To: **Kim O'Dell, Tracey Piccone, Jana Newman, Cal Neidrauer**
From: **Gary Goforth**
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Subject: **STA-3/4 Phosphorus Loading Performance Measure**

EXECUTIVE SUMMARY

Performance measures for long-term average monthly inflows to STA-3/4 from Lake Okeechobee were derived based on recent phosphorus concentrations measured in Lake releases to the south. The algorithms used in the recent EAA Regional Feasibility Study to manipulate the SFWMM output and generate the STA-3/4 inflow set for the DMSTA model are summarized. In addition, the complete listing of SFWMM output terms required to simulate the phosphorus performance of STA-3/4 is provided.

DERIVATION OF PERFORMANCE MEASURES

The projected phosphorus load to STA-3/4 and the other STAs from Lake Okeechobee was updated recently as part of the EAA Regional Feasibility Study. Phosphorus inflows to STA-3/4 were based on the recalibrated SFWMM simulation, utilizing the 1965-2000 rainfall record and regional water management conditions for the 2006 period (ADA/Burns & McDonnell 2005). Three categories of Lake Okeechobee releases influence the operation and performance of the Everglades STAs:

1. **Regulatory Releases.** STA-3/4 is the only stormwater treatment area designed to capture and treat regulatory releases from Lake Okeechobee.
2. **Water Supply for the STAs.** When available, lake water is delivered to the STAs to maintain a minimum depth of 0.5 ft above the average ground elevation.
3. **Water Supply for Downstream Users.** To minimize the potential for phosphorus overload of the STAs, the EAA Regional Feasibility Study assumed that water supply releases from Lake Okeechobee that needed to reach the WCAs and downstream users would not be captured and treated by the STAs (ADA/Burns & McDonnell 2005).

The average annual combined phosphorus load to STA-3/4 from Lake Okeechobee was estimated to be 11,339 kg/yr for the 35 water years (May-April) simulated in the EAA Regional Feasibility Study. The average monthly phosphorus loads and phosphorus concentrations from Lake Okeechobee regulatory releases and water supply deliveries to STA-3/4 are summarized in Table 1. With the 2004 and 2005 hurricanes, phosphorus concentrations in releases from Lake Okeechobee have increased significantly and average approximately 145 ppb from S-351 and 146 ppb from S-354 (O'Dell personal comm. 2006). The performance measures for Lake Okeechobee releases to STA-3/4 were derived by dividing the long-term average monthly phosphorus loads by the recent average phosphorus concentration. This assumes no attenuation in phosphorus concentration in the canals between the Lake and STA-3/4. The resulting average monthly flows are presented in Table 1.

Table 1. Long-term Monthly Average Lake Input to STA-3/4.

	EAA RFS	EAA RFS	Current	Perf. Measure	Perf. Measure
Month	TP Load	TP Conc	TP Conc	Flow	Flow
	kg	ppb	ppb	cfs	acre-feet
January	1,780	64	145.5	5,000	9,917
February	2,135	58	145.5	5,998	11,897
March	1,722	48	145.5	4,837	9,594
April	2,292	73	145.5	6,439	12,772
May	1,986	103	145.5	5,578	11,063
June	323	83	145.5	908	1,802
July	120	78	145.5	337	668
August	114	71	145.5	320	635
September	19	103	145.5	52	104
October	272	109	145.5	763	1,513
November	322	69	145.5	905	1,794
December	255	58	145.5	716	1,420
Total	**11,339**	67	145.5	31,853	63,179

WY2004, 2005 and 2006 (partial) (O'Dell personal communication):
S-351: 145 ppb
S-354: 146 ppb

The .dss structures used to compute the performance measures are 351RG, 354RG and WSSTA3.

SUMMARY OF SFWMM VARIABLES TO BE USED IN STA-3/4 DMSTA SIMULATIONS

Daily time series for the following SFWMM simulated structure flow variable names will be needed to complete the DMSTA simulations for STA-3/4.

NNRST3 = NNRC basin runoff routed to STA-3/4 through North New River Canal and G-370

S7BMPR = Emergency bypass of untreated EAA runoff around STA-3/4 through S-7 into WCA-2A

WLES7 = Portion of untreated runoff from NNRC basin in the EAA used to meet SA-2 demands in the LEC via existing S-7

MIAST3 = Runoff from Miami Canal basin, 298 District, S-236 Basin, and G-136 to STA-3/4 through Miami Canal and G-372

SSDST3 = Flow from South Shore Drainage District to STA-3/4

S236SO = Portion of runoff from S-236 (SFCD) Basin routed south to appropriate STAs

G136SO = Portion of G-136 flow routed south to STA-3/4

S8BPMR = Emergency bypass of untreated EAA runoff around STA-3/4 through S-8 into WCA-3A

WLES8 = Portion of untreated runoff from Miami Canal basin in the EAA used to meet SA-3 demands in the LEC via existing S-8

S3PMP = Flow back pumped for flood control to Lake Okeechobee at S-3 from Miami Canal basin

WL1351 = Water supply from Lake Okeechobee to LEC SA-2 via NNRC in the EAA

WL2351 = Water supply from Lake Okeechobee to LEC SA-3 via NNRC through S-150 in the EAA

WL3351 = Water supply from Lake Okeechobee to LEC SA-3 via Hillsboro Canal in the EAA

S351PK = Flow from Lake Okeechobee through S-351 to help meet Everglades National Park (ENP) flow targets

351RG = Lake Okeechobee regulatory discharge via S-351

WSST1W = Water supply discharge from Lake Okeechobee to STA-1W

WST1EE = Water supply discharge from Lake Okeechobee to eastern portion of STA-1E

WST1EW = Water supply discharge from Lake Okeechobee to western portion of STA-1E

WSST2E = Water supply discharge from Lake Okeechobee to eastern portion of STA-2

WSST2M = Water supply discharge from Lake Okeechobee to middle portion of STA-2

WSST2W = Water supply discharge from Lake Okeechobee to western portion of STA-2

S352L8 = Water supply discharge from Lake Okeechobee via S-352 into L-8 Canal

WLC352 = Water supply discharge to LEC from Lake Okeechobee via S-352

FLIMPM = Import Glades water met by Lake Okeechobee via Miami Canal through S-354

LKTSEM = Water supply from Lake Okeechobee to meet supplemental Big Cypress Reservation (BCR) Seminole demands

S354PK = Flow from Lake Okeechobee through S-354 to help meet ENP flow targets

WSHOLY = Water supply releases from Lake Okeechobee to Holeyland

WLC354 = Water supply discharge to LEC from Lake Okeechobee via S-354

354RG = Lake Okeechobee regulatory discharge via S-354

WSSTA3 = Water supply discharge from Lake Okeechobee to STA-3/4

WSSTA5 = Water supply discharge from Lake Okeechobee to STA-5

WSSTA6 = Water supply discharge from Lake Okeechobee to STA-6 via S-354 and Miami Canal

METHOD FOR CALCULATING FLOWS AND PHOSPHORUS LOADS TO STA-3/4

Consistent with the methods developed in the EAA Regional Feasibility Study, the following algorithms will be used to compile the inflow to STA-3/4 (ADA/B&M 2005).

S-2/S-7 Basin runoff. Total S-2/S-7 Basin runoff estimated from the results of the simulation would be

S-2/S-7 runoff = (NNRST3 + S7BMPR + WLES7)*0.89

The average monthly concentrations are listed in Table 3.3 (ADA/B&M 2005). Note: for easy cross reference to the EAA Regional Feasibility Study, the table numbers have not been changed.

Table 3.3: Average TP Concentrations in S-2/S-7 Basin Runoff*

Month	Average TP Conc. (ppb)	Month	Average TP Conc. (ppb)
January	40	July	74
February	61	August	71
March	65	September	72
April	88	October	92
May	96	November	144
June	83	December	106

* Derived from Table 4.11 of final Task 1.3 report (June 27, 2005).

South Shore Drainage District. The daily runoff volume from the SSDD for WY 1966–1994 is estimated using the following equation :

SSDD Runoff = 0.041*(NNRST3 + S7BMPR + WLES7)

The average monthly concentrations are listed in Table 2.8 (ADA/B&M 2005).

Table 2.8: Average TP Concentrations in South Shore Drainage District Runoff*

Month	Average TP Conc. (ppb)	Month	Average TP Conc. (ppb)
January	83	July	103
February	85	August	104
March	111	September	122
April	138	October	120
May	95	November	115
June	97	December	107

* Derived from Table 9.10 of final Task 1.3 report (June 27, 2005).

For the balance of the model simulation period, WY 1995-2000, historic discharge and TP concentration data are used without modification.

South Florida Conservancy District. The daily basin runoff from the SFCD, for WY 1966–1994 only, is then calculated using the following equation:

SFCD Runoff = 0.0853*(MIAST3–SSDST3–S236SO–G136SO+S8BPMR +WLES8+S3PMP)

The average monthly concentrations are listed in Table 2.11 (ADA/B&M 2005).

Table 2.11: Average TP Concentrations in South Florida Conservancy District Runoff*

Month	Average TP Conc. (ppb)	Month	Average TP Conc. (ppb)
January	88	July	107
February	139	August	123
March	131	September	126
April	104	October	137
May	111	November	169
June	104	December	123

* Derived from Table 9.13 of final Task 1.3 report (June 27, 2005).

For the balance of the simulation period, WY 1995-2000, actual historic discharge and TP concentration data are used without modification.

S-3/S-8 Basin runoff. Runoff from the S-3 and S-8 basins is tributary to the Miami Canal will be delivered primarily to STA-3/4 via Pump Station G-372. From the SFWMM simulation, the daily runoff volumes that would be delivered to STA-3/4 at G-372 are calculated using the following equation:

S-3/S-8 Runoff = [MIAST3–SSDST3–S236SO–G136SO] + S8BPMR+WLES8

The average monthly concentrations are listed in Table 3.7 (ADA/B&M 2005).

Table 3.7: Average TP Concentrations in S-3/S-8 Basin Runoff*

Month	Average TP Conc. (ppb)	Month	Average TP Conc. (ppb)
January	40	July	96
February	41	August	90
March	47	September	90
April	67	October	95
May	92	November	132
June	67	December	60

* Derived from Table 5.22 of final Task 1.3 report (June 27, 2005).

C-139 Basin Runoff through G-136 to STA-3/4. During high runoff events, a portion of the runoff from the C-139 Basin is diverted to the east into the S-3/S-8 Basin through structure G-136. In the SFWMM simulation, a portion of this water is assumed to flow south and contribute to the inflow to STA-3/4 (flow term G136SO). The daily TP loads in inflow to STA-3/4 from the C-139 Basin will be calculated using average monthly TP concentrations in G-136 discharge that were developed from historic data. TP concentrations within the C-139 Basin are assumed to decrease by 10 percent. The average monthly concentrations are listed in Table 4.2 (ADA/B&M 2005).

As depicted in the SFWMM simulation, not all of the flow through G-136 is considered to flow south and pass through STA-3/4. The destination of the remainder (**flow term G136EA**) is not explicitly defined but may contribute to flow that is back pumped to Lake Okeechobee at S-3 or be used within the S-3/S-8 basin for irrigation.

Table 4.2: Average TP Concentrations in G-136 Discharge

Month	Average TP Concentration (ppb)	
	Measured[1]	Adjusted[2]
January	84	75
February	134	120
March	114	103
April	66	60
May	66	60
June	188	169
July	242	218
August	220	198
September	210	189
October	181	163
November	246	221
December	80	72

1 Derived from Table 8.1 of final Task 1.3 report (June 27, 2005).

Lake Okeechobee Releases

Total Flow-Through Releases at S-351. Lake Okeechobee releases at S-351 can flow down either the Hillsboro or North New River canals. The distribution of these releases between the two canals will vary dynamically based on a number of factors so only the total releases at this location are addressed below. In the 2006 SFWMM simulation, the daily flow-through release volumes at S-351 are the summation of a number of individual flow terms as indicated by the following equation:

Total Release = [WL1351+WL2351+WL3351+S351PK] +

[351RG+WSST2E+WSST2M+WSST2W]

District staff will provide the current estimate of TP concentrations of Lake water released at S-351.

Total Flow-Through Releases at S-352. Lake Okeechobee releases at S-352 pass into the West Palm Beach Canal. In the 2006 SFWMM simulation, the daily flow-through release volumes at S-352 are the summation of a number of individual flow terms as indicated by the following equation:

Total Release = [S352L8+WLC352] + [WSST1W+WST1EE+WST1EW]

District staff will provide the current estimate of TP concentrations of Lake water released at S-352.

Total Flow-Through Releases at S-354. Lake Okeechobee releases at S-354 pass into the Miami Canal. In the 2006 SFWMM simulation, the daily flow-through release volumes at S-354 are the summation of a number of individual flow terms as indicated by the following equation:

Total Release = [FLIMPM+LKTSEM+S354PK+WSHOLY+WLC354] +

[354RG+WSSTA3+WSSTA5+WSSTA6]

District staff will provide the current estimate of TP concentrations of Lake water released at S-354.

Water Supply Bypass

Flow-through releases from Lake Okeechobee that are intended to satisfy water supply demands downstream of the EAA may not be routed through a STA for treatment. The volumes and TP loads in this water supply bypass are characterized below.

Water Supply Bypass at S-351. As modeled in the SFWMM simulation, there are four flow terms that constitute water supply bypass volumes at S-351: WL1351, WL2351, WL3351 and S351PK. District staff will provide the current estimate of TP concentrations of Lake water released at S-351.

Water Supply Bypass at S-352. At S-352, water supply bypass is represented by two terms in the 2006 SFWMM simulation: S352L8 and WLC352. District staff will provide the current estimate of TP concentrations of Lake water released at S-354.

Water Supply Bypass at S-354. As modeled in the SFWMM simulation, there are five flow terms that constitute water supply bypass volumes at S-354: FLIMPM, LKTSEM, S354PK, WSHOLY, and WLC354. District staff will provide the current estimate of TP concentrations of Lake water released at S-354.

Flow-Through Releases to be Treated

The remainder of the flow-through releases from Lake Okeechobee, those which are not considered to be water supply bypass, will either be diverted through STA-3/4 for treatment before being released to the EPA or are water supplies for the STAs themselves.

Flow-Through Releases at S-351 to be Treated. As modeled in the SFWMM simulation, there are four flow terms that constitute lake flow-through releases at S-351 that will require treatment: 351RG, WSST2E, WSST2M, and WSST2W.

Flow-through Releases to be treated in STA-1E and STA-1W. As modeled in the SFWMM simulation, there are three flow terms that constitute lake flow-through releases that will require treatment in STA-1E and STA-1W: WSST1W, WST1EE, and WST1EE.

Flow-Through Releases at S-354 to be Treated. As modeled in the SFWMM simulation, there are four flow terms that constitute lake flow-through releases at S-354 that will require treatment: 354RG, WSSTA3, WSSTA5, and WSSTA6.

REFERENCES

ADA/Burns & McDonnell Engineering Inc. August 2005. Everglades Agricultural Area Regional Feasibility Study Deliverable 1.5.2 – Inflow Data Sets for the Period 2006-2009 (Final Report), prepared for the South Florida Water Management District.

O'Dell, K. 2006. Flow-weighted phosphorus concentration for releases from S-351 and S-354, February 16, 2006.