The MilCor Group Inc.

*Engineering a Value-Driven Sustainable Environment*

**Florida Department of Environmental Protection**

**Request for Information #2020018**

**Projects to reduce nutrients and restore flow in the St. Lucie River and Estuary Basin Management Action Plan**

# CAULKINS - TROUP WATER FARM

Submittal Deadline: October 21, 2019 at 5:00PM

Submitted By:
The MilCor Group, Inc

On Behalf Of:

Caulkins Citrus Company, Ltd.
7801 SW Citrus Boulevard
Indiantown, FL 34956
FEI: 59-1046068

West Citrus Boulevard Stuart FL, LLC
1521 Westbranch Drive, Suite 100
McLean, VA 22102

Bar-B Ranch
3386 SE Cassell Lane
Stuart, FL 34997
FEI: 59-1004187

10975 Southeast Federal Highway
Hobe Sound Florida 33455

725 Southeast Port St. Lucie Boulevard #104
Port St. Lucie Florida 34984

Phone 772-223-8850
Fax 772-223-8851

Email marketing@themilcorgroup.com

Web www.themilcorgroup.com

# Florida Department of Environmental Protection
# Request for Information #2020018

## Projects to reduce nutrients and restore flow in the Lake Okeechobee Basin Management Action Plan

## CAULKINS - TROUP
## WATER FARM

## Table of Contents

## SECTION 3.00 – INTERESTED ENTITY'S CONTACT INFORMATION

Interested entities are asked to provide the following information:

| CONTACTS | |
|---|---|
| Primary contact regarding this submission? (OWNER)<br>WEST CITRUS BLVD SMART LLC | Name: BILL FRISBIE<br>Email Address: Bill.F@gladstoneland.com<br>Phone: 571-334-8403<br>Title or Role in Organization:<br>~~VICE PRESIDENT~~<br>MANAGING DIRECTOR |
| Company Website URL: | |
| Type of Organization (Corporation, Partnership, etc.): | LIMITED LIABILITY CORPORATION |
| How long has your company been in this type of business? | Years: 15<br>Months: — |
| Location of Project Manager that would serve the Department: | City: JUPITER<br>State: FL |
| Location of Regional Sales Manager that would serve the Department: | City:<br>State: N/A |

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## SECTION 3.00 – INTERESTED ENTITY'S CONTACT INFORMATION

Interested entities are asked to provide the following information:

| **CONTACTS** | |
|---|---|
| Primary contact regarding this submission? Caulkins Citrus Co. FEI # 59-1046068 | Name: George Caulkins<br>Email Address: george@greendeck.com<br>Phone: 303-880-1160<br>Title or Role in Organization: President |
| Company Website URL: | N/A |
| Type of Organization (Corporation, Partnership, etc.): | Fl. Limited Partnership |
| How long has your company been in this type of business? | Years: 58<br>Months: |
| Location of Project Manager that would serve the Department: | City: Hobe Sound<br>State: FL |
| Location of Regional Sales Manager that would serve the Department: | City: Hobe Sound<br>State: FL |

– Remainder of Page Intentionally Left Blank –

## SECTION 3.00 – INTERESTED ENTITY'S CONTACT INFORMATION

Interested entities are asked to provide the following information:

| CONTACTS | |
|---|---|
| Primary contact regarding this submission?<br>Bar-B Ranch<br>FEI #59-1004187 | Name: Lance K. Troup<br>Email Address: LTroup@mac.com<br>Phone: 305-218-4190<br>Title or Role in Organization:<br>President |
| Company Website URL: | na |
| Type of Organization (Corporation, Partnership, etc.): | S-corp |
| How long has your company been in this type of business? | Years: 58<br>Months: 6 |
| Location of Project Manager that would serve the Department: | City: Hobe Sound<br>State: FL |
| Location of ~~Regional Sales~~ Manager that would serve the Department: | City: Stuart<br>State: FL |

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REPRESENTATIVE AUTHORIZATION

Florida Department of Environmental Protection
3800 Commonwealth Boulevard, MS #93
Tallahassee, Florida 32399-3000

**Re: FDEP RFI #2020012 – Lake Okeechobee BMAP and RFI #2020018 – St. Lucie River & Estuary BMAP**

Please be advised that the undersigned has authorized the following person(s)/entity to act on their behalf in seeking approval for the above referenced application:

Melissa G. Corbett, P.E.
Kenneth Rau, P.E.
The Milcor Group, Inc.
10975 SE Federal Highway
Hobe Sound, FL 33455
772.223.8850
melissac@themilcorgroup.com / kennethr@themilcorgroup.com
TIN: 26-2959425

Witness:

Celeste Naumova
Print Name

Faye Towns
Print Name

By:

Paul J. Whalen, Authorized Agent
West Citrus Boulevard Stuart FL, LLC
Citrus Boulevard Stuart FL, LLC
West St. Lucie Farms LLC

ACKNOWLEDGEMENT

STATE OF FLORIDA
COUNTY OF Florida | Palm Beach

The foregoing was acknowledged before me this 15 day of October, 2019, by Paul J Whalen, and [✓] is personally known to me or [ ] has produced ____________ as identification.

Notary Stamp

Amanda Jean Prevatte
NOTARY PUBLIC
STATE OF FLORIDA
Comm# FF939915
Expires 11/30/2019

FLORIDA NOTARY ASSOCIATION
SINCE 1978

Notary Public

WEST ST. LUCIE FARMS COMPANY, LLC
14095 STATE ROAD 7
DELRAY BEACH, FL 33495
PHONE: 561-498-5771

December 23, 2014

To Whom it may Concern:

Until further notice, Paul J. Whalen of TAC Environmental Water Resources Consulting, Inc., is authorized to obtain, review, discuss environmental and water resource issues, submit applicable documentation and permit applications, and perform related permit compliance activities specific to company holdings: *WEST ST. LUCIE FARMS COMPANY LLC.*

Sincerely,

Angela Pero
West St. Lucie Farms Company LLC
President

GLADSTONE LAND

August 16th, 2019

South Florida Water Management District
Florida Department of Agriculture and Consumer Services
Florida Department of Environmental Protection
Florida Department of Health
U.S. Army Corps of Engineers

RE: Gladstone Land Corporation
Authorized Representative – Environmental and Water Resources Related Permitting/Submittals

To Whom It May Concern:

Please be advised I hereby designate Paul J. Whalen, P.H. of TAC Environmental Water Resources Consulting, Inc. as an authorized representative of Gladstone Land Corporation to act on the company's behalf to discuss environmental and water resource issues, submit applicable documentation and permit applications, and perform related permit compliance activities specific to company holdings:

Gladstone Land Corporation
Citrus Boulevard Stuart FL LLC
West Citrus Boulevard Stuart FL LLC
Corbitt Road Immokalee LLC
Immokalee Exchange LLC
Parrot Avenue Okeechobee LLC
Orange Avenue Fort Pierce LLC
Owl Hammock Immokalee LLC

Sincerely,
Gladstone Land Corporation

David Gladstone

David Gladstone, CEO and Chairman

REPRESENTATIVE AUTHORIZATION

Florida Department of Environmental Protection
3800 Commonwealth Boulevard, MS #93
Tallahassee, Florida 32399-3000

**Re: FDEP RFI #2020012 – Lake Okeechobee BMAP and RFI #2020018 – St. Lucie River & Estuary BMAP**

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Kenneth Rau, P.E.
The Milcor Group, Inc.
10975 SE Federal Highway
Hobe Sound, FL 33455
772.223.8850
melissac@themilcorgroup.com / kennethr@themilcorgroup.com
TIN: 26-2959425

Witness: [signature]

Jeannie Henry
Print Name

[signature]

Suzanna Andrianakos
Print Name

By: [signature]

GEORGE CAULKINS

CAULKINS CITRUS CO, PRES.
Print Name, Title

ACKNOWLEDGEMENT

STATE OF COLORADO
COUNTY OF Denver

The foregoing was acknowledged before me this 15th day of October, 2019, by George Caulkins, and [ ] is personally known to me or [ ] has produced Colorado Driver License as identification.

Notary Stamp

SUZANNA ANDRIANAKOS
NOTARY PUBLIC
STATE OF COLORADO
NOTARY ID 19924009688
My Commission Expires Sept. 28, 2023

[signature]
Notary Public

REPRESENTATIVE AUTHORIZATION

Florida Department of Environmental Protection
3800 Commonwealth Boulevard, MS #93
Tallahassee, Florida 32399-3000

**Re: FDEP RFI #2020012 – Lake Okeechobee BMAP**
**and RFI #2020018 – St. Lucie River & Estuary BMAP**

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The Milcor Group, Inc.
10975 SE Federal Highway
Hobe Sound, FL 33455
772.223.8850
melissac@themilcorgroup.com / kennethr@themilcorgroup.com
TIN: 26-2959425

Witness:

Cody Litzenburg
Print Name

Jose Sobrado
Print Name

By:

Lance K Troup, President
Print Name, Title

ACKNOWLEDGEMENT

STATE OF FLORIDA
COUNTY OF Martin

The foregoing was acknowledged before me this 14th day of October, 2019, by Lance Troup, and [ ] is personally known to me or [X] has produced FL DL as identification.

Notary Stamp

Notary Public

Notary Public State of Florida
Gabrielle Paige
My Commission GG 305093
Expires 02/24/2023

**Project Narrative**

The Caulkins-Troup Water Farm is proposed as an interconnection with the existing successful Caulkins Water Farm (CWF) to provide additional storage to capture and storage either Lake Okeechobee or C-44 Drainage Basin excess runoff prior to release through the S-80 Locks.

The Troup parcel is located northwest of CWF. This project proposes an interconnection via CWF existing perimeter canal located on the north end of the property, connecting to the Troup property via an easement across the north end of the FPL property to the southeast corner of the Troup property where a pump will lift water into the property.

The Troup property encompasses 1,900 acres of improved pastureland. It has a series of interconnecting ditches, and low lying wetland areas throughout the property. Site elevations range from a low of 23.5 feet NAVD, which is the assumed water table elevation, to a high of 29.5 feet. The perimeter of the property has an existing berm around the vast majority of it, with current elevations as high as 32.0 feet. The proposed water farm would require ensuring that the entire perimeter is bermed such that the site could be flooded during wet times with approximately 2-feet of water over the site area. Water would flow from the pump at the southeast corner of the Troup property into the interconnected ditch system, filling the lower areas, or approximately 1,400 acres of the 1,900 acres, and leaving the 500 acres of higher natural lands unaffected.

Utilizing an infiltration rate of 0.035 ft/day, as established by the CWF, and an anticipated 200 days of pumping, it is estimated that the site will hold approximate 8,400 ac-ft of pumped water, in addition to holding rainfall of 8,500 ac-ft on the site, based on an average rainfall of 60" per year. The total storage volume is anticipated at 16,900 ac-ft.

The FDEP has a stated removal efficiency of 45% results, and assumed TN concentrations of 1.43 mg/l, and TP concentrations of 0.214 mg/l in captured runoff. Caulkins Water Farm has documented a higher removal rate and higher concentration levels of the C-44 inflow water.

It is estimated that between 4,888 – 7,884 pounds of TP will be removed (2,200 – 3,547 pounds at 45% efficiency), at a cost of between $329.28 – $531.12 per pound ($731.74 - $1,180.27 at 45% efficiency). TN removal will be between 32,663 – 36,934 pounds (14,698 – 16,620 at 45% efficiency) at a cost of $70.29 - $79.48 per pound ($156.20 – $176.63 at 45% efficiency). This is based on pumped water only; no credit is taken for stored rainfall.

The anticipated design, permitting and construction cost for this project is $1,018,000, with an Average Annual Cost Present Worth of $2,596,114 per the SFWMD Calculator.
The anticipated annual operation and maintenance cost is $150 per ac-ft of storage.

It is anticipated that this project could be up and running in 32 months.
Detailed cost estimates, removal calculations and a concept plan are included herein.

The MilCor Group Inc.

*Engineering a Value-Driven Sustainable Environment*

# Florida Department of Environmental Protection

## Request for Information #2020018

## Projects to reduce nutrients and restore flow in the St. Lucie River and Estuary Basin Management Action Plan

# CAULKINS-TROUP WATER FARM

1. Specific TRA ID and basin name.
   **TRA ID – 5**
   **Basin Name – C-44/S-153**

2. If a private entity is the lead contact, please list any local governments that may be a part of the team. Local government involvement is not a requirement but for this effort is encouraged.
   **There has been no local government involvement with the Caulkins-Troup Water Farm (CTWF).**

3. What parameter the project or activity will address (TN/TP/flow). If the project or activity addresses multiple parameters, please state in the response.
   **Project will address TN, TP, and Flow.**

   **The project will capture and hold rainfall year-round and excess water (flow) from the C-44 / Lake Okeechobee during the rainy season, allowing for groundwater recharge and nutrient removal (TN/TP).**

4. A general summary of the project or activity being proposed and include at a minimum:
   a) Whether the project or activity is based on known and accepted scientific principles of biological, chemical, or physical processes.
   **The proposed project is based upon the principals and methodologies employed at other Water Farm projects.**

   b) Whether it has been deployed successfully elsewhere and provide examples.
   **The methodology has been employed at the Caulkins Water Farm, Spur Land/Bull Hammock project, and the Evans Ideal 1000 project.**

   c) How success is measured or determined.
   **Success is measured based upon the volume of water retained by the project. Water is retained in the form of retained rainfall and water pumped into the project from the C-44 basin. Both retained rainfall and pumped water reduce the total volume of flow to the St. Lucie estuary. Water pumped into the projected from the C-44 removes nutrients from the C-44 basin.**

Office Location & Mailing Address:

10975 SE Federal Hwy
Hobe Sound
Florida
33455

Phone
772-223-8850
Fax
772-223-8851

Email
marketing@themilcorgroup.com

Web
www.themilcorgroup.com

**The FDEP has accepted that 45% of the nutrient load from water pumped into a water farm will be considered as removed nutrient load.**

d) Whether the technology/treatment been previously permitted in the state of Florida. Please identify the permit type and identification (or the associated permit if part of a larger project or activity).

**Water farms have been permitted in several locations in the state. Permits required will include:**

**South Florida Water Management District:**

**Environmental Resource Permit**
**Consumptive Water Use Permit**
**Temporary Dewatering Permit**

**Army Corps of Engineers**

**Department of Army Permit**

5. Estimate of total costs for the project or activity, including operation and maintenance costs if applicable. If a multi-year project or activity provide a cost breakdown by year for up to a 20-year period.

| | |
|---|---|
| **Construction Costs:** | **$ 1,018,686** |
| **Annual Participation Payment:** | **$ 2,535,000** |
| | |
| **Average Annual Cost, Net Present Worth*:** | **$ 2,596,114** |

***Assuming 3% Interest**

**The Annual Participation Payment is a fixed fee based upon a $150/ac-ft reimbursement for the estimated amount of water to be retained by the project, per available legislature funding.**

6. Estimated reduction benefits (TN/TP concentration or load – please state clearly if using another metric) to the specific basin or basins and include how that calculation was developed. If a multi-year project or activity provide reduction benefits by year.

| | |
|---|---|
| **Estimated Phosphorus Load Reduction** | **1.00 MT/year** |
| **Estimated Nitrogen Load Reduction** | **6.67 MT/year** |

***Based upon 45% removal of FDEP Nutrient Concentrations.**

**The nutrient load reduction estimates are based upon the estimated amount of water that will be pumped into the Caulkins-Troup Water Farm from the C-44. Per the Florida Department of Environmental Protection, 45% of the nutrient load within water that is retained in a water farm is removed. It should be noted that Caulkins Water Farm has demonstrated that the removal is higher, as this system is designed for retention.**

7. Estimated flow restoration benefits (volume) to the specific basin or basis and include how that calculation was developed. If a multi-year project or activity provide flow benefits by year.

| | |
|---|---|
| **Estimated Yearly Rainfall Retention** | **8,500 ac-ft** |
| **Estimated C-44/St. Lucie River Flow Reduction** | **8,400 ac-ft** |
| **Total** | **16,900 ac-ft** |

**The Caulkins-Troup Water Farm will reduce the water volume from the C-44 basin that reaches the St. Lucie River. This will occur by retaining all rainfall that falls onto the Troup property (approximately 1,900 acres) and by retaining and percolating into the surficial aquifer water that is pumped from the C-44 into the CTWF.**

8. Monitoring plan that will quantify benefits from the project or activity. If the monitoring plan includes data associated with a regulatory permit or requirement, state in the plan.

   **The annual benefits of the project will be quantified based upon the volume of water retained on the project, the nutrient load removed from the C-44, and the cost of operating the project.**

   **The CTWF will have an automatic sampler installed to collect surface water quality data from the pump withdrawal point for the duration of the project. Rain gauges will be installed to measure direct rainfall retained on the project. The volume of water pumped into the water farm from the C-44 canal will be measured via calibrated inflow pumps. The Operator will keep a daily log of how long the inflow pump ran, on the days when the pump was turned on, so that the volume of inflows could be calculated based on the run time. The nutrient (TN and TP) concentrations measured at the pump intake area will be were multiplied by the volume of the pump inflows for the measurement of the nutrients retained on by the water farm. If any water release occurred, the discharge(s) from the water farm would be monitored and recorded.**

   **This data will be recorded by the CTWF Operator and reported to the Florida Department of Environmental Protection and the South Florida Water Management District monthly, unless otherwise requested by either agency, or a more frequent interval.**

9. Any applicable permits (existing or expected) that may be associated with the project or activity.

   **Required Permitting:**

   **Army Corps of Engineers**

   **Department of Army Permit**

   **South Florida Water Management District**

   **Environmental Resource Permit**

10. A schedule that includes estimated time and readiness to proceed for the project or activity. The Department anticipates any project or activity – that meets criteria listed in this request - that is implementable within three years will have a higher priority if funding is made available.

**The Anticipated Project Schedule is as follows:**

| | |
|---|---|
| **Survey:** | **2 Months** |
| **Design:** | **6 Months** |
| **Engineering Plans & Reports** | |
| **Phase 1/Phase 2 Environmental Report** | |
| **Environmental & Wildlife Assessment** | |
| **Archeological Assessment** | |
| **Geotechnical Assessment** | |
| **Permitting:** | **12 Months** |
| **Army Corps of Engineers** | |
| **South Florida Water Management District** | |
| **Construction:** | **12 Months** |
| **Total:** | **32 Months** |

**Extended permitting duration is due primarily to expected ACOE review period.**

11. Identify any necessary infrastructure needed for this project or activity (e.g., electricity, connection to sewer, land easements). Provide a plan to address any infrastructure deficiencies that may be present at the location of the project or activity.

    **The following agreements & infrastructure will be required:**
    **Land-lease or usage agreement**
    **Drainage Easement With Adjacent Property (Water Source)**
    **Agreement/Partnership With Caulkins Water Farm**
    **Electrical supply to pump station**

12. Does this project or activity include the purchase or lease of land? If Yes, provide a summary of agreements, leases, or pertinent information to demonstrate status of land acquisition.

    **A lease or usage agreement from the property owner will be required to construct and operate the project.**

13. For any project or activity that includes treatment technologies, please provide the following:
    a) Material Data Safety Sheet for any chemicals used as part of the technology.

       **n/a – no treatment technology chemical usage is proposed.**

    b) Estimated target dose (concentration and duration of treatment) of any chemicals used as part of the technology, if appropriate, and explain how those doses were/would be determined.

       **n/a – no treatment technology chemical usage is proposed.**

    c) If the project or activity includes the use of a chemical(s), describe how it is used. At a minimum, describe whether the chemical is added directly to the ambient surface water or if it is added to a side stream treatment system which will eliminate or significantly reduce the amount of chemical that is introduced into the surface water.

**n/a – no treatment technology chemical usage is proposed.**

d) What are the influent water characteristics such as pH, salinity, alkalinity, or hardness which would render the technology inapplicable?

**No influent water characteristics would affect the project performance.**

e) Provide demonstrable proof (data) from previous field applications that the technology works and can achieve the stated removal rates?

**Please see the attached:**

**The Water Farming Pilot Projects:**
**An Evaluation of Water Farming As a Means for Providing Water Storage/Retention and Improving Water Quality In the Indian River Lagoon/Saint Lucie River Watershed**

**Final Report**

**August 17, 2018**
**The South Florida Water Management District**

f) Yes, No, or N/A, Have the chemicals been rated by the U.S. Environmental Protection Agency (EPA) as non-toxic and suitable for use in potable waters?

**n/a – no treatment technology chemical usage is proposed.**

g) Yes, No, or N/A, Are there Florida surface water criteria for any of these chemicals? If yes, is the technology in question capable of meeting Florida surface water criteria at all times at the recommended dose?

**n/a – no treatment technology chemical usage is proposed.**

h) If the technology relies on biological organisms, are any of them currently classified, or likely to be classified as invasive, exotic, or pathogenic?

**n/a – the project does not rely on biological organisms.**

i) Yes or No, Does the technology produce any waste products or by-products? If yes, are the waste products or byproducts nontoxic? Please provide a waste management plan that details disposal methods and locations of disposal.

**No.**

j) Yes or No, Are any of the waste or byproducts of known concern to the Everglades ecosystem (e.g. sulfate or mercury)? If yes, are they in a chemically bound or unbound state?

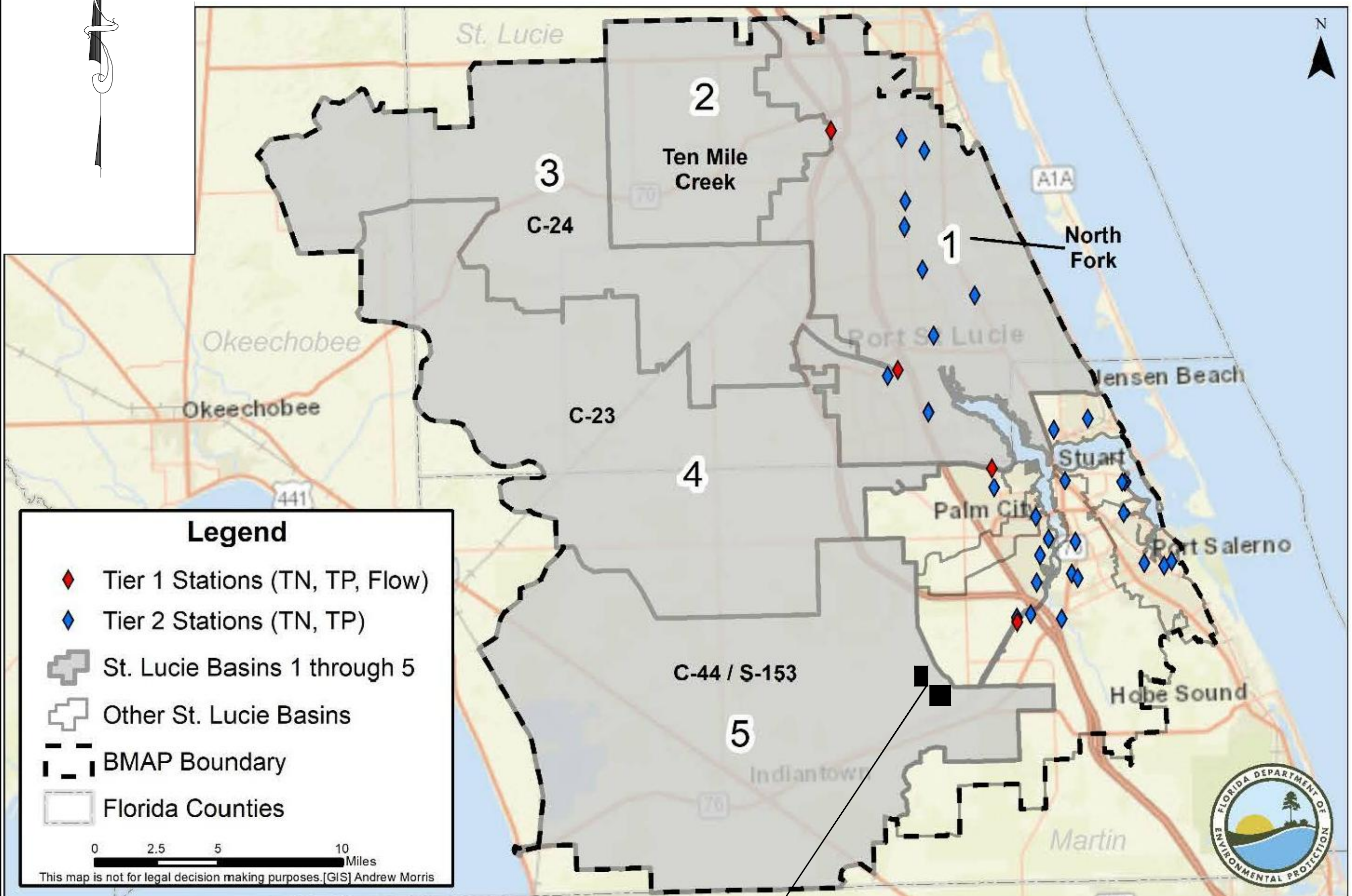
**n/a – the project will not produce waste byproducts.**

14. Provide any additional information the Department should be aware of or should consider. Expand on any relevant topics that were not specifically described in this RFI.

    **The Caulkins-Troup Water Farm proposes a partnership between Caulkins Water Farm and Troup Farm to utilize the Troup property as a water farm. The project proposes to retain approximately two feet of water on the Troup property, routed to the property from the C-44, via the Caulkins Water Farm and a proposed conveyance ditch to the Troup property. The project takes advantage of the existing Caulkins Water Farm C-44 withdrawal facilities and a partially constructed perimeter berm around the Troup property.**

15. Yes or No, Does the interested entity agree that the plans for monitoring, audits and site inspections, which are meant to demonstrate and confirm the project or activities efficacy and reliability, can be prepared in full cooperation with the Department; use EPA or Department standard methods; use only laboratories with National Environmental Laboratory Accreditation Program (NELAP) certification; and that the plan must meet the full approval of the SFWMD?

    **Yes.**




**PROJECT PROPERTY**

| NO. | DATE: | REVISION: | BY |
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CALL 48 HOURS BEFORE YOU DIG 811

DRAWN: A.T.
PROJECT: S0102
FILE: exhibit A.dwg
10-8-19


THE MILCOR GROUP, INC.

CIVIL ENGINEERS
10975 SE FEDERAL HIGHWAY
HOBE SOUND, FL 33455

PH: (772)223-8850
FAX: (772) 223-8851

WWW.THEMILCORGROUP.COM

CERTIFICATE OF AUTHORIZATION: 28246


**LOCATION MAP**

**CAULKINS-TROUP WATER FARM**

MARTIN COUNTY, FLORIDA

MELISSA G. CORBETT
LICENSE
No 59292
Oct 16 2019
STATE OF FLORIDA
PROFESSIONAL ENGINEER

**SHEET NO.**

**T1**


| NO. | DATE: | REVISION: | BY |
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CALL 48 HOURS BEFORE YOU DIG
811

DRAWN: A.T. 10-8-19
PROJECT: S0102
FILE: exhibit A.dwg

THE MILCOR GROUP, INC.
CIVIL ENGINEERS
10975 SE FEDERAL HIGHWAY
HOBE SOUND, FL 33455
PH: (772)223-8850
FAX: (772) 223-8851
WWW.THEMILCORGROUP.COM
CERTIFICATE OF AUTHORIZATION: 28246

AERIAL

CAUKINS-TROUP WATER FARM
MARTIN COUNTY, FLORIDA

MELISSA G. CORBETT
LICENSE
No 59292
Oct 14 2019
STATE OF FLORIDA
PROFESSIONAL ENGINEER

SHEET NO.
T2

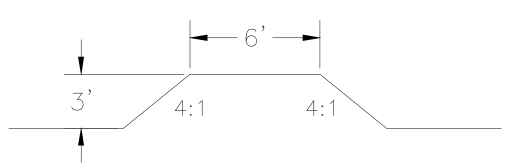

UNMARKED AREAS – UPLANDS WITH NO INUNDATION ANTICIPATED

PERIMETER LENGTH AS SHOWN = @ 37,500'

DEEP WATER STORAGE AREA ±780 ACRES

SHALLLOW WATER STORAGE AREA ±420 ACRES

EXISTING DITCH




TYPICAL PERIMETER BERM SECTION

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CALL 48 HOURS BEFORE YOU DIG 811

DRAWN: A.T. 10-8-19
PROJECT: S0102
FILE: exhibit A.dwg

THE MILCOR GROUP, INC.
CIVIL ENGINEERS
10975 SE FEDERAL HIGHWAY
HOBE SOUND, FL 33455
PH: (772)223-8850
FAX: (772) 223-8851
WWW.THEMILCORGROUP.COM
CERTIFICATE OF AUTHORIZATION: 28246

# CONCEPT SITE PLAN

# CAULKINS-TROUP WATER FARM

MARTIN COUNTY, FLORIDA

MELISSA G. CORBETT LICENSE No 59292 Oct 14 2019 STATE OF FLORIDA PROFESSIONAL ENGINEER

SHEET NO.

T3

J:\S01 Seabranch\water farm addition\exhibit A.dwg, PRINTED BY: Alext ON Mon, Oct 14 2019

| Troup - 2 ft over site | | | | |
|---|---|---|---|---|
| **ITEM** | **Unit Price** | **Units** | **Quantity** | **Total $** |
| Clearing & Grubbing | $1,300.0 | AC | 39.6 | $51,481 |
| Riser/Culvert Inspection, Modifications/Replacement | $1,500.0 | EA | 4.0 | $6,000 |
| Containment Berm Construction (assume exist is 50% intact) | $3.0 | CY | 34,722.2 | $104,167 |
| Seed and Mulch (assume 50% intact) | $1.5 | SY | 95,833.3 | $143,750 |
| Silt Fence | $1.0 | LF | 43,900.0 | $43,900 |
| Pump Station | $50,000.0 | LS | 1.0 | $50,000 |
| Culverts - Double 48" HDPE | $100.0 | LF | 500.0 | $50,000 |
| Turbidity Barrier | $10.0 | LF | 100.0 | $1,000 |
| Emergency Discharge | $50,000.0 | EA | 1.0 | $50,000 |
| Conveyance Ditch | $3.0 | CY | 18,963.0 | $56,889 |
| **SUB-TOTAL** | | | | **$557,186** |
| Engineering Design/Permitting | $155,000.0 | LS | 1.0 | $155,000 |
| Survey, Construction Staking, As-builts | $105,000.0 | LS | 1.0 | $105,000 |
| Density Testing | $105,000.0 | LS | 1.0 | $105,000 |
| Environmental/Wildlife Assessment | $9,500.0 | LS | 1.0 | $9,500 |
| Archeological Assessment | $70,000.0 | LS | 1.0 | $70,000 |
| Phase 1/Phase 2 Environmental Assessment | $10,000.0 | LS | 1.0 | $10,000 |
| Geotechnical Testing | $7,000.0 | LS | 1.0 | $7,000 |
| **GRAND-TOTAL** | | | | **$1,018,686** |

## Troup - Troup Water Farm - Water Farming Project Cost Effectiveness Analysis

10/28/2016
EBV/BG

Owner: Troup
Project Title: Troup Water Farm

Type of Service: Water Farming - Retention & Storage

Interest Rate 0.03 Life Span (yrs) 20

1 metric ton = 2204.6 lbs 1 acre-foot = 325851 gallons

**FIXED FEE AT MAX VOLUME**

| | Year | Project Service Area: acres\1 | Water Retention Estimate: ac ft\2 | Capital Cost\3 | Annual Operation Cost\4 | Annual Maintenance Cost\5 | Annual Participation Payment \6 | Total: | Discount Factor | Annual Discounted Total Costs |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 2019 | 1,900 | 0 | $1,018,686.00 | | | $0.00 | $1,018,686 | 1.000 | $1,018,686 |
| 1 | 2020 | 1,900 | 16,900 | $0.00 | $0.00 | $0.00 | $2,535,000.00 | $2,535,000 | 0.971 | $2,461,165 |
| 2 | 2021 | 1,900 | 16,900 | $0.00 | $0.00 | $0.00 | $2,535,000.00 | $2,535,000 | 0.943 | $2,389,481 |
| 3 | 2022 | 1,900 | 16,900 | $0.00 | $0.00 | $0.00 | $2,535,000.00 | $2,535,000 | 0.915 | $2,319,884 |
| 4 | 2023 | 1,900 | 16,900 | $0.00 | $0.00 | $0.00 | $2,535,000.00 | $2,535,000 | 0.888 | $2,252,315 |
| 5 | 2024 | 1,900 | 16,900 | $0.00 | $0.00 | $0.00 | $2,535,000.00 | $2,535,000 | 0.863 | $2,186,713 |
| 6 | 2025 | 1,900 | 16,900 | $0.00 | $0.00 | $0.00 | $2,535,000.00 | $2,535,000 | 0.837 | $2,123,023 |
| 7 | 2026 | 1,900 | 16,900 | $0.00 | $0.00 | $0.00 | $2,535,000.00 | $2,535,000 | 0.813 | $2,061,187 |
| 8 | 2027 | 1,900 | 16,900 | $0.00 | $0.00 | $0.00 | $2,535,000.00 | $2,535,000 | 0.789 | $2,001,152 |
| 9 | 2028 | 1,900 | 16,900 | $0.00 | $0.00 | $0.00 | $2,535,000.00 | $2,535,000 | 0.766 | $1,942,866 |
| 10 | 2029 | 1,900 | 16,900 | $0.00 | $0.00 | $0.00 | $2,535,000.00 | $2,535,000 | 0.744 | $1,886,278 |
| 11 | 2030 | 1,900 | 16,900 | $0.00 | $0.00 | $0.00 | $2,535,000.00 | $2,535,000 | 0.722 | $1,831,338 |
| 12 | 2031 | 1,900 | 16,900 | $0.00 | $0.00 | $0.00 | $2,535,000.00 | $2,535,000 | 0.701 | $1,777,998 |
| 13 | 2032 | 1,900 | 16,900 | $0.00 | $0.00 | $0.00 | $2,535,000.00 | $2,535,000 | 0.681 | $1,726,212 |
| 14 | 2033 | 1,900 | 16,900 | $0.00 | $0.00 | $0.00 | $2,535,000.00 | $2,535,000 | 0.661 | $1,675,934 |
| 15 | 2034 | 1,900 | 16,900 | $0.00 | $0.00 | $0.00 | $2,535,000.00 | $2,535,000 | 0.642 | $1,627,120 |
| 16 | 2035 | 1,900 | 16,900 | $0.00 | $0.00 | $0.00 | $2,535,000.00 | $2,535,000 | 0.623 | $1,579,728 |
| 17 | 2036 | 1,900 | 16,900 | $0.00 | $0.00 | $0.00 | $2,535,000.00 | $2,535,000 | 0.605 | $1,533,717 |
| 18 | 2037 | 1,900 | 16,900 | $0.00 | $0.00 | $0.00 | $2,535,000.00 | $2,535,000 | 0.587 | $1,489,045 |
| 19 | 2038 | 1,900 | 16,900 | $0.00 | $0.00 | $0.00 | $2,535,000.00 | $2,535,000 | 0.570 | $1,445,675 |
| 20 | 2039 | 1,900 | 16,900 | $0.00 | $0.00 | $0.00 | $2,535,000.00 | $2,535,000 | 0.554 | $1,403,568 |
| Evaluation Metrics/Indicators: | | | | | | | | | | |
| Net Present Value, (NPV @ 3.0%) | | | 338,000 | $1,018,686 | $0 | $0 | $37,714,399 | $38,623,623 | | $38,733,085 |
| Estimated Cost per Acre-Foot of Water Retained: | | | | $3 | $0 | $0 | $112 | $114 | | |
| Percent Breakdown: Est. cost / ac ft.: | | | | 2.6% | 0.0% | 0.0% | 97.6% | 100.0% | | |
| Average Annual Cost: Present worth equivalent: | | | | | | | | $2,596,114 | | |
| Average Annual Cost per Acre: | | | | | | | | $1,366 | | |

Notes: The Costs In Each Column Are Escalated for the Year They Are Shown.

\1 Total project acreage is depicted above.

\2 25th = 36,443; 50th = 60,616; 75th = 80,079 (including sum of rainfall and pumped volume)

\3 Design Under FDACS Cost Share Agreement ($200,000), Construction ($5,205,506.94) and Monitoring Network ($50,000)

\4 Included in Service Payment

\5 Included in Service Payment

\6 Fixed fee per legislative funding.

# Caulkins-Troup Water Farm
# Nutrient Removal Estimate

| | | | | |
|---|---|---|---|---|
| Phosphorus Concentration | 0.345175 mg/l | 2.881E-06 lb/gal | (Average of Caulkins Readings 2018) |
| Nitrogen Concentration | 1.617 mg/l | 1.349E-05 lb/gal | (Average of Caulkins Readings 2018) |

| | Storage Area (ac) | Ave Storage Depth (ft) | Storage Volume (ac-ft) | Estimated Infil Rate (ft/day) | Ac-ft infil/day | ft^3/day | lb-Phosphorus Removal/day | MT Phosphorus Removal | MT Phosphorus Removal @ 45% Efficency | lb-Nitrogen Removal/day | MT Nitrogen Removal | MT Nitrogen Removal @ 45% Efficency |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Deep Storage | 780 | 5 | 3,900 | 0.035 | 27.3 | 1,189,188 | 25.6 | | | 120.0 | | |
| Shallow Storage | 420 | 2 | 840 | 0.035 | 14.7 | 640,332 | 13.8 | | | 64.6 | | |
| Uplands | 500 | 0 | 0 | 0 | 0 | 0 | 0.0 | | | 0.0 | | |
| | | | | Deep Storage | 200 | days pumpage | 5,124.7 | 2.33 | 1.05 | 24,007.1 | 10.89 | 4.90 |
| | | | | Shallow Storage | 200 | days pumpage | 2,759.5 | 1.25 | 0.56 | 12,926.9 | 5.87 | 2.64 |
| | | | | Uplands | 200 | days pumpage | 0.0 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 |

| | | | |
|---|---|---|---|
| Phosphorus Concentration | 0.214 mg/l | 1.786E-06 lb/gal | (FDEP Concentrations) |
| Nitrogen Concentration | 1.43 mg/l | 1.193E-05 lb/gal | (FDEP Concentrations) |

| | Storage Area (ac) | Ave Storage Depth (ft) | Storage Volume (ac-ft) | Estimated Infil Rate (ft/day) | Ac-ft infil/day | ft^3/day | lb-Phosphorus Removal/day | MT Phosphorus Removal | MT Phosphorus Removal @ 45% Efficency | lb-Nitrogen Removal/day | MT Nitrogen Removal | MT Nitrogen Removal @ 45% Efficency |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Deep Storage | 780 | 5 | 3,900 | 0.035 | 27.3 | 1,189,188 | 15.9 | | | 106.2 | | |
| Shallow Storage | 420 | 2 | 840 | 0.035 | 14.7 | 640,332 | 8.6 | | | 57.2 | | |
| Uplands | 500 | 0 | 0 | 0 | 0 | | 0.0 | | | 0.0 | | |
| | | | | Deep Storage | 200 | days pumpage | 3,177.2 | 1.44 | 0.65 | 21,230.7 | 9.63 | 4.33 |
| | | | | Shallow Storage | 200 | days pumpage | 1,710.8 | 0.78 | 0.35 | 11,431.9 | 5.19 | 2.33 |
| | | | | Uplands | 200 | days pumpage | 0.0 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 |

# Caulkins-Troup Water Farm
# Removal Summary

| Caulkins-Troup | | | Nutrient Concentrations - Average of Caulkins WF Sampling (2018) (200 Days Pumpage) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Ave. Annual Cost, Present Worth | Infil vol/day | lb. Phos. Removed/year | cost/lb. Phos. removed | cost/lb. Phos. Removed @45% eff. | lb. Nitrogen Removed | cost/lb. Nitrogen removed | cost/lb. Nitrogen Removed @45% eff. |
| Deep Storage | $2,596,114 | 27.30 | 5,125 | | | 24,007 | | |
| Shallow Storage | | 14.70 | 2,759 | | | 12,927 | | |
| Uplands | | 0.00 | 0 | | | 0 | | |
| **Total** | | 42.00 | 7,884 | $329.28 | $731.74 | 36,934 | $70.29 | $156.20 |

| Caulkins-Troup | | | Nutrient Concentrations - Per FDEP (200 Days Pumpage) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Ave. Annual Cost, Present Worth | Infil vol/day | lb. Phos. Removed/year | cost/lb. Phos. removed | cost/lb. Phos. @45% eff. | lb. Nitrogen Removed | cost/lb. Nitrogen removed | cost/lb. Nitrogen Removed @45% eff. |
| Deep Storage | $2,596,114 | 27.30 | 3,177 | | | 21,231 | | |
| Shallow Storage | | 14.70 | 1,711 | | | 11,432 | | |
| Uplands | | 0.00 | 0 | | | 0 | | |
| **Total** | | 42.00 | 4,888 | $531.12 | $1,180.27 | 32,663 | $79.48 | $176.63 |

| Caulkins-Troup | | | Annual Water Retention | | | |
|---|---|---|---|---|---|---|
| | Ave. Annual Cost, Present Worth | Infil vol/day | Rainfall (ac-ft) | C-44 Pumpage (ac-ft) (200 days) | Cost per Ac-ft Pumped (200 days) | Cost per Ac-ft Pumped + Rainfall |
| Deep Storage | $2,596,114 | 27.30 | 3,900 | 5,460 | 475 | |
| Shallow Storage | | 14.70 | 2,100 | 2,940 | 883 | |
| Uplands | | 0.00 | 2,500 | 0 | | |
| **Total** | | 42.00 | 8,500 | 8,400 | 1,359 | $153.62 |

# THE WATER FARMING PILOT PROJECTS:

## AN EVALUATION OF WATER FARMING AS A MEANS FOR PROVIDING WATER STORAGE/ RETENTION AND IMPROVING WATER QUALITY IN THE INDIAN RIVER LAGOON/ SAINT LUCIE RIVER WATERSHED

## FINAL REPORT

August 17, 2018

The South Florida Water Management District

This project and the preparation of this report was funded in part by a Section 319 Nonpoint Source Management Program Implementation grant from the U.S. Environmental Protection Agency through an agreement (No. G0391) with the Nonpoint Source Management Section of the Florida Department of Environmental Protection. The final total cost of the project was \$3,422,989, of which \$1,506,401 was provided by the U.S. Environmental Protection Agency.

**THE WATER FARMING PILOT ROJECTS:** AN EVALUATION OF WATER FARMING AS A MEANS FOR PROVIDING WATER STORAGE/RETENTION AND IMPROVING WATER QUALITY IN THE INDIAN RIVER LAGOON/SAINT LUCIE RIVER WATERSHED

**FINAL REPORT**

The South Florida Water Management District

with the University of Florida

Mary L. Oakley, Watershed Coordinator, University of Florida

Center for Landscape Conservation Planning

Boyd Gunsalus, Project Manager, South Florida Water Management District

August 17, 2018

This project and the preparation of this report was funded in part by a Section 319 Nonpoint Source Management Program Implementation grant from the U.S. Environmental Protection Agency through an agreement (No. G0391) with the Nonpoint Source Management Section of the Florida Department of Environmental Protection. The original total cost of the project was $3,087,401, of which $1,506,401 was provided by the U.S. Environmental Protection Agency. The final total cost of the project was $3,422,989. The matching funds from the SFWMD increased from $1,581,000 initially (51% of the original total cost) to $1,916,588 (56% of the final total cost).

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## Acronyms and Abbreviations

| | |
|---|---|
| **Ac-ft** | Acre-feet or acre-foot (The amount of water needed to cover one acre one foot deep.) |
| **BMAP** | Basin Management Action Plan |
| **CA** | Cooperative Agreement (Partners for Fish & Wildlife Cooperative Agreement) |
| **CERP** | Comprehensive Everglades Restoration Plan |
| **CFS** | Cubic feet per second (1 cfs = 1.9835 acre-feet per day) |
| **CREP** | Conservation Reserve Enhancement Program (also Florida CREP) |
| **DWM** | Dispersed Water Management (Program or projects) |
| **EPA** | (U.S.) Environmental Protection Agency |
| **ESA** | Environmental Site Assessment |
| **FDACS** | Florida Department of Agriculture and Consumer Services |
| **FDEP** | Florida Department of Environmental Protection |
| **FSA** | Farm Service Agency (of the U.S. Department of Agriculture) |
| **IRCL** | Indian River Citrus League |
| **IRL-S** | Indian River Lagoon—South study or plan (also IRL-S/CERP) |
| **NEEPP** | Northern Everglades and Estuaries Protection Program |
| **NE-PES** | Northern Everglades Payment for Environmental Services Program |
| **O & M** | Operations and Maintenance |
| **PES** | Payment for Environmental Services |
| **RFP** | Request for Proposals |
| **SAS** | Surficial Aquifer System |
| **SFWMD** | South Florida Water Management District |
| **SHA** | Safe Harbor Agreement (through the U.F. Fish and Wildlife Service) |
| **SLE** | St. Lucie River and Estuary (also SLE BMAP) |
| **SJRWMD** | St. Johns River Water Management District |
| **STA** | Stormwater Treatment Area |
| **TMDL** | Total Maximum Daily Load |
| **TN** | Total Nitrogen |
| **TP** | Total Phosphorous |
| **USDA** | U.S. Department of Agriculture |
| **USFWS** | U.F. Fish and Wildlife Service, or the Service |
| **WF** | Water Farm |
| **WFPP** | Water Farming Pilot Project |
| **WQT** | Water Quality Credit Trading |

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## Executive Summary

This is the final report on the results of a multi-year Water Farming Pilot Program jointly funded by the South Florida Water Management District (SFWMD) and the Florida Department of Environmental Protection (FDEP) through a Section 319 Nonpoint Source Management Program Implementation Grant from the U.S. Environmental Protection Agency (EPA). The total initial budget for the Pilot Program was $3,087,401, inclusive of $1,506,401 in Section 319 grant funding from FDEP (for cost reimbursement to the SFWMD) and $1,581,000 in matching funds from the SFWMD. The final costs totaled $3,422,989.[1]

In the pilot program, three *water farms*, totaling 1,373 acres, were each field-tested for 24 consecutive months of operation after an initial period for project design, permitting and construction. Each of the three pilot program participants were allowed up to one year to construct the water farm. This final report provides an overview of the pilot projects (the three water farms) and a summary of the field test findings. Additional details about the pilot projects are available in the technical reports attached (see Appendix B).

*Water Farming* is a term coined by the Indian River Citrus League (IRCL) and adopted by the SFWMD for the previously untested practice of retaining surface water, collected from rainfall and inflows from regional drainage canals and stored on fallow citrus groves. Water farming was conceptualized as a way to reduce freshwater discharges and associated nutrients from the major drainage canals that would otherwise flow into the St. Lucie Estuary. As a water farm is designed to *not* release any water collected and stored on its site, the *nutrients* in the stored water are also retained on site.

Water farming can be done on public or private lands. All three of the water farms in the pilot program are privately owned. The participating private landowners were paid a fee for providing water farming services in a public-private partnership with the SFWMD.

Water Farming was proposed as a way to quickly regain some of the lost surface storage in the St Lucie Watershed to reduce the damaging discharges from the major drainage canals into that coastal estuary. When the Section 319 grant for the pilot program was awarded to the SFWMD by FDEP in August 2013, water farming on fallow citrus groves was the most recent innovation to be tested within the SFWMD’s established Dispersed Water Management (DWM) Program. It is important to remember that Water Farming is considered an interim measure to help provide nutrient reductions and reduce damaging discharges until the Indian River Lagoon South Comprehensive Everglades Restoration Plan can be fully implemented. The DWM Program was launched in 2005 with the implementation of water detention projects on cattle ranches in the Northern Everglades region, some of which were and continue to be funded through the SFWMD's Florida Ranchlands Environmental Services Program and the Northern Everglades Payment for Environmental Services (NE-PES) Program.

The St. Lucie Estuary (SLE) Watershed, on the east coast, is a part of the Northern Everglades region and is adjacent to the inland/central Lake Okeechobee Watershed, as shown in **Figure 5 (**in the Introduction). The SLE Watershed is included in the Northern Everglades and Estuaries Protection Program (NEEPP), a program intended to improve the water quality in the Northern Everglades region. In 2007 the Florida Legislature authorized NEEPP and listed "loss of surface water storage" among the "adverse changes" to the hydrology in the watersheds addressed by the NEEPP which have resulted in water quality problems.[2]

The general goals of the Water Farming Pilot Program were to:

- Reduce the volume of runoff from direct rainfall;
- Reduce regional canal system water volume discharged to the SLE;
- Reduce the load of total nitrogen and total phosphorous to the SLE;
- Monitor and document the costs and benefits; and
- Make an informed decision regarding the future role of water farming.

No two water farms in the pilot program were alike, which provided the opportunity to test the new practice at different scales and in different field conditions. The three water farming pilot projects ranged in size from 60 to 900 acres, each located in a different sub-basin within the SLE Watershed, and all were constructed to retain water of differing maximum depths: either up to two feet or four feet deep. The projects were not launched simultaneously. Instead they became operational, one by one, over a 15-month period, from February 2014 to May 2015. The amount of rain that fell on the project site during each project's 24-month field test was measured and recorded, as part of the standardized water quality monitoring protocol for the pilot program.

The specific goals of the pilot program were to:

- Store an average annual volume of 11,285 acre-feet (combined total water storage for the three water farms);
- Reduce the average annual load of total nitrogen by 27,822 pounds (combined total for the three water farms);
- Reduce the average annual load of total phosphorous by 6,641 pounds (combined total for the three water farms); and
- Retain 100 percent of the onsite rainfall and pumped-in surface waters (from the regional canals) with no offsite discharge of surface water from the water farms back to the regional canals.

**Results.** The water storage and nutrient reduction goals of the pilot program were met and even exceeded. A chief attribute of water farming, the potential for its **rapid implementation**, was confirmed. The site preparation and construction of each of the pilot projects was completed within five months following contract execution. There was no offsite *surface* discharge from the water farms during their 24-month testing period. (The three projects had varying rates of soil infiltration or vertical seepage, which is discussed in Chapter 1, section 1.5.)

The total amount of water stored by the three water farms during their two-year field tests was 46,491.84 acre-feet, which was more than twice the 24-month storage goal for the pilot program of 22,570 acre-feet. (Chapter 1, **Tables 2 and 3**, provides details about performance measures and comparative costs.)

**Nutrient Load Reductions.** The amount of total nitrogen (TN) and total phosphorous (TP) the three pilot projects retained from drainage canal inflows, during their 24-month test period, totaled 140,562 pounds of TN and 22,928 pounds of TP. On an average annual basis, the projects' performance exceeded the goal for TP reduction by 4,823 lbs (or by 72.62 percent) and exceeded the goal for TN reduction by 42,459 lbs (or by 152.61 percent), as is shown in **Table 5** in Chapter 2. The individual contributions of each water farm toward the total load reductions are listed in **Table 6**, as are the unit costs of the nutrient reductions.

The average unit cost of the nutrient reductions on the water farms was found to be only *one percent* of the average unit cost of nutrient reductions provided by 50 non-agricultural projects implemented in the developed areas of the same (SLE) watershed by the city and county stakeholders in the FDEP's St. Lucie River and Estuary Basin Management Action Plan. This finding is reported in Chapter 2, section 2.5.

Funding for a regional expansion of water farming was appropriated by the Florida Legislature in 2016. It was specified in the Appropriations Act[3] that no less than $47,838,034 of the $56,838,034 appropriated shall be used to implement the NEEPP through public-private partnerships for DWM projects on private agricultural lands, including water farming projects.[4] Additional guidance that accompanied the funding included: "Public-private partnerships for water storage and water quality improvements that can be implemented expeditiously shall receive priority consideration for funding."[5] The SFWMD, FDEP and the Florida Department of Agriculture and Consumer Services have been working collaboratively to implement six new DWM projects on 70,087 acres within the Northern Everglades region, including water farming projects totaling 17,520 acres in the SLE and Indian River Lagoon Watersheds. The projects coming on line are listed in **Table 8** in Chapter 3. The new projects list includes a 2,787-acre expansion in the SLE Watershed of one of the water farming participants in the Section 319-funded pilot program: the Caulkins Citrus Company in Martin County. The Caulkins pilot project, a 413-acre water farm, was successfully operated for two years when the funding for expansion was appropriated in 2016.

In addition to implementing the Caulkins 3,200-acre (total) expansion project, which became operational in December 2017, the SFWMD extended the contracts of the other two pilot program participants so that those water farms could also continue to operate beyond the close of their 24-month field testing period.

The Three Water Farming Pilot Projects: Aerial Photographs

The Spur Land & Cattle/Bull Hammock Water Farm (a 60-acre impoundment).

The Caulkins Citrus Company's Water Farm (the initial 413-acre pilot project).

Evans Ideal 1000 Water Farm (the 900-acre project prior to filling, above, then filled, below).

# Introduction

This is the final report on the results of a multi-year Water Farming Pilot Program jointly funded by the South Florida Water Management District (SFWMD) and the Florida Department of Environmental Protection (FDEP) through a Section 319 Nonpoint Source Management Program Implementation Grant from the U.S. Environmental Protection Agency (EPA). In the Pilot Program, three *water farms,* totaling 1,373 acres, were each field-tested for 24 consecutive months of operation after an initial period for project design, permitting and construction. Each of the three pilot program participants were allowed up to one year to construct the water farm. This final report provides an overview of the pilot projects and a summary of the findings. Additional details are available in the technical reports included in Appendix B.

To clarify the terminology used in this report, *pilot program* is used to refer to the entire Section 319 grant-funded Water Farming Pilot Program, which has otherwise been called the Section 319 Water Farming Demonstration Project. The three water farms that were tested in the Section 319 Pilot Program are referred to, interchangeably, as the water farms (WFs) and the pilot projects, or simply the *projects.*

## What is Water Farming?

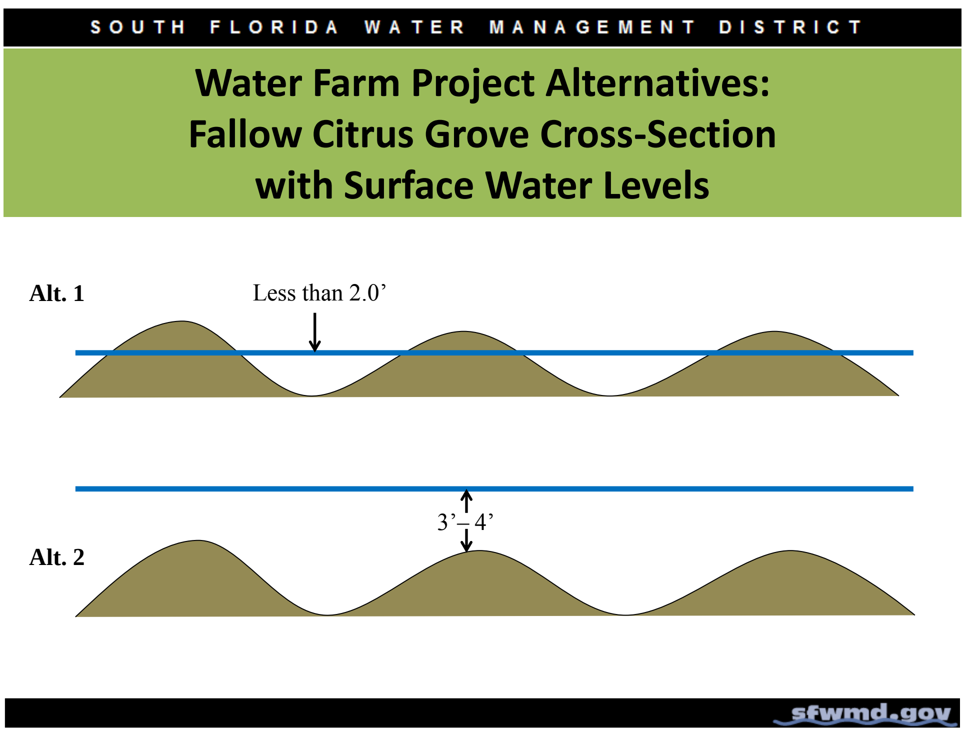
*Water Farming* is a term coined by the Indian River Citrus League (IRCL) and adopted by the SFWMD for the previously untested practice of retaining surface water, collected from rainfall and inflows from regional drainage canals, on fallow citrus groves. Water farming was conceptualized as a way to reduce freshwater discharges from the major drainage canals into the St. Lucie Estuary, which disrupt the salinity balance in the estuary, and to reduce nutrient pollution in the estuary. As a water farm is designed to *not* release any water collected and stored on its site, the *nutrients* in the stored water are also retained on site.

Water farming can be done on public or private lands. All three of the water farms in the pilot program are privately owned. The participating private landowners were paid a fee for providing water farming services in a public-private partnership with the SFWMD.

Two types of water farms were tested, differing by the maximum depth of water they can safely hold. The shallower type, called **Alternative #1**, is intended to make use of the existing farm infrastructure and can store rainfall and some canal inflows to nearly the top of the planting beds,[6] for a maximum depth of up to two feet in the furrows between the planting beds. Alternative 1 type projects are relatively lower-cost to implement, especially if perimeter berms are present. (Many groves in the region have perimeter berms.)

The **Alternative #2** type of water farm requires more capital, for construction, to implement but it can store greater volumes per acre than an Alternative 1 project. Instead of using existing berms, substantial perimeter levees up to seven feet high are constructed to store up to four feet of water above the top of the beds, with six feet of water in the furrows. These standards are in accordance with the SFWMD's criteria for a minor impoundment as defined in the Environmental Resource Permit Applicant's Handbook. **Figure 1**, a cross-sectional drawing of the planting beds and furrows in a citrus grove, depicts the different water levels in the two types of projects (Alt.1 and Alt. 2).

**Figure 1. Water Farm Alternative Scenarios (Surface Water Levels) #1 and #2**



Two of the three water farms were the deeper storage, Alternative 2 type of project: the Caulkins Citrus Company's 413-acre water farm and the Spur Land & Cattle 60-acre water farm. The third pilot project was an Alternative 1: the 900-acre Evans Ideal 1000 water farm. **Figure 2** is an aerial view of Ideal 1000 at its maximum storage depth, which shows that the tops of the planting beds are still visible at full stage. **Figure 3** is an aerial view of the Spur Land & Cattle project at its full stage. In this case the water depth exceeds the top of the planting beds.

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**Figure 2. The Alternative 1 Water Farm at Full Stage (Evans Ideal 1000)**

**Figure 3. An Alternative 2 Water Farm at Full Stage (Spur Land & Cattle)**

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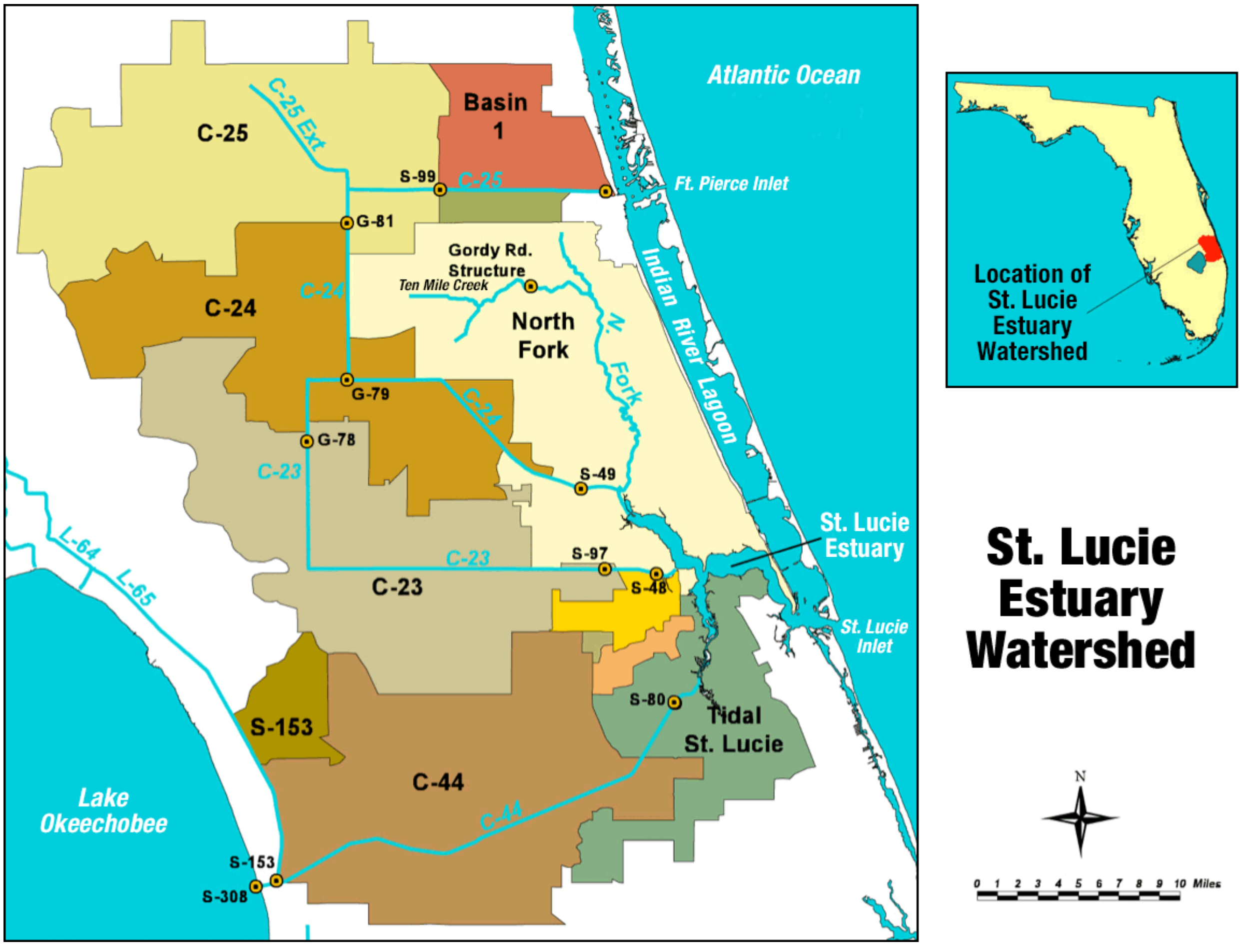
## Project Area Location and Description

The St. Lucie River and Estuary (SLE) Watershed, in which the Section 319 Pilot Program was conducted, is located on the east coast of Florida in a region known as the Treasure Coast and is composed of nearly all of Martin and St. Lucie Counties plus a portion of eastern Okeechobee County.

The SLE is a major tributary to the Indian River Lagoon (IRL)—an estuary of national significance. The IRL is one of 28 designated Estuaries of National Significance in the U.S. and Puerto Rico which are part of the EPA's National Estuary Program.[7]

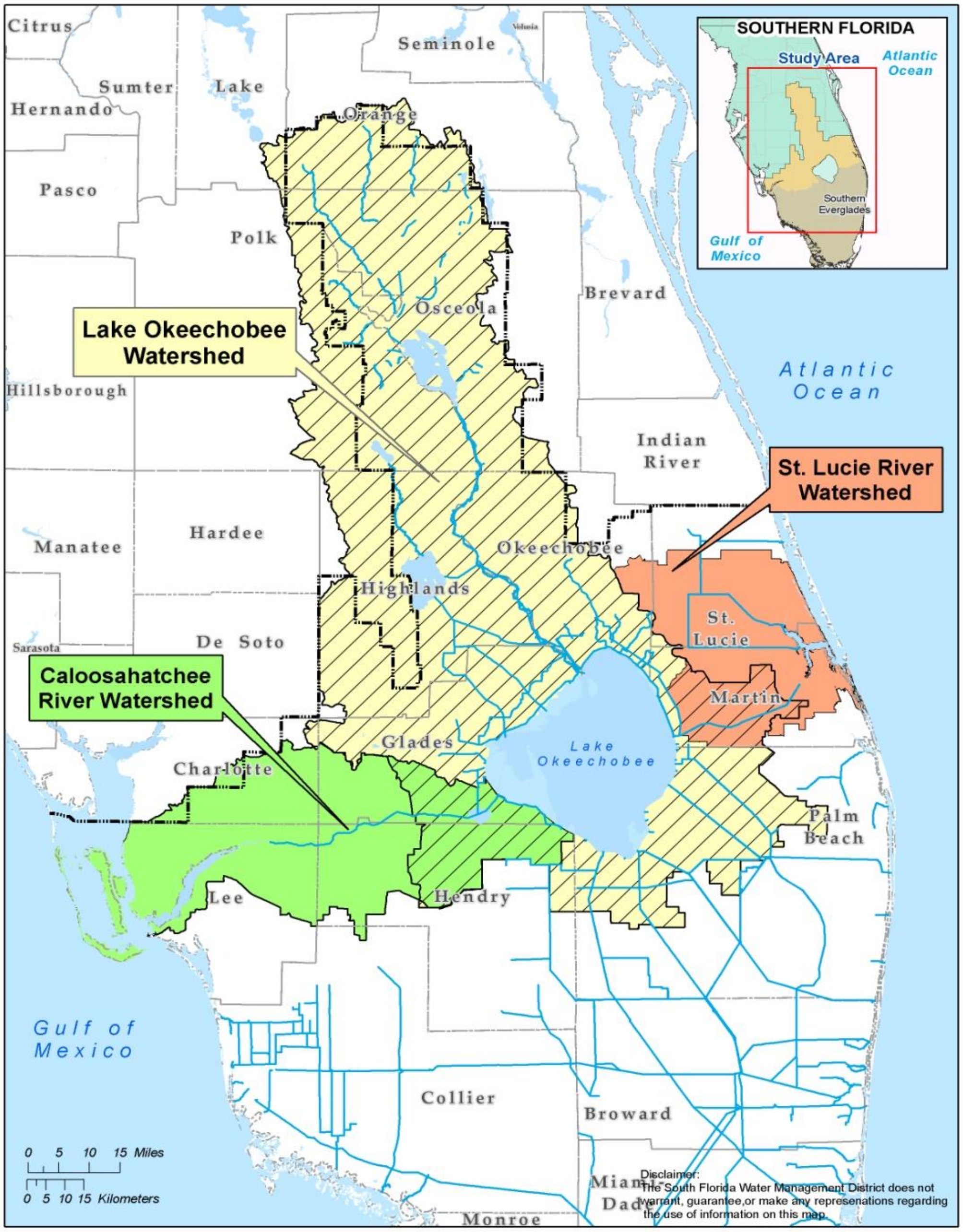
The SLE Watershed covers over half a million acres (537,805 acres)[8] of predominantly agricultural lands. Agricultural land use accounts for 54 percent of the watershed (289,635 acres), urbanized areas cover 19 percent (102,717 acres),[9] and natural areas (wetlands and forests) account for the balance of 27 percent. The SLE Watershed comprises several substantial sub-watersheds, or basins, shown in **Figure 4**.

**Figure 4. The St. Lucie Estuary Watershed: Its State Location and Drainage Basins**




The SLE Watershed is considered to be part of the Northern Everglades and is adjacent to the Lake Okeechobee Watershed, as shown in **Figure 5**. The SLE Watershed is included in the Northern Everglades and Estuaries Protection Program (NEEPP), as are the Caloosahatchee River and Estuary Watershed on the west coast and the centrally located (inland) Lake Okeechobee Watershed.

**Figure 5. Northern Everglades and Estuaries Protection Program (NEEPP) Watersheds**




The NEEPP is intended to improve the water quality in the Northern Everglades. In authorizing the NEEPP, the Florida Legislature listed "loss of surface water storage" among the "adverse changes" to the hydrology in these watersheds which have resulted in water quality problems.[10]

Water Farming was proposed as a way to quickly regain some of the lost surface storage in the SLE Watershed to reduce the damaging discharges from the major drainage canals into the coastal estuaries. Water Farming on privately owned fallow citrus groves was the most recent innovation within the SFWMD's established Dispersed Water Management (DWM) Program, which was launched in 2005.

Unlike most DWM projects, which have been implemented on ranchlands, water farming was proposed to potentially make use of a vast inventory of fallow citrus groves in the SLE Watershed. The citrus industry has been very hard hit by hurricanes and diseases, especially Citrus Greening, or Huanglongbing (HLB). As a result, the Treasure Coast has lost 38 percent of its productive citrus acreage since 2008,[11] the year when citrus greening became widespread in Florida. **Figure 7** is a map of the Treasure Coast, inclusive of the SLE Watershed, which depicts in blue the groves which have become fallow since 2006. The acreage that was still in citrus production as of November 2014 is shown in yellow.

## Engineering Assessments of Water Farms Preceded the 319 Grant for the Pilot Program

Preliminary engineering assessment studies of the water farming concept were completed by AECOM in 2012[12] as a first step. In general, the purpose of the assessment was to gather site information, develop conceptual plans, and evaluate the costs and benefits of enhanced water management activities on fallow citrus groves. The concept of water farming on fallow citrus was developed to investigate the viability of providing (1) varying degrees of modification to existing grove infrastructure for retention of runoff, (2) enhanced water management capabilities to provide storage for flood control and alternative sources of irrigation water supply, and/or (3) nutrient load reductions within the Indian River Lagoon and St. Lucie Estuary Watersheds. Because these options appeared to be cost effective and could be implemented quickly, they were supported by the local water management districts, agricultural agencies and local governments as an interim measure for reducing discharges to the coastal estuary and lagoon. Water Farming may offer a bridge between the current water resource restoration goals and the implementation of large-scale regional projects within the State of Florida, helping to prevent further degradation of Florida's coastal waters.

The SFWMD's award of a Section 319 matching grant in 2013 made it financially feasible to conduct the next step of pilot testing the practice in the field on multiple sites in the SLE Watershed. Three pilot projects were selected by the SFWMD from five respondents to a request for proposals to participate in a water farming pilot program the SFWMD issued in April 2013. The total initial budget for the pilot program was $3,087,401, inclusive of $1,505,401 in Section 319 grant funding from EPA through FDEP and $1,581,000 in matching funds from the SFWMD. The final costs of the projects totaled $3,422,989.[13]

There are four major drainage canal sub-basins (basins) in the SLE Watershed. The C-23, C-24 and C-44 Canals discharge into the SLE. The C-25 Canal discharges directly into the IRL on the northern end of the SLE Watershed. (**Figure 4** shows these basins.) The three water farms in the pilot program are located in each of the three basins with major canals that discharge into the SLE. As shown in **Figure 6**, each water farm is adjacent to a major canal (which are also called *regional* or "C-Canals"). Specifically, from north to south in **Figure 6**:

- Evans (Properties) Ideal 1000 water farm is located along the C-24 Canal in St. Lucie County;
- The Spur Land & Cattle/Bull Hammock water farm is located on the C-23 Canal in Martin County (the label for the C-23 is eclipsed by the asterisk marking the site in Figure 3); and
- The Caulkins Citrus Company's water farm is located on the C-44 Canal, also in Martin County.

**Figure 6. Siting of the Three Water Farms in the St. Lucie Estuary Watershed**

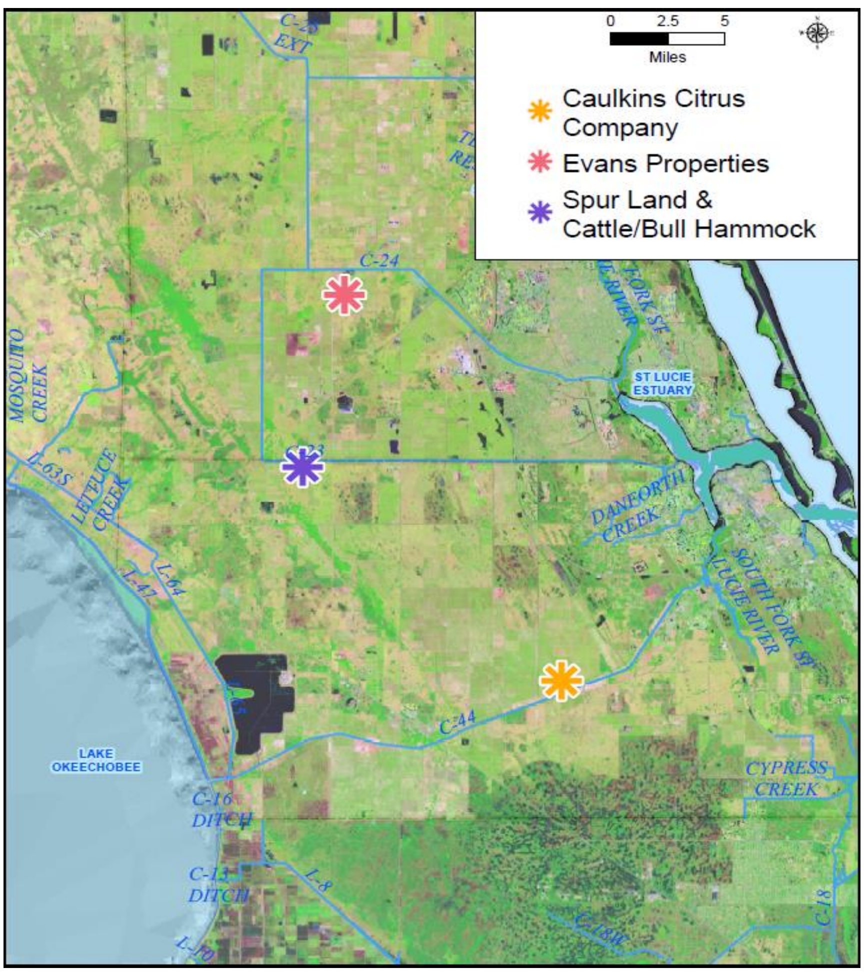
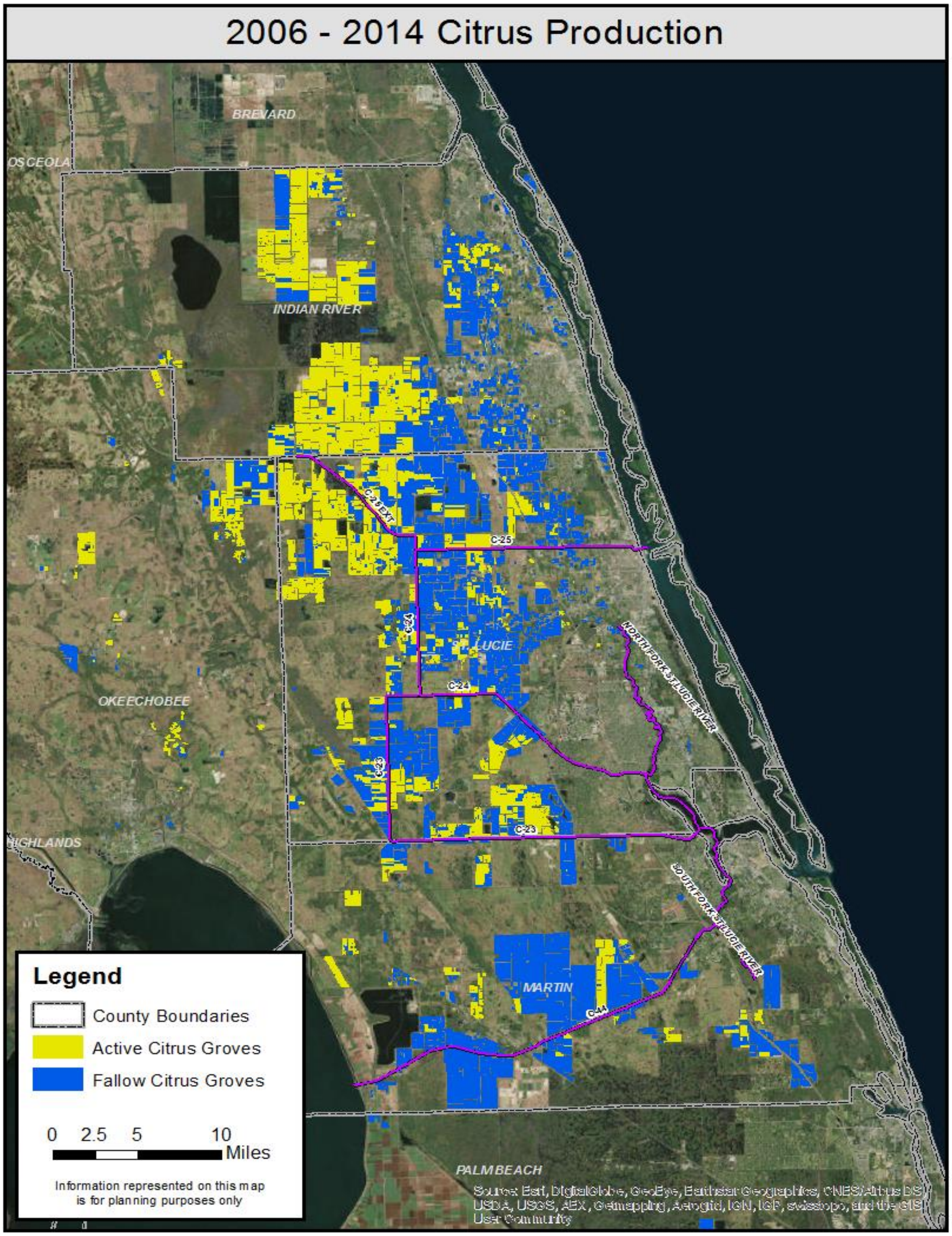


**Figure 7. Loss of Citrus Production in the Treasure Coast of Florida: 2006-2014**



The three projects were placed under contract by the SFWMD one by one, over a 15-month period, and consecutively launched. The first project to begin its 24-month monitored field test, post construction, was the 413-acre Caulkins water farm, which began its operations in February 2014. Spur Land & Cattle, a 60-acre impoundment, was the second project launched, in January 2015. The last and largest project launched, in May 2015, was the 900-acre Ideal 1000 water farm owned by Evans Properties.

Though all three water farms were similar in concept, they all differed in how they function, operate and retain surface waters. These variations provided valuable information to test the water farming concept at different scales and field conditions.

### The General Goals of the Pilot Program

The general goals of the Water Farming Pilot Program were to:[14]

- Reduce volume discharged from direct rainfall;
- Reduce regional canal system water volume discharged to the SLE;
- Reduce the load of total nitrogen and total phosphorous to the SLE;
- Monitor and document the costs and benefits; and
- Make an informed decision regarding the future role of water farming.

There were also measurable performance targets for the three pilot projects, which were included in the SFWMD's application for Section 319 grant funding. Those targets are addressed in Chapters 1 and 2.

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# Chapter 1: Water Storage Results

## 1.1 Water Storage Goal for the St. Lucie River and Estuary Watershed

The surface water storage goal developed for the SLE and IRL after years of study by the SFWMD and the U.S. Army Corps of Engineers addressed the need to reduce damaging discharges to the SLE from the St. Lucie River Watershed, known as *local basin runoff*, which is transported to the SLE largely via the C-Canals (C-23, C-24 and C-44). The water storage goal for the SLE does not address the contribution of discharges from Lake Okeechobee, which has been unnaturally connected to the SLE since the 1920s, when the 25-mile long St. Lucie Canal—also known as the C-44—began its operations as the newly constructed main drainage and navigation outlet from the 730-square mile lake to the east coast. Discharges from Lake Okeechobee are separately addressed in the Comprehensive Everglades Restoration Plan (CERP). The component of CERP which pertains to the SLE is an extensive focal study of the SLE Watershed called the *Indian River Lagoon—South Study*, which offers diagnoses and treatment recommendations for the watershed in the form of prescribed storage and restoration projects.

**A goal of 200,000 acre-feet of added surface water storage** to the SLE Watershed was recommended in the Indian River Lagoon—South (IRL-S) study[15] to reduce the local basin runoff, and that target was incorporated into the SFWMD's St. Lucie River Watershed Protection Program. That storage goal was predicated on the assumption that other CERP projects would be constructed to control Lake Okeechobee discharges.

Water farming has not been proposed as a remedy for the destructive discharges from Lake Okeechobee. The volume and velocity of the lake discharges, when a regulatory release is in effect, are often too great to be pumped into an impoundment fast enough to make an appreciable difference. Yet water farms can help reduce the local basin runoff by increasing surface storage, and there is a large quantified need for that in the SLE Watershed.

## 1.2 Storage Goal for the Water Farming Pilot Program

The SFWMD initially calculated, as part of the application for the Section 319 grant funding, that the combined water storage volume of the three water farming projects would be a total of **11,000 acre-feet per year**. The total was based on the volume estimates for each pilot project which were included in the proposals submitted by the prospective water farmers in response to the SFWMD's Water Farming RFP.

After the first year of operation, the three pilot projects stored a combined total of 24,430 acre-feet: more than twice the 11,000 acre-feet annual estimate. (For individual pilot project storage volumes per year, refer to **Table 2**.)

## 1.3 Storage Goals for Each of the Water Farms

In addition to the aggregate storage goal, there were separate storage goals for each of the pilot projects. The goal for each water farm was calculated using a combination of an objective measure—the *static fill volume* of the particular project—and an estimated multiplier: the number of static volume *refills* each project would likely have, on an average annual basis, based largely on an assessment of the types of soil underlying the project site. The equation for the static fill variable is the impoundment size multiplied by the maximum depth of water the impoundment can hold. For example, a 100-acre impoundment that can store water four feet deep has a static fill volume of 400 acre-feet. Water is lost over time, though, due to evaporation and vertical seepage through the soils. In the field test, each project had opportunities to add more water to the impoundment, through rain and inflows from the canals, to replace water losses. Each time the amount of replacement water added up to the static fill volume, one volume refill was counted.

**Table 1** shows the initial storage goals for each of the pilot projects and the aggregate storage goal for the pilot program overall. The total of the three projects' individual goals exceeded 11,000 (by 285 acre-feet) due to refinements in the storage estimates which were made during the contracting process between the SFWMD and the landowners after the Section 319 grant application was submitted to FDEP.

### Table 1. Water Storage Goals for the Water Farming Pilot Projects

| Project Name, and Impoundment Size | Type of Water Farm, and its Maximum Storage Depth | Static Fill, in Acre-Feet | Estimated Number of Volume Refills | Estimated Annual Storage, in Ac-Ft | Storage Goal for the Two-Year Field Test, in Acre-Feet |
|---|---|---|---|---|---|
| **Caulkins Citrus Company, 413 acres** | Alternative 2, Four feet deep | 1,652 | 4.1 | 6,780 | 13,560 |
| **Spur Land & Cattle/Bull Hammock, 60 acres** | Alternative 2, Four feet deep | 240 | 3.625 | 870 | 1,740 |
| **Evans Ideal 1000, 960 acres** | Alternative 1, Two feet deep | 1,920 | 1.893 | 3,635 | 7,270 |
| **Totals** | | **3,812** | | **11,285** | **22,570** |

The Caulkins Water Farm (WF) was expected to store the most water, among the three pilot projects, even at less than half the acreage of the Evans WF (413 versus 960 acres). The differences in the type of water farm and the expected amount of soil infiltration explain why the storage goal for the Caulkins WF was nearly twice the goal for the Evans WF (6,780 and 3,635 acre-feet, respectively). The Caulkins WF

Alternative 2 project could accept more inflows and impound water higher than the Evans WF Alternative 1 project. The Caulkins WF was sited on deep sandy soils with a higher infiltration rate than the Evans WF, where relatively little and much slower water losses through vertical seepage occurs. The Spur Land & Cattle WF, like the Evans WF, had very limited vertical seepage. What increased the estimated number of volume refills for the Spur Land WF was the plan to allow for wet season overflows from the primary 60-acre impoundment into an adjacent 130-acre slough, contained in a larger impoundment on the property. (The berms surrounding the 60-acre water farm were constructed for the pilot project. The lower berms surrounding the 130-acre slough were previously built on the property at the landowner's expense.) The plan anticipated the benefit of partial hydrological restoration of the dehydrated slough.

### 1.4 Goals vs. Measured Performance: An Overview

**Table 2** provides an overview of the measured performance of the WFs, in comparison with the water storage goals. (**Table 3** offers details on the performance measures and comparative project costs.) **The aggregate two-year storage goal for the Section 319 Pilot Program was met.** In fact, the total amount of storage contributed by the three WFs collectively from their two-year field tests measured *more than double the performance goal*: 46,491.84 acre-feet, shown in **Table 2**, compared to the initial aggregate goal of 22,570 acre-feet, shown in **Table 1**. The volume amount by which each WF's performance went over (or under) the storage goal is listed in the last column of **Table 2**. The Caulkins WF's individual goal exceedance of 21,593.81 acre-feet accounted for 90.26 percent of the goal exceedance of 23,923.84 acre-feet for the Section 319 Pilot Program as a whole.

**Table 2. Water Storage Results of the Water Farms: Goals vs. Measured Performance**

| Project Name | Measured Total Storage (Rain and Inflows): Year 1, in Acre-Feet | Measured Total Storage (Rain and Inflows): Year 2, in Acre-Feet | Measured Total Storage in Two-Year Test, in Acre-Feet | Over or (Under) the Storage Goal, in Acre-Feet |
|---|---|---|---|---|
| Caulkins Citrus Company | 17,688.33 | 17,465.46 | 35,153.79 | 21,593.79 |
| Spur Land & Cattle/Bull Hammock | 824.65 | 758.90 | 1,583.55 | (156.45) |
| Evans Ideal 1000 | 5,917.60 | 3,838.88 | 9,756.48 | 2,486.48 |
| Totals | **24,430.58** | **22,063.24** | **46,493.82** | **23,923.82** |

The rest of the aggregate goal exceedance is attributable to the performance of the Evans WF. The Evans project stored 2,486.48 acre-feet more than its initial two-year storage goal of 7,270 acre-feet. The Spur Land & Cattle WF fell just short of its two-year goal, by 156.45 acre-feet (as shown in **Table 2**), because overflows into the adjacent dehydrated slough did not occur during the 24-month field test. This is further discussed in Chapter 2, section 2.4.

### 1.5 Infiltration on the Caulkins Water Farm

Though the word *storage* is used to refer to the water retention capacity of the pilot projects, the storage goal for the Caulkins WF was exceeded mainly because of the high rate of vertical seepage on its site. Most of the water pumped into the Caulkins impoundment from the adjacent C-44 Canal percolates into a layer of unconfined sand, estimated to be at least 40-feet deep. A high rate of sustained soil infiltration was expected and was factored into the initial storage goal for the project, which was based on achieving 4.1 volume refills per year on average. The actual average number of volume refills the Caulkins WF had during its 24-month field test was 10.64 per year—two and a half times more than predicted. This was due to relatively rapid vertical infiltration into the surficial aquifer system. The high rate of infiltration was immediately apparent. Soon after the field test of the Caulkins WF began, the SFWMD decided to install multiple monitoring wells on the project site to determine where and how fast the infiltrated water was flowing. The question (and concern) was whether or not the water pumped into the water farm from the C-44 Canal was quickly returning to the canal, via subsurface flow.

The SFWMD issued its first annual report on the Caulkins water farm seepage study in September 2015.[16] The District had installed a total of 14 groundwater monitoring wells for the investigation (in October and November 2014 and in February 2015) at depths ranging from nine to 130 feet below land surface. The findings from the first year of the study included an estimate that it would likely take nearly three years for water to return to the C-44 Canal by flowing through the surficial aquifer system (SAS). Specifically:

> Average groundwater flow velocities from the surface reservoir to the C-44 Canal were calculated based on the assumption that most of the flow toward the C-44 Canal occurred through the lower deep portion of the SAS. Based on Kh values of 50 ft/d (the upper end of the Kh range) and using a distance of 900 feet from the southern edge of the WFPP to the C-44 Canal, the resultant velocity and travel time estimate are 0.9 ft/d and 2.7 years, respectively. This travel time may help nutrient reduction by absorbing nutrient pulses within the C-44 Canal and normalizing discharge back to the C-44 Canal over a period of years, and by providing residence time within the SAS to facilitate nutrient adsorption.[17]

The SFWMD continued the seepage study through a second year. The researchers specified that the vast majority of the seepage was vertical (over 90 percent) and estimated that most of the seepage descended into the lower *deep* portion of the SAS then *took an average of eleven years to return to the C-44 Canal*.

> Approximately 47 ac-ft/day (92 percent) of seepage from the impoundment was vertical, and approximately 4 ac-ft/day (8 percent) was lateral into the shallow SAS to the north, west, east, and south perimeter canals. Approximately 99 percent of vertical flow from the impoundment was into the lower deep aquifer…Travel time from the impoundment to the C-44 Canal was calculated assuming most flow toward the C-44 Canal occurred through the lower deep portion of the SAS…[A] travel time of approximately 11 years was estimated as an average for the entire impoundment [to the C-44 Canal]. The southern edge of the impoundment is approximately 900 feet from the C-44 Canal. The estimate for the nearest water in the impoundment [from the southern edge] to reach the C-44 Canal is approximately 3.5 years.[18]

### 1.51 Comparative Recession Rates Among the Three Pilot Projects

An analysis was conducted to compare how quickly the water levels receded within the three water farms. Four time periods were examined during each of the pilot project's 24-month monitoring period[19] (for a total of 12 periods among the three pilot projects). The date ranges of the time periods differed across the three water farms. During all time periods in the analysis, each of which ranged from 10 to 30 days, there was no rainfall and no pumping into the water farm.

It was found that the average daily rate of recession on the Caulkins WF was nearly three times faster than the rate on the Evans WF and nearly four times faster than the rate on the Spur Land & Cattle WF. Specifically, the average daily rate of recession for the Caulkins WF was **0.088** feet per day (based on four time periods totaling 51 days, from August 21, 2014 to March 13, 2016); the average daily rate of recession for the Evans WF was **0.030** (based on four time periods totaling 69 days, from February 25, 2016 to November 4, 2016); and the average rate of recession for the Spur WF was **0.022** feet per day (based on four time periods totaling 85 days, from February 25, 2016 to December 29, 2016). The recession rates analyzed on the Caulkins WF ranged from an average of 0.078' per day, during March 2016, to 0.095' per day (i.e., close to one-tenth of a foot per day) in August 2014. The highest periodic rate on the Evans WF was an average of 0.038' per day in April 2016. For the Spur WF, the highest average rate was 0.027' per day in April/May 2016.

## 1.6 Comparison of Costs and Performance for Water Storage

**Table 3** provides a comparison among the three water farms of the component costs of each project and the unit costs for water storage. The performance values, also shown in **Table 3,** were derived from the water quality monitoring records maintained by the SFWMD for each of the pilot projects. Those values are based on a 24-month period of record, which differs in date range across the three WFs. The starting date of each project's monitoring period, shown in **Table 3**, followed a period of variable length among the projects when the pumps were tested and the monitoring equipment was calibrated. That period was the post-construction *commissioning* phase, during which monitoring data were recorded but not counted in the performance values shown in the tables in this report, including **Table 3**. Similarly, monitoring data recorded after the end of each WF's 24-month monitoring period for the Section 319 Pilot Program were not included in the performance values presented in this report. (The SFWMD elected to extend the contract beyond the two-year field test for all three of the pilot projects, which is discussed in Chapter 3.)

The cost figures shown in **Table 3** are based on a reconciliation of the financial accounting records for the pilot projects, maintained by the SFWMD, and the contracts between the SFWMD and each of the water farmers. The final cost accounting reflected the fact that not all expenses incurred could be reimbursed under the rules for cost-reimbursement in the Section 319 Pilot Program. In some cases, project expenses could not be sufficiently substantiated by a water farmer if, for example, receipts for minor purchases or records for workers' time were not produced. Only the SFWMD's payments to the water farmers, per the allowable and substantiated costs invoiced by the water farmers, were considered in the component and total costs shown for the projects in **Table 3**.

The financial accounting for the Caulkins WF was the most complex of the three for two reasons: 1) It was the only project for which variable expenses for operations and maintenance (O&M) were permitted, whereas the cost of O&M was covered for the other two projects in one fixed-fee annual service payment; and, 2) the contract for the Caulkins WF was amended four times during the pilot program for the purpose of increasing the amount of the allowable payments, and the total contract price, by mutual agreement between the SFWMD and the Caulkins Citrus Company. The main reason for the multiple cost increases was the fact that the project continued to pump in more C-44 Canal water than expected and, as a result, incurred greater operating expenses than anticipated. (The Caulkins WF's 24-month monitoring period coincided with prolonged regulatory releases from Lake Okeechobee into the C-44 Canal.) The allotted amount for construction was also increased to raise the design-height of the perimeter berms from six to seven feet in order to meet the Florida Environmental Resource Permit Volume IV criteria for a minor impoundment. The contracted price increases for the Caulkins WF brought the total cost of that project (**Table 3** variable 3a) to $1,785,432, which is $521,796 more than the initial not-to-exceed contract price of $1,263,363 (**Table 3** variable 3b).

The total cost of the two other water farms—the initial capital for construction and the two annual fixed payments inclusive of O&M and a landowner's participation, or service, payment—matched their initial not-to-exceed contracted totals, which were $1,392,117 for Evans and $245,440 for Spur Land & Cattle, as shown in **Table 3**. One cost-neutral transfer between two expense categories was made in the single contract modification for Evans: After the site preparation (capital) costs came in $11,334.91 under the budget, the operations budget was increased by that exact amount to allow for additional pumping of offsite inflows to increase storage.

**Table 3. Pilot Project Comparisons: Component Costs and Unit Costs for Water Storage**

| Project Costs and Performance | Caulkins Citrus Company | Spur Land & Cattle | Evans Ideal 1000 |
|---|---|---|---|
| Size of Primary Impoundment | 413 acres | 60 acres | 960 acres |
| **1. Capital: Start-Up Costs/Construction** | | | |
| 1a. Planning, Design and Permitting | $3,303[1] | $25,209 | $47,299 |
| 1b. Site Development and Certification | $361,606 | $110,791 | $259,146 |
| 1c. Total Capital Costs (Non-recurring) | **$364,909** | **$136,000** | **$306,445** |
| **2. Recurring: Annual Operating Costs** | | | |
| 2a. Operations & Maintenance and Annual Participation Payment, per Year | $710,261 | $54,720 | $542,836 |
| 2b. Total Operating Costs for Two Years | **$1,420,523** | **$109,440** | **$1,085,672** |
| | | | |
| **3a. Total Pilot Project Costs** (1c + 2b) | **$1,785,432**[2] | **$245,440** | **$1,392,117** |
| 3b. Initial Contracted Total Cost | $1,263,636 | $245,440 | $1,392,117 |
| **Monitoring Record: 24-Month Period** | **7/05/14-7/04/16** | **1/01/15-12/31/16** | **5/15/15-5/14/17** |
| **4. Measured Water Storage** | **Acre-Feet** | **Acre-Feet** | **Acre-Feet** |
| 4a. Year 1 Inflow Volume Retained | 16,418.01 | 617.95 | 1,900.00 |
| 4b. Year 2 Inflow Volume Retained | 15,395.30 | 495.30 | 554.08 |
| 4c. **Total Canal Inflows** (24-Months) | **31,813.31** | **1,113.25** | **2,454.08** |
| | **Acre-Ft (Inches)** | **Acre-Ft (Inches)** | **Acre-Ft (Inches)** |
| 4d. Year 1 Rainfall Retained | 1,270.32 (36.91") | 206.70 (41.34") | 4,017.60 (50.22") |
| 4e. Year 2 Rainfall Retained | 2,070.16 (60.15") | 263.60 (52.72") | 3,284.80 (41.06") |
| 4f. **Total Rainfall Retained** (24-Months) | **3,340.48** (97.06") | **470.30** (94.06") | **7,302.40** (91.28") |
| 4g. **24-Month Total: Inflows & Rainfall** | **35,153.79** | **1,583.55** | **9,756.48** |
| 4h. 24-Month Storage Goal | 13,560 | 1,740 | 7,270 |
| **5. Unit Costs for Water Storage** | | | |
| 5a. Cost per Acre-Foot[3] (2-Year Actual) | $50.79/ac-ft | $154.99/ac-ft | $142.69/ac-ft |
| 5b. Longer-term [4] (10-Year Estimate) | $42.48/ac-ft | $86.29/ac-ft | $117.56/ac-ft |

[1] In addition to this reimbursement, the Caulkins Citrus Company reported it had paid $50,000 for a preliminary engineering design (for which the company was not reimbursed as the expense was insufficiently substantiated).

[2] This total includes public (SFWMD) payments only. It does not include the start-up expenses the Caulkins Citrus Company paid privately. The company initially reported a total contribution of $177,391 ($50,000 for design plus $127,391 for site development). About $68,000 of the company's total, unreimbursed contribution was sufficiently substantiated by the SFWMD.

[3] Based on the total public cost of the pilot project (variable 3a) divided by total rainfall and canal inflows retained over the 24-month monitoring period (variable 4g).

[4] Ten-year unit cost projection/estimate equation: Total initial capital costs + total annual operating costs (no inflation factors) x 10 (years), divided by the average annual total water retention (per the 2-year record) x 10.

The increased costs of the Caulkins WF, via the contract amendments, made it the most expensive of the three WFs to construct and operate, in terms of total dollar outlay. (The Evans WF had the highest total contract price at the start of the pilot program. It exceeded the *initial* contract price for the Caulkins WF by $128,481.) On the basis of the *unit* cost for water storage, however, the Caulkins WF was the most cost-effective of the three projects because of its exceptional performance.

For instance, the final total cost of the Caulkins WF exceeded the total cost of the Evans WF by 22.03 percent, but the Caulkins WF stored 360.31 percent more water (inflows and rain) than the Evans WF. The cost per acre-foot of water stored in the two-year test (the unit cost, variable 5a in **Table 3**) for the Caulkins WF was about one-third of the unit cost of the other two projects. Specifically, the unit cost for storage was $50.79 per acre-foot for the Caulkins WF, $154.99 per acre-foot for the Spur Land WF and $142.69 per acre-foot for the Evans WF, as shown in **Table 3**.

The "total benefit" provided by each of the three Water Farming Pilot Projects was estimated by adding the total volume of water pumped into the project and the rainfall retained on-site. The "total benefit" does not account for the pre-project (baseline) condition to estimate the "net benefit" of each project. However, future DWM projects, including, water farm projects, will be evaluated using the net benefit which is the difference between the estimated average annual volume stored within the project versus the average annual volume stored in the existing pre-project (baseline) condition."

### 1.61 Long-Term Unit Costs (Ten-Year Estimates)

The unit cost for water storage would decrease in the longer term for all three projects, based on a ten-year projection shown in **Table 3**. The Spur Land WF would have the largest reduction in unit cost: a 44.32 percent drop, from $154.99 in the two-year test to $86.29 per acre-foot in the 10-year estimate. The decrease in longer-term unit costs for the Caulkins and Evans projects would be less than half the drop projected for the Spur Land WF: a 16.36 percent reduction (to $42.48) for the Caulkins WF and a 17.61 percent reduction (to $117.56) for the Evans WF. The annual costs and average annual performance of the projects, based on the two-year field test results for each, were held constant in the projection estimates.

### 1.62 Comparison of Rainfall

The SFWMD intended to field test two different types of water farms, the Alternative 1 and 2 projects, in a variety of site conditions. Each project was located in a different sub-basin within the St. Lucie River Watershed, the soils underlying the projects differed, and the projects were launched one at a time over a period of more than a year, exposing each to variable weather conditions during their two-year field tests.

There were substantial differences in the amount of rainfall recorded in year one and year two for each of the projects (the Caulkins WF, for example, had 23 more inches of rain in its second year than in its first year), and there were large differences across the projects in annual rainfall amounts, such as 19.09 fewer inches in the second year for the Evans WF than in the second year for the Caulkins WF, as shown in **Table 3**. However, the variance in the total amount of rainfall at the end of two years was no more than six percent, across the three WFs. All three had over 90 total inches of rain, differing by 5.78 inches from the project that experienced the most (the Caulkins WF, with 97.06 inches) and the least (the Evans WF, with 91.28 inches).

### 1.7 Ancillary Costs: Environmental Site Assessments and Water Quality Monitoring

Limited Phase I and Phase II Environmental Site Assessments (ESAs) were conducted on all three water farm sites prior to construction, which resulted in remediation on two of the project sites: the Evans WF and the Spur WF. Copper was detected in the soil on approximately five percent of the Evans Ideal 1000 WF and on approximately 33 percent of the Spur Land & Cattle WF. It was later confirmed on the Ideal 1000 WF that the project site preparations, such as grading which mixed and inverted the affected soil, resolved the problem. On the Spur WF, however, copper was still detected upon retesting after initial remediation. Inverting the affected soil *again* resolved the problem. The costs for environmental assessment, including the necessary retesting, and remediation totaled $29,647.52 for the Spur WF, $10,490.19 for the Evans WF and $0 for the Caulkins WF, as no remediation was necessary there.

For water quality monitoring, the capital cost to build a walkway and platform for the auto-sampler and gauges was between $15,000 and $15,672 on each of the three project sites. The cost of the outsourced service to collect the water quality samples on all three project sites for the 24 months totaled $31,789.[20]

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# Chapter 2: Nutrient Reduction Results

## 2.1 Nutrient Reduction Goal for the Water Farming Pilot Program

The nutrient reductions for the water farming pilot projects were estimated by the SFWMD staff as one value for the three pilot projects combined, as shown in **Table 4**, which is a copy of a table completed by the SFWMD staff for the Section 319 grant application. *Because the intent was to have zero discharge from the water farms* except, possibly, in an extreme weather event (each project site would have an emergency overflow release structure in case of a severe hurricane, for instance), the nutrient load reduction/retention efficiency rate of the projects was estimated to be 97 percent during the 24-month operational period of the projects. If no allowance was made for the possibility of some discharge during extreme weather occurrences over the course of two years, a 100 percent efficiency rate would have been proposed for the projects. The premise was that if none of the water stored in the water farms would be released through surface discharge, then none of the nutrients in the stored water would be released. (*Zero water discharge meant zero nutrient discharge*, thus a 100 percent nutrient reduction potential under normal operating conditions.)

Most of the water stored in the water farms was stormwater runoff pumped in from the regional drainage canals, which discharge to the St. Lucie Estuary. One of the primary benefits of the water farming concept, in the context of the Section 319 grant-funded pilot program, was the potential to retain nutrients on the water farms that would otherwise contribute to the pollutant load in the FDEP verified-impaired SLE. An added benefit, in the broader context of regional Everglades restoration, was the potential for the water farms to also reduce the volume of salinity-balance-disrupting *freshwater* discharged to the estuary.

**The three water farms retained 100 percent of the rainfall and the pumped surface waters (from canals) during their 24-month test period with no offsite discharges.** To estimate the pre-project pollutant loads and the post-project load reductions listed in **Table 4**, the SFWMD staff used the locally documented Event Mean Concentrations (EMC) for citrus land uses for the C-23, C-24 and C-44 basins (per each pilot project location) for total nitrogen (TN) and total phosphorous (TP). The EMCs referenced were from Appendix A of the St. Lucie River Watershed Protection Plan, 2012 Update. **The SFWMD estimated, as a goal, that the demonstration project would achieve a nutrient reduction of 6,641 pounds of TP and 27,822 pounds of TN per year, on average, as shown in Table 4**, based on a 97 percent efficiency rate of the projects**.** This meant that the Section 319 Pilot Program could result in a total reduction of 13,282 pounds of TP and 55,644 pounds of TN by the end of the two-year field test of the three water farming pilot projects.

**Table 4. Initially Estimated Load Reductions for the Water Farming Pilot Program**

| BMPs Installed<br>BMP #1 | | TSS<br>lbs/yr | TP<br>lbs/yr | TN<br>lbs/yr |
|---|---|---|---|---|
| Pollutant Loads | Pre-Project | 252,358 | 6,839 | 28,655 |
| | Post-Project | 7,334 | 198 | 833 |
| | Load Reduction | 245,024 | 6,641 | 27,822 |
| | % Reduction | 97 | 97 | 97 |

The SFWMD's estimate of pre-project Total Suspended Solids (TSS) was based on a general EMC for TSS for citrus land use in Florida.[21] **The total annual reduction in TSS was estimated to be 245,024 pounds.** This meant that the pilot program could result in a total load reduction of close to half a million pounds of TSS (490,048 pounds) by the end of the two-year test of the three water farming pilot projects.

## 2.2 Water Quality Monitoring Equipment and Sampling Protocols

Each of the pilot projects had an automatic sampler installed to collect surface water quality data from the pump inflows for the 24-month operational timeframe. Rain gauges were installed to measure direct rainfall retained on the WF sites. The volume of water pumped into the water farms from a canal was measured via calibrated inflow pumps. Each landowner kept a daily log of how long the inflow pumps ran, on the days when the pumps were turned on, so that the volume of inflows could be calculated based on the run time. The nutrient (TN and TP) concentrations measured at the pump intake areas[22] were multiplied by the volume of the pump inflows (in cubic feet per second) for the measurement of the nutrients retained on each WF (daily material load). If any water releases occurred, the discharge(s) from the WF would be monitored and recorded.

Measurements of TSS on the water farms were collected manually by *once-weekly grab samples*, unlike the more frequent sampling for nutrient concentrations based on timed collections at three-hour intervals by the auto-samplers every day the inflow pumps were running. The weekly grab samples of TSS were to be taken only if the inflow pumps were on or had been running during the past seven days. The grab samples for TSS were taken from the same source of water that the auto-sampler received.

### 2.3 The Pilot Program Goals vs. Measured Performance: An Overview

The measured nutrient load reductions, for TP and TN, exceeded the estimated initial reductions target. The values given for "Actual Annual Load Reduction," shown in **Table 5**, are an average annual value, per the sum of the measured reductions for all three of the water farms during their 24-month test periods divided by two, for a 12-month total. At the end of the two-year test period, the three pilot projects combined had retained from canal inflows a total of 22,928 pounds of TP and 140,562 pounds of TN. On an average annual basis, the projects' performance exceeded the goal for TP reduction by 4,823 lbs (or by 72.62 percent) and exceeded the goal for TN reduction by 42,459 lbs (or by 152.61 percent), as shown in **Table 5**. The individual contributions of each WF toward the total load reduction of the Section 319 Pilot Program are listed in **Table 6**.

**Table 5. Aggregate Nutrient Load Reductions: Target vs. Measured Performance**

| | TP<br>Pounds per Year | TN<br>Pounds per Year |
|---|---|---|
| **Target Annual Load Reduction[5]** | 6,641 | 27,822 |
| **Measured Annual Load Reduction[6]** | 11,464 | 70,281 |
| **Difference Between Target and Measured Performance** | 4,823 lbs/year over the target<br>**(Goal exceedance: +72.62%)** | 42,459 lbs/year over the target<br>**(Goal exceedance: +152.61%)** |

### 2.4 Comparison of Nutrient Reduction Performance

The nutrient reductions on the water farms were a product of the nutrient concentrations measured in the inflows from the canals and the volume of the inflows. The pilot projects with greater inflows were more likely to have greater nutrient reductions, although average nutrient concentrations vary among C-Canals (as shown in **Table 7**). *Retained rainfall did not factor into the nutrient reductions, only pumped inflows.*

The Caulkins WF stored the most water and retained the most nutrients by far, of the three pilot projects. As shown in **Table 6**, the 24-month total nutrient reductions for the Caulkins WF were 8.023 metric tons

[5] From the initial Load Reduction estimates shown in Table 4.

[6] Average annual reductions shown in Table 5 are the measured 24-month total reductions, for the three water farms combined, divided by two. The 24-month aggregate reduction was 140,562 pounds TN and 22,928 lbs TP.

of TP and 53.988 metric tons of TN. The Evans WF came in second in nutrient reduction performance with 1.644 metric tons of TP and 6.978 metric tons of TN retained in 24 months.

Despite the larger size of the Evans WF, it was at a relative disadvantage for nutrient reductions because it was designed to mainly retain rainfall that fell on the project site. Only when extra storage capacity was available would surface water from the adjacent St. Lucie County ditch be pumped into the water farm. The Evans WF's performance was also affected by the exceptionally *dry* wet season in which operations began. Although the Evans WF was ready to accept initial inflows in May 2015, the pump was not turned on until August 20, 2015 because there was no surplus water in the regional system to pump into the WF before then. Not unexpectedly, the Evans WF had even less canal inflow volume in its second year (554 acre-feet in year two vs. 1,900 acre-feet in year one, as shown in **Table 3**) because pumping was supposed to apply mainly toward the first-time fill-up, right after the WF's launch, and to merely supplement rainfall retention, if necessary and appropriate.

The performance of the Spur Land & Cattle WF was less than it most likely would have been had overflows occurred from the 60-acre primary impoundment into the adjacent 130-acre slough (contained in a separate impoundment). The slough's headwaters were severed long ago when the regional C-23 Canal was constructed. Occasional overflows during the wet season would have helped rehydrate the slough, providing the environmental benefits of hydrological restoration and wildlife habitat enhancement. Occasional overflows would have also created capacity for more inflows directly from the C-23 Canal, to refill the primary impoundment.

The original design for the Spur Land WF was to be able to pull water from either the West Dike Canal (a drainage canal that discharges directly into the C-23 Canal) or from the C-23 Canal. It was soon realized that the canal stages for the C-23 Canal were not high enough to prevent over drainage of the West Dike Canal. As a result, water could only be removed from the West Dike Canal. To solve this problem, the landowner of the Spur WF worked with the Florida Department of Agriculture and Consumer Services on a cost sharing agreement to install a set of riser culverts in the West Dike Canal (just upstream of the C-23 Canal outfall), which allows for water to be withdrawn from the West Dike Canal or the C-23 Canal independently of each other. These culverts were installed at the end of Spur Land's two-year operational agreement for the pilot program. The Spur WF monitoring data for 2017 (partial year) indicate that more water had been pumped into the water farm already in 2017 than in the previous two years as a result of the on-site improvements for operational flexibility.

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**Table 6. Pilot Project Comparisons: Nutrient Load Reductions and Unit Costs**

| Project Costs and Performance | Caulkins Citrus Company | Spur Land & Cattle | Evans Ideal 1000 |
|---|---|---|---|
| Size of Water Farm Impoundment | 413 acres | 60 acres | 960 acres |
| **Monitoring Record:** 24-Month Period | 7/05/14-<br>7/04/16 | 1/01/15-<br>12/31/16 | 5/15/15-<br>5/14/17 |
| Total Pilot Project Costs[7] | $1,785,432 | $245,440 | $1,392,117 |
| Total Canal Inflows (24-Months)<br>in Acre-Feet | 31,813.31 | 1,113.25 | 2,454.08 |
| **1. Nutrients Retained from Canal Inflows, in Metric Tons (and Pounds)** | **MT<br>(LB)** | **MT<br>(LB)** | **MT<br>(LB)** |
| 1a. Year 1 Total Phosphorous (TP) | 3.339 MT TP<br>(7,361 lbs) | 0.317 MT TP<br>(698 lbs) | 1.204 MT TP<br>(2,654 lbs) |
| 1b. Year 2 Total Phosphorous (TP) | 4.684 MT TP<br>(10,326 lbs) | 0.417 MT TP<br>(919 lbs) | 0.440 MT TP<br>(970 lbs) |
| **1c. Total Phosphorous Retained in 24-Months** | **8.023 MT TP<br>(17,687 lbs)** | **0.734 MT TP<br>(1,617 lbs)** | **1.644 MT TP<br>(3,624 lbs)** |
| 1d. Year 1 Total Nitrogen (TN) | 26.761 MT TN<br>(58,998 lbs) | 1.472 MT TN<br>(3,245 lbs) | 5.547 MT TN<br>(12,229 lbs) |
| 1e. Year 2 Total Nitrogen (TN) | 27.227 MT TN<br>(60,025 lbs) | 1.320 MT TN<br>(2,910 lbs) | 1.431 MT TN<br>(3,155 lbs) |
| **1f. Total Nitrogen Retained in 24-Months** | **53.988 MT TN<br>(119,023 lbs)** | **2.792 MT TN<br>(6,155 lbs)** | **6.978 MT TN<br>(15,384 lbs)** |
| **2. Unit Costs for Nutrient Reductions** | **Caulkins** | **Spur Land** | **Evans[8]** |
| 2a. Cost per Pound of TP Reduced (Two-Year Actual) | $100.95/lb. TP | $151.79/lb. TP | $384.14/lb.TP |
| 2b. Longer-Term[9] Unit Costs for TP Reductions (10-Year Estimate) | $84.44/lb. TP | $84.50/lb. TP | $316.49/lb. TP |
| 2c. Cost per Pound of TN Reduced (Two-Year Actual) | $15.00/lb. TN | $39.88/lb. TN | $90.49/lb. TN |
| 2d. Longer-Term Unit Costs for TN Reductions (10-Year Estimate) | $12.55/lb. TN | $22.20/lb. TN | $74.55/lb. TN |

[7] Per variable 3 in Table 3 (includes total initial verified capital costs and two years of payments for operations).

[8] Because nutrient concentrations were measured only in the water pumped into the water farms from canals, not in the rainfall or runoff retained, the Evans project is at a disadvantage in a comparison of unit costs for nutrient reductions with the "Alternative 2" projects, which were designed to accept more canal inflows.

[9] Ten-year unit cost projection/estimate equation: Total initial capital costs + total annual operating costs (no inflation factors) x 10 (years), divided by the average annual pounds of nutrients retained (TP, TN) x 10 (years).

As the smallest water farm and the one with the slowest rate of vertical seepage, or soil infiltration, the nutrient reduction totals of the Spur WF ranked third among the three projects. During its 24-month test period, the Spur WF retained a total of 0.734 metric tons of TP (1,617 pounds) and 2.792 metric tons of TN (6,155 pounds), as shown in **Table 6**.

The mean and range of nutrient concentrations measured in the canals from where the projects withdrew their inflows, during each of the project's 24-month monitoring period of record, are listed in **Table 7**. The Caulkins WF drew its inflows from the C-44 Canal, which had the *lowest* average, minimum and maximum concentrations of TN and TP compared to canal inflows for the two other pilot projects.

**Table 7. Nutrient Concentrations in Canals During the Testing Period**

| **Concentrations in Each Water Farm's 2-Year Monitoring Record** | Caulkins Citrus Company: **C-44 Canal** | Spur Land & Cattle: **C-23 Canal** | Evans Ideal 1000: **St. Lucie County Canal**[10] |
|---|---|---|---|
| Measurement of Concentrations | Milligrams per Liter | Milligrams per Liter | Milligrams per Liter |
| | | | |
| **Average TN** Concentration | **1.319** | **1.946** | **2.129** |
| **Minimum TN** Concentration | 0.966 | 1.380 | 1.590 |
| **Maximum TN** Concentration | 2.630 | 3.280 | 3.900 |
| **Average TP** Concentration | **0.179** | **0.459** | **0.489** |
| **Minimum TP** Concentration | 0.085 | 0.129 | 0.280 |
| **Maximum TP** Concentration | 0.651 | 1.194 | 1.000 |

## 2.5 Comparison of Unit Costs for Nutrient Reductions

The costs per pound of nutrients retained, or reduced, during the two-year test and estimated in a ten-year projection are listed for each pilot project at the bottom of **Table 6**. The unit costs are based on the *total* project costs: the initial verified capital costs and two years of participation payments for operations). As cost-effectiveness has tracked with performance, the project with the largest nutrient reductions also had the lowest unit costs for reductions: the Caulkins WF. The cost per pound of TP reduced during the two-

[10] The St. Lucie County drainage canal, which bisects the Evans Ideal 1000 grove, flows into the C-24 Canal.

year test, in comparison with the Caulkins WF's unit cost of $100.95 per pound, was 1.5 times higher for the Spur WF (at $151.79/pound) and 3.8 times higher for the Evans WF (at $384.14/pound).

The relative cost-effectiveness of the Caulkins project is even more pronounced for TN reductions. The cost per pound of TN during the two-year test, in comparison with Caulkins' unit cost of $15 per pound, was 2.6 times higher for Spur ($39.88/pound) and *six* times higher for Evans ($90.49/pound). Nutrient concentration levels factor into the unit cost comparisons. Though the average concentration was lowest for Caulkins for both TP and TN, there was a greater difference for TP than for TN, as shown in **Table 7**. The average concentration for TP was at least 2.5 times higher for the other two projects, whereas the average TN concentration was between 1.47 and 1.61 times higher than Caulkins for the Spur and Evans projects, respectively. *The unit cost advantage of the Caulkins WF for nutrient reductions would have been even greater if the C-44 Canal had higher average concentrations instead of the lowest in **Table 7**.*

In the ten-year projections for unit costs, the Caulkins WF loses its advantage over the Spur WF for TP reductions: both projects have a comparable cost of just over $84 dollars per pound of TP. Although the longer-term unit costs are lower than the two-year costs for all projects, the relatively low annual cost of the Spur project makes it increasingly more economical over time, on a unit cost basis, for performance.

The longer-term unit costs for nutrient reductions shown in **Table 6** range from $12.55 per pound of TN, for Caulkins, to $316.49 per pound of TP, for Evans. The average ten-year unit cost for all three projects for nutrient reductions was approximately only ***one percent*** of the adjusted average unit cost for nutrient reductions for 50 non-agricultural projects implemented by the city and county stakeholders participating in FDEP's St. Lucie River and Estuary Basin Management Action Plan (BMAP), in the same watershed as the water farming pilot projects. A summary of the costs of those 50 non-agricultural projects can be found in **Appendix A.**

The cost data available for the 50 nutrient-reduction projects did not include operations and maintenance, only capital costs, whereas O&M expenses were included in the long-term unit costs for the water farms. The addition of O&M would substantially increase the average unit costs of nutrient reductions reported for the non-agricultural projects, which were (per initial capital investment alone): $3,979 per pound of TN and $12,523 per pound of TP. In comparison, the average ten-year unit cost for the three water farms was $36.43 per pound of TN (0.91 percent of the average for TN for 50 non-agricultural projects) and $161.81 per pound of TP (1.29 percent of the average for TP for 50 non-agricultural projects).

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## Chapter 3: Funding Opportunities and Outcomes

One of the objectives of the Watershed Coordinator's outreach role in this Section 319 Pilot Program was to explore funding opportunities for a potential regional expansion of water farming and related practices. This chapter offers a summary of the funding outcomes and of other funding opportunities considered.

### 3.1 The 2016 FL Legislature Funded a Regional Expansion of Water Farming

Given the substantial cost of water farming, it was reasonable to assume that funding for a regional expansion of the practice would need to come, in large part, from Florida State legislative appropriations. The 2016 General Appropriations Act, passed by the Florida Legislature and approved by the Governor in March 2016, included approximately $50 million to be used to implement the Northern Everglades and Estuaries Protection Program (NEEPP) through public-private partnerships to expeditiously launch water storage projects such as water farming and related practices.

The 2016 Specific Appropriation 1590A, which totaled $56,838,034, was intended to address the state of emergency Florida's Governor Rick Scott had declared[23] in the counties directly impacted by sustained and heavy releases from Lake Okeechobee, which began on January 30, 2016.[24] The appropriation specified that:

> [F]irst consideration shall be given to projects that will efficiently and effectively provide relief from discharges to the St. Lucie and Caloosahatchee Rivers and estuaries. Public-private partnerships for water storage and water quality improvements that can be implemented expeditiously shall receive priority consideration for funding.[25]

It was also specified in the Appropriations Act that, "No less than $47,838,034 [84 percent] of the funds provided in Specific Appropriation 1590A shall be used to implement the NEEPP, as set forth in section 373.4595, Florida Statutes, through **public-private partnerships** as provided in section 373.4591, F.S." That section of the Florida statutes was amended earlier in the 2016 Legislative Session[26] in a way that supported water farming: The 2016 legislative amendment to section 373.4591, underlined in the section language to follow, indicated strengthened legislative support for, and prioritization of, water storage projects on private lands. The practice of water farming was recognizable in the expanded section, in which groundwater recharge was also explicitly acknowledged in what appeared to be a recognition of a distinguishing characteristic of the Caulkins WF, whose success in the pilot program was well known by several prominent Florida Legislators by that time. (The Caulkins project began its field test in 2014.)

In January 2016, Section 373.4591 of the Florida Statutes was amended to read:

373.4591 **Improvements on private agricultural lands.**

> (1) The Legislature encourages public-private partnerships to accomplish water storage, groundwater recharge, and water quality improvements on private agricultural lands. Priority consideration shall be given to public-private partnerships that:
>
> (a) Store or treat water on private lands for purposes of enhancing hydrologic improvement, improving water quality, or assisting in water supply;
> (b) Provide critical groundwater recharge; or
> (c) Provide for changes in land use to activities that minimize nutrient loads and maximize water conservation. (From Senate Bill 552, signed into law January 21, 2016.)

The $56.8 million for the NEEPP was appropriated to FDEP to administer. FDEP, the SFWMD and the Florida Department of Agriculture and Consumer Services (FDACS) are the three Coordinating Agencies for the NEEPP. With FDEP in the lead on the prioritization of water storage projects for funding, the agencies began working together to implement six large-scale projects on private lands. Proposals for the public-private projects were solicited by FDEP to support the TMDL/BMAP process for the Northern Everglades area. The six projects that were selected by FDEP for implementation are listed in **Table 8**. (The two Scott Grove projects [6000 and 2000, of Evans Properties] are being implemented as one project under one contract. That is why the new project count is six but there are seven projects sites in Table 8.)

**Table 8. New Storage Projects Coming on Line from the 2016 Legislative Appropriation**

| Water Storage Project Name and/or Ownership | Impoundment Size in Acres | Estimated Average Annual Storage Volume in Acre-Feet |
|---|---|---|
| Caulkins Citrus Company's Water Farm Expansion | 3,200 | 60,000 |
| Bluefield Grove, Evans Properties | 6,602 | 39,000 |
| Scott 6000 Grove, Evans Properties | 5,686 | 23,400 |
| Scott 2000 Gove, Evans Properties | 2,032 | 6,000 |
| Brighton Valley, Lykes Brothers | 8,200 | 34,000 |
| El Maximo, Latt Maxcy Ranch | 9,175 | 27,000 |
| Alico | 35,192 | **TBD** |
| **Totals** | **70,087 Acres** | Well Over **189,400 Acre-Feet** |

The new storage projects range in size from just over 2,000 acres (Scott 2000) to more than 35,000 acres (Alico), as listed in **Table 8**. The six projects will collectively cover 70,087 acres and are expected to store well over 189,400 acre-feet of water, on an average annual basis. The storage is expected to exceed the average annual estimated volume because the storage volume of the project with the largest footprint, Alico, is yet to be determined at the time of this writing and is not included in the estimated total for storage volume shown in **Table 8**. All estimated storage values and overall project construction costs for each project were determined by the landowner and then provided to the Legislature for funding.

Additionally, and before the 2016 appropriation, the SFWMD created a 320-acre water farm on public land (owned by the SFWMD) on the C-23 Canal, next to the C-23 Canal Extension. That public project, called Section C, has an average annual storage capacity of 3,856 acre-feet. It began its operations in December 2016.

Four of the six public-private partnership water storage projects selected by FDEP for funding through the 2016 appropriation are owned by two of the three participant-landowners in the Section 319 Water Farming Pilot Program: The Caulkins Citrus Company and Evans Properties, which proposed three project sites. The new Caulkins WF is a 2,787-acre expansion at the site of their 413-acre water farming pilot project. New cells, similar to the pilot impoundment, were added to cover the entire former citrus grove in western Martin County with a 3,200-acre (total) impoundment. The expanded project began operations in December 2017 after taking only ten months to construct. The three new project sites of Evans Properties will provide a total of 14,320 acres of deeper storage (Alternative 2) water farms. Bluefield Grove on the C-23 Canal in western St. Lucie County is a 6,602-acre stand-alone project, whereas the Scott Groves, which straddle the C-25 Extension Canal in the northwestern reaches of the St. Lucie River Watershed, could work independently or together. The Scott Groves water farm project is expected to be operational in 2018, under a ten-year contract with the SFWMD.

### 3.2 $96 Million in USDA Funding for Florida Was Found Then Lost: Florida CREP Update

One of the most exciting funding discoveries in 2015, as part of the funding inquiry for this pilot program, was a federal budget of $96 million that could be spent for various water quality improvement projects on privately-owned agricultural lands in the Section 319 Pilot Program region of Florida—i.e., within the SFWMD and in the St. Johns River Water Management District (SJRWMD) areas for projects benefitting the Northern Everglades and east coast estuaries, including the SLE and the Indian River Lagoon. The $96 million federal budget dedicated to this specific region of Florida only (not statewide) was attached to the USDA Conservation Reserve Enhancement Program (CREP):

> The Conservation Reserve Enhancement Program (CREP) is a part of the Conservation Reserve Program (CRP), the country's largest private-land conservation program. Administered by the Farm Service Agency (FSA), CREP targets high-priority conservation concerns identified by a State, and federal funds are supplemented with non-federal funds to address those concerns. In exchange for removing environmentally sensitive land from production and establishing permanent resource conserving plant species, farmers and ranchers are paid an annual rental rate along with other federal and state incentives as applicable per each CREP agreement. Participation is voluntary, and the contract period is typically 10–15 years.[27]

An agreement between the State of Florida and the USDA/Farm Service Agency had been executed in 2002, to enroll up to 30,000 acres in Florida CREP, with a combined state and federal budget of $153 million. Although the federal budget dedicated to Florida CREP had not been used—no acreage had been enrolled in the program since its inception in 2002—it was verified in the fall of 2015 that the $96 million was still on reserve for Florida CREP and that money could still be spent. The agreement, which went through several modifications since 2002, needed to be administratively updated but it was still in force.

FDACS, the state agency that had developed the CREP agreement in 2002 with FSA, worked with FSA again in 2016 to update the agreement. It was determined that CREP could not be applied toward the implementation of large water farms on fallow citrus groves, but FDACS intended to use the program to help implement other types of DWM projects and to protect and restore wetland acreage in the region.

Unfortunately, in April 2017, Florida's Commissioner of Agriculture (Adam Putnam) received written notification from the USDA that the Florida CREP agreement had been terminated and the $96 million budget was withdrawn.

### 3.3 A Continuation of Funding for the Water Farming Pilot Projects from the State

The SFWMD offered the water farming pilot program participants an opportunity to extend their water farming contracts, after the conclusion of their two-year test period, subject to funding from the Florida legislature. (Note: The extensions are outside of the Section 319 grant-funded program.) All three agreed, resulting in a two-year continuation of the Spur Land & Cattle project and a one-year continuation of the Evans Ideal project, for the same annual compensation each received during the pilot program, and a nine-month contract extension for the Caulkins project. In the case of Caulkins, their shorter extension allowed for continued operations until the construction on their water farming expansion project could begin. Water quality monitoring has continued on the three water farms under the extended contracts.

Because unit costs for water storage and nutrient reductions on water farms are lower in the longer term, based on estimated projections (shown in **Tables 3 and 6**), the SFWMD may decide later to offer contract extensions again, budget permitting and if the water farmers remain interested in providing the service and do so cost effectively.

### 3.4 The St. Johns River Water Management District Also Funded a WF Pilot Project

In January 2016, the Governing Board of the SJRWMD announced the launch of a new water farming pilot project in that district to benefit water quality in the Indian River Lagoon. Two water farms, selected through an RFP issued by SJRWM in the fall of 2015, are expected to become operational in Indian River County in 2018.

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# Chapter 4: Summary of Findings and Lessons Learned

## 4.1 Summary of the Findings

The Section 319 Water Farming Pilot Program enabled the SFWMD to verify that water farms on fallow citrus groves could come on line very quickly and operate effectively and in accordance with the initial engineering assessment of the practice (AECOM, *Assessment of Water Farming on Agricultural Lands*).[28]

As interim projects designed to reduce coastal discharges, a chief attribute of water farming, now confirmed, is **rapid implementation**. The site preparation and construction of each of the pilot projects was completed within five months following contract execution. Even the large water farms coming on line next, listed in **Table 8**, are likely to become operational within one year of contract execution with the SFWMD, as evidenced by the completion of the construction of the Caulkins new 3,200-acre expansion project within ten months.

The performance of the pilot projects met or exceeded expectations; and, specifically, in the case of the Caulkins project, greatly exceeded expectations. Mainly because of the outstanding performance of the Caulkins project, the water storage and nutrient reduction goals initially set for the Section 319 Pilot Program (the aggregate goals) were exceeded. For instance, the aggregate goal for water storage was exceeded by 23,923.84 acre-feet, as was shown in **Table 2** in Chapter 1**.** The Caulkins water farm's goal exceedance of 21,593.81 acre-feet accounted for 90.26 percent of the aggregate goal exceedance. *The three water farms collectively stored a total of 46,493.82 acre-feet during the two-year field test.*

Similarly, for nutrient reductions, the Caulkins water farm's performance accounted for 84.67 percent of the total average annual TN reductions of the three projects collectively, shown in **Table 5** in Chapter 2, and 77.13 percent of the collective average annual TP reductions. The three water farms exceeded the initial aggregate goal for TN reductions by 42,459 lbs per year (or by 152.61 percent) and exceeded the aggregate goal for TP reductions by 4,823 lbs per year (or by 72.62 percent), as was shown in **Table 5**. *The three water farms collectively retained 140,562 pounds of TN and 22,928 pounds of TP in two years.*

Water farming offers a comparatively cost-effective means to achieve nutrient reductions, and the cost-effectiveness is even enhanced over time. It was found, for example, that the average ten-year unit cost for nutrient reductions on the three water farming pilot projects was only ***one percent*** of the average unit cost for nutrient reductions estimated for 50 non-agricultural projects implemented by the city and county stakeholders participating in FDEP's St. Lucie River and Estuary Basin Management Action Plan, as was discussed in section 2.5.

## 4.2 Lessons Learned

The Section 319 Pilot Program resulted in *proof of concept* for the practice of water farming, as well as it expanded the thinking about the characteristics of an effective water farm. Additionally, the pilot program offered lessons and new considerations regarding the design, operations and maintenance of water farms.

### 4.21 Utilizing Deep Sandy Soils for Water Farming Sites

The soil conditions on the Caulkins WF (unconfined sand with a high rate of infiltration) changed, or at least broadened, the concept of water farm as a potential groundwater recharge component. The Indian River Citrus League, for example, imagined that water farms would be retention areas, like reservoirs or farm ponds, that would gradually lose volume to evapotranspiration and minor soil seepage when not collecting water during the wet season. The SFWMD, however, had listed "high percolation sites" as one of the three acceptable "approaches" for water farming pilot projects in their April 1, 2013 RFP submittal guidelines.[29] Prior to that, aquifer or groundwater recharge had been regarded as one of the important *secondary*, or co-benefits of the water farming concept. Based on the field test of the Caulkins water farm, it is now evident that a high percolation site can lead to exceptionally high water "storage" performance.

### 4.22 When Contracting for Water Farming Services, Fixed Fee is Preferred

The terms of the SFWMD's contracts with the water farming pilot projects were not all alike. There was one fixed-price annual payment for the Evans and Spur Land projects that was inclusive of O&M and a landowner's participation payment. For the Caulkins project, however, there were separate categories for the annual participation payment and for O&M. Both cost categories were intended to be a fixed fee, but the O&M expenses increased considerably when the pumping of inflows continued to exceed estimates, as discussed in Chapter 1, section 1.6. The lesson learned is that future contracts should have a fixed fee for O&M to cover an anticipated amount of annual pumping (average annual) based on an analysis of historical records and a good understanding of the soils on the project site.

### 4.23 Construction and Management Considerations for Water Farms:

#### *4.231 Sodding the Berms Can Be More Advantageous Than Seeding*

The construction of an Alternative 2 type of water farm includes building substantial earthen berms, or levees, up to seven feet high around the perimeter of the impoundment. The berms must receive a vegetative groundcover to protect their integrity. The low-cost way to gain groundcover is to hydro-seed at least the berms' slopes. The top of the berms may be covered with mulch, if not seeded.

It was found, however, that the greater initial expense of applying grass stripping or sod to the berms, instead of seeding, should be considered a safety measure when the water farm is being implemented on an accelerated schedule, as the integrity of the berm is protected more quickly. And sodding can result in lower ongoing maintenance costs, which can be considered as an offset against the higher initial cost.

#### *4.232 Planting Beds Dissipate Wave Energy During Storms*

It was realized during the field testing of the water farms that the raised planting beds, which are a fixture in most citrus groves in the SLE Watershed, are a fortuitous and safety-enhancing design feature of the projects. The planting beds serve the purpose of reducing wave energy in the WF during a storm—they prevent large waves from forming which could erode or overtop the perimeter berms. Wave breaks are an especially important design consideration for the larger-scale projects coming on line in the watershed.

#### *4.233 Aquatic Vegetation Must Be Managed*

The field test revealed that water farms will be affected to varying degrees by the growth of invasive or exotic aquatic vegetation because they accept water from the regional canal system. The vegetation must be managed periodically and it was controlled by different methods on each of the pilot project sites. For example, it was necessary to spray herbicides at the Spur Land & Cattle WF, whereas roller chopping was used instead of spraying at the Evans WF. And because the Caulkins WF could dry out so completely, when not pumping canal inflows, it was sufficient at that site to passively allow the vegetation to dry out.

### *4.3 Funding Needs*

*As an interim measure, water farming is productive and cost efficient by providing benefits to the regional water management system and decreasing damaging discharges to tide.*

*Annual funds are necessary from the Legislature to keep these projects operational. That said, it is important to maintain funding levels necessary to achieve the ultimate longterm results provided by Comprehensive Everglades Restoration Project. The two program can work in concert, but requires dedicated funding.*

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## Notes

[1] This project and the preparation of this report was funded in part by a Section 319 Nonpoint Source Management Program Implementation grant from the U.S. Environmental Protection Agency through an agreement (No. G0391) with the Nonpoint Source Management Section of the Florida Department of Environmental Protection. The original total cost of the project was $3,087,401, of which $1,506,401 was provided by the U.S. Environmental Protection Agency. The final total cost of the three pilot projects, not including indirect or ancillary costs, was $3,422,989, due to service contract amendments between the SFWMD and the pilot program participants. The matching funds from the SFWMD increased from $1,581,000 initially (51% of the original total cost) to $1,916,588 (56% of the final total cost). The Section 319 grant contribution from EPA/FDEP remained unchanged ($1,506,401).

[2] Florida Statutes, Title XXVIII, Chapter 373-Water Resources, Northern Everglades and Estuaries Protection Program (NEEPP), 373.4595(1)(b) Findings and Intent.
The NEEPP pertains to three waterbodies and their watersheds: The St. Lucier River and Estuary on the east coast, the Caloosahatchee River and Estuary on the west coast and Lake Okeechobee, the central (inland) watershed.

[3] Specific Appropriation 1590A, passed by the Florida Legislature in March 2016.

[4] Section 373.4591 of the Florida Statutes, Improvements on Private Agricultural Lands, was referenced in the Appropriation (1590A of 2016).

[5] Conference Report on Florida House Bill 5001, General Appropriations Act, Amendment 212343, page 237.

### Introduction

[6] A bed is an elevated, mounded row of soil that is flattened at the top, on which the citrus trees are planted. Beds can range in height among groves from approximately two to five feet. Beds are separated by drainage ditches, or furrows that run in between the beds and convey water to larger drainage canals.

[7] The National Estuary Program (NEP) is place-based, non-regulatory program to protect and restore water quality and ecological integrity of estuaries of national significance (https://www.epa.gov/nep/overview-national-estuary-program). The Indian River Lagoon NEP is managed by the IRL Council, which is a special district of Florida that was

established in 2015 (http://itsyourlagoon.com/). Prior to the establishment of the IRL Council, the IRLNEP was administratively housed within the St. Johns River Water Management District.

[8] South Florida Water Management District, *2015 South Florida Environmental Report*, Chapter 10: St. Lucie and Caloosahatchee River Watershed Protection Plan Annual and Three-Year Updates, page 10-2.

[9] Ibidem, page 10-16; based on 2009 Florida Land Use Cover Classification System (FLUCCS) data.

[10] Florida Statutes, Title XXVIII, Chapter 373-Water Resources, Northern Everglades and Estuaries Protection Program, 373.4595(1)(b) Findings and Intent.

[11] Ivice, Paul, "Disease Drags Grapefruit Crop to Near-Record Lows," *Indian River Press Journal,* April 15, 2015.

[12] AECOM*, Assessment of Water Farming on Agricultural Lands*, Prepared for the Indian River Citrus League, May 1, 2012. A similar assessment was also completed for the Gulf Coast Citrus League. Both studies were conducted in cooperation with the South Florida Water Management District.

[13] The total cost of the pilot projects subsequently increased through contract amendments, as discussed in Chapter 1, section 1.6 and shown in Table 3. The initial contracted cost of the three pilot projects was $2,901,193. After consecutive amendments to the Caulkins Citrus Company's water farming contract, the final total cost of the 3 projects was $3,422,985. The cost increases were paid by the SFWMD. The EPA's contribution did not increase.

[14] From a presentation on the South Florida Water Management District's Dispersed Water Management (DWM) Program (Update), including an overview of the Water Farming Pilot Project, delivered by Boyd Gunsalus, Senior Environmental Scientist, DWM Unit of the SFWMD, and Project Manager of the Water Farming Pilot Program, June 25, 2015, at the SFWMD's Upper East Coast Water Supply Plan Update Kick-Off Workshop, Stuart City Hall.

## Chapter 1

[15] U.S. Army Corps of Engineers, Jacksonville District and South Florida Water Management District, *Central and Southern Florida Project Indian River Lagoon – South, Final Integrated Project Implementation Report and Environmental Impact Statement* (Final IRL-South PIR and EIS), March 2004.

[16] South Florida Water Management District, Janzen, J., Geddes, E., Gunsalus, B. and Rodberg, K., *Seepage Investigation of the Caulkins Water Farm Pilot Project: First Annual Report, Technical Publication* WS-37, September 2015.

[17] South Florida Water Management District*, Seepage Investigation of the Caulkins Water Farm Pilot Project: First Annual Report,* Technical Publication WS-37, September 2015, page 48.

[18] South Florida Water Management District, Janzen, J., Geddes, E., Gunsalus, B. and Rodberg, K., *Seepage Investigation of the Caulkins Water Farm Pilot Project: Final Report,* Technical Publication WS-43, August 2017, pages 31-32.

[19] The analysis was conducted by the project manager for the Section 319 Water Farming Pilot Program, Boyd Gunsalus of the South Florida Water Management District.

[20] The service provider, Archbold Biological Station, charged the same price to service each site, which amounted to $10,596.35 per project site for the duration of the two-year field test.

## Chapter 2

[21] Harper, Harvey and Baker, D., *Evaluation of Current Stormwater Design Criteria within the State of Florida*, Final report prepared by Environmental Research & Design for the Florida Department of Environmental Protection, June 2007.

[22] The auto-samplers collected a water sample every three hours from the water source for the inflow pumps (i.e., in the adjacent canal near the intake point for the pump). The timed auto-sampling was collected in one bottle each day, which resulted in a daily composite sample. The bottles filled daily by the auto-samplers were collected at each water farming site once a week on a set day (e.g., every Monday), for lab analysis. One value for nutrient concentrations measured in the composite sample(s), in milligrams per liter (mg/L), was entered in the dataset for each day the pump was on. If/when the pump ran for multiple consecutive days, then the concentration readings were based on an analysis of the composite samples collected over that time period, which would be in multiple bottles. The values recorded for the nutrient concentrations on each day the pumps ran was the average of the nutrient concentrations in the multiple bottles of composite samples for up to seven days. In those cases, the dataset shows a repeated value for seven days of the concentration given for each nutrient (though a different value for TN and for TP concentrations). A new sampling period and a new concentration measurement would begin on day eight, if/when the inflow pump ran for more than seven consecutive days.

## Chapter 3

[23] Executive Order Number 16-59 issued on February 26, 2016 by Governor Rick Scott, pertaining to Lee, Martin, and St. Lucie Counties.

[24] Treadway, Tyler, Our Indian River Lagoon: "State of Emergency Declared," *Indian River Press Journal,* February 27, 2016, page 10A.
Governor Scott declared a state of emergency for Martin and St. Lucie Counties again in June 2016 (Executive Order 16-155), following an algal bloom present in the counties' local waterways, especially the St. Lucie River, that was attributed to heavy regulatory releases from Lake Okeechobee which had continued since January 2016. Among the Governor's directives issued with the June Executive Order, the SFWMD was to take several actions including, "Store additional water through dispersed water management projects" (in *News Releases* from the Governor's staff on June 29, 2016: "Gov. Scott Declares State of Emergency in St. Lucie and Martin Counties Following Algal Blooms").

[25] Conference Report on Florida House Bill 5001, General Appropriations Act, Amendment 212343, page 237.

[26] The amendment was part of the 134-page *Water Bill*, passed early in the 2016 Leg. Session as Senate Bill 552.

[27] From https://www.fsa.usda.gov/programs-and-services/conservation-programs/conservation-reserve-enhancement/index, accessed September 1, 2017. The Fact Sheet for Florida CREP had been accessible from this federal program webpage. (Florida was listed among the states with a CREP agreement) until the summer of 2017.) Florida's CREP agreement was terminated in April 2017 by the USDA.

## Chapter 4

[28] AECOM, *Assessment of Water Farming on Agricultural Lands*, Prepared for the Indian River Citrus League, May 1, 2012, Palm City, Florida.

[29] South Florida Water Management District, Dispersed Water Management Northern Everglades Invitation for Water Farming Pilot Project, Submittal Guidelines, Solicitation Number 6000000576, April 1, 2013, page 7. Excerpt: "Designs of individual pilot project sites will be developed and cost effectively implemented based on the following [three] approaches:

- Above ground flooding of former grove production areas…

- Retaining additional stormwater in existing water management facilities…
- High percolation sites: Consider and evaluate surface water retention on deep sand ridges where water is diverted away from the regional system thereby reducing the volume of surface water reaching the estuaries and then infiltrated in sandy soils recharging the aquifer system."

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## Appendix A

### Table 9. Average Unit Cost of Nutrient Reductions via 50 Projects in the St. Lucie BMAP

| St. Lucie River and Estuary BMAP Stakeholders | Number of Projects (for which costs are available) | Total Cost of the Projects | Cost of TN Removal per pound | Cost of TP Removal per pound | Remaining Required TN Reductions per BMAP in pounds/year | Remaining Required TP Reductions per BMAP in pounds/year |
|---|---|---|---|---|---|---|
| 1a. City of Port St. Lucie MS4 | 14 | $43,576,100 | $6,233 | $13,098 | (-10,566) | 14,112 |
| 1b. PSL Septic Tank Phase-out | Ongoing Program | $91,075,666 | $2,662 | Not Quantified by DEP | | |
| 2a. Martin County MS4 | 19 | $34,344,161 | $1,816 | $5,404 | (-9,353) | 6,670 |
| 2b. Martin County Septic to Sewer Conversions | Ongoing Program | $7,089,742 | $461 | Not Quantified by DEP | | |
| 3. St. Lucie County Non-MS4 | 1 | $1,862,859 | $26,164 | $72,485 | 5,584 | 3,019 |
| 4. St. Lucie County MS4 | 4 | $8,334,072 | $3,171 | $8,066 | 1,454 | 821 |
| 5. City of Fort Pierce MS4 | 3 | $7,075,160 | $12,264 | $29,916 | 1,917 | 18 |
| 6a. City of Stuart MS4 | 6 | $7,301,006 | $2,836 | $6,131 | (-2,090) | (-48) |
| 6b. Stuart Septic Tank Removals | Ongoing Program | $3,200,000 | $2,387 | Not Quantified by DEP | | |
| **Totals & Ave. Unit Costs** | **50** | **$203,858,766** (Total for all 50 projects) | Average= **$6,444** | Average= **$22,517** | **8,955** | **24,640** |
| ***Adjusted*** Ave. Unit Cost | 49 | | **$3,979** | **$12,523** | | |

**Data source**: FDEP's 2015 Progress Report for the St. Lucie River and Estuary Basin Management Action Plan. Prepared by the Division of Environmental Assessment and Restoration Water Quality Restoration Program Florida Department of Environmental Protection Tallahassee, FL 32399, in cooperation with the St. Lucie River and Estuary Technical Stakeholders, December 2015

"Total Cost" of the projects does NOT include the cost of operations and maintenance, for non-agricultural stakeholders 1a through 6b

***Adjusted*** Average is the average cost excluding the cost outlier project in row #3 (for St. Lucie County Non-MS4).

# Appendix B

**See Separate Attachments**