Lake Okeechobee Discharges, Harmful Algae Blooms and LOSOM

Martin County Conservation Alliance, Florida Oceanographic Society, Indian Riverkeeper

February 20, 2020 – Gary Goforth, Ph.D., P.E.

Disclaimer: Opinions expressed are those of the author and not of Florida Oceanographic Society or any other group.

Gary Goforth, LLC

Three engineers walked into a bar.

Three engineers walked into a bar.

The fourth one ducked.

Take Home Messages

1. Pollution of Lake Okeechobee is primarily responsible for “HABs”

2. Lake operations currently governed by “LORS2008”
   - if Corps and SFWMD don’t move sufficient water west and south, then
   - lake levels could rise in wet season to “high risk” potential
   - could require releases of algae-laden polluted lake water to estuaries

3. Lake Okeechobee System Operations Manual (LOSOM)
   - ***Public input is critical!***

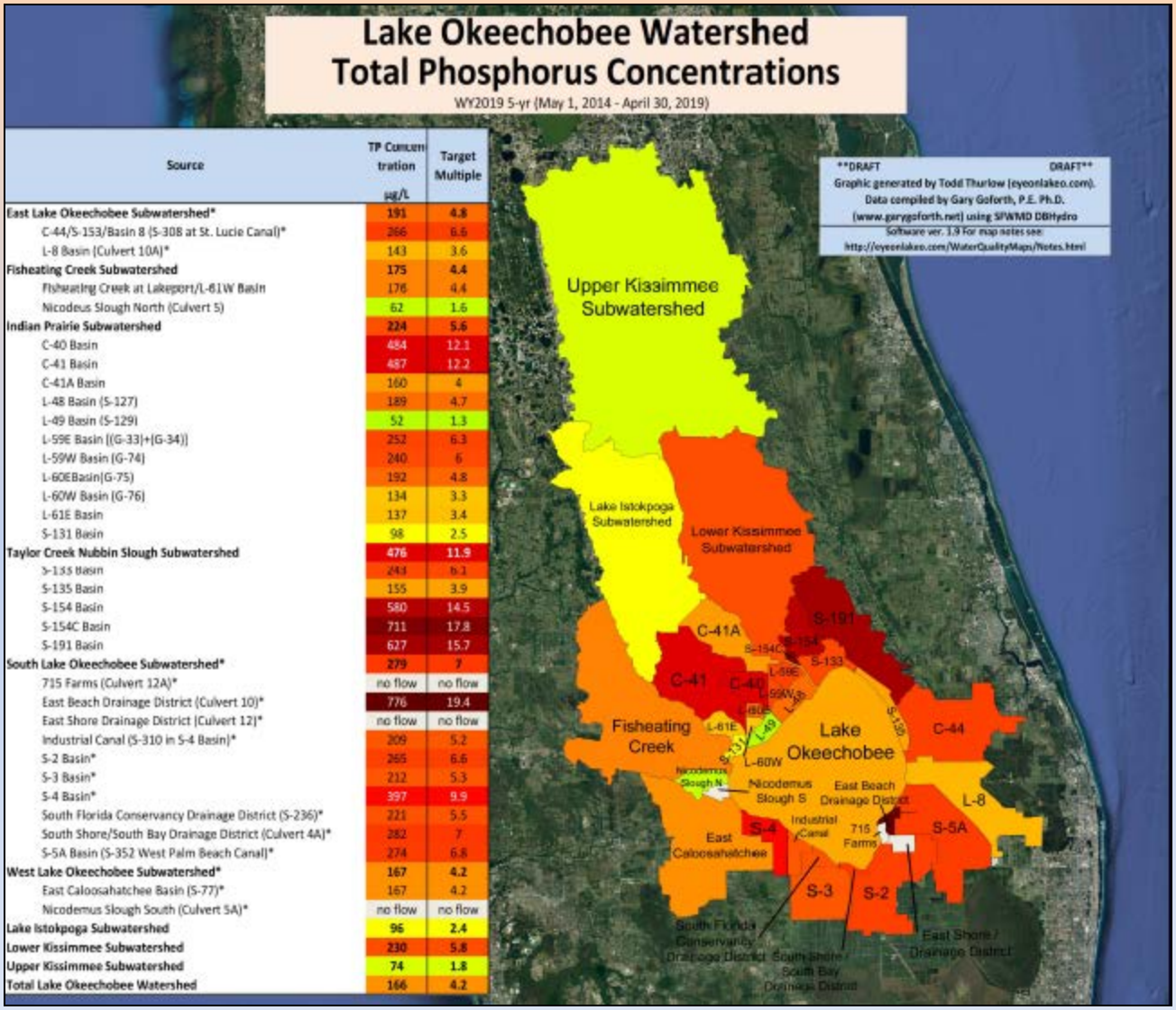
Even after EAA Reservoir is built and more Lake water is sent south, HABs will occur until State fixes pollution of Lake Okeechobee

Note: St Lucie Watershed also suffers from pollution and may eventually sustain HABs without lake releases

Part 1. Pollution of Lake Okeechobee

Lake has a 5,400-sq mile watershed

- All basins around lake are contributing pollution
- Orlando ("Mickey Mouse") – some of the cleanest water entering the lake

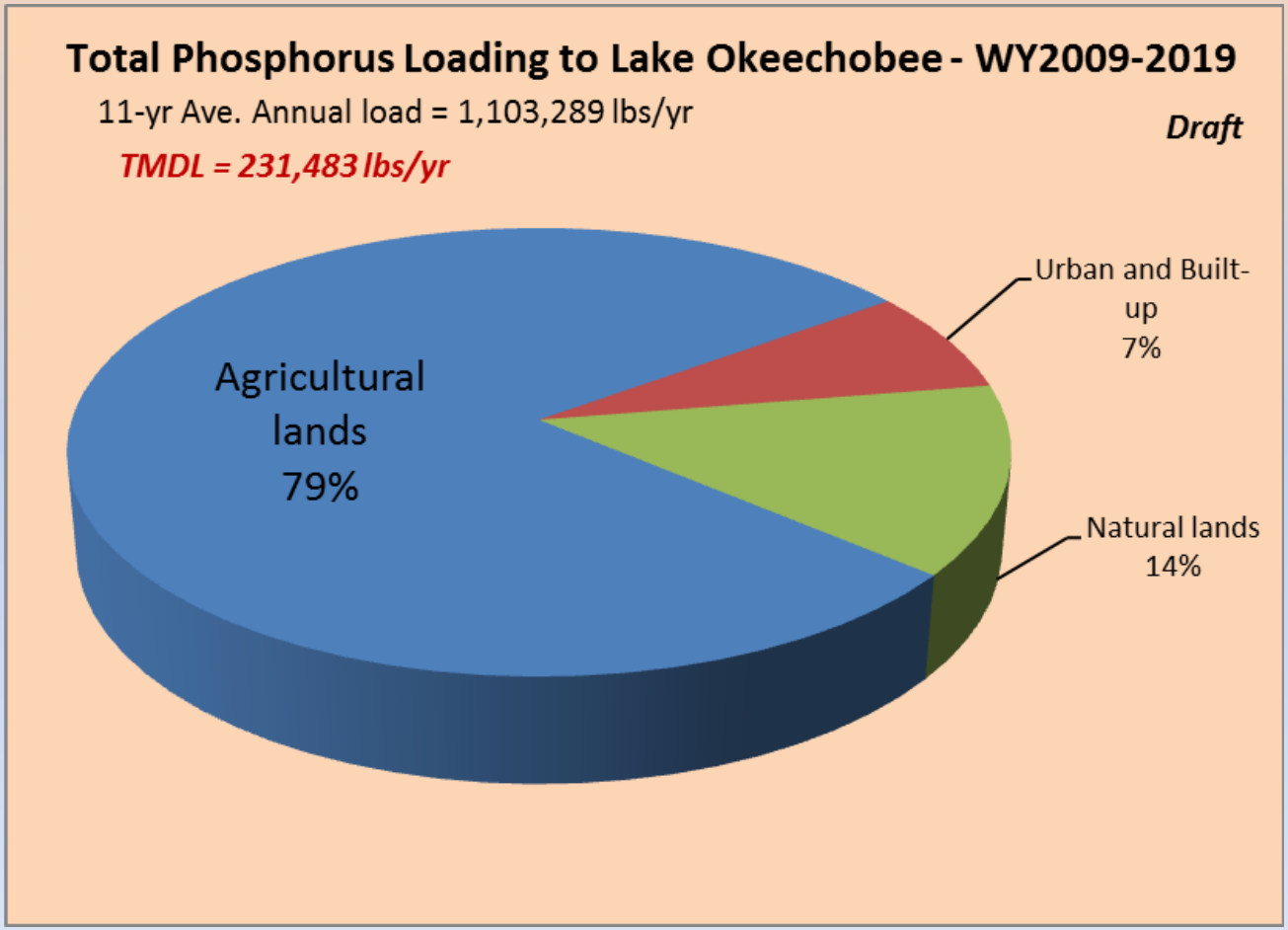


Source	TP Concentration µg/L	Target Multiple
East Lake Okeechobee Subwatershed*	191	4.8
C-44/S-153/Basin 8 (S-308 at St. Lucie Canal)*	266	6.6
L-8 Basin (Culvert 10A)*	143	3.6
Fisheating Creek Subwatershed	175	4.4
Fisheating Creek at Lakeport/L-61W Basin	176	4.4
Nicodeus Slough North (Culvert 5)	62	1.6
Indian Prairie Subwatershed	224	5.6
C-40 Basin	484	12.1
C-41 Basin	487	12.2
C-41A Basin	160	4
L-48 Basin (S-127)	189	4.7
L-49 Basin (S-129)	52	1.3
L-59E Basin [(G-33)+(G-34)]	252	6.3
L-59W Basin (G-74)	240	6
L-60EBasin(G-75)	192	4.8
L-60W Basin (G-76)	134	3.3
L-61E Basin	137	3.4
S-131 Basin	98	2.5
Taylor Creek Nubbin Slough Subwatershed	476	11.9
S-133 Basin	243	6.1
S-135 Basin	155	3.9
S-154 Basin	580	14.5
S-154C Basin	711	17.8
S-191 Basin	627	15.7
South Lake Okeechobee Subwatershed*	279	7
715 Farms (Culvert 12A)*	no flow	no flow
East Beach Drainage District (Culvert 10)*	776	19.4
East Shore Drainage District (Culvert 12)*	no flow	no flow
Industrial Canal (S-310 in S-4 Basin)*	209	5.2
S-2 Basin*	265	6.6
S-3 Basin*	212	5.3
S-4 Basin*	397	9.9
South Florida Conservancy Drainage District (S-236)*	221	5.5
South Shore/South Bay Drainage District (Culvert 4A)*	282	7
S-5A Basin (S-352 West Palm Beach Canal)*	274	6.8
West Lake Okeechobee Subwatershed*	167	4.2
East Caloosahatchee Basin (S-77)*	167	4.2
Nicodemus Slough South (Culvert 5A)*	no flow	no flow
Lake Istokpoga Subwatershed	96	2.4
Lower Kissimmee Subwatershed	230	5.8
Upper Kissimmee Subwatershed	74	1.8
Total Lake Okeechobee Watershed	166	4.2

Pollution Sources to Lake Okeechobee

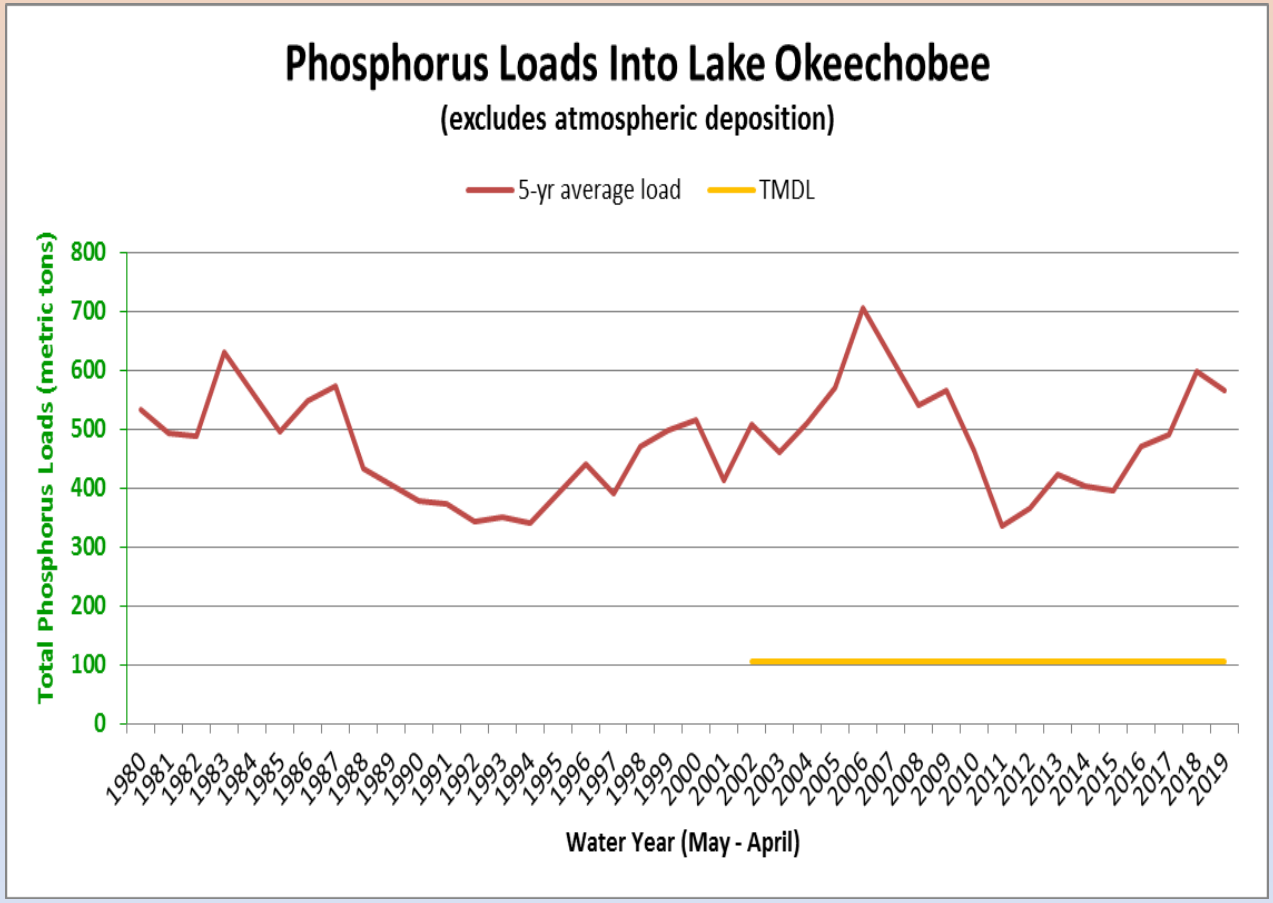
Agricultural runoff is largest source of pollution

State water quality improvement program is broken



No Significant Improvement

State has been negligent in protecting water quality: lack of enforcement, reducing regulations, misinformation

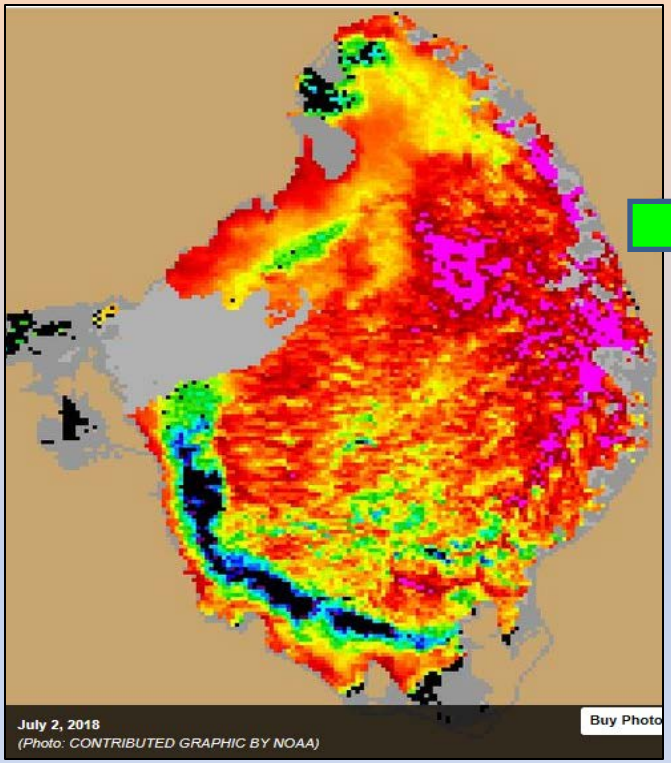


Result: HABs on Lake -> Estuaries

On July 2, 2018, NOAA reported that 90 percent of Lake's open water was covered by toxic blue green algae.

Discharges to St. Lucie Estuary began June 1

Adverse health, economic and environmental impacts



Estuaries are already suffering from pollution from the local watershed.

St Lucie Estuary has been receiving polluted discharges from Lake Okeechobee since 1923

- Human health has suffered
  - Exposure to dangerous toxins in HABs:
    - a rate of death from non-alcoholic liver disease that is 1.9 times higher than the national average, correlated to discharges from Lake Okeechobee
    - concerns over neurological diseases resulting from other components within the cyanobacteria.
    - Pets have suffered, died
- Economy has suffered
  - depressed real estate values, loss of water-related jobs, and other losses to businesses that rely on clean water
- Environment has suffered
  - the region's estuarine and near-shore ecosystems have been significantly degraded due to the discharge of millions of tons of Lake sediment (muck) and nutrients.
- **Next up: Lake operations**

Part 2. Operation of Lake Okeechobee and the regional system

The Corps' Systems Operations Manual

- The Corps of Engineers and South Florida Water Management District operate thousands of water control structures
- Guidelines for Lake Okeechobee known as LORS2008

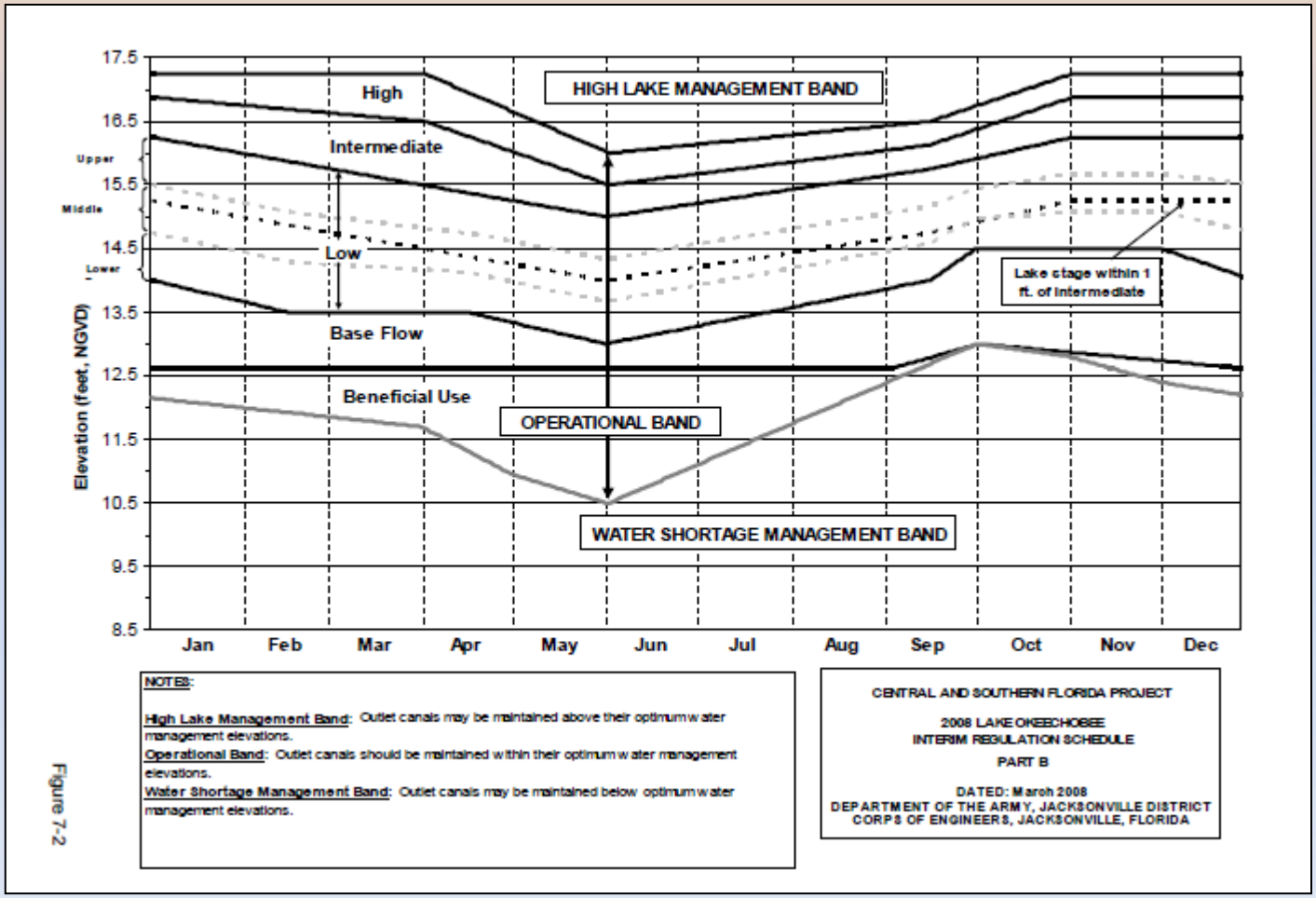
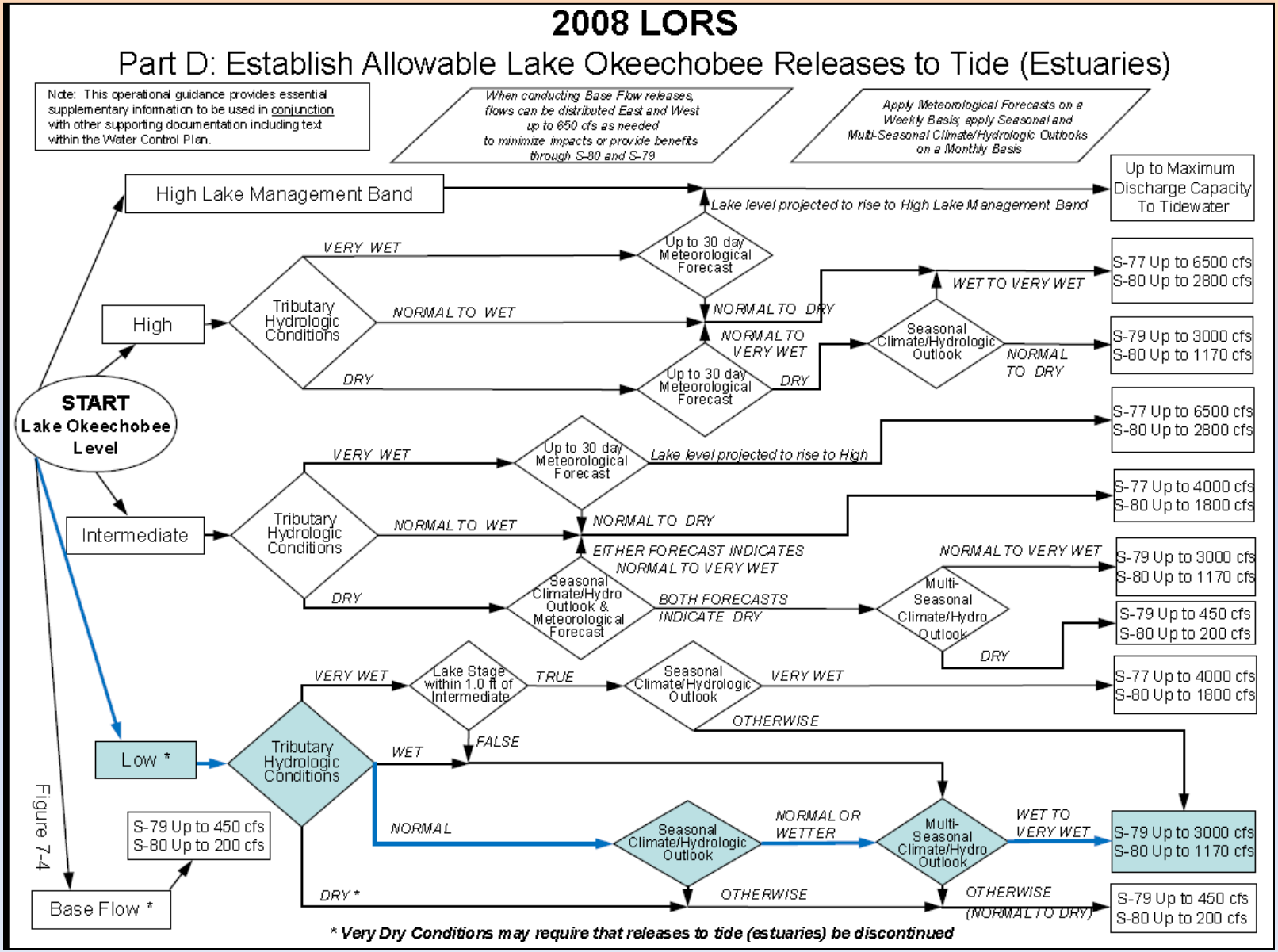


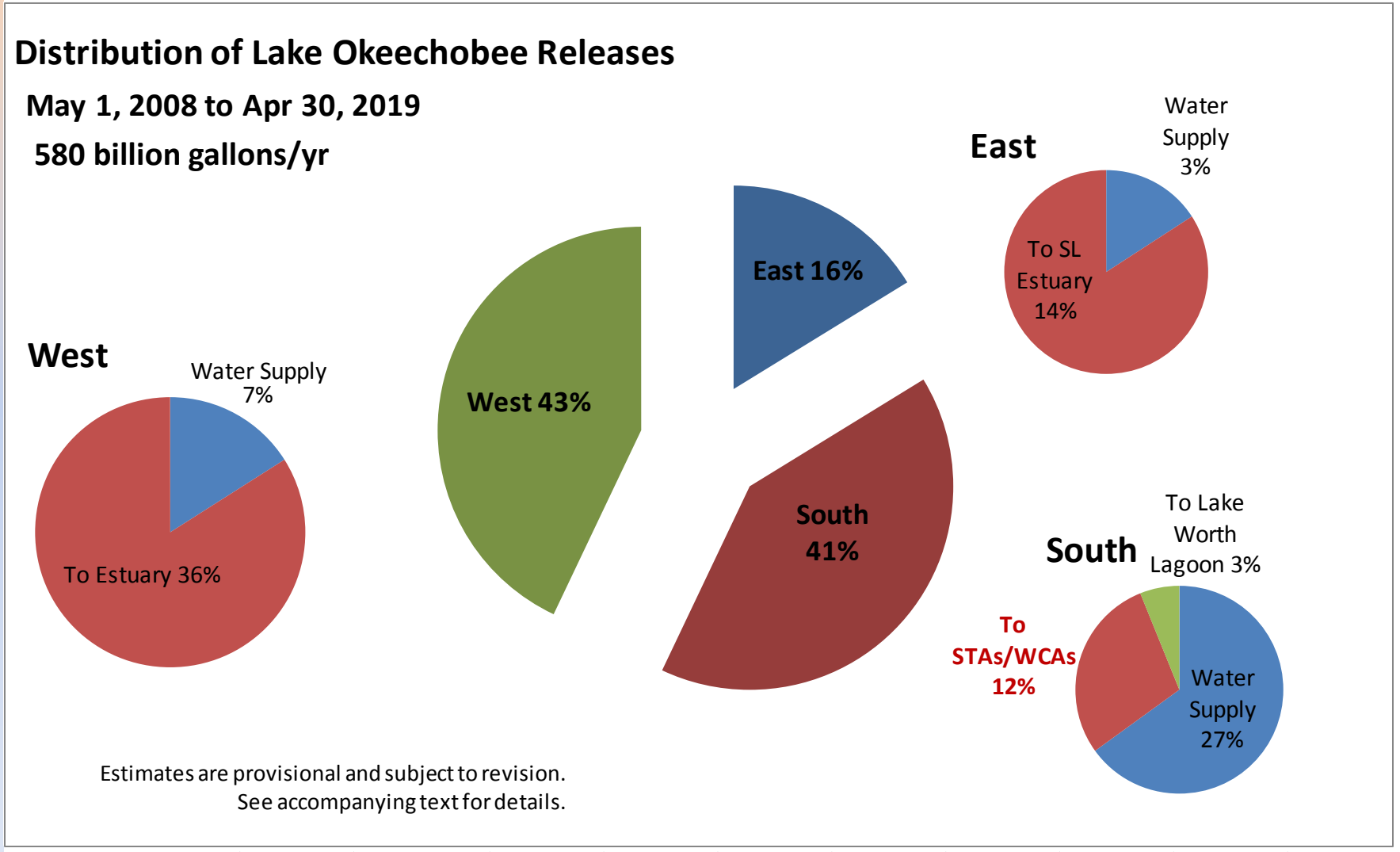
Figure 7-2

LORS guidance on releases to estuaries



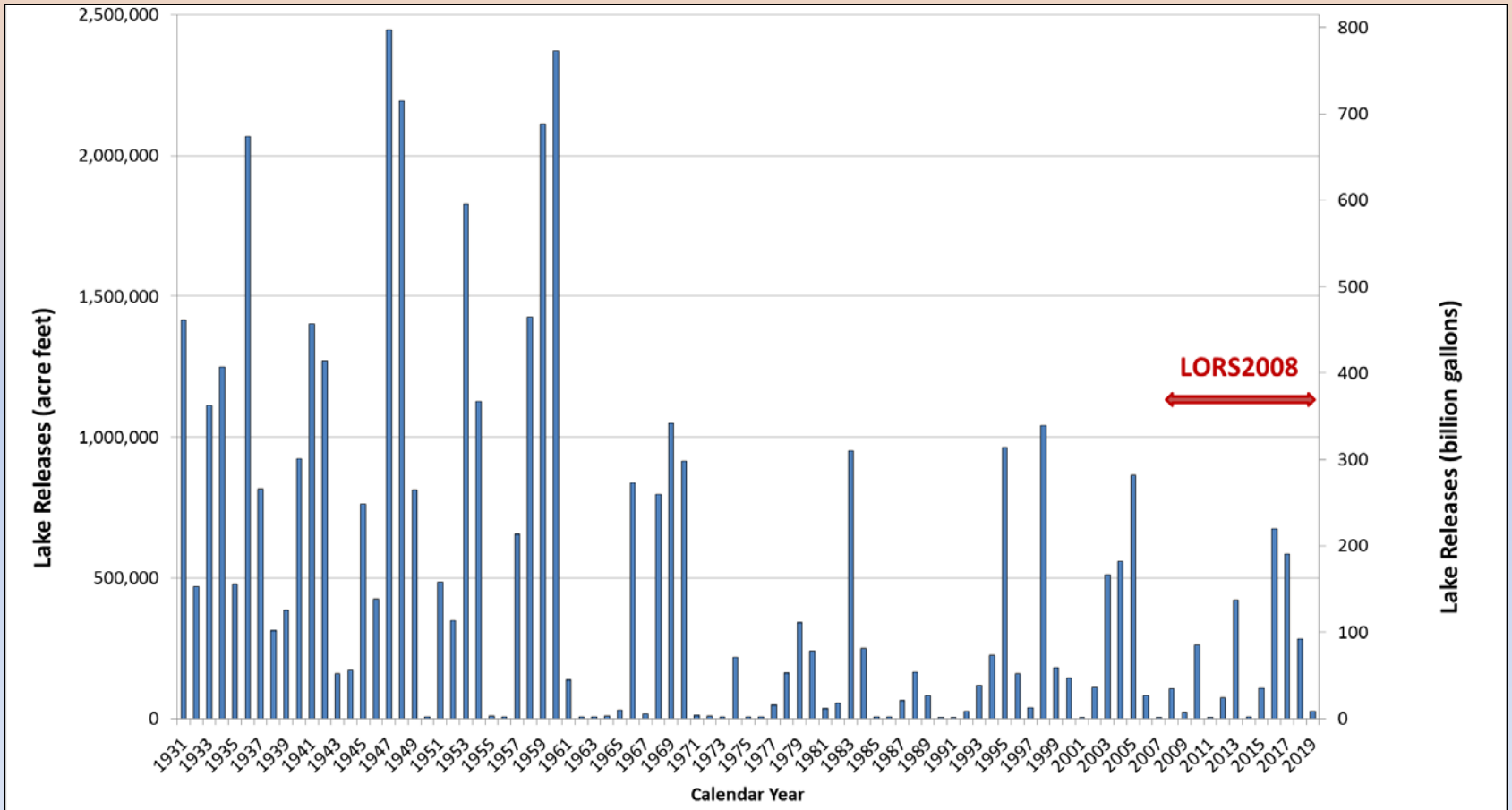
Where does the water go?

More than half (750 million gallons/day) goes to the estuaries
Only 12% goes to the Everglades



Lake Releases to the St Lucie Estuary

Lake operations change over time
Structure at Lake (Port Mayaca Spillway and Locks)
Structure at east end of canal (St Lucie Spillway and Locks)



Notes: 1. Lake releases to C-44 flows estimated by USGS for 4/1/1931 to 9/30/1952; No data for Lake releases to C-44 for 10/1/1952 - 12/31/1964; Lake releases to C-44 estimated by SFWMD for 1/1/1965 to 2014; S-80 flow estimates by SFWMD begin 10/1/1952.

2. Prior to January 1, 1965 concurrent flow estimates were not available for Lake releases to the C-44 Canal and flow at S-80, so approximations of Lake releases to the St. Lucie River were necessary:

1931-1952: Assumed annual Lake release to River was approximately equal to (S-308 flow x 0.918)

1953-1964: Assumed annual Lake release to River was approximately equal to (S-80 flow x 0.767)

Current Operations Exacerbate Adverse Impacts on Human Health

LORS2008 lowered the upper operating depth, and forced more polluted water to the estuaries during the summer & fall – when potential for HAB is highest

Period - Beginning June 1	Lake stage on June 1 ft NGVD	June 1 - December 31 Lake discharges Billion gallons	TP Load lbs	TN Load lbs	TSS Load lbs
pre-LORS2008: 1979-2007	13.3	38.0	49,597	548,410	11,468,224
LORS2008: 2008-2019	12.2	52.1	74,945	674,940	20,329,875
Change since LORS208	-9%	37%	51%	23%	77%

Time for a change …

Part 3. Lake Okeechobee System Operations Manual (LOSOM)

A New Operations Manual is Under Development: LOSOM

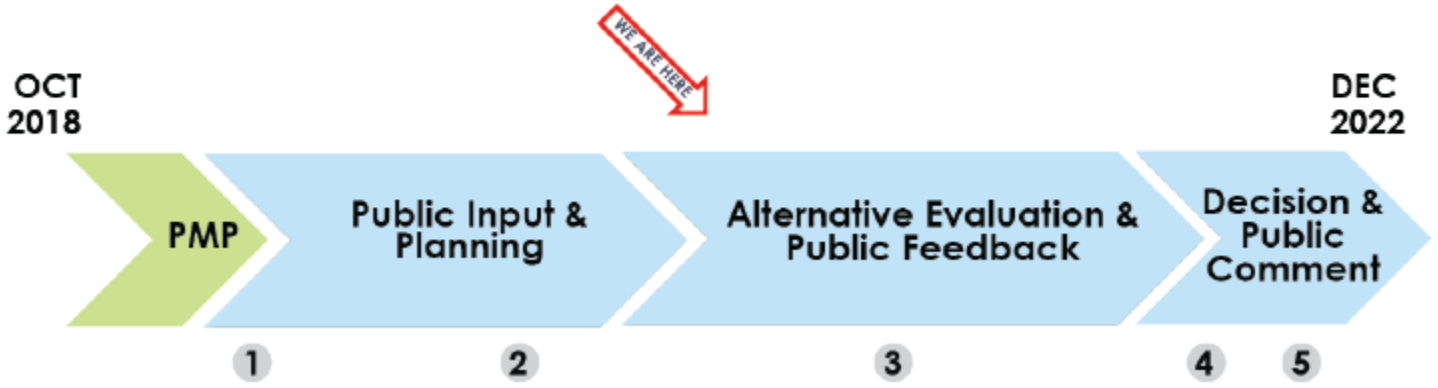
Purpose: to define operations that address:

- flood risk management;
- water supply for agricultural irrigation, municipalities and industry, environment, and Native American tribes;
- navigation;
- enhancement of fish and wildlife; and
- recreation.

The Corps must consider the effects on the human environment, including the adverse effects on public health.

Key Milestones of LOSOM Process

Approved PMP and Review Plan	January 2019
Public Scoping/Plan Formulation	February – September 2019
Public Workshops/Alternative Evaluation	October 2019 – September 2021
Prepare Draft LOSOM/NEPA document	October 2021 – January 2022
Public Comment/Draft LOSOM/NEPA document	February – March 2022
Prepare Final LOSOM/NEPA document	April – May 2022
Final LOSOM NEPA document	September 2022
Signed Record of Decision (ROD)	December 2022



LOSOM Development

- Project Development Team (PDT) meetings give *government agencies* opportunity to provide input
- Members of the public are invited to attend/comment

  Thursday February 27, 2020 (Web Meeting) 1:30 – 4:30

  Tuesday March 31, 2020 (Okeechobee and Web Meeting) 10 – 4:00

  Thursday April 23, 2020 (Web Meeting) 1 – 4:30
- 6 sub-teams:
  - Ecological,
  - Engineering,
  - Economics,
  - Water Supply,
  - **Water Quality/HAB** and
  - Modeling and Plan Formulation

LOSOM Water Quality Metrics

Metrics have been identified for Lake O/estuaries

1. **Human health: Chlorophyll A used as surrogate for *microcystin*.**
2. **Ability of alternative to allow minimal discharges during peak algal bloom months.**
3. Nutrient loading to estuaries from Lake O/local basin runoff
4. Closeness of fit to salinity envelope. Water quality link with healthy oyster population
5. Percent of time Lake O releases are within the pulse envelope windows and not exceeding peak or low desired release volumes

What You Can Do

- ***Stay involved – our health, economy and environment are at stake***
- Martin County has an active team
  - John Maehl (jmaehl@martin.fl.us)
- Attend a PDT meeting (online)
- Make your voices heard – send comments
  - email: LakeOComments@usace.army.mil
  - Written: Dr. Ann Hodgson, USACE, Jacksonville
- *Put an end to toxic discharges*

"ZERO DISCHARGES"

For Further Information

- Corps: https://www.saj.usace.army.mil/LOSOM/
- Congressman Brian Mast: https://mast.house.gov/search?q=losom
- SFWMD: https://www.sfwmd.gov/our-work/lake-okeechobee
  - Jacqui Thurlow-Lippisch (jthurlowlippisch@sfwmd.gov)
- Martin County: https://www.martin.fl.us/LOSOM
- Gary Goforth: http://www.garygoforth.net/Other%20projects.htm

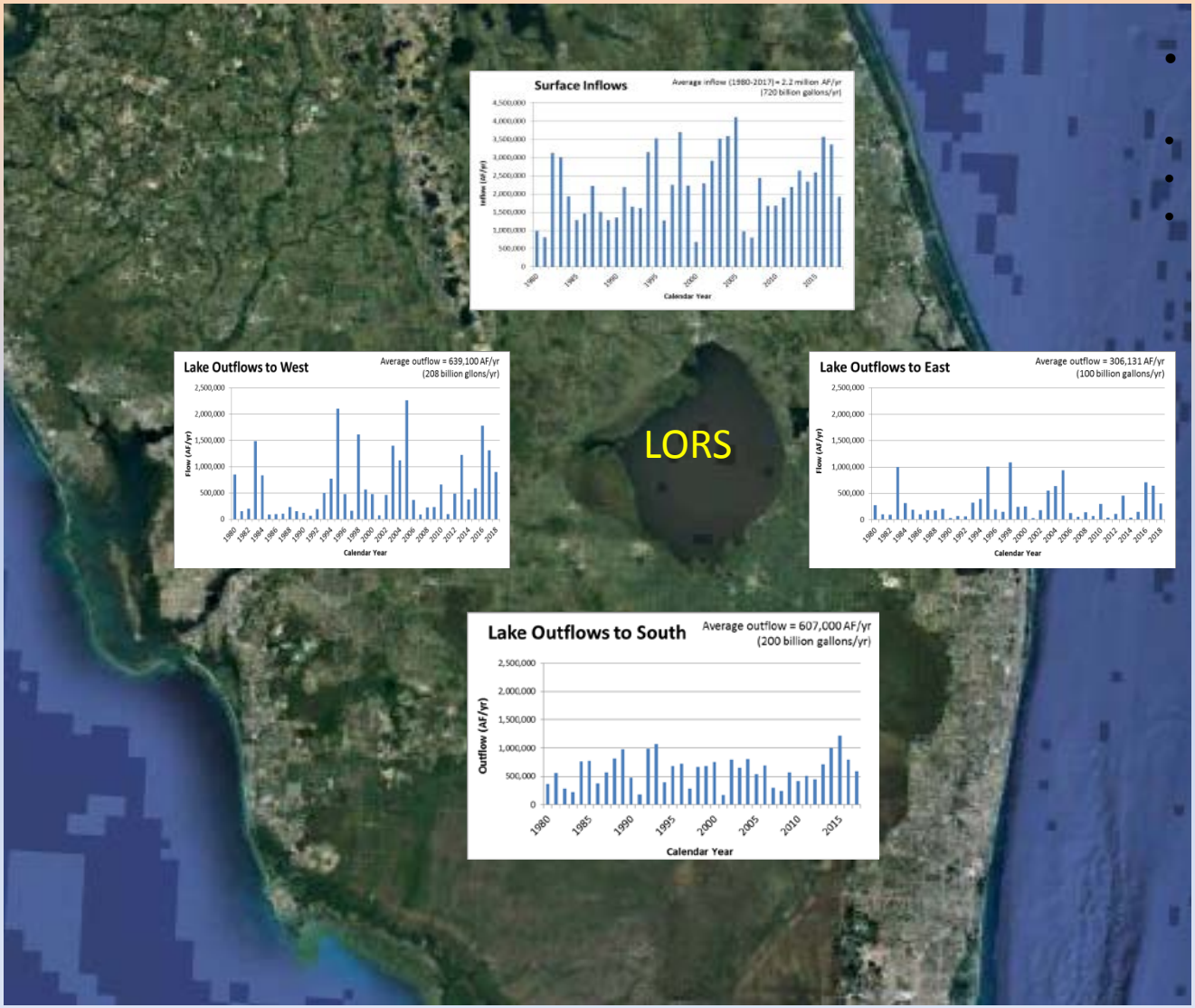
Questions or comments?

Good Water Quality is Good for the Economy

27,000 jobs and $840 million per year in water-related businesses around the St. Lucie Estuary

50,000 jobs and $3 billion per year around the Caloosahatchee Estuary

Lake Inflow and Outflow are Highly Variable



- 9 sub-watersheds covering 3.4 million acres
  - 50% agriculture
  - 38% natural lands and water
  - 12% communities

5-yr average

Surface inflow

~2.6 billion gallons/day (BG/day)

Outflow influenced by LORS2008

Average about 2 BG/day

Average inflows increased about 40%, but

Average outflows increased more than 60% during LORS2008

Lake Okeechobee Pollution

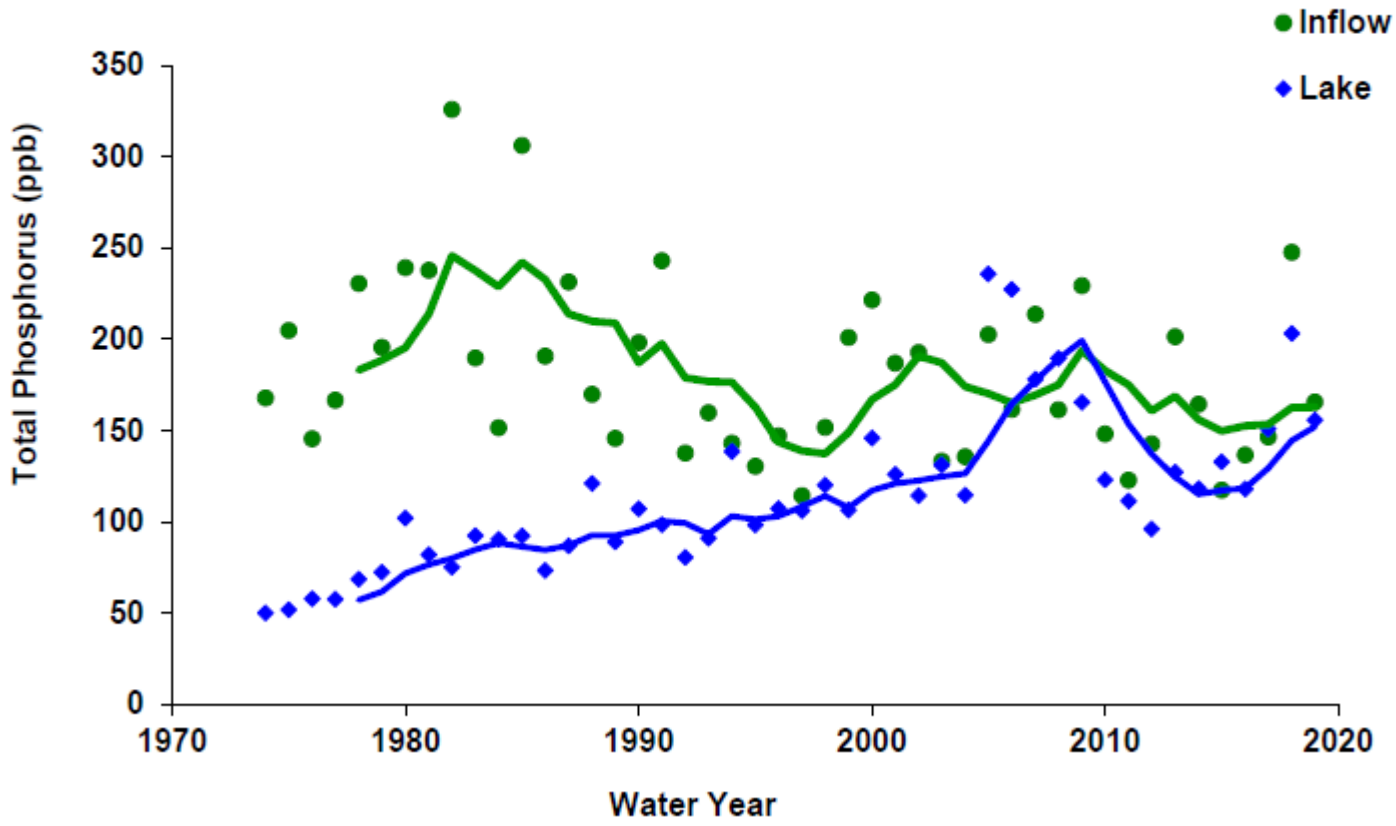
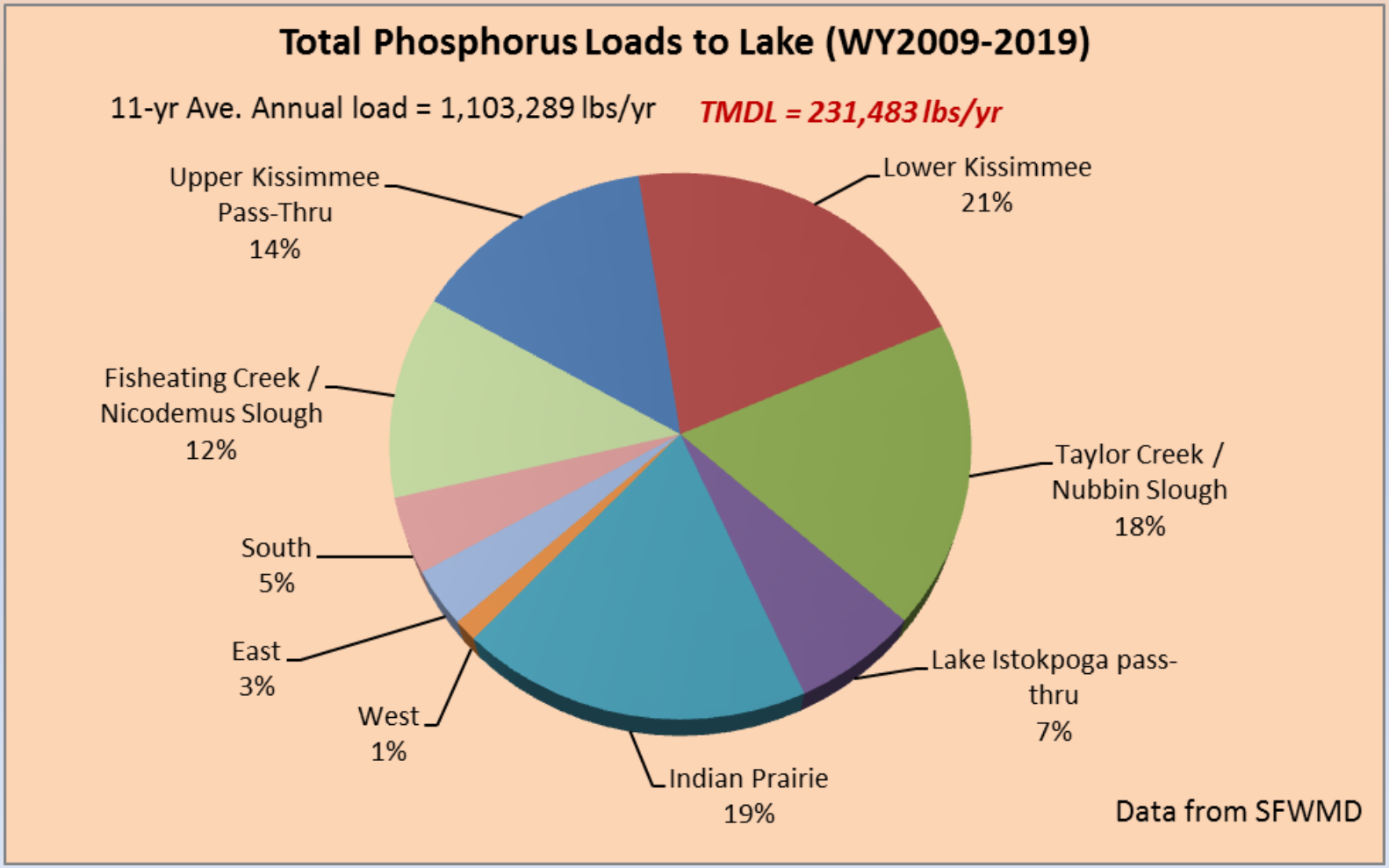


Figure 8B-15. Timelines of inflow (FWM) and average lake TP concentrations (five-year moving average trend lines) calculated from the Lake Okeechobee P budget. (Note: ppb – parts per billion, which is equivalent to µg/L.)

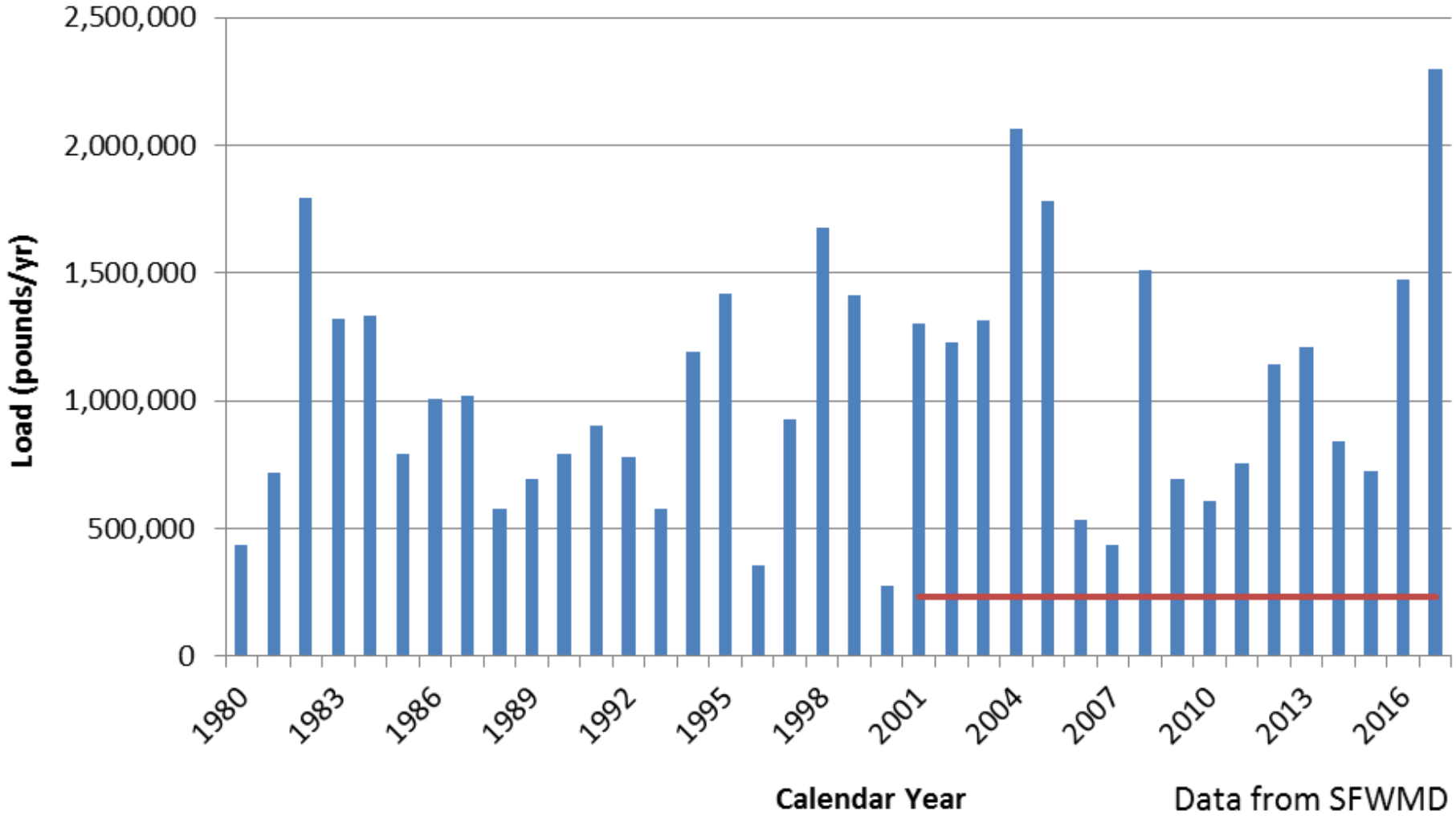
Lake Okeechobee Phosphorus Sources



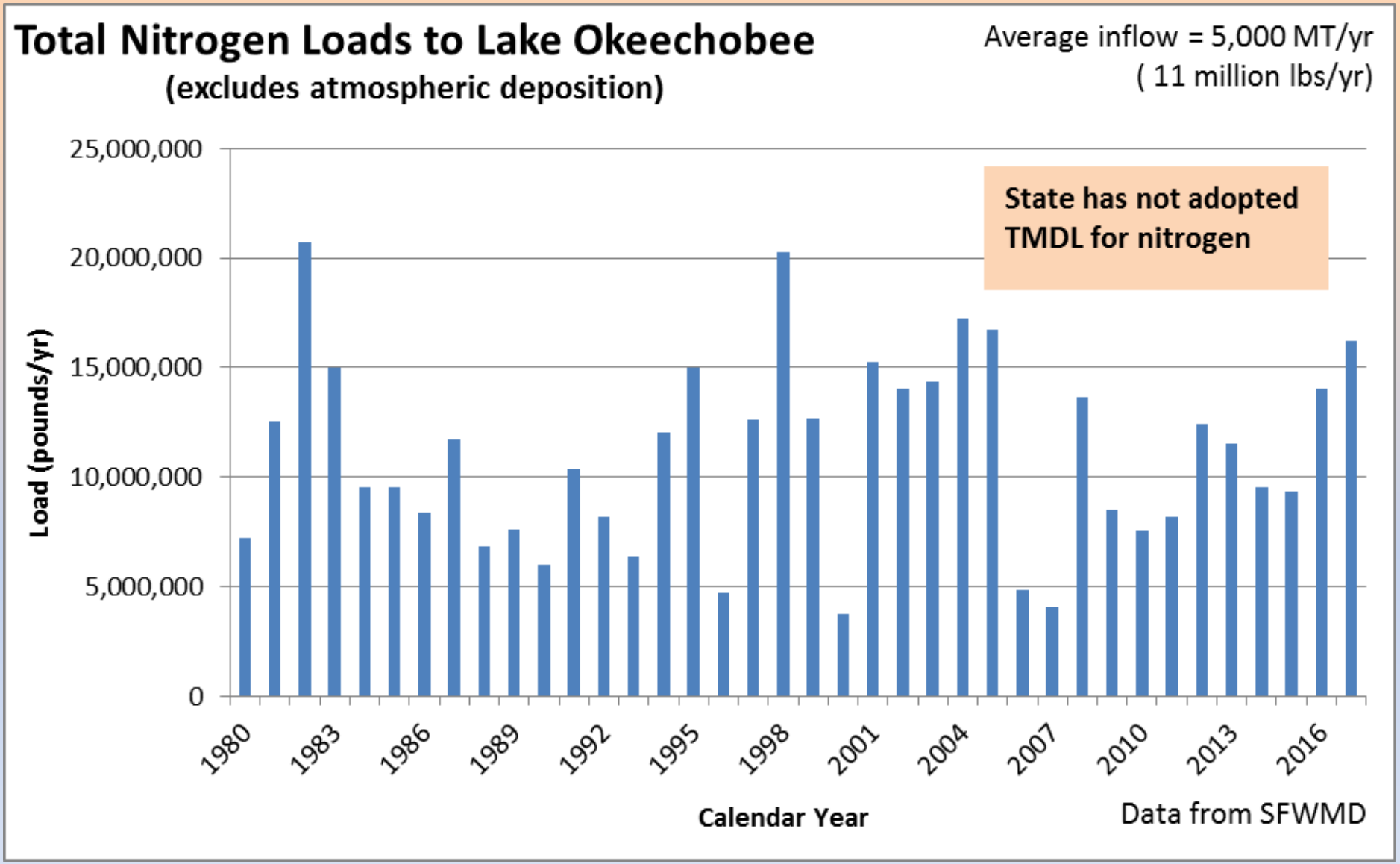
Total Phosphorus Loads to Lake Okeechobee

(excludes atmospheric deposition)

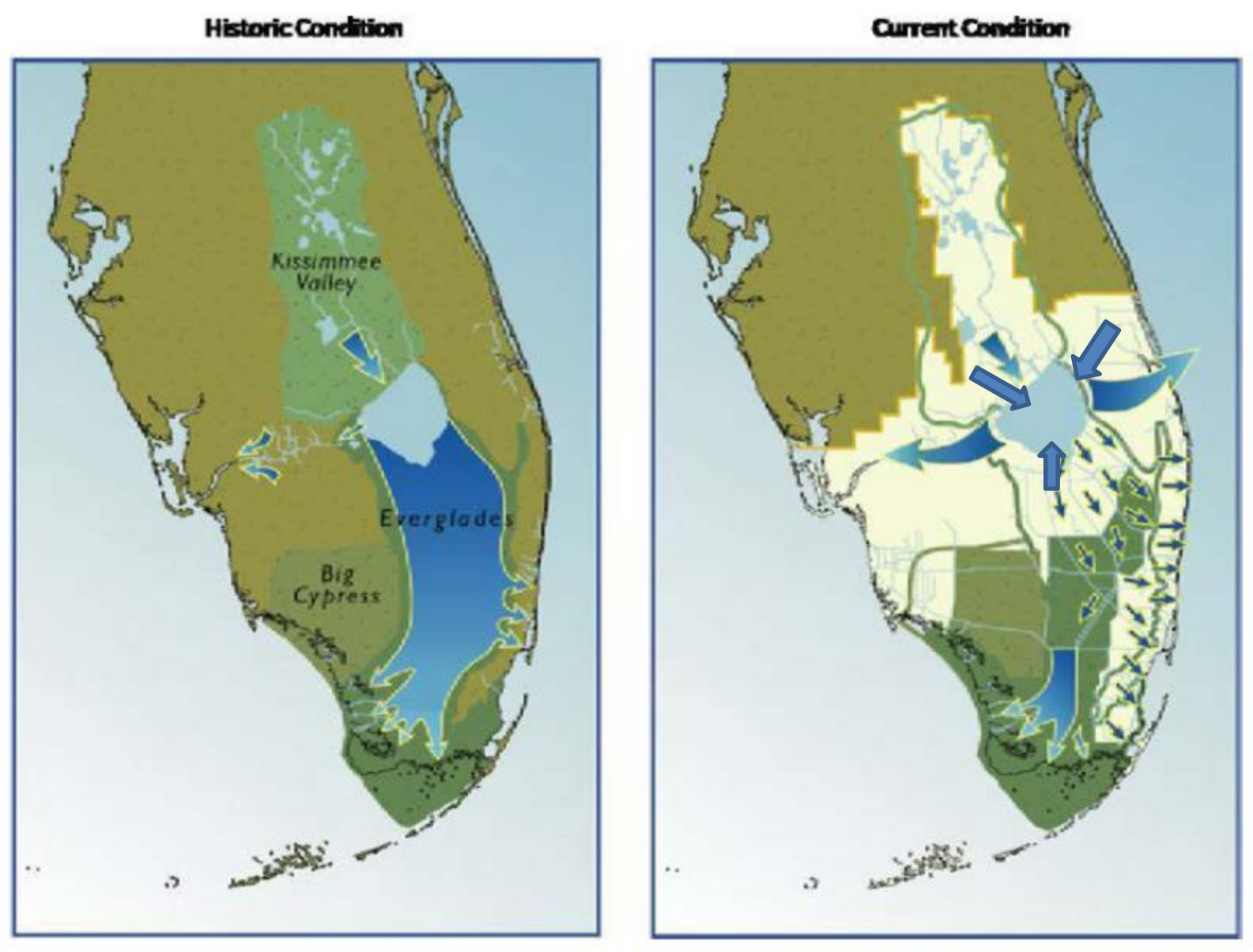
Average inflow = 477 MT/yr
(1 million lbs/yr)



TMDL = 231,483 lbs/yr

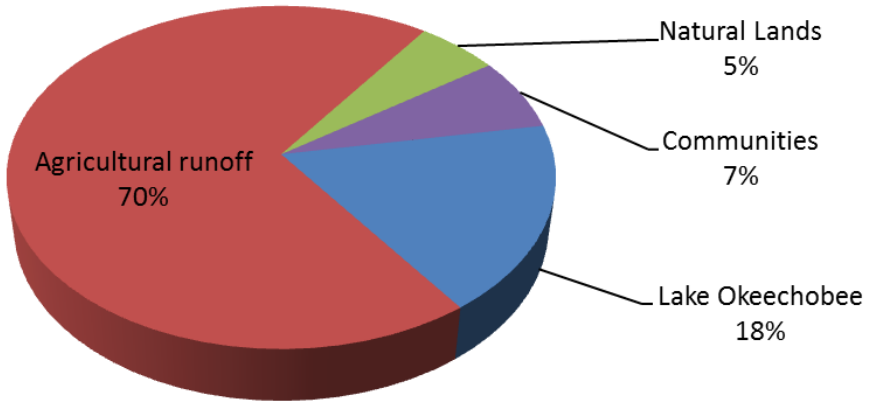

Total Nitrogen Loads to Lake Okeechobee
(excludes atmospheric deposition)
Average inflow = 5,000 MT/yr
(11 million lbs/yr)
State has not adopted TMDL for nitrogen
Load (pounds/yr)
25,000,000
20,000,000
15,000,000
10,000,000
5,000,000
0
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
Calendar Year
Data from SFWMD

On average, about 750 million gallons per day of Lake Okeechobee water is diverted to the estuaries.



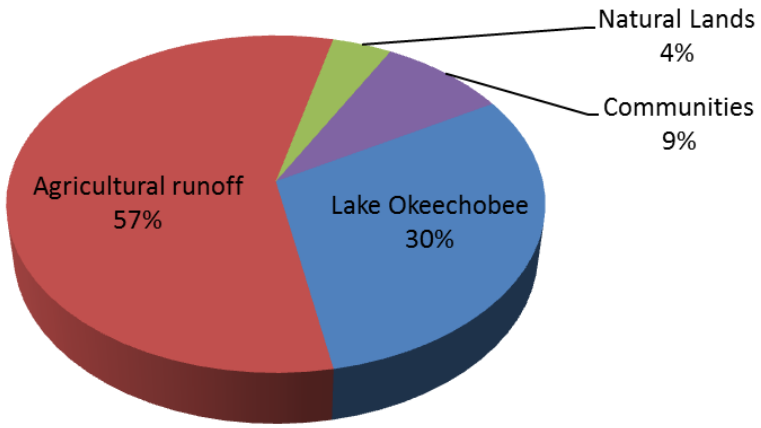
Agricultural Runoff is the Largest Pollution Source of St Lucie Estuary

Total Phosphorus Loads to St. Lucie River & Estuary (WY2008-2019)



Draft subject to revision; loads in pounds/yr; Coastal tributaries loads estimated as percentage of other basin loads.

Total Nitrogen Loads to St. Lucie River & Estuary (WY2008-2019)



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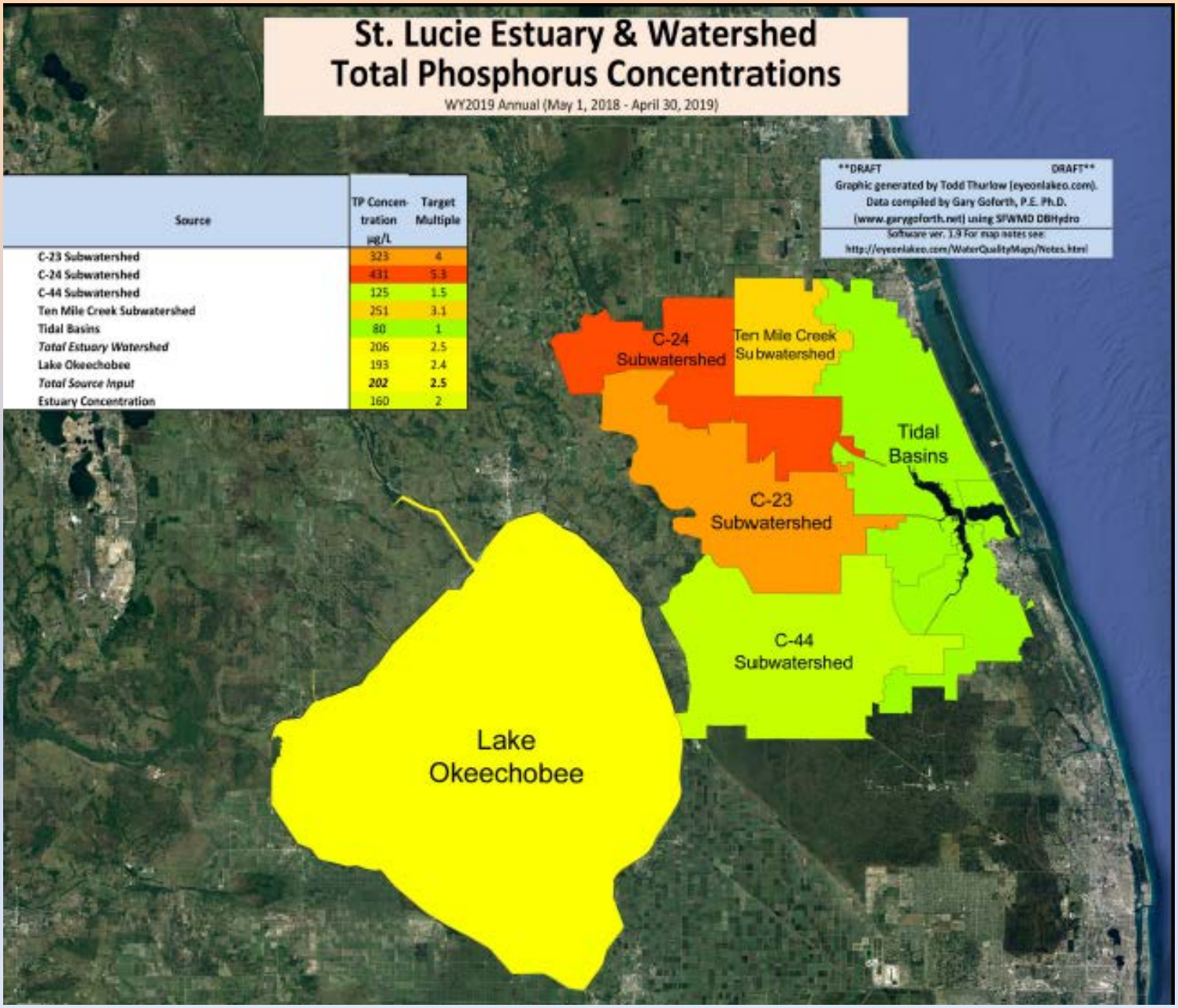
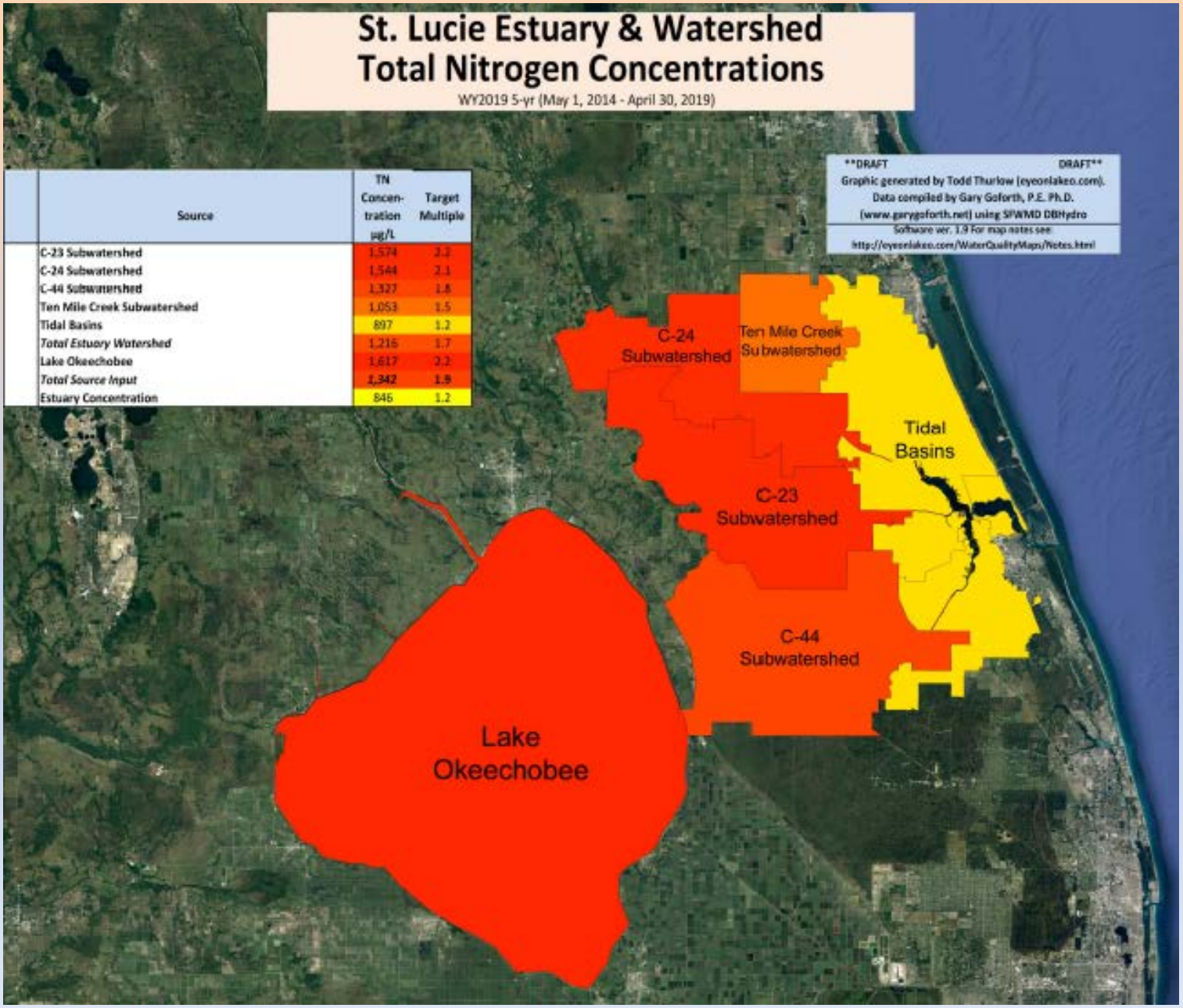
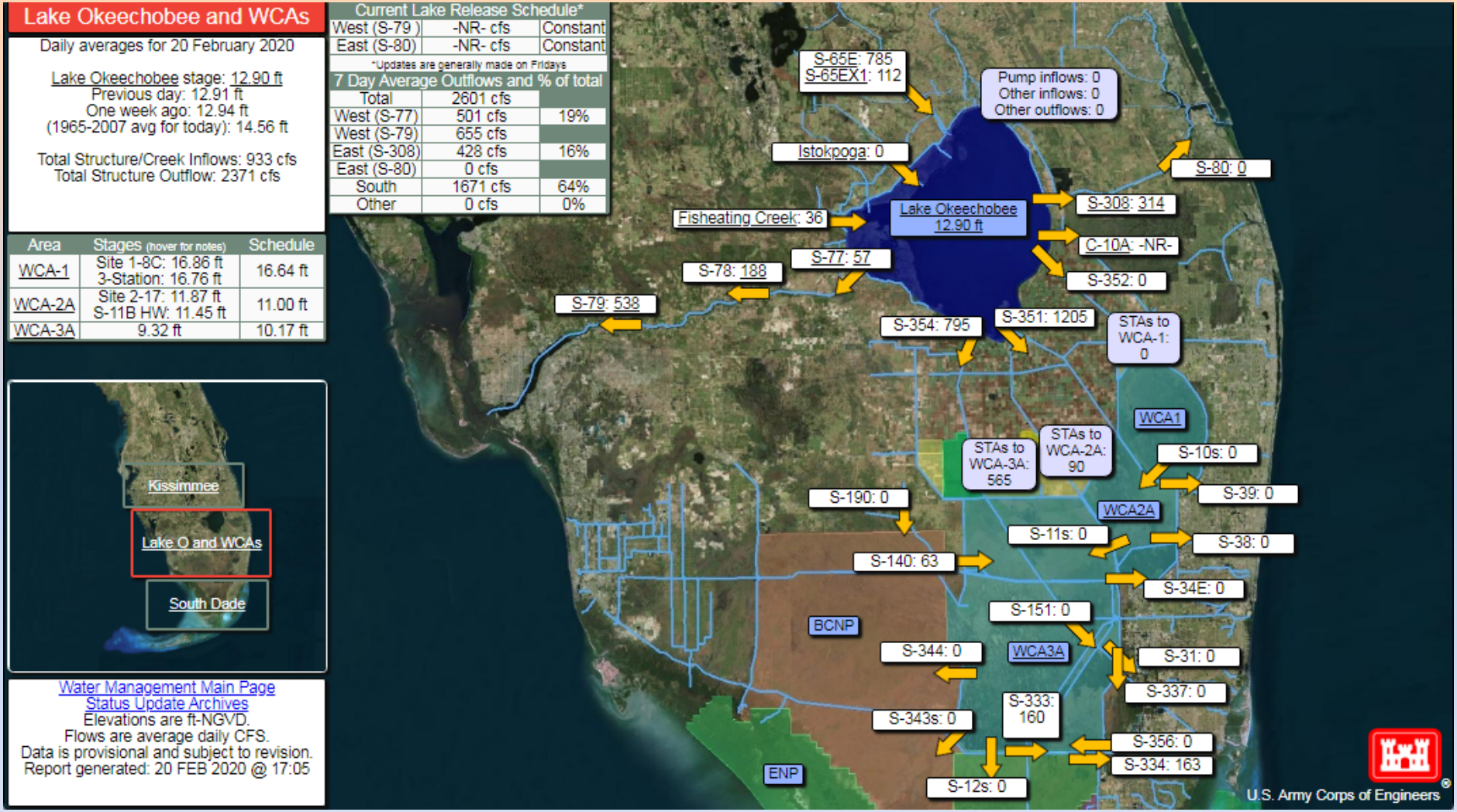

St. Lucie Estuary & Watershed
Total Phosphorus Concentrations
WY2019 Annual (May 1, 2018 - April 30, 2019)
DRAFT DRAFT
Graphic generated by Todd Thurlow (eyeonlakeo.com).
Data compiled by Gary Goforth, P.E. Ph.D.
(www.garygoforth.net) using SFWMD DBHydro
Software ver. 1.9 For map notes see:
http://eyeonlakeo.com/WaterQualityMaps/Notes.html
Source | TP Concentration µg/L | Target Multiple
C-23 Subwatershed | 323 | 4
C-24 Subwatershed | 431 | 5.3
C-44 Subwatershed | 125 | 1.5
Ten Mile Creek Subwatershed | 251 | 3.1
Tidal Basins | 80 | 1
Total Estuary Watershed | 206 | 2.5
Lake Okeechobee | 193 | 2.4
Total Source Input | 202 | 2.5
Estuary Concentration | 160 | 2
C-24 Subwatershed
Ten Mile Creek Subwatershed
Tidal Basins
C-23 Subwatershed
C-44 Subwatershed
Lake Okeechobee



Source	TN Concentration µg/L	Target Multiple
C-23 Subwatershed	1,574	2.2
C-24 Subwatershed	1,544	2.1
C-44 Subwatershed	1,327	1.8
Ten Mile Creek Subwatershed	1,053	1.5
Tidal Basins	897	1.2
Total Estuary Watershed	1,216	1.7
Lake Okeechobee	1,617	2.2
Total Source Input	**1,342**	**1.9**
Estuary Concentration	846	1.2


Lake Okeechobee and WCAs
Daily averages for 20 February 2020
Lake Okeechobee stage: 12.90 ft
Previous day: 12.91 ft
One week ago: 12.94 ft
(1965-2007 avg for today): 14.56 ft
Total Structure/Creek Inflows: 933 cfs
Total Structure Outflow: 2371 cfs
Current Lake Release Schedule*
West (S-79) -NR- cfs Constant
East (S-80) -NR- cfs Constant
*Updates are generally made on Fridays
7 Day Average Outflows and % of total
Total 2601 cfs
West (S-77) 501 cfs 19%
West (S-79) 655 cfs
East (S-308) 428 cfs 16%
East (S-80) 0 cfs
South 1671 cfs 64%
Other 0 cfs 0%
Area Stages (hover for notes) Schedule
WCA-1 Site 1-8C: 16.86 ft 3-Station: 16.76 ft 16.64 ft
WCA-2A Site 2-17: 11.87 ft S-11B HW: 11.45 ft 11.00 ft
WCA-3A 9.32 ft 10.17 ft
Kissimmee
Lake O and WCAs
South Dade
Water Management Main Page
Status Update Archives
Elevations are ft-NGVD.
Flows are average daily CFS.
Data is provisional and subject to revision.
Report generated: 20 FEB 2020 @ 17:05
S-65E: 785
S-65EX1: 112
Pump inflows: 0
Other inflows: 0
Other outflows: 0
Istokpoga: 0
S-80: 0
S-308: 314
Fisheating Creek: 36
Lake Okeechobee 12.90 ft
C-10A: -NR-
S-77: 57
S-78: 188
S-352: 0
S-79: 538
S-354: 795
S-351: 1205
STAs to WCA-1: 0
WCA1
STAs to WCA-3A: 565
STAs to WCA-2A: 90
S-10s: 0
S-39: 0
S-190: 0
WCA2A
S-11s: 0
S-38: 0
S-140: 63
S-34E: 0
S-151: 0
BCNP
S-344: 0
WCA3A
S-31: 0
S-337: 0
S-333: 160
S-343s: 0
S-356: 0
S-334: 163
ENP
S-12s: 0
U.S. Army Corps of Engineers