Lake Okeechobee System Operating Manual

Iteration 2 Modeling -
S-77/S-308 Load Estimates

Sanibel-Captiva Conservation Foundation

Conservancy of Southwest Florida

July 08, 2021
(Updated: July 09, 2021)

Paul Julian PhD
pjulian@sccf.org

Iteration 2 - Model runs

Alternative	Description
ECBr [1]	LOSOM Existing Condition Baseline 2019
NA25 [2]	LOSOM No Action 2025 (FWO)
AA	ESLE Framework. Enhances SLE ecology.
BB	SPLC Framework. Improve water supply to pre-LORS08
CC	Pareto Plan D Framework. Enhances CRE ecology and improves water supply
DD	Pareto Plan A Framework. Incremental improvement over LORS.
EE1	Stage Target Operation Framework. Improve water supply performance by reducing flows south.
EE2	Stage Target Operations Framework. Reduce flows to SLE by reducing Zone B release rate.

[1] Existing Conditions Baseline 2019, revised (replaces LSMECB)

[2] No action Condition 2025 (replaces LSM25B)

Methods

- Due to variability in concentration-Discharge relationships and lack of water quality-hydrodynamic model (like ENLM) monthly mean TP and TN concentration data was used.

	Total Phosphorus ($\mu g\ L^{-1}$)		Total Nitrogen ($mg\ L^{-1}$)	
Month	S-77	S-308	S-77	S-308
Jan	79 ± 34 (71)	256 ± 143 (45)	1.43 ± 0.23 (70)	2.25 ± 0.97 (44)
Feb	87 ± 46 (64)	237 ± 150 (42)	1.46 ± 0.35 (65)	2.00 ± 0.74 (42)
Mar	93 ± 34 (65)	230 ± 181 (41)	1.55 ± 0.59 (65)	2.03 ± 1.10 (41)
Apr	104 ± 38 (67)	220 ± 92 (43)	1.54 ± 0.24 (65)	1.95 ± 0.49 (43)
May	113 ± 61 (74)	187 ± 73 (49)	1.69 ± 0.55 (68)	1.80 ± 0.43 (44)
Jun	117 ± 83 (64)	174 ± 81 (41)	1.65 ± 0.42 (64)	1.64 ± 0.61 (38)
Jul	152 ± 103 (71)	212 ± 121 (47)	1.78 ± 0.41 (69)	1.55 ± 0.28 (46)
Aug	159 ± 90 (72)	187 ± 108 (48)	1.81 ± 0.72 (66)	1.57 ± 0.49 (48)
Sep	155 ± 87 (73)	185 ± 95 (50)	1.72 ± 0.47 (70)	1.60 ± 0.48 (50)
Oct	109 ± 100 (72)	177 ± 85 (46)	1.64 ± 0.66 (69)	1.56 ± 0.31 (45)
Nov	81 ± 42 (69)	192 ± 88 (44)	1.47 ± 0.33 (67)	1.86 ± 0.64 (44)
Dec	83 ± 40 (69)	235 ± 129 (45)	1.45 ± 0.24 (67)	2.07 ± 0.77 (45)

Mean ± Std Dev (N)

POR: May 1999 - April 2020

Methods

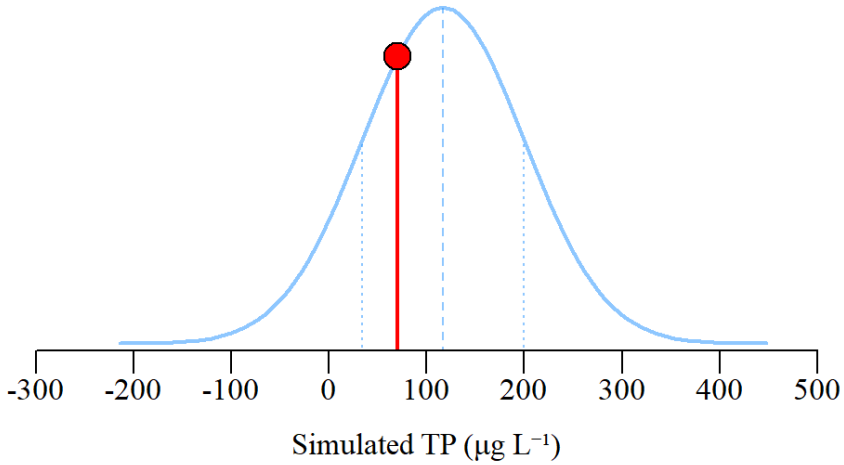
- Monthly TP/TN concentrations were pulled from a normal distribution using monthly mean and sd values for each month within the simulation period of record (1965 - 2016).
- If negative "simulated" values occurred (its possible given a normal distribution), the values was set to the POR mean value.

Example R Code

```
set.seed(123)
mean.val<-0.1168
sd.val<-0.0826

sim.TP<-rnorm(1,
              mean=mean.val,
              sd=sd.val)
sim.TP
```

```
## [1] 0.07050471
```



Example normal distribution with with $sim.TP$ identified.

Methods

Proof of concept

- Comparison of observed and simulated WQ data
  - POR: May 1999 - Apirl 2020
  - Want to ensure long-term mean values are comparable (i.e. POR mean).

		Observed		Simulated	
Site	Parameter	Mean	St. Dev.	Mean	St. Dev.
S77	TP (mg L^{-1})	0.1116	0.0741	0.1175	0.0682
	TN (mg L^{-1})	1.60	0.48	1.61	0.47
S308	TP (mg L^{-1})	0.2071	0.1175	0.2176	0.1079
	TN (mg L^{-1})	1.82	0.68	1.84	0.67

Methods

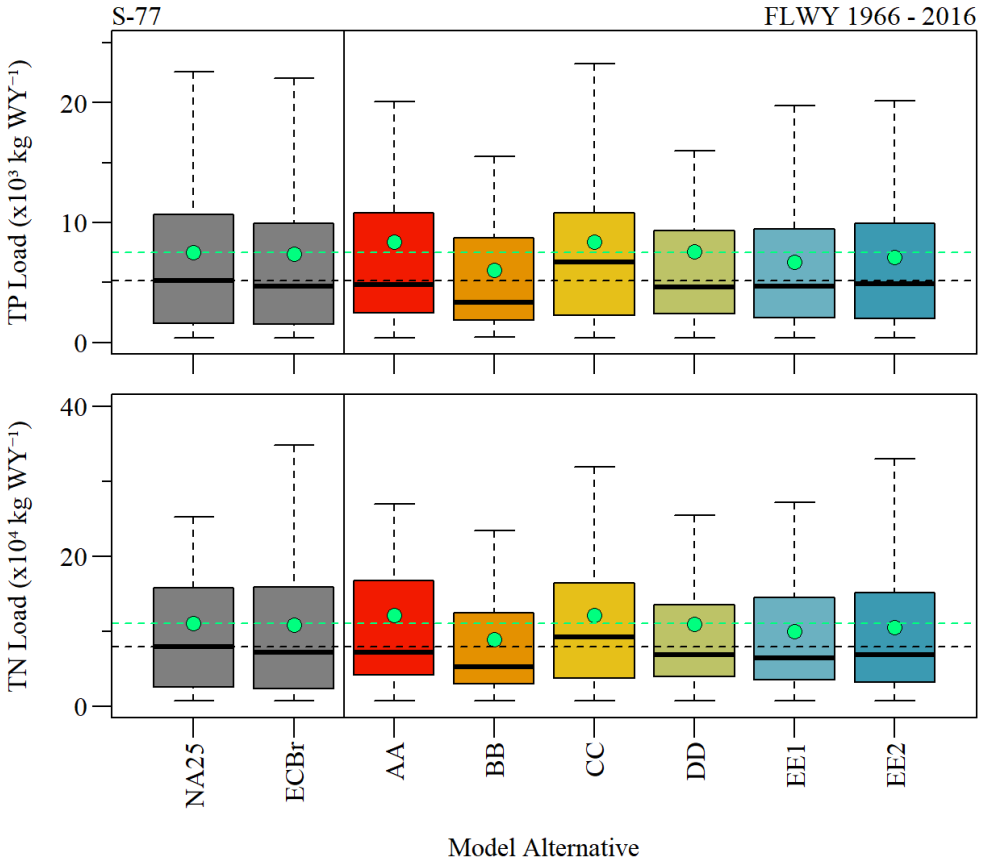
- Simulated TP & TN conc. were paired with daily discharge values for each alternative during the period of simulation.
- Load were estimated by interpolating concentrations daily from simulated data. Daily interpolated water quality concentrations were then multiplied by daily flow and summed for each WY.
- Load and FWM were estimated for S-77, S-308 and S-308 backflow events.

Assumptions

- No annual (or seasonal) trend in TP or TN concentrations during the period of simulation.

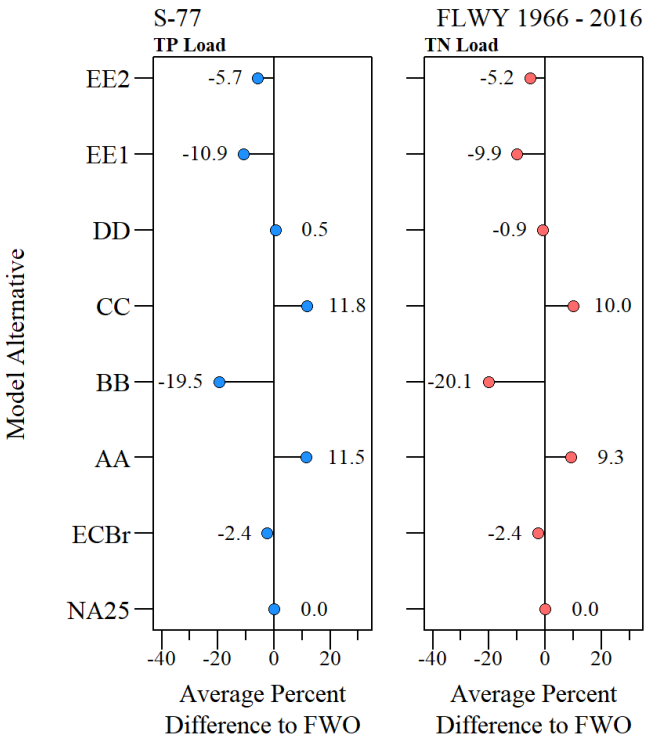
- Monthly data come from a normal distribution.

S-77 Load



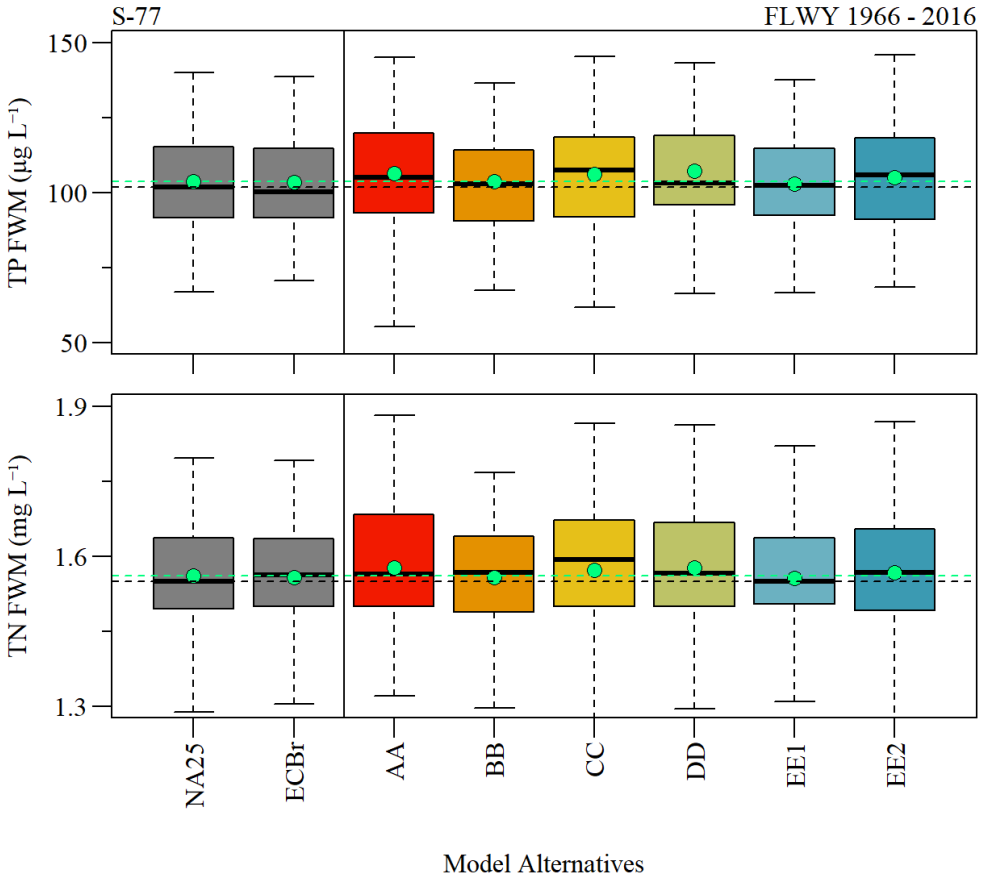
Boxplot representing annual TP (top) and TN (bottom) loads during the simulation period across alternatives. Black-dashed line represents the FWO median and green dashed line and point in boxplot indicates period of simulation mean.

S-77 Load Summary



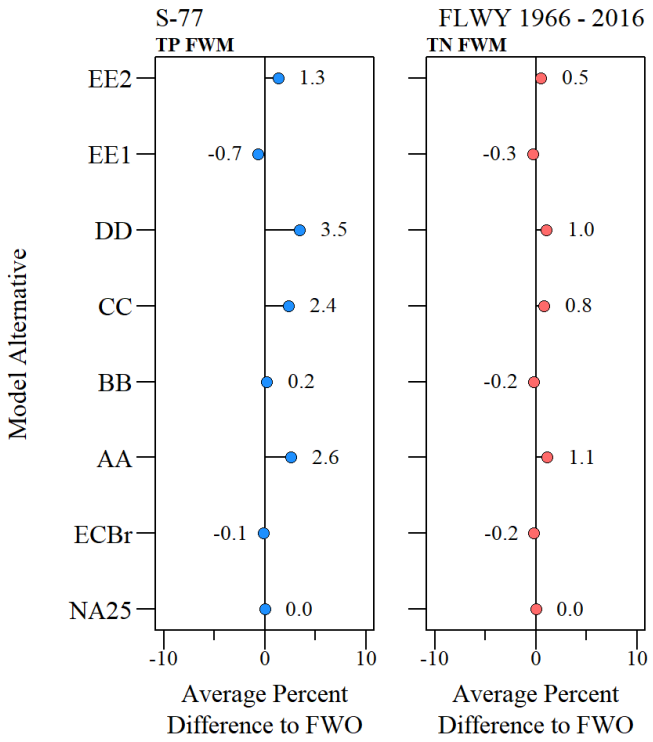
Percent difference of average load relative to the FWO (NA25) alternative over the entire simulation period for total phosphorus (left) and total nitrogen (right) loads.

S-77 FWM



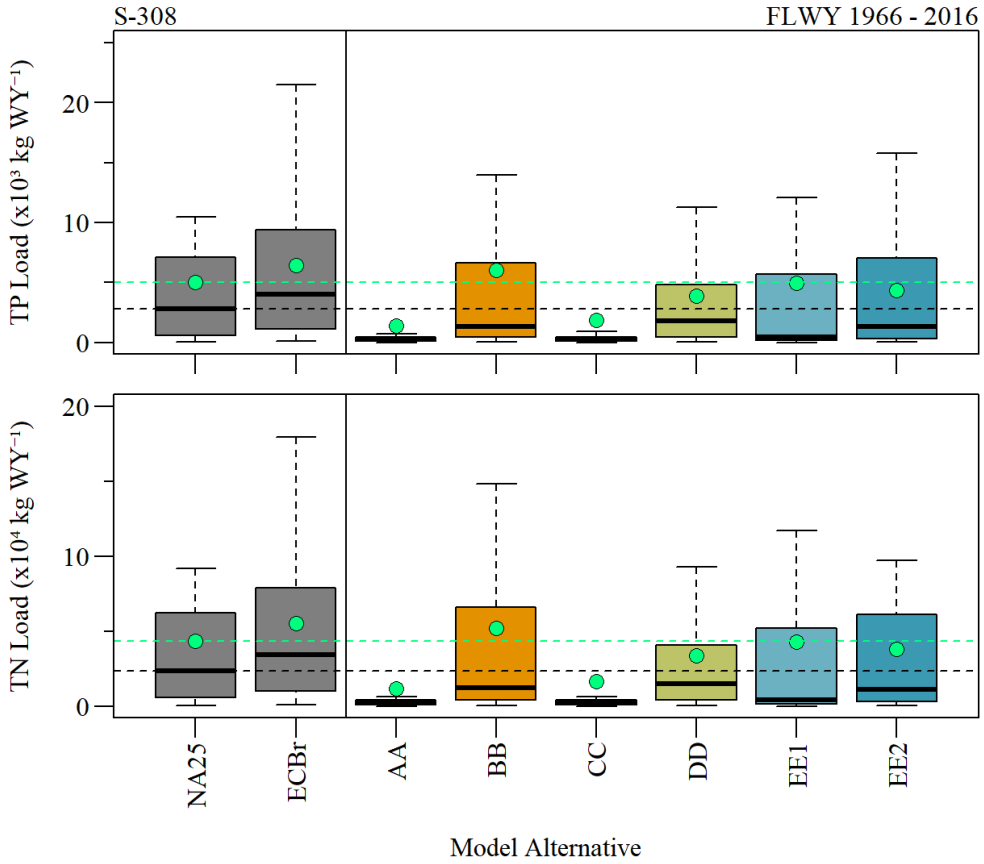
Boxplot representing annual TP (top) and TN (bottom) flow-weighted mean concentration during the simulation period across alternatives. Black-dashed line represents the FWO median and green dashed line and point in boxplot indicates period of simulation mean.

S-77 FWM Summary



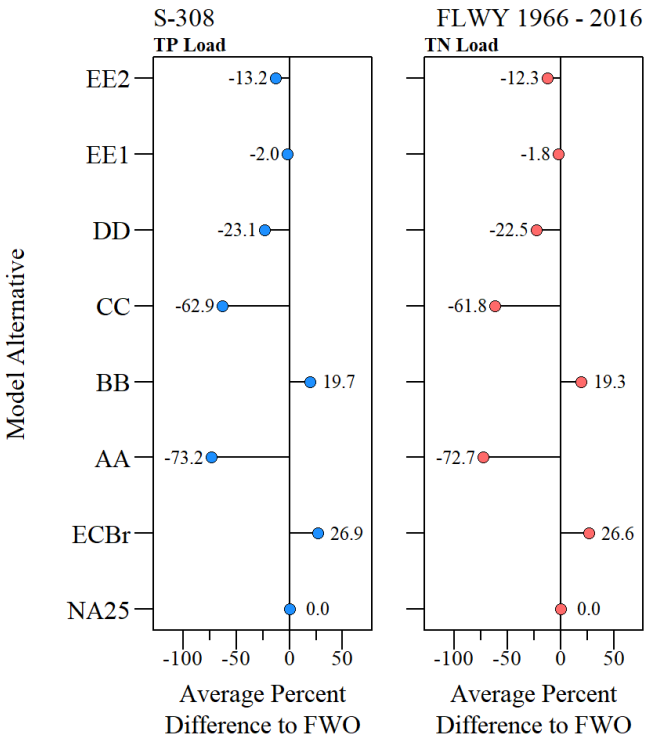
Percent difference of average load relative to the FWO (NA25) alternative over the entire simulation period for total phosphorus (left) and total nitrogen (right) loads.

S-308 Load



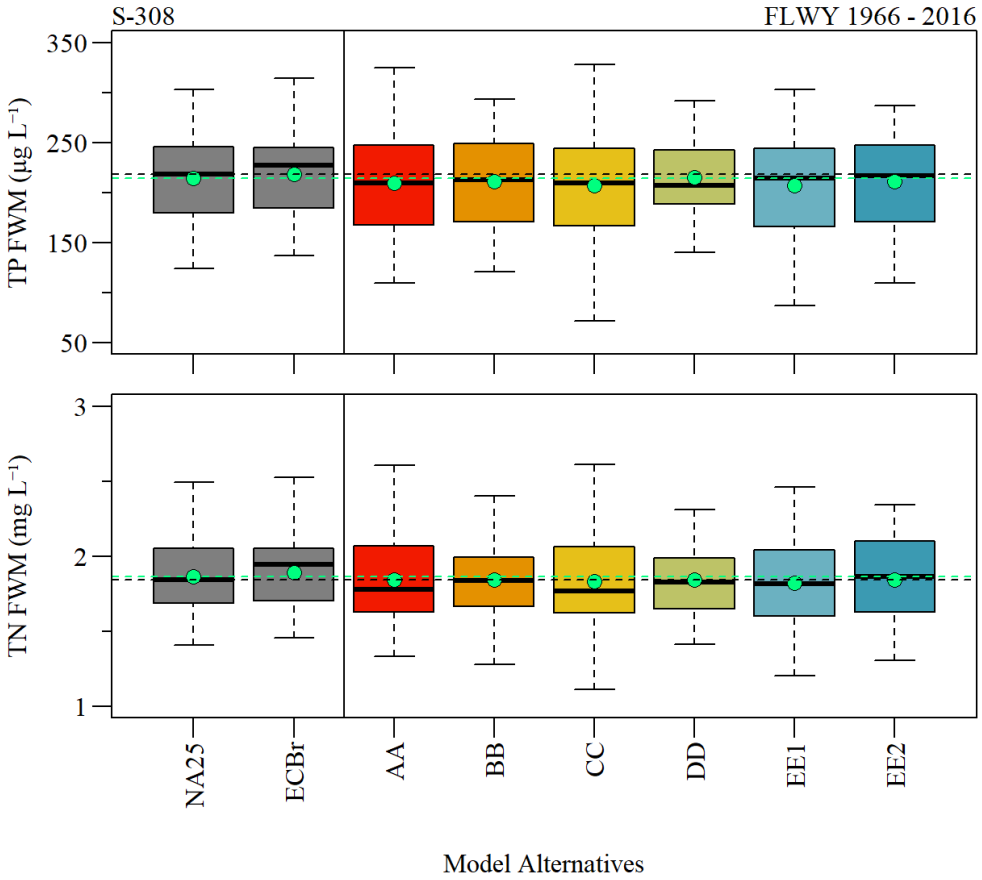
Boxplot representing annual TP (top) and TN (bottom) loads during the simulation period across alternatives. Black-dashed line represents the FWO median and green dashed line and point in boxplot indicates period of simulation mean.

S-308 Load Summary



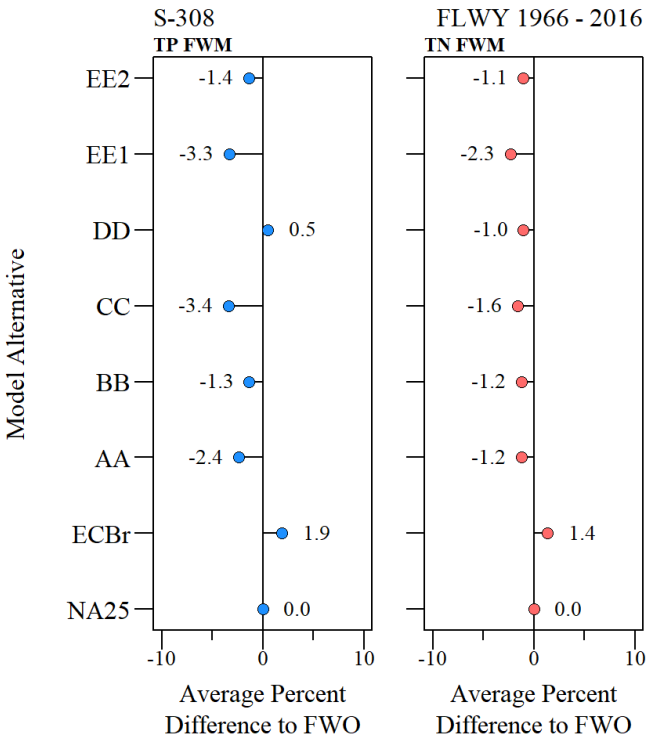
Percent difference of average load relative to the FWO (NA25) alternative over the entire simulation period for total phosphorus (left) and total nitrogen (right) loads.

S-308 FWM



Boxplot representing annual TP (top) and TN (bottom) flow-weighted mean concentration during the simulation period across alternatives. Black-dashed line represents the FWO median and green dashed line and point in boxplot indicates period of simulation mean.

S-308 FWM Summary



Percent difference of average load relative to the FWO (NA25) alternative over the entire simulation period for total phosphorus (left) and total nitrogen (right) loads.

S-77 Summary

Period of simulation annual mean discharge, total phoshphorus and total nitrogen load and flow-weight mean concentrations

Alt	Discharge (kAc-Ft WY^{-1})	TP Load (kg WY^{-1})	TN Load (kg WY^{-1})	TP FWM (µg L^{-1})	TN FWM (mg L^{-1})
NA25	573.5	75241	1106665	103.6	1.56
ECBr	560.5	73443	1079641	103.5	1.56
AA	619.5	83901	1209732	106.3	1.58
BB	461.7	60602	884074	103.8	1.56
CC	623.5	84091	1216789	106.1	1.57
DD	564.6	75611	1096539	107.2	1.58
EE1	517.6	67049	996968	102.9	1.56
EE2	545.0	70915	1048721	105.0	1.57

WY1966 - 2016 (May 1965 - Apirl 2016)

S-308 Summary

Period of simulation annual mean discharge, total phoshphorus and total nitrogen load and flow-weight mean concentrations for S308 and S-308 Backflow.

	S-308 (From Lake to C-44 Canal)					S-308 Back Flow (From C-44 Canal to Lake)		
Alt	Discharge (kAc-Ft WY^{-1})	TP Load (kg WY^{-1})	TN Load (kg WY^{-1})	TP FWM (µg L^{-1})	TN FWM (mg L^{-1})	Discharge (kAc-Ft WY^{-1})	TP Load (kg WY^{-1})	TN Load (kg WY^{-1})
NA25	190.1	50483	435807	214.3	1.86	38.8	9889	83802
ECBr	240.2	64052	551943	218.4	1.89	45.9	11395	96059
AA	54.7	13552	118896	209.2	1.84	46.1	12073	101936
BB	229.1	60450	520088	211.4	1.84	37.0	9303	79854
CC	75.5	18712	166548	207.0	1.83	45.6	11872	100787
DD	149.4	38819	337866	215.4	1.85	42.2	10836	92671
EE1	189.0	49455	428082	207.2	1.82	46.0	11895	100734
EE2	170.4	43798	382382	211.4	1.84	45.6	11801	99738

WY1966 - 2016 (May 1965 - Apirl 2016)

Summary

	S77	S308
Load	BB lower relative to FWO (lower lake flows)	AA and CC lower relative to FWO (lower lake flows)
	CC higher relative to FWO (higher lake flows)	BB higher relative to FWO (higher lake flows)
FWM	EE1 lower relative to FWO	CC lower relative to FWO
	DD higher relative to FWO	DD higher relative to FWO for TP

- Some plans (AA,CC,DD & EEs) increase the flow and load associated with backflow at the S308.
  - of the water discharged through S308, 84% and 60% is returned to the lake as backflow in plan AA and CC, respecitvley.

Acknowledgments

South Florida Water Management District (DBHYDRO)

US Army Corps of Engineers (USACE LOSOM)

- Interagency Modeling Center

HTML Slide deck | PDF Slide deck | RMarkdown Source

Analysis Script