Appendix 4-1: Annual Permit Report for Lake Okeechobee Water Control Structures Operation

Permit Report Dates: (May 1, 2010–April 30, 2011)
Permit Number: 0174552

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SUMMARY

Based on Florida Department of Environmental Protection (FDEP) permit reporting guidelines, **Table 1** shows cross references for permit-specific conditions in the permit and the specific reference pages. **Table 2** lists key permit-related information. Table A1 in Attachment A shows specific pages, tables, and graphs where project status and annual reporting requirements are addressed. **Table 3** lists the attachments included with this report.

Table 1. Permit specific conditions and reference in the permit.

Permit Conditions	Permit Reference (0174552)
Modification	0174552-008
Annual Monitoring Reports	Specific Condition 14, page 9

Table 2. Key permit-related information.

Project Name	**Lake Okeechobee Operating Permit**
Permit Number	0174552
Most Recent Modification	0174552-008
Issue and Expiration Date	Issue: June 18, 2007 Expiration: June 18, 2012
Project Phase	N/A
Relevant Period of Record	May 1, 2010–April 30, 2011
Report Generator	Thomas James tjames@sfwmd.gov 561-682-6356
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Submission Date	TBD

Table 3. Attachments included with this report.

Attachment	Title
A	Specific Conditions and Cross References
B1–B11	Lake Okeechobee Structure and Water Quality Monitoring Data

INTRODUCTION

The Lake Okeechobee Operating Permit (0174552-001-GL) was issued under the authority of the Lake Okeechobee Protection Act, Chapter 373.4595, Florida Statutes (F.S.), and Title 62, Florida Administrative Code (F.A.C.). This annual report is submitted by the South Florida Water Management District (SFWMD or District) to the Florida Department of Environmental Protection (FDEP) to fulfill the requirements of Modifications 006, 007, and 008 of the Operating Permit (0174552) and Specific Condition 14, Annual Monitoring Reports of the permit. The modifications to the permit include the following:

- Addition of monitoring at site C41H78, which replaces monitoring at structures HP-7, Inflow-1, Inflow-2, Inflow-3, and L-61E
- Change in the duration column for grab samples at S-2 and S-3 when pumping occurs
- Change in grab samples at S-2 and S-3 to include pH, temperature, conductivity, dissolved oxygen, and all chemical parameters listed in **Table 6**
- Replacement of BOD5 with total organic carbon
- Discontinued calcium monitoring
- Modified chlorophyll *a* monitoring requirements
- Modification of the parameter list for sites S351, S354, G207, and G208

This report includes two sections: (A) *Monitoring Data*, which includes records and general descriptions of data collected to meet the requirements of this permit for Water Year 2011 (WY2011) (May 1, 2010–April 30, 2011), and (B) *Performance Evaluation*, which includes an analysis of these data for Florida Class I water quality exceedances, total phosphorus (TP) loadings, data collected within Lake Okeechobee under the Lake Okeechobee Research and Monitoring Plan, and applicable records from the ambient pesticide and herbicide monitoring data.

A. MONITORING DATA

WATER QUALITY

An attachment of all water quality samples, including qualified samples, collected at Lake Okeechobee structures (**Figure 1** and **Table 4**) was developed from the District's hydrometeorological and water quality database, DBHYDRO (SFWMD 2010; Attachment B1). These records include analytical results of grab or in situ samples taken throughout the year for 17 parameters required in the Permit (**Table 5**). Daily flow data (Attachment B2) and daily rainfall data (Attachment B3) also are reported.

The appendices of water quality incorporate the permit-required data and metadata that include (1) date, location, and time of sampling or measurements; (2) person responsible for performing the sampling or measurements; (3) date analyses were performed or the appropriate code as required by Chapter 62-160, F.A.C.; (4) laboratory/person responsible for performing the analyses; (5) analytical methods used, including Method Detection Limit (MDL) and Practical Quantitation Limit (PQL); (6) results of such analyses, including appropriate data qualifiers and all compounds detected; (7) depth of sampling (for grab samples); and (8) flow conditions and weather conditions at the time of sample collection.

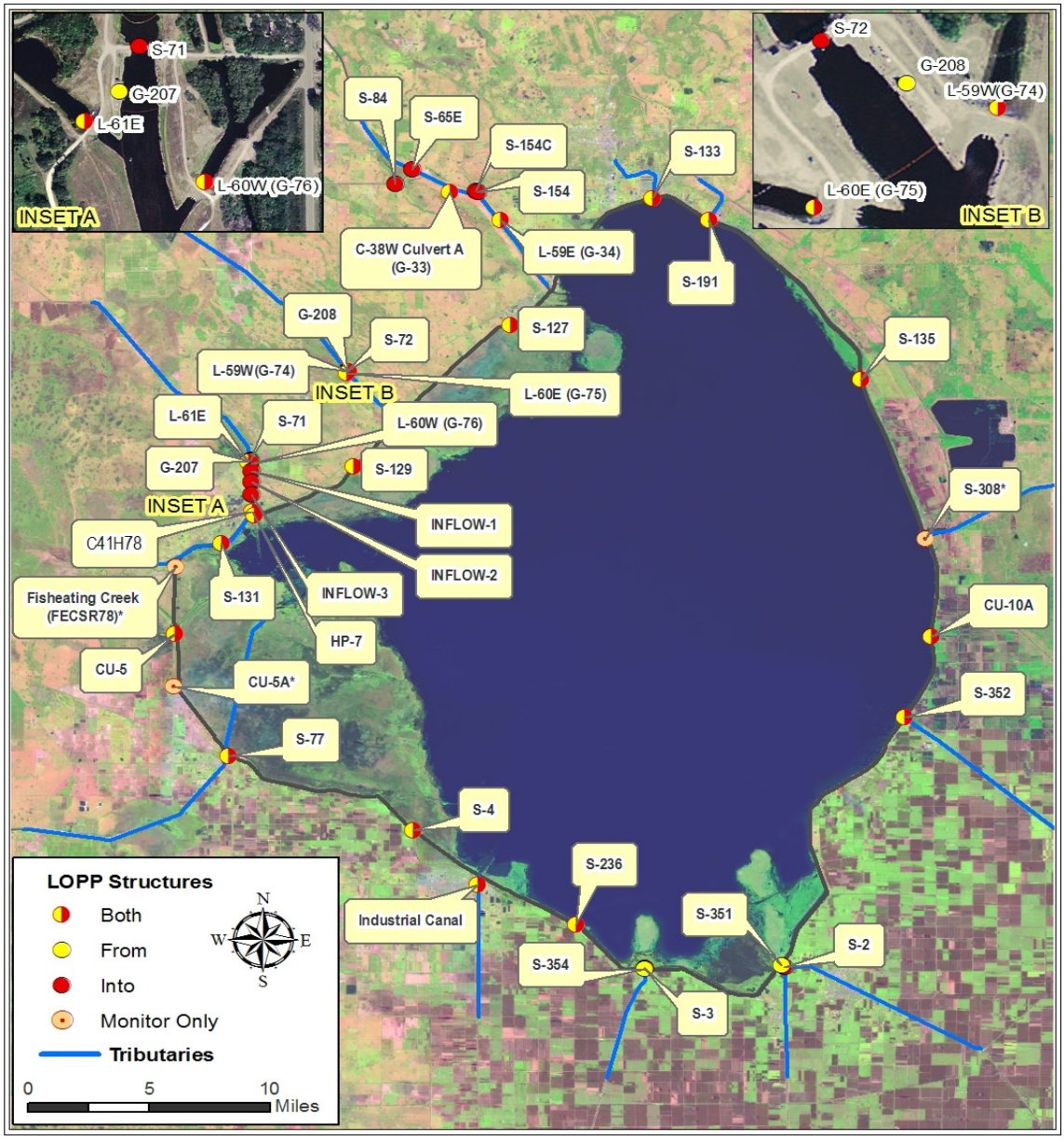

Figure 1. Structures included in the Lake Okeechobee Operating Permit.

Table 4. Structures monitored for compliance with Permit 0174552-001-GL (Modification 0174552-006-EM).

Structure	Into/ From	DBHYDRO Inflow Direction[5]	Structure Description	Latitude	Longitude
S-2	Into	-	Four (4) unit pump station, 3,600 cfs	26 41 58.81	80 42 48.09
S-3	Into	-	Three (3) unit pump station, 2,670 cfs	26 41 56.24	80 48 26.21
S-4	Both	+	Three (3) unit pump station, 2,805 cfs	26 47 24.64	80 57 42.43
S-65E	Into	+	Gated spillway with six (6) cable operated vertical lift gates, lock structure with sector gates	27 13 31.16	80 57 45.22
S-71	Into	+	Gated spillway, three (3) stem operated vertical lift gates	27 02 03.19	81 04 15.23
S-72[3]	Into	+	Gated spillway, two (2) stem operated vertical lift gates	27 05 35.18	81 00 21.22
S-84	Into	+	Gated spillway with two (2) vertical lift gates	27 12 58.16	80 58 24.22
S-127	Both	+	Five (5) unit pump station, 625 cfs, plus gated spillway/lock	27 07 21.56	80 53 45.41
S-129	Both	+	Three (3) unit pump station, 375 cfs, plus gated spillway	27 01 48.19	81 00 05.22
S-131	Both	+	Two (2) unit pump station, 250 cfs, plus gated spillway, lock	26 58 45.23	81 05 24.72
S-133	Both	+	Five (5) unit pump station, 625 cfs, plus outlet structure	27 12 23.92	80 48 02.59
S-135	Both	+	Four (4) unit pump station, 500 cfs, plus spillway and lock	27 05 12.71	80 39 40.14
S-154C	Into	+	Concrete pipe culvert, one (1) barrel, with gate	27 12 39.58	80 55 11.38
S-154	Into	+	Reinforced concrete box culvert, two (2) barrels, sluice gate	27 12 38.82	80 55 06.24
S-191	Both	+	Gated spillway with three (3) cable operated vertical lift gates	27 11 31.17	80 45 45.20
S-236	Both	+	Three (3) unit pump station, 255 cfs, plus outlet	26 43 40.41	80 51 10.12
S-351[1]	Both	-	Gated spillway with three (3) vertical lift gates	26 42 03.00	80 42 54.96
S-352[1]	Both	-	Gated spillway with two (2) vertical lift gates	26 51 50.61	80 37 56.65
S-354[1]	Both	-	Gated spillway with two (2) vertical lift gates	26 41 55.96	80 48 26.25
CU-5	Both	+	Three (3) barrel cmp, slide gates	26 53 06.93	81 07 18.23
CU-10A	Both	-	Five (5) barrel cmp	26 55 01.45	80 36 51.33
C-38W Culvert A (G-33)	Both	+	Pipe inflow under levee	27 12 39.00	80 56 11.69
G-207	From	+	One (1) unit pump station, 135 cfs	27 1 59.54	81 04 17.36
G-208[3]	From	+	One (1) unit pump station, 135 cfs	27 5 32.65	81 00 20.04

Table 4. Continued.

Structure	Into/ From	DBHYDRO Inflow Direction[5]	Structure Description	Latitude	Longitude
S-72 Weir Auxiliary Water Supply Pump Station [4]	From	-	Three unit pump station	27 03 59.36	80 58 41.07
L-59E (G-34)	Both	+	Three (3) barrel culvert	27 11 31.17	80 54 11.21
L-59W(G-74)	Both	+	Two (2) barrel gated culvert	27 06 26.18	80 59 57.22
L-60E (G-75)	Both	+	Two (2) barrel gated culvert	27 05 05.18	81 01 27.22
L-60W (G-76)	Both	+	Two (2) barrel gated culvert	27 01 58.19	81 03 06.23
C41H78[2]	Both	+	Canal downstream of G-207, Inflow-1, Inflow-2, Inflow-3, HP-7, L-61E and S-71	26 59 51.52	81 04 05.90
Industrial Canal	Both	-	Represents flows at S-310	26 45 14.00	80 55 07.22
L-61E[2]	Both	N/A	Two (2) barrel culvert with flashboards	27 01 59.19	81 05 17.23
HP-7[23]	Both	N/A	Single barrel culvert with flap gate with winch	27 00 00.00	81 04 10.00
Inflow-1[23]	Into	N/A	Single barrel culvert with flap gate, on Harney Pond Canal, downstream of S-71	27 01 36.53	81 04 12.49
Inflow-2[23]	Into	N/A	Single barrel culvert with flap gate, on Harney Pond Canal	27 01 10.77	81 04 12.20
Inflow-3[23]	Into	N/A	Single barrel culvert with flap gate, on Harney Pond Canal	27 00 41.13	81 04 11.74

[1] Structures have the ability to incorporate the use of temporary forward pumps (see Specific Condition 4) for discharging water from Lake Okeechobee during periods of low water levels.

[2] C41H78 site is used to estimate required inflow and water quality at Inflow-1, Inflow-2, Inflow-3, HP-7, and L-61E per Modification 0174552-006-EM, dated September 17, 2009

[3] Locations are approximate, not owned or operated by the SFWMD

[4] S-72 Weir Auxiliary Water Pump Station monitoring is conducted at both S-72 and G-208

[5] + : inflow to lake is a positive number and outflow is a negative number
- : inflow to lake is a negative number outflow is a positive number

cfs – cubic feet per second

cmp – corrugated metal pipe

Table 5. Parameters monitored and appendices where data are reported for compliance with Permit 0174552-001-GL (Modification 0174552-007).

Parameter Name	Parameter Description	Units	Sample Type	Sampling Frequency	Structures Sampled[1,2]	Attachment
ALK	Alkalinity	mg/L	G	BI-W if flowing, M if not flowing	ALL	B1
TOC	Total Organic Carbon	mg/L	G	BI-W if flowing, M if not flowing	S-308, S-77	B1
CHLA	Chlorophyll *a*	µg/L	G	BI-W if flowing, M if not flowing	S-308, S-77	B1
NH4	Dissolved Ammonia	mg/L	G	BI-W if flowing, M if not flowing	ALL	B1
DO	Dissolved Oxygen	mg/L	INSITU	BI-W if flowing, M if not flowing	ALL	B1
PH	pH	SU	INSITU	BI-W if flowing, M if not flowing	ALL	B1
SCOND	Specific Conductance	µS/cm	INSITU	BI-W if flowing, M if not flowing	ALL	B1
TEMP	Temperature	Deg C	INSITU	BI-W if flowing, M if not flowing	ALL	B1
TURB	Turbidity	NTU	G	BI-W if flowing, M if not flowing	ALL	B1
TKN	Total Kjeldahl Nitrogen	mg/L	G	BI-W if flowing, M if not flowing	ALL	B1
			ACF	W if flowing	G-207, G-208	B1
TP	Total Phosphorus	mg/L	G	BI-W if flowing, M if not flowing	ALL, FECSR78, S-77, S-308, CU-5A	B1
			ACF	W if flowing, M if not flowing	S-351, S-354	B1
			ACF	W if flowing,	G-207, G-208	B1
TN	Total Nitrogen	mg/L	CAL	BI-W if flowing, M if not flowing	ALL	B1
			CAL	W if flowing, M if not flowing	S-351, S-354	B1
			CAL	W if flowing	G-207, G-208	B1
NOX	Nitrate + Nitrite	mg/L	G	BI-W if flowing, M if not flowing	ALL	B1
			ACF	W if flowing,	G-207, G-208	B1
SRP	Soluble Reactive Phosphorus	mg/L	G	BI-W if flowing, M if not flowing	ALL	B1
TFE	Total Iron	µg/L	G	Q	ALL	B1
TSS	Total Suspended Solids	mg/L	G	BI-W if flowing, M if not flowing	ALL	B1
FLOW	Flow	CFS	PR	DAV	ALL (pumps)	B2
	Flow	CFS	CAL	DAV	ALL (culverts or gates), FECSR78, S-77, S-308, CU-5A	B2
RAIN	Rainfall Volume	Inches	RG	DAC	Rainfall Sampling Station	B3

Table 5. Continued.

Key to abbreviations

ALL – structures owned and operated by the District, as specified in Table 1
ACF – flow-proportional composite sampler
BI-W – biweekly
CAL – calculated
CFS – cubic feet per second
DAC – daily accumulation
DAV – daily average
G – grab sample
INSITU – measured with probe on-site
M – monthly
mg/L – milligrams per liter
NTU – nephelometric turbidity units
µg/L – micrograms per liter
µS/cm – microsiemens per centimeter
PR – pump records
Q – quarterly
RG – rain gauge
SU – standard units

[1] C41H78 (Harney Pond Canal) monitoring station is the representative monitoring site for HP-7, Inflow-1, Inflow-2, Inflow- 3, and L-61E.
[2] S-72 Weir Auxiliary Water Pump Station monitoring is conducted at both S-72 and G-208

Table 6. Water quality monitoring for S-2 and S-3 flood control backpumping for compliance with Permit 0174552-001-GL (Modification 0174552-006-EM).

Site	Type	Duration	Parameters
S-2	ACF*	Event** duration	TP and TN*** only
S-2	Grab	Event duration ≤ 72 hours: Collect one sample for nutrients (TN and TP) and all chemical parameters listed in **Table 5** within 24 hours of initiation of pumping operations. Event duration >72 hours: Collect one sample during first 24 hours and then every 72 hours.	Physical parameters - pH, temperature, conductivity, and dissolved oxygen; Chemical parameters - All chemical parameters listed in **Table 5**.
S-3	ACF	Event duration	TN and TP only
S-3	Grab	Event duration ≤ 72 hours: Collect one sample for nutrients (TN and TP) and all chemical parameters listed in **Table 5** within 24 hours of initiation of pumping operations. Event duration >72 hours: Collect one sample during first 24 hours and then every 72 hours.	Physical parameters - pH, temperature, conductivity, and dissolved oxygen; Chemical parameters - All chemical parameters listed in **Table 5**.

ACF – autosampler composite flow proportional
TP – total phosphorus
TN – total nitrogen
* Flow-proportional composite sampler
** An event is defined as continuous or intermittent pumping activity separated by a cessation of 72 hours or greater.
*** TN = Total Kjeldahl Nitrogen + Nitrate + Nitrite

FLOW DATA

Daily flow data for permitted structures are stored in DBHYDRO (SFWMD 2010, Attachment B2). Additional flow information for structures that contribute to the total phosphorus (TP) loads to Lake Okeechobee, but are not included in the Permit (FECRSR78, S-77, S-308, CU-5A, CU-10, CU-4, CU-12, CU-12A) are also found in Attachment B**2**. These data were downloaded from DBHYDRO on September 7, 2011. Updates and revisions to the data may occur after this time. As described in the 2011 Annual Permit Report for Lake Okeechobee Water Control Structures Operation (SFWMD 2011a), the monitoring site, C41H78, is operational along the Harney Pond Canal. This new site, as approved in Permit Modification 0174552-006-EM, accounts for the combined flow and TP load contribution from the minor structures L-61E, HP7, Inflow 1, Inflow 2, and Inflow 3. To determine the contributions from these minor structures, the flow measured and load calculated from sites S71, L60W (G76), and G207 are subtracted from the C41H78 measurement and load calculation. Improvements in measurement at C41H78 allowed for better estimates of flow and load from the small basins using monthly summed data. Only positive flows at C41H78 were summed monthly. The estimate for July 2010 was negative and was therefore set at zero. District employees continue to work on methods to more precisely estimate the flow and load from these minor structures using the C41H78 information.

As reported in the 2011 Annual Permit Report for Lake Okeechobee Water Control Structures Operation (SFWMD, 2011a), Fisheating Creek flow is now reported using DBKEY WH036 (U.S. Geological Survey, ID 02257000), a site co-located with water quality sampling for the creek (FECRSR78). While the site improves on the accuracy of flow and load to Lake Okeechobee, flows can at times be negative as wind-driven seiches move water from the lake into the creek. Only positive values are used in load calculations to the lake.

Structures S-2 and S-351 and structures S-3 and S-354 share common preferred flow data. Flow into the lake at these locations occurs through S-2 and S-3 pump stations, while flow out of the lake occurs at spillways S-351 and S-354 through either gravity flow or temporary forward pumps.

During WY2011, inflow volume to Lake Okeechobee was approximately 0.94 million acre feet (ac-ft) (**Table 7**). This is less than half the baseline period (1991–2005) flow of 2.5 million ac-ft (SFWMD et al., 2011). The four largest flows for this water year were S-65E, S-84, Fisheating Creek, and S-71. All of these are northern basins where the majority of flow to the lake originates. Because of the dry year, no backpumping after action reports at S-2 and S-3 were required. Flow recorded at these pump stations were small and for routine maintenance as specified in Specific Condition 5 of the permit. Inflow to Lake Okeechobee in WY2011 began with a typical wet season. Flow to the lake was highest from May to September. This was followed by low flow in the dry season months of October to February. Rainfall increased in March, resulting in higher flows for March and April (see *Rainfall* section).

Lake stage declined throughout the reporting period from over 15 feet (National Geodetic Vertical Datum, or ft NGVD) in early May 2010 to less than 11 ft NGVD by the end of April 2011 (**Figure 2**). A water shortage warning was issued by the District on November 19, 2010, followed by Modified Phase I and II restrictions that were issued on March 21, 2011, by the District.

In WY2011, outflow from the lake was slightly more than 1.5 million ac-ft (**Table 8**). Discharges to the south (Everglades Agricultural Area) through S-351, S-352, and S-354 were highest in March and April 2011. Regulatory and pulse releases through S-77 and S-308 were implemented from May–June 2010. This was followed by a baseflow release from July 1–10, 2010, a regulatory release from July 11–22, 2010, and a pulse release from July 23–August 5, 2010. Subsequently, baseflow releases continued until October 14, 2010, at which time a no-flow

period was implemented. Additional baseflow and beneficial use flow releases through S-77 were implemented from October 29–December 16, 2010, and January 28–March 18, 2011. After this time, discharges through S-77 and S-308 were discontinued as water levels reached the water shortage management zone.

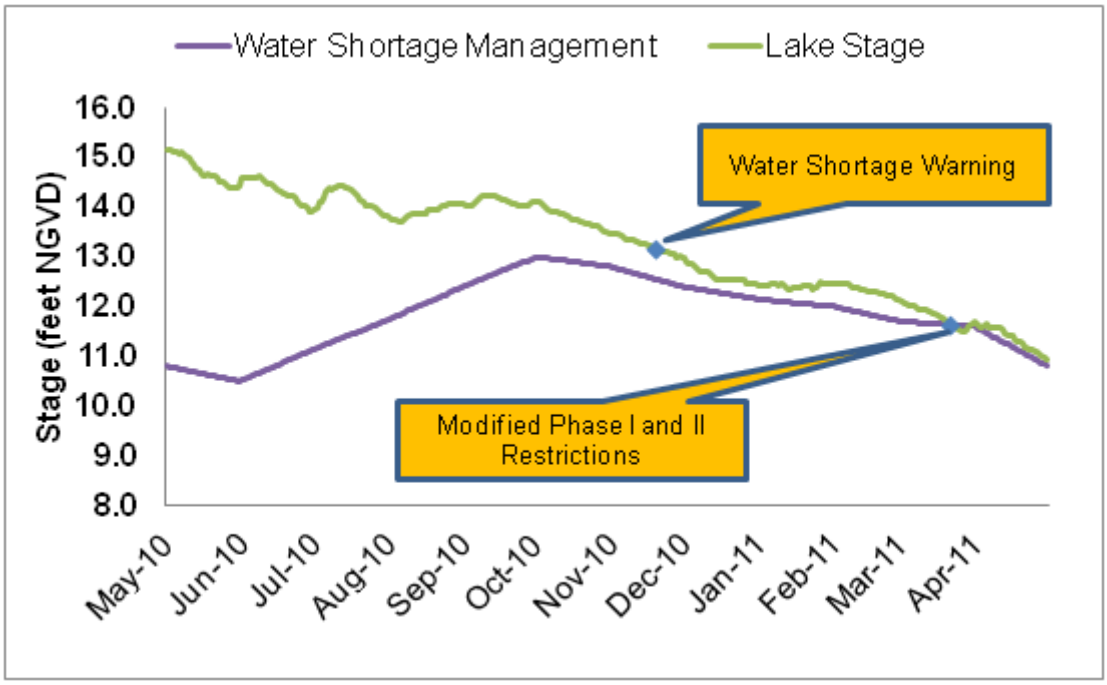

Figure 2. Lake Okeechobee stage values (feet National Geodetic Vertical Datum, or ft NGVD) for WY2011 and water shortage management criteria (from USACE, 2008).

Table 7. Monthly inflow to Lake Okeechobee by structure (acre-feet, or ac-ft) for Water Year 2011 (WY2011) (May 1, 2010–April 30, 2011).

Region	Structure	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	Total
East	L8 (CU-10A)	0	0	0	302	1,071	869	0	0	145	0	254	0	2,641
	S-308C[2]	0	0	1,470	928	212	557	0	434	2,688	464	728	981	8,461
	Total	**0**	**0**	**1,470**	**1,231**	**1,283**	**1,426**	**0**	**434**	**2,832**	**464**	**982**	**981**	**11,102**
North	C-38W Culvert A (G-33)	2	0	20	1	165	0	0	0	0	0	0	0	187
	C41H78[3]	6,012	13,831	16,182	17,120	7,279	1,901	2,969	1,397	6,337	4,692	4,585	4,852	87,155
	L-61E, HP7, Inflow 1, 2, 3[3]	3,498	5,405	0	1,959	1,425	1,744	2,848	1,115	5,978	4,475	0	0	41,513
	CU-5	494	0	0	0	0	0	0	0	0	5	0	0	499
	Fisheating Creek-Lakeport	12,142	5,831	11,810	12,030	25,474	4,419	1,085	703	351	482	163	28	74,517
	L-59E (G-34)	194	52	590	12	0	0	0	0	0	0	0	0	848
	L-59W(G-74)	0	0	1,248	495	7,362	0	0	0	416	25	0	0	9,546
	L-60E (G-75)	13	174	120	538	525	4	0	60	0	0	0	0	1,435
	L-60W (G-76)	8	118	122	230	152	0	0	281	358	217	0	0	1,606
	S-127	559	174	1,844	263	647	9	412	0	0	0	0	0	3,486
	S-129	409	1,066	427	1,102	758	0	0	0	271	99	105	0	4,086
	S-131	274	581	174	436	299	0	44	0	0	0	0	0	1,764
	S-133	508	177	2,195	809	3,630	460	0	0	0	0	0	0	7,780
	S-135	276	478	1,545	2,288	386	41	575	100	241	0	69	1	5,420
	S-154	1,732	0	4,047	1,543	4,173	522	0	0	0	0	0	0	12,018
	S-154C	141	113	461	281	295	133	82	62	88	64	38	67	1,825
	S-191	1,041	779	15,320	3,947	11,879	581	146	0	0	1	152	135	33,980
	S-65E	156,761	47,649	72,699	46,216	49,047	14,443	7,820	6,406	10,874	10,741	8,551	56,039	487,246
	S-71	2,506	8,307	16,296	14,931	5,702	157	121	0	0	0	1,200	993	50,213
	S-72	116	1,086	7,003	5,423	1,494	111	0	52	0	0	546	912	16,743
	S-84	12,188	8,231	58,140	28,013	11,260	3	1	37	689	1	872	0	134,909
	Total*	**192,862**	**80,223**	**194,062**	**120,515**	**124,671**	**22,627**	**13,135**	**8,816**	**19,266**	**16,110**	**11,696**	**58,174**	**889,623**

Table 7. Continued.

Region	Structure	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	Total
South	CU-10[12]	0	0	0	0	0	0	0	0	0	0	0	0	0
	CU-12[12]	0	0	0	0	0	0	0	0	0	0	0	0	0
	CU-12A[12]	0	0	0	0	0	0	0	0	0	0	0	0	0
	CU-4A[12]	0	0	0	0	0	0	0	0	0	0	0	0	0
	Industrial Canal	866	1,193	2,744	2,306	1,708	42	0	34	882	58	1,204	190	11,226
	S-2 (S-351)	0	185	0	0	236	0	97	0	0	0	0	0	517
	S-236	0	0	0	0	0	0	0	0	0	0	0	0	0
	S-3 (S-354)	0	0	55	0	213	0	0	0	0	0	0	0	268
	S-352	0	0	0	0	0	0	0	0	0	0	0	0	0
	S-4	518	1,811	3,569	3,261	2,283	409	376	76	344	183	254	193	13,277
	Total	**1,384**	**3,188**	**6,367**	**5,568**	**4,440**	**451**	**473**	**110**	**1,226**	**241**	**1,458**	**383**	**25,288**
West	CU-5A[2]	0	0	0	0	0	6	495	13,503	406	0	1,003	1,649	17,063
	S-77[2]	0	0	0	0	0	0	0	0	0	0	0	587	587
	Total	**0**	**0**	**0**	**0**	**0**	**6**	**495**	**13,503**	**406**	**0**	**1,003**	**2,237**	**17,650**
Total*		**236,032**	**124,781**	**252,377**	**169,760**	**171,237**	**65,385**	**54,977**	**64,989**	**64,845**	**57,872**	**60,220**	**106,605**	**943,476**

* does not include C41H78 flows
1 included in other permits
2 provides flows and loads to lake, not owned operated by SFWMD
3 L61E, HP7, Inflows 1,2,3 estimated using the formula C41H78-(S-71+L60W+G-207)

Table 8. Monthly discharge flow (ac-ft) from Lake Okeechobee for WY2011.

Station	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	Total
CU-10A	22,296	16,251	15,985	12,442	7,283	10,998	9,809	11,308	6,662	7,539	5,792	3,552	129,918
CU-5	136	6	0	0	0	0	0	0	0	0	0	0	142
CU-5A[2]	6,743	5,800	5,049	4,092	7,311	4,326	2,856	334	1,883	3,320	2,354	1,730	45,796
G-207	0	0	0	0	0	450	1,365	1,614	648	494	1,031	338	5,941
G-208	0	0	0	0	0	731	2,029	1,458	533	1,040	794	441	7,028
Industrial Canal	2,168	2,017	1,406	568	790	4,209	2,278	5,093	1,242	6,353	5,247	6,923	38,295
S-127	0	0	0	0	0	0	0	0	0	0	0	0	0
S-129	0	0	0	0	0	0	0	0	0	0	0	21	21
S-131	0	0	0	0	0	0	0	0	0	0	0	0	0
S-135	634	642	796	1,708	243	1,344	227	543	0	0	666	5	6,810
S-308[2]	95,629	62,384	53,740	10,973	12,791	3,327	15,009	9,763	1,844	3,251	13,438	3,227	285,375
S-351[1]	17,535	12,589	15,747	2,007	99	18,757	13,239	20,440	4,335	17,350	44,888	43,394	210,381
S-352[1]	6,518	8,169	6,851	285	151	4,313	9,473	13,785	2,866	4,127	14,991	15,007	86,536
S-354[1]	19,906	7,182	9,239	9,657	323	12,249	7,698	10,335	1,530	17,648	39,530	25,426	160,723
S-77[2]	195,665	112,401	105,917	18,063	4,643	29,485	29,929	35,191	0	17,066	18,101	19,839	586,301
Total	367,230	227,441	214,731	59,796	33,636	90,190	93,912	109,863	21,543	78,187	146,834	119,902	1,563,266

[1] Structures have the ability to incorporate the use of temporary forward pumps for discharging water from Lake Okeechobee during periods of low water levels.

[2] Provides flows from the lake, not owned operated by SFWMD

RAINFALL

Daily rainfall measurements were obtained from the stations used to report the Lake Okeechobee Basin rainfall (SFWMD, 2011b). These were used for consistency with Volume I, Chapter 2. Each station has one to four separate methods to record rainfall. One recording method from each station was chosen in the order of Preferred, Operations and Maintenance Department, Telemetry, and Campbell Scientific Recorder. The total monthly rainfall estimate for the Okeechobee Basin was 34.4 inches, which was 9.8 inches below the basin's 30-year average and 11.4 inches below the 30-year average for the District region (**Table 9**). This represents a 22 percent rainfall deficit compared to the 30-year averages for both the Okeechobee region and District-wide. The driest months (October 2010, December 2010 and February 2011) all had less than an inch of rainfall. The drier-than-normal wet and dry seasons have led to severe and extreme drought throughout most of the District since April 2011 (see Volume I, Chapter 2).

Table 9. Monthly rainfall averages (inches) for WY2011 compared to the 30-year period (1981–2010).

	Lake Okeechobee			District-Wide		
Month	1981-2010 Average	WY2011	Difference	1981–2010 Average	WY2011	difference
MAY	3.3	2.6	-0.7	3.9	3.4	-0.5
JUN	7.0	5.1	-1.9	8.3	5.7	-2.6
JUL	6.0	6.6	0.5	7.0	6.1	-0.9
AUG	6.7	7.0	0.3	7.8	8.7	0.9
SEP	5.6	4.5	-1.1	6.8	6.2	-0.6
OCT	3.0	0.1	-2.8	3.8	0.5	-3.3
NOV	1.9	1.1	-0.8	2.4	1.6	-0.8
DEC	1.6	0.6	-1.0	1.9	0.9	-1.0
JAN	1.7	2.1	0.4	1.9	2.4	0.5
FEB	2.1	0.3	-1.8	2.3	0.3	-1.9
MAR	3.2	3.3	0.1	3.1	2.7	-0.4
APR	2.2	1.2	-0.9	2.5	1.7	-0.8
TOTAL	44.2	34.4	-9.8	51.6	40.3	-11.4

B. LAKE OKEECHOBEE OPERATING PERMIT CLASS I WATER QUALITY PERFORMANCE EVALUATION

The parameters included in the Lake Okeechobee Operating Permit with Florida Class I criteria include alkalinity, dissolved oxygen, pH, specific conductivity, turbidity, and total iron (**Table 10**). Permit Modification 0174552-006-EM replaced biochemical oxygen demand (BOD) with total organic carbon (TOC), which does not have a Class I criteria. The Turbidity criterion of 32.3 nephelometric turbidity units (NTU) was based on natural background values as described in a previous annual report (SFWMD, 2009). The criterion for conductivity was set to 1,275 microsiemens per centimeter (µS/cm), because this was greater than the 50% above background value (SFWMD, 2009).

The water quality data for each station were separated into three categories (inflow, outflow, and no-flow), where appropriate. These categories were determined from daily flow measurements when available (Attachment B2) or from visual inspection records (Attachment B1). All flagged measurements (denoted by "yes") were removed from this analysis. All measurements below the detection limit were set to half of the detection limit. The mean, maximum, minimum, number of samples, standard deviation, 25th, median and 75th percentiles, and number of exceedances from Florida Class I standards were determined for each structure for each given flow period (Attachments B4 through B6). The samples that exceeded the Class I criteria were tabulated (Attachment B7).

A binomial hypothesis test was used to determine if there was a greater than 10 percent excursion rate of Class I standards (H0≤f0.10; HA: f ≥ 0. 10) (Weaver and Payne, 2005; SFWMD, 2009). This excursion rate is given a category of concern-C (**Table 11**). All flow and structure sample sets contained fewer than 28 samples (the cutoff at which the type II error rate is greater than 20 percent for the binomial test). Therefore, a preliminary evaluation was used based on the percent of excursions greater than 20 percent ("concern" or C), between 0 and 20 percent ("potential concern" or PC), and 0 percent ("no concern" or NC).

To more accurately evaluate the excursion rate, a longer 10-year period of record (WY2002–WY2011) was used for the binomial hypothesis testing. The categories for the tests included C (HA: f ≥ 0.10), PC (HA: 0.05 ≤ f < 0.1), minimal concern-MC (HA: 0 < f < 0.05), and NC (H0: f=0) (**Table 11**). An evaluation of these data: mean, maximum, minimum, number of samples, standard deviation, 25th, median and 75th percentiles, and number of exceedances from Florida Class I standards were determined for each structure for each given flow period for the previous 10-year period (Attachment B8).

Table 10. Class I criteria values for Lake Okeechobee monitoring.

Parameter	Units	Criteria
ALK	mg/L	≥ 20
DO	mg/L	≥ 5
pH	SU	6 - 8.5
SCOND	µS/cm	≤ 1275 or ≤ 1.5 * natural background (whichever is greater) ≤ 1275
TURB	NTU	≤ 29 + natural background ≤ 32.3
TFE	µg/L	≤ 1000

mg/L – milligrams per liter
SU – standard units
µS/cm – microsiemens per centimeter
NTU – nephelometric turbidity units
µg/L – micrograms per liter

Table 11. Excursion categories for Class I water quality tests (adapted from Weaver and Payne, 2005).

Excursion Category	Class I Water Quality Binomial Test	Preliminary Analysis of Class I Water Quality % Exceedances (less than 28 samples)
Concern	> 10%	>20%
Potential Concern	5 to 10%	> 0% and < 20%
Minimal Concern	0% < and < 5%	N/A
No Concern	0%	0%

DISSOLVED OXYGEN

The Class I criteria for dissolved oxygen (DO) specifies that values shall not be less than 5 milligrams per liter (mg/L). DO was sampled at 22 locations during inflow events in WY2011 (**Table 12**, Attachment B4). Of these locations, one was classified as "no concern," one as "potential concern," and 20 as "concern." Three other inflow structures were not sampled during inflow events in the current water year. At S-236, there were no days of inflow; at CU-5, there were 19 days of inflow; and at S-2, there were three days of inflow. Of the 116 samples collected during inflow events, 69 were below the DO Class I criterion (Attachment B4). For the 10-year analysis, all 25 structures were classified as a "concern" (**Table 12**, Attachment B8). The low DO may be caused by several factors, including high temperature, high dissolved organic carbon, microbial activity, or laminar flow of water in the canals that prevents turbulent mixing of the water with air. Further research is needed to determine the key factors. Management practices to meet the proposed numeric nutrient criteria may reduce the organic carbon input to the tributaries. Other practices to increase turbulence of the canal flow (e.g., baffle boxes or mechanical mixing) may also improve DO conditions.

For no-flow events, one structure was classified as "no concern," five were classified as "potential concern," and 15 were classified as "concern" (**Table 13**). Five structures were not sampled during no-flow events. At C41H78, CU-10A, and Industrial Canal, there were not any no-flow days. Samples were not taken at S-154C during the 18 days of no flow nor at S-65E during the 19 days of no flow. Of the 235 samples taken during no-flow events, 80 were below the DO Class I criterion (Attachment B5). For the 10-year analysis, two were classified as "no concern" and 24 as a "concern" (**Table 13**, Attachment B8). Because there is even less turbulence during no-flow events, DO conditions are likely to be worse than during flow conditions.

For outflow events, one structure was classified as "no concern," three as "potential concern," one as "concern," and three were unmeasured (**Table 14**). Of the three unmeasured structures, CU-5 had 15 days of outflow, S-129 had two days of outflow, and S-131 had none. Of the 59 samples taken during outflow events, 11 were below the DO Class I criterion (Attachment B6). For the 10-year analysis, one structure was classified as "potential concern," one as "minimal concern," and five as "concern" (**Table 14**, Attachment B8). S-129 had two days of outflow in the last 10 years (recorded in WY2011), while S-131 had none. As with inflow events, the low DO may be due to various factors as noted above.

Table 12. Levels of concern[A] for Class I parameters at Lake Okeechobee structures during inflow events.

Station	Alkalinity	Dissolved Oxygen	pH	Specific Conductivity	Total Iron	Turbidity
C-38W	NC*/NC*	C*/C*	NC*/NC*	C*/C*	C*/ND	NC*/NC*
C41H78	NC/NC*	C/C*	NC/NC*	NC/NC*	NC*/NC*	NC/NC*
CU-10A	NC/NC*	C/C*	NC/NC*	C/C*	PC*/ND	C/NC*
CU-5	NC*/ND	C*/ND	NC*/ND	NC*/ND	NC*/ND	NC*/ND
INDUSCAN	NC/NC*	C/C*	NC/NC*	NC/NC*	PC*/NC*	C/NC*
L-59E	PC/NC*	C/C*	NC/NC*	C/C*	C*/NC*	NC/NC*
L-59W	NC*/NC*	C/C*	NC/NC*	NC/NC*	C*/ND	NC/NC*
L-60E	PC*/NC*	C/C*	NC/NC*	NC/NC*	NC*/NC*	NC*/NC*
L-60W	NC*/NC*	C*/C*	NC*/NC*	NC*/NC*	NC*/NC*	NC*/NC*
S-127	NC*/NC*	C/C*	NC*/NC*	NC/NC*	NC*/NC*	NC*/NC*
S-129	NC/NC*	C/C*	NC/NC*	NC/NC*	NC*/ND	NC/NC*
S-131	NC/NC*	C/C*	NC/NC*	NC/NC*	NC*/NC*	NC/NC*
S-133	NC*/NC*	C*/C*	NC*/NC*	NC*/NC*	NC*/ND	PC*/NC*
S-135	NC/NC*	C/C*	NC/NC*	NC/NC*	NC*/NC*	PC/NC*
S-154	NC/NC*	C/C*	NC/NC*	C/NC*	C*/ND	NC/NC*
S-154C	NC/NC*	C/C*	NC/NC*	C/C*	PC*/NC*	MC/NC*
S-191	NC/NC*	C/C*	MC/NC*	NC/NC*	NC*/NC*	NC/NC*
S-2	NC/ND	C/ND	NC/ND	C/ND	NC*/ND	PC/ND
S-236	NC*/ND	C*/ND	NC*/ND	C*/ND	NC*/ND	NC*/ND
S-3	NC/NC*	C/NC*	NC/NC*	PC/NC*	NC*/ND	NC/NC*
S-4	NC/NC*	C/C*	NC/NC*	MC/PC*	NC*/NC*	NC/NC*
S-65E	MC/NC	C/C*	MC/NC	NC/NC*	C/NC*	NC/NC*
S-71	C/NC*	C/C*	MC/NC*	NC/NC*	NC*/NC*	NC/NC*
S-72	MC/NC*	C/C*	NC/NC*	NC/NC*	PC*/NC*	NC/NC*
S-84	C/NC*	C/PC*	MC/PC*	MC/NC*	PC*/NC*	MC/NC*

[A] C – "concern"; PC – "potential concern"; MC – "minimal concern"; NC – "no concern"; ND - not determined (no data)

* - less than 28 samples preliminary test used

Listing before '/' is for WY2002–WY2011; after '/' is for WY2011

Table 13. Levels of concern[A] for Class I parameters at Lake Okeechobee structures during no-flow events.

Station	Alkalinity	Dissolved Oxygen	pH	Specific Conductivity	Total Iron	Turbidity
C-38W	NC/NC*	C/PC*	C/NC*	C/C*	NC/NC*	C/NC*
C41H78	NC*/ND	NC*/ND	NC*/ND	NC*/ND	ND	NC*/ND
CU-10A	NC*/ND	C*/ND	NC*/ND	NC*/ND	NC*/ND	C*/ND
CU-5	NC/NC*	C/C*	NC/NC*	NC/NC*	PC*/NC*	MC/NC*
INDUSCAN	NC*/ND	NC*/ND	NC*/ND	NC*/ND	ND	NC*/ND
L-59E	NC/NC*	C/C*	MC/NC*	C/NC*	NC*/NC*	MC/NC*
L-59W	MC/NC*	C/C*	NC/NC*	NC/NC*	NC*/NC*	NC/NC*
L-60E	NC/NC*	C/C*	NC/NC*	NC/NC*	PC*/NC*	NC/NC*
L-60W	NC/NC*	C/C*	MC/NC*	NC/NC*	NC*/NC*	NC/NC*
S-127	NC/NC*	C/C*	NC/NC*	C/NC*	NC*/NC*	NC/NC*
S-129	NC/NC*	C/PC*	MC/NC*	NC/NC*	NC/NC*	NC/NC*
S-131	NC/NC*	C/C*	MC/PC*	NC/NC*	NC*/NC*	NC/NC*
S-133	NC/NC*	C/C*	NC/NC*	NC/NC*	C/NC*	NC/NC*
S-135	NC/NC*	C/NC*	MC/NC*	NC/NC*	NC*/NC*	MC/NC*
S-154	NC/NC*	C/C*	MC/NC*	C/PC*	C/C*	MC/NC*
S-154C	NC*/ND	C*/ND	NC*/ND	C*/ND	NC*/ND	PC*/ND
S-191	NC/NC*	C/C*	MC/NC*	C/NC*	NC*/NC*	NC/NC*
S-2	NC/NC*	C/C*	NC/NC*	C/NC*	C/NC*	C/NC*
S-236	NC/NC*	C/C*	NC/NC*	C/C*	NC/NC*	NC/NC*
S-3	NC/NC*	C/C*	NC/NC*	C/NC*	C/NC*	C/NC*
S-352	NC/NC*	C/C*	MC/NC*	MC/NC*	C*/NC*	C/PC*
S-4	NC/NC*	C/PC*	MC/NC*	MC/PC*	NC*/NC*	MC/NC*
S-65E	NC*/ND	C/ND	NC/ND	NC/ND	NC*/ND	NC*/ND
S-71	MC/NC*	C/C*	MC/PC*	NC/NC*	NC*/NC*	NC/NC*
S-72	MC/NC*	C/PC*	MC/NC*	NC/NC*	NC*/NC*	NC/NC*
S-84	PC/NC*	C/PC*	MC/NC*	NC/NC*	PC*/NC*	MC/NC*

[A] C "concern"; PC "potential concern"; MC "minimal concern"; NC "no concern"; ND - not determined (no data)

[*] - less than 28 samples preliminary test used

Listing before '/' is for WY2002–WY2011; after '/' is for WY2011

Table 14. Levels of concern[A] for Class I parameters at Lake Okeechobee structures during out flow events.

Station	Alkalinity	Dissolved Oxygen	pH	Specific Conductivity	Total Iron	Turbidity
C41H78	NC*/NC*	C*/C*	NC*/NC*	NC*/NC*	NC*/NC*	NC*/NC*
CU-10A	NC/NC*	C/PC*	MC/PC*	MC/NC*	C*/C*	C/C*
CU-5	NC*/NC*	C*/C*	NC*/NC*	NC*/NC*	NC*/NC*	NC*/NC*
INDUSCAN	NC/NC*	C/C*	MC/PC*	MC/NC*	PC*/NC*	C/NC*
S-127	NC*/ND	C*/ND	NC*/ND	NC*/ND	ND	NC*/ND
S-129	ND	ND	ND	ND	ND	ND
S-131	ND	ND	ND	ND	ND	ND
S-135	NC*/NC*	PC*/NC*	PC*/C*	NC*/NC*	NC*/ND	NC*/NC*
S-352	NC/NC*	MC/PC*	MC/PC*	NC/NC*	C*/C*	C/C*

[A] C - "concern"; PC - "potential concern"; MC - "minimal concern"; NC- "no concern"; ND - not determined (no

- less than 28 samples preliminary test used

Listing before '/' is for WY2002–WY2011; after '/' is for WY2011

ALKALINITY AND PH

The Class I criteria for alkalinity specifies that the value shall not be less than 20 mg/L $CaCO_3$ equivalents. For inflow events in WY2011, alkalinity was measured at 22 structures (**Table 12**). Three structures (CU-5, S-2, and S-236) had no inflow alkalinity measurements. Of the 119 measurements, no excursions were found (Attachment B4). For the 10-year period, 19 structures were classified as "no concern," two as "minimal concern," and two as "concern" (**Table 12**, Attachment B8). Low alkalinity was associated with basins in the Indian Prairie, which may indicate natural conditions with more acidic soils from wetlands. Further investigation is needed to confirm this assertion.

For no-flow events, no excursions were found at 21 structures (**Table 13**, Attachment B5). The other five structures (C41H78, CU-10A, Industrial Canal, S-154C, and S-65E) were not measured during no-flow events. Of the 237 samples taken during no-flow events, no excursions were found. For the 10-year period of analysis, 22 structures were classified as "no concern," three as "minimal concern," and one as "potential concern" (**Table 12**, Attachment B8).

For outflow events in WY2011, alkalinity was measured at six structures (**Table 14**, Attachment B6). Of the 61 samples taken, no excursions were found. Three structures (S-127, S-129, and S-131) were not measured. For the 10-year period of record, no excursions were found at the seven stations (**Table 14**, Attachment B8).

The Class I criteria for pH specifies that the value shall must not be below 6.0 or above 8.5. For inflow events, 21 structures were classified as "no concern" and one as 'potential concern" (**Table 12**). Of the 117 samples taken during inflow events, only one was outside the pH criteria range (Attachment B4). For the 10-year period, 21 structures were classified as "no concern" and four as "minimal concern" (**Table 12**, Attachment B8).

For no-flow events, there were two structures classified as "potential concern." The remaining 19 structures that were sampled were classified as "no concern" (**Table 13**). Five structures (C41H78, CU-10A, Industrial Canal, S-154C, and S-65E) were not measured. Of the 239 samples taken during no-flow events, two were outside the pH criteria range (Attachment B5). For the 10-year period, there were 13 sites listed as "no concern," 12 as "minimal concern,"

and one as "concern" (C-38W) (**Table 13**, Attachment B8). The concern at C-38W was for pH above 8.5, which may have been caused by high groundwater inflows.

For outflow events, one structure (S-135) was classified as "concern," three as "potential concern," and two as "no concern" (**Table 14**). S-127, S-129, and S-131 were not measured. Of the 61 samples taken during outflow events, only four were outside the pH criteria range (Attachment B6). For the 10-year period, three structures were classified as "no concern," three as "minimal concern," and one (S-135) as "potential concern" (**Table 14**, Attachment B8).

CONDUCTIVITY

The conductivity criterion for Lake Okeechobee tributaries was set at 1,275 microsiemens per centimeter (µS/cm). For inflow events, 17 structures were classified as "no concern," one as "potential concern," four as "concern," and three (CULV-5, S-2, and S-236) were not sampled (**Table 12**). Of the 116 samples taken during inflow events, 22 exceeded the conductivity criterion (Attachment B4). For the 10-year period of record, 15 were classified as "no concern," two as "minimal concern," one as "potential concern," and seven as "concern" (**Table 12**, Attachment B8). High conductivity is likely a result of groundwater seepage.

For no-flow events, 17 structures were classified as "no concern," two as "potential concern," nine as "concern," and five (C41H78, CULV10A, Industrial Canal, S-154C, and S-65E) were not sampled (**Table 13**). Of the 239 samples taken during no-flow conditions, 23 exceeded the conductivity criterion (Attachment B5). For the 10-year period of record, 15 were classified as "no concern," two as "minimal concern," and nine as "concern" (**Table 13**, Attachment B8). Similar to inflow conditions, high conductivity was likely a result of groundwater seepage.

For outflow events, no excursions were found out of the 61 samples measured among eight structures (**Table 14**, Attachment B6). S-127, S-129, and S-131 were not sampled. For the 10-year period, five structures were classified as no concern, two as minimal concern and two (S-129 and S-131) were not sampled (**Table 14**, Attachment B8).

TURBIDITY

The Class I turbidity criterion for Lake Okeechobee tributaries is 32.3 NTU. The exceedance value was based on 29 NTU plus a background value of 3.3, which was determined based on the median value of turbidity in lake tributaries from 1990–2000 (SFWMD, 2009). For inflow events, there were no excursions from the 115 samples. S-2, S-236, and CULV-5 were not measured (Attachment B4, **Table 12**). For the 10-year period, 18 structures were classified as "no concern," two as "minimal concern," three as "potential concern," and two as "concern" (**Table 12**, Attachment B8). Turbidity concerns in Culv10A and the Industrial Canal may be due to runoff from agricultural lands as well as resuspended sediments that have accumulated in the bottom of the canals during inflow events. Further investigation would be needed to confirm these explanations.

For no-flow events, 20 structures were classified as "no concern," one as "potential concern," and five (C41H78, CU-10A, Industrial Canal, S-154C, and S-65E) were not sampled (**Table 13**). Of the 233 samples taken during no-flow conditions, one exceeded the criterion for turbidity (Attachment B5). For the 10-year period, 14 structures were classified as "no concern," six as "minimal concern," one as "potential concern," and five as "concern" (**Table 13**, Attachment B8). Turbidity concerns in S-2, S-3, S-352, Culv10A, and C-38W may be related to accumulation of sediments in the bottom of the canals.

For outflow events, four were classified as "no concern," two as "concern," and three (S-127, S-129, and S-131) were not sampled (**Table 14**). Of the 58 samples taken during outflow events, 14 exceeded the criteria for turbidity (Attachment B6). For the 10-year period, four structures

were classified as "no concern," three as "concern," and two (S-129, S-131) were not measured (**Table 13**, Attachment B8). Turbidity concerns at S-352 and CULV10A during outflow could be attributed to their location, which is near the very open turbid region of Lake Okeechobee. The Industrial Canal is not as close to open water, but a canal leads directly from the Industrial Canal lock to the lake's pelagic zone.

IRON

The Class I criterion for iron is not to exceed 1 mg/L. While not toxic at this level, the criterion is primarily to prevent staining in clothes washing (Environmental Health Laboratory, 2010). This parameter is only measured quarterly; therefore, there are enough samples at only a few structures to perform a binomial test with accuracy for the 10-year period. Of the 23 samples taken at 15 structures during inflow events, no exceedances were found (**Table 12**, Attachment B4). For the 10-year period of record, 15 structures were classified as "no concern," five as "potential concern," and five as "concern" (**Table 12**, Attachment B8). Iron occurs in soils and groundwater of the Lake Okeechobee watershed resulting in the high concentrations (Ground Water Protection Section, 2009).

For no-flow events, 20 structures were classified as "no concern," one as "concern," and three (C41H78, S65E, Industrial Canal) were not measured (**Table 13**). Of the 61 samples taken during no-flow periods, only two exceeded the iron standard (Attachment B5). For the 10-year period, 16 structures were classified as "no concern," three as "potential concern," and five as concern. Iron concerns at S-133, S-154, S-352, S-2, and S-3 may be attributed to groundwater seepage.

For outflow events, three structures were classified as "no concern," two as "concern," and four (S-127, S-129, S-131, and S-135) were not sampled (**Table 14**). Of the 12 samples taken during outflow periods, two exceeded the criterion for iron (Attachment B6). For the 10-year period, three structures were classified as "no concern," one as "potential concern," two as "concern," and three (S-127, S-129, S-131) were not measured (**Table 12**, Attachment B8). The two concerns, S-352 and CULV10A, could be attributed to the proximity of the structures to the open waters of the lake, which are relatively high in iron (Ground Water Protection Section, 2009)

TOTAL PHOSPHORUS LOADS

The WY2011 TP load to Lake Okeechobee is 178 metric tons (mt) including 35 mt from atmospheric deposition (FDEP, 2001). Most of the surface load comes from the northern watersheds (135.9 mt), followed by south (4.2 mt), east (1.6 mt), and west (1.2 mt), **(Table 15**). Target loads based on the Total Maximum Daily Load (TMDL) were exceeded by 57.4 mt in the north, 0 mt in the south, 0 mt in the east, and 1.1 mt in the west region. Overall in WY2011, the TMDL was exceeded by 37.9 mt. The five-year average (WY2007–WY2011) TP load to Lake Okeechobee was 367 mt per year, which exceeds the TMDL by 227 mt (**Table 16a**). This five-year average includes two regional droughts during WY2007–WY2008 and WY2011. The droughts reduced the flow and loads to the lake substantially compared to the 1991–2005 baseline of 2.5 million ac-ft and 546 mt TP (SFWMD et al., 2011) (**Table 16b**). Further analysis of these loads is presented in Volume I, Chapter 8, which documents the trends of water flow, TP load, and TP mean flow-weighted concentration in each Lake Okeechobee sub-watershed.

Table 15. TP loads (metric tons, or mt) for each structure by month.

Region	Structure	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	Total	Target Loads	+Above/ -Below Target
East	L-8(C10A)	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.4		
	S-308	0.0	0.0	0.2	0.1	0.0	0.1	0.0	0.0	0.3	0.1	0.1	0.2	1.2		
	Total	0.0	0.0	0.2	0.2	0.2	0.2	0.0	0.0	0.4	0.1	0.2	0.2	1.6	16.8	-15.2
North	C-38W C-33	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	C41H78	1.5	4.0	7.8	4.7	2.4	0.4	0.4	0.2	1.2	0.8	0.7	0.6	24.7		
	CU-5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1		
	FECR	4.1	1.5	2.0	1.5	4.1	0.5	0.1	0.0	0.0	0.1	0.0	0.0	13.9		
	L-61E[1]	0.9	1.5	0.0	0.0	0.6	0.5	0.6	0.5	1.3	0.8	0.7	0.5	7.9		
	L-59E	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3		
	L-59W	0.0	0.0	0.5	0.2	2.8	0.0	0.0	0.0	0.2	0.0	0.0	0.0	3.6		
	L-60E	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2		
	L-60W	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2		
	S-127	0.1	0.0	0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5		
	S-129	0.1	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4		
	S-131	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2		
	S-133	0.1	0.0	0.6	0.2	0.8	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.8		
	S-135	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4		
	S-154	2.2	0.0	2.3	0.6	2.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	7.3		
	S-154C	0.1	0.1	0.6	0.4	0.3	0.1	0.0	0.0	0.1	0.0	0.0	0.0	1.9		
	S-191	0.9	0.6	9.5	1.8	6.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	19.2		
	S-65E	13.1	3.5	12.5	5.4	5.2	1.5	0.5	0.4	0.7	0.6	0.6	4.9	48.9		
	S-71	0.6	2.5	7.9	5.1	1.8	0.1	0.0	0.0	0.0	0.0	0.2	0.2	18.3		
	S-72	0.0	0.3	2.3	0.8	0.4	0.0	0.0	0.0	0.0	0.0	0.1	0.1	4.1		
	S-84	0.9	0.5	3.4	1.1	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7		
	Total*	23.3	10.8	42.4	17.4	25.0	3.2	1.3	1.0	2.4	1.6	1.7	5.7	135.9	78.6	57.4

Table 15. Continued.

Region	Structure	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	Total	Target Loads	+Above/ -Below Target
South	CU-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	CU-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	CU-12A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	CU-4A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	INDS	0.1	0.1	0.3	0.2	0.2	0.0	0.0	0.0	0.1	0.0	0.1	0.0	1.2		
	S-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1		
	S-236	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	S-3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	S-352	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	S-4	0.1	0.5	0.9	0.6	0.5	0.1	0.0	0.0	0.1	0.0	0.0	0.0	2.8		
	Total	0.2	0.6	1.2	0.8	0.7	0.1	0.1	0.0	0.2	0.0	0.2	0.0	4.2	9.6	-5.4
West	CU-5A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.1	0.1	1.1		
	S-77	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.1	0.2	1.2	0.01	1.1
Total	**Surface***	23.5	11.4	43.8	18.4	25.9	3.5	1.4	1.9	2.9	1.7	2.2	6.2	142.9	105.0	37.9
	Atmospheric Deposition													35.0	35.0	
	Sum*													177.9	140.0	37.9

*does not include C41H78 loads

[1] L-61E, HP7, Loads 1,2,3 estimated using the formula C41H78-(S-71+L60W+G-207)

Table 16a. TP loads (mt) to Lake Okeechobee over the past five water years.

Water Year	North	East	South	West	Atmospheric Deposition*	Total
2007	183	13	5	7	35	243
2008	93	95	5	21	35	249
2009	585	22	26	17	35	685
2010	393	17	21	12	35	478
2011	136	2	4	1	35	178
Average	278	29.8	12.2	11.6	35	367
Percent of total	81%	6%	3%	2%	7%	100%

* 35 metric tons/year from atmospheric deposition (FDEP, 2001).

Table 16b. Surface flows (millions of ac-ft) to Lake Okeechobee (WY2007–WY2011).

Water Year	North	East	South	West	Total
2007	0.55	0.06	0.03	0.04	0.68
2008	0.46	0.43	0.02	0.11	1.02
2009	1.82	0.16	0.1	0.1	2.18
2010	2.14	0.09	0.09	0.09	2.41
2011	0.89	0.01	0.03	0.02	0.95
Average	1.172	0.15	0.054	0.072	1.448
Percent Total	86%	8%	3%	3%	100%

PESTICIDE MONITORING PROGRAM

The District maintains a pesticide monitoring program to meet various permit and other mandated requirements, including Class I (drinking water) criteria of Chapter 62-302, F.A.C. On a quarterly basis for water and semiannual basis for sediment, samples are measured for 73 pesticides and their breakdown products at sites throughout the District region (Pfeuffer, 2010a,b; 2011a,b). Additional information on the pesticide monitoring program can be found on the District's website at www.sfwmd.gov, under the *Scientist & Engineers, Environmental Monitoring* section, and the *Pesticide Reports* link.

For Lake Okeechobee, pesticides are monitored at S-65E, S-191, Fisheating Creek (FECSR78), S-2, S-3, and S-4. The data are included in Attachments B9 and B10. In the four surface water sampling events (September and December 2010; March and April 2011), ametryn, atrazine, atrazine breakdown product, bromacil, hexazinone, metolachlor, metribuzin, norflurazon, prometryn, and simazine were detected in at least one sample. However, bromacil, metolachlor, metribuzin, and norflurazon were detected at two northern sample sites (S-191 and S-65E), while ametryn, prometryn, and simazine were detected at the three southern sites (S-2, S-3, and S-4) (**Table 17**). The concentrations of most of these pesticides were below their respective PQL.

Table 17. Pesticide residues (µg/L) above the Method Detection Limit (MDL) found in surface water samples collected at Okeechobee sampling sites in September and December 2010, and March and April 2011 (From Pfeuffer, 2010a,b, 2011a,b) and chronic toxicity values for the water flea (*Daphnia magna*). [Note: None of the values exceed the chronic toxicity for *Daphnia magna*.]

Site	Date	Flow	Ametryn	Atrazine	Atrazine Desethyl	Bromacil	Hexazinone	Metolachlor	Metribuzin	Norflurazon	Prometryn	Simazine
FECSR78	9/21/2010	Y	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	12/7/2010	N	BDL	BDL	BDL	BDL	0.034 [b]	BDL	BDL	BDL	BDL	BDL
	3/1/2011	N	BDL	0.029 [b]	BDL	BDL	0.033 [b]	BDL	BDL	BDL	BDL	BDL
	4/25/2011	N	BDL	0.099	BDL	BDL	0.11	BDL	BDL	BDL	BDL	BDL
S-65E	9/21/2010	N	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	12/6/2010	Y	BDL	0.035 [b]	0.0099 [b]	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	3/1/2011	Y	BDL	0.033 [b]	BDL	0.12 [b]	BDL	0.089 [b]	0.026 [b]	BDL	BDL	BDL
	4/25/2011	Y	BDL	0.021 [b]	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
S-191	9/21/2010	N	BDL	BDL	BDL	0.16 [b]	0.036 [b]	BDL	BDL	0.022 [b]	BDL	BDL
	12/6/2010	N	BDL	BDL	BDL	BDL	0.73	BDL	BDL	BDL	BDL	BDL
	3/1/2011	N	BDL	0.015 [b]	BDL	BDL	0.34	BDL	BDL	BDL	BDL	BDL
	4/25/2011	N	BDL	0.035 [ab]	BDL	BDL	0.25 [a]	BDL	BDL	BDL	BDL	BDL
S-2	9/20/2010	N	0.057	0.046	BDL	BDL	BDL	BDL	BDL	BDL	0.021 [b]	BDL
	12/7/2010	N	BDL	0.12 [a]	0.026 [ab]	BDL	BDL	BDL	BDL	BDL	BDL	0.011 [ab]
	2/28/2011	N	0.0095 [b]	0.20	0.026 [b]	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	4/26/2011	N	BDL	0.29	0.031 [b]	BDL	BDL	BDL	BDL	BDL	BDL	BDL
S-3	9/20/2010	N	BDL	0.12	0.026 [b]	BDL	BDL	BDL	BDL	BDL	BDL	0.011 [b]
	12/7/2010	N	BDL	0.10	0.023 [b]	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	2/28/2011	N	BDL	0.22	0.028 [b]	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	4/26/2011	N	BDL	0.27	0.030 [b]	BDL	BDL	BDL	BDL	BDL	BDL	BDL
S-4	9/20/2010	N	0.030 [b]	0.038 [b]	BDL	BDL	0.058 [b]	BDL	BDL	BDL	BDL	BDL
	12/7/2010	N	0.010 [b]	0.11	0.025 [b]	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	2/28/2011	N	BDL	0.26	0.031 [b]	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	4/26/2011	N	BDL	0.30	0.031 [b]	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Chronic toxicity of *Daphnia magna*			1,400(c)	345 (c)	N/A	6,050(d)	7,580 (c)	1,175 (c)	210 (e)	>750 (f)	930 (c)	55 (c)

N - no Y - yes ; BDL denotes that the result is below the method detection limit
a - results are the average of replicate samples
b - value reported is greater than or equal to the method detection limit and less than the practical quantitation limit
c - U.S. Environmental Protection Agency (1991)
d - U.S. Environmental Protection Agency (1996a)
e - U.S. Environmental Protection Agency (1998)
f - U.S. Environmental Protection Agency (1996b)

The measured concentration of each compound is compared to the appropriate criterion outlined in Rule 62-302.530, F.A.C. If a pesticide compound is not specifically listed, acute and chronic toxicity criterion are calculated as one-third and one-twentieth, respectively, of the amount lethal to 50 percent of the test organisms in 96 hours, using the lowest technical grade effective concentration (EC_{50}) or lethal concentration (LC_{50}). The EC_{50} is a concentration at which 50 percent of the aquatic species tested exhibit a toxic effect short of mortality within a short (acute) exposure period; the LC_{50} technical grade is a concentration at which 50 percent of the aquatic animals tested die within a short (acute) exposure period. These criteria are determined using data from the summarized literature for the species significant to the indigenous aquatic community (Chapter 62-302.200, F.A.C.). These values are listed for the water flea (*Daphnia magna*), which is the most susceptible test organism for these pesticides (**Table 17**). Based on excursion categories recommended for the Everglades Protection Area (Weaver and Payne, 2005) any site where a pesticide was detected are to be labeled as potential concern**.**

Sediment samples taken at all of the sites in December 2010 and April 2011 showed detectable concentrations of two pesticides, dichlorodiphenyldichloroethane (DDD) and dichlorodiphenyldichloroethylene (DDE) (**Table 18**). Sediment concentrations are compared to freshwater sediment quality assessment guidelines (MacDonald Environmental Sciences, Ltd., and United States Geological Survey, 2003). A value below the threshold effect concentration (TEC) should not have a harmful effect on sediment-dwelling organisms. Values above the probable effect concentration (PEC) may potentially have harmful effects to such organisms.

During WY2011, DDD and DDE were only detected at S-2, S-3, and S-4. DDE is an environmental dehydrochlorination product of DDT, a popular insecticide for which the U.S. Environmental Protection Agency cancelled all uses in 1973. The large volume of DDT used historically; the persistence of DDT, DDE, and DDD; and the large hydrophobicity of these compounds account for the frequent detections in sediments. The latter attribute also results in a significant bioconcentration factor. In sufficient quantities, these residues have reproductive effects in wildlife and carcinogenic effects in many mammals. The DDD sediment concentrations detected range from 2.9 to 20 micrograms per kilogram (µg/kg). Any concentration below the TEC (4.9 µg/kg) should not affect sediment-dwelling organisms, while concentrations above the PEC (28 µg/kg) frequently affect such organisms. The sediment concentrations detected at S-2 and S-3 were less than the PEC and did not exceed the level of concern. DDE values ranged from 11 to 88 µg/kg in these sediments. The TEC is 3.2 µg/kg and the PEC is 31 µg/kg for DDE in freshwater sediments. Both concentrations of DDE detected at S-2 exceeded the PEC and may possibly affect sediment-dwelling organisms.

Table 18. Pesticide residues (µg/kg) above the MDL in sediment samples from Okeechobee sampling sites in December 2010 and April 2011 (from Pfeuffer 2010a, 2011b). [Note: Values in bold are above probable effect concentration.]

Site	Date	DDD-p,p'	DDE-p,p'
S-2	12/7/2010	20 [ab]	**88** [a]
	4/26/2011	13 [b]	**56**
S-3	12/7/2010	3.0 [b]	14
	4/26/2011	2.9 [b]	14
S-4	12/7/2010	BDL	BDL
	4/26/2011	BDL	11 [b]

BDL denotes that the result is below the MDL
a - results are the average of replicate samples
b - value reported is ≥MDL and < PQL

IN-LAKE WATER QUALITY MONITORING

The District maintains 37 in-lake sampling stations to monitor water quality in all ecological regions of Lake Okeechobee (**Figure 3**). The effects of nutrient loading, high and low water levels, droughts, and hurricanes on trends and changes in water quality have been evaluated using this information (Havens and James, 2005; James and Havens, 2005; Zhang et al., 2007; James et al., 2008; Zhang et al., 2009; McCormick et al. 2010). Volume I, Chapter 8 includes a detailed evaluation of these WY2011 data. An attachment of all water quality samples collected at the in-lake sampling sites (**Figure 3**) was developed from DBHYDRO (Attachment B11). These records include analytical results of grab samples for 15 water quality parameters (**Table 5**).

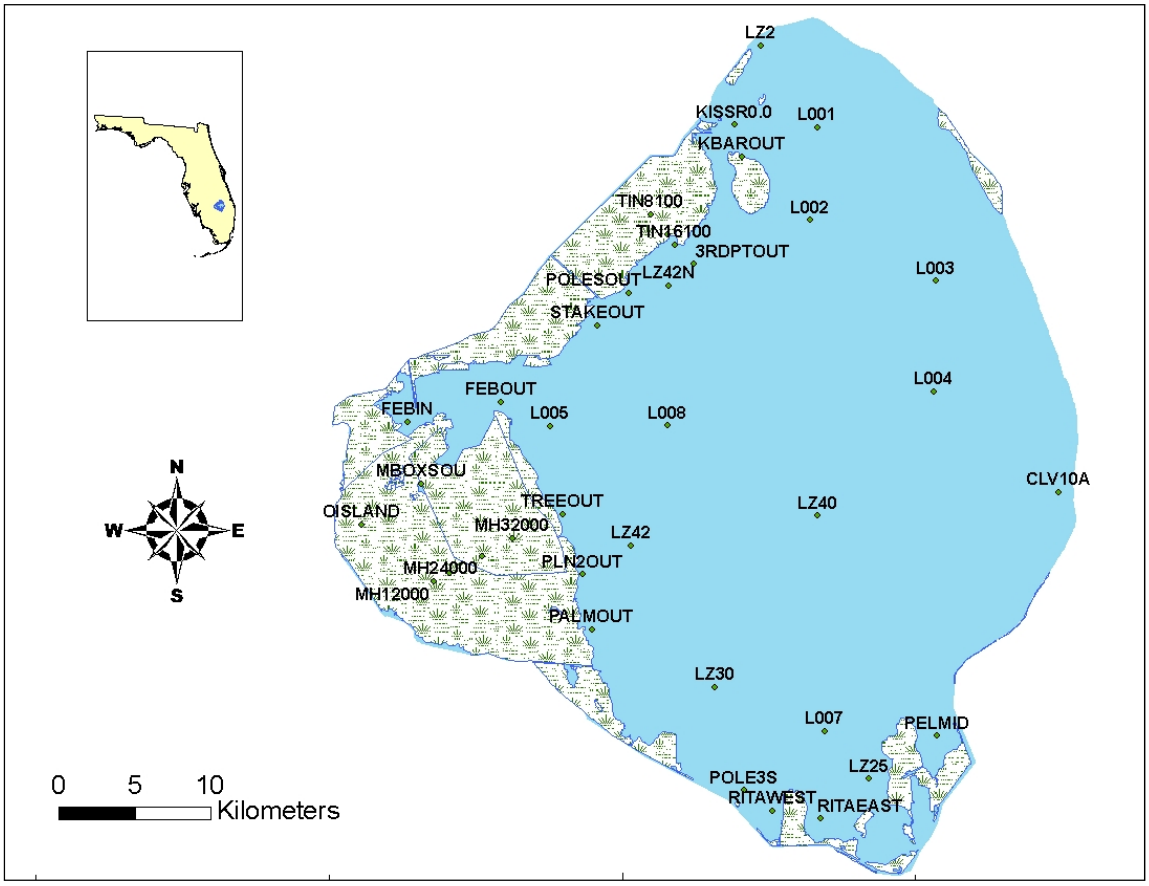

Figure 3. Active water quality monitoring stations in Lake Okeechobee.

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Attachment A: Specific Conditions and Cross-References

Table A-1. Specific conditions and cross-references presented in this report.

Specific Condition # & Description	Applicable Phase	Action and Frequency	Reported in 2012 SFER (Note: "V1" = Volume 1, "V3" = Volume 3, Appendix 4-1)			
			Table Number	Narrative (Page Number)*	Figure Number	Attachment
11A. Implementation of the Lake Okeechobee Protection Plan (This is SC#9A in original permit)	---	Annual		V1: Ch.8	---	---
11B. Annual compliance evaluation by region (This is SC#9B in original permit)	---		15, 16a	V3:1-23	---	---
14. Annual Monitoring Report	---		4–18	V3:2-32	1–5	B1–B11
14A. Water Quality Data. Records of monitoring information shall include all applicable laboratory information specified in Rule 62-160.340(2), F.A.C.	---		4–6	V3:15	1	B1
14A1. Date, location, and time of sampling or measurements	---	Annual	---	---	1	B1
14A2. Person responsible for performing the sampling or measurements	---	Annual	---	---	---	B1
14A3. Dates analyses were performed or the appropriate code as required by Chapter 62-160, F.A.C.	---	Annual	---	---	---	B1
14A4. Laboratory/Person responsible for performing the analyses	---	Annual	---	---	---	B1
14A5. Analytical methods used, including MDL and PQL	---	Annual	---	---	---	B1
14A6. Results of such analyses, including appropriate data qualifiers, and all compounds detected	---	Annual	---	---	---	B1

Specific Condition # & Description	Applicable Phase	Action and Frequency	Reported in 2012 SFER (Note: "V1" = Volume 1, "V3" = Volume 3, Appendix 4-1)			
			Table Number	Narrative (Page Number)*	Figure Number	Attachment
14A7. Depth of sampling (for grab samples)	---	Annual	---	---	---	B1
14A8. Flow conditions and weather conditions at time of sample collection	---	Annual	---	---	---	B1
14A9. Monthly flow volumes	---	Annual	7, 8	V3: 9—14	---	---
14B. Performance Evaluation. With the raw data, the permittee must submit an evaluation of the water quality monitoring data collected	---	Annual	10—18	V3:- 16—23	---	B4—B11
14B1. The analysis shall include the identification of exceedances of water quality criteria, other than phosphorus, as well as the frequency of exceedances	---	Annual	10—14	V3: 16—30	---	B4—B8
14B2. The permittee shall determine the annual total phosphorus loading to Lake Okeechobee	---	Annual	15, 16a, SFER -13	V3: 23—27, SFER: 8-59	SFER: 8-38— 8-40	---
14B3. The permittee shall report the five-year rolling average of phosphorus loading to Lake Okeechobee	---	Annual	16a, SFER 8-2	V3: 23, SFER: 8-15	---	---
14B4. The permittee shall provide the data from their ambient pesticide and herbicide monitoring program that is applicable to Lake Okeechobee	---	Annual	17,18	V3: 27—30	---	B9, B10
14B5. The permittee shall provide data collected within Lake Okeechobee under the Lake Okeechobee Research and Monitoring Program	---	Annual	---	V3:31	5	B11
21. Permit Modifications for the 3-Year Update to the LOPP (This is SC#19 in original permit)	---	2011 LOPP Update (submitted to FDEP in March 2011), as required.	---	---	---	---

PQL – Practical Quantitation Limit; MDL – Method Detection Limit; F.A.C. – Florida Administrative Code
*Narrative Page Number: SFER (2012 South Florida Environmental Report – Volume I, Chapter 8)
LOPP (2011 Lake Okeechobee Protection Plan Update)

Attachment B: Lake Okeechobee Water Quality and Flow Monitoring Data

This project information (Attachments B1–B11) is required by Modification 006 of the Operating Permit (0174552) and Specific Condition 14, Annual Monitoring Reports of the permit, and is available upon request.