C-43 West Basin Storage Reservoir Water Quality Feasibility Study

January 21, 2020

Working Group Members

- Florida Department of Environmental Protection (DEP)
- South Florida Water Management District (SFWMD)
- Hendry County
- Lee County
- City of Sanibel
- City of Cape Coral
- Lehigh Acres Municipal Services Improvement District (MSID)

C-43 WBSR Study Team

- J-Tech – A joint venture between Jacobs Engineering and Tetra Tech, Inc.
- Wetland Solutions, Inc (WSI)

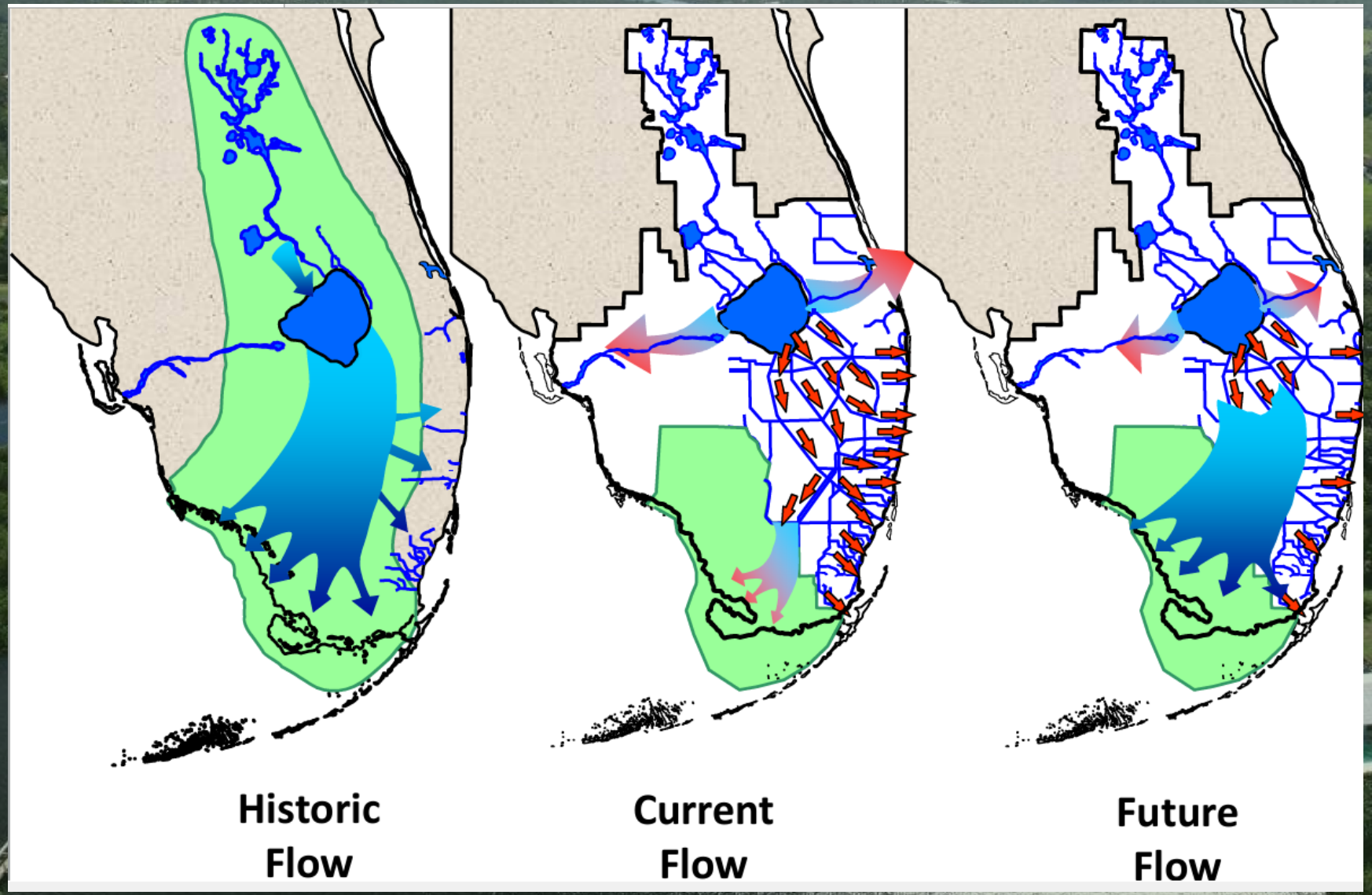
Goals of the Meeting

1)Based on what you hear today about possible water quality treatment technologies, IDENTIFY what questions, comments, or concerns you have.

- 2) After hearing about the STUDY PROCESS AND CONSTRAINTS, we want to make sure you have a good understanding of the study process and constraints.


Understanding the Big Picture

Changes in Hydrology



Executive Order 19-12, January 10, 2019

- Greater protection of Florida's environment and water quality
- Harmful Algal Blooms
- Provide additional treatment and improve the quality of water leaving the C-43 West Basin Storage Reservoir

DEP is Leading the Following Regional Efforts

- Harmful Algal Bloom (Red Tide) Task Force
- Blue-Green Algae Task Force
- Caloosahatchee BMAP and Request for Information (RFI)
- Agricultural BMPs
- Working Group for the C-43 WBSR Water Quality Feasibility Study
- Technology Library

http://fldeploc.dep.state.fl.us/tech_portal/tech_library_intro.asp

C-43 WBSR Water Quality Feasibility Study Objectives

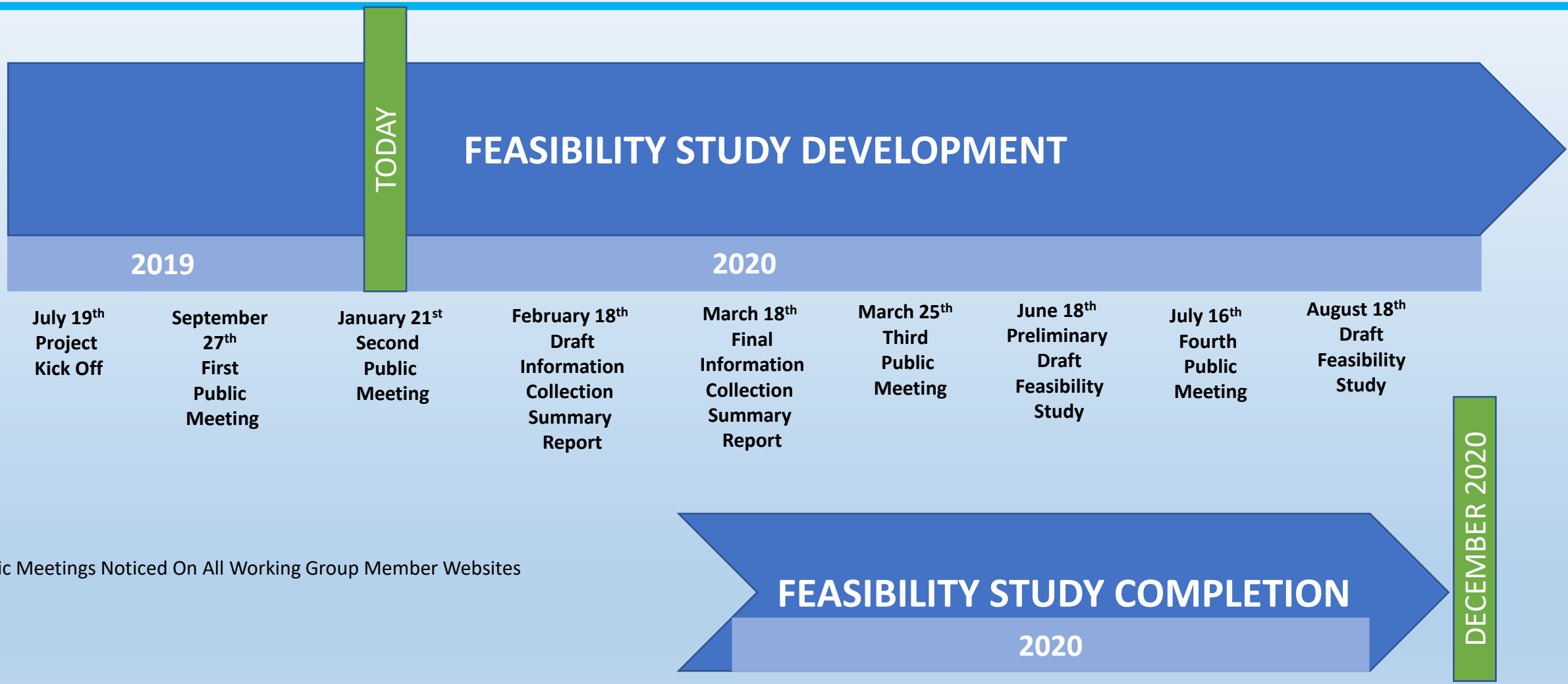
Identifying Opportunities to Provide Additional Treatment and Improve Water Quality Leaving the C-43 Reservoir is the <u>Primary Objective</u>

- **Evaluate treatment options**
- **The goal of the Study is to identify at a minimum <u>three</u> alternatives**

Study will Evaluate

- Pre-treatment (prior to entering reservoir)
- In-reservoir treatment
- Post storage treatment
- Cost-effective and technically feasible
- Use conventional and/or innovative treatment methods
- Consider biological, chemical and physical water quality treatment technologies
- Scalable and “available” for long-term
- Compatible with the objectives of the C-43 Reservoir Project

Next Steps & Public Meetings



Public Meetings Noticed On All Working Group Member Websites


The C-43 Reservoir

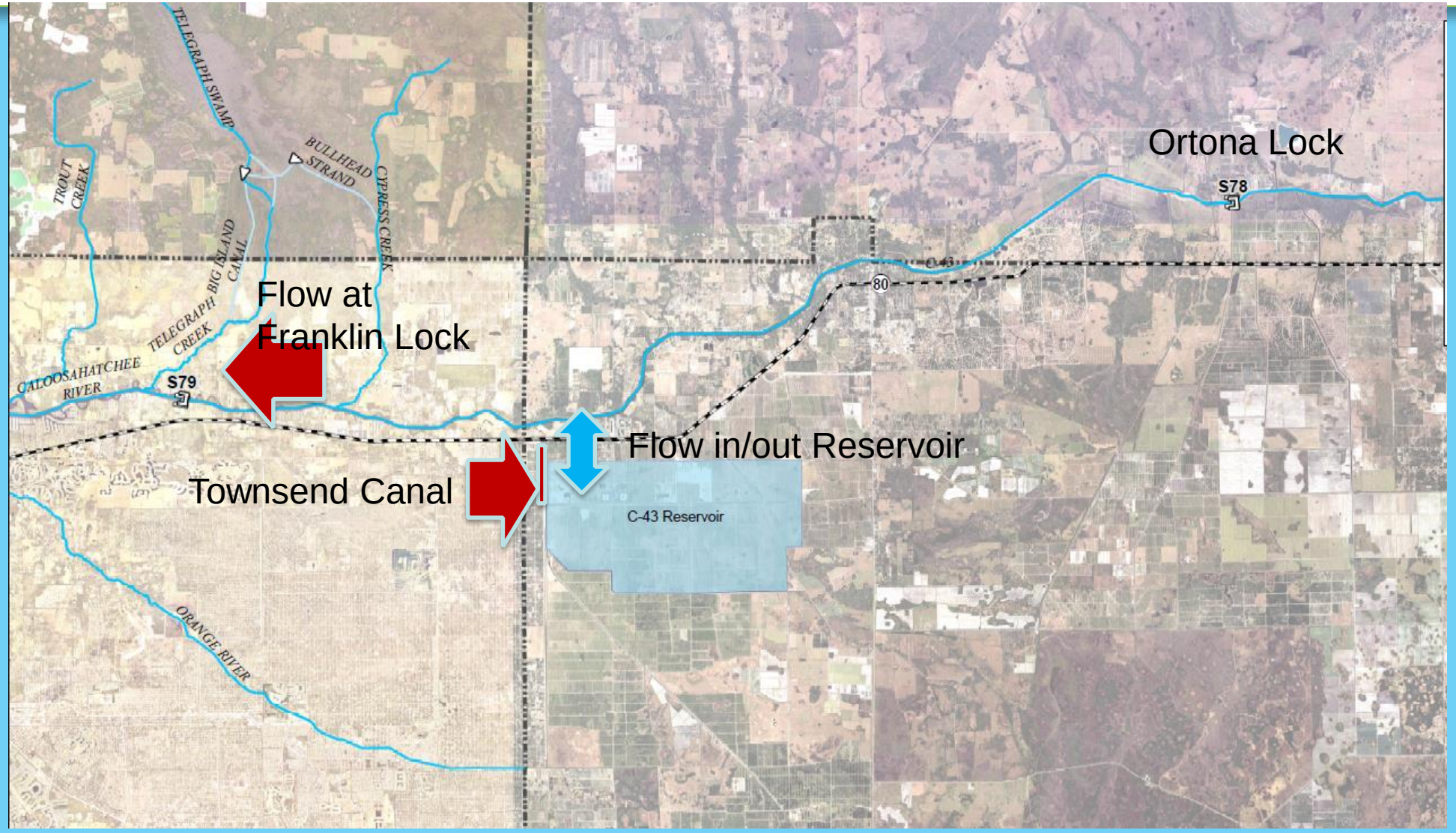
C- 43 West Basin Storage Reservoir - Project Purpose

- **Capture excess basin runoff and Lake Okeechobee releases;**
- **Improve quantity, timing and distribution of freshwater flows to the Caloosahatchee Estuary, to help maintain proper salinity levels; and**
- **Maintain water supply for existing legal users.**

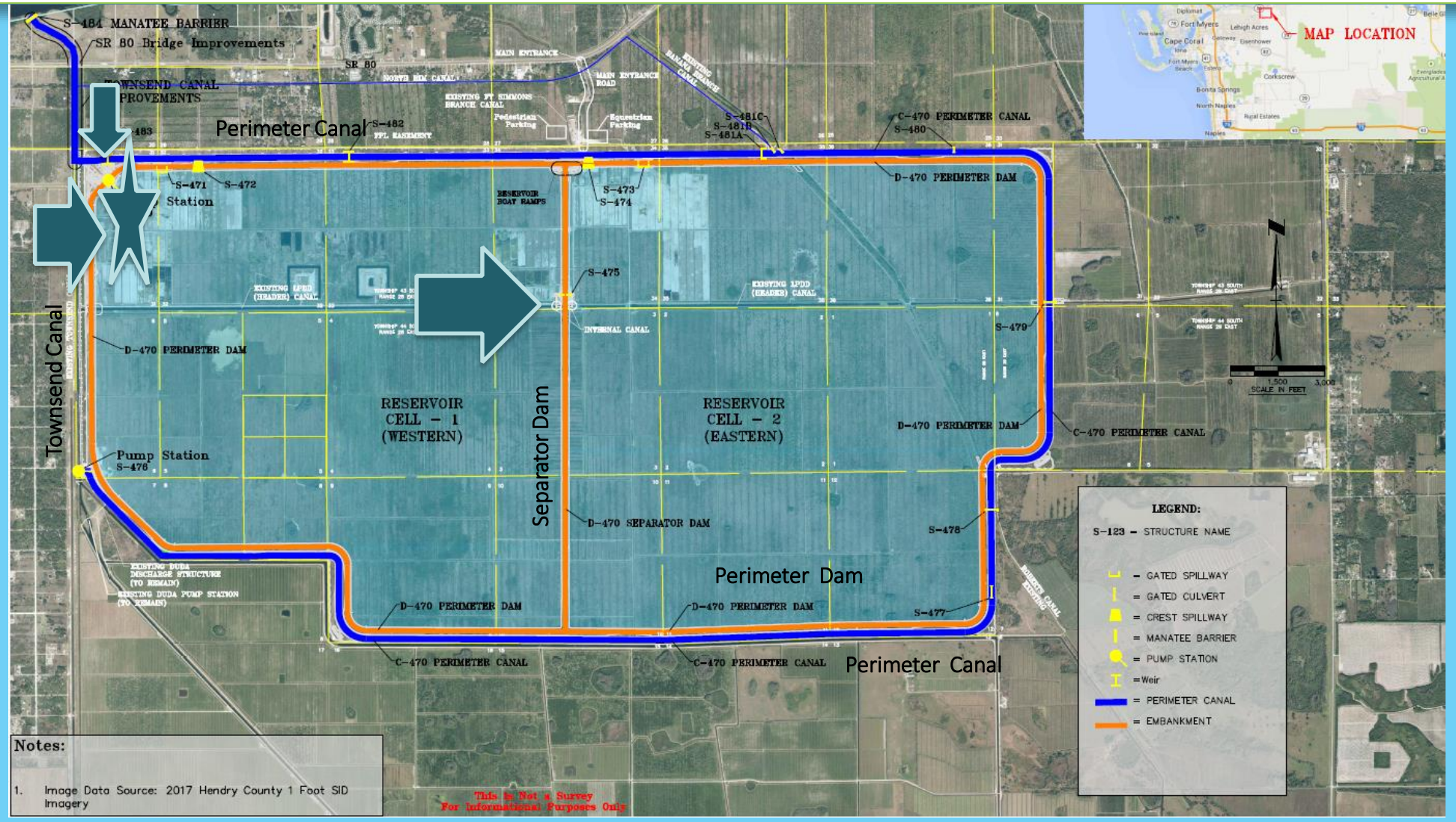
C- 43 West Basin Storage Reservoir – Project Background

- C-43 Project is a component of the Comprehensive Everglades Restoration Plan (CERP)
- Project Implementation Report (PIR) and Environmental Impact Statement (EIS) approved in 2010
- Authorized by Congress in Section 7002(5) of the Water Resources Reform and Development Act of 2014
- Project Partnership Agreement executed in June 2016
- Project will be funded by annual State of Florida legislative appropriations and USACE will credit all eligible costs

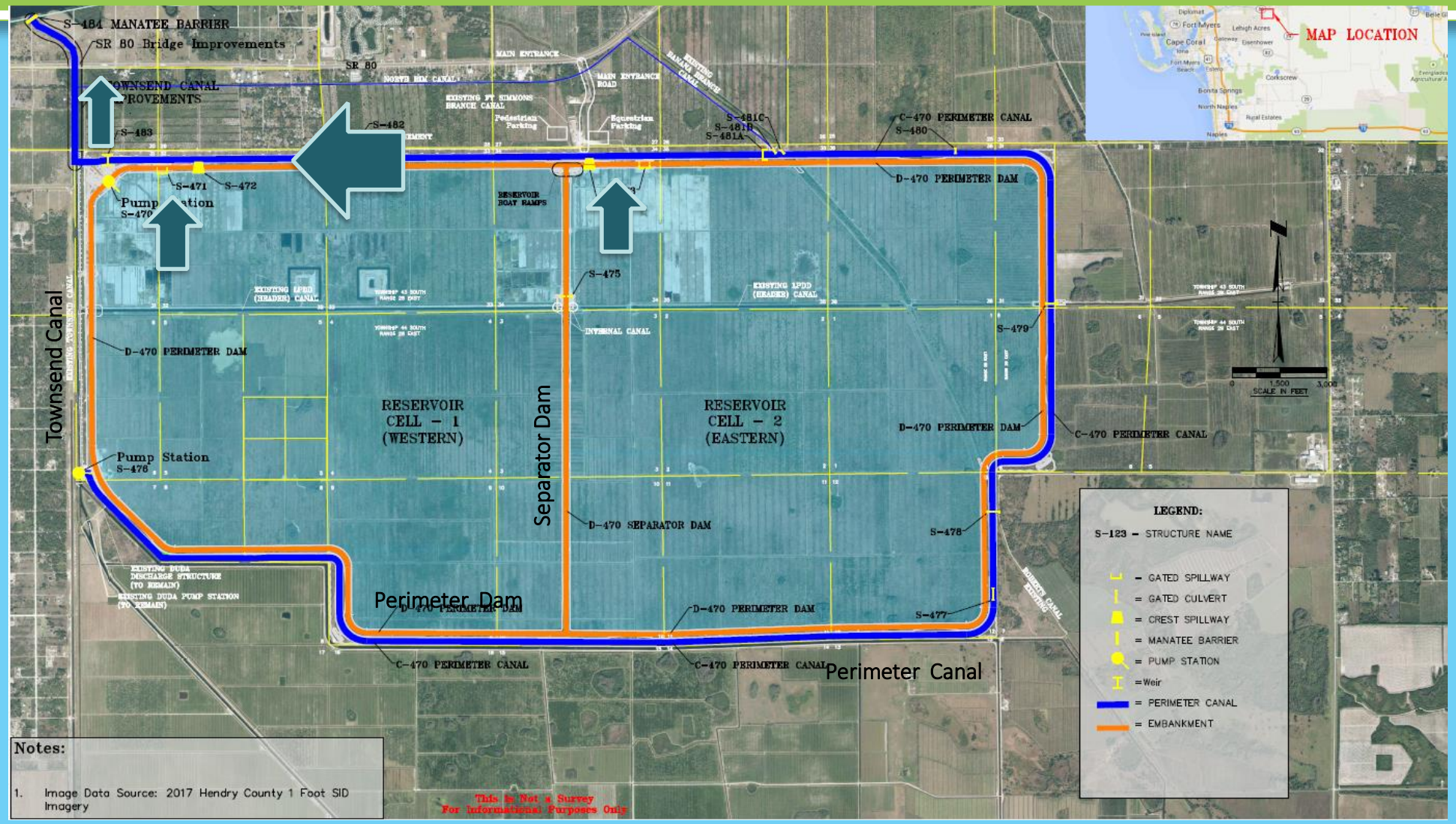
C43 Reservoir Operations



C43 Reservoir Inflow – via S470



C43 Reservoir Discharge (normal)



General Operational Notes

- **Major Constraints: Lake Okeechobee operation schedule, Caloosahatchee Estuary minimum flows and levels (MFLs)**
- **Operated to store excess local basin runoff and regulatory releases from Lake Okeechobee and the local basin and to deliver water to the Caloosahatchee River based on maintaining desirable salinity levels in the estuary as measured by flows at S-79**
- **Dry season discharges are based on flows at S-79 and reservoir water elevations**
- **Wet season pumping is based on flows at S-79 and reservoir water elevations**

General Operational Notes

- Fill during wet season
- Discharge during dry season
- Project Operations Plan from PIR is currently being updated to reflect detailed project design
  - Modeled discharge to meet MFL = 450 cfs
- Inflow capacity = 1500 cfs
- >2,500 cfs emergency discharge capacity

Study Constraints

Study Constraints

- **Cannot affect the congressionally approved C-43 Reservoir project purposes, benefits, infrastructure, construction schedule, or operation**
- **Project lands have not been specifically identified for the Study; technologies will be evaluated independent of land availability**
- **The Study will focus on reviewed and accepted technologies included in the DEP Library for Water Issues**
- **The C-43 Reservoir and the selected treatment component(s) are not intended to achieve compliance with the Caloosahatchee River and Estuary Total Maximum Daily Loads (TMDLs)**

Focusing on the Study

Treatment Technologies
Physical, Chemical, Biological

Treatment Technology Overview

- Treatment needs and concepts
- DEP accepted technology application: status
- Other technologies identified to date
- Physical treatment
- Chemical treatment
- Biological treatment

What to Treat?

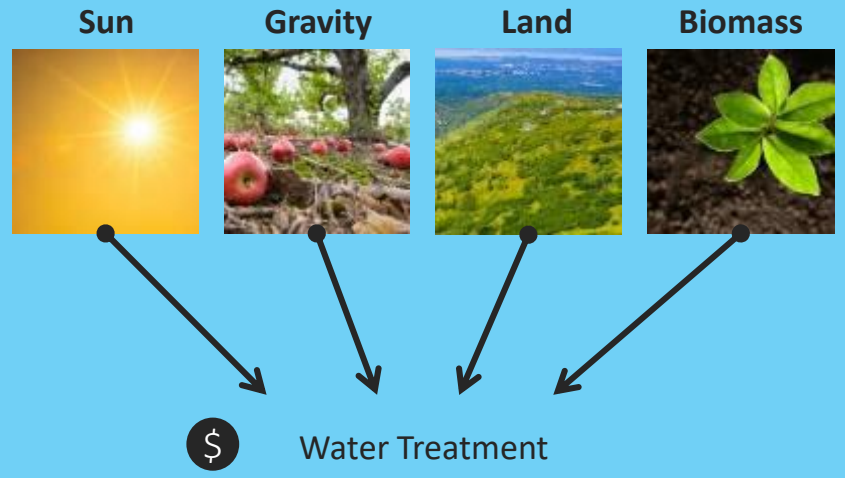
Treatment Focus on Nutrients

- Nitrogen
  - Dissolved Organic Nitrogen
  - Dissolved Bio-available Organic Nitrogen
  - Dissolved Inorganic Nitrogen (Ammonia, Nitrate, Nitrite)
  - Total Nitrogen
- Phosphorus
  - Particulate Phosphorus
  - Soluble Reactive Phosphorus
  - Total Phosphorus
- Suspended Solids (Algae, Particulates)

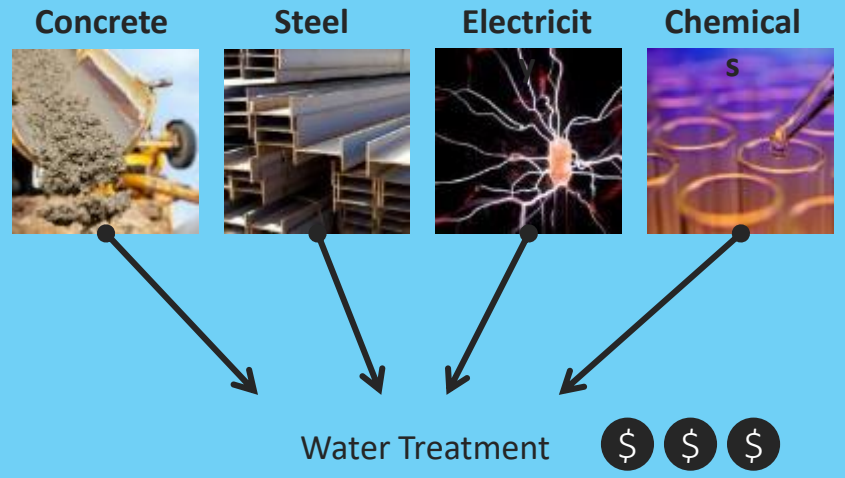
How to Treat?

Natural and Conventional Treatment Approaches

Natural Systems

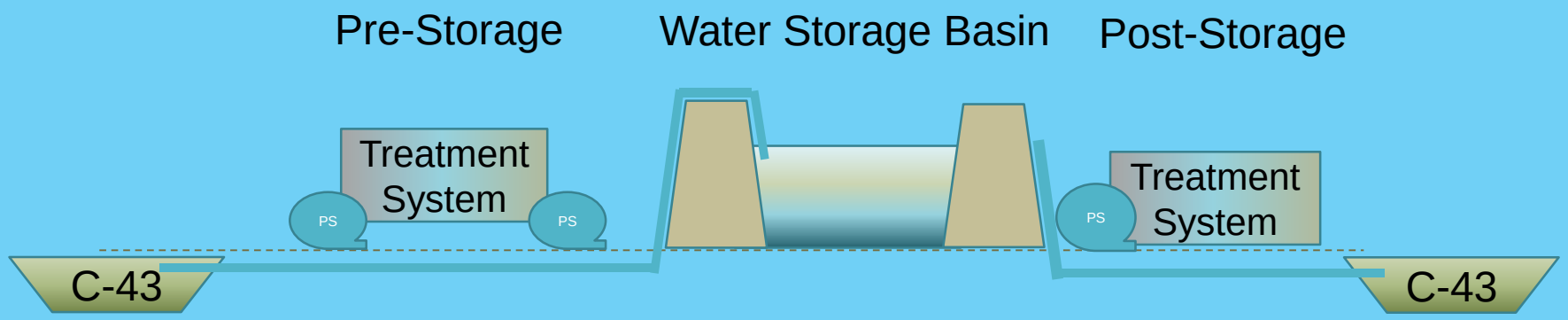


Conventional Systems



Where to Treat?

Reservoir Operating Constraints Are Important



	Pre-Storage	Water Storage Basin	Post-Storage
Flow/Volume	High flow (1500 cfs) during loading	Large volume (170,000 ac-ft) during storage	Lower flow (450 cfs) during discharge
Duration	~3 months	~4 months	~5 months
Purpose	Manage C43 nutrient load to WSB	Reduce nutrients and manage algae in WSB	Manage WSB nutrient load to C43

Physical Treatment Technologies

Filtration

Passing water through a physical barrier.

Sorption

Capture within or bond to surfaces of a material.

Dissolved Air Flotation (DAF)

Dissolved air bubbles attach to and float suspended particles allowing them to be removed.

Oxidation

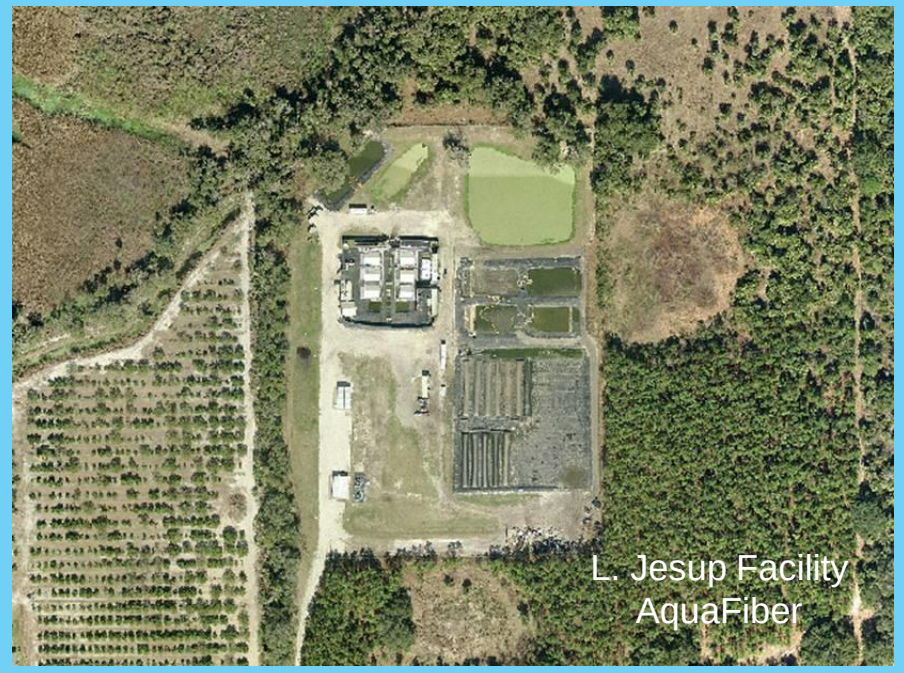
Plasma arc gasification (PAG) uses electricity and high temperatures without combustion (burning).

Sonication

Ultrasonic wavelengths disrupt internal algae cells

Physical/Chemical Process Technology: Coagulation/Flocculation/Flotation

Aquafiber (FDEP No. 1579)



- Modified and patented dissolved air flotation (DAF) system for the physical removal of algae and nutrients
- Capable of making fertilizer pellets out of algae or destroying algae onsite

Treatment

- 93% Total Phosphorus
- 65% Total Nitrogen
- 80% Total Suspended Solids
- 99% Oxygen saturation

Scalability

- 0.03-0.12 ac/cfs
- Modular and scalable

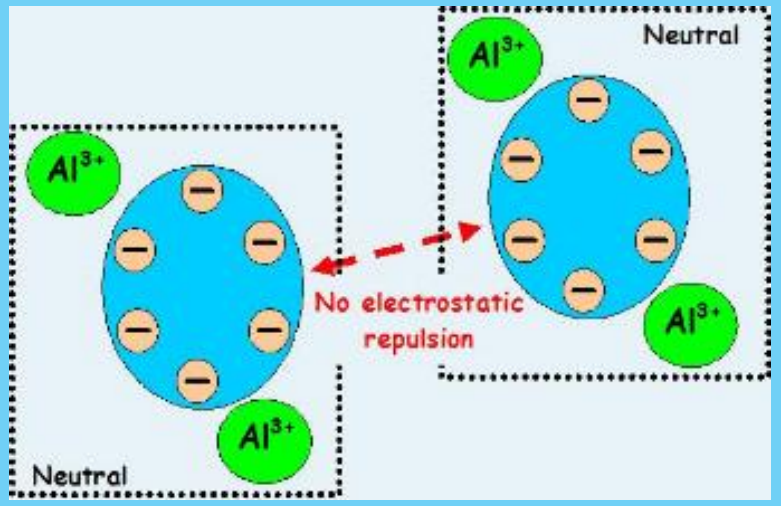
Operation and Maintenance

- Power for air and flow control, can reduce by utilizing gravity head
- Facility estimated to take 18-24 months to design, permit and construct
- AquaFiber capable of operating or licensing agreement for operation to client

Chemical Treatment Technologies

Coagulation

Adding charged chemicals to water to neutralize opposite charges on suspended solids, allowing the small suspended particles to stick together.



Flocculation

Slow-mixing with chemicals promotes binding of particles to form larger particles that settle out of the water.

Chemical Process Technology: Coagulation/Flocculation/Sedimentation

Electro-coagulation (FDEP No. 1505)

Powell Water Systems

- Electric current between aluminum and iron electrodes releases electrons and charged metal ions, neutralizing particles and precipitating with metal ions.

Treatment

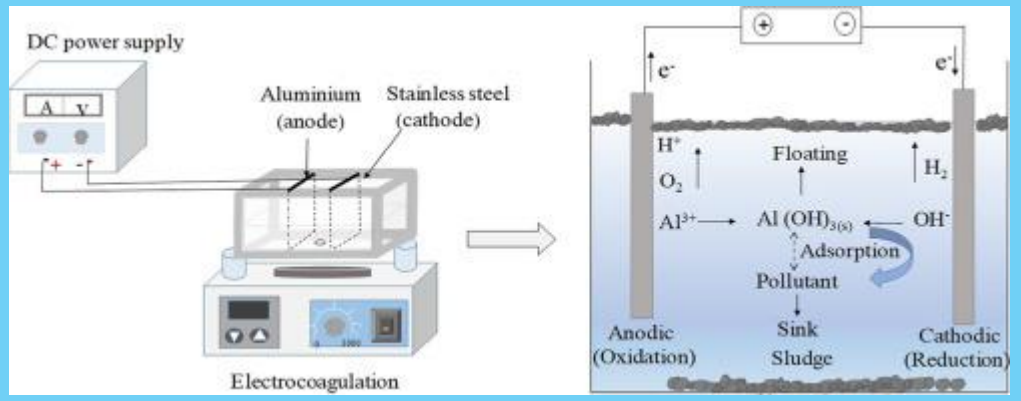
- Total Nitrogen >80%
- Total Phosphorous >95%

Scalability

- Flow
- Hydraulic residence time

Operation and Maintenance

- Electrode replacement
- Sludge removal, drying and disposal
- Power supply



Biological Treatment Technologies

Bioremediation

- Treatment of water through seeding of microbes that feed on the nutrients for removal, thereby minimizing the available nutrients for algae growth
- Introduces naturally occurring microbes in quantities and in environments that reduce the nutrient availability in the water
- The microbial culture is carefully prepared to feed on the desired contaminants

Floating Wetland Islands (FWIs) and Treatment Wetlands

- Use of natural or existing wetlands to provide treatment of water through natural physical (sedimentation, sorption), chemical (precipitation), and biological (uptake, transformation, burial) processes.
- To be covered by Wetland Solutions Inc.

Biological Process Technology: Bioremediation

BioCleaner Bio6 (DEP No. 1698)

- Bundles an air blower, aerogrids, and biotubes filled with media to filter and aerate a water body
- Capable of using different microbial communities depending on the waste to remove
- Modular system allows for easy removal and replacement of fiberglass framework

Treatment

- Treats BOD, COD, TSS, oil and grease, and surfactants
- Increases DO in the water
- Capable of treating at least 50 Kg of BOD total each day

Scalability

- Placed directly into the reservoir
- Scalable by adding as many units as desired for treatment

Operation and Maintenance

- Compressor and ring blower need yearly maintenance
- Aerogrid needs maintenance every 2 years
- Media needs replacement every year

Data Collection Summary Report

Performed literature review and assessed available technology based upon information sources:

- DEP Technologies Database
- Working Group experience and case studies
- Other professionals with similar project experience
- Technology vendor submittals
- **PUBLIC INPUT**

Technology Status Summary

30 FDEP Accepted Water Technologies (as of 01/16/2019)

- *15 Physical*
- *7 Chemical*
- *8 Biological*

- *3 No response*

8 Unsolicited Submittals or Non-proprietary Applications

- *5 Physical*
- *2 Chemical*
- *1 Biological*

Vendor Responses-
FDEP Accepted Technologies (Physical)

Physical (Sedimentation/Filtration)

- ✓ 1900 – StormPro
- ✓ 1865 – Kraken Filter
- ✓ 1847 – Aqua-Filter
- ✓ 1843 – Aqua-Swirl
- ✓ 1756 – Downstream Defender
- ✓ 1696 – Hydro Dry Screen
- ✓ 1479 – StormSack
- ✓ 1480 – StormBasin
- ✗ 1619 – Integrated onsite stormwater management solutions
- \+ Side Bank Filter – ACF Environmental

Physical (Sorption)

- ✓ 1678 – NutriGone BAM
- ✓ 1641 – PhosRedeem

Physical (DAF)

- ✓ 1579 – AquaLutions

Physical (Oxidation)

- ✓ 1769 – MagneGas Plasma Arc

Physical (Aeration)

- ✓ Air Diffusion System

✓ Information provided ✗ No information provided \+ Information pending

36

Vendor Responses - DEP Accepted Technologies (Chemical)

Chemical (Coagulants/Flocculants)

- 1398 –Aluminum Sulfate
- 1397 – FLOPAM EM 230 PWG
- 1390, 1396 – Ciba Krysalis (BASF) FC
- 1395 – Ciba Krysalis (BASF) FA
- 1394 – OPTIMER 7194 PLUS
- 1392 – Dredgeclear 53

Chemical (Coagulation)

- 1505- Electrocoagulation

Information provided

No information provided

Information pending

Vendor Responses - DEP Accepted Technologies (Biological)

Bioremediation

- ✗ 1882 – Omega Water Sciences
- ✓ 1698 – Biocleaner Bio6
- ✓ 1473 – Microbe-LIFT
- ✓ 1858 – Southern Algae Control
- ✗ 1626 – Bioremediation and oxidation of nutrient load
- ✓ 1478 – FocalPoint

Wetlands

- ✓ 1677 – Floating wetland Islands (to be included under treatment wetlands)

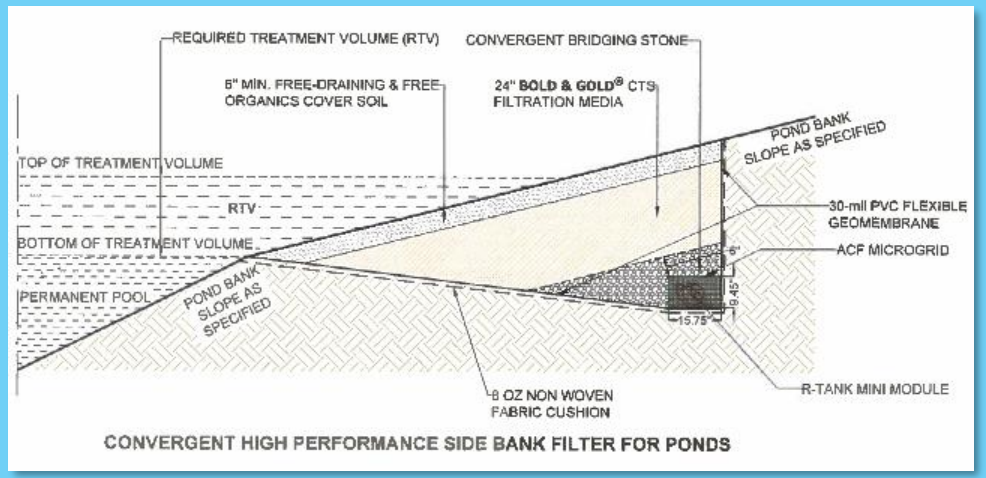
✓ Information provided ✗ No information provided + Information pending

Unsolicited Submittals

Physical (Sedimentation/Filtration)

+ Side Bank Filter – ACF Environmental

Bold & Gold Sorption Activated Media



Physical (Aeration)

✓ Air Diffusion Systems

Fine Bubble Diffusers

✓ Information provided

✗ No response to information request

\+ Information pending

In-Reservoir Treatment Technologies

- Technologies to treat within the reservoir often combine physical, chemical and biological approaches. This can include technologies on the DEP list
- Aeration (physical) and algicide (chemical) are common reservoir management approaches
- Chemical dosing with nutrient inactivating compounds is increasingly common
- The reservoir ecosystem also provides mechanisms for treatment

FDEP Accepted Technologies with Florida Case Studies

Technology	Location	Type of Treatment
AquaFiber	Rockledge; Lake Jesup	Physical (DAF)
Air Diffusion System	Havana, FL	Physical (Aeration)
NutriGone	Rockledge; Viera	Physical (Sorption, sedimentation)
MagneGas	St. Pete & Clearwater	Physical (Oxidation)
Electrocoagulation	Sanford; Hazen; St. Pete (3)	Chemical
Microbe Lift Product	Ft. Myers; Captiva; Jacksonville (2); Windermere	Biological
SouthernAlgaeControl	Florida Lake Okeechobee	Biological

In-Reservoir Treatment

Limits Nutrient and Light Availability to Algae

Aeration/Destratification

1,100 acres, 15.5 billion gallons
C B Young Reservoir, Tampa Bay Water, FL

Nutrient Inactivation

Alum Application

In-Reservoir Treatment
Decrease Algal Population

Ultrasonication

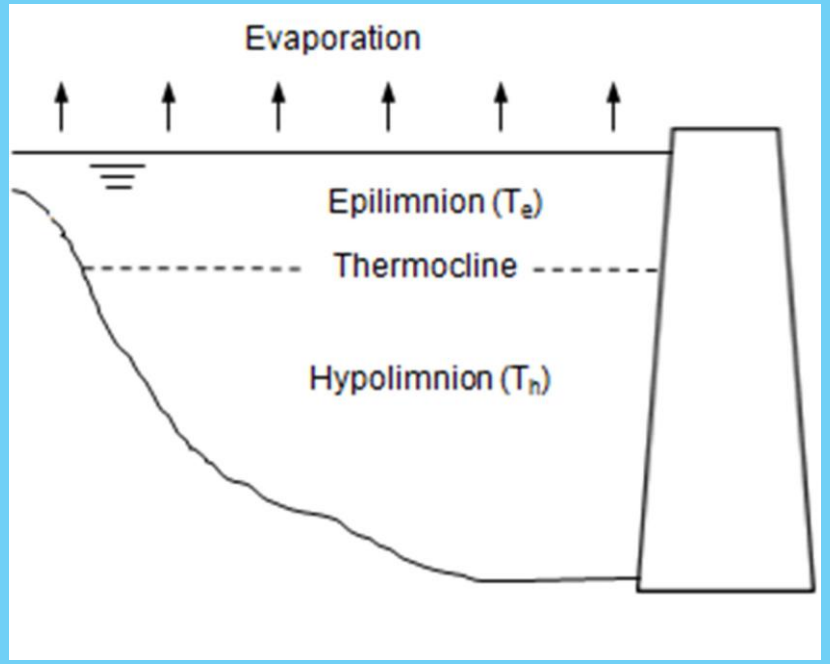
www.LGSonic.com

Algistat/Algicide Application

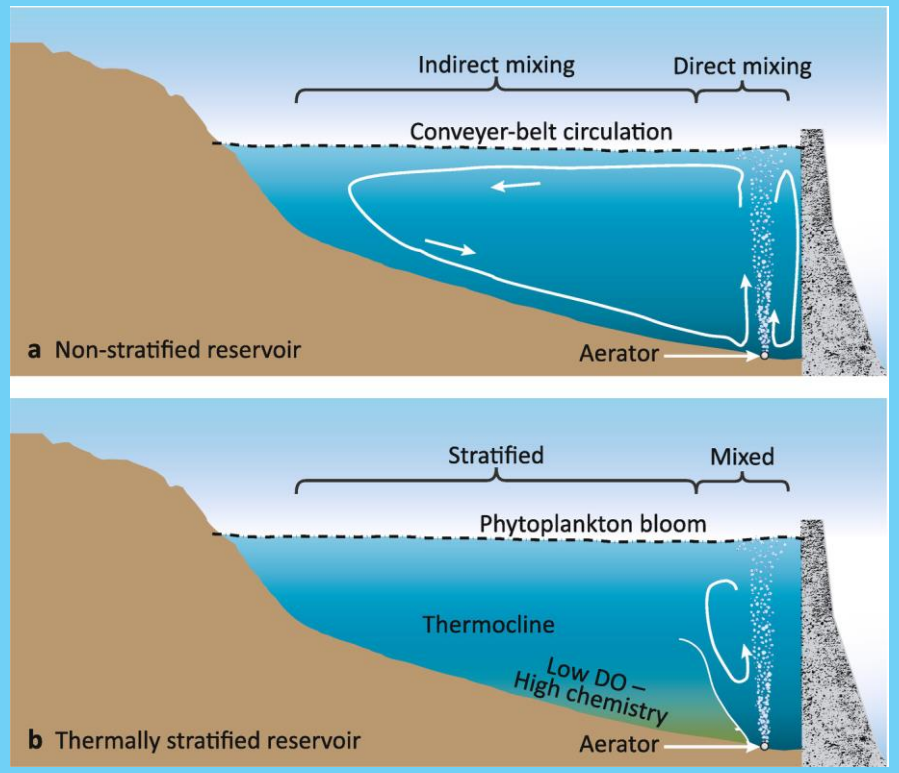
PAK 27 Application

In-Reservoir Treatment

Enhanced Biological Treatment through Artificial Circulation



Reservoir will stratify by temperature and oxygen, creating low oxygen sediments



Recirculate aerobic water with oxidized nitrogen forms to low oxygen hypolimnion

Example Comparison Matrix

Technology	Proc	FL	Concentration (mg/L)	CR (%)	Area (ac)	Flow (cfs)	Scale Factor*	Power	Residuals	Cost
AquaFiber	CT/ DAF	Y	TN In 1.3 TP In 0.2	TN 65% TP 90%	1	6	.17 Ac/cfs	Vendor to send information	Lbs/d/cfs Residuals would include TSS and algae and vary greatly based on concentrations in.	20 MGD facility - $20.5M capital - $1/1,000 gal O&M cost
Powell Water Systems	Electro-coagulation	Y	TN In 2.0 TP In 0.2	TN 80% TP 95%	0.7	34	.02 Ac/cfs	0.5 kWh/ 1,000 gal	Residuals would include TSS and is removed as powder rather than sludge with 83% less solids than alum treatment	$7M per 250 cfs unit
Biocleaner6	Bio-remediation	Y	TN In 796 TN Out 39 PO4 In 6.8 PO4 Out 0.02	TN x% TP x% BOD 90%	In-res	1.4 cfs air	N/A	2 h.p. blower. 1.6 kW	In reservoir treatment	$65,000; $2,600/2 year O&M

*Scale Factor does not include residuals collection and treatment area

Technology Selection Criteria

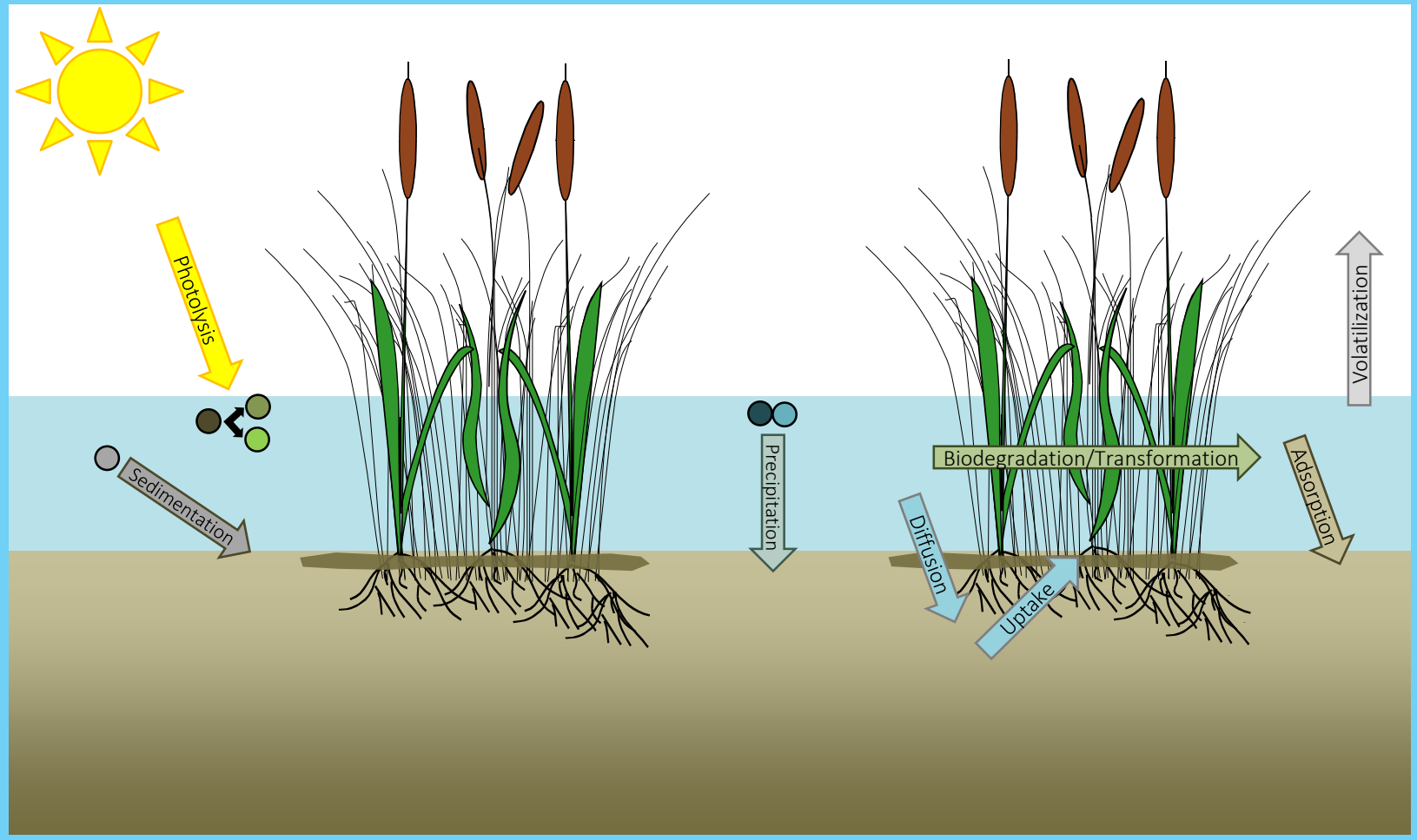
Next Steps

Selection Criteria Categories

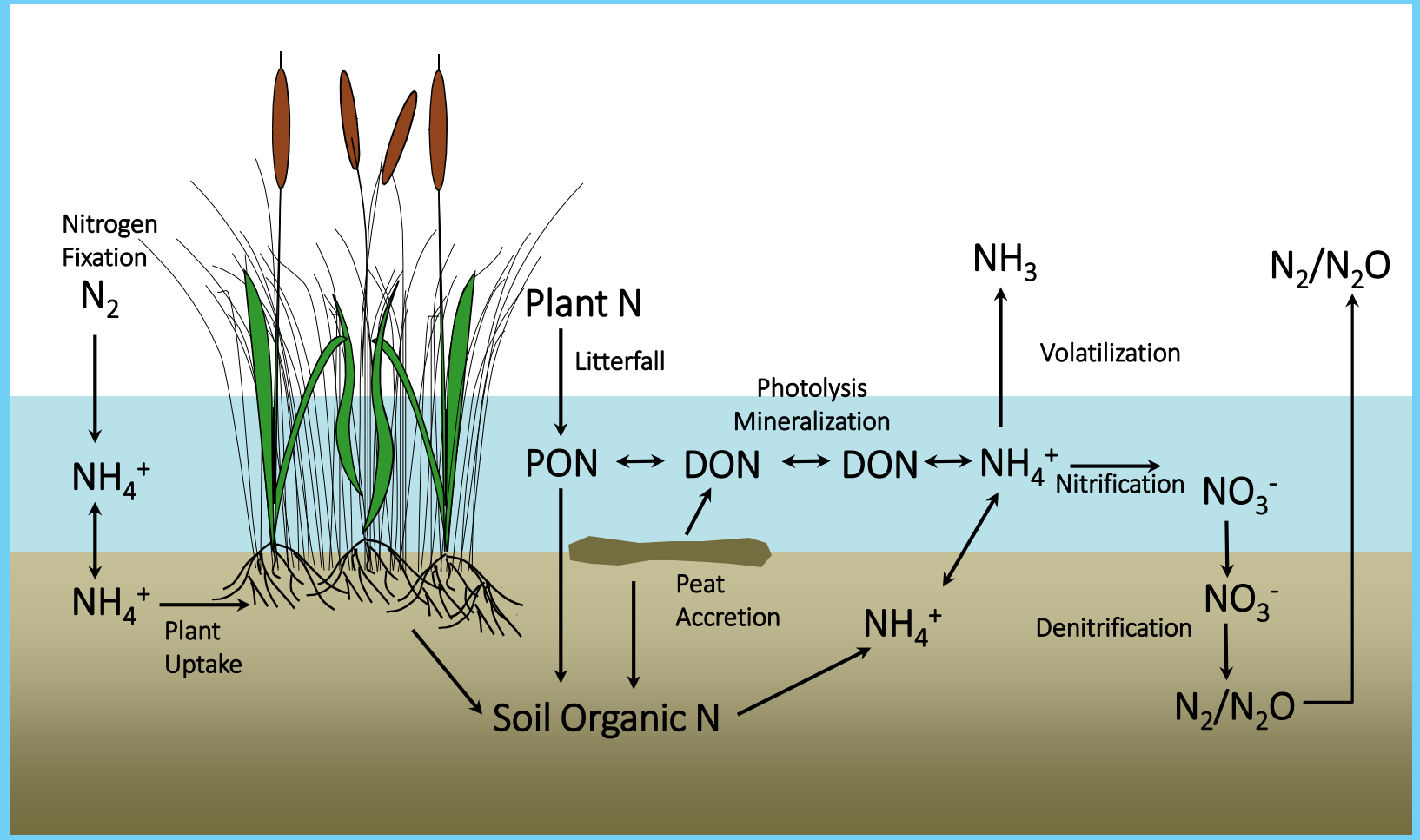
- Performance
  - ✓ *Proven results*
  - ✓ *Florida specific data validating results of the technology*
  - ✓ *Cannot cause harm*
- Cost
- Physical requirements
- Administrative

Wetland Treatment and STAs

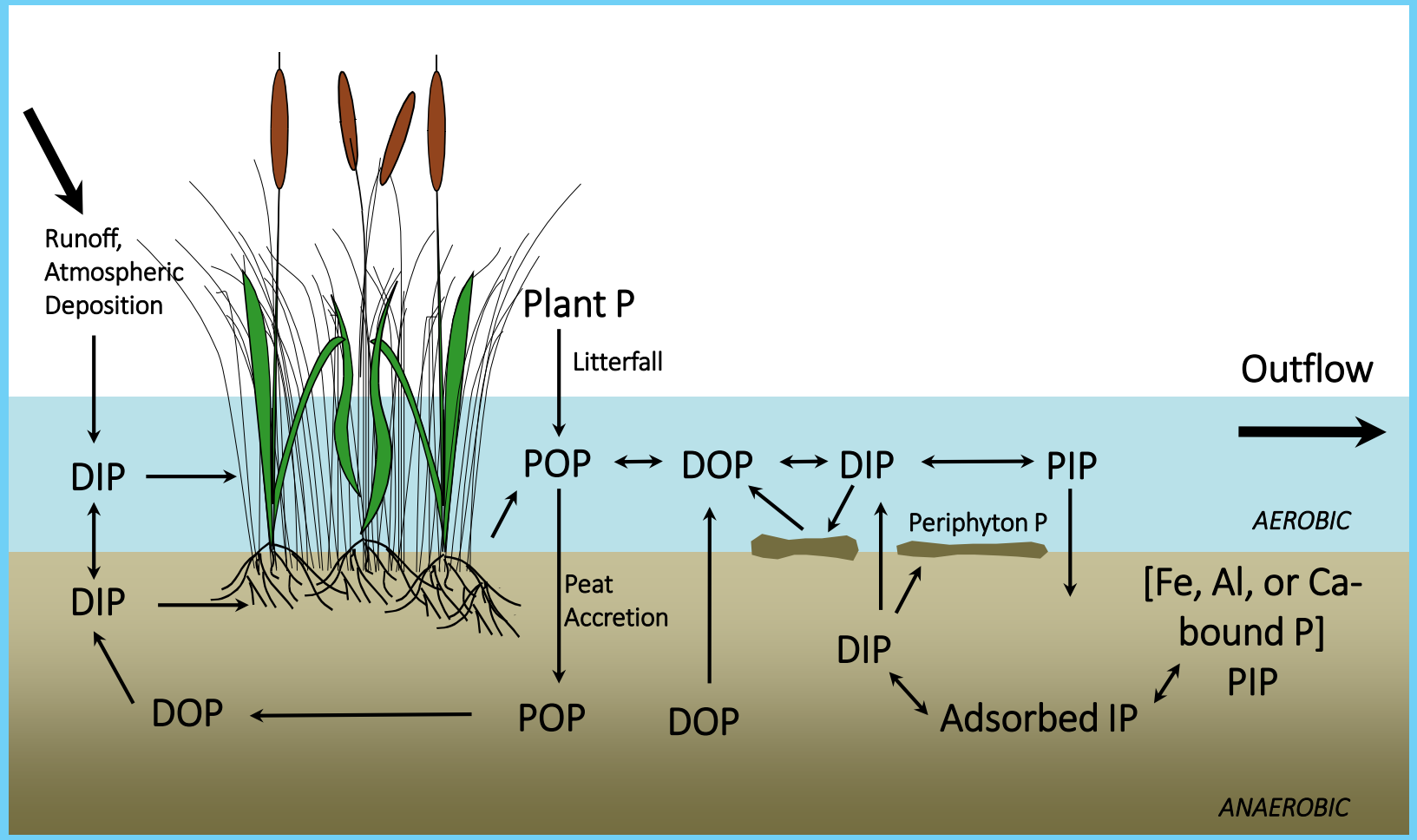
Wetland Water Quality Processes



Wetland Nitrogen Cycle



Wetland Phosphorus Cycle



Treatment Wetland Plant Communities

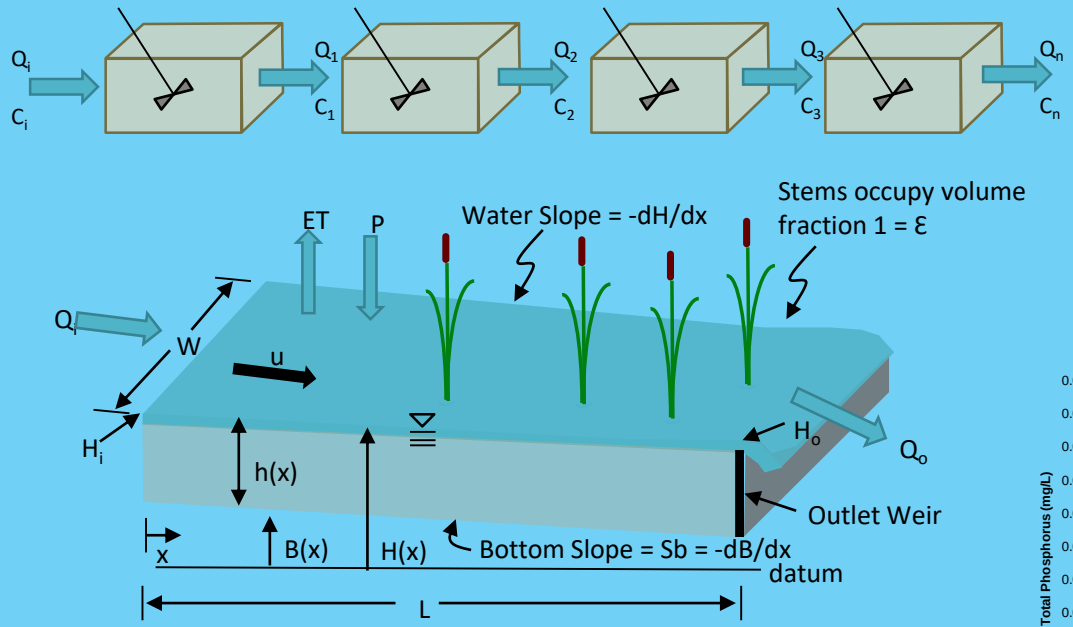
Floating Aquatic Vegetation (FAV)

Emergent Aquatic Vegetation (EAV)

Submerged Aquatic Vegetation (SAV)

Periphyton

Treatment Wetlands are Engineered Systems

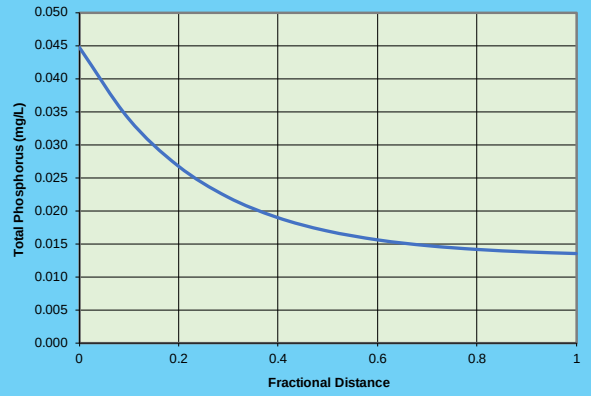


P-k-C* Model

(Kadlec and Wallace 2009)

$$\left(\frac{C_2 - C^*}{C_1 - C^*}\right) = \left(1 + \frac{k}{Pq}\right)^{-P}$$

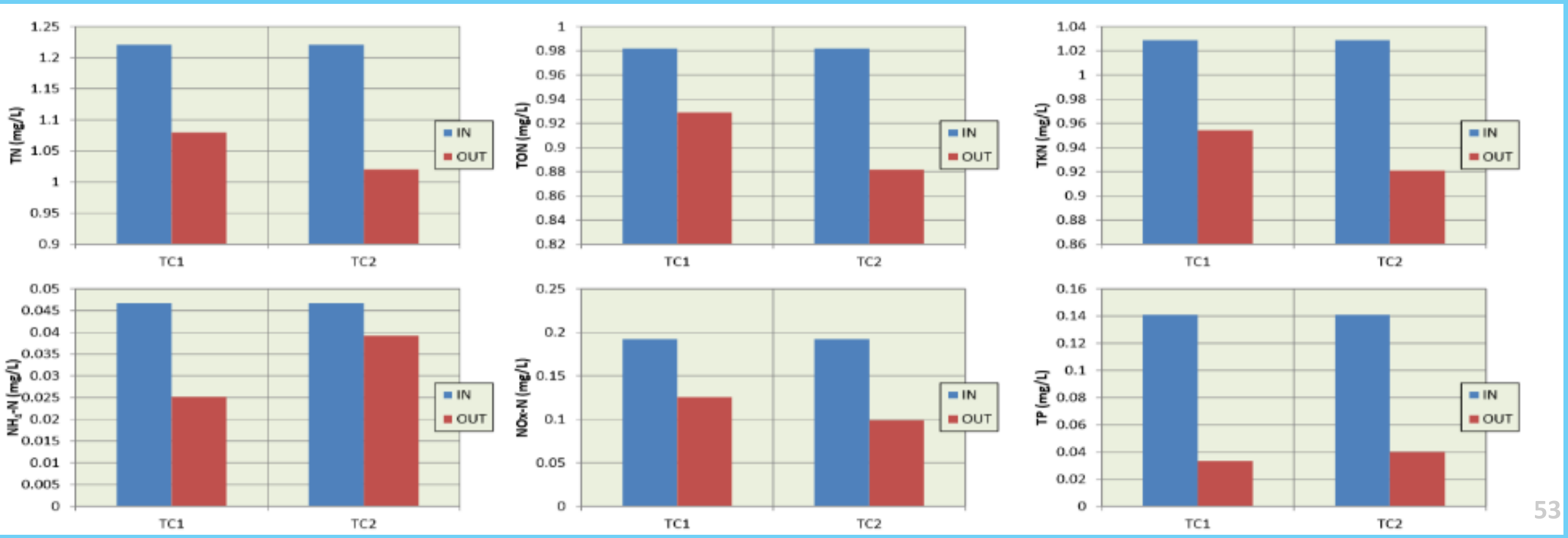
C_1 = inflow concentration (mg/L)
C_2 = outflow concentration (mg/L)
C* = background concentration (mg/L)
k = 1st order rate coefficient (m/yr)
P = apparent number of tanks-in-series
q = hydraulic loading rate (m/yr)



C-43 West Storage Reservoir Test Cell Water Quality (2007)

Concentration Reductions

- TN 14%
- TP 74%



C-43 WQTTP Mesocosm Study (2019)

Final Project Report

Deliverable 8.3

C-43 Water Quality Treatment and Testing Project
(C43-WQTTP) – Phase 1

Prepared for

South Florida Water Management District

Date

July 9, 2019

Prepared by

J-Tech in association with Wetland Solutions, Inc.

C-43 WQTTP Mesocosm Study (2019)

Objectives: test wetland based strategies to demonstrate removal of nitrogen, especially DON, from the C-43 Canal

- What vegetation community will provide best treatment performance for TN and DON?
- What contribution will on-site soils have on nitrogen uptake and release?
- What hydraulic loading rate (HLR) will result in the most efficient nitrogen removal rate?

C-43 WQTTP Mesocosm Study (2019)

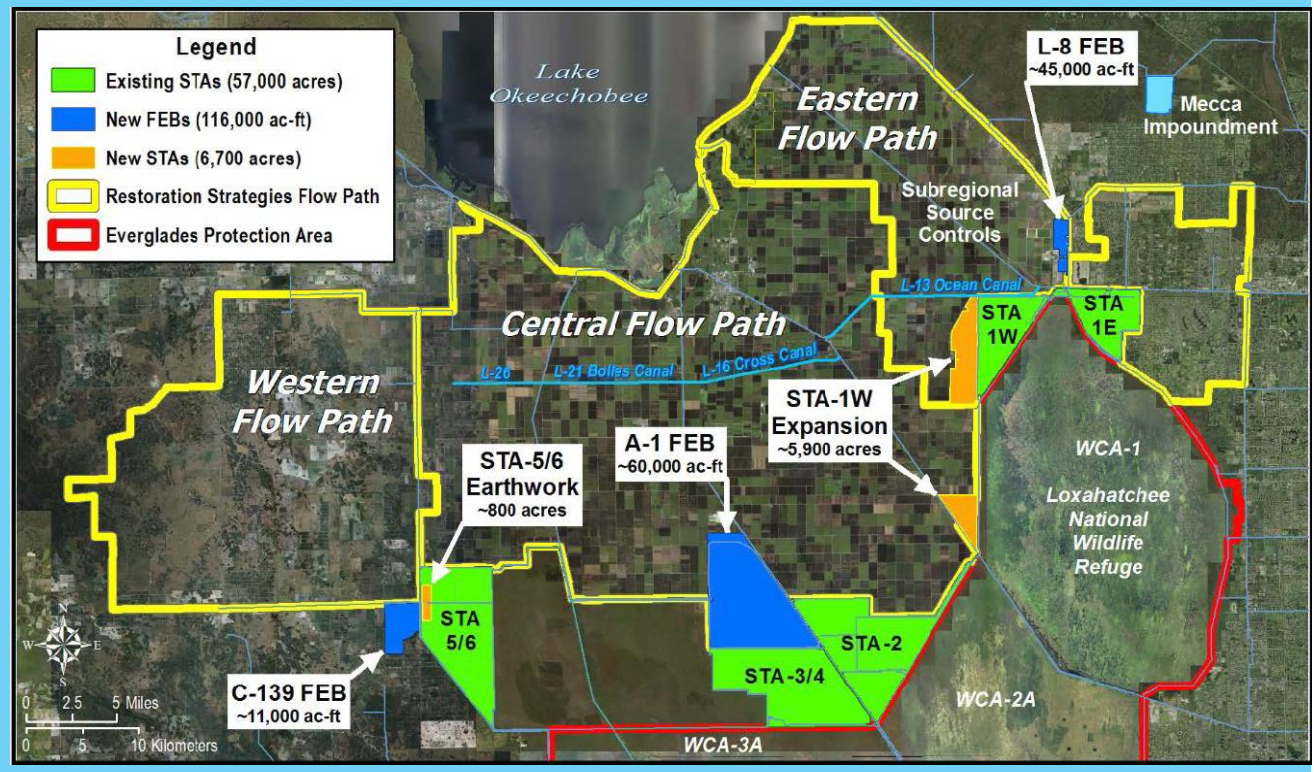
Preliminary Results:

- TN: 23% concentration reduction and 33% mass reduction
- DON: comprised 68% of source water TN
- DON reduction better in wet season (14%) than dry season (4%)
- Some DON converted to BDON and removed
- DIN removal greater than 90%
- TN removal similar between plant communities
- TP removal greater than 75% (SAV better than EMV)

SFWMD EAA STAs – Nitrogen

Site	TN In (mg/L)	TN Out (mg/L)	%	POR
STA 1E	2.19	1.52	31	WY07-16
STA 1W	3.56	2.31	35	WY04-16
STA 2	3.49	2.15	38	WY03-16
STA 3/4	3.43	1.88	45	WY06-16
STA 5	1.66	1.44	14	WY01-12
STA 6	2.09	1.43	32	WY02-07
STA 5/6	1.55	1.27	18	WY14-16

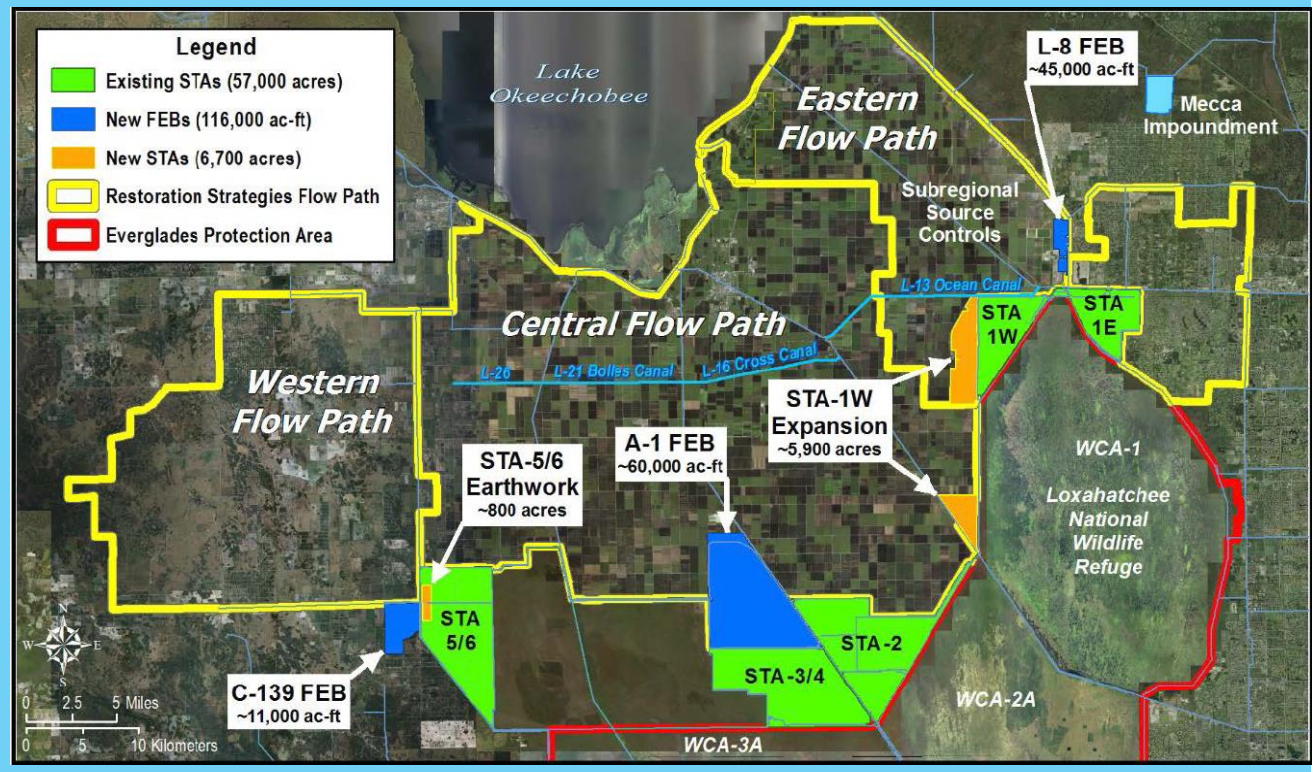
SFWMD, 2017 (Technical Publication WR-2017-001)



SFWMD EAA STAs - Phosphorus

Site	TP In (ug/L)	TP Out (ug/L)	%	POR
STA 1E	265	47	82	WY05-18
STA 1W	228	39	83	WY94-18
STA 2	158	38	76	WY00-18
STA 3/4	128	12	91	WY04-18
STA 5/6	234	74	68	WY98-18

South Florida Environmental Report 2019



Regional Filter Marsh Projects

Site	Size (ac)	TN In (mg/L)	TN out (mg/L)	TN (%)	TP In (mg/L)	TP Out (mg/L)	TP (%)
Ten Mile	~13	1.01	0.81	20	0.074	0.029	61
Briarcliff	15	0.93	0.83	11	0.025	0.008	68
Powell Creek	18	1.08	0.93	14	0.087	0.024	72
Lakes Park*	18	0.66	0.62	6	0.033	0.026	21
Freedom Park	23	1.47	0.87	41	0.210	0.033	84

Wet Detention Pond Study – Lee County

Project Details

- Evaluation of 3 wet detention ponds

Concentration Reductions

- Site 1: TN 26% from 1.92 to 1.42 mg/L
- Site 2: TN 50% from 1.27 to 0.64 mg/L
- Site 3: TN 49% from 2.29 to 1.17 mg/L

Floating Treatment Wetlands – Lee Co. and Naples

Project Details

- Evaluation of FTW in multiple stormwater wet detention ponds

Results

- Inconclusive for nutrient concentration improvement in the water column
- Potential allelopathic interaction between plant roots and algae
- FTWs shade the water column and may help to reduce algae

Next Steps

Future Public Meetings

Date	Time	Location
March 25, 2020	6pm-8pm	SW Florida Community Foundation Collaboratory, 2031 Jackson Street, Suite 100, Fort Myers, FL 33901
July 16, 2020	2pm-4pm	SW Florida Community Foundation Collaboratory, 2031 Jackson Street, Suite 100, Fort Myers, FL 33901

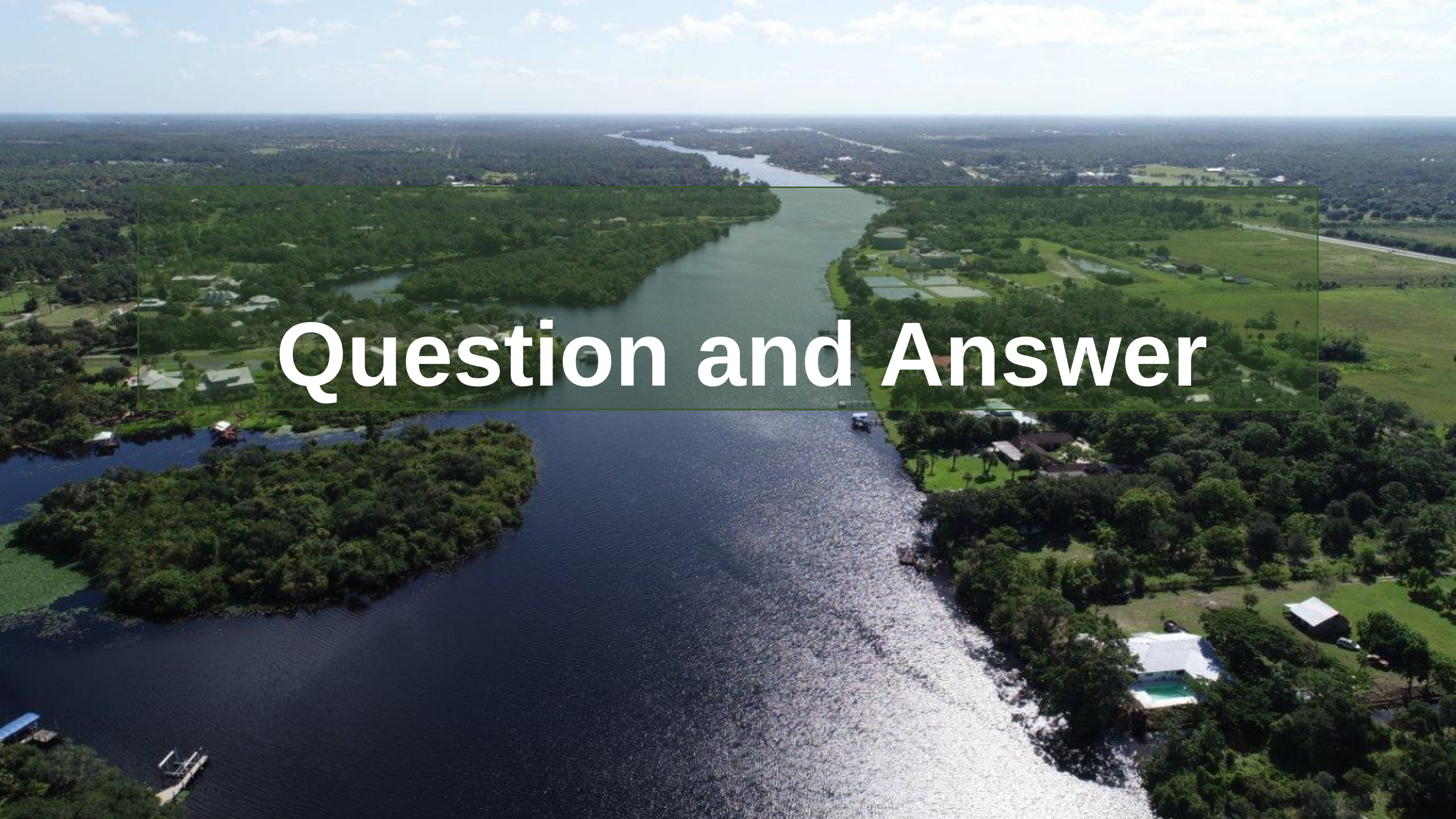
Project Deliverables

Reports	Due Date	Summary
Data Collection Information Summary Report	March 18, 2020	Review of all available studies/literature regarding water quality treatment, especially regarding nitrogen removal, that are pertinent to the Caloosahatchee River Basin. Additionally, the literature review shall contain information relevant to preventing and managing blue-green alga blooms, solids, and nutrients in other similar water bodies, with a focus on Florida.
C-43 WBSR Water Quality Improvement Feasibility Study	October 18, 2020	Review of all technically feasible, conventional and innovative biological, chemical and physical water quality treatment technologies currently available at a scale necessary (or ready to be scaled) for eventual pre-treatment, in reservoir treatment, and/or post-treatment application for the C- 43 WBSR including cost-benefit and trade-off analysis.

Public Input and Project Website

C43waterquality@sfwmd.gov

https://www.sfwmd.gov/content/c43waterqualitystudy


Question and Answer