**	46%
% of lake-wide all inflow	**46%**		
(Lake-wide all inflow total)	**4,592**	**2,532**	100%

Table 2. Monthly summary: Water Supply Backpumping and Augmentation Sites and All Lake Wide Inflows, June 1, 2001 through September 21, 2001

Notes: All flow data are are preliminary estimations.
S2, S3, S4, and S352 loads are calculated using the auto sampler concentrations.
CULV10A, S77, and S308 loads are calculated interpolating grab concentrations.

June 1 -30

STATION	FLOW		Total Phosphorus (TP)		Total Nitrogen (TN)	
	cfs-days	acre-feet	loads (metric tons)	FWMC (ppb)	loads (metric tons)	FWMC (ppb)
S2	8,142	16,149	2.38	119.6	75.25	3,777.5
S3	3,825	7,587	0.48	51.3	35.30	3,772.5
CULV10A (L8)	930	1,845	0.30	131.7	3.53	1,551.8
S77	18,744	37,178	6.06	132.1	92.25	2,011.5
S308	7,452	14,781	4.27	234.2	33.22	1,822.1
S4	0	0	0	N/A	0	N/A
S352	0	0	0	N/A	0	N/A
Sum for above sites	39,093	77,540	13.49	141.1	239.55	2,504.6
All lake-wide total	44,539	88,341	16.24	149.0	269.28	2,471.2

July 1 - 31

STATION	FLOW		Total Phosphorus (TP)		Total Nitrogen (TN)	
	cfs-days	acre-feet	loads (metric tons)	FWMC (ppb)	loads (metric tons)	FWMC (ppb)
S2	32,393	64,251	7.38	93.1	301.12	3,799.5
S3	19,748	39,170	2.81	58.1	168.86	3,495.0
CULV10A (L8)	7,373	14,624	2.02	111.8	32.81	1,819.1
S77	13,904	27,578	6.12	179.9	66.42	1,952.5
S308	14,308	28,380	9.19	262.6	60.42	1,725.9
S4	0	0	0	N/A	0	N/A
S352	0	0	0	N/A	0	N/A
Sum for above sites	87,727	174,003	27.51	128.2	629.64	2,933.6
All lake-wide total	178,404	353,860	122.22	280.0	1,138.51	2,608.4

August 1 - 31

STATION	FLOW		Total Phosphorus (TP)		Total Nitrogen (TN)	
	cfs-days	acre-feet	loads (metric tons)	FWMC (ppb)	loads (metric tons)	FWMC (ppb)
S2	37,706	74,789	9.09	98.5	347.55	3,767.4
S3	19,964	39,598	4.55	93.2	143.55	2,938.9
CULV10A (L8)	17,644	34,996	5.18	120.0	114.43	2,650.9
S77	2,268	4,499	0.96	172.4	10.22	1,842.0
S308	14,649	29,056	18.50	516.3	105.94	2,956.0
S4	5,042	10,001	1.82	147.6	31.39	2,544.4
S352	1,455	2,886	0.82	229.2	24.04	6,752.3
Sum for above sites	98,729	195,825	40.91	169.4	777.12	3,217.3
All lake-wide total	267,956	531,483	152.81	233.1	1,831.83	2,794.2

September 1 - 21

STATION	FLOW		Total Phosphorus (TP)		Total Nitrogen (TN)	
	cfs-days	acre-feet	loads (metric tons)	FWMC (ppb)	loads (metric tons)	FWMC (ppb)
S2	20,640	40,940	5.11	101.3	170.41	3,374.6
S3	21,787	43,213	6.12	114.8	211.49	3,967.7
CULV10A (L8)	11,806	23,417	2.02	70.0	54.94	1,902.0
S77	0	0	0	N/A	0	N/A
S308	9,451	18,746	8.12	351.3	38.01	1,644.0
S4	1,030	2,043	0.47	185.0	8.26	3,279.0
S352	0	0	0	N/A	0	N/A
Sum for above sites	64,714	128,358	21.84	138.0	483.11	3,051.4
All lake-wide total	250,376	496,614	122.25	199.6	1,352.35	2,207.7

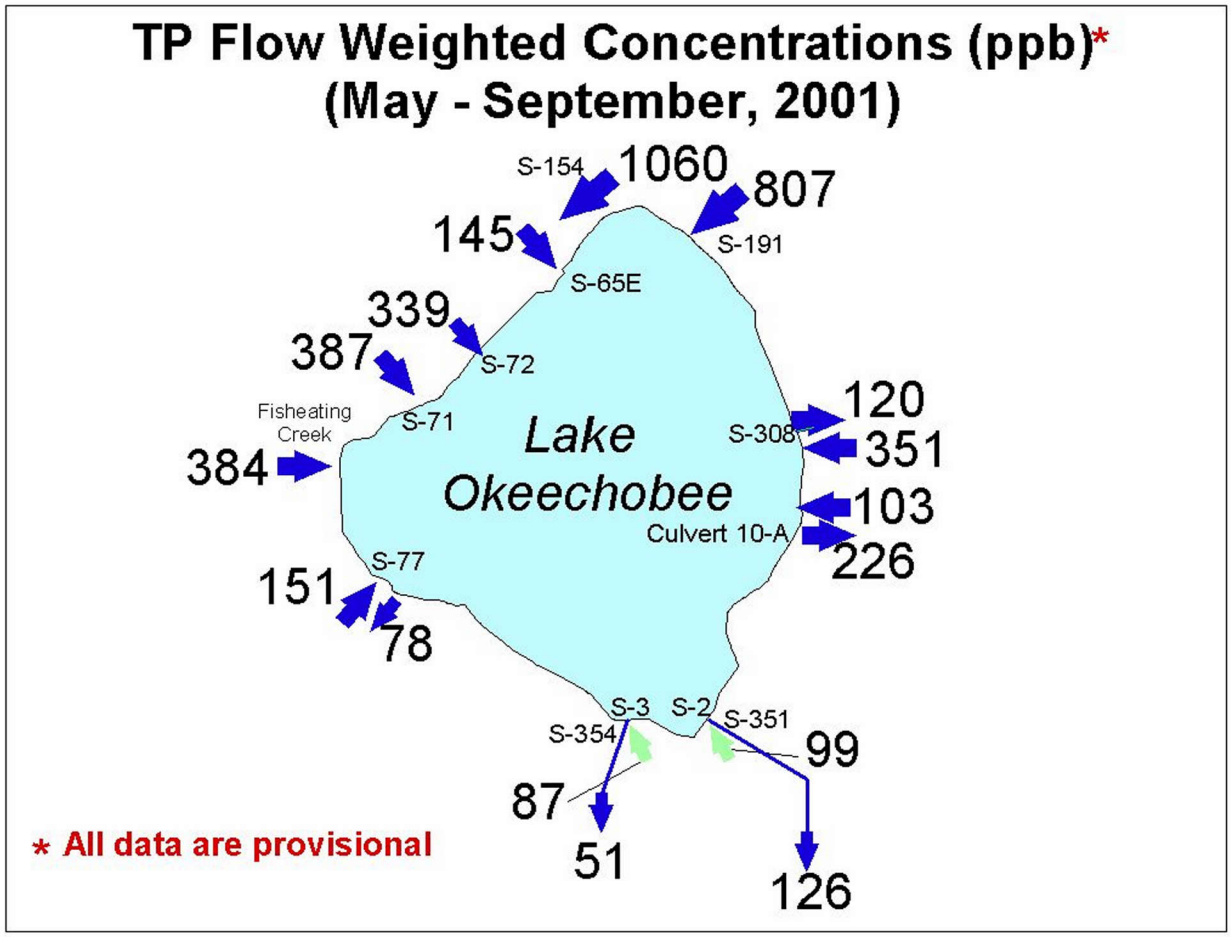

TP Flow Weighted Concentrations (ppb)*
(May - September, 2001)
S-154
1060
807
145
S-191
S-65E
339
387
S-72
Fisheating
Creek
S-71
Lake
Okeechobee
S-308
120
351
384
103
Culvert 10-A
226
S-77
151
78
S-3
S-2
S-351
S-354
99
87
51
126
* All data are provisional

Figure 1.

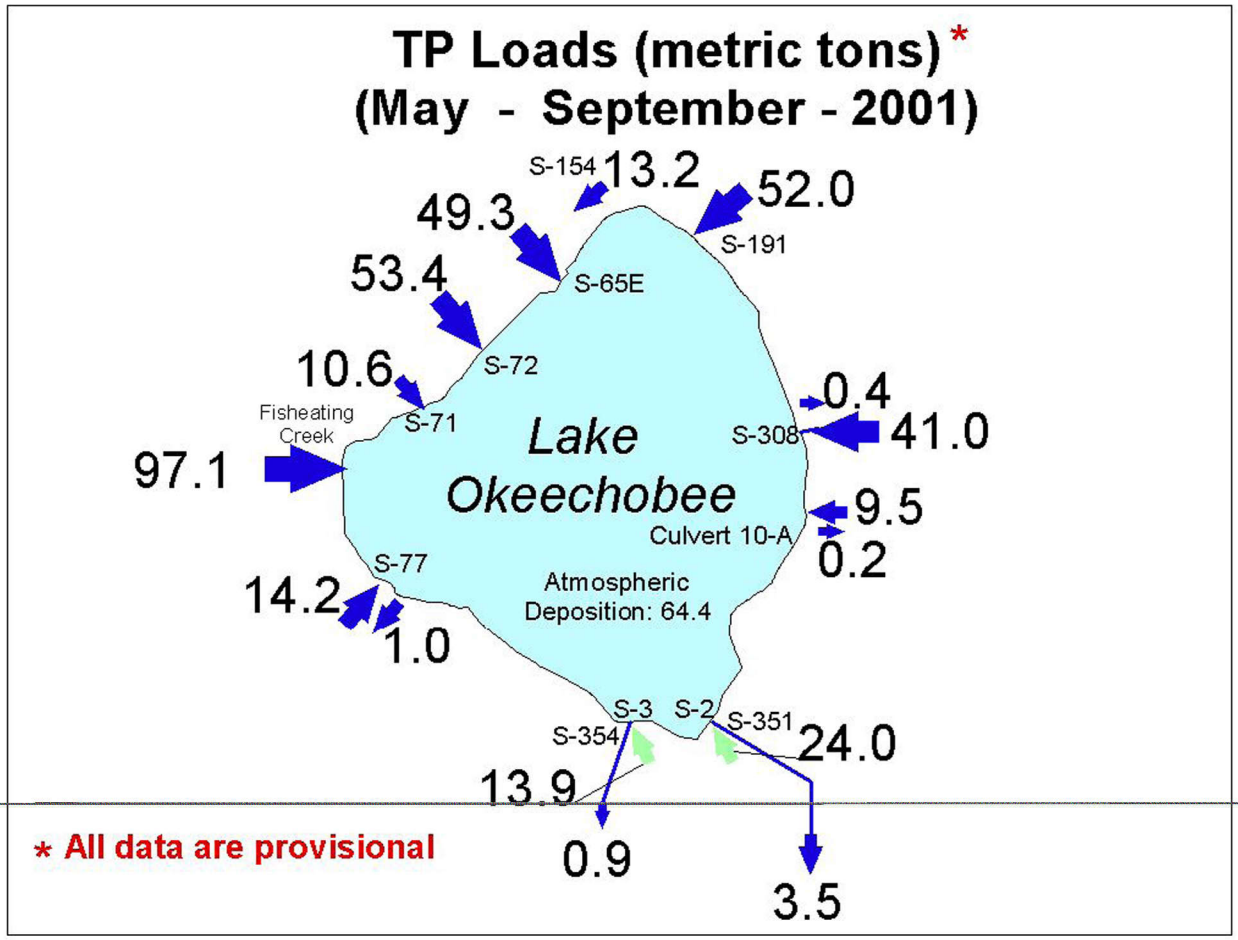

TP Loads (metric tons) *
(May - September - 2001)
S-154
13.2
52.0
49.3
S-191
53.4
S-65E
10.6
S-72
0.4
Fisheating
Creek
S-71
Lake
Okeechobee
S-308
41.0
97.1
9.5
Culvert 10-A
0.2
S-77
14.2
Atmospheric
Deposition: 64.4
1.0
S-3
S-2
S-351
S-354
24.0
13.9
* All data are provisional
0.9
3.5

Figure 2.

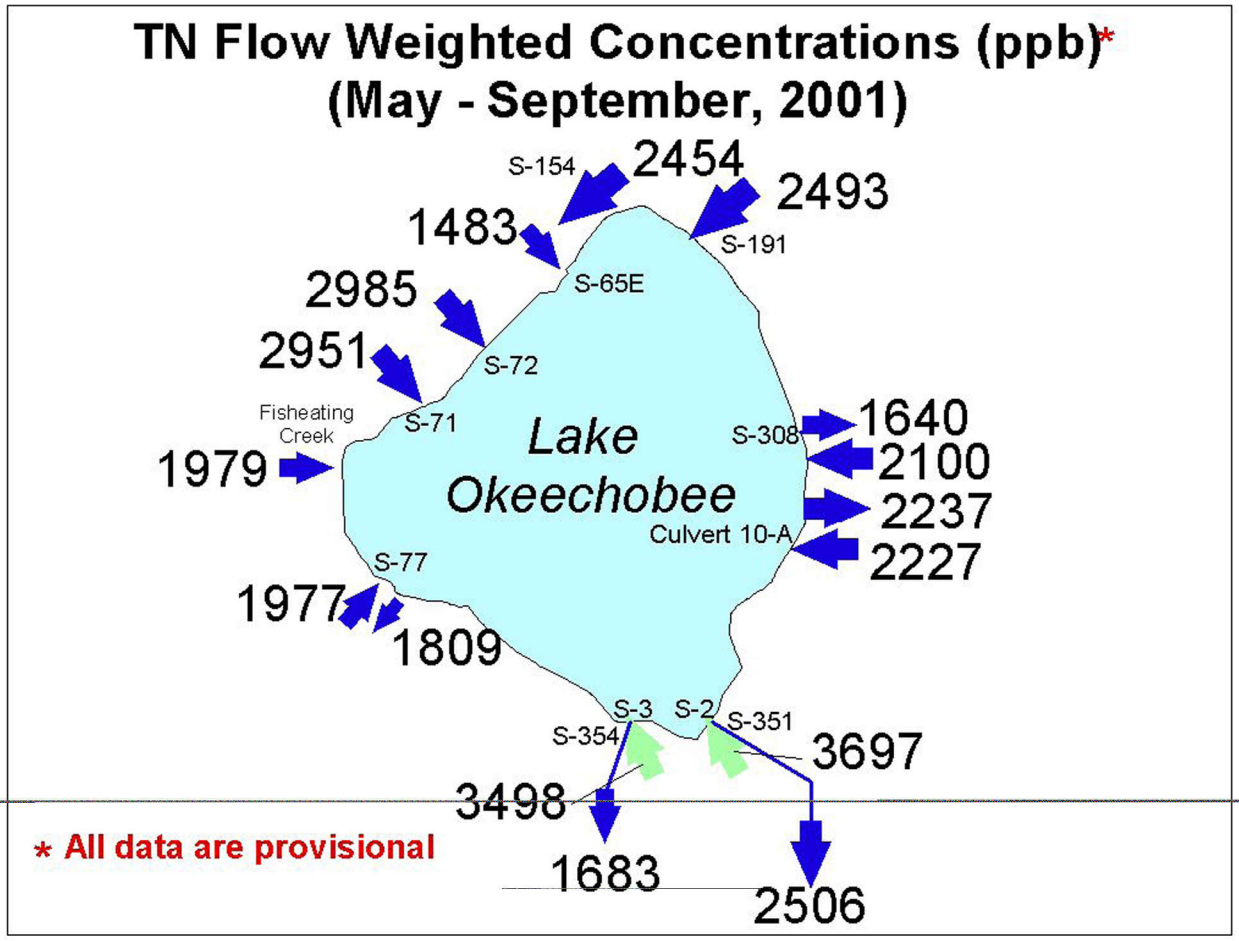

TN Flow Weighted Concentrations (ppb)*
(May - September, 2001)
S-154
2454
2493
1483
S-191
S-65E
2985
2951
S-72
Fisheating
Creek
S-71
Lake
Okeechobee
S-308
1640
2100
1979
2237
Culvert 10-A
2227
S-77
1977
1809
S-3
S-2
S-351
S-354
3697
3498
1683
2506
* All data are provisional

Figure 3.

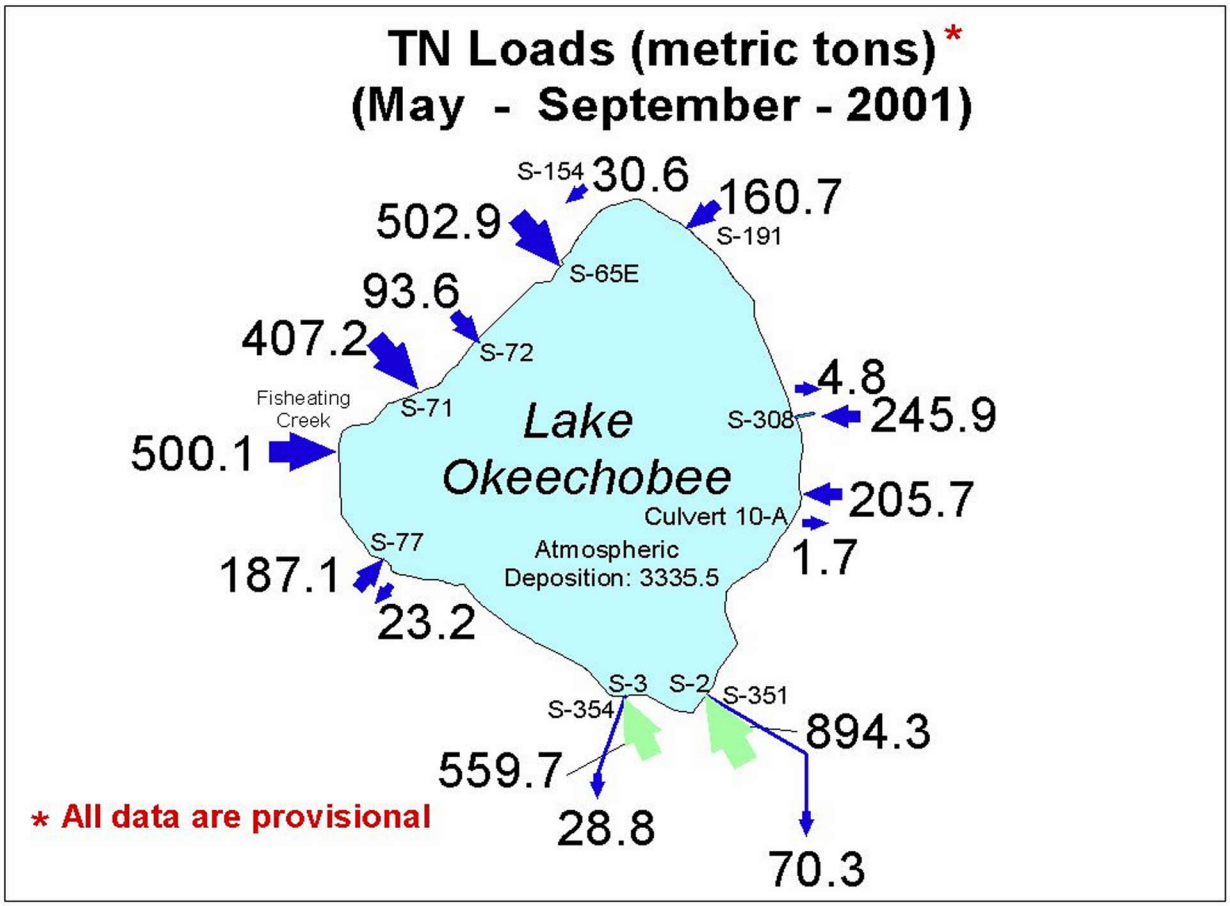

TN Loads (metric tons)*
(May - September - 2001)
S-154
30.6
160.7
S-191
502.9
S-65E
93.6
407.2
S-72
4.8
Fisheating Creek
S-71
Lake Okeechobee
S-308
245.9
500.1
205.7
Culvert 10-A
1.7
S-77
Atmospheric Deposition: 3335.5
187.1
23.2
S-3
S-2
S-351
S-354
894.3
559.7
28.8
70.3
* All data are provisional

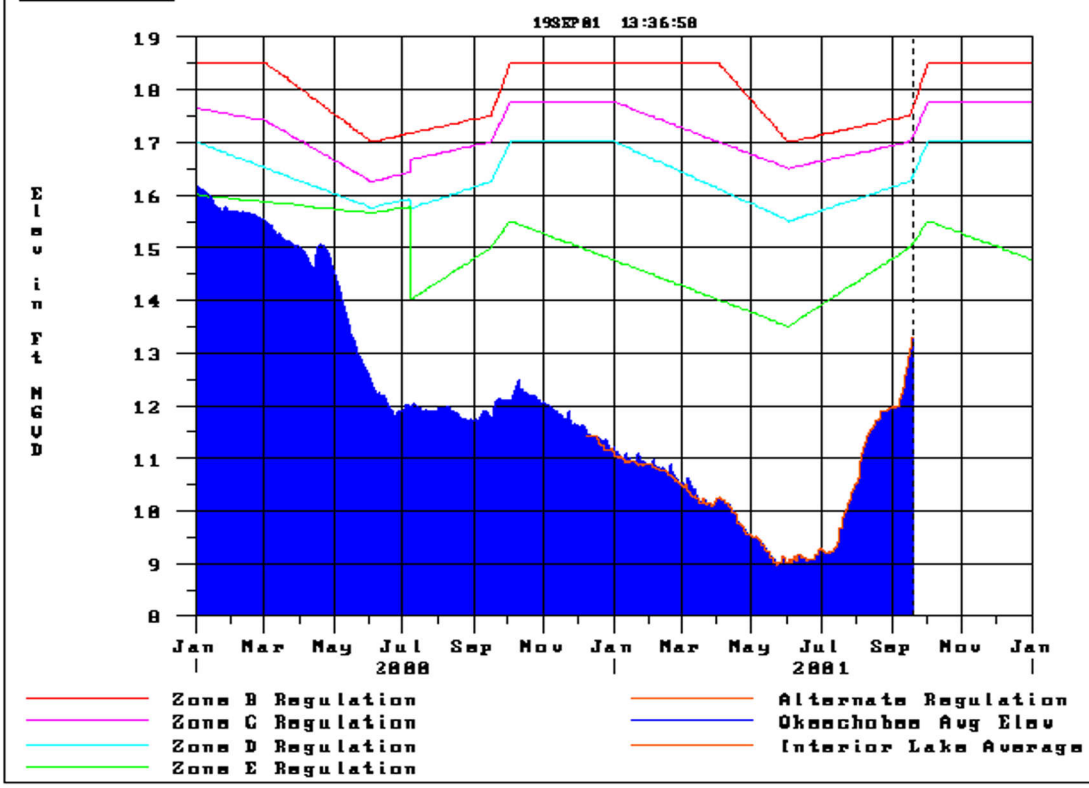
Figure 4.

Table 3. Lake Stage and Rainfall for Lake Okeechobee and Vicinity.

Stage: **COE Data. Average-daily lake average. In feet-NGVD.**
Rainfall: **Monthly Sum of SFWMD Provisional 24-Hour Rainfall In Inches Ending 7am EST (8am EDT) On The Indicated Date**

DATE	STAGE (feet)		BASIN MONTHLY RAINFALL (inches)							
	beginning	ending	EAA West	EAA East	Lake Okeechobee	Upper Kissimmee	Lower Kissimmee	East Caloos.	MartinSt.Lucie County	Palm Beach County
June 1 -30	9.01	9.27	6.51	6.12	5.69	8.04	6.58	6.56	7.44	6.56
July 1 - 31	9.26	10.53	7.14	8.24	9.07	8.44	8.89	13.44	11.71	9.41
August 1 - 31	10.61	11.98	4.53	5.78	6.19	6.67	4.53	8.48	8.18	7.95
September 1 - 21	11.96	13.56	8.21	6.24	7.80	9.87	8.47	9.04	7.31	9.86
sum (June1 -Sept 21)	**9.01**	**13.56**	**26.39**	**26.38**	**28.75**	**33.02**	**28.47**	**37.52**	**34.64**	**33.78**

Figure 5


Lake Okeechobee
19SEP01 13:36:58
Elev in Ft NGVD
19
18
17
16
15
14
13
12
11
10
9
8
Jan Mar May Jul Sep Nov Jan Mar May Jul Sep Nov Jan
2000
2001
Zone B Regulation
Zone C Regulation
Zone D Regulation
Zone E Regulation
Alternate Regulation
Okeechobee Avg Elev
Interior Lake Average

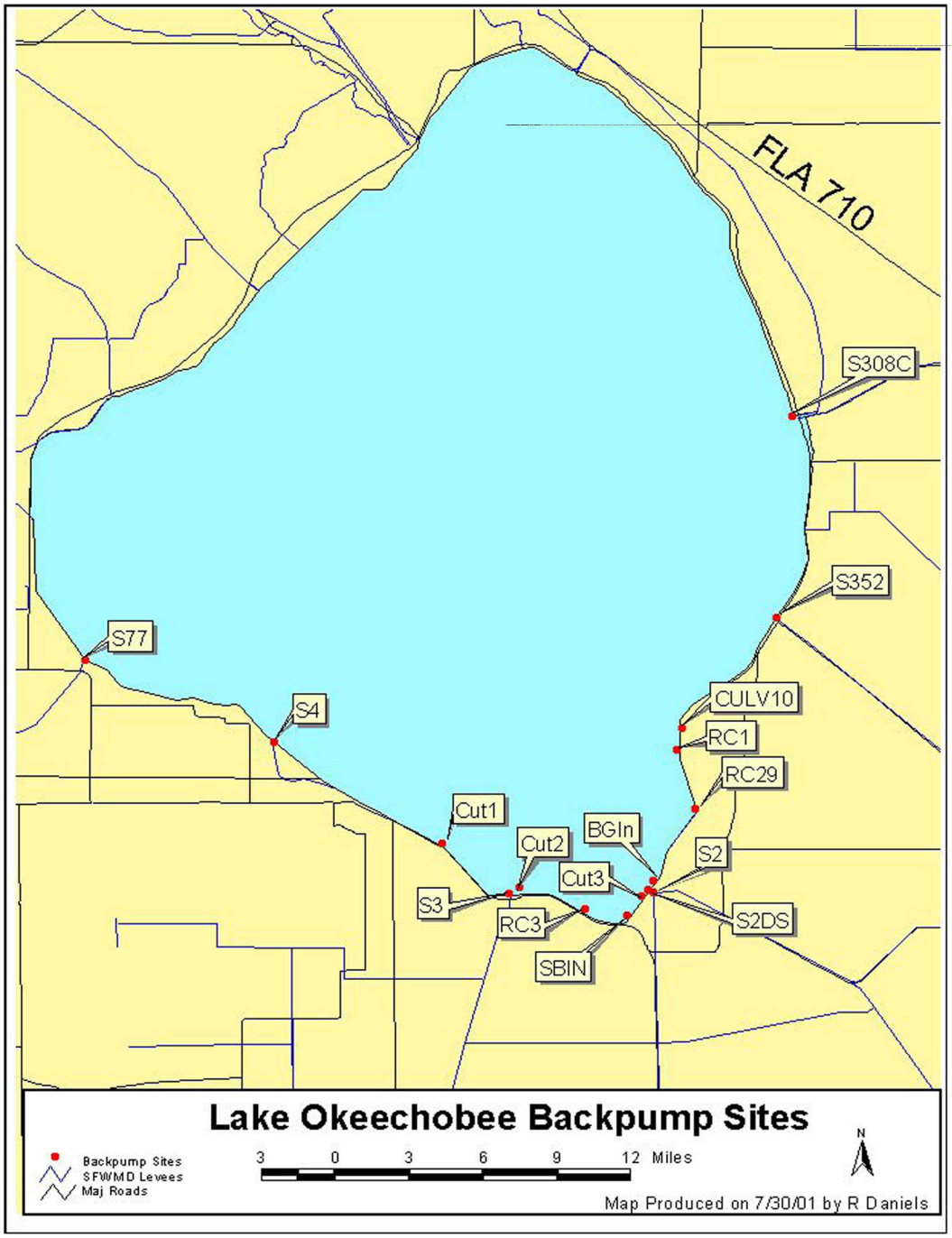


Figure 6. Lake Okeechobee Water Quality Sampling Locations

Table 4. Pesticides at S2: June 1, 2001 through September 21, 2001 Backpumping Events.

Parameters	Sampling Dates												FAC 62-302 Class I Criteria
	06/01/01*	06/08/01	06/12/01*	06/25/01*	06/28/01*	07/10/01	07/16/01	07/20/01	07/25/01	07/27/01*	07/27/01*	08/02/01, 08/03/01*	
ametryn (µg/L)	0.013	0.057	0.065	0.11	0.085	0.046	0.065	0.078	0.16	0.072	0.072	0.046	
atrazine (µg/L)	0.44	BDL	0.98	9.4	2.5	0.66	0.36	0.41	1.9	0.28	0.28	0.16	
atrazine desethyl (µg/L)	0.083	0.16	0.10	0.18	0.091	0.059	0.053	0.067	0.12	0.031	0.031	0.025	
atrazine desisopropyl (µg/L)	0.024	0.033	0.030	0.032	0.015	0.010	0.013	0.018	0.032	0.018	0.018	BDL	
bromacil (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
diazinon (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
hexazinone (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
malathion (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	less than or equal to 0.1 mg/L
gamma-BHC (Lindane) (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
metolachlor (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	0.17	BDL	BDL	BDL	BDL	BDL	
norflurazon (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
parathion methyl (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
simazine (µg/L)	0.019	0.021	0.021	0.043	0.012	BDL	BDL	BDL	0.019	BDL	BDL	0.027	

* average of duplicate values
BDL = below detection limit

Table 5. Pesticides at S3: June 1, 2001 through September 21, 2001 Backpumping Events.

Parameters	Sampling Dates															FAC 62-302 Class I Criteria
	06/05/01*	06/06/01*	06/07/01*	06/08/01*	06/10/01*	06/12/01	06/22/01*	06/25/01*	06/28/01*	07/12/01*	07/16/01	07/20/01	07/25/01*	07/27/01	08/02/01, 08/03/01	
ametryn (µg/L)	0.014	BDL	BDL	0.046	0.065	BDL	0.075	0.084	0.061	0.048	0.051	0.062	0.052	0.038	0.04	
atrazine (µg/L)	0.43	1.7	1.6	BDL	0.83	0.83	0.51	0.59	5.9	1.9	0.25	0.37	0.27	0.14	0.1	
atrazine desethyl (µg/L)	0.071	0.17	0.16	0.15	0.13	BDL	0.01	0.085	0.12	0.093	0.048	0.060	0.042	BDL	0.025	
atrazine desisopropyl (µg/L)	0.018	0.034	0.029	0.030	BDL	BDL	0.017	0.013	0.021	0.021	0.015	0.017	0.013	BDL	BDL	
bromacil (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
diazinon (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
hexazinone (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
malathion (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.040	BDL	BDL	BDL	less than or equal to 0.1 mg/L
gamma-BHC (Lindane) (µg/L)	BDL	BDL	BDL	BDL	BDL	0.0058	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
metolachlor (µg/L)	BDL	0.14	0.14	0.11	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
norflurazon (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
parathion methyl (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
simazine (µg/L)	0.014	0.014	0.014	0.016	BDL	BDL	BDL	BDL	0.025	BDL	BDL	BDL	BDL	BDL	BDL	

* average of duplicate values
BDL = below detection limit

Table 6. Pesticides at S308, S77 and Culvert 10A at L8: June 1, 2001 through September 21, 2001 Backpumping Events.

Station	S308	S77	L8	FAC 62-302
Date / Parameter	07/10/01	07/10/01	07/10/01*	Class I Criteria
ametryn (µg/L)	BDL	0.060	0.11	
atrazine (µg/L)	BDL	0.10	BDL	
atrazine desethyl (µg/L)	BDL	0.026	0.012	
atrazine desisopropyl (µg/L)	0.014	0.011	BDL	
bromacil (µg/L)	0.51	0.26	BDL	
diazinon (µg/L)	BDL	BDL	0.049	
hexazinone (µg/L)	BDL	0.027	BDL	
gamma-BHC (Lindane) (µg/L)	BDL	BDL	BDL	
malathion (µg/L)	BDL	BDL	BDL	less than or equal to 0.1 mg/L
metolachlor (µg/L)	BDL	BDL	BDL	
norflurazon (µg/L)	1.0	0.25	BDL	
parathion methyl (µg/L)	BDL	BDL	BDL	
simazine (µg/L)	0.096	0.040	BDL	

* average of duplicate values
BDL = below detection limit

Table 7. Pesticides at S2 Downstream and S3 Downstream: June 1, 2001 through September 21, 2001 Backpumping Events.

Station	S2DOWN					S3DOWN					FAC 62-302
Date / Parameter	07/17/01	07/20/01	07/24/01	07/27/01	08/02/01, 08/03,01	07/18/01*	07/20/01	07/24/01	07/27/01	08/02/01, 08/03/01	Class I Criteria
ametryn (µg/L)	0.090	0.072	0.065	0.063	0.046	0.049	0.065	0.058	0.043	0.05	
atrazine (µg/L)	0.48	0.33	0.49	0.29	0.150	0.26	0.34	0.24	0.15	0.1	
atrazine desethyl (µg/L)	0.061	0.052	0.033	0.031	0.027	0.050	0.054	0.037	0.019	0.02	
atrazine desisopropyl (µg/L)	0.024	0.017	0.012	0.017	BDL	0.010	0.017	0.010	0.0098	BDL	
bromacil (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
diazinon (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
hexazinone (µg/L)	0.025	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
malathion (µg/L)	BDL	BDL	BDL	BDL	BDL	0.030	0.031	BDL	BDL	BDL	less than or equal to 0.1 mg/L
gamma-BHC (Lindane) (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
metolachlor (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
Norflurazon (µg/L)	0.24	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
Parathion Methyl (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.052	BDL	
simazine (µg/L)	0.042	BDL	BDL	BDL	0.018	BDL	BDL	BDL	BDL	BDL	

* average of duplicate values
BDL = below detection limit

Table 8. Pesticides at CUT1 and CUT 3: June 1, 2001 through September 21, 2001 Backpumping Events.

Parameters	CUT1					CUT3					FAC 62-302 Class I Criteria
	07/18/01	07/20/01*	07/24/01	07/27/01	08/02/01, 08/03/01	07/18/01	07/20/01	07/24/01	07/27/01	08/02/01, 08/03/01*	
ametryn (µg/L)	0.065	0.059	0.062	0.042	0.04	0.081	0.077	0.055	0.057	0.06	
atrazine (µg/L)	0.30	0.22	0.22	0.17	0.1	0.73	0.30	0.25	0.24	0.2	
atrazine desethyl (µg/L)	0.049	0.037	0.033	0.034	0.02	0.079	0.047	0.041	0.026	0.03	
atrazine desisopropyl (µg/L)	BDL	0.012	0.011	0.0091	BDL	0.023	0.016	0.015	0.012	BDL	
bromacil (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
diazinon (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
hexazinone (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
malathion (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	less than or equal to 0.1 mg/L
gamma-BHC (Lindane) (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
metolachlor (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
norflurazon (µg/L)	BDL	BDL	BDL	BDL	BDL	0.11	0.024	BDL	BDL	BDL	
parathion methyl (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
simazine (µg/L)	BDL	BDL	BDL	BDL	BDL	0.025	BDL	BDL	BDL	0.03	

* average of duplicate values
BDL = below detection limit

Table 9. Pesticides at PH in, BG in, SB in: June 1, 2001 through September 21, 2001 Backpumping Events.

Station	PH in*		BG in		SB in		FAC 62-302
Date / Parameter	08/17/01*	08/20/01	08/17/01	08/20/01	08/17/01	08/20/01	Class I Criteria
ametryn (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	
atrazine (µg/L)	0.15	0.015	0.088	0.022	0.089	0.030	
atrazine desethyl (µg/L)	0.039	0.17	0.018	0.03	0.017	0.06	
atrazine desisopropyl (µg/L)	0.019	0.042	BDL	BDL	BDL	0.014	
bromacil (µg/L)	0.092	0.015	BDL	BDL	BDL	BDL	
diazinon (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	
hexazinone (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	
malathion (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	less than or equal to 0.1 mg/L
gamma-BHC (Lindane) (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	
metolachlor (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	
norflurazon (µg/L)	0.059	BDL	BDL	BDL	BDL	0.022	
parathion methyl (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL	
simazine (µg/L)	0.045	0.047	BDL	BDL	BDL	BDL	

* average of duplicate values
BDL = below detection limit

Table 10. List of Pesticide Compounds Monitored during the Backpumping Events in 2001.

Chlorinated herbicides and organochlorine pesticides are not analyzed after 8/3/01 sampling event.
@ Prometon is added beginning 8/17/01 sampling event

Chlorinated (Phenoxy Acid) Herbicides*
2,4-D*
2,4,5-T*
2,4,5-TP (silvex)*

Organonitrogen and phosphorus Pesticides
alachlor
ametryn
atrazine
atrazine desethyl
atrazine desisopropyl
azinphos methyl
bromacil
butylate
chlorpyrifos ethyl
chlorpyrifos methyl
demeton
diazinon
disulfoton
ethion
ethoprop
fenamiphos (nemacur)
fonofos (dyfonate)
hexazinone
malathion
metalaxyl
metolachlor
metribuzin
mevinphos
naled
norflurazon
parathion ethyl
parathion methyl
phorate
prometryn
simazine
prometon@

Organochlorine Pesticides*
aldrin*
alpha-BHC*
beta-BHC*
delta-BHC*
gamma-BHC (lindane)*
carbophenothion (trithion)*
chlordane*
chlorothalonil*
cypermethrin*
DDD-p,p'*
DDE-p,p'*
DDT-p,p'*
dicofol (kelthane)*
dieldrin*
endosulfan I (alpha)*
endosulfan II (beta)*
endosulfan sulfate*
endrin*
endrin aldehyde*
heptachlor*
heptachlor epoxide*
methoxychlor*
mirex*
permethrin*
toxaphene*
PCB-1016*
PCB-1221*
PCB-1232*
PCB-1242*
PCB-1248*
PCB-1254*
PCB-1260*
trifluralin*

Table 11. Ultra-Trace Mercury Data for June 1, 2001 through September 21, 2001 Backpumping Events.

station	date	THG, ng/l	TMHG, ng/l
S2	06/08/01	2.99	0.126
	06/12/01	4.776	0.237
	06/25/01	1.81	0.222
	06/28/01	ND	0.185
	07/10/01	1.3	0.488
	07/16/01	2.28	0.222
	07/20/01	2.31	0.173
	07/25/01	ND	0.239
	07/30/01	2.43	0.195
	08/02/01	ND	0.367
S3	06/05/01	1.16	0.12
	06/06/01	1.59	0.096
	06/07/01	1.357	0.094
	06/08/01	1.58	0.098
	06/10/01	2.07	0.113
	06/12/01	1.687	0.127
	06/22/01	1.71	0.332
	06/25/01	1.59	<0.014
	06/28/01	2.03	0.124
	07/12/01	ND	0.204
	07/16/01	2.43	0.446
	07/20/01	1.71	0.138
	07/25/01	ND	0.273
	07/30/01	2.98	0.221
S2DOWN	07/18/01	ND	0.15
	07/20/01	3.64	0.193
	07/24/01	ND	0.264
	08/02/01	3.29	0.3
S3DOWN	07/18/01	2.81	0.271
	07/20/01	1.84	0.177
	07/24/01	ND	0.29
CULV10A	07/05/01	6.26	0.23
	08/14/01	5.56	1.69
S308C	07/05/01	6.47	0.33
S352	08/05/01	4.75	0.798
S77	07/05/01	ND	0.147
CUT1	07/18/01	ND	0.134
	07/20/01	2.37	0.242
	07/24/01	1.75	0.193
	07/30/01	4.84	0.18
CUT3	07/18/01	2.24	0.259
	07/20/01	2.65	0.089
	07/24/01	4.82	0.266

Note: a "ND" value indicates that the value did not meet QA/QC criteria

Table 12. Water Quality Data Summary at S2 for June 1, 2001 through September 21, 2001 .

Parameters	Period	Sample Type	n	min	max	avg	S.D.	FAC 62<302 Class I Criteria
Physical								
Temperature (°C)	06/01/01 - 09/19/01	grab	32	25.4	32.1	28.9	1.7	
Specific Conductivity (µmhos/cm)	06/01/01 - 09/19/01	grab	32	653	1185	991	127	Not greater than 50% above background or 1,275 µmhos/cm
Dissolved Oxygen (mg/L)	06/01/01 - 09/19/01	grab	32	1.6	12.5	3.4	2.2	Not less than 5.0 mg/L
Water pH (units)	06/01/01 - 09/19/01	grab	32	6.9	7.9	7.3	0.2	Not less than 6.0 or greater than 8.5 units
Turbidity (NTU)	06/01/01 - 09/19/01	grab	30	2.7	36.0	9.7	8.2	Less than or equal to 29 NTU above background
Color (PCU)	06/01/01 - 09/19/01	grab	30	26	176	126	29	
Total Suspended Solids (mg/L)	06/01/01 - 09/19/01	grab	28	2.8	83.0	15.9	19.3	
Total Dissolved Solids (mg/L)	06/01/01 - 09/19/01	grab	24	415.0	789.0	648.8	100.5	
Hardness (mg/L as CaCO3)	06/01/01 - 09/19/01	grab	16	190.6	464.6	388.6	61.6	
Alkalinity (mg/L as CaCO3)	06/01/01 - 09/19/01	grab	29	133.9	350.7	281.4	53.9	
Nutrients								
Total Nitrogen (mg/L)	06/01/01 - 09/19/01	grab	33	1.5	9.5	3.7	1.5	
	06/01/01 - 09/19/01	comp	34	2.5	5.4	3.6	0.8	
Total Kjeldahl Nitrogen (mg/L)	06/01/01 - 09/19/01	grab	33	1.4	7.9	2.9	1.1	
	06/01/01 - 09/19/01	comp	34	2.0	4.3	3.0	0.5	
Total Dissolved Kjeldahl Nitrogen (mg/L)	06/01/01 - 09/19/01	grab	23	1.2	3.1	2.4	0.5	
Nitrate+Nitrite as N (mg/L)	06/01/01 - 09/19/01	grab	33	0.023	1.870	0.798	0.585	
	06/01/01 - 09/19/01	comp	34	0.010	1.732	0.593	0.474	
Nitrite as N (mg/L)	06/01/01 - 09/19/01	grab	33	<0.004	0.156	0.059	0.039	
Nitrate as N(mg/L)	06/01/01 - 09/19/01	grab	32	0.036	1.789	0.761	0.542	Equal or less than 10 mg/L as N
Ammonium as N (mg/L)	06/01/01 - 09/19/01	grab	33	0.021	0.615	0.233	0.157	
Un<ionized Ammonia as NH3 (mg/L)	06/01/01 - 09/19/01	grab	32	0.001	0.009	0.004	0.002	Equal or less than 0.02 mg/L as NH_3
Total Phosphorus (mg/L)	06/01/01 - 09/19/01	grab	33	0.033	1.136	0.124	0.185	
	06/01/01 - 09/19/01	comp	34	0.058	0.171	0.106	0.026	
Orthophosphate as P (mg/L)	06/01/01 - 09/19/01	grab	32	0.007	0.083	0.048	0.022	
Total Dissolved Phosphorus (mg/L)	06/01/01 - 09/19/01	grab	23	0.014	0.087	0.050	0.022	
Silica (mg/L)	06/01/01 - 09/19/01	grab	24	8.213	22.904	16.523	3.799	
Major Ions								
Chloride (mg/L)	06/01/01 - 09/19/01	grab	29	86.590	140.860	108.152	11.767	Equal or less than 250 mg/L
Sulfate (mg/L)	06/01/01 - 09/19/01	grab	24	16.880	125.150	66.541	29.573	
Sodium (mg/L)	06/01/01 - 08/03/01	grab	16	50.952	86.001	65.136	9.967	
Potassium (mg/L)	06/01/01 - 08/03/01	grab	16	6.620	9.862	8.036	0.793	
Calcium (mg/L)	06/01/01 - 08/03/01	grab	16	48.928	126.850	105.271	17.235	
Magnesium (mg/L)	06/01/01 - 08/03/01	grab	16	16.611	35.902	30.555	4.717	
Trace Metals								
Total Arsenic (µg/L)	06/01/01 - 08/0201	grab	11	3.2	6.1	4.7	0.8	Less than or equal to 50 µg/L
Total Cadmium (µg/L)	06/01/01 - 08/0201	grab	11	<0.3	0.3	<0.3	0.1	Less than or equal to calculated value
Total Copper (µg/L)	06/01/01 - 08/0201	grab	11	2.1	3.5	2.9	0.4	Less than or equal to calculated value
Total Iron (µg/L)	06/01/01 - 08/0201	grab	11	90.0	477.2	238.1	150.3	Less than or equal to 300 µg/L
Total Lead (µg/L)	06/01/01 - 08/0201	grab	11	<0.8	<0.8	<0.8		Less than or equal to calculated value
Total Zinc (µg/L)	06/01/01 - 08/0201	grab	11	<4	<4	<4		Less than or equal to calculated value
Phytoplankton Indicators								
Chlorophyll a (µg/L)	06/01/01 - 09/19/01	grab	22	3.1	159.2	21.4	34.1	
Chlorophyll a2 (µg/L)	06/01/01 - 09/19/01	grab	22	2.1	150.6	17.8	32.4	
Chlorophyll b (µg/L)	06/01/01 - 09/19/01	grab	23	<1	3.7	<1	0.8	
Chlorophyll c (µg/L)	06/01/01 - 09/19/01	grab	23	<1	10.1	1.9	2.3	
Pheophytin a (µg/L)	06/01/01 - 09/19/01	grab	22	<1	13.1	5.3	3.7	
Carotenoid (µg/L)	06/01/01 - 09/19/01	grab	22	2.0	56.0	9.5	12.0	
Total Organic Carbon (mg/L)	06/01/01 - 09/19/01	grab	23	17.2	47.2	37.1	7.2	

Table 13. Water Quality Data Summary at S3 for June 1, 2001 through September 21, 2001 .

Parameters	Period	Sample Type	n	min	max	avg	S.D.	FAC 62<302 Class I Criteria
Physical								
Temperature (°C)	06/02/01 - 09/19/01	grab	34	26.0	31.7	29.2	1.6	
Specific Conductivity (µmhos/cm)	06/02/01 - 09/19/01	grab	34	570	1124	811	133	Not greater than 50% above background or 1,275 µmhos/cm
Dissolved Oxygen (mg/L)	06/02/01 - 09/19/01	grab	34	2.1	8.2	4.3	1.7	Not less than 5.0 mg/L
Water pH (units)	06/02/01 - 09/19/01	grab	34	7.0	8.2	7.4	0.3	Not less than 6.0 or greater than 8.5 units
Turbidity (NTU)	06/02/01 - 09/19/01	grab	33	2.3	17.6	6.4	4.1	Less than or equal to 29 NTU above background
Color (PCU)	06/02/01 - 09/19/01	grab	33	26	190	120	40	
Total Suspended Solids (mg/L)	06/02/01 - 09/19/01	grab	32	<3	26.0	8.3	5.5	
Total Dissolved Solids (mg/L)	06/05/01 - 09/19/01	grab	28	374.0	735.0	520.2	93.9	
Hardness (mg/L as CaCO3)	06/05/01 - 08/03/01	grab	20	199.1	370.7	315.8	53.4	
Alkalinity (mg/L as CaCO3)	06/05/01 - 09/19/01	grab	32	111.4	274.6	219.9	39.1	
Nutrients								
Total Nitrogen (mg/L)	06/02/01 - 09/19/01	grab	35	1.6	6.0	3.2	1.1	
	06/06/01 - 09/22/01	comp	34	2.3	5.8	3.4	0.8	
Total Kjeldahl Nitrogen (mg/L)	06/02/01 - 09/19/01	grab	35	1.5	3.1	2.4	0.5	
	06/06/01 - 09/22/01	comp	34	2.0	5.8	2.7	0.7	
Total Dissolved Kjeldahl Nitrogen (mg/L)	06/05/01 - 09/19/01	grab	27	1.2	2.9	2.1	0.5	
Nitrate+Nitrite as N (mg/L)	06/02/01 - 09/19/01	grab	34	0.049	2.926	0.894	0.799	
	06/06/01 - 09/22/01	comp	34	<0.004	2.081	0.759	0.653	
Nitrite as N (mg/L)	06/02/01 - 09/19/01	grab	34	0.007	0.132	0.049	0.035	
Nitrate as N(mg/L)	06/02/01 - 09/19/01	grab	34	0.036	2.815	0.846	0.769	Equal or less than 10 mg/L as N
Ammonium as N (mg/L)	06/02/01 - 09/19/01	grab	33	0.014	0.468	0.135	0.124	
Un<ionized Ammonia as NH3 (mg/L)	06/02/01 - 09/19/01	grab	33	0.000	0.008	0.003	0.002	Equal or less than 0.02 mg/L as NH_3
Total Phosphorus (mg/L)	06/02/01 - 09/19/01	grab	35	0.035	0.129	0.072	0.026	
	06/06/01 - 09/22/01	comp	34	0.032	0.506	0.086	0.080	
Orthophosphate as P (mg/L)	06/02/01 - 09/19/01	grab	34	0.004	0.091	0.030	0.027	
Total Dissolved Phosphorus (mg/L)	06/05/01 - 09/19/01	grab	27	0.011	0.099	0.040	0.029	
Silica (mg/L)	06/05/01 - 09/19/01	grab	28	6.289	17.771	9.874	2.698	
Major Ions								
Chloride (mg/L)	06/05/01 - 09/19/01	grab	32	59.690	129.640	87.847	17.877	Equal or less than 250 mg/L
Sulfate (mg/L)	06/05/01 - 09/19/01	grab	28	14.760	107.500	53.385	24.332	
Sodium (mg/L)	06/05/01 - 08/03/01	grab	20	48.583	88.322	57.556	9.301	
Potassium (mg/L)	06/05/01 - 08/03/01	grab	20	5.170	8.774	7.141	0.765	
Calcium (mg/L)	06/05/01 - 08/03/01	grab	20	50.823	113.767	94.421	18.510	
Magnesium (mg/L)	06/05/01 - 08/03/01	grab	20	11.442	27.866	19.571	3.552	
Trace Metals								
Total Arsenic (µg/L)	06/05/01 - 08/03/01	grab	15	2.8	5.5	4.0	0.8	Less than or equal to 50 µg/L
Total Cadmium (µg/L)	06/05/01 - 08/03/01	grab	15	<0.3	0.3	<0.3	0.0	Less than or equal to calculated value
Total Copper (µg/L)	06/05/01 - 08/03/01	grab	15	1.3	3.0	2.3	0.5	Less than or equal to calculated value
Total Iron (µg/L)	06/05/01 - 08/03/01	grab	14	69.1	285.3	128.7	67.6	Less than or equal to 300 µg/L
Total Lead (µg/L)	06/05/01 - 08/03/01	grab	15	<0.8	<0.8	<0.8		Less than or equal to calculated value
Total Zinc (µg/L)	06/05/01 - 08/03/01	grab	15	<4	<4	<4		Less than or equal to calculated value
Phytoplankton Indicators								
Chlorophyll a (µg/L)	06/05/01 - 09/19/01	grab	26	4.8	46.9	16.6	11.5	
Chlorophyll a2 (µg/L)	06/05/01 - 09/19/01	grab	26	3.3	39.1	12.9	9.8	
Chlorophyll b (µg/L)	06/05/01 - 09/19/01	grab	26	<1	8.6	1.1	1.6	
Chlorophyll c (µg/L)	06/05/01 - 09/19/01	grab	27	<1	4.3	1.6	1.1	
Pheophytin a (µg/L)	06/05/01 - 09/19/01	grab	26	<1	12.5	5.2	3.3	
Carotenoid (µg/L)	06/05/01 - 09/19/01	grab	27	2.2	22.9	8.1	5.4	
Total Organic Carbon (mg/L)	06/05/01 - 09/19/01	grab	28	18.4	46.9	32.6	6.8	

Table 14. Water Quality Data Summary at S4 for June 1, 2001 through September 21, 2001 .

Parameters	Period	Sample Type	n	min	max	avg	S.D.	FAC 62<302 Class I Criteria
Physical								
Temperature (°C)	06/18/01 - 09/24/01	grab	14	5.0	31.9	27.8	6.9	
Specific Conductivity (µmhos/cm)	06/18/01 - 09/24/01	grab	14	421	1136	742	230	Not greater than 50% above background or 1,275 µmhos/cm
Dissolved Oxygen (mg/L)	06/18/01 - 09/24/01	grab	14	1.0	12.6	4.7	3.8	Not less than 5.0 mg/L
Water pH (units)	06/18/01 - 09/24/01	grab	14	6.6	8.3	7.3	0.5	Not less than 6.0 or greater than 8.5 units
Turbidity (NTU)	06/18/01 - 09/24/01	grab	6	1.9	14.9	6.5	4.8	Less than or equal to 29 NTU above background
Color (PCU)	06/18/01 - 09/24/01	grab	6	80	222	149	56	
Total Suspended Solids (mg/L)	06/18/01 - 09/24/01	grab	6	1.2	38.0	13.3	13.6	
Total Dissolved Solids (mg/L)	07/16/01 - 07/16/01	grab	1			408.0		
Hardness (mg/L as CaCO3)	07/16/01 - 07/16/01	grab	1			275.5		
Alkalinity (mg/L as CaCO3)	06/18/01 - 09/24/01	grab	6	156.1	238.1	196.7	29.4	
Nutrients								
Total Nitrogen (mg/L)	06/18/01 - 09/24/01	grab	14	2.3	4.3	3.0	0.6	
	08/04/01 - 09/19/01	comp	8	2.0	3.3	2.7	0.4	
Total Kjeldahl Nitrogen (mg/L)	06/18/01 - 09/24/01	grab	14	1.8	4.2	2.6	0.6	
	08/04/01 - 09/19/01	comp	8	2.0	3.0	2.5	0.3	
Total Dissolved Kjeldahl Nitrogen (mg/L)								
Nitrate+Nitrite as N (mg/L)	06/18/01 - 09/24/01	grab	14	0.044	1.082	0.326	0.288	
	08/04/01 - 09/19/01	comp	8	<0.004	0.431	0.182	0.144	
Nitrite as N (mg/L)	06/18/01 - 09/24/01	grab	7	0.017	0.161	0.076	0.051	
Nitrate as N(mg/L)	06/18/01 - 09/24/01	grab	7	0.008	0.972	0.306	0.340	Equal or less than 10 mg/L as N
Ammonium as N (mg/L)	06/18/01 - 09/24/01	grab	14	0.015	0.822	0.383	0.266	
Un<ionized Ammonia as NH3 (mg/L)	06/18/01 - 09/24/01	grab	14	0.000	0.012	0.006	0.003	Equal or less than 0.02 mg/L as NH_3
Total Phosphorus (mg/L)	06/18/01 - 09/24/01	grab	14	0.110	0.388	0.213	0.083	
	08/04/01 - 09/19/01	comp	8	0.076	0.185	0.149	0.037	
Orthophosphate as P (mg/L)	06/18/01 - 09/24/01	grab	7	0.006	0.151	0.074	0.064	
Total Dissolved Phosphorus (mg/L)								
Silica (mg/L)	07/16/01 - 07/16/01	grab	1			13.241		
Major Ions								
Chloride (mg/L)	06/18/01 - 09/24/01	grab	6	48.330	131.120	94.753	26.765	Equal or less than 250 mg/L
Sulfate (mg/L)	07/16/01 - 07/16/01	grab	1			62.190		
Sodium (mg/L)	07/16/01 - 07/16/01	grab	1			55.615		
Potassium (mg/L)	07/16/01 - 07/16/01	grab	1			7.869		
Calcium (mg/L)	07/16/01 - 07/16/01	grab	1			85.045		
Magnesium (mg/L)	07/16/01 - 07/16/01	grab	1			15.342		

Table 15. Water Quality Data Summary at S77 for June 1, 2001 through September 21, 2001 .

Parameters	Period	Sample Type	n	min	max	avg	S.D.	FAC 62-302 Class I Criteria
Physical								
Temperature (°C)	06/18/01 - 0/24/01	grab	11	27.9	36.3	30.3	2.4	
Specific Conductivity (µmhos/cm)	06/18/01 - 0/24/01	grab	11	247	694	578	166	Not greater than 50% above background or 1,275 µmhos/cm
Dissolved Oxygen (mg/L)	06/18/01 - 0/24/01	grab	10	1.0	11.8	5.3	3.2	Not less than 5.0 mg/L
Water pH (units)	06/18/01 - 0/24/01	grab	11	6.6	8.5	7.5	0.5	Not less than 6.0 or greater than 8.5 units
Turbidity (NTU)	06/18/01 - 0/24/01	grab	11	1.6	9.1	3.7	2.4	Less than or equal to 29 NTU above background
Color (PCU)	06/18/01 - 0/24/01	grab	11	73	532	167	138	
Total Suspended Solids (mg/L)	06/18/01 - 0/24/01	grab	11	2.0	19.2	7.4	5.7	
Total Dissolved Solids (mg/L)	06/18/01 - 0/24/01	grab	1			383.0		
Hardness (mg/L as CaCO3)	06/18/01 - 0/24/01	grab	2	238.2	242.7	240.4		
Alkalinity (mg/L as CaCO3)	06/18/01 - 0/24/01	grab	11	42.8	204.6	165.1	57.3	
Nutrients								
Total Nitrogen (mg/L)	06/18/01 - 09/24/01	grab	15	1.7	2.9	2.0	0.4	
Total Kjeldahl Nitrogen (mg/L)	06/18/01 - 09/24/01	grab	15	1.5	2.6	1.9	0.3	
Nitrate+Nitrite as N (mg/L)	06/18/01 - 09/24/01	grab	15	<0.004	0.577	0.115	0.162	
Nitrite as N (mg/L)	06/18/01 - 09/24/01	grab	11	<0.004	0.089	0.018	0.025	
Nitrate as N(mg/L)	06/18/01 - 09/24/01	grab	8	<0.004	0.488	0.110	0.163	Equal or less than 10 mg/L as N
Ammonium as N (mg/L)	06/18/01 - 09/24/01	grab	15	<0.009	1.013	0.169	0.253	
Un-ionized Ammonia as NH_3 (mg/L)	06/18/01 - 09/24/01	grab	11	0.000	0.006	0.002	0.002	Equal or less than 0.02 mg/L as NH_3
Total Phosphorus (mg/L)	06/18/01 - 09/24/01	grab	15	0.105	0.268	0.185	0.054	
Orthophosphate as P (mg/L)	06/18/01 - 09/24/01	grab	11	0.011	0.207	0.096	0.070	
Silica (mg/L)	06/18/01 - 09/24/01	grab	1			11.582		
Major Ions								
Chloride (mg/L)	06/18/01 - 09/24/01	grab	11	28.730	75.350	58.413	14.317	Equal or less than 250 mg/L
Sulfate (mg/L)	07/16/01 - 07/16/01	grab	1			32.170		
Sodium (mg/L)	07/16/01 - 07/16/01	grab	2	34.598	35.641	35.119		
Potassium (mg/L)	07/16/01 - 07/16/01	grab	2	6.655	6.976	6.816		
Calcium (mg/L)	07/16/01 - 07/16/01	grab	2	79.198	80.018	79.608		
Magnesium (mg/L)	07/16/01 - 07/16/01	grab	2	9.811	10.414	10.112		
Trace Metals								
Total Arsenic (µg/L)	07/05/01 - 07/05/01	grab	1			2.2		Less than or equal to 50 µg/L
Total Cadmium (µg/L)	07/05/01 - 07/05/01	grab	1			<0.3		Less than or equal to calculated value
Total Copper (µg/L)	07/05/01 - 07/05/01	grab	1			1.5		Less than or equal to calculated value
Total Iron (µg/L)	07/05/01 - 07/05/01	grab	1			70.4		Less than or equal to 300 µg/L
Total Lead (µg/L)	07/05/01 - 07/05/01	grab	1			<0.8		Less than or equal to calculated value
Total Zinc (µg/L)	07/05/01 - 07/05/01	grab	1			<4		Less than or equal to calculated value

Table 16. Water Quality Data Summary at S308 for June 1, 2001 through September 21, 2001 .

Parameters	Period	Sample Type	n	min	max	avg	S.D.	FAC 62-302 Class I Criteria
Physical								
Temperature (°C)	06/18/01 - 09/24/01	grab	11	26.8	30.8	29.0	1.2	
Specific Conductivity (µmhos/cm)	06/18/01 - 09/24/01	grab	11	516	849	686	114	Not greater than 50% above background or 1,275 µmhos/cm
Dissolved Oxygen (mg/L)	06/18/01 - 09/24/01	grab	11	0.3	4.8	3.5	1.2	Not less than 5.0 mg/L
Water pH (units)	06/18/01 - 09/24/01	grab	11	6.9	7.6	7.2	0.2	Not less than 6.0 or greater than 8.5 units
Turbidity (NTU)	06/18/01 - 09/24/01	grab	11	2.5	19.0	8.8	5.9	Less than or equal to 29 NTU above background
Color (PCU)	06/18/01 - 09/24/01	grab	11	40	218	111	51	
Total Suspended Solids (mg/L)	06/18/01 - 09/24/01	grab	11	1.2	23.6	10.7	8.2	
Total Dissolved Solids (mg/L)	07/16/01 - 08/28/01	grab	2	418.0	478.0	448.0		
Hardness (mg/L as CaCO3)	07/05/01 - 07/16/01	grab	2	250.0	265.2	257.6		
Alkalinity (mg/L as CaCO3)	06/18/01 - 09/24/01	grab	11	114.5	190.9	156.3	27.7	
Nutrients								
Total Nitrogen (mg/L)	06/18/01 - 09/24/01	grab	15	1.4	4.3	1.9	0.7	
Total Kjeldahl Nitrogen (mg/L)	06/18/01 - 09/24/01	grab	15	1.3	4.1	1.7	0.7	
Total Dissolved Kjeldahl Nitrogen (mg/L)	08/28/01 - 08/28/01	grab	1			1.2		
Nitrate+Nitrite as N (mg/L)	06/18/01 - 09/24/01	grab	15	0.074	0.405	0.215	0.086	
Nitrite as N (mg/L)	06/18/01 - 09/24/01	grab	11	0.008	0.052	0.031	0.014	
Nitrate as N(mg/L)	06/18/01 - 09/24/01	grab	11	0.059	0.353	0.180	0.082	Equal or less than 10 mg/L as N
Ammonium as N (mg/L)	06/18/01 - 09/24/01	grab	15	0.170	0.321	0.235	0.048	
Un-ionized Ammonia as NH_3 (mg/L)	06/18/01 - 09/24/01	grab	11	0.001	0.007	0.003	0.002	Equal or less than 0.02 mg/L as NH_3
Total Phosphorus (mg/L)	06/18/01 - 09/24/01	grab	15	0.196	0.740	0.325	0.136	
Orthophosphate as P (mg/L)	06/18/01 - 09/24/01	grab	11	0.119	0.406	0.219	0.078	
Total Dissolved Phosphorus (mg/L)	08/28/01 - 08/28/01	grab	1			0.259		
Silica (mg/L)	07/16/01 - 08/28/01	grab	2	10.654	11.515	11.085		
Major Ions								
Chloride (mg/L)	06/18/01 - 09/24/01	grab	11	60.430	104.860	82.132	14.488	Equal or less than 250 mg/L
Sulfate (mg/L)	07/16/01 - 08/28/01	grab	2	47.230	59.200	53.215		
Sodium (mg/L)	07/05/01 - 07/16/01	grab	2	50.912	61.473	56.192		
Potassium (mg/L)	07/05/01 - 07/16/01	grab	2	6.981	9.310	8.146		
Calcium (mg/L)	07/05/01 - 07/16/01	grab	2	81.290	86.101	83.695		
Magnesium (mg/L)	07/05/01 - 07/16/01	grab	2	11.424	12.192	11.808		
Trace Metals								
Total Arsenic (µg/L)	07/05/01 - 07/05/01	grab	1			1.9		Less than or equal to 50 µg/L
Total Cadmium (µg/L)	07/05/01 - 07/05/01	grab	1			<0.3		Less than or equal to calculated value
Total Copper (µg/L)	07/05/01 - 07/05/01	grab	1			4.6		Less than or equal to calculated value
Total Iron (µg/L)	07/05/01 - 07/05/01	grab	1			694.8		Less than or equal to 300 µg/L
Total Lead (µg/L)	07/05/01 - 07/05/01	grab	1			<0.8		Less than or equal to calculated value
Total Zinc (µg/L)	07/05/01 - 07/05/01	grab	1			<4		Less than or equal to calculated value
Phytoplankton Indicators								
Chlorophyll a (µg/L)	08/28/01 - 08/28/01	grab	1			7.2		
Chlorophyll a2 (µg/L)	08/28/01 - 08/28/01	grab	1			5.8		
Chlorophyll b (µg/L)	08/28/01 - 08/28/01	grab	1			<1		
Chlorophyll c (µg/L)	08/28/01 - 08/28/01	grab	1			<1		
Pheophytin a (µg/L)	08/28/01 - 08/28/01	grab	1			2.2		
Carotenoid (µg/L)	08/28/01 - 08/28/01	grab	1			3.4		
Total Organic Carbon (mg/L)	08/28/01 - 08/28/01	grab	1			21.1		
Dissolved Organic Carbon (mg/L)	08/28/01 - 08/28/01	grab	1			21.6		

Table 17. Water Quality Data Summary at C-10A at L8 for June 1, 2001 through September 21, 2001 .

Parameters	Period	Sample Type	n	min	max	avg	S.D.	FAC 62-302 Class I Criteria
Physical								
Temperature (°C)	06/18/01 - 09/24/01	grab	10	27.7	30.6	29.3	1.0	
Specific Conductivity (µmhos/cm)	06/18/01 - 09/24/01	grab	10	510	968	680	142	Not greater than 50% above background or 1,275 µmhos/cm
Dissolved Oxygen (mg/L)	06/18/01 - 09/24/01	grab	10	1.5	4.5	2.7	1.0	Not less than 5.0 mg/L
Water pH (units)	06/18/01 - 09/24/01	grab	10	7.0	7.6	7.2	0.2	Not less than 6.0 or greater than 8.5 units
Turbidity (NTU)	06/18/01 - 09/24/01	grab	10	3.3	46.2	14.1	13.6	Less than or equal to 29 NTU above background
Color (PCU)	06/18/01 - 09/24/01	grab	10	38	255	127	80	
Total Suspended Solids (mg/L)	06/18/01 - 09/24/01	grab	10	4.6	97.0	27.5	29.0	
Total Dissolved Solids (mg/L)	07/16/01 - 07/16/01	grab	1			519.0		
Hardness (mg/L as CaCO3)	07/05/01 - 07/16/01	grab	2	199.5	275.3	237.4		
Alkalinity (mg/L as CaCO3)	06/18/01 - 09/24/01	grab	10	143.1	205.2	172.6	22.4	
Nutrients								
Total Nitrogen (mg/L)	06/18/01 - 09/24/01	grab	14	1.0	3.6	2.0	0.7	
Total Kjeldahl Nitrogen (mg/L)	06/18/01 - 09/24/01	grab	14	0.9	2.7	1.9	0.6	
Nitrate+Nitrite as N (mg/L)	06/18/01 - 09/24/01	grab	14	0.010	0.881	0.151	0.227	
Nitrite as N (mg/L)	06/18/01 - 09/24/01	grab	10	<0.004	0.043	0.014	0.012	
Nitrate as N(mg/L)	07/02/01 - 09/24/01	grab	9	0.045	0.325	0.105	0.085	Equal or less than 10 mg/L as N
Ammonium as N (mg/L)	06/18/01 - 09/24/01	grab	14	0.041	0.415	0.144	0.100	
Un-ionized Ammonia as NH_3 (mg/L)	06/18/01 - 09/24/01	grab	10	0.001	0.003	0.002	0.001	Equal or less than 0.02 mg/L as NH_3
Total Phosphorus (mg/L)	06/18/01 - 09/24/01	grab	14	0.042	0.170	0.098	0.038	
Orthophosphate as P (mg/L)	06/18/01 - 09/24/01	grab	10	0.012	0.052	0.032	0.013	
Silica (mg/L)	07/16/01 - 07/16/01	grab	1			14.764		
Major Ions								
Chloride (mg/L)	06/18/01 - 09/24/01	grab	10	51.520	143.320	84.813	28.484	Equal or less than 250 mg/L
Sulfate (mg/L)	07/16/01 - 07/16/01	grab	1			43.360		
Sodium (mg/L)	07/05/01 - 07/16/01	grab	2	37.075	77.381	57.228		
Potassium (mg/L)	07/05/01 - 07/16/01	grab	2	1.729	4.687	3.208		
Calcium (mg/L)	07/05/01 - 07/16/01	grab	2	71.716	90.385	81.051		
Magnesium (mg/L)	07/05/01 - 07/16/01	grab	2	4.951	12.047	8.499		
Trace Metals								
Total Arsenic (µg/L)	07/05/01 - 07/05/01	grab	1			1.6		Less than or equal to 50 µg/L
Total Cadmium (µg/L)	07/05/01 - 07/05/01	grab	1			<0.3		Less than or equal to calculated value
Total Copper (µg/L)	07/05/01 - 07/05/01	grab	1			<1.2		Less than or equal to calculated value
Total Iron (µg/L)	07/05/01 - 07/05/01	grab	1			650.7		Less than or equal to 300 µg/L
Total Lead (µg/L)	07/05/01 - 07/05/01	grab	1			<0.8		Less than or equal to calculated value
Total Zinc (µg/L)	07/05/01 - 07/05/01	grab	1			<4		Less than or equal to calculated value

Table 18. Water Quality Data Summary at S-352 for June 1, 2001 through September 21, 2001 .

Parameters	Period	Sample Type	n	min	max	avg	S.D.	FAC 62-302 Class I Criteria
Physical								
Temperature (°C)	06/05/01 - 09/24/01	grab	15	25.4	32.2	29.2	1.6	
Specific Conductivity (µmhos/cm)	06/05/01 - 09/24/01	grab	15	631	1851	946	436	Not greater than 50% above background or 1,275 µmhos/cm
Dissolved Oxygen (mg/L)	06/05/01 - 09/24/01	grab	14	0.5	12.9	4.9	3.0	Not less than 5.0 mg/L
Water pH (units)	06/05/01 - 09/24/01	grab	15	6.8	8.3	7.7	0.4	Not less than 6.0 or greater than 8.5 units
Turbidity (NTU)	06/05/01 - 09/24/01	grab	11	6.8	42.6	21.4	15.5	Less than or equal to 29 NTU above background
Color (PCU)	06/05/01 - 09/24/01	grab	11	23	145	63	44	
Total Suspended Solids (mg/L)	06/05/01 - 09/24/01	grab	11	7.2	53.0	26.8	16.7	
Total Dissolved Solids (mg/L)	06/05/01 - 07/31/01	grab	5	386.0	552.0	426.8	70.8	
Hardness (mg/L as CaCO3)	06/05/01 - 07/31/01	grab	5	186.9	244.9	203.9	23.7	
Alkalinity (mg/L as CaCO3)	06/05/01 - 09/24/01	grab	11	125.0	318.9	178.2	64.5	
Nutrients								
Total Nitrogen (mg/L)	06/05/01 - 09/24/01	grab	20	1.4	7.5	3.0	1.8	
Total Kjeldahl Nitrogen (mg/L)	06/05/01 - 09/24/01	grab	20	1.3	5.9	2.7	1.4	
Nitrate+Nitrite as N (mg/L)	06/05/01 - 09/24/01	grab	20	0.007	1.598	0.332	0.496	
Nitrite as N (mg/L)	06/05/01 - 09/24/01	grab	12	<0.004	0.303	0.055	0.093	
Nitrate as N(mg/L)	06/05/01 - 09/24/01	grab	8	0.006	1.295	0.371	0.463	Equal or less than 10 mg/L as N
Ammonium as N (mg/L)	06/05/01 - 09/24/01	grab	20	<0.009	2.000	0.371	0.642	
Un-ionized Ammonia as NH_3 (mg/L)	06/05/01 - 09/24/01	grab	16	0.001	0.042	0.007	0.011	Equal or less than 0.02 mg/L as NH_3
Total Phosphorus (mg/L)	06/05/01 - 09/24/01	grab	20	0.104	0.421	0.184	0.071	
Orthophosphate as P (mg/L)	06/05/01 - 09/24/01	grab	12	0.008	0.163	0.060	0.044	
Silica (mg/L)	06/05/01 - 09/24/01	grab	5	8.387	16.529	10.486	3.402	
Major Ions								
Chloride (mg/L)	06/05/01 - 09/24/01	grab	11	80.740	271.280	120.051	58.907	Equal or less than 250 mg/L
Sulfate (mg/L)	06/05/01 - 07/31/01	grab	5	47.350	79.170	57.298	12.679	
Sodium (mg/L)	06/05/01 - 07/31/01	grab	5	49.557	92.043	59.560	18.255	
Potassium (mg/L)	06/05/01 - 07/31/01	grab	5	6.442	8.233	7.048	0.699	
Calcium (mg/L)	06/05/01 - 07/31/01	grab	5	48.354	60.439	53.349	4.412	
Magnesium (mg/L)	06/05/01 - 07/31/01	grab	5	13.936	22.817	17.172	3.391	
Phytoplankton Indicators								
Chlorophyll a (µg/L)	06/05/01 - 06/19/01	grab	2	21.0	26.3	23.7		
Chlorophyll a2 (µg/L)	06/05/01 - 06/19/01	grab	2	16.0	22.3	19.2		
Chlorophyll b (µg/L)	06/05/01 - 06/19/01	grab	2	<1	1.1	<1		
Chlorophyll c (µg/L)	06/05/01 - 06/19/01	grab	2	<1	<1	<1		
Pheophytin a (µg/L)	06/05/01 - 06/19/01	grab	2	5.0	7.8	6.4		
Carotenoid (µg/L)	06/05/01 - 06/19/01	grab	2	11.4	12.0	11.7		
Total Organic Carbon (mg/L)	06/05/01 - 07/31/01	grab	3	15.7	18.0	16.7	1.2	
Dissolved Organic Carbon (mg/L)	06/05/01 - 07/31/01	grab	4	15.5	17.2	16.4	0.7	

Table 19. Water Quality Data Summary at S2DOWN for June 1, 2001 through September 21, 2001 .

Parameters	Period	Sample Type	n	min	max	avg	S.D.	FAC 62-302 Class I Criteria
Physical								
Temperature (°C)	06/04/01 - 08/30/01	grab	11	25.5	31.0	28.3	1.7	
Specific Conductivity (µmhos/cm)	06/04/01 - 08/30/01	grab	11	786	1161	986	107	Not greater than 50% above background or 1,275 µmhos/cm
Dissolved Oxygen (mg/L)	06/04/01 - 08/30/01	grab	11	1.4	4.7	2.9	1.1	Not less than 5.0 mg/L
Water pH (units)	06/04/01 - 08/30/01	grab	11	7.0	7.5	7.1	0.2	Not less than 6.0 or greater than 8.5 units
Turbidity (NTU)	06/04/01 - 08/30/01	grab	11	3.2	17.3	10.1	3.8	Less than or equal to 29 NTU above background
Secchi Disk Depth, meters	06/10/01 - 08/30/01	grab	10	0.4	0.8	0.6	0.1	
Color (PCU)	06/04/01 - 08/30/01	grab	11	96	163	119	22	
Total Suspended Solids (mg/L)	06/04/01 - 08/30/01	grab	11	4.0	19.2	12.3	4.9	
Total Dissolved Solids (mg/L)	06/04/01 - 08/30/01	grab	11	491.0	759.0	628.7	78.0	
Hardness (mg/L as CaCO3)	06/04/01 - 08/30/01	grab	13	297.6	432.1	366.2	37.2	
Alkalinity (mg/L as CaCO3)	06/04/01 - 08/30/01	grab	11	207.4	330.5	275.1	40.6	
Nutrients								
Total Nitrogen (mg/L)	06/04/01 - 08/30/01	grab	11	2.0	5.0	3.5	1.0	
Total Kjeldahl Nitrogen (mg/L)	06/04/01 - 08/30/01	grab	11	2.0	3.5	2.7	0.4	
Total Dissolved Kjeldahl Nitrogen (mg/L)	06/04/01 - 08/30/01	grab	11	1.8	3.2	2.3	0.4	
Nitrate+Nitrite as N (mg/L)	06/04/01 - 08/30/01	grab	11	0.054	1.650	0.876	0.598	
Nitrite as N (mg/L)	06/04/01 - 08/30/01	grab	11	0.008	0.095	0.060	0.033	
Nitrate as N(mg/L)	06/04/01 - 08/30/01	grab	11	0.046	1.563	0.816	0.567	Equal or less than 10 mg/L as N
Ammonium as N (mg/L)	06/04/01 - 08/30/01	grab	11	0.024	0.620	0.255	0.187	
Un-ionized Ammonia as NH_3 (mg/L)	06/04/01 - 08/30/01	grab	11	0.001	0.005	0.003	0.001	Equal or less than 0.02 mg/L as NH_3
Total Phosphorus (mg/L)	06/04/01 - 08/30/01	grab	11	0.039	0.120	0.090	0.027	
Orthophosphate as P (mg/L)	06/04/01 - 08/30/01	grab	11	0.006	0.065	0.042	0.021	
Total Dissolved Phosphorus (mg/L)	06/04/01 - 08/30/01	grab	11	0.012	0.074	0.047	0.022	
Silica (mg/L)	06/04/01 - 08/30/01	grab	11	9.509	21.283	14.805	3.866	
Major Ions								
Chloride (mg/L)	06/04/01 - 08/30/01	grab	11	92.740	127.460	103.497	9.546	Equal or less than 250 mg/L
Sulfate (mg/L)	06/04/01 - 08/30/01	grab	11	20.700	105.410	65.976	24.214	
Sodium (mg/L)	06/04/01 - 08/30/01	grab	13	51.280	85.757	64.597	9.610	
Potassium (mg/L)	06/04/01 - 08/30/01	grab	13	6.778	9.196	7.785	0.793	
Calcium (mg/L)	06/04/01 - 08/30/01	grab	13	79.252	115.018	101.100	9.421	
Magnesium (mg/L)	06/04/01 - 08/30/01	grab	13	20.648	35.175	28.281	3.912	
Trace Metals								
Total Arsenic (µg/L)	07/18/01 - 08/02/01	grab	5	4.4	5.4	4.9	0.4	Less than or equal to 50 µg/L
Total Cadmium (µg/L)	07/18/01 - 08/02/01	grab	5	<0.3	<0.3	<0.3		Less than or equal to calculated value
Total Copper (µg/L)	07/18/01 - 08/02/01	grab	5	2.0	3.1	2.7	0.4	Less than or equal to calculated value
Total Iron (µg/L)	07/18/01 - 08/02/01	grab	5	149.5	322.1	225.5	81.3	Less than or equal to 300 µg/L
Total Lead (µg/L)	07/18/01 - 08/02/01	grab	5	<0.8	<0.8	<0.8		Less than or equal to calculated value
Total Zinc (µg/L)	07/18/01 - 08/02/01	grab	5	<4	<4	<4		Less than or equal to calculated value
Phytoplankton Indicators								
Chlorophyll a (µg/L)	06/04/01 - 08/30/01	grab	11	4.8	139.2	31.1	37.9	
Chlorophyll a2 (µg/L)	06/04/01 - 08/30/01	grab	10	3.5	125.4	25.0	36.7	
Chlorophyll b (µg/L)	06/04/01 - 08/30/01	grab	11	<1	3.7	1.1	1.0	
Chlorophyll c (µg/L)	06/04/01 - 08/30/01	grab	11	<1	10.2	2.7	3.0	
Pheophytin a (µg/L)	06/04/01 - 08/30/01	grab	11	2.0	14.3	8.0	4.0	
Carotenoid (µg/L)	06/04/01 - 08/30/01	grab	11	2.3	44.0	12.1	11.4	
Total Organic Carbon (mg/L)	06/04/01 - 08/30/01	grab	11	29.5	40.7	34.9	4.2	
Dissolved Organic Carbon (mg/L)	06/04/01 - 08/30/01	grab	11	30.1	42.6	35.3	4.9	

Table 20. Water Quality Data Summary at S3DOWN for June 1, 2001 through September 21, 2001 .

Parameters	Period	Sample Type	n	min	max	avg	S.D.	FAC 62-302 Class I Criteria
Physical								
Temperature (°C)	06/04/01 - 08/30/01	grab	11	26.1	33.2	29.3	2.0	
Specific Conductivity (µmhos/cm)	06/04/01 - 08/30/01	grab	11	668	981	867	103	Not greater than 50% above background or 1,275 µmhos/cm
Dissolved Oxygen (mg/L)	06/04/01 - 08/30/01	grab	11	2.4	8.8	4.2	1.8	Not less than 5.0 mg/L
Water pH (units)	06/04/01 - 08/30/01	grab	11	7.0	8.0	7.3	0.3	Not less than 6.0 or greater than 8.5 units
Turbidity (NTU)	06/04/01 - 08/30/01	grab	11	5.3	10.7	7.1	1.6	Less than or equal to 29 NTU above background
Secchi Disk Depth, meters	06/10/01 - 08/30/01	grab	10	0.6	0.9	0.7	0.1	
Color (PCU)	06/04/01 - 08/30/01	grab	11	31	148	115	34	
Total Suspended Solids (mg/L)	06/04/01 - 08/30/01	grab	10	4.8	14.8	9.2	2.9	
Total Dissolved Solids (mg/L)	06/04/01 - 08/30/01	grab	11	408.0	663.0	560.4	75.8	
Hardness (mg/L as CaCO3)	06/04/01 - 08/30/01	grab	12	186.3	374.8	320.7	52.8	
Alkalinity (mg/L as CaCO3)	06/04/01 - 08/30/01	grab	11	124.5	274.2	231.7	42.5	
Nutrients								
Total Nitrogen (mg/L)	06/04/01 - 08/30/01	grab	11	1.8	5.1	3.3	1.0	
Total Kjeldahl Nitrogen (mg/L)	06/04/01 - 08/30/01	grab	11	1.7	3.3	2.5	0.4	
Total Dissolved Kjeldahl Nitrogen (mg/L)	06/04/01 - 08/30/01	grab	11	1.3	2.8	2.1	0.4	
Nitrate+Nitrite as N (mg/L)	06/04/01 - 08/30/01	grab	11	0.091	1.918	0.751	0.700	
Nitrite as N (mg/L)	06/04/01 - 08/30/01	grab	11	0.018	0.085	0.043	0.023	
Nitrate as N(mg/L)	06/04/01 - 08/30/01	grab	11	0.052	1.833	0.708	0.680	Equal or less than 10 mg/L as N
Ammonium as N (mg/L)	06/04/01 - 08/30/01	grab	11	0.031	0.318	0.132	0.097	
Un-ionized Ammonia as NH_3 (mg/L)	06/04/01 - 08/30/01	grab	11	0.000	0.004	0.002	0.001	Equal or less than 0.02 mg/L as NH_3
Total Phosphorus (mg/L)	06/04/01 - 08/30/01	grab	11	0.042	0.121	0.066	0.022	
Orthophosphate as P (mg/L)	06/04/01 - 08/30/01	grab	10	0.006	0.043	0.021	0.015	
Total Dissolved Phosphorus (mg/L)	06/04/01 - 08/30/01	grab	11	0.012	0.050	0.026	0.015	
Silica (mg/L)	06/04/01 - 08/30/01	grab	11	6.773	12.559	9.598	1.871	
Major Ions								
Chloride (mg/L)	06/04/01 - 08/30/01	grab	11	74.760	110.540	94.734	9.969	Equal or less than 250 mg/L
Sulfate (mg/L)	06/04/01 - 08/30/01	grab	11	27.770	77.380	58.221	14.480	
Sodium (mg/L)	06/04/01 - 08/30/01	grab	12	48.690	64.542	56.653	5.343	
Potassium (mg/L)	06/04/01 - 08/30/01	grab	12	5.069	7.442	6.687	0.744	
Calcium (mg/L)	06/04/01 - 08/30/01	grab	12	46.598	112.413	97.916	18.213	
Magnesium (mg/L)	06/04/01 - 08/30/01	grab	12	12.915	22.890	18.746	3.098	
Trace Metals								
Total Arsenic (µg/L)	06/04/01 - 08/30/01	grab	4	3.3	5.0	4.3	0.8	Less than or equal to 50 µg/L
Total Cadmium (µg/L)	06/04/01 - 08/30/01	grab	4	<0.3	<0.3	<0.3		Less than or equal to calculated value
Total Copper (µg/L)	06/04/01 - 08/30/01	grab	4	2.5	3.4	2.9	0.4	Less than or equal to calculated value
Total Iron (µg/L)	06/04/01 - 08/30/01	grab	4	175.6	476.3	287.2	137.4	Less than or equal to 300 µg/L
Total Lead (µg/L)	06/04/01 - 08/30/01	grab	4	<0.8	<0.8	<0.8		Less than or equal to calculated value
Total Zinc (µg/L)	06/04/01 - 08/30/01	grab	4	<4	<4	<4		Less than or equal to calculated value
Phytoplankton Indicators								
Chlorophyll a (µg/L)	06/04/01 - 08/30/01	grab	11	7.8	133.4	35.2	37.8	
Chlorophyll a2 (µg/L)	06/04/01 - 08/30/01	grab	11	5.3	116.3	29.8	34.0	
Chlorophyll b (µg/L)	06/04/01 - 08/30/01	grab	11	<1	4.8	1.2	1.3	
Chlorophyll c (µg/L)	06/04/01 - 08/30/01	grab	11	<1	13.8	3.4	3.8	
Pheophytin a (µg/L)	06/04/01 - 08/30/01	grab	11	3.4	21.7	7.1	5.1	
Carotenoid (µg/L)	06/04/01 - 08/30/01	grab	11	4.4	48.2	14.0	12.9	
Total Organic Carbon (mg/L)	06/04/01 - 08/30/01	grab	11	21.9	42.1	34.4	5.3	
Dissolved Organic Carbon (mg/L)	06/04/01 - 08/30/01	grab	11	18.3	41.6	33.9	6.3	

Table 21a. Water Quality Data Summary at CUT1 for June 1, 2001 through September 21, 2001 .

Parameters	Period	Sample Type	n	min	max	avg	S.D.	FAC 62-302 Class I Criteria
Physical								
Temperature (°C)	06/04/01 - 08/30/01	grab	11	27.1	33.1	29.6	1.7	
Specific Conductivity (µmhos/cm)	06/04/01 - 08/30/01	grab	11	657	1112	864	137	Not greater than 50% above background or 1,275 µmhos/cm
Dissolved Oxygen (mg/L)	06/04/01 - 08/30/01	grab	11	3.0	8.4	5.2	1.8	Not less than 5.0 mg/L
Water pH (units)	06/04/01 - 08/30/01	grab	11	7.2	8.2	7.4	0.3	Not less than 6.0 or greater than 8.5 units
Turbidity (NTU)	06/04/01 - 08/30/01	grab	11	2.8	11.1	6.4	2.6	Less than or equal to 29 NTU above background
Secchi Disk Depth, meters	06/10/01 - 08/30/01	grab	9	0.4	1.0	0.6	0.2	
Color (PCU)	06/04/01 - 08/30/01	grab	11	32	177	107	42	
Total Suspended Solids (mg/L)	06/04/01 - 08/30/01	grab	11	4.4	18.4	8.4	4.3	
Total Dissolved Solids (mg/L)	06/04/01 - 08/30/01	grab	11	425.0	704.0	552.5	88.4	
Hardness (mg/L as CaCO3)	06/04/01 - 08/30/01	grab	12	194.3	381.3	302.6	56.1	
Alkalinity (mg/L as CaCO3)	06/04/01 - 08/30/01	grab	11	125.6	274.6	220.0	48.5	
Nutrients								
Total Nitrogen (mg/L)	06/04/01 - 08/30/01	grab	11	1.8	4.3	2.9	0.7	
Total Kjeldahl Nitrogen (mg/L)	06/04/01 - 08/30/01	grab	11	1.7	3.0	2.4	0.4	
Total Dissolved Kjeldahl Nitrogen (mg/L)	06/04/01 - 08/30/01	grab	11	1.3	2.9	2.0	0.4	
Nitrate+Nitrite as N (mg/L)	06/04/01 - 08/30/01	grab	11	0.028	1.282	0.516	0.432	
Nitrite as N (mg/L)	06/04/01 - 08/30/01	grab	11	0.007	0.108	0.043	0.029	
Nitrate as N(mg/L)	06/04/01 - 08/30/01	grab	11	0.021	1.174	0.474	0.407	Equal or less than 10 mg/L as N
Ammonium as N (mg/L)	06/04/01 - 08/30/01	grab	11	0.011	0.405	0.167	0.124	
Un-ionized Ammonia as NH_3 (mg/L)	06/04/01 - 08/30/01	grab	11	0.001	0.014	0.004	0.004	Equal or less than 0.02 mg/L as NH_3
Total Phosphorus (mg/L)	06/04/01 - 08/30/01	grab	11	0.045	0.196	0.083	0.043	
Orthophosphate as P (mg/L)	06/04/01 - 08/30/01	grab	10	0.005	0.040	0.019	0.013	
Total Dissolved Phosphorus (mg/L)	06/04/01 - 08/30/01	grab	11	0.013	0.051	0.027	0.012	
Silica (mg/L)	06/04/01 - 08/30/01	grab	11	6.395	14.979	10.809	2.857	
Major Ions								
Chloride (mg/L)	06/04/01 - 08/30/01	grab	11	69.590	122.810	98.039	13.881	Equal or less than 250 mg/L
Sulfate (mg/L)	06/04/01 - 08/30/01	grab	11	41.270	92.910	60.647	15.599	
Sodium (mg/L)	06/04/01 - 08/30/01	grab	12	39.017	83.865	61.289	11.664	
Potassium (mg/L)	06/04/01 - 08/30/01	grab	12	5.490	8.507	7.054	0.967	
Calcium (mg/L)	06/04/01 - 08/30/01	grab	12	48.495	113.773	91.276	18.833	
Magnesium (mg/L)	06/04/01 - 08/30/01	grab	12	12.064	24.551	18.247	3.822	
Trace Metals								
Total Arsenic (µg/L)	06/04/01 - 08/30/01	grab	4	3.1	5.7	4.2	1.1	Less than or equal to 50 µg/L
Total Cadmium (µg/L)	06/04/01 - 08/30/01	grab	4	<0.3	<0.3	<0.3		Less than or equal to calculated value
Total Copper (µg/L)	06/04/01 - 08/30/01	grab	4	1.9	2.7	2.3	0.3	Less than or equal to calculated value
Total Iron (µg/L)	06/04/01 - 08/30/01	grab	4	76.3	216.6	144.6	57.3	Less than or equal to 300 µg/L
Total Lead (µg/L)	06/04/01 - 08/30/01	grab	4	<0.8	<0.8	<0.8		Less than or equal to calculated value
Total Zinc (µg/L)	06/04/01 - 08/30/01	grab	4	<4	<4	<4		Less than or equal to calculated value
Phytoplankton Indicators								
Chlorophyll a (µg/L)	06/04/01 - 08/30/01	grab	11	11.8	167.7	44.2	44.1	
Chlorophyll a2 (µg/L)	06/04/01 - 08/30/01	grab	11	10.2	149.6	36.9	39.9	
Chlorophyll b (µg/L)	06/04/01 - 08/30/01	grab	11	<1	4.4	1.6	1.4	
Chlorophyll c (µg/L)	06/04/01 - 08/30/01	grab	11	<1	13.6	3.6	3.7	
Pheophytin a (µg/L)	06/04/01 - 08/30/01	grab	11	2.1	20.2	9.9	5.6	
Carotenoid (µg/L)	06/04/01 - 08/30/01	grab	11	5.0	56.8	16.4	14.3	
Total Organic Carbon (mg/L)	06/04/01 - 08/30/01	grab	11	21.1	39.4	32.8	6.5	
Dissolved Organic Carbon (mg/L)	06/04/01 - 08/30/01	grab	11	19.7	39.6	32.3	6.9	

Table 21b. Water Quality Data Summary at CUT2 for June 1, 2001 through September 21, 2001 .

Parameters	Period	Sample Type	n	min	max	avg	S.D.	FAC 62-302 Class I Criteria
Physical								
Temperature (°C)	07/28/01 - 08/30/01	grab	3	31.8	33.6	32.6	0.9	
Specific Conductivity (µmhos/cm)	07/28/01 - 08/30/01	grab	3	805	1082	920	145	Not greater than 50% above background or 1,275 µmhos/cm
Dissolved Oxygen (mg/L)	07/28/01 - 08/30/01	grab	3	0.3	6.2	3.7	3.1	Not less than 5.0 mg/L
Water pH (units)	07/28/01 - 08/30/01	grab	3	7.1	7.9	7.4	0.4	Not less than 6.0 or greater than 8.5 units
Turbidity (NTU)	07/28/01 - 08/30/01	grab	3	3.5	6.7	5.3	1.7	Less than or equal to 29 NTU above background
Secchi Disk Depth, meters	08/17/01 - 08/30/01	grab	2	0.6	0.7	0.7		
Color (PCU)	07/28/01 - 08/30/01	grab	3	118	149	138	17	
Total Suspended Solids (mg/L)	07/28/01 - 08/30/01	grab	3	4.0	7.4	5.6	1.7	
Total Dissolved Solids (mg/L)	07/28/01 - 08/30/01	grab	3	527.0	676.0	594.3	75.5	
Hardness (mg/L as CaCO3)	07/28/01 - 07/28/01	grab	1			310.9		
Alkalinity (mg/L as CaCO3)	07/28/01 - 08/30/01	grab	3	217.7	303.6	251.0	46.1	
Nutrients								
Total Nitrogen (mg/L)	07/28/01 - 08/30/01	grab	3	2.6	3.2	2.8	0.4	
Total Kjeldahl Nitrogen (mg/L)	07/28/01 - 08/30/01	grab	3	2.3	2.5	2.5	0.1	
Total Dissolved Kjeldahl Nitrogen (mg/L)	07/28/01 - 08/30/01	grab	3	1.9	2.2	2.1	0.2	
Nitrate+Nitrite as N (mg/L)	07/28/01 - 08/30/01	grab	3	0.077	0.910	0.380	0.461	
Nitrite as N (mg/L)	07/28/01 - 08/30/01	grab	3	0.017	0.043	0.030	0.013	
Nitrate as N(mg/L)	07/28/01 - 08/30/01	grab	3	0.060	0.867	0.350	0.449	Equal or less than 10 mg/L as N
Ammonium as N (mg/L)	07/28/01 - 08/30/01	grab	3	0.018	0.082	0.047	0.032	
Un-ionized Ammonia as NH_3 (mg/L)	07/28/01 - 08/30/01	grab	3	0.000	0.004	0.002	0.002	Equal or less than 0.02 mg/L as NH_3
Total Phosphorus (mg/L)	07/28/01 - 08/30/01	grab	3	0.057	0.102	0.077	0.023	
Orthophosphate as P (mg/L)	07/28/01 - 08/30/01	grab	3	0.016	0.023	0.020	0.004	
Total Dissolved Phosphorus (mg/L)	07/28/01 - 08/30/01	grab	3	0.025	0.036	0.031	0.006	
Silica (mg/L)	07/28/01 - 08/30/01	grab	3	8.374	17.172	12.693	4.401	
Major Ions								
Chloride (mg/L)	07/28/01 - 08/30/01	grab	3	92.400	131.320	107.323	20.987	Equal or less than 250 mg/L
Sulfate (mg/L)	07/28/01 - 08/30/01	grab	3	47.770	48.680	48.370	0.520	
Sodium (mg/L)	07/28/01 - 07/28/01	grab	1			59.852		
Potassium (mg/L)	07/28/01 - 07/28/01	grab	1			6.110		
Calcium (mg/L)	07/28/01 - 07/28/01	grab	1			99.425		
Magnesium (mg/L)	07/28/01 - 07/28/01	grab	1			15.222		
Phytoplankton Indicators								
Chlorophyll a (µg/L)	07/28/01 - 08/30/01	grab	3	14.1	55.0	37.4	21.0	
Chlorophyll a2 (µg/L)	07/28/01 - 08/30/01	grab	3	8.3	45.3	29.8	19.2	
Chlorophyll b (µg/L)	07/28/01 - 08/30/01	grab	3	1.7	3.8	2.7	1.1	
Chlorophyll c (µg/L)	07/28/01 - 08/30/01	grab	3	1.4	5.1	2.9	1.9	
Pheophytin a (µg/L)	07/28/01 - 08/30/01	grab	3	9.2	13.5	11.0	2.2	
Carotenoid (µg/L)	07/28/01 - 08/30/01	grab	3	5.9	21.0	14.5	7.8	
Total Organic Carbon (mg/L)	07/28/01 - 08/30/01	grab	3	35.4	42.1	38.3	3.5	
Dissolved Organic Carbon (mg/L)	07/28/01 - 08/30/01	grab	3	34.7	42.8	38.5	4.1	

Table 21c. Water Quality Data Summary at CUT3 for June 1, 2001 through September 21, 2001 .

Parameters	Period	Sample Type	n	min	max	avg	S.D.	FAC 62-302 Class I Criteria
Physical								
Temperature (°C)	06/04/01 - 08/30/01	grab	11	25.8	32.0	29.7	1.7	
Specific Conductivity (µmhos/cm)	06/04/01 - 08/30/01	grab	11	780	1157	960	103	Not greater than 50% above background or 1,275 µmhos/cm
Dissolved Oxygen (mg/L)	06/04/01 - 08/30/01	grab	11	1.4	9.5	5.0	2.6	Not less than 5.0 mg/L
Water pH (units)	06/04/01 - 08/30/01	grab	11	7.0	8.1	7.4	0.4	Not less than 6.0 or greater than 8.5 units
Turbidity (NTU)	06/04/01 - 08/30/01	grab	11	2.9	24.3	14.1	7.0	Less than or equal to 29 NTU above background
Secchi Disk Depth, meters	06/10/01 - 08/30/01	grab	10	0.3	0.9	0.5	0.2	
Color (PCU)	06/04/01 - 08/30/01	grab	11	80	144	110	21	
Total Suspended Solids (mg/L)	06/04/01 - 08/30/01	grab	11	2.8	45.0	19.9	13.9	
Total Dissolved Solids (mg/L)	06/04/01 - 08/30/01	grab	11	494.0	776.0	613.8	80.0	
Hardness (mg/L as CaCO3)	06/04/01 - 08/30/01	grab	12	281.7	431.9	344.5	41.7	
Alkalinity (mg/L as CaCO3)	06/04/01 - 08/30/01	grab	11	198.2	318.4	258.7	39.3	
Nutrients								
Total Nitrogen (mg/L)	06/04/01 - 08/30/01	grab	11	2.0	5.7	3.7	1.1	
Total Kjeldahl Nitrogen (mg/L)	06/04/01 - 08/30/01	grab	11	2.0	3.9	2.9	0.7	
Total Dissolved Kjeldahl Nitrogen (mg/L)	06/04/01 - 08/30/01	grab	11	1.6	2.7	2.2	0.3	
Nitrate+Nitrite as N (mg/L)	06/04/01 - 08/30/01	grab	11	0.041	1.843	0.788	0.603	
Nitrite as N (mg/L)	06/04/01 - 08/30/01	grab	11	0.011	0.135	0.066	0.044	
Nitrate as N(mg/L)	06/04/01 - 08/30/01	grab	11	0.029	1.747	0.721	0.566	Equal or less than 10 mg/L as N
Ammonium as N (mg/L)	06/04/01 - 08/30/01	grab	11	0.012	0.626	0.181	0.168	
Un-ionized Ammonia as NH_3 (mg/L)	06/04/01 - 08/30/01	grab	11	0.001	0.009	0.003	0.002	Equal or less than 0.02 mg/L as NH_3
Total Phosphorus (mg/L)	06/04/01 - 08/30/01	grab	11	0.052	0.366	0.122	0.092	
Orthophosphate as P (mg/L)	06/04/01 - 08/30/01	grab	11	0.006	0.059	0.025	0.018	
Total Dissolved Phosphorus (mg/L)	06/04/01 - 08/30/01	grab	11	0.013	0.067	0.032	0.018	
Silica (mg/L)	06/04/01 - 08/30/01	grab	11	8.730	22.064	13.657	3.875	
Major Ions								
Chloride (mg/L)	06/04/01 - 08/30/01	grab	11	94.040	128.850	104.712	9.659	Equal or less than 250 mg/L
Sulfate (mg/L)	06/04/01 - 08/30/01	grab	11	24.810	108.510	65.387	20.962	
Sodium (mg/L)	06/04/01 - 08/30/01	grab	12	54.029	73.595	63.886	6.087	
Potassium (mg/L)	06/04/01 - 08/30/01	grab	12	6.681	8.494	7.240	0.619	
Calcium (mg/L)	06/04/01 - 08/30/01	grab	12	74.272	114.961	97.111	11.737	
Magnesium (mg/L)	06/04/01 - 08/30/01	grab	12	20.514	35.174	24.831	4.513	
Trace Metals								
Total Arsenic (µg/L)	07/18/01 - 07/30/01	grab	4	4.5	4.9	4.7	0.2	Less than or equal to 50 µg/L
Total Cadmium (µg/L)	07/18/01 - 07/30/01	grab	4	<0.3	<0.3	<0.3		Less than or equal to calculated value
Total Copper (µg/L)	07/18/01 - 07/30/01	grab	4	2.6	3.5	2.9	0.4	Less than or equal to calculated value
Total Iron (µg/L)	07/18/01 - 07/30/01	grab	4	96.3	507.8	236.0	184.5	Less than or equal to 300 µg/L
Total Lead (µg/L)	07/18/01 - 07/30/01	grab	4	<0.8	<0.8	<0.8		Less than or equal to calculated value
Total Zinc (µg/L)	07/18/01 - 07/30/01	grab	4	<4	<4	<4		Less than or equal to calculated value
Phytoplankton Indicators								
Chlorophyll a (µg/L)	06/04/01 - 08/30/01	grab	11	6.9	332.3	83.5	109.9	
Chlorophyll a2 (µg/L)	06/04/01 - 08/30/01	grab	11	5.9	286.8	72.8	98.6	
Chlorophyll b (µg/L)	06/04/01 - 08/30/01	grab	11	<1	5.3	1.9	2.0	
Chlorophyll c (µg/L)	06/04/01 - 08/30/01	grab	11	<1	22.5	6.9	7.5	
Pheophytin a (µg/L)	06/04/01 - 08/30/01	grab	11	1.4	55.0	13.1	14.4	
Carotenoid (µg/L)	06/04/01 - 08/30/01	grab	11	2.8	128.9	32.4	40.4	
Total Organic Carbon (mg/L)	06/04/01 - 08/30/01	grab	11	28.6	42.0	35.1	4.6	
Dissolved Organic Carbon (mg/L)	06/04/01 - 08/30/01	grab	11	27.3	42.9	34.4	4.9	

Table 22. Water Quality Data Summary at INT for June 1, 2001 through September 21, 2001 .

Station	Parameters	Period	Sample Type	n	min	max	avg	S.D.	FAC 62-302 Class I Criteria
BGINT	***Physical***								
	Temperature (°C)	06/04/01 - 08/30/01	grab	11	25.6	31.8	28.5	1.8	
	Specific Conductivity (µmhos/cm)	06/04/01 - 08/30/01	grab	11	775	1168	1005	112	Not greater than 50% above background or 1,275 µmhos/cm
	Dissolved Oxygen (mg/L)	06/04/01 - 08/30/01	grab	11	1.3	5.4	3.1	1.2	Not less than 5.0 mg/L
	Water pH (units)	06/04/01 - 08/30/01	grab	11	7.0	7.3	7.1	0.1	Not less than 6.0 or greater than 8.5 units
	Secchi Disk Depth, meters	06/10/01 - 08/30/01	grab	10	0.3	0.9	0.6	0.2	
	Color (PCU)	06/04/01 - 08/03/01	grab	9	96	165	125	21	
	Total Dissolved Solids (mg/L)	08/17/01 - 08/30/01	grab	2	492.0	657.0	574.5		
	Major Ions								
	Chloride (mg/L)	08/17/01 - 08/30/01	grab	2	99.010	124.790	111.900		Equal or less than 250 mg/L
	Phytoplankton Indicators								
	Total Organic Carbon (mg/L)	06/04/01 - 08/30/01	grab	11	30.3	43.5	36.6	4.4	
	Dissolved Organic Carbon (mg/L)	06/04/01 - 08/30/01	grab	11	30.7	44.2	36.8	4.9	
SBINT	***Physical***								
	Temperature (°C)	06/04/01 - 08/30/01	grab	11	27.3	32.5	29.8	1.4	
	Specific Conductivity (µmhos/cm)	06/04/01 - 08/30/01	grab	11	704	1035	891	110	Not greater than 50% above background or 1,275 µmhos/cm
	Dissolved Oxygen (mg/L)	06/04/01 - 08/30/01	grab	11	1.8	9.0	5.9	2.2	Not less than 5.0 mg/L
	Water pH (units)	06/04/01 - 08/30/01	grab	11	7.1	8.0	7.5	0.3	Not less than 6.0 or greater than 8.5 units
	Secchi Disk Depth	06/10/01 - 08/30/01	grab	10	0.3	0.9	0.6	0.2	
	Color (PCU)	06/04/01 - 08/30/01	grab	9	40	117	94	25	
	Total Dissolved Solids (mg/L)	08/17/01 - 08/30/01	grab	2	492.0	642.0	567.0		
	Major Ions								
	Chloride (mg/L)	08/17/01 - 08/30/01	grab	2	83.370	126.270	104.820		Equal or less than 250 mg/L
	Phytoplankton Indicators								
	Total Organic Carbon (mg/L)	06/04/01 - 08/30/01	grab	11	21.5	40.4	33.6	5.4	
	Dissolved Organic Carbon (mg/L)	06/04/01 - 08/30/01	grab	11	20.5	42.8	33.4	6.5	
PHINT	***Physical***								
	Temperature (°C)	06/10/01 - 08/30/01	grab	10	25.6	33.6	29.5	2.3	
	Specific Conductivity (µmhos/cm)	06/10/01 - 08/30/01	grab	10	602	988	745	110	Not greater than 50% above background or 1,275 µmhos/cm
	Dissolved Oxygen (mg/L)	06/10/01 - 08/30/01	grab	10	4.1	8.3	6.0	1.4	Not less than 5.0 mg/L
	Water pH (units)	06/10/01 - 08/30/01	grab	10	7.5	8.3	7.9	0.3	Not less than 6.0 or greater than 8.5 units
	Color (PCU)	06/10/01 - 08/03/01	grab	8	21	100	45	28	
	Total Dissolved Solids (mg/L)	06/17/08 - 08/30/01	grab	2	418.0	490.0	454.0		
	Major Ions								
	Chloride (mg/L)	06/17/08 - 08/30/01	grab	2	92.260	97.750	95.005		Equal or less than 250 mg/L
	Phytoplankton Indicators								
	Total Organic Carbon (mg/L)	06/10/01 - 08/30/01	grab	10	14.6	33.9	22.0	5.5	
	Dissolved Organic Carbon (mg/L)	06/10/01 - 08/30/01	grab	10	13.8	33.0	21.6	5.6	

Table 23. Water Quality Data Summary at Rim Canals for June 1, 2001 through September 21, 2001 .

Station	Parameters	Period	Sample Type	n	min	max	avg	S.D.	FAC 62-302 Class I Criteria
RC1	***Physical***								
	Temperature (°C)	06/04/01 - 08/30/01	grab	11	26.5	32.2	29.0	1.8	
	Specific Conductivity (µmhos/cm)	06/04/01 - 08/30/01	grab	11	705	1186	994	146	Not greater than 50% above background or 1,275 µmhos/cm
	Dissolved Oxygen (mg/L)	06/04/01 - 08/30/01	grab	11	1.9	6.4	3.9	1.5	Not less than 5.0 mg/L
	Water pH (units)	06/04/01 - 08/30/01	grab	11	7.1	7.8	7.3	0.2	Not less than 6.0 or greater than 8.5 units
	Turbidity (NTU)	06/04/01 - 08/30/01	grab	11	5.6	18.0	10.5	3.1	Less than or equal to 29 NTU above background
	Secchi Disk Depth, meters	06/10/01 - 08/30/01	grab	10	0.4	0.9	0.6	0.2	
	Color (PCU)	06/04/01 - 08/30/01	grab	10	56	154	106	29	
RC3	***Physical***								
	Temperature (°C)	06/04/01 - 08/30/01	grab	11	27.0	31.5	29.6	1.4	
	Specific Conductivity (µmhos/cm)	06/04/01 - 08/30/01	grab	11	708	1062	889	119	Not greater than 50% above background or 1,275 µmhos/cm
	Dissolved Oxygen (mg/L)	06/04/01 - 08/30/01	grab	11	2.9	8.9	6.1	2.3	Not less than 5.0 mg/L
	Water pH (units)	06/04/01 - 08/30/01	grab	11	7.2	8.0	7.5	0.3	Not less than 6.0 or greater than 8.5 units
	Turbidity (NTU)	06/04/01 - 08/30/01	grab	11	5.0	25.1	9.9	6.1	Less than or equal to 29 NTU above background
	Secchi Disk Depth	06/10/01 - 08/30/01	grab	10	0.3	0.8	0.5	0.1	
	Color (PCU)	06/04/01 - 08/30/01	grab	11	42	144	102	32	
RC6	***Physical***								
	Temperature (°C)	06/10/01 - 08/30/01	grab	9	26.8	32.3	29.5	1.9	
	Specific Conductivity (µmhos/cm)	06/10/01 - 08/30/01	grab	9	349	824	613	148	Not greater than 50% above background or 1,275 µmhos/cm
	Dissolved Oxygen (mg/L)	06/10/01 - 08/30/01	grab	9	0.3	7.0	3.1	2.1	Not less than 5.0 mg/L
	Water pH (units)	06/10/01 - 08/30/01	grab	9	6.7	7.4	7.1	0.2	Not less than 6.0 or greater than 8.5 units
	Turbidity (NTU)	06/10/01 - 08/30/01	grab	9	1.6	10.2	6.9	2.7	Less than or equal to 29 NTU above background
	Secchi Disk Depth	06/10/01 - 08/17/01	grab	7	0.2	0.8	0.5	0.2	
	Color (PCU)	06/10/01 - 08/30/01	grab	9	82	556	209	178	
RC29	***Physical***								
	Temperature (°C)	0604/01 - 08/30/01	grab	11	26.0	32.3	28.6	1.8	
	Specific Conductivity (µmhos/cm)	0604/01 - 08/30/01	grab	11	790	1145	1019	108	Not greater than 50% above background or 1,275 µmhos/cm
	Dissolved Oxygen (mg/L)	0604/01 - 08/30/01	grab	11	2.2	6.6	3.4	1.3	Not less than 5.0 mg/L
	Water pH (units)	0604/01 - 08/30/01	grab	11	7.0	7.6	7.2	0.2	Not less than 6.0 or greater than 8.5 units
	Turbidity (NTU)	0604/01 - 08/30/01	grab	11	4.0	16.4	8.5	3.2	Less than or equal to 29 NTU above background
	Secchi Disk Depth	06/10/01 - 08/30/01	grab	10	0.3	0.8	0.6	0.1	
	Color (PCU)	0604/01 - 08/30/01	grab	11	92	160	123	21	

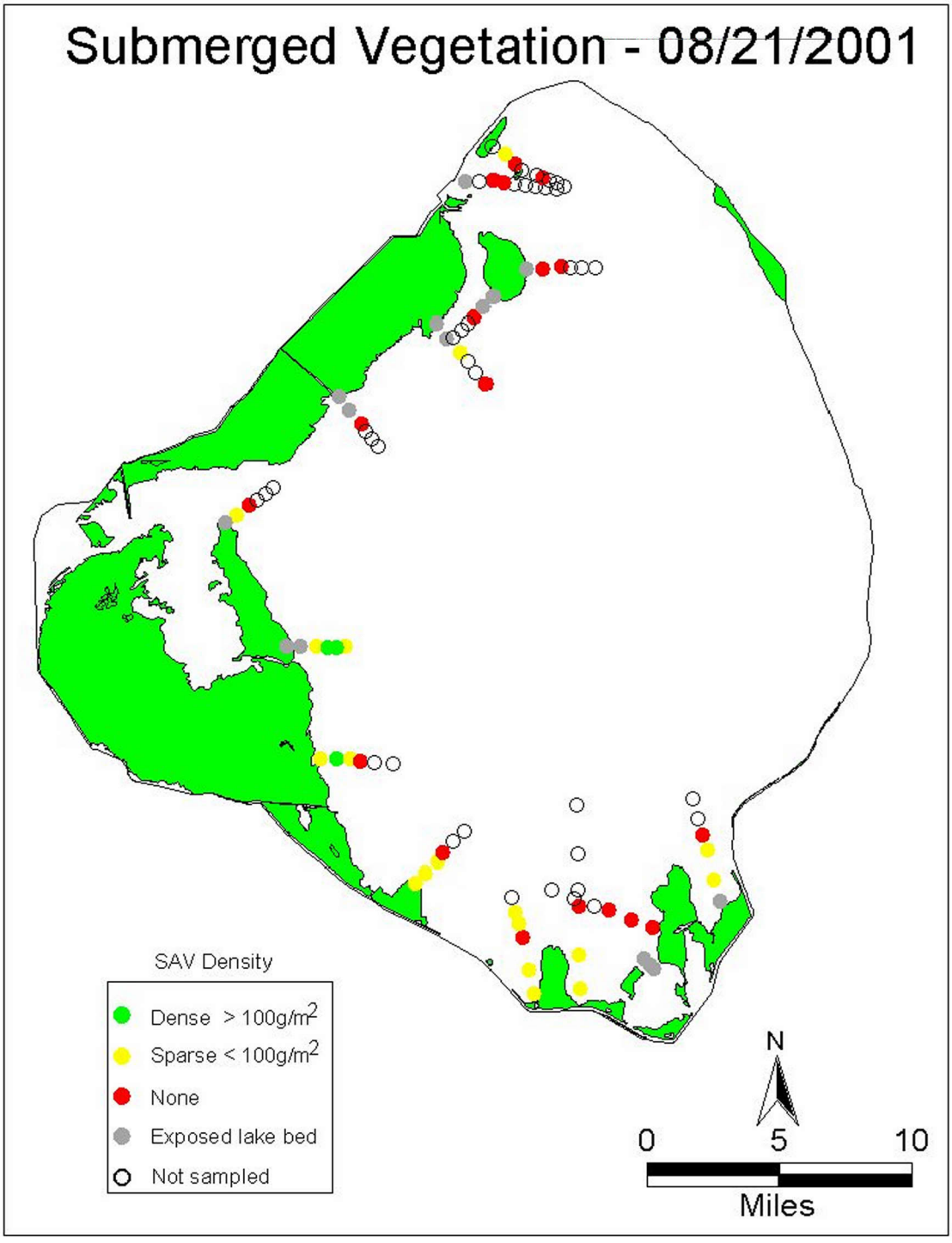

Submerged Vegetation - 08/21/2001
SAV Density
Dense > 100g/m2
Sparse < 100g/m2
None
Exposed lake bed
Not sampled
N
0
5
10
Miles

Figure B1.

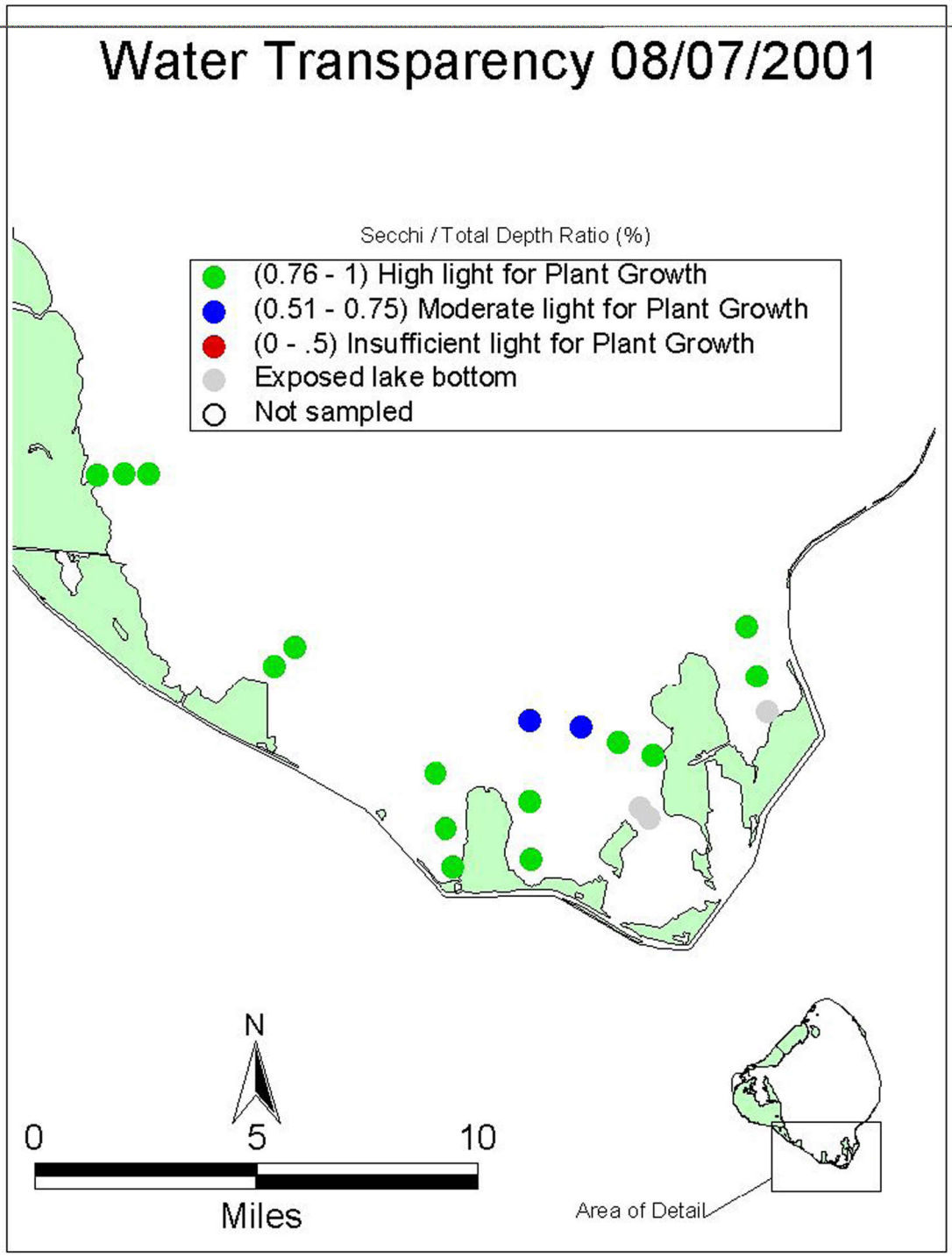

Water Transparency 08/07/2001
Secchi / Total Depth Ratio (%)
(0.76 - 1) High light for Plant Growth
(0.51 - 0.75) Moderate light for Plant Growth
(0 - .5) Insufficient light for Plant Growth
Exposed lake bottom
Not sampled
N
0
5
10
Miles
Area of Detail

Figure B2.

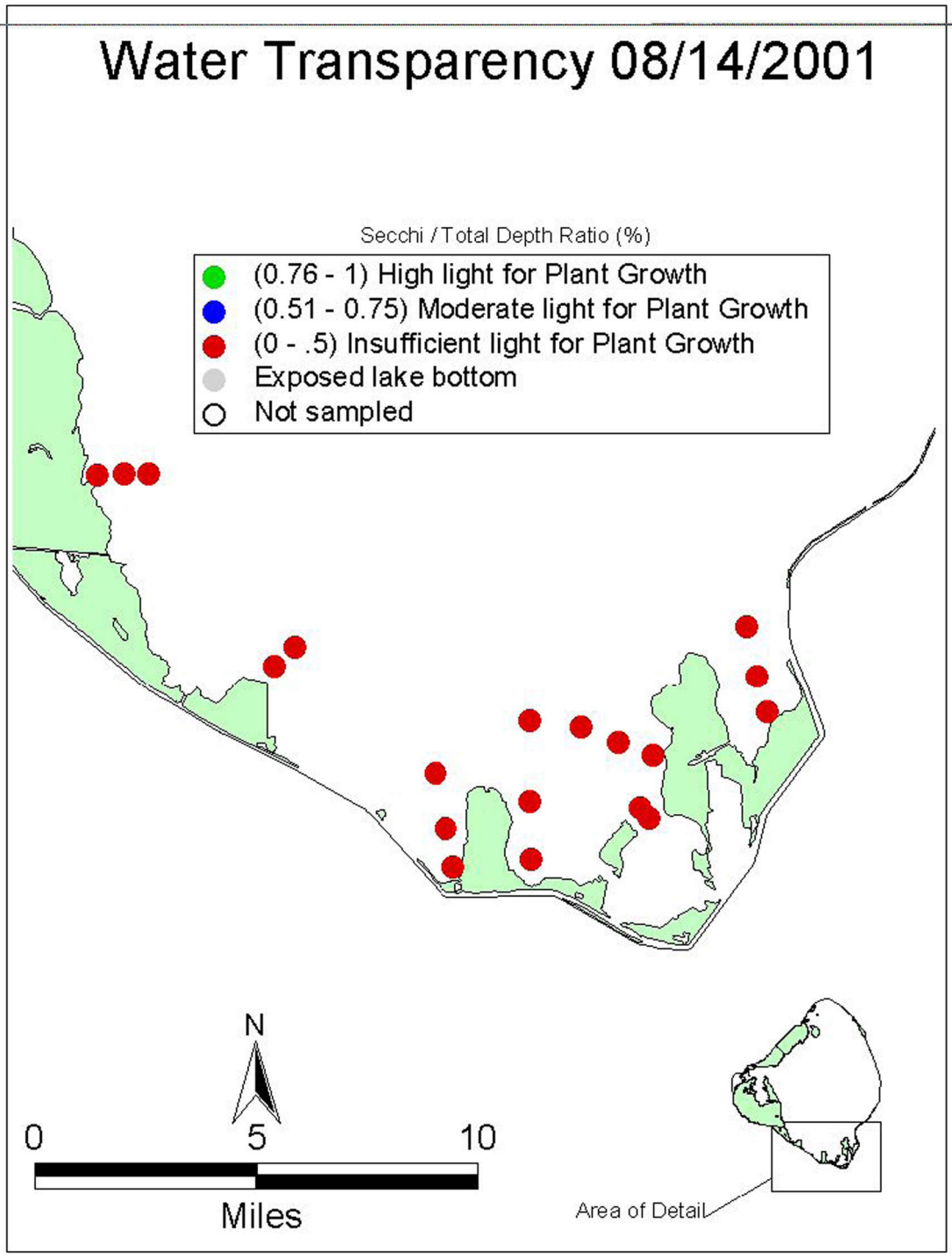

Water Transparency 08/14/2001
Secchi / Total Depth Ratio (%)
(0.76 - 1) High light for Plant Growth
(0.51 - 0.75) Moderate light for Plant Growth
(0 - .5) Insufficient light for Plant Growth
Exposed lake bottom
Not sampled
N
0
5
10
Miles
Area of Detail

Figure B3.

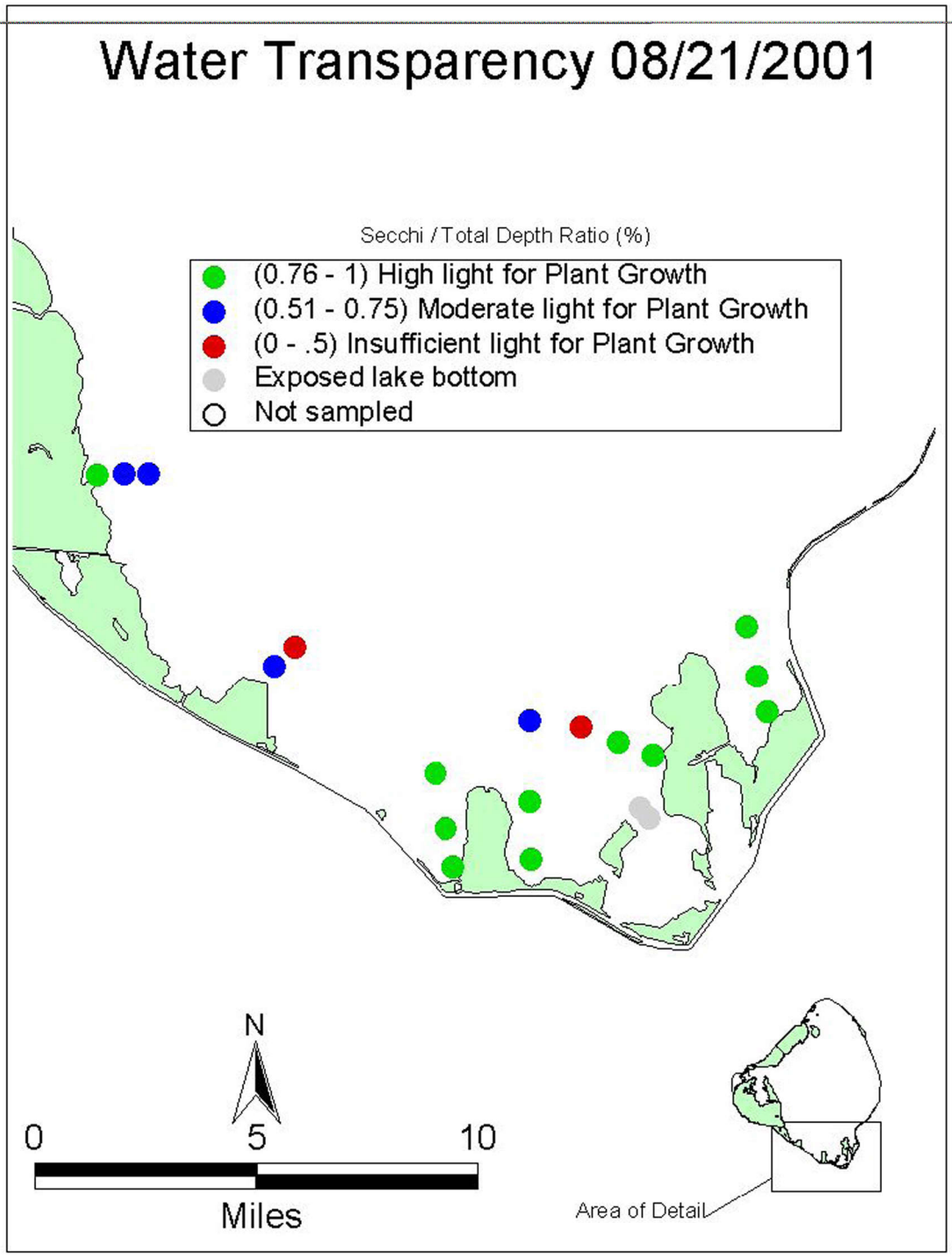

Water Transparency 08/21/2001
Secchi / Total Depth Ratio (%)
(0.76 - 1) High light for Plant Growth
(0.51 - 0.75) Moderate light for Plant Growth
(0 - .5) Insufficient light for Plant Growth
Exposed lake bottom
Not sampled
N
0
5
10
Miles
Area of Detail

Figure B4.

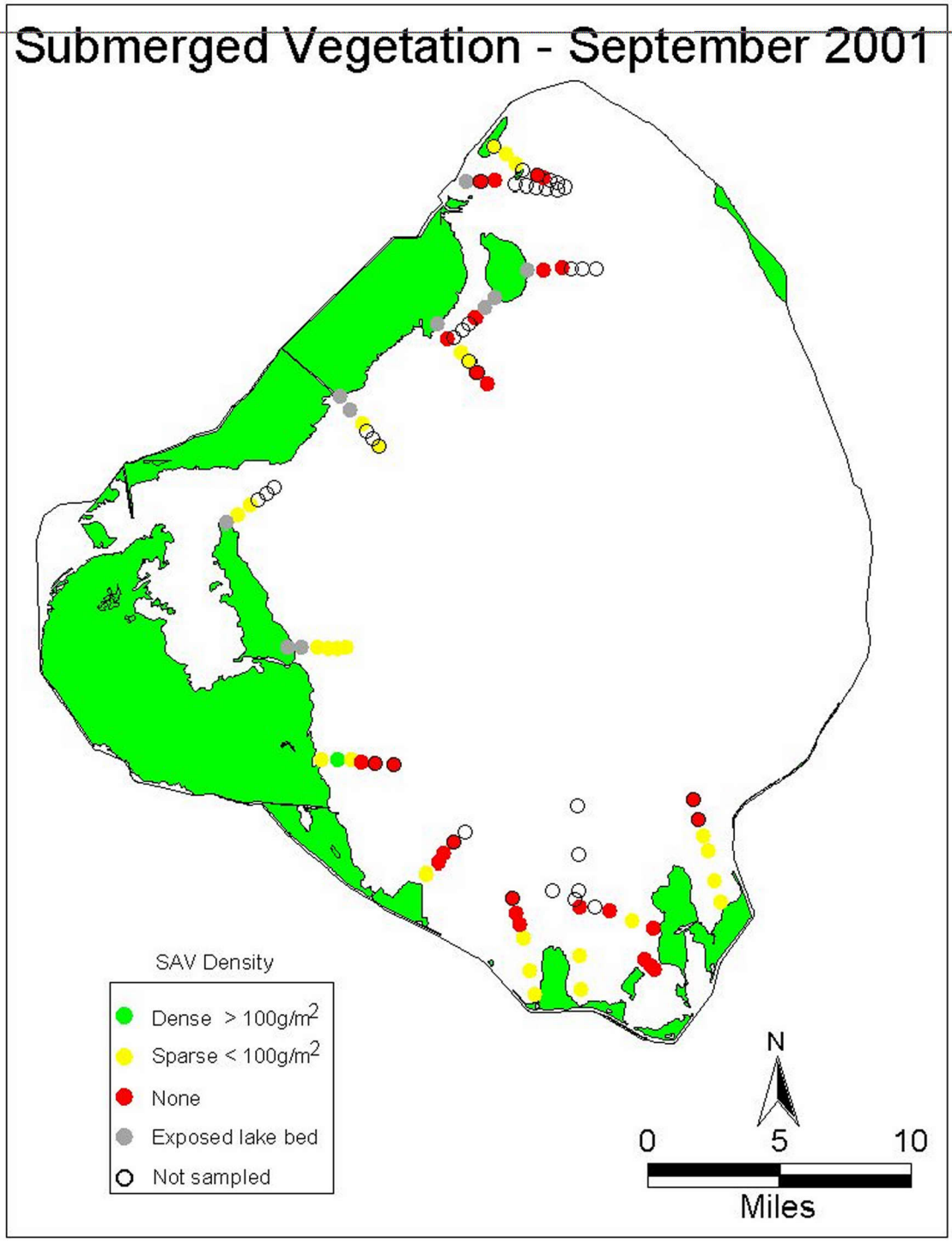

Submerged Vegetation - September 2001
SAV Density
Dense > 100g/m2
Sparse < 100g/m2
None
Exposed lake bed
Not sampled
N
0
5
10
Miles

Figure B5.

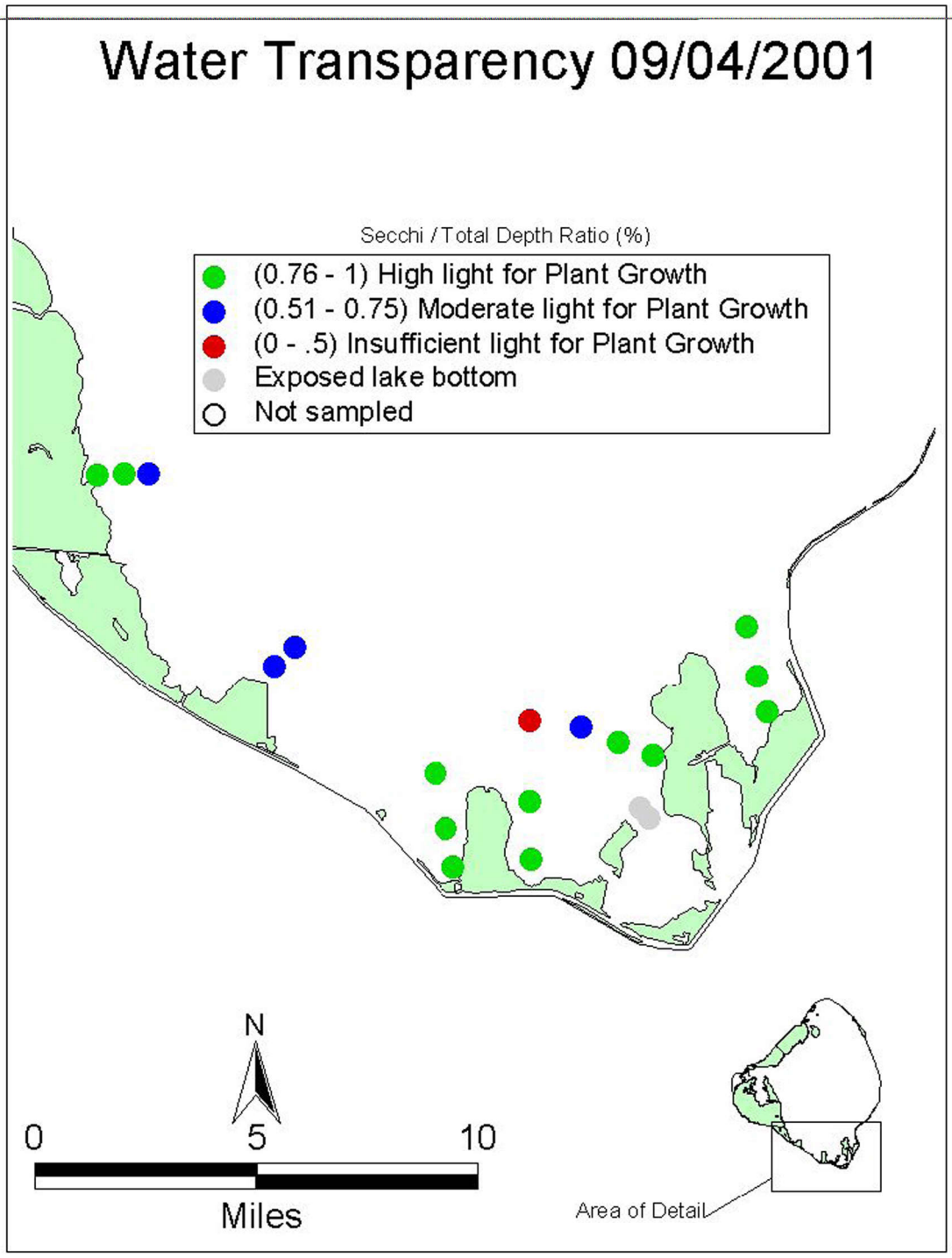

Water Transparency 09/04/2001
Secchi / Total Depth Ratio (%)
(0.76 - 1) High light for Plant Growth
(0.51 - 0.75) Moderate light for Plant Growth
(0 - .5) Insufficient light for Plant Growth
Exposed lake bottom
Not sampled
N
0
5
10
Miles
Area of Detail

Figure B6.

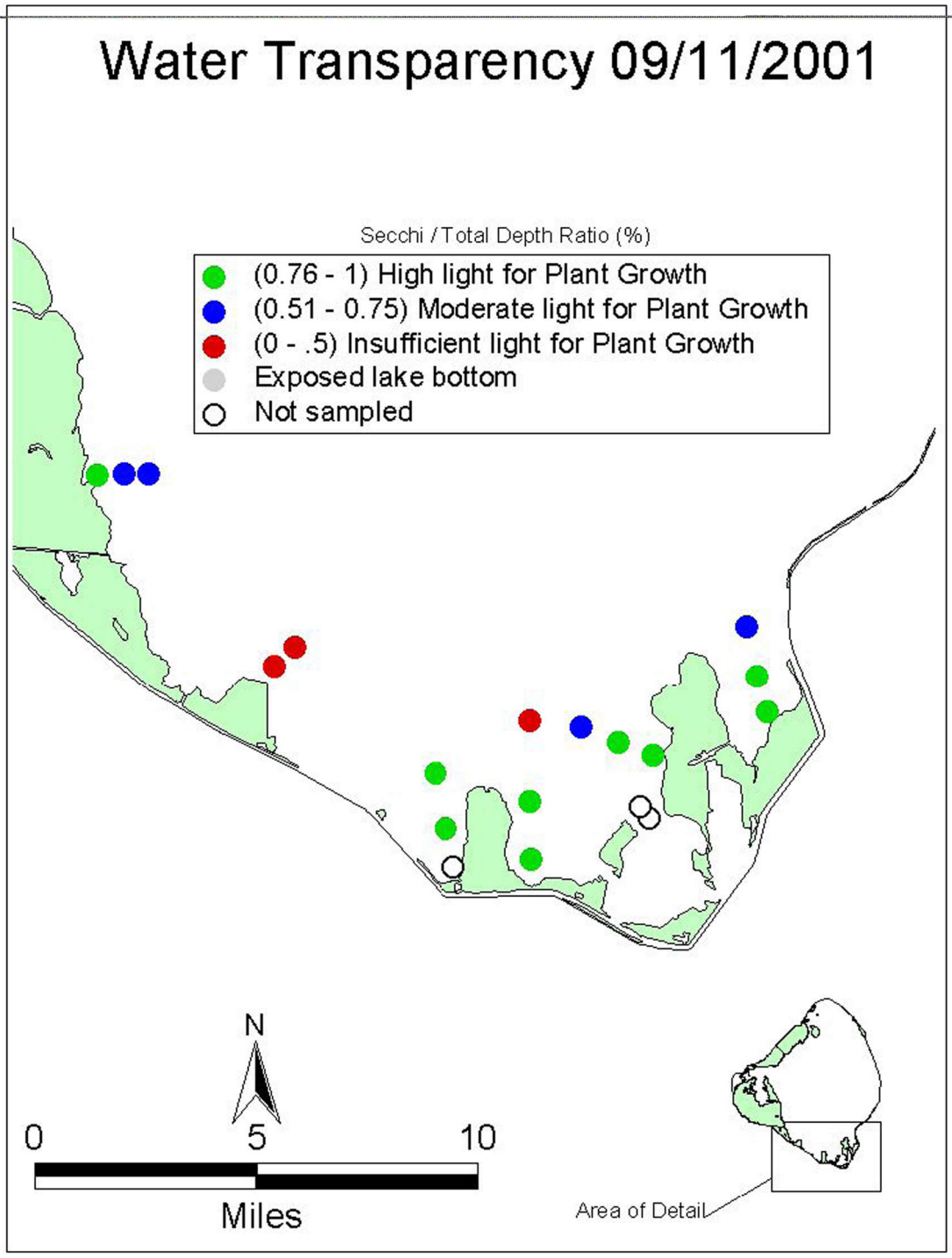

Water Transparency 09/11/2001
Secchi / Total Depth Ratio (%)
(0.76 - 1) High light for Plant Growth
(0.51 - 0.75) Moderate light for Plant Growth
(0 - .5) Insufficient light for Plant Growth
Exposed lake bottom
Not sampled
N
0
5
10
Miles
Area of Detail

Figure B7.

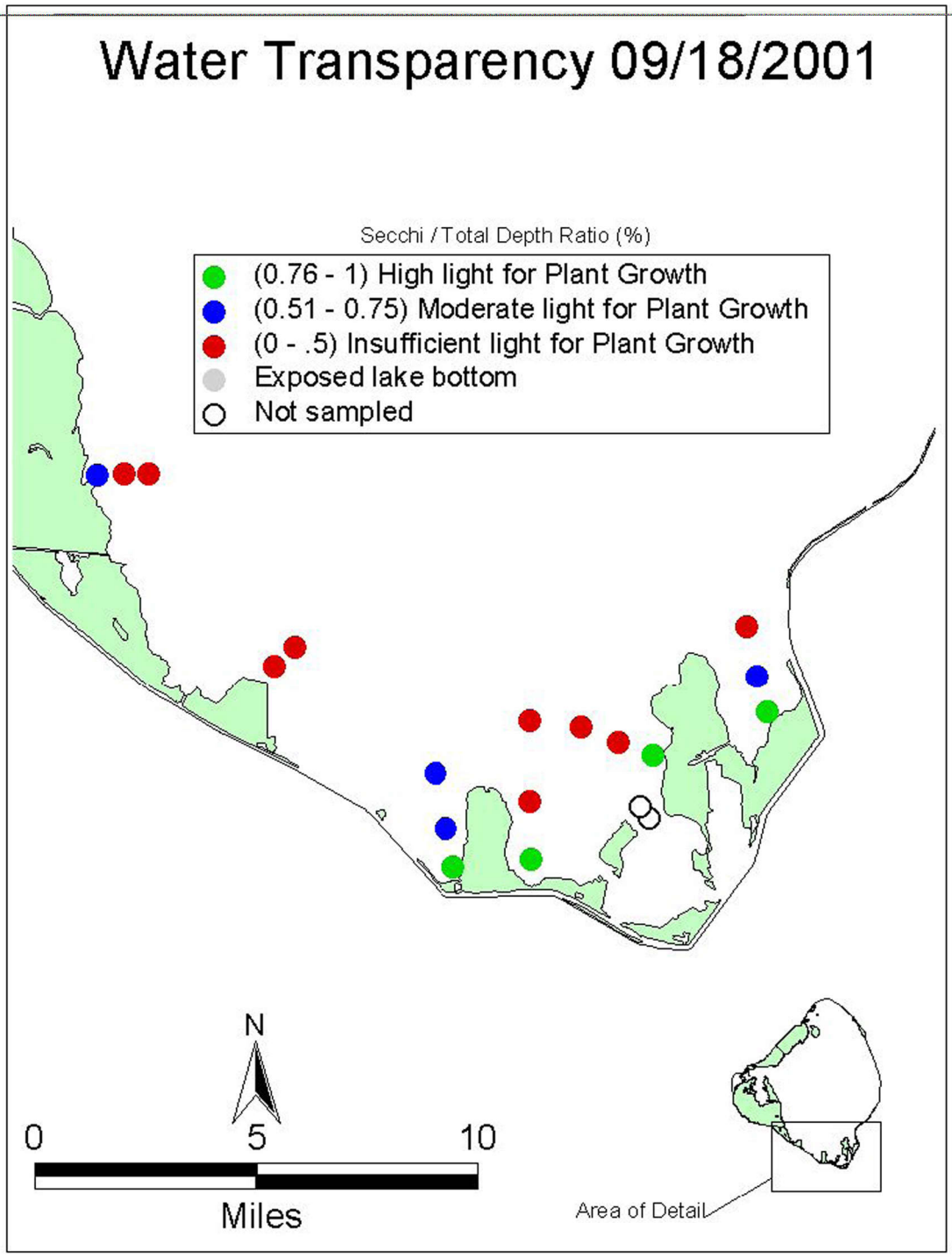

Water Transparency 09/18/2001
Secchi / Total Depth Ratio (%)
(0.76 - 1) High light for Plant Growth
(0.51 - 0.75) Moderate light for Plant Growth
(0 - .5) Insufficient light for Plant Growth
Exposed lake bottom
Not sampled
N
0
5
10
Miles
Area of Detail

Figure B8.

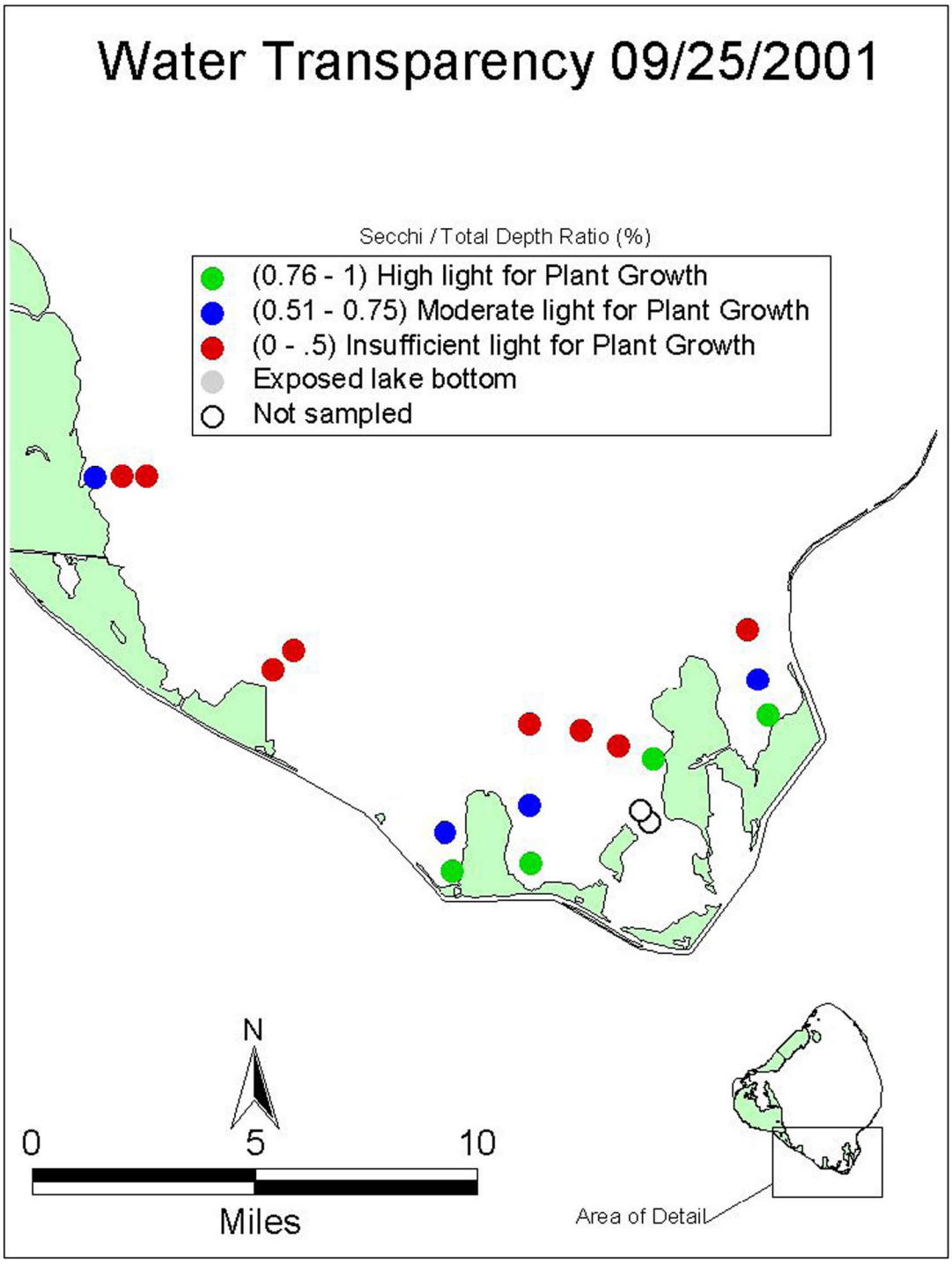

Water Transparency 09/25/2001
Secchi / Total Depth Ratio (%)
(0.76 - 1) High light for Plant Growth
(0.51 - 0.75) Moderate light for Plant Growth
(0 - .5) Insufficient light for Plant Growth
Exposed lake bottom
Not sampled
N
0
5
10
Miles
Area of Detail

Figure B9.

Table 24: Lake Recess Period (April 25, 2000 - June 30, 2000)
Outflow Volume and Total Phosphorus Load

note: TP load is calculated using interpolated values of grab measurements.

STRUCTURE	FLOW		TP LOAD	
	sum of cfs-days	acre-feet	kg	metric tons
S308	69142	137142	25802	**26**
L8 (at CULV10A)	5363	10638	1961	**2**
S352	38486	76336	12160	**12**
S351 (at S2)	80057	158791	20084	**20**
S354 (at S3)	50284	99737	12581	**13**
INDUSTRIAL CANAL	12702	25193	3420	**3**
S77	139420	276536	73792	**74**
total	**395455**	**784373**	**149800**	**150**

Gross flow-weighted-mean concentration (ppb) for the period : 155 ppb.

Appendix 4A-1: Tools for Monitoring Enforcement of Water Use Restrictions during the Drought

Robert M. Brown

EXHIBIT 1: PLAN FOR IMPLEMENTING WATER SHORTAGE ENFORCEMENT IN AGRICULTURAL AND URBAN AREAS

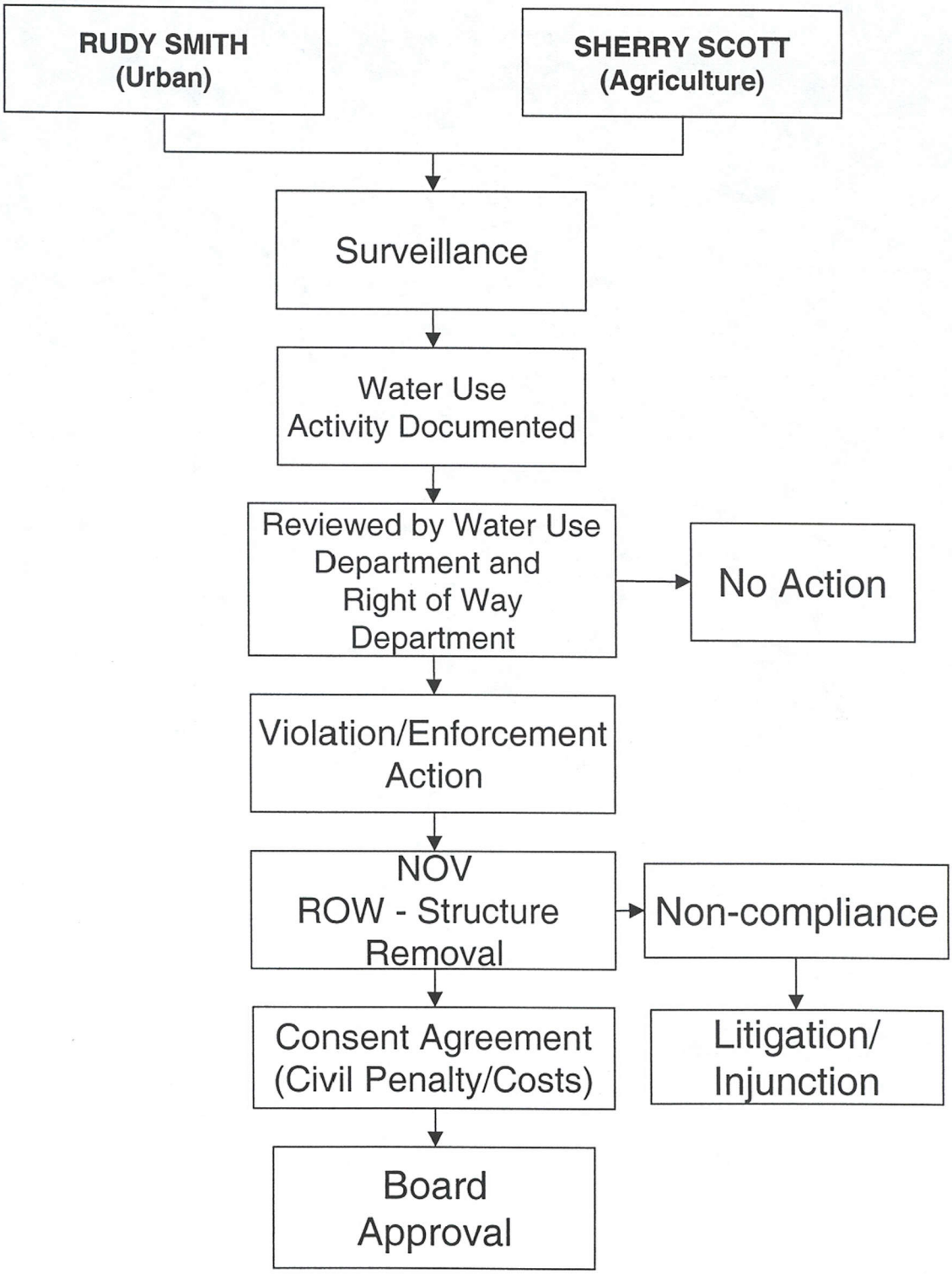

RUDY SMITH
(Urban)
SHERRY SCOTT
(Agriculture)
Surveillance
Water Use
Activity Documented
Reviewed by Water Use
Department and
Right of Way
Department
No Action
Violation/Enforcement
Action
NOV
ROW - Structure
Removal
Non-compliance
Consent Agreement
(Civil Penalty/Costs)
Litigation/
Injunction
Board
Approval

EXHIBIT 1

EXHIBIT 2: WATER SHORTAGE VIOLATION FIELD REPORT FORM

Water Shortage Violation Field Report

Date _____ Day _____ Time _____ AM/PM

Property Name _____

Property Address _____
Street City County

Contacted Name _____

Contacted Address _____
Street City State Zip

Check only one box
☐NE – ☐NW – ☐SE – ☐SW Corner of Cross-Street _____ *or*

Check only one box
☐N – ☐S – ☐E – ☐W Side of Street Near Intersection of _____

Section _____ Twp _____ Range _____

Type: ☐ PUD ☐ Apartments ☐ Business ☐ Golf Course ☐ Dewatering
☐ Municipal Park ☐ Municipal Property/Medians ☐ Nursery
☐ Agricultural ☐ Other _____

Violation:
☐ 40E-21.531 (3)(c): Landscape irrigation outside of restricted odd/even days or times
☐ 40E-21.531 (3)(a): Nursery irrigation outside of restricted odd/even days or times
☐ 40E-21.531 (2)(a) Agricultural irrigation outside of restricted odd/even days or times
☐ 40E-21.531 (__)(__) Other _____
☐ 40E-2.041 (1): Lack of valid water use permit

Field Inspector (print) _____ Initials: _____

FOR WATER USE REGULATION STAFF

Property Owner _____ Phone No. _____

Owner Address _____
Street City State Zip

WU Permit No. _____ ☐ No WU Permit ☐ City Water

Variance No. _____ ☐ No Variance Board Order No. _____

Category: ☐ <100,000 GPD ☐ 100,000 to 1,000,000 GPD ☐ > 1,000,000 GPD

Offense: ☐ First ☐ Second ☐ Third ☐ _____

Water Use Compliance Reviewer (print) _____ Initials _____

Water Use Compliance Supervisor (signature) _____

EXHIBIT 2

Disposition: _____

ATTACH PHOTO DOCUMENTATION WITH DATE & TIME STAMP TO THIS REPORT.

LOCATION MAP

Comments:

EXHIBIT 3: PENALTY ASSESSMENT MATRIX FOR VIOLATIONS OF WATER SHORTAGE RESTRICTIONS

PENALTY ASSESSMENT MATRIX

Extent of Deviation

Potential for Harm	Major	Moderate	Minor
Major	$10,000 to $8,000	$7,999 to $6,000	$5,999 to $4,600
Moderate	$4,600 to $3,200	$3,199 to $2,000	$1,999 to $1,200
Minor	$1,199 to $600	$599 to $200	$199 to $100

EXHIBIT 3

ERC Division 1999

EXHIBIT 4: TABLE OF WATER RESTRICTION PENALTIES PER DAY, PER OFFENSE

WATER RESTRICTION PENALTIES

	100,000 GPD or Less *	100,000 to 1,000,000 GPD*	1,000,000 GPD or more*
1st Offense**	$ 200	$ 500	$ 1,000
2nd Offense**	$ 1,500	$ 2,500	$ 5,000
3rd Offense***	$ 5,000	$ 7,500	$ 10,000

* Permitted Allocation

** Per Day, Per Offense

*** Revocation of Permit and Injunctive Relief

EXHIBIT 4

EXHIBIT 5: NOTICE OF VIOLATION/CONSENT AGREEMENT FOR MODIFIED PHASE II RESTRICTIONS

CON 24-06-04

Date:

VIA CERTIFIED MAIL

Dear Sir or Madam:

NOTICE OF VIOLATION/CONSENT AGREEMENT

Subject: **Violation of Water Restrictions**
Project:
Permit No. :
County
Order No. _____

The purpose of this correspondence is to advise you that you are in violation **of Modified Phase II Water Restrictions as described in Water Shortage Order Number 2001-48** (copy attached). District staff documented this violation **at**_____**a.m. on** _____ **2001**. The violation consisted of _____**irrigation** and occurred outside of the designated day and time specified for irrigation.

As a result of this violation the District will seek a civil penalty/costs in the amount of _____**Dollars ($0.00).** The District is authorized to seek civil penalties up to Ten Thousand Dollars ($10,000.00) per day, per offense and to recover staff investigative time and attorney fee's under Section 373.129 **Florida Statutes**. The penalty/costs amount referenced above was generated from a penalty matrix specifically designed for water restriction violations and is based upon the matrix used by the United States Environmental Protection Agency (EPA). This penalty/costs amount represents a first time offense. Be advised that should the District document further violations of the **Modified Phase II Water Restriction Order Number 2001-48,** civil penalties/costs will increase substantially and may include revocation of permit no. _____ and injunctive relief by the court.

EXHIBIT 5

Project:
Order No. _____
Date:
Page 2

Your execution of this short form consent agreement constitutes your acknowledgement to the terms to resolve this violation. This agreement will then be presented to the District's Governing Board with a staff recommendation for approval. The terms and conditions of which may be enforced in a court of competent jurisdiction pursuant to Sections 120.69, 373.129 and 373.136, Florida Statutes.

Without admitting liability, you have provided assurances of good faith compliance with all agreements entered into between yourselves and the District in consideration for the District not taking action to seek judicial imposition of damages, or civil penalties/costs for the violation described above. If you do not sign and return this letter to the South Florida Water Management District, at the address given above, within seven (7) days of receipt it will be assumed that you do not intend settling this matter according to the terms described herein. Subsequently, this matter would then be referred to the District's Office of Counsel with a recommendation that formal enforcement action be taken against you.

The civil penalty/District costs amount of _____**($0.00)** is to be paid by certified check or money order to the South Florida Water Management District, 3301 Gun Club Road, Post Office Box 24680, West Palm Beach, Florida 33416-4680, to the attention of Rudy Smith, Senior Regulatory Supervisor, Environmental Resource Compliance Department. This payment is due within fourteen (14) days of execution of this agreement by the District's Governing Board.

Should you have any questions or require additional information, please contact me at (561) 682-6599. Your attention and cooperation in this matter is important to avoid further action.

Sincerely,

Rudy Smith
Sr. Regulatory Supervisor
Environmental Resource Compliance Department
South Florida Water Management District

RS
Attachment(s)

Project:
Order No. _____
Date:
Page 3

DONE AND SO ORDERED at West Palm Beach, Palm Beach County, Florida, this _____ day of _____ 2001.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
BY ITS GOVERNING BOARD

BY: _____
Deputy Executive Director

RESPONDENT

BY: _____

ATTEST:

BY: _____
Assistant Secretary

c: John Fumero, SFWMD, Office of Counsel

EXHIBITS 6 AND 7: NOTICE OF VIOLATION/CONSENT AGREEMENT FOR PHASE II RESTRICTIONS

CON 24-06-04

Date:

VIA CERTIFIED MAIL

Dear Sir or Madam:

NOTICE OF VIOLATION/CONSENT AGREEMENT

Subject: **Violation of Water Restrictions**
Project:
County
Sec./Twp. S/Rge. E
Order No. _____

The purpose of this correspondence is to advise you that you are in violation **of Phase II Water Restrictions** as described in **Water Shortage Order Number 2001-04** (copy attached) and consumptive use of water without a permit. District staff documented this violation **at _____a.m. on_____, 2001.** The violation consisted of _____ irrigation and occurred outside of the designated day specified for irrigation.

As a result of this violation of **Phase II Water Restriction Order Number 2001-04** the District will seek a civil penalty and recovery of costs in the amount of **_____Dollars ($00.00).** The District is authorized to seek civil penalties up to Ten Thousand Dollars ($10,000.00) per day, per offense and to recover staff investigative time and attorney fee's under Section 373.129 **Florida Statutes**. The penalty amount referenced above was generated from a penalty matrix specifically designed for water restriction violations and is based upon the matrix used by the United States Environmental Protection Agency (EPA). This penalty amount represents a first time offense. Be advised that should the District document further violations of the Phase II Water Restrictions, civil penalties will increase substantially.

EXHIBIT 6

Project:
Order No. _____
Date:
Page 2

Furthermore, you are directed to submit a permit application for the consumptive use of water within 30 days of receipt of this correspondence and to obtain District authorization in a timely manner. You are required to obtain a permit authorization for the consumptive use of water under Section 373.219, **Florida Statutes** and Rules 40E-2 or 40E-20, **Florida Administrative Code**. Accordingly, you are directed to cease all unauthorized use of water in violation of state law until a permit is issued. Failure to submit and complete this permit application will result in the District taking additional enforcement action to mandate compliance. You may contact Mr. Jeffrey Rosenfeld of the District's Water Use Permitting Department at (561) 682-6922 for further information.

Your execution of this short form consent agreement constitutes your acknowledgement to the terms to resolve this violation. This agreement will then be presented to the District's Governing Board with a staff recommendation for approval. The terms and conditions of which may be enforced in a court of competent jurisdiction pursuant to Sections 120.69, 373.129 and 373.136, **Florida Statutes**.

Without admitting liability, you have provided assurances of good faith compliance with all agreements entered into between yourselves and the District in consideration for the District not taking action to seek judicial imposition of damages, or civil penalties for the violation described above. If you do not sign and return this letter to the South Florida Water Management District, at the address given above, within seven (7) days of receipt, it will be assumed that you do not intend settling this matter according to the terms described herein. Subsequently, this matter would then be referred to the District's Office of Counsel with a recommendation that formal enforcement action be taken against you.

The civil penalty/District costs amount of _____ **Dollars ($00.00)** is to be paid by certified check or money order to the South Florida Water Management District, 3301 Gun Club Road, Post Office Box 24680, West Palm Beach, Florida 33416-4680, to the attention of Rudy Smith, Sr. Regulatory Supervisor, Environmental Resource Regulation Department. This payment is due within fourteen (14) days of execution of this agreement by the District's Governing Board.

Project:
Order No. _____
Date:
Page 3

Should you have any questions or require additional information, please contact me at (561) 682-6599. Your attention and cooperation in this matter is important to avoid further action.

Sincerely,

Rudy Smith
Sr. Regulatory Supervisor
Environmental Resource Compliance Department
South Florida Water Management District

RS
Attachment(s)