Interim Report for the Water Farming Demonstration Project

Options Assessment and Opportunities Identification: For Nutrient Load Reduction and Surface Water Storage in the St. Lucie River Watershed

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Prepared for the South Florida Water Management District
Mary Oakley, University of Florida Center for Landscape Conservation Planning

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(Deliverable Two)

August 2, 2016

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Prepared by Mary Lucier Oakley, Watershed Coordinator
University of Florida Center for Landscape Conservation Planning

On the cover: Aerial photograph of the Caulkins Citrus Company's water farming pilot project in Indiantown, Florida by Melissa Corbett, P.E., Engineer of Record for the Caulkins Water Farm.

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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)
AWS	Alternative Water Supply (for agricultural irrigation)
BOD	Biological Oxygen Demand
BMAP	Basin Management Action Plan
CEAP	Conservation Effects Assessment Project
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)
CRP	Conservation Reserve Program
CSA	Critical Source Area
DEP	(Florida) Department of Environmental Protection
DWM	Dispersed Water Management (Program or projects)
EPA	(U.S.) Environmental Protection Agency
ESA	(U.S.) Endangered Species Act
ESA	Environmental Site Assessment
FDACS	Florida Department of Agriculture and Consumer Services
FSA	Farm Service Agency (of the U.S. Department of Agriculture)
IFAS	Institute of Food and Agricultural Sciences of the University of Florida (also UF-IFAS)
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 or projects)
NRCS	Natural Resources Conservation Service (of the U.S. Department of Agriculture)
O & M	Operations and Maintenance
PES	Payment for Environmental Services
PWS	Payment for Watershed Services
RCPP	Regional Conservation Partnership Program (under NRCS)
R/STA	Reservoir and Stormwater Treatment Area (refers to a public regional facility)
SFWMD	South Florida Water Management District, or the 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
WCD	Water Control District
WF-PES	Water Farming-Payment for Environmental Services (pilot)
WFPP	Water Farming Pilot Project
WQT	Water Quality Credit Trading

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Executive Summary

Water Farming is the term coined by the Indian River Citrus League (IRCL) and adopted by the South Florida Water Management District (SFWMD) for the novel practice of storing surface water on fallow citrus groves. The practice is currently being field tested on three pilot project sites in the St. Lucie River and Estuary Watershed as part of a Clean Water Act Section 319(h) grant-funded demonstration project.

The SFWMD was the recipient of the three-million-dollar (total) matching grant awarded in 2013 by the Florida Department of Environmental Protection (DEP). Supporting organizations in this demonstration project include the IRCL and the Florida Farm Bureau Federation. The project area, the St. Lucie River and Estuary (SLE) Watershed, is composed of nearly all of Martin and St. Lucie Counties and a portion of eastern Okeechobee County, in the Treasure Coast region on the east coast of Florida. The St. Lucie River is a major tributary to the Indian River Lagoon.

There will be a two-year operating and monitoring period for each of the pilot projects. The first of the three projects to launch (The Caulkins Citrus Company's water farm) began its operations in February 2014, the second project launch (Spur Land & Cattle) occurred in January 2015, and the third project (Evans Ideal 1000) began its operations in May 2015. The testing period will be completed in May 2017.

The water farming pilot projects are performing well in the field test. With more than a year remaining in the demonstration's testing period, the original estimate for water storage volume and nutrient reductions, set by the SFWMD for all three projects combined for 24-months of operations, has already been reached.

In fact, after only the first year of operations, *one project alone*, the Caulkins Citrus Company's 413-acre water farm, *exceeded* the total annual retention volume initially estimated for all three projects of 11,000 acre-feet of storage per year. The Caulkins pilot project had retained 11,842 acre-feet by the end of 2014, and 28,483 acre-feet of rainfall and inflows from the C-44 Canal by the end of 2015 (during 22.5 months of operations).

The 22.5-month water quality monitoring record (that includes measures of nutrient concentrations in the inflows from the C-44 Canal, which are pumped into the water farm) for the Caulkins project showed that the amount of nutrients removed from the system by this one project also exceeded the initial estimates by the SFWMD for all three projects over a 24-month period. Specifically, the Caulkins project has exceeded the estimated load reduction, so far, for total nitrogen (TN) by 32,518 pounds and by 276 pounds of total phosphorous (TP). (Pilot project performance values are provided in Table 1 in chapter 1.)

Water farming is a recent innovation within the SFWMD's established Dispersed Water Management (DWM) Program. Water farms differ from most other types of DWM projects in four important ways:

1. Water farms provide deeper water storage, with water levels up to four feet above the top of the mounded citrus tree planting beds, and up to six feet of depth in the furrows between the beds.
2. The projects are designed to *retain* water in the water farm impoundment. The rain that falls on the project site and the inflows pumped into the impoundment from regional canals are held on site. The storage volume is *not released* back into the regional canals during the wet season.
3. This means the efficiency rate for nutrient reductions is nearly 100 percent, since no surface water leaving the site also means no nutrients are released. Although these projects could release in exceptional storm events, which is why the efficiency rate is set at 97 % instead of 100 percent, there have been no releases from the pilot projects, with monitoring records of up to 22.5 months. (The quantity of nutrient reductions on water farms is measured via water quality monitoring.)
4. Unlike other DWM projects on ranchlands that use a minor portion of a pasture and displace very little agricultural production, water farms preclude any agricultural production on the groves on which they are located. Water farmers are "all in" while they commit a grove to this practice.

One of the most significant performance features is how quickly the water farms can come on-line. Each of the pilot projects took just a few months to construct and even the largest of the proposed water farms, which could store 30,000 acre-feet or more, could be implemented within one year of contract execution. In contrast, it can take a decade or more to design and construct a public regional reservoir facility.

<u>Key questions addressed in this report were:</u> *How much water farming would be needed to meet the goals in the SLE Watershed, for water storage and nutrient reductions, and how much would that option cost?* The answers are based on an estimate of the cost and performance of a regional expansion of the practice, which is discussed in chapter 3 (please see Table 4 and Appendix 2). The answers are summarized next.

A total of 20,000 acres of water farming, of the deeper storage project type, would meet an estimated 60 to 100 percent of the water storage goal for the SLE Watershed, by storing 120,000 to 200,000 acre-feet per year drawn in from the regional canals, as well as retaining the rainfall on the project properties. (The variable used in the estimated range of storage volume—the number of static volume refills per year—is explained in chapter 3, section 3.45.) The water storage goal that was established for the SLE Watershed of 200,000 acre-feet per year, which is discussed in chapter 2, section 2.1, does not pertain to the periodic discharges into the SLE from Lake Okeechobee.

Twenty thousand acres of water farms would also substantially meet the nutrient reduction goals for the agricultural lands in DEP's St. Lucie River and Estuary Basin Management Action Plan (SLE BMAP). Specifically, a 20,000-acre expansion of water farming would meet an estimated 132 percent of the required reductions remaining for TN, and 55.35 percent of the required reductions remaining for TP.

The unit cost of nutrient reductions on water farms was found to be *one percent or less* of the average unit cost of 50 nutrient reduction projects implemented by non-agricultural SLE BMAP stakeholders, as shown in Table 5 in chapter 5.

More would still need to be done to reduce TP, and the strategic use of the Florida Conservation Reserve Enhancement Program (CREP), *and its untapped federal budget of $96 million* dedicated to the project area to reduce nutrient runoff on agricultural lands, could support that effort. (The nutrient reduction goals for the SLE Watershed are detailed in Tables 2a, 2b and Table 3 in chapter 2. The Florida CREP program is described in chapter 6.)

The estimated cost of 20,000 acres of water farms, presented in Table 4 in chapter 3, would be just over $27 million in one-time start-up costs, to design and build all of the projects. The estimated recurring annual costs, for operations and maintenance and a service payment to the water farmers, would total about $12.6 million per year. The projected cost to build and then to operate 20,000 acres of water farms *for ten years* would be an estimated $153.2 million.

There are 13 proposed water farm projects totaling about 20,000 acres included in this report, based largely on the responses among Indian River Citrus League members who were queried by the IRCL (discussed in chapter 3).

The 2016 General Appropriations Act, passed by the Florida Legislature and approved by the Governor in March 2016, includes a substantial appropriation that could be a funding opportunity for water farming. The 2016 appropriation totaling $56,838,034 is to be used to implement the Northern Everglades and Estuaries Protection Program (NEEPP, which applies to the SLE, as well as to the Lake Okeechobee and Caloosahatchee River Watersheds). It is specified in the Appropriations Act that at least $47,838,034 of the appropriation shall be used to implement the NEEPP "through public-private partnerships as provided in section 373.4591, F.S. (Improvements on private agricultural lands)." Section 373.4591, F.S. was amended by the Legislature earlier in 2016 in a way that is supportive of water farming and other DWM projects, as discussed in chapter 4, section 4.21 of this report. It is stated in the Appropriations Act that, "Public-private partnerships for water storage and water quality improvements that can be implemented expeditiously shall receive priority consideration for funding."[1]

The SLE, the Indian River Lagoon and the citrus industry have sustained serious set-backs in recent years and are thought to be at a critical juncture, or nearing a tipping point, now. The Indian River Lagoon lost 60 percent of its sea grass beds in 2011 from a severe algal bloom and is under great threat again in 2016, as is the South Fork of the St. Lucie River.[2] The Treasure Coast has lost 38 percent of its productive citrus acreage since 2008, mainly due to citrus greening disease.[3]

IRCL leadership has recognized the large inventory of fallow citrus groves as potential infrastructure to use for water storage that could help citrus producers retain their land while better treatment, if not a cure, for citrus greening can be found. At the same time, the storage would help the estuaries by reducing the pollutant-carrying discharges from the drainage canals to those coastal waters. Perhaps the most salient aspect of this storage option is speed. The Executive Vice President of the IRCL, Doug Bournique, states: "We can do this *today*."

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Introduction

Water Farming is the term coined by the Indian River Citrus League (IRCL) and adopted by the South Florida Water Management District (SFWMD) for the novel practice of storing surface water on fallow citrus groves. The practice is currently being field tested on three pilot project sites in the St. Lucie River and Estuary Watershed as part of a Clean Water Act Section 319(h) grant-funded demonstration project. (Chapter 1 provides information on the matching grant project, funding, partners and preliminary results.)

Although the term water farming has been used by newspaper reporters to refer to any surface water storage projects on private agricultural lands in South Florida, the term is specifically applied by the SFWMD and in this report to water storage projects on previously productive (now out of production) citrus groves on private or publicly owned land.

Project Area Location and Description

The St. Lucie River and Estuary (SLE) Watershed is located on the east coast of Florida, within the state's Treasure Coast region, and is composed of nearly all of both Martin and St. Lucie Counties plus a portion of eastern Okeechobee County. The SLE Watershed is considered to be part of the Northern Everglades and is adjacent to the Lake Okeechobee Watershed, as shown in **Figure 1**. The SLE is a major tributary to the southern Indian River Lagoon—an estuary of national significance. The Indian River Lagoon is one of 28 designated estuaries of national significance in the United States and in Puerto Rico which are part of the Environmental Protection Agency's (EPA) National Estuary Program.[4]

The St. Lucie Watershed covers over half a million acres (537,805 acres)[5] of predominantly agricultural lands, shown in **Figure 2**. Agricultural land use accounts for 54 percent of the watershed (289,635 acres); urbanized areas 19 percent (102,717 acres).[6] Natural areas (wetlands and forests) account for the balance.

Also shown in **Figure 2** are the 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 Indian River Lagoon west of the Fort Pierce Inlet. The SLE Watershed is included in the Northern Everglades and Estuaries Protection Program (NEEPP), along with the Caloosahatchee River and Estuary Watershed on Florida's west coast and the centrally located (inland) Lake Okeechobee Watershed. 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 that have resulted in water quality problems.[7]

The SLE Watershed stands out, however, as the most hydrologically altered area of all in the Northern Everglades region, as indicated in **Figure 3**, which shows the results of a GIS analysis in which uniform criteria for hydrological alteration, particularly the density of drainage canals, were applied statewide.[8] (The areas with the highest density of drainage ditches and canals appear in red to orange in **Figure 3**.)

Figure 1. Northern Everglades and Estuaries Protection Program (NEEPP) Watersheds

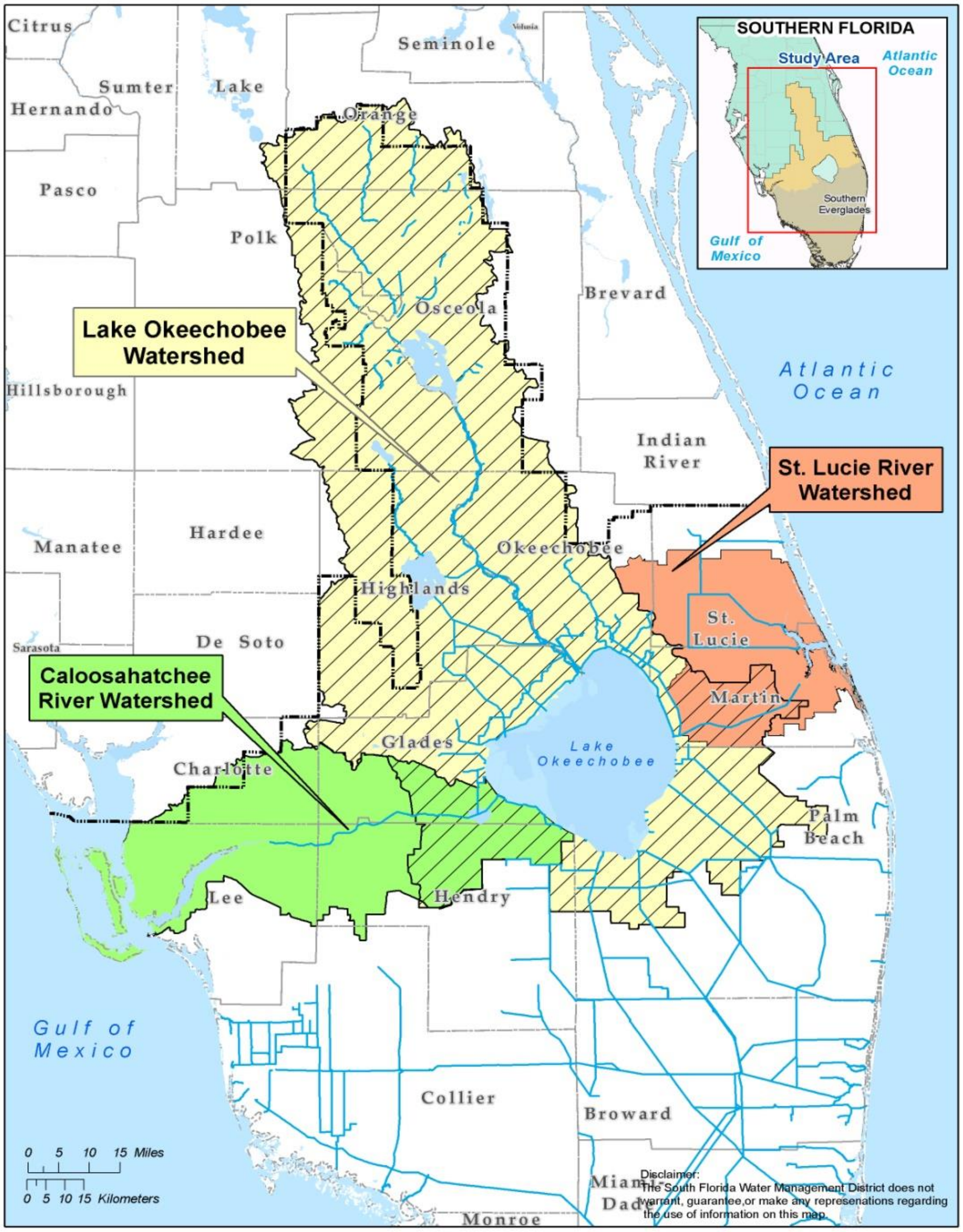


Figure 2. St. Lucie River and Estuary Watershed

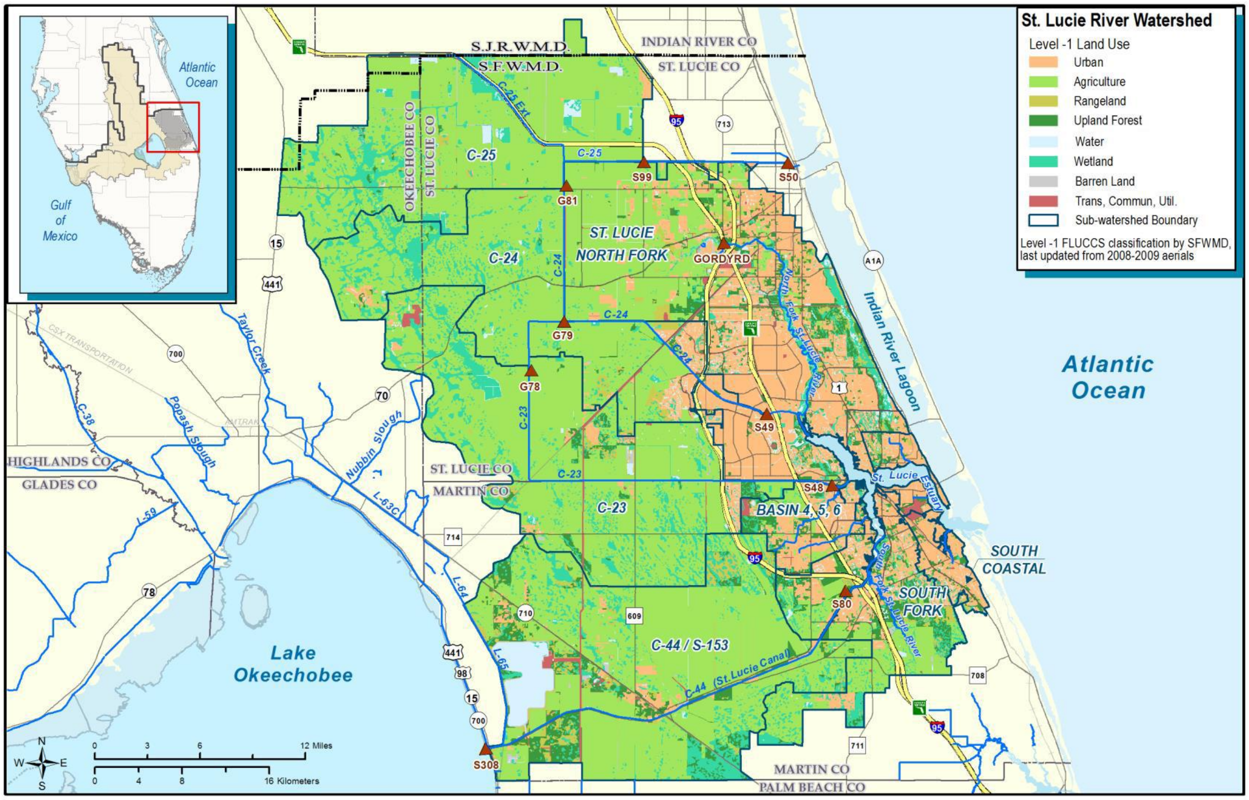
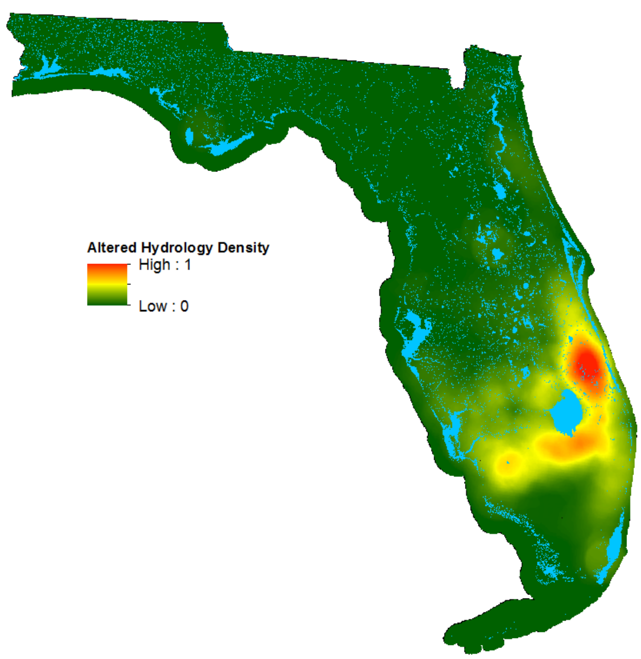


Figure 2 Graphic from the SFWMD's 2015 South Florida Environmental Report, page 10-17 (Figure 10-5).

Figure 3. Altered Hydrology/Canal Density in Florida



Pilot Testing via the Water Farming Demonstration Project

Water Farming has been 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 and managed fallow citrus groves is a recent innovation within the SFWMD's well-established Dispersed Water Management (DWM) Program. The District describes the DWM Program as a multifaceted approach to working cooperatively with public and private landowners to identify, plan, and implement mechanisms to retain or store water. The total storage, retention and detention created by projects within the DWM Program since 2005 is approximately 93,202 acre-feet.[9]

The DWM Program includes the Northern Everglades Payment for Environmental Services (NE-PES) Program. The NE-PES Program has funded water storage projects mainly on privately owned cattle ranches since the program's pilot phase began in 2005 as the Florida Ranchlands Environmental Services (Pilot) Project, known as FRESP.

Preliminary engineering studies of the water farming concept were completed in 2012[10] as a first step. The SFWMD's award of a Section 319 matching grant in 2013 made it financially feasible to conduct the necessary next step of pilot testing the practice in the field, which is being conducted on a variety of project sites (3) during a two-year operating and monitoring period for each. The first of the three pilot projects to launch began its operations in February 2014, the second project launch occurred in January 2015, and the third project began its operations in May 2015.

This pilot testing phase has two different names. The SFWMD calls it the Water Farming Payment for Environmental Services (WF-PES) Pilot. It is also known as the Water Farming Demonstration Project in the context of the Section 319(h) grant from the Florida Department of Environmental Protection (DEP), which totals $3,087,401: DEP awarded $1,506,401 in cost reimbursement to the District, and the District committed $1,581,000 in match funding (51 percent of the estimated cost of the demonstration project).

The goals of the water farming demonstration project are to:[11]

- 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.

Scope and Focus of This Report

Although other (neighboring) water management districts in the state, in addition to the SFWMD, are interested in water farming on fallow citrus groves, this report centers on the preliminary findings of the first pilot test of the practice in Florida and on its specific setting—the SLE Watershed, which is entirely within the SFWMD's boundaries. This report addresses the costs and performance of the water farming projects in particular. It generally does not address costs or performance of other types of DWM projects.

This interim report was prepared in contribution to the water farming demonstration project, as part of the outreach function of the Watershed Coordinator's role on the project. The assignment for this report is to:

- Provide a progress report on the field testing of the three water farming pilot projects;
- Explore the prospect of a regional expansion of the practice of water farming, taking into account the regional vision of the Indian River Citrus League;
- Estimate how much water farming would be needed to meet the established goals in the SLE Watershed for water storage and nutrient reductions and how much that option would cost; and
- Assess potential funding sources for a regional expansion of water farming and related practices, including the assessment of whether water quality credit trading could be a funding mechanism.

There is a specific goal in the NEEPP for increasing the surface water storage in the SLE Watershed by 200,000 acre-feet, which was determined in the Indian River Lagoon—South Study, completed in 2004 by the SFWMD and the U.S. Army Corps of Engineers. There are also specific goals for reducing nutrient loading to the SLE (detailed in chapter 2) in DEP's Basin Management Action Plan (BMAP) for the St. Lucie River and Estuary. Although the BMAP involves both urban and rural stakeholders in an effort to improve water quality in the SLE, this report focuses on the contribution rural, agricultural lands could make toward meeting the water storage and quality goals, especially by considering the practice of water farming within the context of the goals. (Chapters 2 and 3 provide information about the watershed goals and the estimated costs of a potential expansion of water farming. Chapters 5 and 6 provide information about funding possibilities for an expansion of water farming and related practices on agricultural lands.)

Tipping Points

The Indian River Lagoon is referred to as one of the most biologically diverse estuaries in North America or, commonly, *the* most diverse. That "often-quoted source of Treasure Coast pride" has been based on a seine-pull study conducted in 1974 which Treasure Coast Newspapers recreated in 2015 and conducted with the original lead scientist[12] to answer the question: *Is it still the most biologically diverse, given all of the pollution the 156-mile long lagoon has absorbed in the past 41 years?*[13] The answer is a qualified yes. It is as biologically diverse as it was 41 years ago, but only where there are sea grass beds. Sea grass has yet to fully recover from a severe algae bloom in 2011—the *superbloom*—that killed sixty percent of the lagoon's sea grass beds and coincided with exceptionally high mortality rates in several treasured lagoon wildlife species.

With the influence of one of the strongest El Niños on record arriving in 2015,[14] heavy rains (including in what should be the winter dry season) and the resultant nutrient runoff were potential contributing factors to a new (in 2016) algal bloom—a "brown tide"— in the northern Indian River Lagoon.[15] The arrival of that algal bloom was followed by the largest known fish kill in Indian River Lagoon history in March 2016.[16] In the southern Indian River Lagoon and the SLE, both heavy local basin runoff and discharges from Lake Okeechobee, which began in January 2016, are causing significant stress on these estuaries.[17]

Noted marine scientists who know the local waters well have expressed concern that the ailing Indian River Lagoon and the chronically beleaguered SLE could be reaching a tipping point. They caution that unless significant action is taken at this critical juncture to relieve the stressors on these estuaries, their former rich ecology might not be recoverable: it would change into something different and diminished.[18]

The citrus industry is also at a critical juncture. In anticipation of the release of 2014—2015 Florida citrus crop production figures, which were expected to be at a nearly 50-year low, the state's Commissioner of Agriculture Adam Putnam was quoted as saying, "If the estimate plays out, it will be half of what we harvested just four years ago. We are at a tipping point, and some would say we've blown past the tipping point."[19] Florida's orange crop was later confirmed to be the smallest since the 1965—1966 season.[20]

The forecast for 2015—2016 grapefruit production in the Indian River Citrus District, where nearly three-fourths of Florida's grapefruit are grown in the 200-mile long coastal strip that stretches from Daytona Beach to West Palm Beach, predicts a ten percent decline from the prior year. In response to the forecast, Doug Bournique, Executive Vice President of the Indian River Citrus League, said, "For our area, that's about as positive a scenario as we could have hoped for with the continued issues of greening."[21] Florida grapefruit production has fallen 68.2 percent statewide since the 2003—2004 season, which was just before citrus greening disease was found in Florida.[22]

The decline in citrus production acreage in the SLE Watershed chiefly caused by citrus greening disease, or Huanglongbing (HLB), which was first detected in Miami-Dade County in 2005 and has since spread to all 32 citrus-producing counties in Florida, can be seen in the comparison of **Figure 4** and **Figure 5**.[23] The first map of the watershed (**Figure 4**) shows active citrus production groves (in yellow) in 2006. The second map (**Figure 5**) shows where citrus groves have become fallow (in blue) as of November 2014.[24] The Treasure Coast has lost 38 percent of its productive citrus acreage, mostly grapefruit, since 2008.[25]

IRCL leadership has recognized the fallow groves as potential infrastructure to use for water storage that could help the citrus producers hold on to their land while better treatment or a cure for greening can be found and, *at the same time*, help the coastal estuaries recover by reducing pollutant-carrying discharges. The primary purpose of this interim report is to explore that proposition, while the pilot testing continues.

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Figure 4. Productive Citrus Groves in 2006, in the St. Lucie Watershed and in Indian River County

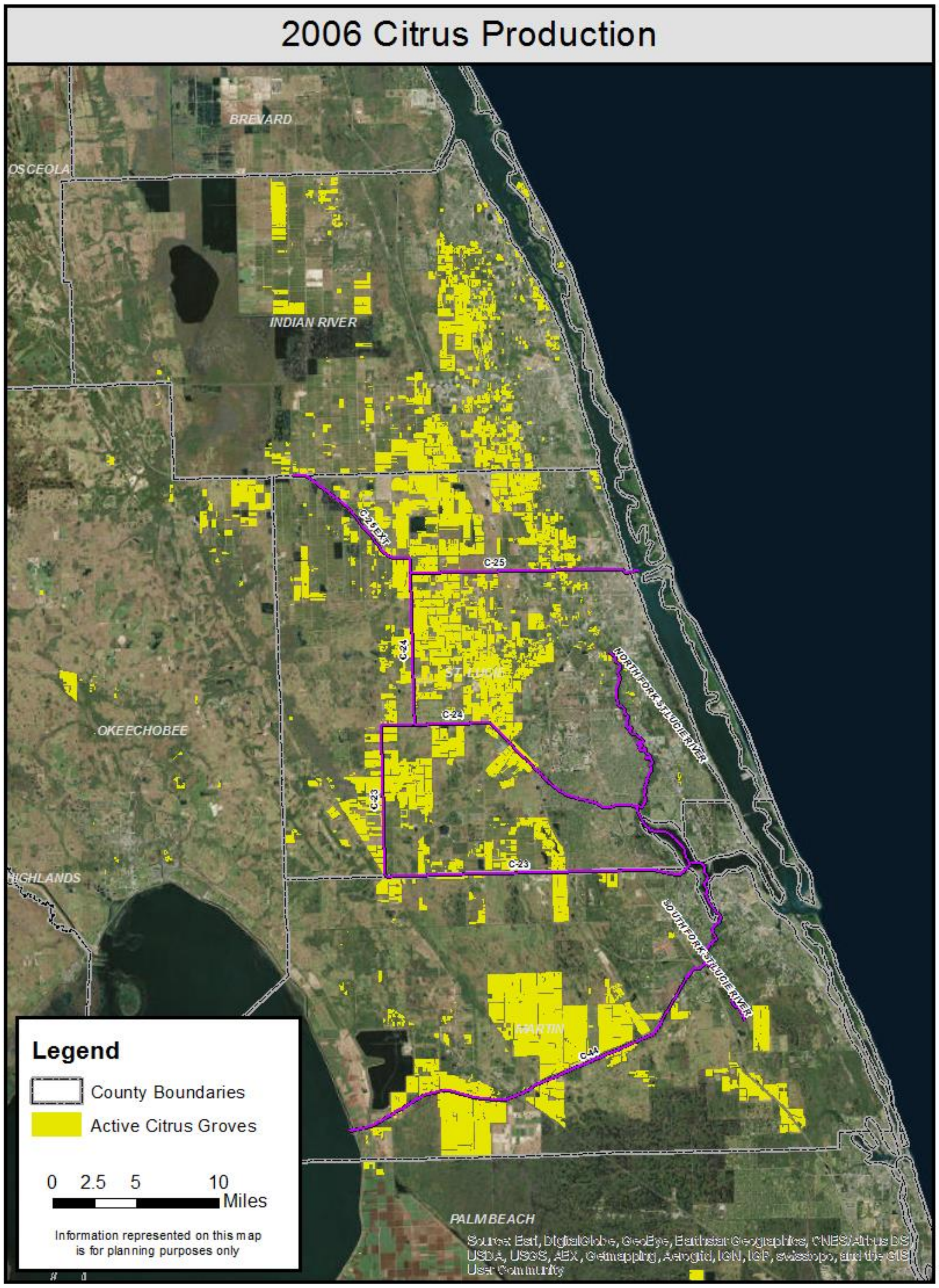
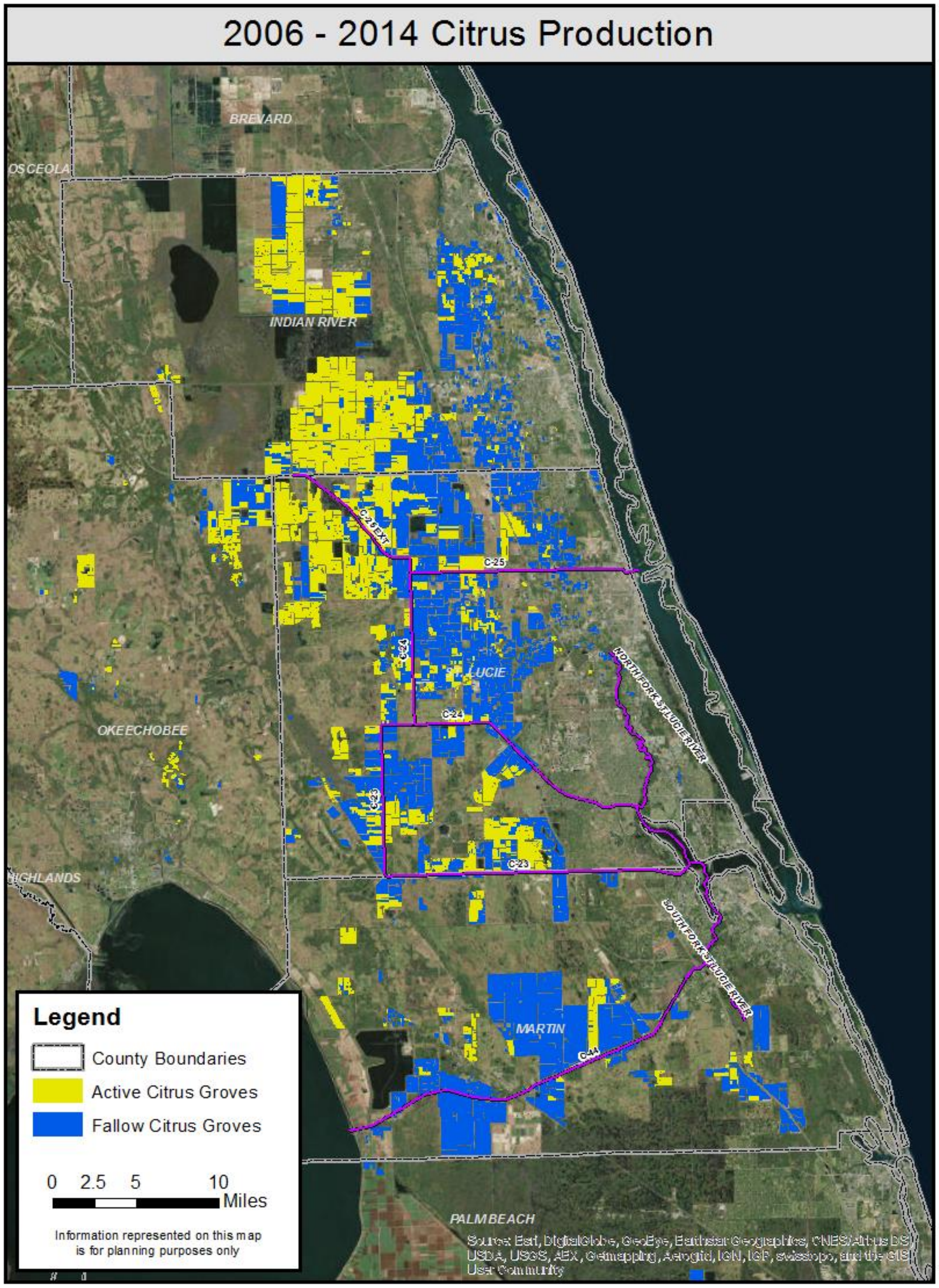


Figure 5. Productive and Fallow Citrus Groves in 2014, in the St. Lucie Watershed and in Indian River County



Chapter 1. The Water Farming Demonstration Project

1.1 Background

The idea of storing excess surface water on fallow citrus groves in the SLE Watershed, which was first considered in the late 1990s, emerged again in 2009 during discussions about the need for and feasibility of building a large regional reservoir in the C-25 basin on the county-line border between the two water management districts: the SFWMD and the St. Johns River Water Management District (SJRWMD). The reservoir would store water that once naturally flowed north from the SLE Watershed into the Upper St. Johns River basin but is now diverted east via the C-25 Canal to the Indian River Lagoon. This reservoir is called the Reconnection because it would functionally restore, at least in part, the former hydrological connection between St. Lucie and Indian River Counties at the boundary line of the water management districts.[26] Both districts have demonstrated sustained interest in this reservoir concept since at least 2005 by jointly funding consecutive contextual studies of the potential Reconnection project.[27]

It became clear during a second study of the Reconnection concept, by HDR Engineering, that a reservoir of this scale would be many years away from being built. The notion then arose of storing water on fallow citrus groves as an interim measure which could do, in a dispersed fashion, right away what the reservoir would do in the future, if and when constructed. Since the SFWMD had a Dispersed Water Management Payment for Environmental Services Program for ranchlands, a similar program for citrus groves was envisioned. One important difference would be that citrus groves, with their existing perimeter berms, could likely store water at depths "measured in feet instead of inches."[28] The idea of farming *water* instead of citrus on grove lands as a potential interim measure was included in the 2009 report by HDR (*St. Lucie and Indian River Counties Water Resources Study*).[29]

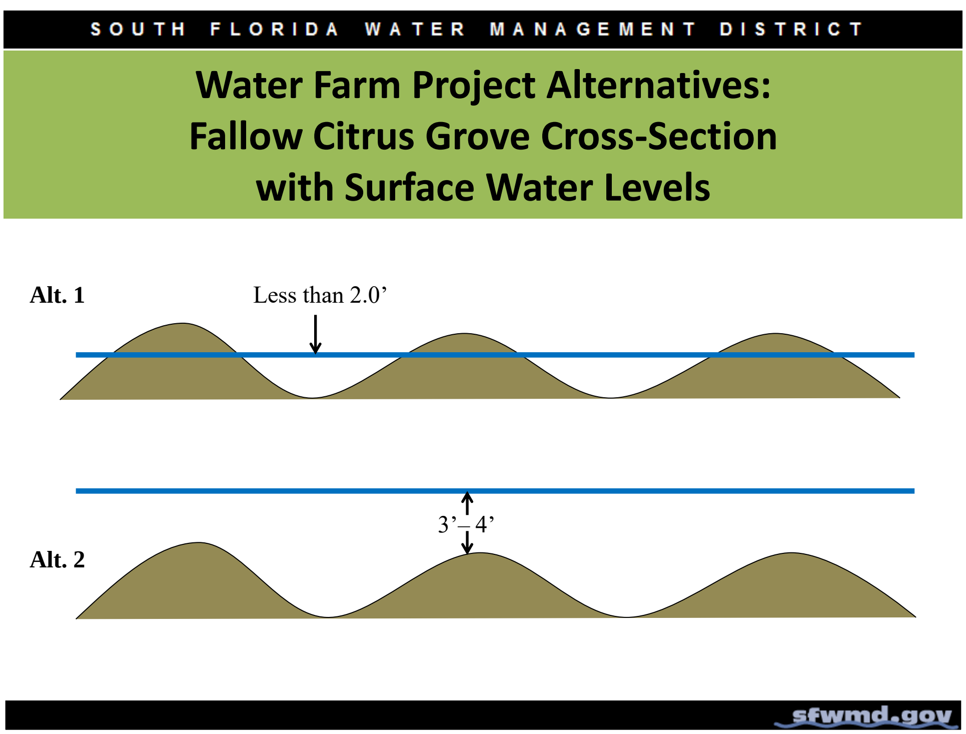
As chief champion of the water farming concept, the Indian River Citrus League commissioned a water farming feasibility study in 2011 through a cooperative agreement with the SFWMD and funding from the District's DWM Program. The study was completed by AECOM in May 2012 (*Assessment of Water Farming on Agricultural Lands*).[30]

AECOM engineers examined two potential water farming sites on privately owned fallow citrus groves in the C-24 basin of the SLE Watershed: the 900-acre Ideal 1000 Grove owned by Evans Properties, Inc., and the 200-acre Four Palms Grove owned by Adams Ranch. Two water storage scenarios were evaluated on each site using a water budget developed for a single average year of local rainfall and analyzed over a ten-year operational period taking evapotranspiration, soil storage, supplemental inflows and discharges or timed releases into account.

The first scenario, called **Alternative #1**, was created to estimate the volume of water which could be retained on each site with minimal improvements to the existing infrastructure. This meant storing the rain that falls on the site to nearly the top of the planting beds,[31] for a maximum depth of up to two feet in the furrows between the planting beds.

The **Alternative #2** scenario was used to evaluate deeper water storage that could be achieved by building substantial perimeter levees up to seven feet high to safely store up to four feet of water above the top of the beds (with six feet of water in the furrows). Alternative #2 would allow for the detention of rainfall *and* supplemental inflows from the regional canal system, which would be pumped into the water farm when there was surplus water in the system that would otherwise be discharged to tide. There would be <u>no</u> discharges from the water farm during the wet season, per the specifications created for Alternative #2. There could be controlled releases during the dry season, however, to provide supplemental surface water to regional canals for agricultural irrigation. **Figure 6,** a cross-sectional drawing of the bedrows and furrows in a citrus grove, depicts the different water levels in the two scenarios ("Alt.1" and "Alt. 2").

Figure 6. Water Farm Alternative Scenarios (Surface Water Levels) #1 and #2



In the conclusion of their report, AECOM offered a general rule of thumb on the storage capacity of water farms based on the parameters that were established and evaluated for that study. For every 1,000 acres of fallow grove that participates in water farming, an average annual increase in retention volume of 1,300 to 1,900 acre-feet is possible (for Alternative #1). Regarding Alternative #2, AECOM report authors added, "…for the more intensive storage alternative, a range of 1,700 to 2,500 acre-feet of annual storage volume is possible on the average grove which can be made available for controlled release to the regional system for irrigation water supply." That statement was followed by a vivid example: the annual amount of water stored specifically in the Evans Ideal 1000 Grove in the Alternative #2 scenario, per AECOM's estimates, *would be sufficient "to refill the volume of irrigation water in the C-24 Canal one time per year*."[32]

Withdrawals from the regional canals are not allowed when the water level in the canals falls below a specified "regulatory stage." A timely release from a water farm could raise the surface elevation in the canal back up to a level that allows permitted users to withdraw water. AECOM's statement meant the release from the Ideal Grove would raise the level in the C-24 Canal to allow for permitted withdrawals.

1.2 The SFWMD Pilot Project and the Section 319 Matching Grant

With a preliminary engineering assessment completed by AECOM on the estimated costs of construction, operations, maintenance and storage performance, the next logical step was to test the concept in the field.

On March 26, 2013, the IRCL hosted a joint meeting of the SFWMD and the SJRWMD to discuss status updates on the Reconnection project (which is still under study) and the next steps for water farming. The then-Executive Director of the SFWMD, Melissa Meeker, announced at this meeting that the SFWMD would release a Request for Proposals (RFP) on April 1, 2013 for citrus producers/potential water farmers interested in participating in a new water farming pilot project in the SLE Watershed.

Ms. Meeker explained at the March meeting that the District wanted to make sure water farming will be a cost-effective program. If a pilot test confirms it is, then the District would extend the program if funding is available. The District would like to continue with the two current test sites (in the AECOM study), Ms. Meeker said, and proposals for those projects would need to be submitted under the RFP to continue. The process would be opened to more participants through the RFP. It was also explained that SFWMD had begun looking at District-owned lands, to do something similar to water farming, and the District wanted to be able to compare costs, per volume, to work with the private sector on storage versus public projects.

Although it was not revealed during the March meeting, the SFWMD had only $1.2 million in the budget to conduct the water farming pilot project.[33] Opportunities for matching funds were quickly investigated and the most promising opportunity was to apply for a federal Clean Water Act Section 319(h) matching grant through DEP. The deadline for Section 319 grant proposals was less than two months away, in the annual statewide competitive process in Florida, but a completed proposal was submitted on time in May 2013 by SFWMD. The title of the proposal was "Evaluation of Water Farming as a Means for Providing Water Storage/Retention and Improving Water Quality in the Indian River Lagoon/St. Lucie Watershed."

The Indian River Citrus League, the Florida Farm Bureau Federation and the Indian River Lagoon National Estuary Program are the three community organizations that agreed to be supporting partners in the water farming demonstration project, prior to the District's submission of the 319 grant proposal. Each organization offered to provide in-kind match for the project through ad hoc staff support.

The District had not yet completed their review and selection process for the water farming pilot project RFP when the proposal was submitted for the 319 grant. The SFWMD had formed an internal working group of District staff members to evaluate and rank the proposals from the five respondents to the RFP. The two AECOM study sites were among the proposals submitted to the District. The District's internal group recommended that the three proposals the group had ranked first through third be selected to be the water farming pilot sites. Once the site selection was finalized, the District was permitted to submit more details to DEP to increase specificity in the 319 grant application.

DEP notified the SFWMD on August 22, 2013 that the pilot project had been accepted for funding in the requested amount of $1,505,401 from Section 319. With the District's matching funds and in-kind match from project partners totaling $1,581,000, the initial budget for the water farming demonstration had more than doubled to over three million dollars ($3,087,401). And, as DEP had funds on-hand in the amount of the award to the District, funds that had been returned to DEP from previous 319 grant recipients for projects which came in under budget or were cancelled, the water farming demonstration could begin sooner than would normally be expected. (The usual months-long wait time for 319 funds from EPA to "drop down" from the federal level to DEP for spending in Florida by the grant recipients was avoided.)

Because the water farming pilot would now be conducted as a Section 319 grant-funded demonstration project under the Clean Water Act, water quality monitoring became a part of the pilot, as required by DEP for Section 319 projects and as proposed by the District in the 319 grant application to conform to that requirement. Water quality benefits and water quality monitoring were not among the questions and specifications included in the water farming pilot RFP the District had issued on April 1. The District had been interested primarily in water storage volume then, although it reserved the right to monitor the pilot projects for water quality performance at the District's expense.

1.3 The Water Farming Pilot Projects: An Overview

The three groves selected to be the water farming pilot sites in the Section 319 demonstration project are each described, following this initial overview. There is one pilot project in each of the three major canal basins which discharge into the SLE: Spur Land & Cattle/Bull Hammock in the C-23 basin, Evans Properties' Ideal 1000 in the C-24 basin, and Caulkins Citrus Company's project in the C-44 basin.

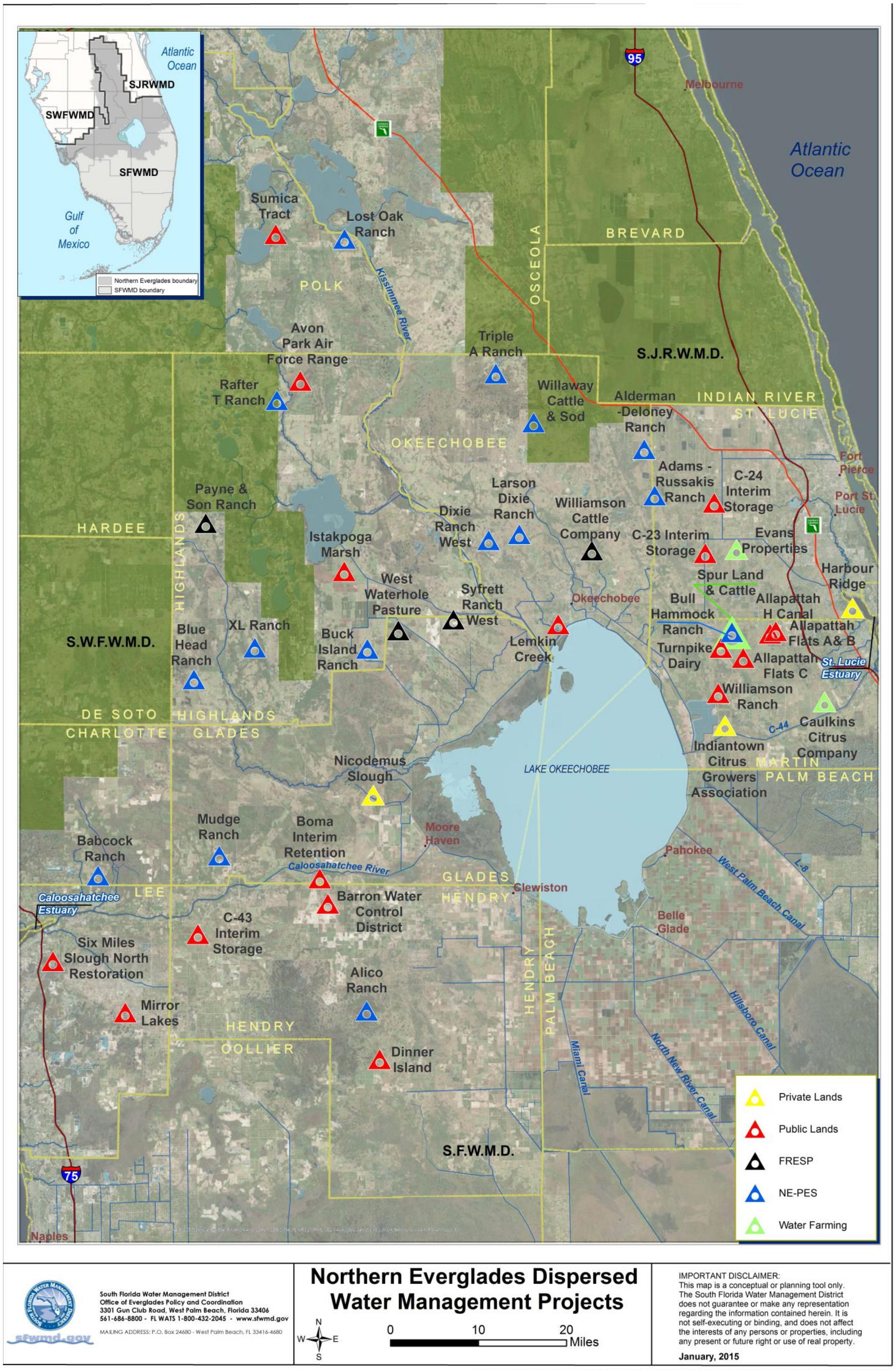
Based on the storage volume estimates for the projects included in the proposals submitted to the District by the prospective water farmers in response to the water farming RFP, the combined storage volume of the three top-ranking pilot projects was a total of 11,000 acre-feet per year. *However, after the first year of pilot project operation, one pilot project alone, the Caulkins Citrus Company's water farm, exceeded that total annual retention volume initially estimated for all three projects.*

One indication the new practice of water farming on fallow citrus groves could be more impactful than Dispersed Water Management projects on ranchlands is the fact that the initial estimate of the annual storage volume for the three pilot projects was 2,649 acre-feet more than the storage estimates for the ten projects in the Northern Everglades Payment for Environmental Services Program.[34] Initial estimated storage volumes for the water farming pilot projects ranged from 870 acre-feet (for Spur Land and Cattle) to 6,780 acre-feet (for Caulkins), whereas the ten NE-PES projects ranged in estimated storage volume from 147 acre-feet (for Alderman-Deloney Ranch) to 3,462 (for Blue Head Ranch). However, the initial engineering estimates of storage performance may differ from measured performance in the field. The first year of performance of the water farming pilot projects exceeded the initial storage estimate. Similarly, NE-PES projects may be performing over or under their initial storage estimates, as listed in the 2014 audit report of the District's DWM Program.[35]

The siting of the three water farming pilot projects is shown (with pale green markers) in **Figure 7**; a map which also shows the location of all the SFWMD's DWM projects, including the NE-PES project sites.[36]

A brief SFWMD staff presentation to the District's Governing Board on April 9, 2015 on the status of the water farming demonstration project at that time is available at: http://www.sfwmd.gov/paa_dad/docs/F-975045895/43_Water%20Farming%20-%20Morrison.pdf. This Power Point includes photographs and siting schematics of the three projects. Two of the three pilot projects were operational then, and the third (Evans Ideal 1000) began operations nearly two months later, at the end of May 2015.

Figure 7. SFWMD's Dispersed Water Management Program: Projects Location Map



Each pilot project participant was given up to one year to complete the final engineering design and to construct the water farm, then two years to operate the project under contract with the SFWMD. The demonstration project overall will last more than three years, with a final report due by late July 2017.

The nutrient reductions for the water farming pilot projects were estimated by the District as one value for the three projects combined, as shown in **Figure 8**, which is a table excerpted from the final version of the 319 grant application. Because the goal was to have zero discharge from the water farms, except in extreme conditions, the efficiency rate of the practice was estimated to be 97 percent during the intended two-year operational period of the pilot projects. District staff used the locally documented Event Mean Concentrations (EMCs) for citrus land uses for the C-23, C-24 and C-44 basins (per each project location) for total nitrogen (TN) and total phosphorous (TP) to estimate the pre-project pollutant loads and the post-project reductions. (The EMCs referenced were those in Appendix A of the St. Lucie River Watershed Protection Plan 2012 update.) The initial estimate was the demonstration project would achieve a total nutrient load reduction of 6,641 pounds of TP per year and 27,822 pounds of TN per year. This meant that the demonstration project could result in a total load 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.

Figure 8. Initially Estimated Load Reductions for the Water Farming Demonstration

BMPs Installed **BMP #1**		**TSS** **lbs/yr**	**TP** **lbs/yr**	**TN** **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 District's estimate of pre-project Total Suspended Solids (TSS) was based on a general EMC for TSS for citrus land use in Florida.[37] The total annual reduction in TSS was estimated to be 245,024 pounds. This meant that the demonstration project 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.

Each of the pilot projects had an automatic sampler installed to collect water quality data on site from the time each project became operational. Rain gauges were installed to measure direct rainfall retained on the property. The volume of water pumped into the water farms from a canal is measured via calibrated inflow pumps. (The water farmers keep a daily log of exactly how long the inflow pumps are running, on the days when the pumps are turned on, so that the volume of inflows can be calculated based on the run time.) The nutrient concentrations, continually measured in the canal inflows, can be multiplied by the volume of the inflows (in cubic feet per second) for an accurate account of the nutrients retained on the water farm (based on the daily material load)—provided there are no surface *discharges* of water. If there would be releases, the discharge(s) would be detected in the monitoring protocol and recorded. To date, there have been no surface discharges from the three pilot projects in the water farming demonstration.

The measurements of TSS on the water farms (from the inflows) are collected by weekly *grab samples*, unlike the more frequent measurements of the nutrients, based on daily collection by the auto-samplers.

Limited Phase I and Phase II Environmental Site Assessments (ESAs) were conducted on all three sites prior to pilot project construction. A problem was found on two sites which warranted remediation and follow-up testing. Copper was detected in the soil in several places on the Ideal 1000 site and on the Spur Land & Cattle site. It was later confirmed on Ideal 1000 that the site preparations, such as grading, would mix and invert the affected soil sufficiently to resolve the problem. On Spur, however, copper was still detected upon retesting after initial remediation. Inverting the affected soil *again* resolved the problem.

The three pilot projects are described in the next sections, in the order in which they became operational. No two of the water farms are alike, which provides the opportunity to test the practice at different scales and in different field conditions.

1.31 The Caulkins Water Farm

The Caulkins Citrus Company Water Farming Pilot Project is a 413-acre impoundment built on a fallow citrus grove next to the north side of the C-44 Canal in Indiantown in western Martin County. This project and the surrounding 2,887 acres also owned by the Caulkins Citrus Company is near the location of the regional C-44 Reservoir and Stormwater Treatment Area (R/STA), a Comprehensive Everglades Restoration Plan (CERP) public project by the SFWMD and the U.S. Army Corps of Engineers, now under construction just west of the Caulkins water farm.

The SFWMD announced in a news release on August 19, 2013[38] that the Caulkins project was ranked first among the respondents to the District's water farming pilot project RFP and an agreement had been made between the Caulkins Citrus Company and the District to implement the proposed pilot project at an approximate cost to the District of $1.2 million over a three-year period, to build and to operate.

The District was officially notified by DEP just three days later, on August 22, 2013, that their application for a Section 319 matching grant for a water farming demonstration had been accepted for funding. Given the agreement with Caulkins was for the entire amount the District had budgeted for the pilot project, it is evident the pilot project could have been a two-year field test of the Caulkins project alone. The Section 319 grant enabled the District to add two more projects to the water farming demonstration, totaling three.

The District's announcement of their selection of the Caulkins site as the first water farming pilot project was surprising to some who are familiar with the property, particularly the fact that it is on deep sand. That fact would presumably impede the *retention* of water, a function generally accepted as the primary purpose of water farms before the demonstration project began. The District, however, had listed "High percolation sites" as one of the three options for water farming pilot projects in their April 1, 2013 RFP submittal guidelines.[39] Aquifer or groundwater recharge was generally accepted as one of the important secondary-, or co-benefits of the practice.

The Caulkins project is indeed on a high percolation site: it is on an unconfined layer of sand at least 40 feet deep.[40] Water percolates there, or filters into the sand, at the fast rate of about one-tenth of a foot per day when there is no pumping (of canal inflows) and no rain. The conditions made it difficult to initially fill up the water farm once the pumping began from the C-44 Canal when the project became operational on February 5, 2014. Conversely, the conditions were conducive to draining the site quickly when the District decided to install monitoring wells to determine where the water was flowing after it was pumped into the impoundment. (The water farm was allowed to dry down temporarily so the wells could be installed in and around the impoundment.) The concern was that the water pumped in from the C-44 Canal might be flowing right back into that canal. Two studies, including initial results from the District's monitoring well study, have quelled the concern that water was moving in a circuit (from the canal to the water farm then back to the canal and back to the water farm).

The first study to address the subsurface flow of water at the project site was commissioned by the Caulkins Citrus Company and was completed in May 2015 by a faculty member of the University of North Florida (UNF) School of Engineering.[41] The preliminary numerical modeling indicated that the inflow water percolating at the water farm "travels very slowly in the surficial aquifer system," taking between 18 months to ten years to travel back to the C-44 Canal.[42] UNF estimated and reported that the inflow water ended up as either evapotranspiration (11.44 percent) or surficial aquifer recharge (82.33 percent) with the rest in temporary reservoir storage (6.23 percent) during the study period.

The SFWMD issued its first annual report on the Caulkins water farm seepage study in September 2015.[43] 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.[44]

The interdisciplinary team of District staff members who conducted the study recommended continuing the investigation for a second year and adding equipment to also measure nutrient concentrations in the subsurface flows from the water farming pilot project (WFPP).

George P. Caulkins, III, is the landowner and President of the Caulkins Citrus Company. Mr. Caulkins has been involved with the company his entire life and employs comparably-experienced land managers, including Ron Hataway who has worked for Caulkins for 40 years and is the manager of the water farm.

In February 2016, the Caulkins water farming pilot project won a community Environmental Stewardship Award from the nonprofit organization Keep Martin [County] Beautiful, which recognizes residents who have projects that improve the quality of life on the Treasure Coast.[45]

1.32 The Spur Land & Cattle Water Farm

The Spur Land & Cattle/Bull Hammock water farming pilot project began operations on January 1, 2015. The project has two components: a 60-acre impoundment—the water farm—on a fallow citrus grove, and an adjacent 130-acre (former) wetland slough that can be rehydrated with any overflow from the primary impoundment. The slough, which had its headwaters cut off long ago, is surrounded by both a berm and a perimeter canal which keep added water on site. The project is located in the C-23 basin and is designed to accept inflows from the C-23 Canal. The property borders the Allapattah Flats, a 13,000-acre wetland restoration project in public ownership that is part of the Natural Storage component of the Indian River Lagoon—South study's slate of recommended projects for SLE Watershed restoration, as part of CERP.

The Spur Land & Cattle project site in Martin County is part of the 7,500-acre Bull Hammock Ranch owned and operated by the Carlton family, who settled in Florida in the 1870s. Wes Carlton is the fourth generation family patriarch who manages Bull Hammock, including the WFPP, as well as over 30,000 acres of Florida ranchlands.[46]

The flexibly designed water farm can alternatively accept and store inflows from a source other than the C-23 Canal. An on-ranch canal receives drainage from Allapattah Flats, which causes that canal to "run like a raging river in the summer," according to Mr. Carlton. Under such conditions, water from the on-ranch canal can be sent to the water farm by gravity flow.[47]

In contrast to the Caulkins' rapid percolation site on unconfined sand, the Carlton's Spur Land & Cattle water farm is naturally underlain by a layer of solid shell rock, which nearly seals the impoundment and minimizes seepage. "It's a bathtub," said the SFWMD's manager of the water farming demonstration.[48]

The Carlton family is noted for land and water conservation. In addition to being water farming pioneers, the family has partnered with federal, state and local governmental agencies to implement water storage and restoration projects, including the rehydration of a (formerly drained) 1,600-acre wooded marsh on the ranch. The USDA Natural Resources Conservation Service (NRCS) selected the Carlton family as a regional honoree of the Environmental Stewardship Award Program in 2015, which placed the family in competition for the national award. NRCS produced a video to announce the recognition of the Carlton family, which can be viewed at the following link to see Wes and his family, their property and projects—including the water farm:
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/fl/newsroom/stories/?cid=nrceprd400411

1.33 The Evans Ideal 1000 Water Farm

The 900-acre Ideal 1000 water farm in the C-24 basin in St. Lucie County is the largest of the three pilot projects in the demonstration. It began operations in May 2015, which means its 24-month field test will last through April 30, 2017. The last-in-line start was not attributable to a lack of readiness on the part of the property owner, Evans Properties, Inc. The project was instead delayed mainly due to administrative requirements of the Section 319 grant program.

The 1,000-acre Ideal 1000 Grove is next to the south side of the C-24 Canal. The north end of the grove contains a 70-acre above-ground reservoir, adjacent to the C-24 Canal, which had been used by Evans Properties as a source of irrigation water for the 900-acre former citrus production area below the reservoir that has become the water farm. Another source of water is the St. Lucie County drainage canal that flows east through the middle of the grove before turning northeast to discharge into the C-24 Canal.

Evans Properties had submitted two proposals for the Ideal 1000 Grove, in response to the District's pilot project RFP, for the two water storage scenarios AECOM had studied: Alternative #1 and Alternative #2, the deeper storage. The District chose Ideal 1000 Alternative #1 to test in the pilot study as it would better fit the budget as the less costly option to construct. Moreover, the other pilot projects, Caulkins and Spur

Land & Cattle, are the Alternative #2 type, storing water up to four feet above the top of the planting beds. Substantial improvements would need to be made to the perimeter berms to store water that deep, whereas the existing berms would largely suffice for the Alternative #1 scenario in which water is stored no deeper than the top of the beds. The decision to test Alternative #1, however, removed the opportunity to verify in the demonstration project AECOM's estimate (reported in section 1.1) that Ideal 1000 as an Alternative #2 type of project would have enough storage volume to refill the C-24 Canal one time each year, to replenish irrigation supply in that basin.

Although the Ideal 1000 project could accept inflows from the C-24 Canal or the St. Lucie County canal, AECOM recommended use of the St. Lucie County canal which bisects the grove, for the easiest access. (To instead send water from the C-24 Canal to the impoundment would require retrofitting the existing infrastructure.)[49] Accessing sources for inflows applies more to an Alternative #2 scenario than to the Alternative #1, which could eventually reach maximum stage, or design elevation, just by retaining all direct rainfall on site. This has the potential to be true for the Evans Ideal 1000 site, which AECOM had predicted "will experience virtually no losses due to downward seepage since there are deeper layers of impervious soil below the property."[50] The pilot project has had intermittent inflows from the St. Lucie County canal in its first year of operation, in addition to holding the rain.

AECOM had estimated, using average annual rainfall data, that Ideal 1000 in the Alternative #1 scenario would reach equilibrium by the end of five years, meaning that rainfall would replace all volume lost through evapotranspiration. At that point, supplemental inflows from a canal would not be necessary to keep the water farm at its maximum stage. That, however, is another estimate that cannot be empirically verified within the 24-month field testing period.

According to AECOM's 2012 study, the Ideal 1000 Alternative #1 would produce an average annual retention volume of 3,704 acre-feet. (The estimate was slightly lowered in the pilot project proposal[51] to 3,635 acre-feet.) About the retention, AECOM reported, "This yields a net positive change (reduction in runoff to the regional system) of 1,752 acre-feet from the existing fallow conditions on the property."[52]

Evans Properties, a family-owned cattle and citrus company established in Florida in 1951, has extensive land holdings in eight counties in the state, including 12,000 acres still in active citrus production. Ron Edwards, President and CEO of the company, has taken an active interest in opportunities to diversify operations, especially since the serious blights of canker and greening have stricken the citrus industry. Mr. Edwards, who has volunteered innumerable hours to statewide land and water conservation planning efforts, as a valued advisor to the Florida Fish and Wildlife Conservation Commission and to the Century Commission for a Sustainable Florida (to name only two such advisory roles of long duration), has been at the forefront among those who envision *water management for public benefit* as a potentially viable enterprise for private agricultural landowners in Florida, and as a way to conserve rural lands and water.

1.4 Pilot Project Costs and Initial Performance Data

This interim report provides a summary of the pilot projects costs and initial findings from the monitoring data. The project *costs* reported in **Table 1** are expected to be the final costs of the projects for the three-year demonstration project. The cost information was provided by the SFWMD after all three projects had been constructed and were operative. The cost information had been updated by the District to capture any adjustments that had been made to the original budget figures, which were based on the proposals that had been submitted to the SFWMD by the water farmers in response to the water farming pilot project RFP in April 2013. The *performance* information is not final as it is based on only a portion of what is expected to be a two-year monitoring record for all three of the projects, to be completed in May 2017.

1.41 Initial Capital Costs

The one-time costs for start-up, which are listed in the top section of **Table 1** as capital costs, include the general costs of planning, engineering design, and permitting, and the costs of site development which include construction, materials and equipment as needed. Capital costs ranged from a total of $136,000 for Spur Land & Cattle, the smallest project in acreage size, to $542,300 for Caulkins Citrus Company, the largest project in terms of potential water storage volume.

Evans Ideal 1000 was the most economical project to launch on the basis of capital costs per acre. Capital costs totaled $216,872 for the 900-acre Ideal 1000 project, the largest of the three in acreage. Total capital costs per project acre were $241 for Ideal 1000; $1,313 for Caulkins; and $2,267 for Spur Land & Cattle. The main reason for the unit cost differences is that berms had to be constructed around the Caulkins and Spur water farms, whereas the existing berms were largely sufficient for the Ideal 1000 project, which is the only pilot project intended to store up to two feet of water within the furrows, instead of storing water up to four feet above the planting beds as the two other pilot projects were designed to do.

The *public* cost to launch the Caulkins project was less than the total initial capital costs reported in **Table 1**. The Caulkins Citrus Company paid $177,391 of the total initial start-up costs ($50,000 for the design and $127,391 toward general costs and site development) for which they were not reimbursed. Therefore, the total *public* capital cost of the Caulkins project was $364,909; a public unit cost of $883 per acre.

The unit cost for start-up based on the land area of the primary water farm impoundment does not take into account the secondary component of the Spur Land & Cattle project: the adjacent 130-acre slough. The unit cost *if* incorporating the slough into the total project acreage would be $716 per acre for Spur.

The total initial capital costs (public and private) reported in **Table 1**, which are the actual as-built costs of each of the three projects, differed to varying degrees from the estimated capital costs proffered by the water farmers in their proposals submitted in response to the District's water farming pilot project RFP. Spur Land & Cattle had the closest match between proposed and actual costs: $132,000 versus $136,000 respectively, mostly due to a higher fee for the final engineering design than was originally estimated. The actual capital costs for the Ideal 1000 project were $100,908 lower than the proposed start-up costs, whereas the total costs to launch the Caulkins project came in $62,933 over the estimate in the proposal. That additional capital expense on the Caulkins project was used to construct the perimeter berm one foot higher than proposed.[53] (The berm is seven feet high.)

Once under contract with the SFWMD for the water farming demonstration project, the water farmers were given up to one year to complete the design, permitting and construction of their pilot project site. Contracting occurred in succession, starting with the Caulkins Citrus Company, then Spur Land & Cattle, and lastly Evans Ideal 1000, giving staggered starting times for the projects. All of the projects became operational within one year of contract execution. For example, the Caulkins project came under contract in late August 2013 and became operational in early February 2014; about five months. The earth-moving part of the site development took only three months to complete on the Caulkins site, where there was the most work to do of the three project sites.

1.42 Recurring Annual Costs

As shown in **Table 1**, the total annual costs for each of the projects are $607,638 for Caulkins, $537,188 for Ideal 1000, and $54,720 for Spur Land & Cattle. For both the Spur Land and the Ideal 1000 projects, one fixed-price annual payment is made to the water farmers, which includes compensation for operations and maintenance and the landowner's participation payment. The Caulkins Citrus Company is paid more frequently for operations and maintenance (O & M) reimbursement, which was not a fixed price at the time of contracting with the District and has been adjusted upward since the project became operational. The amount reported for Caulkins' annual O & M in **Table 1**, $342,708, is the adjusted amount which effectively became the fixed price for annual O & M for the project, per 2015 agreement renegotiations.

The Caulkins Citrus Company had requested quarterly payments from the District for O & M, along with a 25 percent payment (quarterly) of the annual landowner's participation fee of $264,930 per year.

Table 1. Water Farming Pilot Project Costs, Performance Measures and Unit Costs

Project Costs and Performance	Caulkins Citrus	Spur Land & Cattle	Evans Ideal 1000
Size of Primary Impoundment	413 acres	60 acres[1]	900 acres
Annual Storage Goal for the Project	6,780 acre-feet	870 acre-feet	3,635 acre-feet
1. Capital: Start-Up Costs			
a. Planning and Design	$50,000	$42,000	$22,478
b. Site Development	$492,300	$94,000	$194,394
c. Total Initial Capital Costs	**$542,300**	**$136,000**	**$216,872**
2. Recurring: Annual			
a. Operations and Maintenance per Year	$342,708	--	--
b. Participation Payment per Year	$264,930	$54,720[2]	$537,188[3]
c. Total Annual Costs	$607,638	$54,720	$537,188
d. Total Annual Costs for Two Years	**$1,215,276**	**$109,440**	**$1,074,376**
3. Total Pilot Project Costs			
a. Total Public Costs	$1,580,186	$245,440	$1,291,248
b. Total Public and Private Costs	**$1,757,576**[4]	**$245,440**	**$1,291,248**
Period of Record for Performance Data	**22.5 months** (2/5/14-12/31/15)	**12 months** (1/1/15-12/31/15)	**4 months** (8/24/15-12/31/15)
4. Performance Measures—*SO FAR*			
a. Total Inflow Volume Retained	**25,605 acre-feet**	592 acre-feet	619 acre-feet
b. Total Rainfall Retained	**2,878 acre-feet**	207 acre-feet	1,952 acre-feet
c. Total Nitrogen (TN) Removed	39.99 metric tons (88,162 pounds)	1.90 metric tons (4,189 pounds)	1.82 metric tons (4,012 pounds)
d. Total Phosphorous (TP) Removed	6.15 metric tons (13,558 pounds)	0.42 metric tons (926 pounds)	0.44 metric tons (970 pounds)
5. Unit Costs[5]—*SO FAR*			
a. Cost per Ac-ft of Inflow Retained	$61.71/ac-ft	--	--
b. Cost per Pound of TN Removed	$17.92/lb		
c. Cost per Pound of TP Removed	$116.55/lb		
6. Estimated 10-Year Unit Costs[6]			
a. Cost per Ac-ft of Inflow Retained	$47.20/ac-ft		
b. Cost per Pound of TN Removed	$13.71/lb		
c. Cost per Pound of TP Removed	$89.13/lb		

[1] The 60-acre water farm is next to a 130-acre slough, which can be rehydrated with overflow from the water farm.
[2] The participation payment also covers the costs of operation and maintenance for Spur Land & Cattle.
[3] The participation payment also covers the costs of operation and maintenance for Evans Ideal 1000.
[4] Caulkins Citrus Company paid $177,391 of the start-up costs ($50,000 for design, $127,391 for site development).
[5] Based on total public costs (Table 1 variable 3a).
[6] Ten-year unit costs projection/estimate equation: 10-year total public cost of $6,441,289 divided by 22.5-month performance measures multiplied by 5.33 (months), for a 120-month (ten year) performance measure projection.

The Ideal 1000 project was the most straightforward of the projects regarding the contracted annual fees. Evans Properties proposed to be paid a total of $104,337 for two years of O & M (based on calculations of $68,137 for operations in the first year, when pumping into the impoundment would increase the costs more so than in the second year when the cost of operations was estimated to be $20,200, plus $8,000 for maintenance for each of the two years). Evans proposed to be paid an additional annual participation fee of $500 per acre for the 970 acres committed to the project, which would total $970,000 for two years of operations. Although the water farm impoundment is 900 acres, the proposal included the 70-acre reservoir on the property because it would be used to detain stormwater overflow before discharge into the C-24 Canal should the water farm reach overflow capacity in extreme weather. The total annual cost for two years of $1,074,376 for Ideal 1000 is a precise match to the proposed price.

For Spur Land & Cattle, Wes Carlton proposed to be paid by the acre-foot of water to be stored in the primary impoundment, instead of by the number of acres of land committed to the project. He originally proposed an annual all-inclusive fee, for the annual service or participation payment and the O & M, of $100 per acre-foot for 240 acre-feet of storage based on a four foot depth on a 60-acre water farm. That volume is referred to as the *static fill* amount. In subsequent dialogues with the District, however, the storage target was increased to 870 acre-feet, which supposed periodic spill-over into the adjacent slough and resultant refills from inflows to the primary impoundment of up to 3.6 times per year. The proposed annual payment was changed from $24,000 for the static fill volume (of 240 acre-feet) to $54,720 for greater dynamic storage (of 870 acre-feet) at a rate of $81 per acre-foot. Accordingly, the total annual cost for two years of the Spur Land project is $109,440, as reported in **Table 1**.

The Caulkins Citrus Company originally proposed to be paid a total of $431,800 for *two* years of O & M, which would be $215,900 per year. Renegotiations after operations had begun resulted in a change in the payment for O & M, which was increased to $342,708 per year (as shown in Table 1) to compensate for the higher costs of pumping more canal inflows than expected. That change increased the two-year cost by $253,616 over the proposed compensation for O & M (from $431,800 to $685,416 for two years).

The proposed additional participation payment for *two* years was $588,780, which would be $294,390 per year. That proposed fee was based on a rate of $43.42 per acre-foot of water stored,[54] which the Caulkins Company estimated would be 6,780 acre-feet per year, or 13,560 acre-feet in two years. The contracted (actual) participation payment of $529,860 for the two-year test of the Caulkins project is less than the proposed amount by $58,920.

With the O & M costs being higher than proposed and the participation payment lower, the net difference between the proposed two-year annual costs and the actual costs is $194,696. The total annual cost (of O & M and participation payments) for two years of the Caulkins project is $1,215,276.

If the participation payment for the Caulkins pilot project had not been a fixed fee based on the *estimated* annual storage volume, but was instead based on receiving $43.42 per acre-foot for the actual pumped-in volume, the participation payment would be $1,111,769 (so far) for the 25,605 acre-feet of water retained from the C-44 Canal that was pumped in during the first 22.5 months of the Caulkins project operations. That hypothetical payment is $581,909 more (at 22.5 months) than the actual 24-month participation payment of $529,860. In other words, paying a rate for measured acre-feet of inflows would have more than doubled the participation payment. If, on the other hand, the Caulkins participation payment had been set at $500 per acre of land, as it was for Ideal 1000, the two-year cost would have been $413,000, which is $116,860 less than the contracted cost of Caulkins participation payment.

The cost of the Caulkins pilot project will be higher in the final analysis than reported here, however, because a supplement will be paid to extend the contract period. In January 2016, the SFWMD and the Caulkins Citrus Company agreed to a six-month extension of the contract to operate the water farm beyond the 24-month demonstration period. Whereas this pilot project would have ended in the first half of February 2016, it will now continue to operate, with water quality monitoring, through July 31, 2016.

1.43 Total Costs of the Pilot Projects

Listed in **Table 1**, row 3b, is the tally of the one-time start-up costs and the recurring annual costs for the total cost, per water farm, of the three-year pilot project. The total costs are compared, next, on the basis of project acreage and the initial storage volume *goal* for each project, even though using those standard measures of comparison across three very disparate projects may have limited meaning. A significant comparison among the water farms will be based on performance measures, perhaps most importantly the unit cost per measured storage volume. In this interim stage of the demonstration, however, with as yet incomplete monitoring records of the intended two-year test run of each pilot project, the cost-per-volume of water storage comparison will necessarily be delayed until after the final results are in (summer 2017).

As shown in **Table 1**, the total cost of the three-year pilot test of the Caulkins project, inclusive of all start-up costs, is $1,757,576. Because the Caulkins Citrus Company contributed $177,391 to the start-up costs, the total public cost of the project is $1,580,186. The total public cost per acre of land is $3,826. The total public cost per acre-foot of water storage, per the proposed storage goal of 13,560 acre-feet over 24 months, is $116.53. The total public and private cost per acre-foot for 13,560 acre-feet is $129.61. The Caulkins project well exceeded its proposed storage goal, however, and thus the actual unit cost is lower.

The total three-year public cost of the Spur Land & Cattle project is $245,440. The total cost per acre of land is $4,091 when considering only the 60-acre primary impoundment. If the 130-acre adjacent slough is also considered, the unit cost is $1,292 per project acre. The total cost per acre-foot of water storage, for the goal of 1,740 acre-feet over 24 months (870 acre-feet per year), is $141.

The total three-year public cost of the Ideal 1000 project is $1,291,248. The total cost per acre of land is $1,435, which is 37 percent of the public cost per acre of the Caulkins project and 35 percent of the cost per acre of the Spur project's primary impoundment. (The Caulkins and Spur projects can accommodate deeper water storage than Ideal 1000.) The total cost per acre-foot of water storage, for the goal of 7,270 acre-feet over 24 months, is $178. If this project merely meets and does not exceed the water storage goal in practice, it will have the highest unit cost for water storage of the three pilot projects despite having the lowest unit cost for construction.

Although the Alternative #1 projects can be substantially less expensive to launch, the unit cost of water storage is likely to be more expensive (in the longer run) for Alternative #1 projects than for Alternative #2, given the latter's greater water storage capacity. This demonstration project can put the suppositions to the test to determine which type of water farming is more cost effective, considering the particular circumstances as well. It could be, for instance, that an Alternative #1 water farm on deep, unconfined sandy soils, similar to the Caulkins' site conditions, could have a relatively low unit cost for storage.

1.44 Performance Measures and Unit Costs—So Far

As previously stated, the unit costs per the actual measured performance in the field will be important data to compare across the projects once the two-year testing period is completed for all three projects. A caveat to note is that the staggered starting dates of the projects' testing periods means the projects are not operating under uniform weather conditions. Whether or not one or more of the projects will be subjected to a difference in weather conditions significant enough to affect performance remains to be seen, but it is possible. The amount of rain that falls specifically on each project site is measured and is a component of the monitoring records which will be available for comparative analysis.

It is also important to consider that the performance of the projects, although they are actively managed by the water farmers, is in large part beyond the control of the water farmers. The decision of when to operate the inflow pumps, for example, is up to the discretion of the SFWMD, and the District's pumping decisions are based on the weather affecting the regional system as well as the maximum capacity of the water farm. A water farmer may want to raise the water level in the impoundment to the maximum design capacity but will not be permitted to operate the inflow pumps when the source of supplemental water, a C-Canal, is below the elevation at which such pumping is allowed.

Each water farm has an operating schedule from the District to use as a guide, which considers the water level in the canal, the seasons, and watershed conditions. Although there can be exceptions to this rule, inflows from the canals usually occur only when the canals are actively discharging to the coastal waters. That operating protocol is very likely to change, however.

The rationale for the current protocol of accepting inflows from a canal only on the days when the canal is discharging to the coast is two-fold and rests on the tenet that a water farm will store only *surplus* water. Specifically, if the water farms accept inflows only on the days of a canal's discharge to coastal waters, then it can be said that water farms store only the water from the regional system that would otherwise be "wasted to tide." It can also be said that water farms do not take water that producers might want or need for irrigation. There is a new recognition, however, that water farms could instead be used *proactively* to ***prevent***, or at least reduce the volume of, canal discharges as much as possible by accepting inflows when watershed conditions are wet and canal levels are high and rising but the canal is not yet discharging. It is also acknowledged that demand for irrigation supply is much lower now and is likely to remain reduced for at least the next several years. Should demand increase, the new operating protocol can be readjusted.

The Caulkins project, which was the first to launch, has the longest period of record at this interim stage in the demonstration project and the only record long enough to be the basis for the calculation of unit costs for performance measures; albeit the unit costs reported in **Table 1** are interim values, not final.

The values reported in **Table 1** for all three projects are based on monitoring data through December 31, 2015. The period of record for the data, in months, is 22.5 for Caulkins, 12 for Spur Land & Cattle, and just over four months for Evans Ideal 1000.

As reported in **Table 1**, the Caulkins water farm has retained 25,605 acre-feet of inflows from the C-44 Canal over 22.5 months. With a month and a half left in the two-year field test, the project has surpassed its original 24-month storage goal of 13,560 acre-feet by 12,045 acre-feet. Given the project goal was to retain 6,780 acre-feet per year, this performance provided almost two extra years' worth of canal water storage as an unexpected bonus. In addition to the volume of C-44 Canal inflows retained, the amount of direct rainfall retained on the Caulkins project site has totaled 2,878 acre-feet so far. With canal inflows plus rainfall, total retention on the Caulkins water farm was 28,483 acre-feet as of December 31, 2015.

The unit cost per acre-foot of inflows retained (not factoring in the rainfall amount) for the Caulkins water farm, based on the 22.5-month monitoring record, is $61.70 per acre-foot, considering the total *public* costs. That unit cost would drop to $47.20 per acre-foot if the 22.5-month record of performance were projected out to ten years, with recurring annual costs (O & M and the participation payment) continued in constant dollars. The estimated ten-year unit costs for the Caulkins project are shown in **Table 1**.

In a Section 319 water quality grant-funded demonstration project, the amount of nutrient attenuation is a crucial performance measure. The Caulkins project has so far retained, or removed from the regional system, a total of 13,558 pounds of phosphorous during the 22.5-month period of record, which exceeds the estimated load reduction for TP the District had predicted for all three projects in the application for the Section 319 grant. The initial estimated load reduction for the three projects was 13,282 pounds of TP in 24 months (**Figure 7** showed the 12-month estimate). The unit cost per pound of TP removed on the Caulkins project, based on 22.5 months of performance, is $116.55. That cost would drop to $89.13 in a ten-year projection of the pilot project's costs and performance, as shown in **Table 1**.

Total nitrogen removed on the Caulkins project has amounted to 88,162 pounds so far. That amount exceeds the initial estimated load reduction for TN for all three projects by 32,518 pounds. The unit cost based on the 22.5-month monitoring record is $17.92 per pound of TN removed, and it falls below $14 per pound in the ten-year projection, to $13.71 per pound of TN, as shown in **Table 1**.

The exceptional performance of the Caulkins pilot project alone has surpassed the initial aggregate goals, estimated for the three pilot projects, for total water storage and nutrient reductions in the Section 319 demonstration project. And the other two projects are on track to meet their individual goals for storage.

The annual water storage goal for the Spur Land & Cattle water farm of 870 acre-feet was nearly met in its first full year of operations. The total storage volume of inflows and rain was 799 acre-feet during the 12-month period of record.

The Evans Ideal 1000 project is in range to potentially meet its storage goal of 3,635 acre-feet per year by the time it completes its first 12 months of operations. Inflows and rainfall retention during the first four months of monitoring have totaled 2,571 acre-feet.

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Chapter 2. Regional Water Storage and Quality Goals: Could Water Farming Help?

2.1 Water Storage Goal

It is important to clarify that the surface water storage goal developed for the SLE 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 itself, known as the 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 CERP (the Comprehensive Everglades Restoration Plan). 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.

The University of Florida Water Institute released a report in March 2015, commissioned by the Florida Senate, to review extant studies and current plans for Everglades restoration and recommend options to move more water from Lake Okeechobee into the *southern* Everglades to reduce damaging discharges to the coastal estuaries, where lake water is periodically discharged east and west to lower the lake levels. The UF study was commissioned in the aftermath of a very heavy and sustained *regulatory release* to the estuaries in 2013, an event which became known as "The Lost Summer" in Martin and St. Lucie Counties and which prompted local protests. The UF Water Institute reported that even during the *Water Year* (WY) that contained the Lost Summer, 63 percent of the freshwater inflows to the SLE came from the local basin runoff, and 37 percent came from Lake Okeechobee. The long-term annual average the UF Water Institute reported for WYs 1997—2014 was that local basin runoff contributed 77 percent of the total inflows to the SLE. The UF Water Institute summarized the finding by stating, "…local runoff is a larger contributor of freshwater inflows than Lake Okeechobee," and added, "Thus to reduce damaging high freshwater discharge to the estuaries, inflows from both Lake Okeechobee and the local basins must be reduced."[55]

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[56] and that target was incorporated into the SFWMD's St. Lucie River Watershed Protection Program. The goal was predicated on the assumption that other CERP projects would be constructed to control Lake Okeechobee discharges. Yet the IRL-S group of projects, listed below, was presumed to provide an estimated 88 percent of the intended restoration benefits to the estuary even if other CERP projects are never constructed.[57]

The group of recommended IRL-S projects, called the Recommended Plan, consists of five features:

1. **Reservoirs**. Construction and operation of four above-ground freshwater storage reservoirs, and their connecting canals, control structures, levees and pumps, providing approximately **130,000 acre-feet of storage**. These would capture water from the C-44, C-23, C-24, and C-25 Canals to reduce peak flows to the SLE.

2. **Stormwater Treatment Areas**. Construction and operation of four stormwater treatment areas (STAs). These STAs would be built on (and require acquisition of) approximately 8,731 acres of existing agricultural and pastureland, and provide about **35,000 acre-feet of storage**. Their operation would reduce sediment, phosphorous and nitrogen deliveries to the estuary and allow for restoration of estuarine water quality.

3. **Natural Storage and Treatment Areas and North Fork Floodplain Restoration**. The natural storage and water quality treatment areas include acquisition and restoration of approximately 92,130 acres of upland/wetland mosaic in Martin, St. Lucie and part of Okeechobee Counties, through alteration of drainage ditches to provide multiple benefits. These areas would provide additional freshwater storage of about **30,000 acre-feet**.

4. **Water Diversion**. The diversion of existing flows via a canal connection and operating rules on new reservoirs and STAs would reduce negative impacts from C-23 and C-24 to the middle estuary and provide more of a natural freshwater pattern in the North Fork of the St. Lucie River.

5. **Muck Removal and Habitat Improvement**. Removal of 7.9 million cubic yards of muck located in the North Fork, South Fork and Middle Estuary would provide immediate and potentially dramatic improvement in water quality as well as improvements in habitat quality and extent.[58]

A total of 195,000 acre-feet of storage is identified in the preceding description of the five features of the IRL-S recommended plan. The four regional reservoirs and STA projects (R/STAs) account for 84 percent of the storage.

Water farming is not 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 too great to be pumped into a reservoir fast enough to make an appreciable difference. Wet-season lake discharges will unfortunately rush past not only the Caulkins water farm located on the C-44 Canal, but also the massive C-44 Reservoir and STA now under construction in the C-44 basin near the Caulkins water farm. Many local citizens do not realize that this $600-million-dollar public reservoir project, one of the four public reservoirs specified in the IRL-S plan, will not mitigate the onslaughts from Lake Okeechobee when they occur. Water farms and the public reservoirs and STAs that are planned as part of IRL-S/CERP will help manage runoff from the local watershed only; however, there is also a great need for such management.

2.2 Water Quality Goal: Basin Management Action Plan for the St. Lucie River and Estuary

A Basin Management Action Plan, or BMAP, is a regularly updated document that details how sufficient reductions in specific pollutants will occur over time to achieve the established Total Maximum Daily Load[59] (TMDL) for the receiving waterbody. A period of fifteen years is usually set for reaching a TMDL goal in Florida, with interim partial reduction targets set from BMAP inception, such as at three five-year intervals in the case of *the St. Lucie River and Estuary BMAP* (or SLE BMAP). DEP hosts and provides technical support to the collaborative local process, involving stakeholders, in which BMAPs are initially developed and then updated. BMAP stakeholders are the entities, or the representative of the entities or groups, which have been identified as contributors to the pollutants that must be reduced collectively in the watershed. The pollutants of concern in the SLE BMAP are the nutrients nitrogen and phosphorous.

The SLE receives drainage from a comparatively large land area in relation to the size of the waterbody. As noted in the 2015 South Florida Environmental Report, the ratio of watershed area and SLE surface area is approximately 150:1, or fully 27.3 times greater in comparison to the 5.5:1 ratio of Tampa Bay[60] (for which an alternative to a BMAP, a Reasonable Assurance Plan, has achieved exemplary results).[61]

The freshwater runoff from such a large drainage area can send the SLE into so-called low salinity shock, when a deluge of freshwater from the drainage canals drastically lowers the salinity level in the estuary for a prolonged period. In this watershed, the volumes of pure freshwater alone would be harmful enough to the estuarine ecology.[62] The freshwater carries a pollutant load as well, however, which increases the ecological harm to the SLE.

The benchmark used to track progress in the SLE BMAP process is a periodic nutrient concentration reading taken in the SLE at the Roosevelt Bridge in the City of Stuart, in Martin County. The BMAPs which address segments of the Indian River Lagoon farther north along the Treasure Coast track progress instead by measures of sea grass coverage in the lagoon.

The SLE BMAP area does not include the C-25 basin, although it is considered to be part of the SLE Watershed, because the C-25 Canal does not discharge into the SLE. Instead, the C-25 discharges directly into the Indian River Lagoon. (The SLE is a major tributary to the IRL.)

The SLE BMAP does not pertain to any pollutants other than TN, TP and Biochemical Oxygen Demand (BOD), for which TMDLs were established.[63] Other pollutants have been acknowledged in other studies, however. For example, the IRL—South study, which included the C-25 basin, noted that pesticide contamination detected in C-25 Canal sediments were among the highest detected in the Indian River

Lagoon Watershed. Heavy metal concentrations, copper in particular, were also found to be very high in the C-25, "which discharges to the most pristine portion of the most biodiverse estuary in North America [the IRL]." [64]

The SLE BMAP does not include the contribution of nutrients to the SLE in the periodic discharges from Lake Okeechobee. A separate BMAP for Lake Okeechobee has been developed. The SLE BMAP is one of many BMAPs in Florida but it has the distinction of having the largest *quantified* nutrient reductions that Agriculture[65] must achieve in the state so far.[66] The nutrient reduction that Agriculture must make in the larger agricultural Lake Okeechobee Watershed has not been quantified in that BMAP yet. Agriculture is one of the 11 substantial (non-de minimus) stakeholders participating in the SLE BMAP.

There are 18 SLE BMAP stakeholders. Seven of the stakeholders were considered to be *de minimus.*[67] De minimus stakeholders were initially identified and their progress is being tracked but their contribution to the problem was considered to be too minor to be given an *allocation* in the first iteration of the BMAP. An allocation is the maximum amount of the nutrients a stakeholder is allowed to discharge annually, measured in pounds or metric tons (MT). (The total of all allocations given to BMAP stakeholders will be close to a TMDL limit.) A stakeholder's allocation invariably comes with a required nutrient reduction. In the development phase of a BMAP, each stakeholder is assigned a starting load that represents how much of the total nutrient load in the watershed is attributable to that particular stakeholder, based on local land use/land cover data. An allocation is also issued to each non-de minimus stakeholder. The difference between the starting load and the allocation is the required reduction to be made by each stakeholder.

Agricultural land use accounts for 54 percent of the SLE Watershed. It follows that Agriculture had the largest starting load among the 11 allocated SLE BMAP stakeholders. Agriculture was assigned 73.5 percent of the entire starting load for TP and 71.4 percent of the entire starting load for TN, as shown in **Tables 2a** and **2b**. The BMAP stakeholders are listed in descending order per the size of the starting load, with Agriculture at the top of the list in **Tables 2a** and **2b**. Other largely agricultural stakeholders such as the Water Control Districts (WCDs) were given individual allocations apart from monolithic *Agriculture* and are represented in the BMAP by the WCD entities. Agriculture is represented in the BMAP by the Florida Department of Agriculture and Consumer Services (FDACS) Office of Agricultural Water Policy.

The original SLE BMAP document was published in 2013. The stakeholders are allowed up to 15 years to achieve their required reductions, until 2028. There have been two annual SLE BMAP progress reports published since the process began. The most recent report was released in December 2015. The progress report explained that the first five-year interim target of about a 33 percent reduction had already been exceeded by the stakeholders, which is good if not surprising news, as credits were given for completed nutrient reduction projects dating back to the year 2000. BMAP credits are usually based on *estimated* reductions for the projects.[68]

The BMAP progress reports do not include an account of the amount of nutrient reductions that the stakeholders still need to make to reach the ultimate goal by the end of the 15-year process in 2028. **Tables 2a and 2b** were created to offer that account for TP reductions (**Table 2a**) and TN reductions (**Table 2b**). Although Agriculture has received more than half of all credits given by DEP for nutrient reductions, the percentage of *total* remaining reductions in the BMAP that must be made by *Agriculture* has increased since the start of the process. Those percentages are given in the last row of these tables.

As shown at the bottom of **Table 2a**, Agriculture's share of the total remaining reductions required for TP by 2028 has increased from about 76 percent in 2013 to 85 percent in 2015, as other stakeholders reduced their own nutrient loads. Agriculture's share of the total remaining reductions required for TN, which was initially 77 percent is now at 94.5 percent (shown in **Table 2b)**. A significant amount of credits for TN has been granted by DEP for septic tank to sewer system conversion projects completed by several BMAP stakeholders, which has resulted in some having not only reached their 2028 reduction goal by 2015 for TN but have even surpassed it, into negative numbers.

The current SLE BMAP goals for water quality, the required reductions remaining in the BMAP across all stakeholders to reach the 2028 target, is *268,296 pounds per year of TP* (down from the starting load of 531,182 pounds per year), *and 563,713 pounds per year of TN* (down from 2,189,658 pounds per year). Those values are shown in **Tables 2a and 2b**. (Negative numbers are not included in the column totals.)

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Table 2a. SLE BMAP Stakeholders' Progress Chart for TP Reductions, as of June 2015

BMAP Stakeholder	Starting Load (2013)	Allocation (2013)	Reductions Required	Reductions Credited (2015)	Required Reductions Remaining (2015-2028)
	TP lbs/yr	**TP lbs/yr**	**TP lbs/yr**	**TP lbs/yr**	**TP lbs/yr**
Agriculture	390,312	83,253	307,059	78,979	228,080
North St. Lucie Water Control District (WCD)	45,884	12,250	33,634	19,087	14,547
City of Port St. Lucie Municipal Separate Storm Sewer System (MS4)	35,016	11,585	23,431	9,319	14,112
Martin County MS4	22,369	7,779	14,590	7,920	6,670
Troup-Indiantown WCD	12,623	4,504	8,119	7,941	178
Hobe St. Lucie Conservancy	5,252	1,732	3,520	3,300	220
St. Lucie County Non-MS4	6,072	1,572	4,500	1,481	3,019
St. Lucie County MS4	4,127	1,278	2,849	2,028	821
City of Fort Pierce MS4	3,879	1,186	2,693	2,675	18
City of Stuart MS4	3,106	1,044	2,062	2,110	-48
FDOT District 4	2,542	833	1,709	1,078	631
Column Totals: TP pounds/year	**531,182**	**127,016**	**404,166**	**135,918**	**268,296***
	Agriculture's share of the total starting load for TP: 73.48%		Agriculture's share of total required TP reductions (in 2013): 75.97%	Agriculture's share of total TP reductions credited: 58.11%	Agriculture's share of total required TP reductions remaining as of 2015: 85.01%

*Negative value is not included in the total.

Table 2b. SLE BMAP Stakeholders' Progress Chart for TN Reductions, as of June 2015

BMAP Stakeholder	Starting Load (2013)	Allocation (2013)	Reductions Required	Reductions Credited (2015)	Required Reductions Remaining (2015-2028)
	TN lbs/yr	TN lbs/yr	TN lbs/yr	TN lbs/yr	TN lbs/yr
Agriculture	1,563,122	750,198	812,924	279,934	532,990
North St. Lucie WCD	197,403	109,557	87,848	69,127	18,721
City of Port St. Lucie MS4	156,481	103,380	53,101	63,667	-10,566
Martin County MS4	100,813	68,655	32,158	41,511	-9,353
Troup-Indiantown WCD	62,219	37,125	25,094	25,055	39
Hobe St. Lucie Conservancy	24,193	14,731	9,462	10,288	-826
St. Lucie County Non-MS4	23,760	14,394	9,756	4,172	5,584
St. Lucie County MS4	18,114	11,386	6,728	5,274	1,454
City of Fort Pierce MS4	17,041	10,562	6,479	4,562	1,917
City of Stuart MS4	13,998	9,238	4,760	6,850	-2,090
FDOT District 4	12,514	7,408	5,106	2,098	3,008
Column Totals: TN pounds/year	**2,189,658**	**1,136,634**	**1,053,416**	**512,538**	**563,713***
	Agriculture's share of the total starting load for TN: 71.38%		Agriculture's share of total required TN reductions (in 2013): 77.17%	Agriculture's share of total TN reductions credited: 54.62%	Agriculture's share of total required TN reductions remaining as of 2015: 94.55%

* Negative values are not included in the total.

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Table 3 offers more details of the required nutrient reductions for Agriculture, and the adjustments made. A credit of about 20 percent of their required nutrient reductions was given to Agriculture for adjustments in the land use/land cover data from 2004 that had been used to assign the starting loads to Agriculture. FDACS submitted to DEP land use updates based on more recent aerial imagery, which reduced the acreage in active agriculture. The updates took into account shifts from agriculture to development and the increased acreage of fallow citrus groves, to which agricultural best management practices (BMPs) do not apply. The credits for land use changes totaled 171,776 pounds per year of TN and 54,191 pounds per year of TP and were recorded in the original BMAP document in 2013, as shown in **Table 3**. DEP also granted Agriculture another large number of credits for the "estimated load reductions via BMPs" for a 90 percent target enrollment[69] of all applicable acreage in the watershed (per FDACS' adjusted total acreage, excluding fallow groves and agricultural acreage within the WCDs). Agriculture was given the full measure of credits in 2013 for attaining the five-year goal of a 90 percent BMP enrollment level although that goal had not yet been reached. Granting those credits was inconsistent with the usual practice of granting credits only after a project has been implemented or, in this case, a goal has been met. The credits granted in 2013 for the BMP enrollment goal were 108,158 pounds per year of TN and 24,788 pounds per year of TP.

As of the 2015 BMAP progress report, FDACS reported that agricultural producers had submitted 247 Notices of Intent (or NOIs, with each submission to FDACS counting as an enrollment in the BMP program), representing 133,488 acres, or 62 percent of the adjusted agricultural acreage.[70] There are nearly 60,000 acres yet to be enrolled in the BMP program to attain the 90 percent agricultural BMP enrollment goal in the St. Lucie Watershed.

What has not been reported in the BMAP documents so far but is shown in the last row of **Table 3** are the required nutrient reductions remaining for Agriculture after the 90 percent BMP enrollment goal has been reached: 443,932 pounds per year of TN (or 201 metric tons) and 212,426 pounds per year of TP (or 96 metric tons). That 15-year BMAP goal will not be met even if BMP enrollment reaches 100 percent. And it is clear the goal cannot be met via *standard* BMPs. Something else, much more, would need to be done.

Table 3. Required Nutrient Reductions for Agriculture (Not Including the WCDs*)

Account for Agriculture in the St. Lucie River and Estuary BMAP	**TN lbs/yr**	**TP lbs/yr**	**Comments** or Explanations
A. Starting Load for Agriculture	1,563,122	390,312	From the initial 2013 BMAP
B. Allocation for Agriculture	750,198	83,253	From the initial 2013 BMAP
C. Required Reductions for Agriculture (in 15 years, from 2013 to 2028)	812,924	307,059	From the initial 2013 BMAP: A-B = C
D. Credits: Estimated Load Reductions for Land Use Changes in Agricultural Acreage (From the Initial 2013 BMAP)	171,776	54,191	Resulted in a 21.1% drop in required reductions for TN and a 17.6% drop for TP
E. Credits: Estimated Reductions for BMP Implementation on Acreage with Notices of Intent Filed for BMP Program (62% BMP Program Enrollment on Adjusted Acreage as of June 30, 2014)	108,158	24,788	Resulted in a 13.3% drop in required reductions for TN and an 8.1% drop for TP
F. Adjusted Required Reductions	**532,990**	**228,080**	C – Credits (D + E) = F
G. Additional Credits for Estimated Reductions to Reach Five-Year Target of 90% of Adjusted Agricultural Acreage Enrolled in BMP Program (by 2018)	89,058	15,654	Credits allotted for 90% enrollment goal (197,216 for TN and 40,442 for TP) minus credits for 62% BMP enrollment as of mid 2014 (shown in row E) = G
H. Remaining Required Reductions for Agriculture Once the 90% BMP Program Enrollment Target Has Been Reached	**443,932** (or 201.4 Metric Tons)	**212,426** (or 96.3 Metric Tons)	F – G = H

*Agriculture, as a single BMAP stakeholder, does not include agricultural acreage within Water Control Districts (WCDs). The following largely agricultural WCDs have separate allocations and required reductions in the St. Lucie BMAP that are not included in this table: Hobe St. Lucie Conservancy District, North St. Lucie River Water Control District, and Troup-Indiantown Water Control District.

2.3 Water Farming as an Interim, or Supplemental, or Alternative Measure to Help Meet Goals

Water farming on fallow citrus groves is a new practice currently in the testing phase. There are varied and evolving opinions on the purpose of water farming and the role it could or should play—if any—in the regional watershed restoration plans, including the NEEPP, IRL–S/CERP plan and the SLE BMAP.

Water farming is most commonly considered to be a potential interim measure to employ before the large public projects, especially the regional reservoirs and STAs recommended in the Indian River Lagoon – South study, come on line. As recounted in section 1.1 of this report, water farming has been regarded as a practical interim strategy since the advent of the concept.

There is a drawback to using water farming as an interim strategy alone that is recognized even by water farming advocates, particularly if the practice is publicly funded for implementation on a sufficient scale to provide interim storage comparable to the amount the regional reservoirs will provide in the future. If water farmers are paid to provide the temporary service for the next ten or fifteen years, the drawback is acknowledged in the form of a question commonly posed: "And *then* what?" The thoughts accompanying that question pertain to specific considerations such as:

- Are public dollars well spent if, at the end of the interim, the water farms just stop?
- If the public spending does not result in public ownership of the land and water farming infrastructure, is that a wise public investment?
- Wouldn't this strategy add more costs to the high costs of the public projects to come, and is having this faster solution worth that?

The "And then what?" question is obviated when water farming is regarded as a supplemental strategy to augment the restoration plans on an open-ended basis and help meet water quality goals in the watershed.

The surface water storage goal of 200,000 acre-feet derived from the IRL-S study will address a *portion* of the freshwater inflows to the SLE. The St. Lucie River Watershed Protection Plan (2009) stated that, on average, the SLE receives about 818,000 acre-feet of inflows per year from the three major canals draining into the estuary: the C-23, C-24 and C-44.[71] The rule of thumb used by the IRL-S study team for runoff (resulting in inflows or discharges to the estuary) in the SLE Watershed was that there is a total of about 1,000,000 acre-feet in a wet year and about 360,000 acre-feet in a dry year.[72] According to these measures, the projects in the IRL-S recommended plan, if all are implemented, may store and treat up to one-fourth of the runoff when it is heavy and just over half (55 percent) when it is not, in the drier years.

Those more familiar with those details of the storage capacity in the IRL-S plan in relation to the storage needs are also those who say it would be appropriate to have additional storage beyond the IRL-S plan.[73]

In regards to attaining water quality targets for the SLE, the IRL-S study team stressed that it will be essential to couple implementation of the recommended plan with aggressive source reduction BMPs, including ancillary storage in the form of water detention on private lands in the watershed. For instance, (two excerpts from the *Final IRL-S Project Implementation Report and EIS* of 2004):

> The success of configurations is dependent upon establishment of effective and aggressive source-reduction BMPs. Effective BMPs may include detention of water on those private properties presenting larger (upper 33%) nutrient loads. These and other ancillary methods to detain water may be required in addition to the regional to help attenuate flows and reduce in-canal pollutant loads. A major unresolved issue is the identification of a funding source for the on-site agricultural reservoirs and water management systems. One possible solution might be a joint private-governmental incentive program to share costs. Failure to include adequate BMPs as an integral part of the implementation of a regional system will result in the inability of the project to meet future TMDL requirements.[74]

> Urban and agricultural BMP implementation will be required to reduce those pollutant loads that bypass the STAs or reservoirs. All water cannot be routed through facilities either due to intentional financially-driven design considerations or because waters are not physically capturable (e.g., residential runoff along the North Fork of the St. Lucie River, or urban stormwater flows downstream of water management district canal structures).[75]

More recent advice on attaining water quality goals was included in the University of Florida Water Institute's report in 2015 (*Options to Reduce High Volume Freshwater Flows to the St. Lucie and Caloosahatchee Estuaries and Move More Water from Lake Okeechobee to the Southern Everglades)*:

> Current Basin Management Action Plans (BMAPs) will not achieve Florida Department of Environmental Protection approved Total Maximum Daily Loads (TMDLs). To achieve water quality standards in Lake Okeechobee, the St. Lucie estuary and the Caloosahatchee estuary, more aggressive BMPs are required. New field-verified agricultural and urban Best Management Practices (BMPs) that protect water quality, advanced *in situ* treatment technologies, and the strategic placement of additional FEB-STAs [Flow Equalizer Basin-Stormwater Treatment Areas] in priority basins will be essential to achieve the State and Federal water quality standards. Beyond existing and planned approaches, the substantial reservoir legacy of phosphorous in the Northern Everglades watershed will necessitate new and more aggressive strategies to combat the mobility of phosphorous.[76]

Water farming is not listed among the standard agricultural BMPs in Florida. Standard BMPs, while important, will not be enough to meet the water quality goals—the TMDLs—in the St. Lucie Watershed. Water farming could be considered for inclusion, however, among a new set of stronger remedies that must be implemented in order to reduce the nutrient loads to the TMDL levels. Water farming offers the advantage of being able to help meet both the water quality and surface storage goals in the watershed.

2.4 Attributes of Water Farming

Many of the positive attributes of the water farming practice are listed and described in the following sub-sections. The two main *drawbacks* are 1) it is regarded as impermanent and, 2) it can be energy-intensive, when the deeper storage type of water farm is largely filled with inflows pumped in from regional canals using either diesel or electric powered pumps. (Most solar powered pumps are not yet powerful enough to lift the water many feet from the canals to the impoundments. That limitation could change in the future.)

2.41 Beneficial Use of Fallow Citrus Grove Infrastructure

Citrus greening disease (following citrus canker disease and destructive hurricanes) has resulted in a vast inventory of fallow groves which could become water storage vessels. Most groves have perimeter berms, perimeter seepage control canals and water intake pumps that can be used to turn the fallow groves into water farms at a relatively low cost for beneficial storage projects.

2.42 Rapid Implementation

Water farms can become operative in a matter of months instead of years. A very large water farm that could rival the capacity of a public reservoir specified in the IRL-S plan would take up to a year to build.

2.43 Supplemental Storage Capacity

As described in section 2.3 above, the plans for meeting the current storage goal of 200,000 acre-feet address only a portion of the average annual local basin runoff. Water farming could augment storage.

2.44 Nutrient Attenuation

Water farms are designed to take inflows from the regional canals and retain the water *and* its pollutants. These *no-release* projects have a presumed efficiency rate for nutrient reductions of 97 percent, which is currently being tested in the field with the pilot projects. A qualification to no-release is explained next.

2.45 Alternative Water Supply

It was posited in the 2012 AECOM assessment of water farming that larger water farms could provide an alternative source of irrigation water at the start of the dry season, as discussed in chapter 1, section 1.1. This would be a beneficial and controlled release to the regional system at a time when the supply could supplant groundwater pumping, to some extent. The extent to which water farms can provide alternative water supply (AWS) is, unfortunately, not under examination as part of the water farming demonstration project. Only one of the three pilot projects, Ideal 1000, could have been appropriate to test AECOM's estimate of AWS volume—on that very site—if it had been built as an Alternative #2 (deeper storage) instead of an Alternative #1 pilot project, as was mentioned in section 1.33. (The other two pilot projects were unsuitable for AWS consideration because the Caulkins pilot project is on a high percolation site and the Spur impoundment is small and intended to contribute any excess water into the adjacent slough, rather than back to the C-23 Canal.) Although assumptions about AWS specifically on water farms will not be empirically informed by the current field testing, it is not unreasonable to compare water farms to agricultural reservoirs which commonly and reliably collect and store surface water for irrigation supply.

USDA researchers found that the use of the Floridan aquifer for citrus irrigation supply has exacerbated the effects of citrus greening in the Indian River Citrus district due to its high chloride content and pH.[77] Surface water, when available, is the much preferred source of irrigation supply among citrus growers. The Indian River Citrus League envisions water farms increasing the available supply of surface water.

Water farms can also provide aquifer recharge to varying degrees, depending on the site conditions. The Caulkins water farming pilot project is an example of a water farm that provides a great deal of recharge.

2.46 Wildlife Habitat

The water farms in the demonstration project are proving to be a popular haven for a great variety of birds. One of the primary objectives of CERP is to increase the spatial extent of short hydroperiod wetlands, which experience periodic flooding and recession but are not continuously inundated. The IRL-South study identified the southern Indian River Lagoon region as "virtually the only area [in the greater Everglades] where this wetland restoration and creation objective can reasonably be met as large areas of undeveloped land remain available."[78] Water farms are shallow water containment areas in which water levels naturally recede in the dry season. These projects function like short hydroperiod wetlands and apparently provide attractive wildlife habitat, based on the many fish, birds, and other animals which frequent the sites. More research and observation over time is needed to verify the potential significant habitat benefits of water farms.

2.5 Potential Lower Cost Alternative for Components of the IRL-S Plan

The projected costs to complete the IRL-S recommended plan have been rising. The original cost estimate in 2004 to implement all of the five features of the IRL-S plan (listed in section 2.1) was $1,210,608,000. In 2013 the estimated cost of implementation was updated to $2,330,000,000. In 2014 the costs were adjusted to $2,401,596,000. In 2015, the estimated costs of implementing the complete IRL-S plan were increased to $4,022,534,000.[79] That $1.6 billion dollar adjustment was a 67 percent jump from the 2014 to the 2015 estimate, an increase that exceeds the total cost of the plan as originally estimated.

Boyd Gunsalus, lead environmental scientist with the SFWMD and project manager of the water farming demonstration project for the District, related a story during his public presentation on water farming.[80] He told the audience he has been working with the citrus industry since 1999 and was advised back then by IRCL member Stan Carter to, "Build a bridge between public and private entities and get involved in this before expensive reservoirs come on line." Mr. Carter suggested that public-private partnerships involving agriculture could provide an alternative to costly public works projects specified in CERP.

Boyd Gunsalus believes that water farming could provide an alternative to components of the IRL-S plan, particularly in the C-23 basin, where the practice could be implemented on both private and public lands, such as on parts of the District-owned footprints for the two regional R/STAs[81] on which construction is slated to begin in about 2021 (on the C-23/24 Reservoir North) and 2031 (the C-23/24 Reservoir South).

Further, U.S. Fish and Wildlife Service staff in the South Florida Ecological Services Office recognize the possibility that public-private partnerships with agricultural landowners could offer an alternative path to realizing at least some of the intended benefits of the full implementation of the third feature of the IRL-S plan (as listed in section 2.1): the Natural Storage and Treatment Areas.[82] The plan called for the public acquisition and restoration of 92,130 acres. Roughly one-half of that acreage has been acquired to date. Water farming or a related restoration practice could help fill that gap, if land buying remains on hold.

Some people are philosophically opposed to the idea of using public funds to pay private landowners for land rental and/or for providing an environmental service for a public benefit; they prefer the public land acquisition and management model instead—the model of the CERP, including the IRL-S plan. The President of the Florida Farm Bureau Federation, John Hoblick, has presented another point of view: "Taxpayers pay three times when government buys land. They must pay for the purchase, they must pay for the maintenance of the acreage and they must pay for the loss of local tax revenue caused by transfer from private hands to public ownership."[83]

The public land acquisition for the C-44 R/STA project cost about $200 million.[84] Additionally, the cost of site development/construction for the C-44 project is over $385 million. The capital start-up costs of $586,249,435 are double the original estimate for the project in 2004, when the C-44 project was initially on a fast-track to be completed by 2009.[85] That is only one of the *four* R/STA projects planned for the SLE Watershed, the only one that has been funded and is currently under construction. In comparison, the estimated initial capital costs to implement two of the largest proposed water farms in the SLE Watershed would be, for each, *one percent or less* of the actual initial capital costs of the C-44 R/STA. Each of the proposed water farms would have storage capacity comparable to the C-44 R/STA.[86] If Stan Carter were alive today, he might advise that there is still time to consider faster, less expensive storage alternatives.

Chapter 3. Potential Water Farms in the St. Lucie River Watershed

3.1 Indian River Citrus League's Membership Query

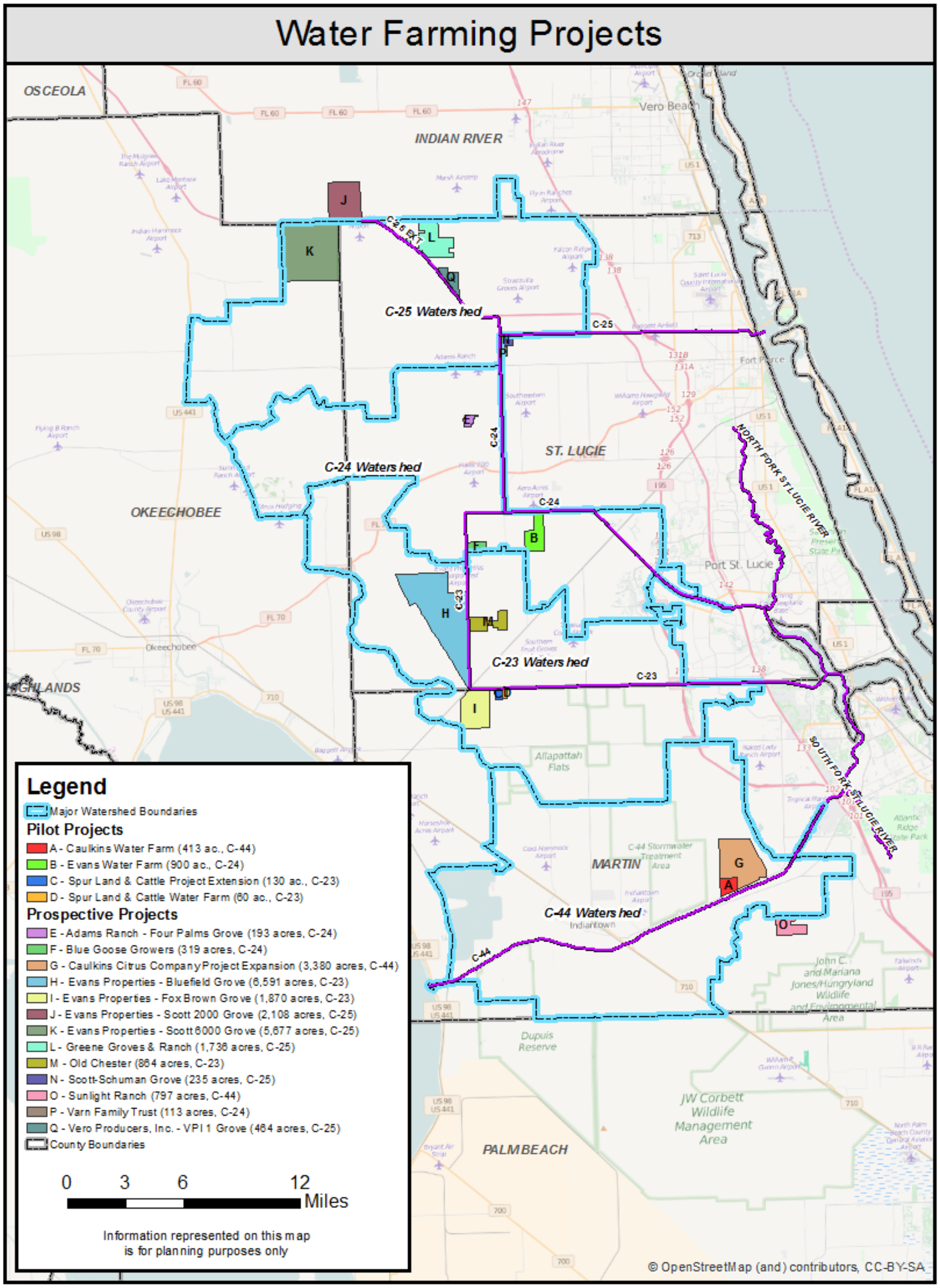
Executive Vice President of the Indian River Citrus League, Doug Bournique, sent an email to the IRCL's members on the Treasure Coast in December 2014 requesting a reply from anyone potentially interested in water farming. He explained in this email that his inquiry was in follow-up to a meeting with SFWMD staff on water farming, which included a discussion about the best way to accelerate opportunities for the practice on the Treasure Coast. The District staff had said that upon the conclusion of the water farming pilot study, if the results are favorable, the District may want to move forward with a solicitation for additional water farming proposals. The staff had stated that if the League created a list of growers who are interested in potentially participating in future water farming projects following the conclusion of the pilot study, it could allow the District to focus the solicitation, which may shorten the solicitation process. Mr. Bournique asked members who were willing to have their names included on the list that would be submitted to the water management districts (SFWMD and SJRWMD) to include size and location information about the groves to be considered as possible future water farms.

On January 30, 2015, Mr. Bournique submitted in an email to the Executive Director of the SFWMD the list of respondents to the League's water farming inquiry with groves in the South Florida District and, on the same day, sent a shorter list to the Executive Director of the SJRWMD of the respondents with groves in the St. Johns River District.

3.11 List of Prospective Water Farming Projects

There were 11 potential water farming sites submitted by the IRCL to the SFWMD, which included four different sites submitted by Evans Properties, Inc. Two additional potential sites were proposed to the SFWMD directly by fallow grove property owners who are not members of the IRCL: Caulkins Citrus Company and Burg & Company for Sunlight Ranch. Those 13 (in total) potential water farming sites constitute the list of proposed or prospective water farming projects discussed in this section. This list should *not* be understood to be an exhaustive list of all potential water farming sites, nor of all property owners who have expressed an interest in water farming to the SFWMD. It has also been said by some IRCL members that more potential water farmers would "come out of the woodwork" in considerable number if or when the key questions regarding funding availability and regulatory concerns (both topics are addressed in subsequent chapters in this report) have been adequately answered. The sites included in the list of 13 are shown on the map of the SLE Watershed, in **Figure 9**, along with the three current water farming pilot projects.

Figure 9. Pilot Projects and Potential Water Farm Locations in the St. Lucie Watershed



In the map legend, the pilots and proposed projects were listed in alphabetical order according to the grove owner's name or the name of the grove site. Each site was assigned a letter, A through Q, and a unique color. The projects list used in the map legend follows, with C-Canal basin location, the exact size in acres of each pilot project and the *approximate* size of each prospective water farm.[87]

3.12 Water Farming Projects Map Legend

Pilot Projects

A - Caulkins Water Farm (C-44), 413 acres

B - Evans Water Farm (C-24), 900 acres

C - Spur Land & Cattle Project Extension (C-23), adjacent slough 130 acres
D - Spur Land & Cattle Water Farm (C-23), primary impoundment 60 acres

Prospective or Proposed Projects

E - Adams Ranch - Four Palms Grove (C-24), 193 acres

F - Blue Goose Growers (C-23), 319 acres

G - Caulkins Citrus Company Project Expansion (C-44), 3,000 acres (including the pilot site)

H - Evans Properties - Bluefield Grove (C-23), 6,602 acres

I - Evans Properties - Fox Brown Grove (C-23)

J - Evans Properties - Scott 2000 Grove (C-25), 2,032 acres *in Indian River County (SJRWMD)*

K - Evans Properties - Scott 6000 Grove (C-25), 5,683 acres

L - Greene Groves & Ranch (C-25), 1,736 acres

M - Old Chester (C-23), 864 acres

N - Scott-Schuman Grove (C-25), 235 acres

O - Sunlight Ranch (C-44), 797 acres

P - Varn Family Trust (C-24), 113 acres (adjacent to "N" project)

Q - Vero Producers, Inc. - VPI 1 Grove (C-25), 464 acres

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The first thing to report about prospective projects is that the three participants in the demonstration project have been open-minded to possibly continuing their projects under a new contract for a term extending beyond the 24-month pilot test. The Caulkins Citrus Company would be interested in only an additional year of operation of the 413-acre pilot site, however, as the company would prefer to greatly expand the size of their project and operate a 3,000-acre site for at least ten years.

As for the list of the additional 13 potential projects, less than half have had a preliminary engineering study done of the potential site. (Studies are a considerable and speculative investment on the part of the grove owners.) Brief descriptions of the project locations are provided next, grouped according to C-basin location. Storage volume estimates are included in the description if available from an engineering study.

3.122 Prospective Projects in the C-44 Basin

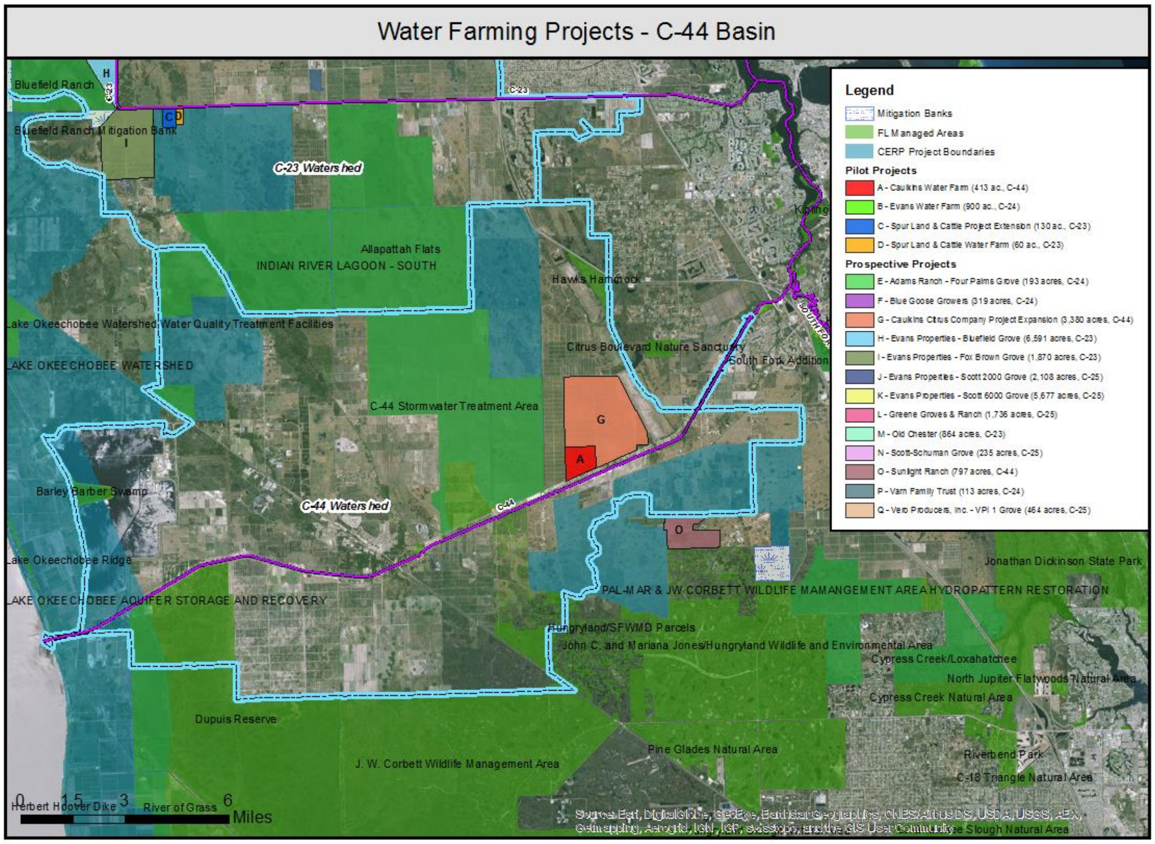
There are two proposed projects in the C-44 basin in Martin County, which are shown in a focus map of that basin, **Figure 9**. The two projects are the Caulkins Citrus Company's proposed 3,000-acre expansion (marked G) and the 797- acre Sunlight Ranch (marked O). The Caulkins project would add more water containment cells, like the pilot project, to cover the entire Caulkins-owned property with a water farm. This potential project is discussed in **Appendix 1**: Profiles of the Largest Proposed Water Farms. **Figure 10** shows the location of the Caulkins pilot project (marked A) and their proposed expansion project (G) in relation to the nearby C-44 R/STA under construction (labeled "C-44 Stormwater Treatment Area").

Sunlight Ranch is a nearly 800-acre property, consisting of two fallow groves and two 90-acre reservoirs, located south of the C-44 Canal. This is the easternmost site of all the proposed water farms. According to preliminary engineering estimates, the project would have the potential to store up to 11,000 acre-fee per year, if used only for water detention. The project could otherwise be operated as a reservoir-assisted STA, offering multiple options in this region, as presented in the preliminary engineering assessment:

> Not only does the property have the potential to become a permanent water dispersion area, providing long term capability of diverting water from the C-44 and recharging the water table while reducing damaging discharges to the estuaries, it is also strategically located such that if operated as a detention Stormwater Treatment Area (STA), the treated water could be diverted to the South Fork of the St. Lucie Estuary separately and downstream of the S-80 structure. This would allow low volume treated water to be discharged to the estuary and reduce the effect of high volume untreated discharges from the C-44. Detained water could also be discharged south through Pal Mar providing headwaters to help meet minimum flows to the NW Fork of the Loxahatchee River. All of the possible diversions of water can be conveyed offsite with existing canals and ditches.[88]

Water from the Sunlight Ranch project could also be dispersed to Corbett Creek or to Cypress Creek, which is in need of supplemental surface flow. The proposed project site is connected to the C-44 Canal now with irrigation canals and pumps, and the supplemental water from the project could be sent in different directions to benefit a range of environmentally important lands and water bodies in the vicinity with minimal modification to the existing infrastructure.[89]

Figure 10. Present and Potential Water Farms in the C-44 Basin



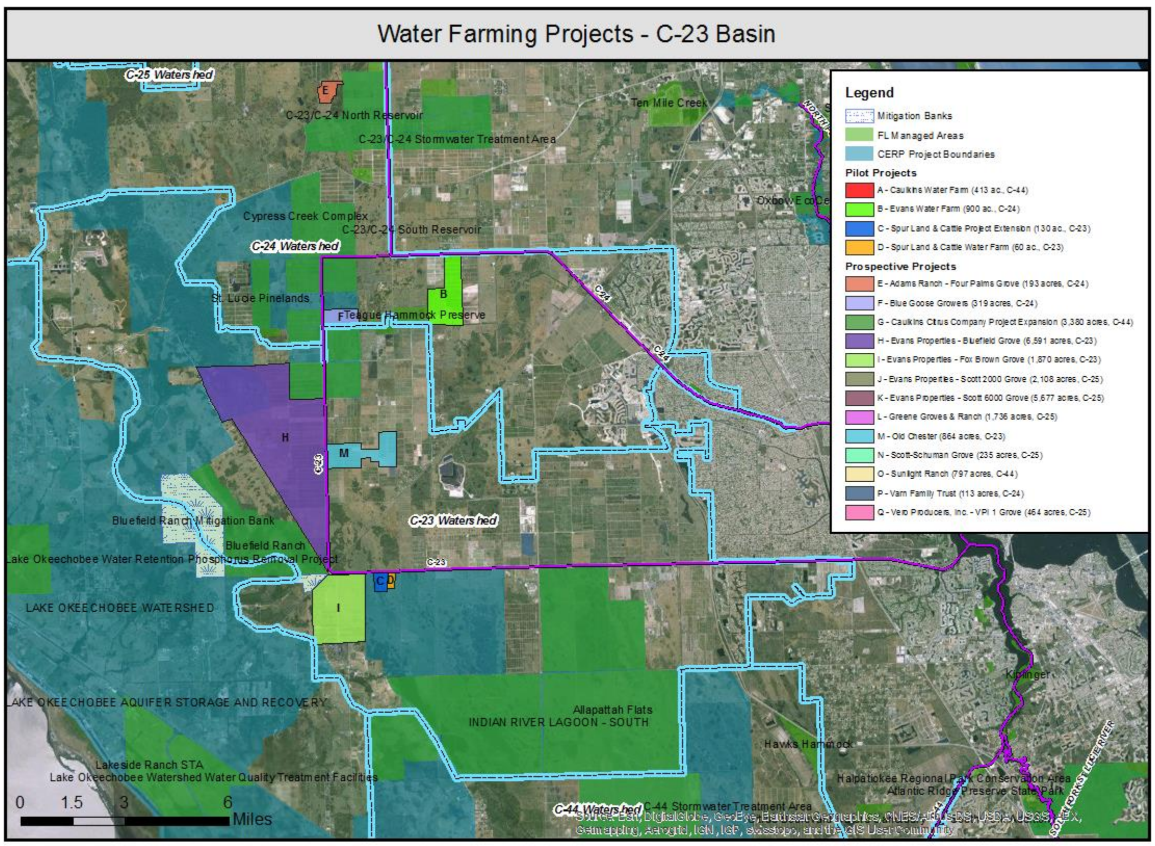
3.123 Prospective Projects in the C-23 Basin

There are four potential water farming project sites in the C-23 basin, as well as the current Spur Land & Cattle water farming pilot project. The location of these projects is shown on the focus map of the C-23 basin, **Figure 11.** The Spur Land project is marked D on the map, for the primary 60-acre impoundment, and C for the adjacent 130-acre slough. The pilot project is located on the south side of the C-23 Canal.

Bluefield Grove owned by Evans Properties is a triangular-shaped 6,602-acre grove (marked H). It is the largest of the 13 proposed project sites and is discussed, as part of a case study of the multiple projects proposed by Evans, in **Appendix 1** of this report. Along the western border of the Bluefield Grove is the privately owned (not by Evans Properties) 2,675-acre Bluefield Ranch Mitigation Bank, where a mosaic of wetlands and uplands are being restored, and the St. Lucie County-owned 3,285-acre Bluefield Ranch Preserve—encompassing the largest stand of native Florida scrub in the county. In the northernmost portion of the eastern border of Bluefield Grove is the southwest section of the lands purchased by the SFWMD for the future C-23/C-24 South Reservoir, which is one of the four regional reservoirs in the IRL-S plan. The northeast corner of the Bluefield Grove was purchased by the District for that R/STA project. The District-owned lands are shown in green in **Figure 11**, and in all of the maps of the basins included in this section. If Bluefield Grove would be developed as a water farm, Evans Properties would likely include that northeast section of Bluefield in the water farming project, in cooperation with the District, so that the perimeter berm that still surrounds that section of the grove could be used in the project (instead of building new berms to exclude that section from the water farming project site).

Evans Properties also owns Fox Brown Grove (marked I), located off the southern tip of Bluefield Grove. The Fox Brown Grove has sandy, highly permeable soils similar to the Caulkins site, according to Ron Edwards of Evans Properties. (The amount of acreage within Fox Brown that could be appropriate for a water farming site has not yet been determined.)

Figure 11. Present and Potential Water Farms in the C-23 Basin

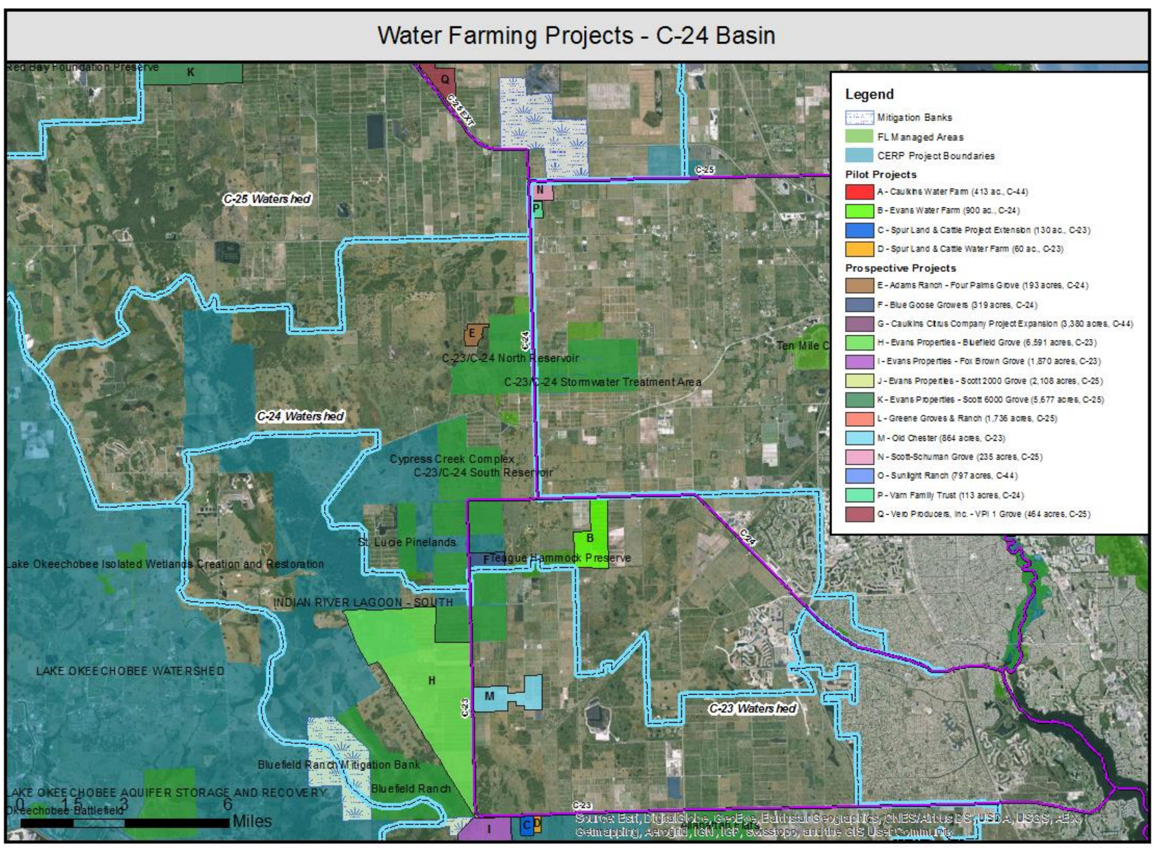


The Old Chester Grove (marked M) is an 864-acre property located near the midpoint of the east side of Bluefield Grove in the C-23 basin. The north-south segment of the C-23 Canal runs between Old Chester and Bluefield. The 319-acre potential site owned by Blue Goose Growers (marked F) is located along the same segment of the C-23 Canal as Old Chester and Bluefield Groves but farther north, at the border of the C-23 and C-24 basins.

3.124 Prospective Projects in the C-24 Basin

There are two proposed projects in the C-24 basin, which are the smallest of the 13 prospective projects. Those project sites as well as the location of the Evans Ideal 1000 water farming pilot project (marked B) are shown in the focus map of the C-24 basin, **Figure 12**.

Figure 12. Present and Potential Water Farms in the C-24 Basin



The two prospective projects in the C-24 basin are each less than 200 acres but are proposed as projects that could complement nearby potential projects. The 113-acre grove owned by the Varn Family Trust (marked P) is adjacent to and could be combined with the 235-acre Scott-Schuman Grove (marked N) to create a larger project site. The Varn Family Trust property is located along the C-24 Canal and is the southern neighbor of the Scott-Schuman Grove, which sits inside the corner formed by the C-24 and C-25 Canals.

The 193-acre Four Palms Grove owned by Adams Ranch, Inc. (marked E) is one of the two sites studied for AECOM's water farming assessment, completed in 2012 for the IRCL. The average annual storage volume of Four Palms Grove, per AECOM's estimates, is 798 acre-feet in the Alternative #1 scenario, and 1,076 acre-feet in the deeper storage Alternative #2 scenario (plus 342 acre-feet for alternative water supply—AWS). [90]

Water storage on the fallow Four Palms Grove is envisioned by Mike Adams, President of Adams Ranch, as part of a potential chain of lower cost, gravity-fed attenuation projects which could be implemented along a natural flow-way, to slow down and treat the drainage from 19,000 acres of improved pasture before it discharges into the C-24 Canal. Four Palms is near the eastern end of the flow-way and could be the last link in the chain of projects.[91] The proposed water farm abuts the SFWMD-owned land where the future C-23/C-24 North Reservoir will be located, as can be seen in **Figure 12**. A Four Palms water farm could augment the SFWMD's plans for creating interim surface water storage on District-owned lands before the public reservoirs are built.

3.125 Prospective Projects in the C-25 Basin

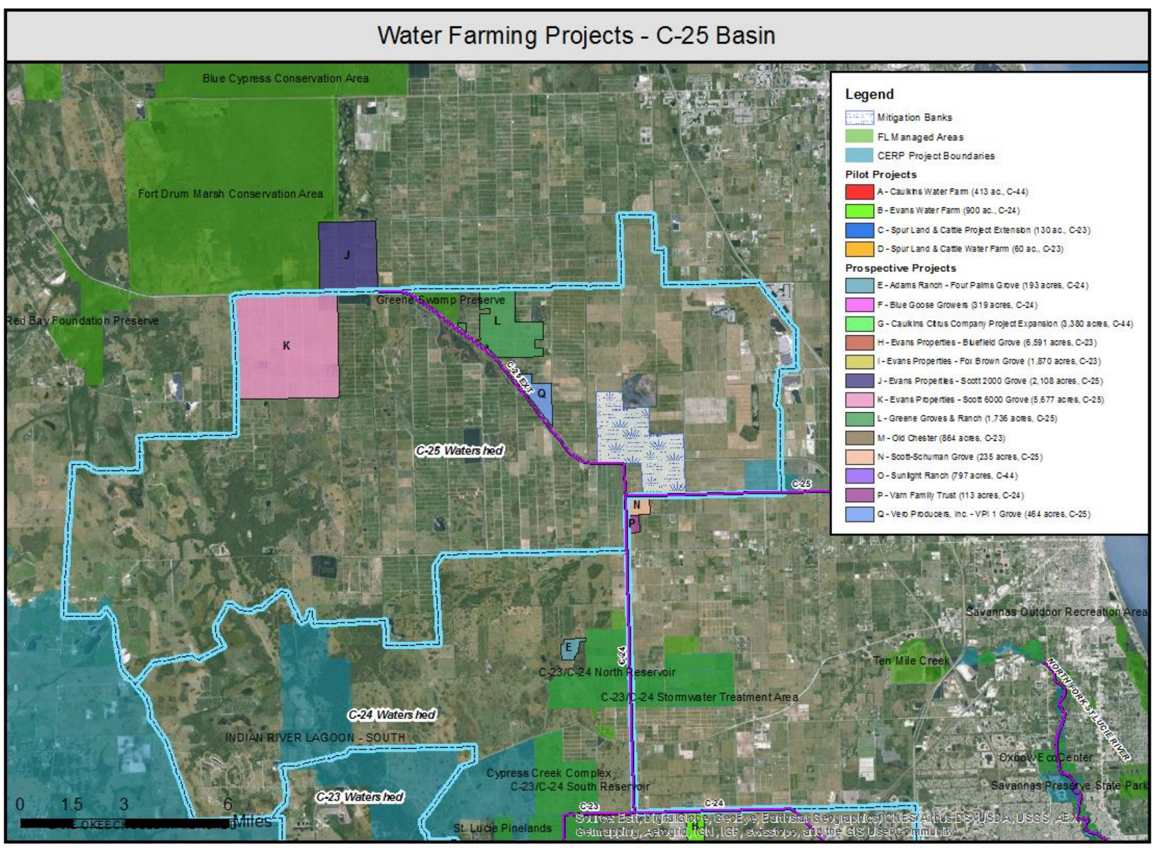
There are five proposed projects in the C-25 basin or bordering the basin and adjacent to the C-25 Canal or C-25 Extension Canal. The project sites are shown in the focus map of the C-25 basin, **Figure 13**.

Evans Properties has two prospective projects that could be designed to work independently or together: the 2,032-acre Scott 2000 Grove (marked J), which is located in Indian River County, and the nearby property to the south in Okeechobee County, the 5,683-acre Scott 6000 Grove (marked K). These two sites are also proposed as a possible location for a potential Reconnection project mentioned in chapter 1, section 1.1. The Scott 6000 Grove is proposed by Evans Properties as a future site of a large regional reservoir and Scott 2000 is where the accompanying STA would be sited. This project, called the Grove Land Reservoir and Stormwater Treatment Area (GLRSTA), is listed among the potential water supply projects in the Solutions-Strategies report for the Central Florida Water Initiative and in the SFWMD's 2016 Upper East Coast Water Supply Plan Update (Appendices). The initial capital costs to implement GLRSTA would be an estimated $435.4 million.[92]

There would be no downside, from an engineering perspective, to using these sites as much lower cost water farms as a precursor to the future construction of GLRSTA.[93] The estimated costs to implement and operate water farms on these sites are presented in detail in **Appendix 1**. In overview, the capital costs to convert Scott 6000 and Scott 2000 into water farms would be an estimated $6.88 and $2.27 million, respectively. Annual costs would total about $3.4 million for Scott 6000 and $1.3 million for Scott 2000.

Greene Groves and Ranch (marked L) is a 3,300-acre property on which an approximate 1,586 acres is proposed as a water farming site. The site is in St. Lucie County and has frontage along both the C-25 Extension Canal operated by the SFWMD and the C-52 Canal operated by the SJRWMD. The property is adjacent to the Greene Swamp Preserve, a publicly-owned conservation area that was donated to St. Lucie County. (A neighboring water farm would be compatible with the management of the Greene Swamp Preserve.)[94] A preliminary engineering report presented four different land area configurations with three different operating options given for each, for a total of 12 project options. The operating options presented were for water retention only (a hold-the-rain scenario), retention plus storage (the site would accept inflows from a canal), and AWS (surplus storage could be released in the dry season to either the South Florida or St. Johns River regional system). From the list of options, estimated average annual storage volume ranges from 7,507 acre-feet to 14,063 acre-feet (plus 10,352 acre-feet per year AWS).[95]

Figure 13. Potential Water Farms in the C-25 Basin



The VPI 1 Grove (marked Q) is a 464-acre potential water farming site owned by Vero Producers, Inc. It is located along the C-25 Extension Canal in St. Lucie County, just south of Greene Groves and Ranch. Southeast of the Vero Producers' proposed site is the 235-acre Scott-Schuman Grove (N) located at the intersection of the C-25 and C-24 Canals in St. Lucie County. As previously stated, the Scott-Schuman site could be coupled with the adjacent Varn Family Trust site for a total project size of about 348 acres.

3.2 Profiles of the Largest of the Proposed Projects (are in Appendix 1)

There is a great need for surface water storage in the SLE Watershed, especially in scenarios where water farming projects would be used either to supplement the storage provided by the future regional R/STAs in the IRL-S plan or to supplant regional reservoir storage in the C-23/C-24 basins. In the latter scenario, it could be that many water farms, large and small, would be needed. From an administrative perspective, however, a member of the SFWMD's Governing Board pointed out that it takes about the same amount of staff time and effort for the District to contract with and manage a small project as a large one.[96] From that perspective, larger, more impactful projects would be prioritized.

A case study profile of the four largest among the 13 proposed projects in terms of land area (2,000 – 6,600 acres) and estimated water storage volume (and AWS, if applicable) is included in **Appendix 1**. These profiled projects are proposed by two companies currently participating in the water farming demonstration project: Evans Properties and the Caulkins Citrus Company.

It should be noted here, however, that a common way to reduce the administrative costs of contracting for multiple smaller projects is to work with an intermediary, or project aggregator, who would bundle many projects into one portfolio. Aggregation can help make a group of smaller projects operate somewhat like one larger project. [97] Project aggregation can also help reduce the costs of project implementation because an intermediary can benefit from economies of scale if organized to implement multiple projects at once. There can be savings in both the soft costs (design, application review and permitting) and the hard costs (materials and equipment/staging) via the coordinated implementation of a batch of similar projects.[98]

The Indian River Citrus League, whether intentionally or not, has already taken a first step in potentially being a water farming project aggregator, by seeking to identify a constellation of potential projects.

3.3 Costs and Benefits of a Potential Regional Expansion of Water Farming

An estimate of the costs and benefits (performance measures) of the proposed water farm projects *in the aggregate* is presented in **Table 4**. The total acreage of the project sites proposed in the SLE Watershed and covered in this chapter (i.e., prospective projects E—Q in the map legend, with some adjustments)[99] is 20,006 acres.[100] A total of 20,000 acres was used for this estimate, which is intended to quantify the costs and the contribution the entire group of proposed water farms, if implemented, could make toward meeting both the surface water storage and nutrient reduction goals for the watershed. The assumptions used in this estimate are listed in the **Table 4** footnotes, detailed in **Appendix 2**, and are discussed next.

3.31 Estimated Initial Capital Costs

Although the acreage of the current pilot projects was not included in the tally of the prospective project acreage, even though those projects could potentially be continued beyond the testing phase, the actual costs of designing and building the pilot projects were considered in the calculation of the average cost of initial capital used in this estimation. Specifically, the average total start-up cost used in this estimation, of $1,359 per project acre for an Alternative #2 (deeper storage) water farm, is the average of the actual per acre costs to design and build the Caulkins and Spur Land & Cattle pilot projects (Ideal 1000 is an Alternative # 1) and the estimated capital costs of four proposed Alternative #2 projects (Bluefield, Scott 6000, Scott 2000, and the Caulkins expansion). The estimated costs of those proposed projects are based on the preliminary engineering studies of those projects, and those estimated costs are presented in the profiles in **Appendix 1**. Total initial capital, the one-time start-up costs to design and build 20,000 acres of water farms, is an estimated $27,180,000, as shown in **Table 4**.

3.32 Estimated Operations and Maintenance Costs

The total O & M costs per year for 20,000 acres of water farms is an estimated $2.6 million, as shown in **Table 4**. The average cost for O & M used in this estimation of $130 per acre per year is based on the estimated cost of O & M for the same four *proposed* projects used to calculate the average cost of initial capital, as shown in **Table 10** in **Appendix 2**. The O & M costs used for the projects proposed by Evans Properties are from the Retention and Storage plus Alternative Water Supply ("R & S + AWS") scenario shown in **Table 6c** in **Appendix 1**. Information about O & M from the pilot projects was not used for the following reasons: Ideal 1000 is an Alternative #1 project (and the average pertains to Alternative #2); the Spur Land & Cattle pilot project receives one all-inclusive participation payment; as such, separate costs for O & M were not determined for Spur; and the O & M expenses for the Caulkins pilot project include general and administrative charges that would more likely be covered instead by participation payments.

3.33 Estimated Annual Participation Payments

An annual participation fee of $500 per acre was used in this estimation, although it is acknowledged that not every prospective water farmer would consider that amount to be acceptable. The Caulkins Company has requested a payment of $700 per acre, for example, in one of their two payment option proposals. Yet $500 is a reasonable estimate, in keeping with the multiple proposals from Evans Properties, for instance. Other potential water farmers have made lower price proposals, such as $350 per project acre plus O & M from Greene Groves and Ranch. Estimated participation payments total $10 million per year, as shown in **Table 4**.

3.34 Year One and Recurring Annual Totals

As shown in **Table 4**, it would cost just under $40 million (i.e., an estimated $39,780,000) to design, build *and operate* 20,000 acres of water farms for the first full year. Annual costs thereafter would total an estimated $12.6 million (also shown in Table 4).

3.35 Estimated Range of Annual Storage Volume

Unlike the other elements of this estimation which have one value, an average, multiplied by 20,000 acres to arrive at an estimated total cost; a *range* of values is offered for the estimated annual storage volume. The average annual volume of water 20,000 acres of water farms could store depends on two factors: 1) the *static fill volume* of the impoundments and, 2) the number of static fill volume refills per year.

An estimate of the static fill volume, in acre-feet, of an Alternative #2 water farm is based on a standard equation used by the SFWMD: four feet of water multiplied by the number of acres in the impoundment. The static fill volume does not stay static for 12 months. Volume loss occurs during the year due to vertical seepage (infiltration/groundwater recharge), evapotranspiration and, perhaps in some cases, an annual controlled release of stored volume back to the regional system in the dry season to supplement agricultural irrigation supply (though the District does not expect AWS to be a reliable benefit on water farms). The volume loss can be replaced by holding more rainfall and accepting additional inflows from regional canals. (Consider this in terms of topping off the tank—adding volume—when the level falls.)

The second factor, the number of volume refills, is a variable that is heavily influenced by the specific site conditions of each water farm, especially the rate of vertical seepage or infiltration that can be expected, which is difficult to accurately predict. For example, three volume refills per year were initially predicted for the Caulkins Citrus Company's 413-acre pilot project, based on a preliminary engineering assessment, but an average of 8.62 annual refills per year have been observed in the field testing—nearly three times more than predicted mainly because the soil infiltration rate turned out to be much higher than estimated.

The number of volume refills depends on the dynamic process, over the course of a year, of adding water to the impoundment each time the stage, or water level in the impoundment, drops below the maximum level. Water is added if and when the available capacity to accept inflows occurs when pumping from a canal is permissible and desirable; generally during the wet season and when canal levels are relatively high. The periodic inflows that occur each time a water farm is brought back up to maximum stage can add up, during the year, to a volume equivalent to or exceeding the static fill volume. Rainfall retained also counts toward the cumulative refill volume (and can reduce the available capacity to accept canal inflows). If the added inflows and rainfall total the volume of the static fill, then the water farm would be said to have two volume fills, or two complete *refills* that year (equal to twice the static fill volume).

If a very large water farm is on a low infiltration site, then it would be less likely to accumulate enough added water during the year to match its very large static fill volume. If the added amounts total only 25 percent of the static fill volume, then the number of annual refills would be 1.25. In an exceptionally dry year the number of refills could be less than one, if the water farm would not fill up to maximum stage even once. Estimated storage volumes of the largest water farms proposed by Evans Properties, based on preliminary engineering assessments, indicate estimated average annual volume refills of only 1.367 for Bluefield (a 6,602-acre site) and 1.250 for Scott 6000 (5,683 acres), as shown in **Appendix 2**, **Table 12**. The average annual volumes that were estimated for those projects were based on a ten-year retrospective analysis that simulated available capacity for adding water during the year with the restriction imposed that inflows could occur only on the days when the adjacent canal was discharging to coastal waters and at a minimum flow rate of 200 CFS. If that restriction is lifted in practice, and water farms are operated more proactively to help prevent canal discharges, then the volume refill amounts would likely increase.

The static fill volume of 20,000 acres of water farms would be 80,000 acre-feet (20,000 acres x 4 feet). The annual storage volume of the collection of water farms is likely to be in the wide range of 120,000 to 200,000 acre-feet, based on applying the volume refill rates of 1.5 to 2.5 per year to all 20,000 acres. At the high end of the range, the storage goal for the SLE Watershed of 200,000 acre-feet would be met with 20,000 acres of water farms. When separate refill rates are applied to the three large projects representing 76 percent of the total 20,000 acres of proposed water farms, and one average rate is applied to the rest of the project acreage, the estimate of total storage volume for all the water farms is narrowed to a range of 151,294 to 170,332 acre-feet per year, as shown in **Table 13** in **Appendix 2**, which would meet 76 to 85 percent of the storage goal for the SLE Watershed. The midpoint of the wide range and the average of the narrowed range is 160,000 acre-feet per year of storage, which would meet 80 percent of the storage goal.

A 2.5 annual refill rate, which is used in the high end of the estimated range of the total storage volume shown in **Table 4**, is a reasonable expectation across varying site conditions, but it is not a conservative assumption. The 1.5 refill rate used in the low end of the estimate is decidedly conservative to use as an average for water farms of all sizes, especially the smaller projects. To put the 2.5 rate in perspective, the number of refills measured at the two Alternative #2 pilot project sites by the end of 2015 was 3.329 on Spur Land & Cattle (in 12 months) and 8.620 on Caulkins (per year, based on a 22.5-month record), for an average of 5.97 refills per year for both projects. A far lower average refill rate of 2.5 was used in the estimate because the site conditions of the Caulkins project, which enable its outstanding performance, are assumed to be quite uncommon. Moreover, the 60-acre Spur Land & Cattle site is uncommonly small (thus has a small static fill volume, which could mean more refills are likely, although, on the other hand, it also has a very low seepage rate). **Table 12** in **Appendix 2** has more information on the refill variable.

The results of the storage volume estimates show that it would likely take a *minimum* of 20,000 acres of water farms to fully meet the water storage goal for the SLE Watershed of 200,000 acre-feet per year, as shown in **Table 4**. The particular projects proposed are quite likely to meet at least 80 percent of the goal.

Table 4. Estimate for Proposed 20,000 Acres of Water Farms: Cost and Performance

For 20,000 Project Acres of Alternative 2 Water Farms (Storage Depth of Four Feet)	Year One	Ten-Year Projection
1. Initial Capital (Total Start-Up Costs)	$27,180,000[7]	
2. Recurring Annual Costs:		
a. Operations and Maintenance per Year	$2,600,000[8]	
b. Participation Payment per Year	$10,000,000[9]	
c. Total Annual Costs	$12,600,000	
3. Total Project Costs (start-up plus annual)	$39,780,000	**$153,180,000**
4. Volume Storage per Year (Range):		
a. Low (at 1.5 Volume Refills per Year)	120,000 acre-feet	1,200,000 acre-feet
b. Midrange (at 2 Volume Refills per Year)	160,000 acre-feet	1,600,000 acre-feet
c. High (at 2.5 Volume Refills per Year)	200,000 acre-feet[10]	2,000,000 acre-feet
5. Percentage of SLE Watershed Storage Goal (Range)	60 (a)-100 percent (c)[11]	
6. Unit Cost of Water Storage (for Midrange Volume)	$248.63/acre-foot	$95.74/acre-foot
7. Total Nitrogen Removed per Year//Unit Cost	584,219 pounds[12]	$26.22/lb TN
8. Percentage of St. Lucie BMAP Goal for TN	132 percent[13]	
9. Total Phosphorous Removed per Year//Unit Cost	117,571 pounds[14]	$130.29/lb TP
10. Percentage of St. Lucie BMAP Goal for TP	55.35 percent[15]	

Appendix 2 provides more details on the basis of assumptions and values used in Table 4.

[7] Based on an average cost of $1,359/acre for planning, design and project construction costs (total initial capital).
[8] Based on an average cost of $130/acre for operations and maintenance (x 20,000 acres).
[9] Based on a cost of $500/acre for participation, or annual water farming services payment (x 20,000 acres).
[10] Based on static fill volume of 80,000 acre-feet (20,000 project acres x four feet of storage depth) with 2.5 refills each year (to replace water volume lost from infiltration, evapotranspiration and optional AWS storage release).
[11] Percentage of the St. Lucie River and Estuary Watershed's surface water storage goal of 200,000 acre-feet.
[12] Based on 120,000 ac-ft/year of canal inflows retained (i.e., 75% of midrange annual storage of volume), with TN concentration of 1.789 mg/l, based on the average concentration in C-44, C-24 and C-23 Canals from the pilot project monitoring record through 12/31/15.
[13] The required reductions remaining for TN = 443,932 pounds/year for Agriculture, per SLE BMAP 2015 update.
[14] Based on 120,000 ac-ft/year of canal inflows detained (75% of midrange storage volume), with TP concentration of 0.367 mg/l, based on average concentration in C-44, C-24 and C-23 Canals from pilot project monitoring record.
[15] The required reductions remaining for TP = 212,426 pounds/year for Agriculture, per SLE BMAP 2015 update.

3.36 Estimated Nutrient Reductions

If 20,000 acres of water farms were implemented, the projects would also provide a reduction in TN loading that would not only meet but would exceed the required reductions remaining for TN, per the December 2015 SLE BMAP update: an estimated 132 percent of the goal could be met for Agriculture. Additionally, the group of projects would meet an estimated 55.35 percent of the BMAP goal for the remaining TP reductions required on agricultural lands, as shown in **Table 4**. The nutrient reduction estimates were based on the midrange for total storage volume. If the total storage would exceed the midrange volume, then the nutrient reductions would be greater than the values shown in **Table 4**.

The unit cost of nutrient reductions on 20,000 acres of water farms is an estimated $26.22 per pound of TN and $130.29 per pound of TP in the ten-year projection shown in **Table 4**. The unit cost estimates were also based on the midrange storage volume.

3.37 Savings in Time and Money

As shown in **Table 4**, the estimated cost of constructing 20,000 acres of water farms is $27,180,000, which is a substantial sum. Yet if the choice were made to meet the water storage goal by making that investment instead of building <u>*all*</u> *three* more public R/STAs, the cost savings could be tremendous.

Consider that the C-44 R/STA can meet 30 percent of the storage goal for the SLE Watershed of 200,000 acre-feet, if using that facility's *maximum* storage capacity of 60,500 acre-feet, for start-up costs totaling about $600 million.[101] In comparison, 20,000 acres of water farms could meet an estimated 60 to100 percent of the storage goal at an initial capital cost of *less than five percent* (4.5 %) of the capital costs of that public R/STA. Moreover, the whole group of water farms could be operated for *ten years* at an estimated cost of about $153 million, or for 76 percent of the cost of just the land that was purchased for the C-44 R/STA (for $200 million[102]).

Fifty percent of the expenses to construct, operate and maintain the R/STAs will be borne by the federal government, via the U.S. Army Corps of Engineers. The cost-sharing agreement cuts the costs in half that the state would otherwise bear, and that is a significant savings. But the federal-state agreement for the CERP projects has proven to be very costly in terms of time: it has contributed to years of delay in getting planned projects on-line to begin helping the SLE. The water farms, in contrast, could be up and running within one year from executing a contract to commence. In comparison, it will take at least 20 more years before the rest of the R/STAs in the IRL-S plan could become operational, based on current forecasting.

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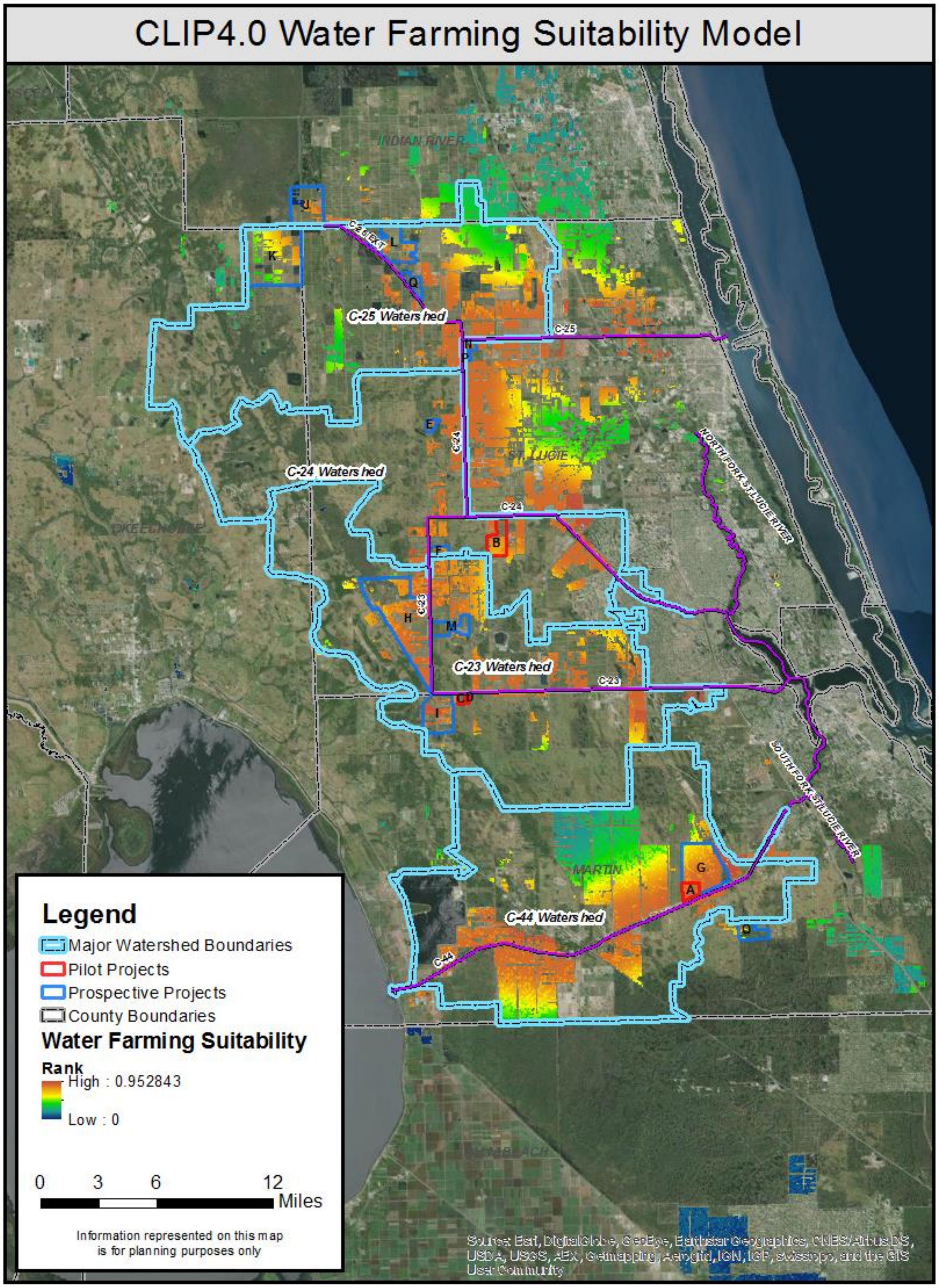
3.4 Land Suitability Model for a Potential Expansion of Water Farming

A preliminary screening analysis was conducted[103] to identify areas in the SLE Watershed that could be suitable for water farming based on the following criteria: fallow citrus groves close to major drainage canals with well-drained soils and water table depths indicative of areas with good soil storage potential. **Figure 14** shows the results of that screening analysis; and the 13 proposed water farms and the three water farming pilot projects are also shown, or sited on the watershed map, in the Figure 14 graphic using the same identification—lettering—for the projects as was used in the legend for all maps in this chapter.

The land suitability analysis output, shown as **Figure 14**, suggests that the 13 proposed water farms and the pilot projects are located in areas meeting the draft suitability criteria. **Figure 14** also shows there is ample additional acreage in the SLE Watershed which meets the initial water farming suitability criteria. The red and orange colors mean relatively greater suitability (red is the highest in the color scale, or key).

Figure 14. Water Farming Land Suitability Analysis in the St. Lucie River Watershed



Chapter 4. Federal and State Policies to Support an Expansion of Water Farming and Related Practices

Although there are 13 water farming projects proposed by current and prospective water farmers in the SLE Watershed, covered in the preceding chapter, some citrus industry experts believe the practice could become more widespread if key policies, which are critically important to water farmers, were in place. This chapter offers a summary of the federal and Florida State policies that could support water farming.

4.1 Federal Policy to Support a Regional Expansion

The top concern among potential water farmers, aside from the availability of funding for the practice, is the need to have sufficient regulatory protection provided by the U.S. Fish and Wildlife Service. Their specific concern is flooding a fallow citrus grove will attract federally listed Threatened and Endangered (T & E) wildlife species to the property, and the associated fear is that if T & E species take up residence on the property the landowner could confront legal challenges. Landowners want to secure the right to resume agricultural operations on their property upon the conclusion of a water farming contract term and to keep the option open to return their property to its prior condition, before it became a water farm.

Those concerns are not unique to would-be water farmers on the Treasure Coast of Florida. One way the U.S. Fish and Wildlife Service (USFWS, or the Service) has addressed similar concerns among private landowners in Florida and elsewhere is through a type of federal permit called a Safe Harbor Agreement (SHA). The SHA permit allows landowners who improve habitat conditions for federally listed species through management actions on their property to return their property to certain baseline conditions without penalty, even if there are listed species present as a result of the habitat-enhancing land management actions. The permission to return to baseline conditions can be called a *reversion clause*. Here is a sketch of how it works once a private landowner signs a Safe Harbor Agreement with USFWS:

> If participating landowners carry out the agreed upon habitat improvements, they may develop, farm, or ranch without fear of being stopped. They are required only to notify the Service to give it an opportunity to relocate any endangered species expected to be adversely affected by changes in land management.[104]

The assurances are provided by the Service through an *Enhancement of Survival Permit* issued to the landowner under the authority of section 10(a)(1)(A) of the Endangered Species Act (ESA), as part of an enrollment, or participation in an SHA. This permitting mechanism offers a net conservation benefit for federally listed or potentially listed (candidate) species, and is a cost-effective way to reduce the risk of species extinction. USFWS can increase the extent of supportive habitat for listed species without the need to publicly acquire or manage the lands.[105]

SHAs can be written for individual landowners or can be programmatic, whereby many landowners could sign on, at their option, to an umbrella agreement which could cover multiple species. A programmatic SHA could work well for water farming. But because it can take quite a lot of time and effort to develop and implement SHAs, the USFWS office in Vero Beach has been interested in finding a different way to address the regulatory concerns of the landowners.

4.11 Proposed Alternative to a Safe Harbor Agreement

To follow is an explanation of a proposed alternative to an SHA which could presumably be implemented faster than an SHA. This explanation was provided by the USFWS South Florida Ecological Services Office in Vero Beach on March 18, 2016, in response to a request for an update on this topic. (This is the alternative that was presented at a meeting convened by the IRCL on water farming on July 27, 2015. [106])

Discussions with Peninsula Florida Landscape Conservation Cooperative and USFWS personnel identified an alternative approach to a SHA: a Cooperative Agreement, to facilitate technical assistance and maximize the wildlife and other conservation benefits of water farming. The Cooperative Agreement, a federal action subject to ESA section 7 compliance, would address the prospect of reversion of the water farm to its former agricultural or other lawful use at the end of a contract, and any potential incidental take of listed species would be authorized in an accompanying section 7 Biological Opinion. These could be agreements with individual landowners, or one or more of the water management districts could also join the USFWS as a party to a programmatic Cooperative Agreement that could provide technical assistance and regulatory certainty, in relation to the ESA, to many water farmers along the Treasure Coast, if not also in a larger geography.

The basis of this alternative is USFWS discretionary authority to enter into Cooperative Agreements for the benefit of its "trust" resources such as migratory birds and threatened and endangered species. This authority is seated in the federal Fish and Wildlife Coordination Act (16 USC 661), Fish and Wildlife Act of 1956 (16 USC 742), and Partnerships for Wildlife Act (16 U.S.C. 3741). These statutes have been used extensively by the agency to facilitate conservation on private lands around the country since the early 1990s.

Procedurally, these types of agreements (inclusive of the requisite Biological Opinion) are not published in the Federal Register and thus could be completed in a more expedited timeframe. Similar to a SHA, implementation would entail working with the landowners to develop (typically brief) management plans for each water farm, which would describe the activities that will take place on the site such as where flooding will occur, how often the area will be flooded, and at what depths. The agreement/plan would also describe what will happen on the site throughout the life of the project (or contract term), including possible return to a dewatered, post-water farm state, as applicable. Each water farmer would also agree to the frequency of on-site monitoring, as part of the individualized management plan.

This SHA alternative would be similar to the technical guidance and regulatory protection that has been available for several years to the participants in the NE-PES program for DWM projects on ranchlands.

4.2 State Policies Supportive of a Regional Expansion

4.21 A Secure Baseline for Wetlands on Private Property

Potential water farmers have been concerned about the regulatory ramifications of creating a wetland on their property via the practice. But there is a provision in Chapter 373 of the Florida Statutes (373.4591) to address that concern. The provision that eliminated the risk of regulatory complications with wetlands created in newly flooded or reflooded areas was passed in the 2012 Legislative Session, with support from Audubon Florida which recognized the concern over wetlands creation as an impediment to landowner participation in the SFWMD's DWM program.[107]

Section 373.4591, F.S. begins with the statement, "The Legislature encourages public-private partnerships to accomplish water storage and water quality improvements on private agricultural lands." The section describes how a baseline condition determining the extent of wetlands on the property should be established and documented before new improvements or practices on the property begin under an agreement with a water management district or with FDACS. The baseline condition documented in an agreement "shall be considered the extent of wetlands and other surface waters on the property for the purpose of regulation under this chapter and for the duration of the agreement and after its expiration," per Improvements on Private Agricultural Lands, 373.4591, F.S.

Section 373.4591, F.S. was modified during the 2016 Legislative Session as part of the 134- page *water bill*, passed early in the 2016 Session as Senate Bill 552. No changes were made to the provisions for securing baseline conditions, regarding wetlands on private property. The language that was added in 2016 to section 373.4591, underlined in the section language to follow, indicates strengthened legislative support for, and prioritization of, water storage projects on private lands. The practice of water farming is recognizable in the expanded section, in which groundwater recharge is also explicitly acknowledged now (in what may be a nod to a pronounced attribute of the Caulkins water farm).

> Section 14. Section 373.4591, Florida Statutes, is 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.)

4.22 Greenbelt Tax Classification Secured for Dispersed Water Management Projects

A bill to encourage water storage projects on farmlands by allowing the projects to maintain agricultural greenbelt tax classification passed in the 2014 Legislative Session and became law. The provision that applies to Dispersed Water Management projects, in 193.461(7) (b), F.S., reads as follows:

> (b) Lands classified for assessment purposes as agricultural lands that participate in a dispersed water storage program pursuant to a contract with the Department of Environmental Protection or a water management district which requires flooding of land shall continue to be classified as agricultural lands for the duration of the inclusion of the lands in such program or successor programs and shall be assessed as nonproductive agricultural lands. Land that participates in a dispersed water storage program that is diverted from an agricultural to a nonagricultural use shall be assessed under s. 193.011 [factors to consider in deriving just valuation].

4.23 Senate Bill 536: Legislative Interest in the Expanded, Beneficial Use of Stormwater

Senate Bill (SB) 536, which passed in the 2014 Legislative Session, directed DEP to conduct a comprehensive study, in coordination with stakeholders, and submit a report on the expansion of use of reclaimed water, stormwater and excess surface water in Florida. Among the recommendations in the final report were two which pertained to DWM projects, including to water farming specifically:

> **Recommendations for Reducing Impediments to Dispersed Water Management**
> • Continued Funding. As discussed above, the major impediment to expansion of DWM programs is largely related to funding limitations. To the extent that the program has secondary benefits of aquifer recharge, habitat restoration and others, additional funding sources should be sought in support of these programs.
>
> • Continue coordination with the agricultural community on the use of fallow agricultural lands for Dispersed Water Management. The availability of fallow agricultural lands (such as citrus groves impacted by Citrus Greening) should be further developed as alternatives for near-term water storage and potential local/regional beneficial use. The WMDs should continue and enhance outreach to the agricultural community to further develop this concept.[108]

SB 536 demonstrated active interest, on the part of the Florida Legislature, in finding ways to better utilize excess stormwater and surface water, to protect water resources across the state.

4.24 Water Quality Credit Trading

The rules governing Water Quality Credit Trading (WQT) in Florida (Chapter 62-306 of the Florida Administrative Code) were revised through extensive public work shopping hosted by DEP, ending in 2015. The new rules, promulgated in January 2016, allow WQT throughout the state and make it feasible for nutrient reduction projects on agricultural lands to be eligible to generate water quality credits for potential trade, or sale, with other BMAP stakeholders within a watershed.

The U.S. Environmental Protections Agency (EPA) describes WQT as an innovative, market-based approach toward Clean Water Act compliance and a tool that offers greater efficiency in achieving water quality goals on a watershed basis. WQT is based on the fact that pollutant sources in a watershed (or BMAP stakeholders in Florida) can face very different costs to control the same pollutant. WQT allows one source to meet its nutrient reduction goals, or regulatory obligations, by using pollution reduction credits created by another source that has lower pollution control costs, thus achieving the same water quality improvement at lower overall cost.

A WQT credit, as defined in 62-306.200, F.A.C, means the amount of an entity's nutrient load reduction below the baseline that can be available for trading. *Baseline* means the annual nutrient load from a pollutant source after performing all required pollution control activities, below which water quality credits may be generated. Credits can be understood as being above and beyond the required reductions. Per the revised rules, an agricultural nonpoint source is considered to have met the baseline condition if the producer is enrolled in the agricultural BMP program applicable to the type of operation and has fully implemented all specific BMPs required, based on an onsite assessment, and as required per 403.067, F.S.

The new rules have made it permissible for individual agricultural producers to potentially sell water quality credits even before the nutrient reduction goal has been met by Agriculture as a whole (i.e., as a BMAP stakeholder group) in a watershed, as long as the individual producer is a verified participant in the applicable agricultural BMP program. That is important because there is far to go before Agriculture can meet its required reductions per the SLE BMAP, as discussed in chapter 2. Now credit-generating projects on agricultural lands, such as water farms, could help Agriculture meet its BMAP goal. This is discussed in chapter 5, section 5.2, in considering WQT as a *conceptual* framework for the funding of water farming.

Using the innovative tool of WQT to help achieve the restoration goals in the SLE Watershed would be consistent with legislative intent for the Northern Everglades and Estuaries Protection Program (NEEPP), especially section 373.4595 (1) (n), F.S., in which WQT is specifically mentioned:

> (n) It is the intent of the Legislature that the coordinating agencies[109] encourage and support the development of creative public-private partnerships and programs, including opportunities for water storage and quality improvement on private lands and **water quality credit trading**, to facilitate or further the restoration of the surface water resources of the Lake Okeechobee watershed, the Caloosahatchee River watershed, and the St. Lucie River watershed, consistent with s. 403.067 [establishment and implementation of Total Maximum Daily Loads].

Chapter 5. Funding for Water Farming and Related Practices

Potential sources of funding for water farming and related practices are discussed in this chapter.

5.1 State Legislative Appropriations

Given the substantial cost of water farming, funding for a regional expansion of the practice would most likely need to come, in large part, from Florida State legislative appropriations. The 2016 General Appropriations Act, passed by the Legislature and approved by the Governor in March 2016, includes a substantial appropriation that could be a funding opportunity for water farming and other DWM projects.

The 2016 appropriation totaling $56,838,034 is to be used to implement the NEEPP. It is specified in the Appropriations Act that the majority of the appropriation (at least 84 percent) shall be used to implement the NEEPP "through public-private partnerships as provided in section 373.4591, F.S." As discussed in chapter 4, section 4.21 of this interim report, section 373.4591, F.S., was amended by the Legislature earlier in 2016 in a way that is supportive of water farming.

The 2016 appropriation is intended to address the state of emergency declared in the counties directly impacted by heavy releases from Lake Okeechobee, which began on January 30, 2016.[110] The excerpt from the 2016 Appropriations Act pertaining to funding for the NEEPP implementation follows next.

> From HB 5001, General Appropriations Act 2016
>
> 1590A GRANTS AND AIDS TO LOCAL GOVERNMENTS AND NONSTATE ENTITIES - FIXED CAPITAL OUTLAY, NORTHERN EVERGLADES AND ESTUARIES PROTECTION
> From the funds in Specific Appropriation 1590A, $55,131,903 from the Land Acquisition Trust Fund and $1,706,131 from the General Revenue Fund shall be used to implement the Northern Everglades and Estuaries Protection Program, as set forth in section 373.4595, Florida Statutes.
>
> **No less than $47,838,034 of the funds provided in Specific Appropriation 1590A shall be used to implement the Northern Everglades and Estuaries Protection Program, as set forth in section 373.4595, Florida Statutes, through public-private partnerships as provided in section 373.4591, Florida Statutes.** [Emphasis added.]
>
> From the funds in Specific Appropriation 1590A, to address the state of emergency for Lee, Martin, and St. Lucie counties declared by Governor Rick Scott in Executive Order Number 16-59 issued on February 26, 2016, first 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.[111]

The $56.8 million for the NEEPP was appropriated to DEP to administer. DEP, the SFWMD and FDACS are the three coordinating agencies for the NEEPP.

It should be noted here that the estimated cost of constructing 20,000 acres of water farms in the SLE Watershed *and* operating all of the projects for the first full year is $39,780,000, as shown in **Table 4** in chapter 3. The projects could be funded by the 2016 appropriation for the NEEPP, particularly per the language bolded in the excerpt from the appropriations bill, with more than $8 million dollars to spare.

5.11 Appropriations through Amendment 1

Perhaps an appropriate place to look for *recurring* funding for a regional expansion of water farming would be within the estimated $800 million+ per year available through Amendment 1: the Florida Water and Land Conservation Initiative; an amendment to the Florida State Constitution that was approved by 75 percent of Floridians who voted in the 2014 election. Amendment 1 was designed to dedicate one-third of net revenue from the existing excise tax on documents (that is paid when real estate is sold) to the Land Acquisition Trust Fund, for 20 years, to acquire and restore Florida conservation and recreation lands. The language on the ballot which described the purpose of the Amendment 1 was fairly broad, which left discretion to the Legislature for implementation of a spending plan:

> Funds the Land Acquisition Trust Fund to acquire, restore, improve, and manage conservation lands including wetlands and forests; fish and wildlife habitat; lands protecting water resources and drinking water sources, including the Everglades, and the water quality of rivers, lakes, and streams; beaches and shores; outdoor recreational lands; working farms and ranches; and historic or geologic sites, by dedicating 33 percent of net revenues from the existing excise tax on documents for 20 years.[112]

Representative Gayle Harrell filed House Bill (HB) 989, called the "Legacy Florida" bill, which pertains to the implementation of Amendment 1. HB 989 provides for the lesser of 25 percent of the available funds or $200 million to be appropriated annually for Everglades restoration projects, giving preference to projects that reduce harmful discharges from Lake Okeechobee to the St. Lucie or Caloosahatchee estuaries in a timely manner. Rep. Harrell's bill passed in the 2016 Legislative Session. (Amendments to the bill appropriate money also to the restoration and management of Florida's springs and Lake Apopka.)

The Legacy Florida bill references specific restoration plans including CERP, as set forth in 373.470, F.S. (Everglades restoration), and the NEEPP, per 373.4595, F.S.

In 373.470(3)(b), there is a reminder that, "The comprehensive plan [CERP] shall be used as a guide and *a framework for a continuing planning process* to (1) Reflect new scientific knowledge, the results of pilot projects, and the results of new and continuing feasibility studies with the Corps." And the NEEPP includes the following language, which recognizes projects with benefits that water farming can provide:

> 3.c. Projects that make use of private lands, or lands held in trust for Indian tribes, to reduce pollutant loadings or concentrations within a basin, or that reduce the volume of harmful discharges by one or more of the following methods: restoring the natural hydrology of the basin, restoring wildlife habitat or impacted wetlands, reducing peak flows after storm events, or increasing aquifer recharge, are eligible for grants available under this section from the coordinating agencies.[113]

It could be consistent with the intent of the Legacy Florida bill if, through updated planning, water farms would stand in for one or more of the R/STAs yet to be built in the SLE Watershed, per the IRL-S/CERP plan. The significant savings could be applied to restoration projects that will reduce the discharges from Lake Okeechobee to the coastal estuaries; and *that* objective is the clear intent of the Legacy Florida bill.

5.12 Future Appropriations for New Pilot Project Program Authorized in 2016 Water Bill

The comprehensive water bill that became law in January 2016 created a new section within Chapter 403 of the Florida Statutes that could provide for the funding of an "Innovative nutrient and sediment reduction and conservation pilot project program." The funding for the program would be contingent upon a specific appropriation in the General Appropriations Act. New section 403.0617, F.S., could provide a context in which individual water farming projects or potentially a group of water farms would be evaluated and possibly prioritized for funding through DEP.

DEP is directed to initiate rulemaking by October 1, 2016, to establish criteria by which the department will evaluate and rank pilot projects for funding. The new section specifies that "the criteria [for ranking] must give preference to projects that will result in the greatest improvement to water quality and water quantity for the dollars to be expended for the projects."

If water farming projects would be considered for funding under this new pilot project program provision in Florida, it could possibly spur the development of guidelines, or price parameters, to assure the lowest possible cost for water farming projects. Water farming would presumably be in statewide competition for funding with many other projects, and cost-effectiveness will clearly be a primary ranking criterion.

5.2 Water Quality Credit Trading: a Conceptual Framework for Funding

Water quality credit trading was defined and discussed previously, at the end of chapter 4. In this chapter on funding opportunities, WQT is considered as a *conceptual framework* for funding an expansion of water farming in order to meet the goals not only for surface water storage but for nutrient reductions—especially for Agriculture—in the SLE Watershed.

The cost of nutrient reductions on water farms has proven to be much lower than the costs of reductions faced by the counties and municipalities participating in the SLE BMAP. For example, the actual cost of reductions on the Caulkins pilot project is $17.92 per pound of TN and $116.55 per pound of TP, as was shown in **Table 1**. An estimate of the projected unit cost of nutrient reductions on 20,000 acres of water farms is $26.22 per pound of TN and $130.29 per pound of TP, as was shown in **Table 4**. In comparison, the average costs of nutrient reductions via 57 projects completed by non-agricultural stakeholders across the multiple Indian River Lagoon BMAPs and the SLE BMAP were estimated to be $2,007 per pound of TN and $5,888 per pound of TP.[114] Those unit costs are 45 and 76 times higher than the unit costs of nutrient reductions on water farms for TP and TN reductions, respectively, per the estimates shown in **Table 4**. That cost difference is a condition for WQT market viability: credit buyers could save money.

Table 5 offers more information on the average costs of nutrient reductions achieved by implementing 50 projects in the SLE Watershed. Fifty projects are only a subset of the total number of projects that have been implemented by SLE BMAP stakeholders so far. The 50 were selected because they were the projects for which cost information was published in the 2015 progress report for the BMAP,[115] along with the estimated nutrient reductions associated with each of the projects. The reported project costs are for the initial capital expenses only. There were no data available in the BMAP documents on O & M.

Three BMAP stakeholders have ongoing programs to phase out residential septic tanks by connecting the neighborhoods to the central wastewater system. In all three cases, the unit cost of nutrient reductions via the septic to sewer conversion projects were calculated separately, mainly because TP reductions were not quantified by DEP for septic conversion projects, only TN reductions. (Including the septic projects in the general average would have inflated the average unit cost of TP removal.) **Table 5** shows the unit costs of TN reductions via septic projects through mid-2015. Total costs and TN reductions will continue to climb, as the work progresses. This is a positive trend, given that sewage from septic tanks has been identified as a significant contributor to the nutrient pollution damaging the coastal estuaries and the offshore reefs.[116]

As shown in **Table 5**, the average cost per pound of nutrient removed via the 50 projects implemented in the SLE Watershed is $6,444 for TN and $22,517 for TP. In an *adjusted average* unit cost that excluded one project with the highest unit costs (a large stormwater project implemented by the St. Lucie County non-MS4), the average cost per pound of nutrient removed was $3,979 for TN and $12,523 for TP, also shown in **Table 5**. Nutrient reduction projects in urban and suburban settings tend to be expensive, for a variety of reasons. One reason the unit costs can be high is because the projects are usually implemented to achieve more than the single benefit of nutrient reductions, such as to reduce community flooding also.

Retrofitting established neighborhoods with new stormwater management systems is a costly endeavor. Correcting untreated outfalls to the river or lagoon with stormwater detention facilities can also be costly,

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Table 5. 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 [16]	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[117]	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[17]	49		$3,979	$12,523		
7. Agriculture[18]	N/A	N/A	N/A	N/A	**443,932**	**212,426**
20,000 Acres of Water Farms (WFs), per estimates in Table 4	Estimated Costs of **10 Years** of the WFs = $153,180,000 for **all** costs (including construction)		**$26.22** (10-year unit cost)	**$130.29** (10-year unit cost)	Could Remove **584,219 lbs TN/year** (midrange estimate)	Could Remove **117,571 lbs TP/year** (midrange estimate)

[16] Total cost of the projects does NOT include the cost of operations and maintenance, for non-agricultural stakeholders 1a through 6b. Data source: DEP's 2015 Progress Report for the St. Lucie River and Estuary BMAP.
[17] Adjusted average is the average cost excluding the cost outlier project in row 3 (for St. Lucie County Non-MS4).
[18] Remaining required reductions for Agriculture once 90% BMP enrollment goal is met (per Table 3 in Chapter 2).

as is a septic to sewer conversion program. Nevertheless, many if not most of the local taxpayers who are interested in the health of the coastal waters would consider those improvements to be worth the expense, as necessary modernization of infrastructure and/or in the interest of public health and the recreational use of the coastal waters.

Although county and municipal BMAP stakeholders could save large sums of money by purchasing water quality credits produced on water farms, if such credits become available, instead of continuing to make improvements to their own stormwater and wastewater systems, such trading would likely be limited for at least two reasons: 1) their planned improvements are of value to their communities, and, 2) few of the non-agricultural stakeholders have large reductions remaining, which means the potential credit-buyers' market is thin (i.e., those stakeholders do not have a need to buy a large number of credits to meet their required reduction goals).

The required reductions remaining among most non-agricultural BMAP stakeholders will be further reduced once DEP begins to grant credits for TP reductions for septic tank conversion programs. Only credits for TN have been granted in the SLE BMAP for the septic programs, but credits for TP will quite likely be granted for those programs sometime in the future, after DEP modifies its estimating tools.[118]

There is one SLE BMAP stakeholder, however, that does need to make large nutrient reductions and has no plan in place yet for fully meeting that challenge: Agriculture, represented by FDACS. As discussed in chapter 2 and shown in **Table 5**, Agriculture has the vast majority of the remaining nutrient reductions to be made in the SLE BMAP, specifically 443,932 pounds of TN per year and 212,426 pounds of TP per year, after meeting the goal of 90 percent enrollment in the agricultural BMP program of applicable lands in the SLE Watershed.

The bottom row of **Table 5** presents pertinent information for Agriculture, in the form of a partial recap of **Table 4** in chapter 3, which showed cost and performance estimates for 20,000 acres of water farms, including the estimated cost per pound of nutrient reductions of $26.22 for TN and $130.29 for TP. As was discussed in chapter 3, section 3.36, if the water farms were implemented, they would provide an estimated reduction in TN that would exceed the required reductions remaining for Agriculture, per the December 2015 SLE BMAP update. Additionally, the group of projects would meet an estimated 55.35 percent of the BMAP goal for TP reductions required on agricultural lands. It would be difficult to find a more economical way to achieve the required reductions remaining for Agriculture than to obtain water quality credits generated on water farms—at unit costs of *one percent or less* of the adjusted average unit cost of the reductions made by non-agricultural stakeholders, via the 50 SLE projects. That is because the lowest cost agricultural BMPs have already been applied: meeting the BMAP goal for Agriculture will likely entail more costly options.

But those unit costs for nutrient reductions on water farms were given in the preceding paragraph as if the reductions would be sold as credits in a WQT market, and that is an unlikely scenario in the SLE BMAP. Instead, the cost of the reductions that could be made on water farms should not exceed the annual cost of operating the projects. That is, there would be *no need to pay more for TN/TP credits than the annual cost of the water farming contracts*, IF water farmers are paid a participation fee for storage instead of being compensated based entirely on a rate paid for the quantity of nutrients removed from the system. In this scenario, the nutrient reductions would be a valuable bonus included, one could say, for free: there would be no *additional* cost to substantially meet the nutrient reduction goals for Agriculture while substantially meeting the water storage goal. In other words, *two* watershed goals could be tackled for the price of one.

Meeting the BMAP goal through *measured* credits, based on water quality monitoring at the water farms, would avoid guesswork over whether Agriculture's goals have been met. The nutrient reductions could be pre-approved by DEP and would be verifiable thereafter.

The City of Port St. Lucie has plans to meet a portion of their remaining BMAP nutrient reduction goal for the city's MS4 by building a water farm on rural property the city acquired near the C-23 Canal and incorporated into the city limits in 2013. This multi-purpose project called the McCarty Ranch Preserve [119] will provide passive recreational opportunities, water storage and an intended future source of drinking water supply for the city, possibly augmented with aquifer storage and recovery wells (ASRs) and a water treatment facility on the property. As the plan is to draw surplus water from the C-23 Canal during the wet season for treatment and storage, this public project could potentially generate WQT credits, although the city may need to apply all reductions to meeting its own BMAP goal instead of trading any credits.

The SJRWMD will soon begin paying water farmers a rate per pound of the nutrients removed on water farms instead of a fixed fee for landowner participation to store water, in that District's upcoming water farming pilot project. This performance-based contract is discussed in section 5.41 of this chapter. The SJRWMD will launch their water farming pilot project as a way to meet nutrient reduction goals in the Central Indian River Lagoon BMAP and to reduce damaging freshwater discharges to the lagoon. *The SJRWMD's pilot program will set the precedent of a public agency purchasing the defined benefit of nutrient reductions on water farms to meet BMAP requirements.*

That is the concept to consider in the SLE Watershed: that water farming could be used to help meet the nutrient reduction requirements in the SLE BMAP. The three coordinating agencies for the NEEPP (DEP, the SFWMD and FDACS) share an interest in achieving the nutrient reduction goals and this could be the fastest and a relatively inexpensive way to make a significant advance toward the goal for Agriculture.

Although funding for water farming is not at all likely to come from water quality credit *trading* with other stakeholders in the SLE BMAP, the practice could be funded through the coordinating agencies in order to meet the BMAP goal. That would be a new and constructive framework in which to think about the benefits of water farming. The 2016 appropriation of $56.8 million for NEEPP could launch a plan.

5.3 Section 319 Grant Funding

Section 319 Nonpoint Source Management Program grant funding enabled the SFWMD to have three different water farming projects field tested in the demonstration project, instead of only one. This source of funding has been supportive of water farming so far, yet it is unlikely to be a potential source of major funding for a regional expansion of the practice because the Section 319 statewide program has limited funding available each year. EPA had given the states about $200 million (total) annually for Section 319 funding from 1999 through 2010, but funding has been reduced from that level since 2011. In 2016, EPA allotted $163.4 million for Section 319,[120] which is apportioned to the states per a formula. In recent years Florida has received from EPA between $5 and $6 million annually for the grants awarded through 319.

Florida's nonpoint source management program generally identifies BMAP areas as priorities, with the Lake Okeechobee and the three Indian River Lagoon BMAPs now identified as the *high-priority* areas. Projects which address agricultural stormwater discharges are approvable under the Section 319 grant program, but new limitations have been imposed by EPA for funding projects which address municipal stormwater systems. Federal requirements have also shortened the grant period; now, most projects must be completed within three years of contract execution, instead of five years. Section 319 funding may not exceed 60 percent of the total cost of the project (which means the non-federal match, including in-kind match, must be at least 40 percent). [121]

Funds are administered by DEP on a cost-reimbursement basis, which means every receipt has needed to be saved in the process of constructing and maintaining the water farming pilot projects. This has caused some annoyance among pilot project managers who have had to sometimes chase down receipts, even for purchases costing only a few dollars, at the request of the SFWMD which, as the primary grant recipient, is responsible for verifying all expenses in the demonstration project. Eligible grant recipients, in addition to water management districts, include state agencies, local governments, nonprofit organizations, public utilities, and colleges and universities. Although Section 319 is unlikely to be a source of major funding for a regional expansion of water farming, it could potentially help cover the costs of implementing water quality monitoring at multiple project sites.

5.4 Water Management Districts

The SFWMD has been the source of funding for water farming so far, by co-funding the demonstration project with matching funds from the Section 319 grant. And the SFWMD has been funding Dispersed Water Management projects on ranchlands for the past ten years, in a program that continues to expand.

5.41 A New Water Farming Pilot in the SJRWMD

There will soon be another water farming pilot project in the Treasure Coast region, to be launched by the St. Johns River Water Management District. The SJRWMD will fund two projects, selected from the respondents to a request for proposals issued by the District in the fall of 2015. The two projects will be located on fallow citrus groves in Indian River County and will be operational by 2018. The District will enter into *performance-based contracts* with both water farmers, who will be reimbursed for the initial costs of project construction and for the monthly costs of water pumping (for fuel or electricity and for pump maintenance). There will not be an additional fixed amount paid annually in the form of a service fee or participation payment. Instead, SJRWMD will pay a set fee *per pound* of the TN and TP actually reduced on the water farms each year. The SJRWMD is initially testing water farming as way to meet nutrient reduction requirements in the Central Indian River Lagoon BMAP.

In the SJRWMD's January 12, 2016 announcement of the Governing Board's approval of the two water farming pilot projects, the board chairman was quoted as saying, "Water farming can potentially have a significant benefit to the health of the Indian River Lagoon. This is a plan that is fiscally responsible for the taxpayer because it is based on projects that perform and provide measurable results."[122]

5.42 The SWFWMD's FARMS Program

The Southwest Florida Water Management District (SWFWMD) has not sponsored water farming projects per se, at least not yet, but it administers a program that pays much of the cost of creating reservoirs on private property so that agriculturalists can use stored surface water for irrigation needs instead of groundwater.

The FARMS program (which stands for Facilitating Agricultural Resource Management Systems) is a cost-share program that pays for 50 to 75 percent of the cost of implementing water-saving projects and practices on private agricultural lands as a way for the District to meet its goal in the Southern Water Use Caution Area Recovery Strategy, as well as other quantified goals for water quality improvement and environmental restoration in the SWFWMD.

One type of project that is popular within the FARMS program, and is growing in popularity in other areas of the state (although it is scarcely known yet in southeast Florida), is a surface water/tailwater recovery system, which enables producers to capture stormwater and recycle irrigation water on their property. A description and a picture of the system are included below, excerpted from the SWFWMD's 2015 annual report on the FARMS program.

> **TAILWATER RECOVERY AND SURFACE-WATER RESERVOIRS**
> An effective BMP implemented by the FARMS Program that has proven to achieve both water quality improvements and groundwater conservation is the development of surface water and/or tailwater recovery ponds (Figure A). These ponds are typically excavated below ground level at the low end of a farm to collect excess irrigation water and stormwater runoff. In order to utilize the pond as a source of irrigation water, the FARMS Program and the grower will share the cost of purchasing surface water pumps, filters, and other appurtenances needed to connect the pond to the existing irrigation system. The use of these ponds for irrigation is effective in reducing or "offsetting" the amount of groundwater that is withdrawn from the Upper Floridan aquifer. The ponds can also serve as the primary means for improving water quality of the downstream watershed by reducing the concentration of mineralized groundwater applied to fields.[123]

Figure A: Typical Tailwater Recovery Pond

The FARMS program is funded from the SWFWMD's budget, annual legislative appropriations, and with intermittent contributions from FDACS. Since the program's inception in fiscal year 2003, 161 projects were implemented (and are tracked by FARMS) at a total cost of $56,601,063 (of which SWFWMD paid $23.1 million; $7.3 million came from state appropriations; $824,232 from FDACS; and the participating agricultural producers have contributed $25.3 million in cost-share). FARMS participants often report an improvement in production values—higher yield and quality—which is attributed to better water quality, once irrigation supply comes from surface water (captured on their property) instead of groundwater with higher chloride content. Testimony from satisfied participants and an overview of some FARMS program projects, including a tailwater recover system, can be viewed in a three minute video available at this link: http://www.swfwmd.state.fl.us/agriculture/farms/.

The Suwannee River Water Management District and the SJRWMD also fund tailwater recovery and nutrient recapture projects, with cost share up to 90 percent (to a maximum of $300,000 per year) for approved projects per the St. Johns River District's new (in 2015) Agricultural Cost-Share Program.[124]

5.5 Conservation Easements and the New Regional Conservation Partnership Program

Conservation easements can be instrumental in maintaining lands in a natural state, and for restoring lands to a natural state, or for protecting "working lands" so they can remain in agricultural production. Conservation easements usually have a minimum 30-year term and most are perpetual. The practice of water farming would be incompatible with the stated objectives of most conservation easements, and many current and prospective water farmers would prefer to keep their options open for the use of their groves upon the conclusion of an initial 10-to-15-year contract to water farm on their property. Permanent conservation easements could be considered, however, as a way to secure and restore more of the acreage identified for the Natural Storage and Treatment Areas component of the IRL-S plan—as an alternative to further public land acquisitions.

That is not a new thought; for example, much of the Allapattah Flats property, which is part of the Natural Storage and Treatment Areas, was secured and is being restored through an NRCS Wetlands Reserve Program (WRP) conservation easement in partnership with the SFWMD. These days, even most of the "land acquisition" for National Wildlife Refuges is done through *easement* acquisitions, not fee simple purchases, because USFWS has found easements to be an effective way to conserve land for less cost.[125]

What is new, from the 2014 Farm Bill, is the Regional Conservation Partnership Program (RCPP) under USDA NRCS, which is a "comprehensive and flexible program that mobilizes partnerships to multiply conservation investments and reach common conservation goals on a regional or watershed scale."[126] The RCPP could offer funding and technical support for multiple restoration objectives in the SLE Watershed, including for practices on productive farmland that would be complementary to water farming. Up to four different NRCS programs can be tapped into under the RCPP (the first two are conservation easement programs, the second two are financial assistance programs): the Agricultural Conservation Easement Program (ACEP), the Healthy Forests Reserve Program (HFRP), the Environmental Quality Incentives

Program (EQIP), and the Conservation Stewardship Program (CSP—an innovative program offering performance-based five-year contracts to farmers, ranchers, and foresters on private lands; the higher the conservation performance, the higher the payments). Total funding under RCPP can be up to $10 million per approved project area in the nationally competitive program. NRCS in Florida also received $970,000 in 2015 for the statewide competitive program.[127] There are now seven RCPP projects approved in Florida, which are listed at: http://www.nrcs.usda.gov/wps/portal/nrcs/main/fl/programs/farmbill/rcpp/.

5.51 Potential Partnership with NRCS and the Dispersed Water Management Program

The NRCS Florida State Office would like the opportunity to explore with the SFWMD the potential benefits of possibly combining the District's DWM program with NRCS's Wetland Reserve Easement (WRE) program.[128] The assumption is that some of the projects funded under the DWM program would match well with WRE objectives, and the federal funding from WRE could replace some District costs. Changes made to NRCS easement programs in the 2014 Farm Bill offer new, more flexible opportunities to leverage public funding.[129] Taking advantage of federal funding opportunities to support DWM in the Northern Everglades would be consistent with statutory guidance for the NEEPP, such as: "In the development and administration of the Lake Okeechobee Watershed Protection Program, the coordinating agencies shall maximize opportunities provided by federal cost-sharing programs and opportunities for partnerships with the private sector" (373.4595 (3), F.S.).[130]

5.6 Federal Funding via the Conservation Reserve Enhancement Program

The Florida Conservation Reserve Enhancement Program (Florida CREP) most likely cannot pay for large water farming projects, but it can help pay for related practices and projects which conserve water and reduce nutrient runoff, such as surface water/tailwater recovery systems, stormwater treatment areas, and even wetlands restoration. The program generally pays for two things: 1) cost reimbursement for the implementation of conservation practices on agricultural lands, and, 2) a rental fee for the acres of private land on which the conservation practices have been implemented, via 14-year or 15-year rental contracts.

The purpose of Florida CREP is to reduce nutrients and sediments in agricultural stormwater runoff, restore environmentally sensitive land in the Florida Everglades, its estuaries, and river lagoon systems, and potentially achieve significant water quality and wildlife habitat benefits in the targeted watersheds.

There is a federal budget on reserve for the Florida CREP project area, which is the SFWMD and the SJRWMD regions, of *$96 million*, which could do a lot to help the SLE and the Indian River Lagoon. This funding opportunity through CREP, developed in 2002 by FDACS and the USDA Farm Service Agency, has not been tapped into yet. Florida CREP and its parent program, the Conservation Reserve Program (CRP), are described next in chapter 6.

Chapter 6. New Funding Opportunities through USDA Farm Service Agency Programs

The Conservation Reserve Program (CRP), covered in this chapter, is the biggest conservation program for private agricultural lands in the country that many Floridians have not heard of. This introduction to the program includes an overview of an offshoot program that was designed in 2002 to address needs in a region of Florida that includes the Treasure Coast and Northern Everglades: the Florida Conservation Reserve Enhancement Program, which has a large, dedicated federal budget available to tap into now.

6.1 USDA Farm Service Agency Conservation Programming

Agricultural conservation programming funded through the federal Farm Bill increased markedly in 1985. The majority of Farm Bill conservation programs are administered by the USDA's Natural Resources Conservation Service (NRCS), with the exception of one program: CRP, which is administered by the USDA's Farm Service Agency (FSA).[131] CRP was launched in 1985 and celebrated its 30th year in 2015 as the largest private lands conservation program.[132]

6.11 The Conservation Reserve Program: Overview and National Enrollment Trends

CRP compensates agricultural producers for voluntarily removing highly erodible and environmentally sensitive farm and grazing lands from production by paying an annual rental fee to producers for those lands through 10- or 15-year CRP contracts, which producers have the option to renew. Additionally, producers with lands enrolled in CRP receive cost-share assistance for implementing one or more conservation practices and they may also be eligible to receive financial incentives such as an initial sign-up bonus or practice completion incentive payments (which augment the annual land rental payments) for establishing and maintaining certain conservation practices. CRP covers about 30 different conservation practices,[133] which are implemented with technical assistance usually provided by NRCS, the U.S. Forest Service, local soil and water conservation districts and other approved technical service providers. CRP currently supports ten different initiatives across the country,[134] plus many more special initiatives identified by the states participating in a CRP offshoot program called the Conservation Reserve Enhancement Program (CREP). CREP is discussed in section 6.2 of this chapter, including Florida's CREP program.

CRP began in 1985 with the primary goal of reducing soil loss from erosion, and an estimated eight billion tons of soil loss from farm fields has been prevented by CRP programming in the past 30 years, according to the federal administrator of FSA. After its inception, CRP's environmental benefit goals were broadened to include the improvement of surface and groundwater quality and the creation and preservation of wildlife habitat. There are now just over 25 million acres enrolled in CRP, with total funding of about $2 billion annually.[135]

The amount of acreage enrolled in CRP has declined by one-third—nearly 12 million acres—since the peak in 2007, when 36.8 million acres were enrolled.[136] Most of the loss of enrolled acreage occurred in the nation's breadbasket, where Midwestern farmers reportedly found they could make more money planting commodity crops even on marginal lands, than from CRP rental payments, once the prices for corn and soybeans began to soar. Conservation and wildlife groups remain concerned that reduced enrollment will negatively impact critical species habitat and water quality. Yet, one of the changes made to CRP in the 2014 Farm Bill reduces over time the maximum acreage that can be enrolled in CRP at any one time, by placing a cap at 26 million acres in fiscal year (FY) 2015, which was set just above the number of acres still enrolled after the sharp decline, then further reducing the cap to 25 million acres in FY 2016, then to 24 million acres in FYs 2017 and 2018. This enrollment level cap created an estimated savings of $3.3 billion over ten years.[137] As all changes made in 2014 within the Farm Bill's Conservation title (the general category for the conservation programs) will result in an estimated total savings of $3.97 billion over ten years,[138] it is evident that most of the savings (83 percent) in conservation will come from the reductions in CRP.

The changes made in the 2014 Farm Bill reflect a decade-long shift in Farm Bill conservation policy toward favoring conservation programs for working lands over traditional land retirement programs such as CRP. Whereas a land retirement program requires producers to remove land from production for the purpose of restoring environmentally sensitive lands, albeit through *temporary* contracts (for 10 or 15 years, although generally renewable for consecutive contract terms), working lands programs such as the Environmental Quality Incentives Program (EQIP) provide producers financial incentives to adopt resource-conserving practices on lands that will remain in production. The policy shift is reflected in the share of conservation funding that has been allotted to each type of program, from the 2002 Farm Bill to the 2014 Farm Bill. In 2002, land retirement programs were allotted 54 percent of total funding for Farm Bill conservation programs, while working lands programs received 35 percent. By 2014 the two program types had fully switched places for funding shares. Working lands programs now have 54 percent of conservation funding while land retirement programs have dropped to a 37 percent share.[139]

Long-term conservation easement programs, with usually either a 30-year or perpetual term, have also lost funding share between the 2002 and 2014 Farm Bills. In 2002, easement programs had 11 percent of conservation funding, then bumped up to 13 percent in the 2008 Farm Bill, but decreased to only a seven percent share in 2014. According to Agricultural Conservation and Natural Resources Policy Specialist Meagan Stubbs of the Congressional Research Service, most conservation and wildlife groups support both land retirement and working lands programs, but they continue to debate about the right mix of land retirement programs: are shorter-term contracts or long-term easements better? Proponents of long-term or permanent easements "cite a more cost-effective investment in sustainable ecosystems for long-term wildlife benefits," Ms. Stubbs noted, while supporters of short-term land retirement programs "cite the increased flexibility, which can generate broader participation than permanent or long-term easement programs," she said.[140] Elsewhere, Stubbs stated that despite setbacks, the demand among producers for the shorter-term land retirement program— CRP—still remains strong and now even exceeds the current cap, or enrollment level limit.[141]

The federal enrollment cap notwithstanding, more use could be made in Florida of funding through CRP. There is still a national budget to tap into, and Florida also receives special allotments for enrollments in CRP of a particular type, such as 5,000 acres for long leaf pine establishment.[142]

6.2 The Conservation Reserve Enhancement Program (CREP) in Florida

Most of the agricultural landowners in the St. Lucie River Watershed who are interested in water farming are not interested in long-term or perpetual easements at this time, preferring to keep their options open to return fallow groves (and potential water farming sites) to production groves in ten or 15 years, especially because a cure for citrus greening could be found by then. It seemed plausible that the relatively flexible and shorter-term CRP contracts could be compatible with the water farmers' current objectives, however. It was certainly worth inquiring whether the program, unknown in south Florida, could be available here.

Amy Roller is the Agriculture Program Specialist for the USDA FSA in Florida and the state-level point of contact for CRP. She explained that 14 counties in north Florida have CRP contracts. The vast majority of those contracts are for longleaf, slash and loblolly pine CRP practices. Although CRP could expand into south Florida, Ms. Roller said there is a far greater opportunity for this region through an offshoot of CRP called the Conservation Reserve Enhancement Program—CREP.

6.21 The Federal Budget and Project Area for Florida CREP

Unlike most CRP proposals for program enrollment, which are submitted by Florida to be ranked in a nationally competitive process for potential funding, CREP proposals, called *offers*, would be reviewed only within the State of Florida to ensure that offers meet program eligibility requirements, including those specific to the customized design of the Florida State Agreement for CREP. What is more, Ms. Roller informed, is ***there is a budget on reserve at the federal level for Florida CREP of $96 million***. More good news is that the non-federal matching funds requirement is only a minimum of 20 percent.

FDACS executed the state agreement for CREP with FSA in 2002. The $96 million dollars for federal matching funds were placed on reserve for Florida CREP at that time and have remained on reserve despite that fact that CREP has not been used yet in Florida. Although the Florida State Agreement contains outdated references to administrative guidelines and is therefore in need of non-substantive updates, the agreement for CREP remains in effect.

States may target specific regions in a state for CREP enrollment to address particular resource protection or environmental improvement needs or goals. In the Florida CREP agreement, the broad region targeted is the Everglades and St. Johns-Ocklawaha and Indian River Lagoon Systems. This region encompasses the entire combined territories of the South Florida and the St. Johns River Water Management Districts, inclusive of the St. Lucie Watershed and all counties bordering the Indian River Lagoon. Up to 30,000 acres within this region may be enrolled in Florida CREP, if eligibility criteria for enrollment are met. A map showing the Florida CREP program area, **Figure 15**, is included on the next page.[143]

6.22 The Purpose of the Program

According to the Agreement between the State of Florida and the USDA, the general reason to implement a CREP program in Florida was "For the enhancement of water quality of agricultural stormwater runoff by reduction of sediment and nutrients." Under the General Provisions of the 2002 Agreement, it says:

> The Florida CREP is designed to reduce the amount of phosphorous, nitrogen, sediments and other agricultural pollutants entering watersheds from agricultural sources while increasing wetland habitat for wading birds, waterfowl and other aquatic organisms through a voluntary, incentive-based program.
>
> The primary goal of this Agreement is to provide an opportunity, through financial and technical assistance within targeted watersheds, for eligible producers in Florida to voluntarily establish filter strips, riparian buffers, hardwood tree plantings, wildlife habitat, wetlands areas, and/or other approved conservation practices that improve water quality (e.g. reduce phosphorous, nitrogen, sediments, etc.) of agricultural stormwater discharges.[144]

The stated goals of Florida CREP, envisioned in 2002 and still needed and appropriate today, are as follows:[145]

- Reduce average annual phosphorus loading into the Everglades Protection Area by approximately 100 metric tons annually through establishment of conservation practices;
- Increase the water storage capacity in the Lake Okeechobee and Indian River watershed through wetland restoration/creation;

Figure 15. Florida Conservation Reserve Enhancement Program Area

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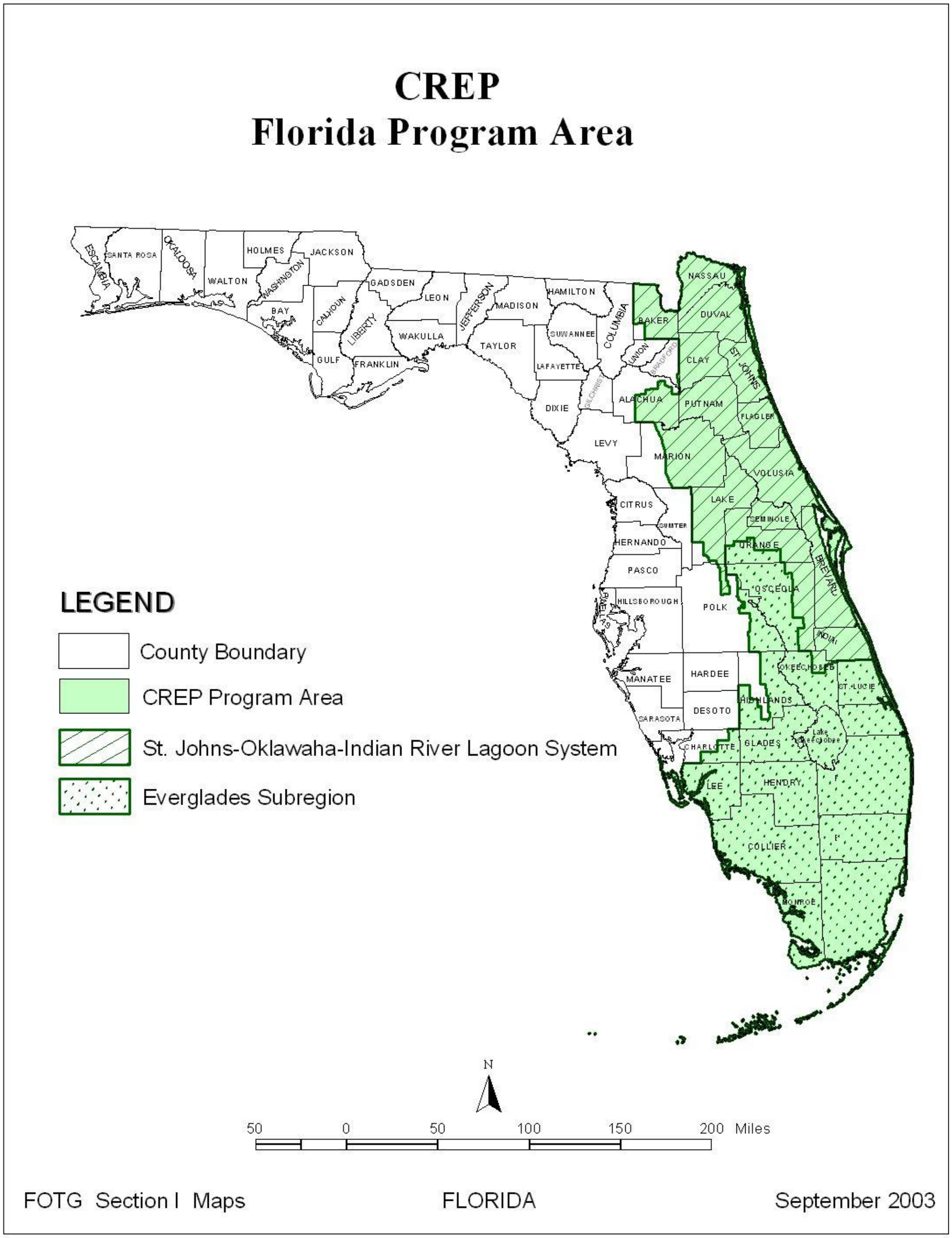

(The stated goals of Florida CREP, continued.)

- Reduce pollutant loading from agricultural operations adjacent to the lower St. Johns River and in the Ocklawaha and Indian River Basin by at least 25 percent below modeled historic average annual loading; and
- Provide substantial wildlife habitat enhancement for the preservation of natural diversity of Florida's biological resources, including threatened and endangered species associated with riparian and wetland habitats.

6.23 Matching Requirements

CREP is a partnership between state and/or tribal governments and the federal government. Regarding cost sharing, CREP can be an 80 percent (federal) and 20 percent (state or tribal) financial partnership—or states may contribute more than 20 percent at their option.

Up to 80 percent of the cumulative cost of implementing CREP is borne by the federal government; a minimum of 20 percent is to be borne by the state. As Florida CREP is federally funded for $96 million dollars, this means the minimum state contribution to enroll 30,000 acres over the years it would take to do that would be a total of $19,200,000, of which only up to $9,600,000 would need to be a *cash* match.

In the Florida CREP Agreement *the state* means FDACS, primarily, although the SFWMD and/or the SJRWMD can be participants in cooperation with FDACS. The matching requirements are flexible. The contributions of other state agencies, such as DEP for example, could also count toward match, as could the contributions of other organizations designated as a state partner. Up to one-half of the non-federal (state) match can be in-kind match; the other half must be cash match. As detailed in the Florida CREP agreement, *in-kind service costs* may include:

> [F]unds and staff time expended for program administration, producer payments, bonus incentive payments, technical assistance in the field, local program assistance, design, construction, operation and maintenance of conservation practices, and state and local expenditures for agricultural nonpoint source pollution related to goals in the project area.
>
> In the event that the State of Florida has not met its share for the cumulative cost of the Florida CREP, Florida will fulfill its obligation to contribute at least 20 percent of the cumulative cost within 180 days after the end of each Federal fiscal year by paying the shortfall to USDA/CCC.[146]

There is a provision in the agreement that the financial commitment is subject to the availability of funds. If financial obligations cannot be met, either party may immediately stop accepting new CREP contracts.

6.24 Program Eligibility Requirements and Conservation Practices Covered

To be eligible to be enrolled in Florida CREP, the land must be within the CREP program boundaries and be cropland (including active citrus groves) that meets recent cropping history requirements, or marginal pastureland (which *could* be a designation for a fallow citrus grove that has become a cattle pasture). The land must be suitable for the implementation of one or more of the conservation practices covered by the Florida CREP, which are (per the 2002 Agreement, referring to CRP practices):

- CRP Practice CP 23 (wetland restoration, which can also include the creation of stormwater treatment areas),
- CRP Practice CP 9 (shallow water areas for wildlife),
- CRP Practice CP 22 (riparian buffer),
- CRP Practice CP 21 (filter strip),
- CRP Practice CP 4D (permanent wildlife habitat—non-easement),
- CRP Practice CP 3A (hardwood tree planting – for CRP, longleaf pines are considered to be hardwood),
- CRP Practice CP 29 (marginal pasture and wildlife habitat buffer), and
- CRP Practice CP 30 (marginal pasture and wetland buffer).

It would be possible to add more covered practices to the Florida CREP program, selected from a more extensive practice menu offered by NRCS, through a modification to the state agreement, if appropriate.

Prospective participants, wishing to enroll acreage in Florida CREP, must have owned or managed the land for one year or more and must have an adjusted annual gross income of no more than $900,000. (The income threshold was $2.5 million prior to the changes made in the 2014 Farm Bill.)

The 2002 Florida CREP agreement also allowed publicly owned land (owned by the state or a county) to be enrolled in CREP. Although publicly owned lands can still be enrolled in CREP, they are ineligible for CRP payments, per policy changes made in the 2008 Farm Bill which excluded public lands from earning CRP payments, including CREP.[147] Only private agricultural lands are eligible for CRP payments now.

6.25 Program Payments to Landowners

CREP has two main payment components: 1) cost share for the implementation of conservation practices, and, 2) an annual rental payment for the acres of land enrolled in the program. In some cases additional incentive payments can be included, such as a one-time signing bonus or practice establishment incentive payments. Those payment components are offered through CRP as well as CREP and they come from the federal benefits. What differentiates CREP from CRP is that states usually offer additional enrollment incentives through CREP, which states have the option to define. Accordingly, Florida CREP includes a State of Florida Incentive Program, described subsequently in section 6.251.

Rental payments under CREP (and CRP) are based on two main factors: the county average rental rate for non-irrigated leased farmland and soil productivity. The county average rental rate uses the National Agricultural Statistic Service's survey of county average rental rates for non-irrigated cropland and pastureland. Counties also have the option to submit data to CRP in a request to raise the rental rates during periods announced by the FSA Administrator. Florida has not had a locally-generated rate review in the Treasure Coast counties in memory. This is part of the reason why current soil rental rates in the SLE Watershed are below the national average and well below the rate in Florida counties to the south. For example, the average soil rental rate for CRP/CREP in St. Lucie County right now is $33 per acre and the national average is $51.09 (with no bonuses applied—the average can range up to $111.70 with added federal incentives). The average rate in nearby Florida counties is even higher: $127 per acre in Palm Beach County and $424 per acre in Miami-Dade County.[148]

Soil productivity is also a factor and is based on an NRCS calculation that uses data of the local soil, landscape and climate to determine the ability of land to produce crops on non-irrigated soil. The type of soils in Treasure Coast counties may pose a limiting factor, yet, it could be worthwhile to request a rate review, which would take into account evidence of actual rental rates for farmland in the region. (The Caulkins property in Martin County collects $700 per acre in land rental from cabbage farmers.)[149] Higher soil rental rates could increase the appeal of Florida CREP and would be good to have in place before the program is publicized. Once a contract for enrollment is signed, the rental payment cannot be changed during the contract term, even if the soil rental rates increase during the term. In Florida CREP, contract terms are 14 or 15 years. If landowners wish to be released from the contract earlier, financial penalties are applied, per federal guidelines, which are intended to minimize the incidence of early terminations.

There is an overall payment cap in CRP/CREP of $50,000 per year. That per person (program enrollee) cap has not been increased since the program's inception 30 years ago and is likely to remain as is. Still, in comparison with other agricultural cost-share programs which, like CREP, typically help cover the cost of implementing a practice or a structural BMP, it is a bonus to also receive an annual rental payment (one that could add up to $750,000 over a 15-year CREP contract if paid up to the $50,000 limit each year). In CREP, the cost reimbursement for conservation practice implementation does *not* count against the annual payment cap, nor would an initial signing bonus (as both benefits would be paid before the first rental payment is made on the first anniversary date of contract execution). FSA pays enrolled landowners up to 50 percent of the cost of practice implementation, based on actual costs verified by receipts, and not to exceed a published ceiling of what a practice implementation should cost in total.[150]

According to the 2002 Florida CREP agreement, FSA will pay a one-time rental bonus payment for wetland restoration projects that restore natural hydrology. A signing incentive payment and a practice incentive payment will be paid by FSA for implementing conservation practices CP 21 and/or CP 22. Incentive payments may have changed and/or more could have been added at the federal program level that would affect the program today. The Florida FSA State Office and FDACS are reviewing the Florida agreement for updates.

6.251 The State of Florida Incentive Program in CREP

Additional incentives are offered in the CREP program through the State of Florida Incentive Program. In overview, these generous benefits are available to program enrollees who elect to extend the term of their conservation lease—essentially double it—or are willing to execute a permanent conservation easement. Specifically, per the 2002 Florida CREP Agreement:

a. If a landowner is willing to execute a voluntary 15-year conservation lease with the state *consecutive* to the 15-year CREP contract (which would be a 30-year, total, commitment of the enrolled acreage), the state will pay a one-time supplemental payment, or bonus, of 12.5 percent of the total annual CREP rental payments. The state will also pay up to 25 percent of the cost-share on the installation of eligible conservation practices. (This means that with both the state and federal cost share, up to 75 percent of the practice implementation expenses would be covered, up to FSA's published cost ceiling for the practice.)

b. If a landowner is willing to execute a voluntary *permanent* easement contract with the state, then the state will pay a one-time bonus equal to 25 percent of the total annual CREP rental payments. For those electing this option, the state will also pay up to 50 percent of the cost-share on the installation of eligible conservation practices. (In no case can the state and federal cost share exceed 100 percent of the cost of practice implementation; meaning, the landowner may have all costs covered but cannot make a profit.)

The specifics of the State of Florida Incentive Program are under review at FDACS. Amy Roller of FSA has strongly suggested that state incentives in CREP should *not* be tied entirely to extensions of contract terms, as CREP is meant to provide a more flexible alternative to long-term or permanent conservation easements. It appears that the national debate among conservationists (mentioned in section 6.11) about whether shorter-term contracts or long-term easements are better is a current conversation among parties to the Florida State Agreement for CREP. The state benefits could be modified via an amendment to the agreement. There will need to be an amendment prepared, in any case, just to record the federal policy and administrative updates that have occurred since the state CREP agreement was last amended in 2010.

6.26 Making Use of CREP

"CREP is a great program and is used to the max in most other states," according to Amy Roller.[151] Thirty-two other states have a CREP program, including eight states that have more than one CREP program (to target more than one region or natural resource priority).[152] For example, Pennsylvania has been using CREP extensively to meet nutrient reduction requirements in the Chesapeake Bay Watershed. Pennsylvania started its CREP program in 2000 with a goal to enroll 100,000 acres, then expanded the program in 2003 to add another 100,000 acres, then expanded CREP again in 2012 to add 20,000 acres.[153] Maryland also uses CREP to benefit the Chesapeake Bay and now has 70,000 acres enrolled in what was FSA's first CREP agreement with a state.[154] The chief of USDA NRCS was quoted in the [Chesapeake] *Bay Journal* as saying the CRP program, including CREP, may have the most potential for protecting impaired waters.[155]

New York considers its CREP program, which is focused on the farmland in the watersheds where the water supply for New York City originates, to be "a capstone" in the ambitious Watershed Ag Program. By working with farmers in the Catskill Watershed to improve water quality, New York was able to save several billion dollars by avoiding the construction of a water filtration plant for the city's supply. CREP was a critical tool to apply to the effective *whole farm planning process* in the Watershed Ag Program.[156]

Just two more examples, among many, of the utility of CREP: Idaho is using CREP to idle up to 100,000 acres in a river valley where groundwater use is over-appropriated, and the Governor of Minnesota is "committed to working with the federal government to provide funds through CREP" to help the state implement its new Water Quality Buffer Initiative, passed into law in 2015.[157]

In Florida, CREP could help FDACS meet the challenge of achieving the required nutrient reductions in the Northern Everglades and estuaries: including 532,990 pounds of TN and 228,080 pounds of TP[158] per the SLE BMAP goal for Agriculture. Large reductions will also be needed in the Lake Okeechobee and Caloosahatchee BMAPs. Some of the state spending through FDACS on the agricultural BMP program could be leveraged to do more using CREP; not as a capstone program, as in New York, but a centerpiece in a stepped-up effort to engage with agriculture to implement structural BMPs.

It is explicit in the Florida CREP Agreement that the program will not pay for practices that are already required; instead, the program is intended to provide additional benefits. An excerpt from the Agreement:

> It is agreed and understood that any federal payments under this Agreement are intended to produce conservation benefits that would otherwise not be obtained…[T]he State will provide assistance to the [USDA FSA] CCC to ensure that private participants do not receive payments for activities they are obligated to perform.[159]

CREP is a fairly complex program to navigate and will require considerable support and coordination at the state and local level, to implement well. Fortunately, there are two organizations that are interested in providing local technical and educational support for CREP and both would be ideal, and complementary, in the role: 1) the Treasure Coast Resource Conservation and Development Council,[160] and, 2) University of Florida IFAS Extension (BMP program leaders).[161] UF-IFAS and FDACS have discussed the need to develop *Phase Two* BMPs in Florida,[162] and perhaps they could be developed now in the SLE Watershed, where the statewide agricultural BMP program in Florida (the FDACS-IFAS partnership) originated with Brian Boman of UF-IFAS and the Indian River Citrus League producers, starting in 1998 in response to a major algal bloom in the Indian River Lagoon that resulted in massive fish kills and created a local crisis.

6.3 Important Lesson from the Conservation Effects Assessment Project

Extensive studies have disproved the long-held hypothesis that water quality projects or conservation practices implemented anywhere in an impaired watershed will help solve the problem. The lessons learned from the synthesis of the USDA Conservation Effects Assessment Project (CEAP) watershed studies "[P]oint to a clear need to change course in how agricultural conservation programs to protect water quality are designed and delivered."[163]

CEAP was set in motion when funding for conservation programs was increased by 80 percent in the 2002 Farm Bill, over the level of funding for conservation programs in the 1996 Farm Bill. The main objective of CEAP, a multi-agency, multi-faceted and multi-year project launched in 2003 and still in progress, is to quantify the environmental benefits of conservation practices at the national and watershed scales as a measure for how, or whether, the program money being spent is meeting the goals.[164] Most CEAP studies, including the Watershed Assessment Studies component, have been retrospective studies.

6.31 Identifying Critical Source Areas

For better protection of water quality at lower costs, it is crucial to identify a watershed's Critical Source Areas (CSAs) in order to prioritize conservation practice implementation, CEAP investigators say—and urge. The concept of a CSA comes from researchers' observations that the majority of a nonpoint source pollutant load can come from a minority of the watershed land—often a small fraction of the watershed. For example, in a large Vermont river basin, about 74 percent of the TP load was estimated to come from just ten percent of the land area.

CSAs occur where a pollutant source (such as phosphorous) coincides with "active hydrologic transport mechanisms," which can readily export the pollutant to surface waters. *Soils with high phosphorous saturation and hydrologic connectivity to the drainage network are likely to pose high risk to water quality*. Targeting those areas for appropriate intervention is cost-effective, as indicated in this finding:

> Modeled P load reductions from implementing selected conservation practices targeted to the highest priority CSAs were ***two to three times greater*** than those achieved by traditional completely voluntary implementation of the same practices at the same level. [Emphasis added.][165]

Targeting CSAs makes such utter sense to CEAP researchers, they state in their publications on findings from the project that CSAs should be identified *before* any conservation practices are implemented.[166]

Soil type is used as a basis for determining benefits in the CRP/CREP programs. Soil type would also be a very good initial screening variable to use in a CSA-identification analysis in the SLE Watershed. It is *known* which soils are more likely to hold onto phosphorous, or not, and which are more likely to leach nitrogen, or not.[167]

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Chapter 7. Options and Opportunities Assessment Summation

There are water storage and nutrient reduction goals to be met in the SLE Watershed, which were detailed in chapter 2. There is an opportunity to help meet those goals relatively efficiently and economically by working with agricultural landowners in public-private partnerships. In comparison with public regional reservoirs, contracted water farms can start providing water quality and storage benefits in a fraction of the time and front-end capital costs. The proposed water farms that could rival the average annual storage capacity of a public regional reservoir, by storing 30,000 acre-feet or more each, are expected to take no more than one year to construct, at an estimated initial cost of several million dollars per project. (The largest of the proposed water farms are profiled in Appendix 1.) In comparison, it can take more than a decade and hundreds of millions of dollars to construct a public regional reservoir facility.

Although water farming on fallow citrus groves is a new practice, the use of incentive-based approaches to enlist private landowners to help meet watershed goals and avoid building costly infrastructure is *not* new. There are watershed programs around the world, on most continents, based on that approach; and just a small sample of the notable examples in other U.S. states are touched on in this summary chapter.

7.1 Using Incentive-Based Approaches to Meet Watershed Goals

Nitrogen and phosphorous pollution are cited as two of the most significant stressors to water quality nationwide. These pollutants have the potential to become "one of the most difficult environmental problems we face in the 21st century."[168] Nitrogen and phosphorous can come from several sources, but animal manure and chemical fertilizers are primary sources and agricultural lands are considered to be the largest contributing source.[169] This is true in the St. Lucie Watershed, where Agriculture is required to accomplish the vast majority of the remaining nutrient reductions in the Basin Management Action Plan: 94 percent of the TN and 85 percent of the TP loading. The SLE BMAP represents the largest *quantified* reduction Agriculture must make among all Florida BMAPs, according to FDACS staff.

States are responsible for water quality but have limited authority over agriculture, which, along with other nonpoint sources, was not addressed in the Clean Water Act of 1972 that regulates point sources.[170] Policy makers and water managers are showing increasing interest in using voluntary, incentive-based approaches toward water quality improvements where traditional regulatory approaches do not apply.[171]

Water quality credit trading is one type of incentive-based instrument which can offer cost savings to regulated point sources if they purchase lower cost credits from agriculture. Earlier studies showed that reducing nutrient pollution from agriculture could be 65 times more cost-effective than imposing further controls on municipal or industrial sources.[172] The EPA and USDA, which jointly support the creation of WQT markets,[173] see trading as a tool to encourage point sources to help fund nonpoint source controls.

In analyses done for this interim report, it was found that the unit cost of nutrient reductions on water farms would be a fraction of the (adjusted) average unit cost of nutrient removal for 50 select projects implemented by SLE BMAP non-agricultural stakeholders (as shown in **Table 5**). In the language of those earlier studies, achieving nutrient reductions on water farms would be about 96 and 152 times more cost-effective for TP and TN, respectively, than implementing nutrient reduction projects in the cities and counties. Yet, it is not the cities and counties that would be expected to purchase water quality credits generated on water farms, should such credits become available. Those BMAP stakeholders were found to have little need or desire to purchase WQ credits, preferring to complete their own projects. The one BMAP stakeholder that is in greatest need of water quality credits is Agriculture, represented by FDACS.

Another type of incentive-based instrument is Payment for (Ecosystem or) Environmental Services (PES). The new practice of water farming is being field tested within the SFWMD's Water Farming Payment for Environmental Services (WF-PES) Pilot. Water farming fits best within a subcategory of PES programs called Payment for Watershed Services (PWS), which is explained in the following excerpts (from *Incentive-Based Instruments for Water Management*, 2015).

> **Payment for ecosystem services**
> Payment for ecosystem services is an incentive-based instrument that seeks to monetize the external, non-market values of environmental services – such as removal of pollutants and regulation of precipitation events – that can then be used as financial incentives for local actors to provide such services. In practical terms, they involve a series of payments to a land or resource manager in exchange for a guaranteed flow of environmental services. Payments are made to the environmental service provider by the beneficiary of those services, e.g. an individual, a community, a company, or a government. In essence, it is based on a beneficiary-pays principle, as opposed to a polluter-pays principle.
>
> Payments for ecosystems services (PESs) that focus on watershed services, commonly referred to as "**payment for watershed services**" (PWSs), can take a variety of forms. They may be intended to prevent the degradation of a watershed or to restore a previously degraded one. They may be small, local schemes covering several hundred hectares or large, national schemes covering millions of hectares. Programs may be financed directly by the beneficiary or by third parties acting on behalf of the beneficiary, e.g. governments or institutions, or some combination thereof. They may involve cash or in-kind payments to be paid all at once or periodically.[174]

The USDA CRP, including CREP (discussed in chapter 6), is among the oldest and longest running PES programs on earth.[175] There are diverse PES and PWS programs in many parts of the world, including in Latin America,[176] Australia, China, and the U.S. A well-known domestic example is the successful PWS program in the Catskills of New York, mentioned in section 6.26 and described next.

> In the late 1990s, New York City was faced with the prospect of building a $4–$6 billion filtration plant with an additional $250 million in annual operating costs to meet new federal drinking water standards. An initial analysis suggested that preserving the upstream rural Catskill watershed would be far less expensive. The city and local farmers came together to develop a plan that could meet both groups' interests. A key element of the plan was the Whole Farm Program, a voluntary effort fully funded by New York City's Department of Environmental Protection whereby farmers would work with technical advisors to custom design pollution control measures to meet an environmental objective while also improving the viability of their farming businesses. By 2006, the city had spent or committed between $1.4 billion and $1.5 billion in watershed protection projects, averaging $167 million in expenditures per year – far less than building a water filtration plant. Participation remains high, with 96 percent of large farms in the watershed participating in the program.[177]

The New York program is internationally recognized as a model of public-private cooperation, where the farming community played an integral role in designing and managing the program—and still does—as represented by the Watershed Agricultural Council (WAC), made up of farmers and foresters. A member of WAC said, "We created some sort of *marriage* between farmers and New York City's water." Her interview and more can be seen in a video about the program and WAC called "Celebrating 20 Years of Working Landscapes for Clean Drinking Water": http://www.nycwatershed.org/about-us/overview/.

New York City's concerted watershed management approach, employed as an alternative to building far more-costly gray infrastructure to address water quality concerns, has been reviewed and approved by the National Research Council.[178]

7.11 Capturing Stormwater to Meet Watershed Goals

Ambitious plans to capture stormwater are being developed and implemented across the country now.

Los Angeles, California has a water management history similar to south Florida's. Catastrophic floods which killed 97 citizens, in the wake of rapid development in the region in the 1920s, resulted in the implementation of a massive engineering scheme by the U.S. Army Corps of Engineers in the 1930s and 40s that has flushed stormwater out of Los Angeles as quickly as possible ever since. Now city officials want to capture that water. "Something that was once viewed as a nuisance is now seen as a necessity," the mayor of Los Angeles said. It is also seen as an opportunity: "By capturing storm water, we can take advantage of a local water source to augment our urban water supply. This would mean we become less dependent on imported water…[and] have greater resilience against droughts," said a Stanford University professor of civil and environmental engineering. Peter Gleick, a founder of the Pacific Institute and lead author of the biennial report on international freshwater resources called *The World's Water,* said, "Governments increasingly see this [stormwater] as a resource. In the future, we are not going to solve California water problems with traditional big massive infrastructure that we have built in the past."[179]

Stormwater capture is of interest not only in water-stressed western states. "Even in more humid areas of the United States, stormwater capture and use are growing in popularity as a means to enhance water supply and reduce nutrient loads to receiving waters," according to a 2016 National Academies report.[180]

Philadelphia, Pennsylvania is deploying "the most comprehensive urban network of green infrastructure in the U.S.,"[181] to slow down and infiltrate stormwater on site, as an update to the city's Combined Sewer Overflow [CSO] Long-Term Control Plan. (Sixty percent of Philadelphia's storm and wastewater sewers are combined. Stormwater runoff must be reduced to limit or prevent overflows.) Philadelphia's Green City, Clean Water Initiative, launched in 2011, sprung from analyzing the city's CSO problem in a larger perspective:

> The staff at the Philadelphia Water Department (PWD) undertook an effort…to evaluate the infrastructure needs associated with controlling 16 billion gallons of combined sewer flows per year. Costs were expected to run in the billions of dollars. PWD questioned whether, after expending the time and money necessary to implement conventional solutions, local waterways and streams would be healthy. The answer was no: they would still have eroded banks, exposed infrastructure, poor aquatic life, impaired fish passage, and poor aquatic habitat.
>
> PWD decided to integrate their stormwater program with other water resource protection and regulatory programs to improve synergy and develop a holistic approach. The idea was to simultaneously address a number of regulations, including combined sewer overflows, a Phase I NPDES stormwater permit, and Clean Drinking Water Act requirements, while preserving and maintaining the health of the watershed. This was the birth of the Office of Watersheds.[182]

Philadelphia is implementing projects on public lands, such as roadside rights-of-way, to reduce runoff. What is significant about the city's initiative are the incentives—both carrot and stick—to encourage the development of stormwater projects *on private lands* as well. First, PWD agreed to issue a 100 percent credit against (increased) monthly stormwater fees to commercial customers if they installed enough green infrastructure (GI) on site to retain one inch of rainfall. Next, to facilitate improvements on more private properties, PWD launched and "aggressively funded" a grant program called the Greened Acre Retrofit Program (GARP), which invites private GI contractors to locate and *aggregate* low-cost green acre opportunities throughout the city to create a portfolio of projects in a bundled application. Under GARP, the city does not set a price per greened acre but accepts bids at a unit price not to exceed a cost ceiling (which PWD can change each year). "By not setting a fixed subsidy rate and prioritizing grant awards based on cost-competiveness, PWD is encouraging contractors to compete for public dollars—which should lead to lower-cost green infrastructure costs over time."[183] The Green City, Clean Waters Initiative will have its first required (five-year) Evaluation and Adaptation Plan due in the fall of 2016.

There is an excellent video that explains Philadelphia's initiative, which was inspired by the stormwater program in Portland, Oregon. The overview in the video includes the extraordinary outreach to involve residential homeowners, commercial and public properties, including schools, in the Green City, Clean Waters Initiative: http://waterblues.org/themes/philadelphia/philadelphia-segment.

The Florida Legislature has demonstrated an active interest in expanding the beneficial use of stormwater (previously mentioned in section 4.23 of this report) by passing SB 536 in 2014 that directed DEP to conduct a comprehensive study and submit a report on the expansion of use of reclaimed water, storm water, and excess surface water in Florida. Among the recommendations in DEP's final report were two which supported dispersed water management projects, including water storage on fallow citrus groves.

7.2 Expanding Water Farming to Meet SLE Watershed Goals

The key questions addressed in this interim report were: How much water farming would be needed to meet the goals in the SLE Watershed, for water storage and nutrient reductions, and how much would that option cost? The answers are based on an estimate of the cost and performance of a regional expansion of the practice, which was detailed in chapter 3 and presented in **Table 4**. The answers are summarized next.

A total of 20,000 acres of water farming of the deeper storage project type would meet an estimated 60 to 100 percent of the water storage goal for the SLE Watershed, by storing 120,000 to 200,000 acre-feet per year drawn in from the regional canals, as well as retaining the rainfall on the project properties. (The variable used in this estimate, the number of volume refills per year, was explained in section 3.35.) The shorter answer is it would likely take a minimum of 20,000 acres of water farms to meet the storage goal.

Regarding the nutrient reduction goals to be met by the SLE BMAP stakeholder Agriculture, 20,000 acres of water farming could meet an estimated 132 percent of the required reductions remaining for TN and 55.35 percent of the required reductions remaining for TP. More would need to be done to reduce TP loading; and the strategic use of Florida CREP, and its dedicated federal budget of $96 million for the project area, could support that effort. (The Florida CREP program was described in chapter 6.)

It would cost an estimated $27.2 million, in one-time start-up costs, to design and build 20,000 acres of water farms, as was shown in **Table 4**. The recurring costs, for O & M plus (let us call it) a Payment for Watershed Services to the water farmers, would total an estimated $12.6 million per year. The projected total cost to build then operate 20,000 acres of water farms *for ten years* would be $153.2 million.

Implementing 20,000 acres of water farms sounds hypothetical, but there are 13 proposed water farming projects totaling about 20,000 acres included in this report, based largely on the responses among Indian River Citrus League members who were queried (discussed in chapter 3). With funding, it could be done.

7.21 Water Quality Goal

The actual unit costs for nutrient reductions on the Caulkins water farm so far (based on 22.5 months of monitoring data and reported in **Table 1**) is $17.92 per pound of TN and $116.55 per pound of TP. The estimated unit cost of nutrient reductions on 20,000 acres of water farms would be $26.22 for TN and $130.29 for TP, in a ten-year projection shown in Table 4. Those unit costs are one percent or less of the adjusted average unit costs for nutrient removal for 50 projects implemented by non-agricultural SLE BMAP stakeholders, shown in **Table 5**.

The reported reductions remaining for the BMAP goal are *after* standard agricultural BMPs have been applied on 90 percent of the applicable lands. Going any further with standard BMPs, even if that were practicable, will not meet the reduction goal of 443,932 pounds of TN (201.4 MTs) and 212,426 pounds of TP (96.3 MTs) in the SLE Watershed. A plan is needed to *supplement* agricultural BMPs. There is an opportunity for water farming to be part of that plan. (**Table 3** provides details of the credits granted by DEP to Agriculture for BMPs in the SLE BMAP.)

Water farms could provide the nutrient reductions needed on agricultural lands at a cost even below the unit costs for TN and TP reductions given above, which are per a separate costing for each nutrient as if they would be "sold separately," or traded in a WQT market. More than likely, however, the payments to water farmers in the SLE Watershed would be independent of the nutrient reduction performance of the water farms. Compensation would be based instead on an agreed-to fixed-price participation payment or maybe a variable payment based on the amount of water stored. In either case, the cost of the nutrient reductions should not exceed the total cost of the annual water farming contract(s), as was discussed in chapter 5, section 5.2. Instead, those reductions would be an added benefit realized at no additional cost.

What that would mean in practice, from the perspective of the coordinating agencies for the Northern Everglades and Estuaries Protection Program (NEEPP)— DEP, FDACS and the SFWMD—is that 132 percent of the TN and 55.32 percent of the TP goal for Agriculture could be met for the annual cost of operating 20,000 acres of water farms, which is an estimated $12.6 million. Since the three coordinating agencies share an interest in achieving the restoration goals for the SLE, perhaps the annual cost of the water farms could be shared as well. The annual cost divided by three is $4.2 million.

7.3 A New Opportunity to Re-conceptualize Storage Options and Plans

The majority of the water storage that will be provided in the SLE Watershed is to be provided by public regional reservoirs and STAs, per the IRL-S plan described in chapter 2, section 2.1. The R/STAs in the IRL-S plan are intended to reduce local basin runoff and provide water supply for agricultural irrigation, not public water supply.

The IRL-S study was completed in 2004—one year before citrus greening disease was detected in Florida. Productive citrus groves covered much of the SLE Watershed then, as shown in **Figure 4** (in the Introduction). Although the need for water storage to reduce local basin runoff and stress on the coastal estuaries is not in question today, the drastic change in the watershed (see **Figure 5**) since 2004 raises the question of how much storage is still needed to supplement supply for agricultural irrigation.

When Doug Bournique, whose tenure as the Executive Vice President of the IRCL predates the IRL-S plan development, was asked in 2016 whether he thought all of the R/STAs in the IRL/S plan would be needed for irrigation supply in the future his answer was, "No." We didn't need them *then* (when citrus was really booming; when no public reservoirs were available), so we don't need them, he reasoned.[184]

If citrus production recovers and/or as new types of agriculture enter the SLE Watershed, there is an opportunity to increase surface water storage for irrigation on private farmland, pastures and groves through upgrades to stormwater management facilities, including the addition of tailwater recovery systems (mentioned in section 5.42). Agricultural cost share programs, including Florida CREP, could provide assistance as needed. Identifying the *critical source areas* in the watershed (mentioned in section 6.31) could help inform the prioritization of cost share assistance for stormwater system improvements.

It is not yet known how much it will cost to construct each of the *three* additional R/STAs in the IRL-S plan (besides the $600 million C-44 R/STA under construction), but the cost estimate of implementing the entire IRL-S plan now stands at $4,022,534,000 ($4 billion+).[185] It is reasonable to imagine that the C-23/C-24 North and South R/STAs would cost approximately $1 billion for both (not the counting land that has been acquired for the facilities) by the time they would be constructed, after 2025. (The cost of the entire IRL-S plan, all five features, was originally estimated in 2004 at $1.2 billion+.)[186]

There is an opportunity to apply adaptive management to the IRL-S plan in CERP that could result in avoided costs of potentially $1 billion or more, by using water farming to help meet the storage and nutrient reduction goals for the SLE instead of building ***all*** *of the rest* of the R/STAs specified in the plan. *The savings identified could be reallocated toward ways to reduce the harmful discharges from Lake Okeechobee to the coastal estuaries, including the SLE.*

It is important to reduce the volume and frequency of discharges to the SLE from <u>all</u> of the C-Canals in the watershed, which collect local basin runoff. However, discharge from Lake Okeechobee is the single largest freshwater source to the SLE: the lake discharge was more than twice the volume of any other single basin in the SLE Watershed, per an eleven-year look-back conducted by the SFWMD for the St. Lucie Watershed Protection Plan.[187] <u>To be clear</u>, all of the other basins *collectively* contributed more discharge to the SLE (62.57 percent in that look-back). But despite the fact that the water storage and nutrient reduction goals for the SLE do not address this single largest source of nutrient-laden discharge, because it is addressed in other restoration plans, it has been understood that the recovery of the SLE and the southern Indian River Lagoon depends on controlling destructive discharges from the largest source:

> While the IRL-S recommended plan addresses to a significant degree the restoration needs associated with impacts from the study area [SLE] watershed, the balance of the Comprehensive Everglades Restoration Plan further contributes to the restoration of the Indian River Lagoon by providing additional storage of excess regional water from Lake Okeechobee and its enormous watershed. The full restoration potential of the St. Lucie River and the southern Indian River Lagoon **is dependent upon** the implementation of the overall restoration plan for the south Florida ecosystem. The IRL-S recommended plan represents one regional set of highly interrelated components of the Comprehensive Everglades Restoration Plan (*Final IRL-S Project Implementation Report and EIS*, 2004).[188]

The near-term surface storage that can be provided on lands owned by the SFWMD, particularly the roughly 10,000 acres that have been acquired for the future construction of the C-23/C-24 R/STAs, will amount to approximately 5,000 acre-feet and will include a 320-acre water farm (to be built and managed by the SFWMD), per the District's interim storage plans.[189] That amount of storage, and the storage provided on other public property (Allapattah, the C-44 R/STA, etc.), could be factored into careful consideration of how much more storage is needed and *where* it is needed most, as a priority.

For instance, should water farms be concentrated in the C-23/C-24 basins, to augment storage planned on public lands there and to achieve, in an alternative way, the C-23 Diversion feature of the IRL-S plan?[190]

> The goal of this [water Diversion] component is to reduce or remove the damaging discharges of the C-23 Canal through Structure S-49 directly into the middle of the estuary. Historically, a natural rise in topography prevented all but groundwater flow from entering the SLE from this portion of the watershed. The current discharges from the C-23 Canal into the middle estuary, at S-48, introduce 'salinity shock' to the SLR and SLE by removing the opportunity for a more natural salinity gradient to form as the freshwater moves from the north and south forks of the river to the middle estuary.[191]

What other restoration objectives can be met if there is a re-conceptualization of *how* they can be met?

7.4 Organizing for Action

Fixing the Lake Okeechobee problem is a much larger and more expensive undertaking than tackling the local basin runoff in the SLE Watershed needs to be—if it would be tackled by using an incentive-based approach involving private landowners. But to be effective, the programmatic approach should be well-planned, well-organized and broadly inclusive. The National Research Council provided advice on organizing for watershed management in its report on *New Strategies for American Watersheds* (1999):

> A truly effective watershed management effort is most likely to be a bottom-up process, driven largely by citizen concerns about local or regional problems and guided by sound data and information. Successful collaborative planning requires broad participation by those likely to be affected by the outcome…Organizations for watershed management are most likely to be effective if their structure matches the scale of the problem.[192]

Similar advice has been offered by the USDA NRCS researchers in *How to Build Better Agricultural Conservation Programs to Protect Water Quality* (2012):

> The most important lesson learned is that an effective watershed management program requires many participants working in concert, with input from key stakeholders, including farmers and others affected by water quality concern and the actions proposed to address it…Once science has identified what is needed, farmers, agency personnel, and the private and nonprofit sectors must work together to get those practices on the ground in the right places and ensure that they are properly managed and maintained.[193]

In the exemplary watershed program in New York, the agricultural council formed by the farmers in the region forged the links among farmers, environmental groups, Extension, NRCS, and other organizations. The agricultural council had support from state and city agencies, including sustained financial support.[194]

It has been suggested by some within the Treasure Coast agricultural community that new organizations could be formed to provide watershed services as a collective of producers, perhaps by establishing Improvement Districts or irrigation utilities for that purpose. Such organizations might be able to provide a single point of contact, for instance, for contracting for many water farms, functioning as an aggregator of multiple projects. The organizations may also provide innovative solutions to water quality problems besides water farming, if the incentive exists to do so. Others outside of Florida have thought about this too and have included ideas in publications of ways to encourage joint actions and to foster innovation, such as this example from Iowa:

> Finally, instead of command-and-control regulations applied to individual farmers, why couldn't we enter into performance agreements with groups of producers in small, impaired watersheds? Producers, organized through a producer group, conservation district, or drainage district would work together to achieve explicit and measurable reductions in water pollution by some specified date. The producers themselves would come up with the plan for getting the job done and be responsible for working together to get the practices in place. Financial help could be provided up front to get things going, but failure to meet the target reductions would result in more restrictive measures.[195]

What is considered to be the most successful WQT program involving agriculture in the U.S. to date is the Great Miami River Watershed Water Quality Credit Trading Program,[196] operated in a 4,000 square mile watershed in southwestern Ohio. One of the features of the program—which was designed to be "farmer friendly"—that has made it successful is its inclusive form of governance.[197] The stakeholders[198] who were directly involved in designing the program and its rules eventually formed themselves into a panel, called the advisory group, which plays an important role in the ongoing operation of the program. Specifically, the advisory group evaluates the bids to sell WQ credits that are submitted by farmers and prioritizes them for purchase, according to the established ranking criteria the advisory group developed.

If there is to be a regional expansion of water farming and related practices, it would be a good idea to draw on these examples to structure an incentives-based program in the Treasure Coast that the public could believe in and support, and that agricultural landowners would want to engage in from the start.

DEP and local scientists agree that the Indian River Lagoon and the St. Lucie River and Estuary need relief from the stress of polluted freshwater discharges now. In dramatic contrast with the exemplary watershed programs in New York, California, and Pennsylvania profiled earlier in this chapter, which entail the implementation of hundreds of projects over two decades or more to meet the goals, the storage goal for the SLE could be nearly or completely met by implementing about a dozen water farms, which could be done in two+ years instead of two+ decades, if there is a funding commitment to do this now.

That approach would have a positive ripple effect on the regional economy, beyond helping the sectors that depend on the recreational use of the coastal waters. Many of the landowners who are interested in water farming on fallow citrus groves are still producing citrus on other active groves, although citrus production costs have *tripled* since 2004.[199] Having a new revenue source from water farming could help those employers retain not only their own company staff but also to sustain the broader infrastructure that supports the citrus industry, including packing houses, mechanics, marketers, accountants, attorneys, farm suppliers, transportation workers and so on.

The water farms have been performing well in the demonstration project that is still in progress—even better so far than expected, as was described in the Executive Summary and detailed in section 1.44 of chapter 1. This simple concept, lower-cost storage option could allow for immediate intervention at this critical juncture to help bolster a foundational industry (citrus) and avert further decline in the estuaries—natural resources that are highly valued hallmarks of the Treasure Coast region of Florida.

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Appendix 1: Profiles of the Largest Proposed Water Farms

Projects Proposed by Evans Properties

Three of the four largest prospective projects are the ones proposed by Evans Properties. The Evans sites, with the exception of the Fox Brown Grove (which is not covered in this section), have had a preliminary evaluation done by Velez Engineering[200] and a subsequent review and update (of the Velez evaluations) done by Hazen and Sawyer. The engineering studies were privately commissioned by Evans Properties.

Table 6a provides the estimated costs and performance of the two largest of the proposed Evans projects: Bluefield Grove (6,602 acres in the C-23 basin) and the Scott 6000 Grove (5,683 acres in the C-25 basin). Each potential project site was evaluated for the three different scenarios that were used in the AECOM study (2012): retention only (RO, holds the rain that falls on the site); retention and storage (R&S, holds the rain and retains inflows from canals); and R&S plus Alternative Water Supply (AWS, holds the rain, accepts and retains inflows from a canal, then can provide a controlled release of water one time in the dry season, back to the regional canal system to supplement agricultural irrigation surface water supply).

The capital costs for start-up are the lowest in the RO scenario, as the shallower storage (up to two feet) requires the least amount of modifications to existing grove infrastructure (for site development). Total initial capital costs for the R&S and AWS scenarios are equivalent, as are the estimated annual costs of maintenance. Only the cost of annual operations differs in the two scenarios and is somewhat higher in the AWS scenario because of the additional expenses expected for a greater amount of water pumping.

The proposed annual Water Farming Services Payment, or participation payment to the landowner, does not vary by operating scenario; it is uniformly based on $500 per acre of land involved in the project. On that basis, the proposed annual payment is in the $3 million-dollar range on project sites of this scale (precise figures are shown in **Table 6a**). Evans is proposing for all of their prospective projects the same compensation they are receiving for operating the pilot project now: $500 per acre of land plus O & M.

To lend some perspective to the $500 per acre proposal, the Indian River Citrus League had expected water farming proposals to be in the $500 to $700 per acre range, commensurate with the range of acceptable returns on an acre of active grapefruit grove. Net profits (earnings per acre) have generally decreased in recent years as production costs have climbed to maintain citrus production in the face of citrus greening. Yet even now it is possible and "it is done" to have earnings of $1,500 to $2,000 per acre on an exceptionally high-producing grove or for some specialty citrus fruits.[201] Such earnings would be greater than average, but one-third of the low end of that range, i.e., $500, represents moderate earnings for Indian River citrus district grapefruit growers.

When questioned about the rationale for the $500 per acre proposal, Ron Edwards has explained that it is in consideration of the investments in infrastructure the company has made on the groves—the *sunk costs*, such as perimeter berms and pumping stations that can be used in a water farming project; it would not need to be constructed from scratch, which means *avoided capital expenses* on the part of the SFWMD. Others acknowledge that water farming fully commits a grove to the project, which is often referred to as being "all in" on that land use, and that differs from ranch owners participating in the NE-PES program who may have a minor fraction of their property devoted to a dispersed water management project that does not adversely affect cattle ranching operations. Although the opportunity costs associated with water farming are considerable, Ron Edwards regards the requested $500 per acre price as a proposal. "Make me an offer," he added,[202] indicating that Evans Properties might entertain the possibility of a volume discount, which is easier to imagine if the company would be contracting for more than one big project.

The Bluefield Grove would cost $3.25 million less in capital costs to turn it into a water farm (R&S or AWS) than the Scott 6000 Grove, as shown in **Table 6a**. Bluefield has exceptionally tall and substantial perimeter berms which were constructed to protect the grove from external seepage, especially coming from the natural lands on the grove's western border. Total capital costs are an estimated $3,629,660 for Bluefield and $6,884,500 for Scott 6000 for the deeper storage options. Total start-up costs on Bluefield would be less than half those on Scott 6000 for the RO option: $1,449,216 and $3,510,974, respectively. Bluefield is 919 acres larger than Scott 6000 and accordingly offers more storage capacity.

The average annual volume retained, in acre-feet, on Bluefield ranges from an estimated 23,738 (for the RO option) to 36,065 plus 6,174 AWS (for the AWS option). On Scott 6000, the range would be 18,813 (RO) to 27,526 plus 7,305 AWS (for the AWS option), as shown in **Table 6a**.

There is a second category of capital costs shown in **Table 6a**: the close-out costs referred to as *reversion*, which means returning the grove to its pre-water farm condition. The one-time cost for reversion would exceed $4 million on these sites, in large part due to the replacement of the groves' tile drainage system. (The assumption is the system will become degraded and inoperable after several years of water farming.) SFWMD has allowed for diversion cost coverage in other dispersed water management project contracts.

The estimated nutrient reductions, as shown in **Table 6a**, are for the RO and AWS options only, as the reductions pertain to the nutrients retained on the site from the canal inflows. Therefore, the estimates for the AWS scenario are *net* values (minus the nutrients released back to the regional canal with the timed release during the dry season; even though a release at that time is unlikely to result in a discharge to the estuaries). The larger retention volume on Bluefield Grove, relative to Scott 6000, corresponds with its larger nutrient reduction values of up to 36,869 pounds per year of TN and 7,397 pounds per year of TP.

Table 6a. Estimated Costs of Evans Properties' Proposed Water Farming Projects

	Bluefield Grove (6,602 acres)			**Scott 6000 Grove** (5,683 acres)		
Estimated Costs and Performance[19]	Retention Only (RO)	Retention & Storage (R&S)	Retention & Storage + AWS[20]	RO $	R&S $	AWS $
1. Capital: Start Up						
a. Site Development	$641,045	$2,179,216	$2,179,216	2,507,835	4,917,496	4,917,496
b. Contingency[21]	$160,261	$544,804	$544,804	626,959	1,229,374	1,229,374
c. Detailed Design[22]	$647,910	$905,640	$905,640	376,180	737,630	737,630
d. Total Initial Capital	**$1,449,216**	**$3,629,660**	**$3,629,660**	**3,510,974**	**6,884,500**	**6,884,500**
2. Recurring: Annual						
a. Operations	$26,543	$111,241	$143,241	56,865	191,312	207,737
b. Maintenance	$36,905	$181,483	$181,483	87,774	344,225	344,225
c. Subtotal: O & M	$63,448	$292,724	$324,724	144,639	535,537	551,962
d. Water Farming Services Payment[23]	$3,301,000	$3,301,000	$3,301,000	2,841,500	2,841,500	2,841,500
e. Total Annual Costs	**$3,363,448**	**$3,593,724**	**$3,625,724**	**2,986,139**	**3,377,037**	**3,393,462**
3. Capital: Close-Out						
a. Reversion	$3,858,355	$3,858,355	$3,858,355	3,688,205	3,688,205	3,688,205
b. Contingency[24]	$964,589	$964,589	$964,589	922,051	922,051	922,051
b. Total Reversion	**$4,822,944**	**$4,822,944**	**$4,822,944**	**4,610,256**	**4,610,256**	**4,610,256**
4. Performance[25]						
a. Volume Retained (acre-feet per year)	23,738	34,813	36,065	18,813	24,574	27,526
b. AWS (ac-ft/yr) [26]	0	0	6,174	0	0	7,305
c. TN Reduced[27] (lbs)		47,182	36,869	-	30,970	15,891
d. TP Reduced[28] (lbs)		9,466	7,397	-	4,847	2,487

[19] In 2014 dollars, from the following studies by Eva Velez, P.E., Velez Engineering, Inc.: "Preliminary Evaluation of Water Farming Bluefield Grove," revised January 14, 2015; "Preliminary Evaluation of Water Farming Scott 6000 Grove," January 21, 2015, and "Preliminary Evaluation of Water Farming Scott 2000 Grove," March 8, 2015.

[20] Alternative Water Supply (AWS) for agricultural irrigation. Though dry season releases were estimated, AWS has not yet been field-tested to empirically validate whether it is a benefit water farms will be able to reliably provide.

[21] 25% of site development costs (1a).

[22] Estimate for detailed engineering design = 15% of site development cost (1a) plus 15% of reversion costs (3a).

[23] Participation payment of $500 per acre (of land used in the project) per year is proposed by Evans Properties.

[24] Contingency = 25% of reversion cost (3a).

[25] Performance estimates are for *average annual* amounts, per water budget analyses using a ten-year data record.

[26] Average annual Alternative Water Supply volume available for release to regional canal in the dry season (~April), from Hazen and Sawyer's 2015 review of Velez Engineering's preliminary studies (per Hazen's 7/27/15 presentation tables).

[27] Average annual Total Nitrogen reduction in pounds per year, from Hazen and Sawyer's review.

[28] Average annual Total Phosphorous reduction in pounds per year, from Hazen and Sawyer's review.

Table 6b provides estimated cost and performance information, in the same format as **Table 6a**, for the 2,032-acre Scott 2000 Grove site and for the Scott 2000 and Scott 6000 Grove sites operating together as two proximal water farms totaling 7,715 acres—1,113 more acres than the Bluefield site. The Scott 2000 Grove is located in Indian River County, northeast of Scott 6000 and in the SJRWMD. (Scott 6000 is in the SFWMD.) As was mentioned in section 3.125, the Scott 6000 and 2000 sites are also being proposed by Evans as the potential future location of the $435 million-dollar Reconnection project called GLRSTA.

Table 6c provides unit costs and projected costs for all of the proposed Evans projects for three different scenarios—RO, R&S, and AWS. In general, the unit costs *per acre* to construct a project and to operate it are substantially lower for the RO option, in comparison with the deeper storage options. But the unit cost per *acre-foot* of water storage is substantially lower in the deeper storage scenarios, as can be seen in **Table 6c**. The unit costs for an acre-foot of water volume retained are given for all options in the 10-year projections, which take into account the one-time total start-up costs and the total recurring annual costs multiplied by ten (years). That total 10-year cost is then divided by the average annual volume retained, multiplied by ten (years). The unit costs for the 20-year projection were calculated the same way, except that the total project costs were inclusive of the additional capital costs for close-out (i.e., site reversion); and the annual costs were multiplied by 20 instead of 10, and updated or *alternative estimates* were used if available, as identified in the footnotes to **Table 6c**. <u>No inflation factors were used in any projections.</u>

Unit costs for the 20-year projection are shown for the AWS option only, except for Bluefield Grove, for which unit costs for all scenarios are shown. For the most part, the unit costs in the 20-year projections are close to the unit costs in the 10-year projections, differing by $1.47 up to $5.76 per acre-foot, with the exception of the Scott 6000 plus Scott 2000 Groves combination project. In that case the unit cost jumps by $30.40, from the 10-year to the 20-year projection (from $137.30 to $167.70 per acre-foot). The substantial increase is mainly attributable to the use of the updated cost estimates in the 20-year projections (but not in the 10-year). The updated or alternative estimate for the recurring annual costs (the O & M component) for the combination site is $1,259,401 higher than the original estimate, as can be seen in **Table 6b**. That annual difference increased the total estimated cost of the project by more than $25 million dollars. If the costs originally estimated by Velez Engineering are used instead for the *annual costs*, the unit cost in the 20-year projection for the combination site would be $136.66 per acre-foot, which would be in keeping with the pattern of being close to the ten-year unit cost. Overall, the unit costs in the 20-year projections indicate that the addition of the one-time, multi-million-dollar reversion cost does not appreciably alter the unit price for water storage, but a large increase in annual costs does have a substantial effect over time.

Table 6b. Estimated Costs for Evans Properties' Proposed Water Farming Projects

	Scott 2000 Grove (2,032 acres)			**Scott 6000 and 2000 Groves**[29] (7,715 acres)	
Estimated Costs and Performance	Retention Only	Retention & Storage	Retention & Storage + AWS	Retention & Storage	Retention & Storage + AWS
1. Capital: Start Up					
a. Site Development	$503,637	$1,768,346	$1,768,346	$6,685,842	$6,685,842
b. Contingency	$125,909	$442,086	$442,086	$1,671,442	$1,671,442
c. Detailed Design	$75,550	$265,260	$265,260	$1,002,890	$1,002,890
d. Total Initial Capital	**$705,096**	**$2,475,692**	**$2,475,692**	**$9,360,192**	**$9,360,192**
e. Alternative Estimate: Capital[30]		**$2,272,000**	**$2,272,000**	**$11,914,000**	**$11,914,000**
2. Recurring: Annual					
a. Operations	$23,037	$67,122	$101,352	$258,434	$309,089
b. Maintenance	$35,255	$123,785	$123,785	$468,010	$468,010
c. Subtotal: O & M	$58,292	$190,907	$225,137	$726,444	$777,099
d. Water Farming Services Payment	$1,016,000	$1,016,000	$1,016,000	$3,857,500	$3,857,500
e. Total Annual Costs	**$1,074,292**	**$1,206,907**	**$1,241,137**	**$4,583,944**	**$4,634,599**
f. Alternative Estimate: Annual[31]		**$1,243,500**	**$1,366,500**	**$4,620,000**	**$5,894,000**
3. Capital: Close-Out					
a. Reversion	$1,340,789	$1,340,789	$1,340,789		
b. Contingency	$335,197	$335,197	$335,197		
c. Total Reversion	**$1,675,986**	**$1,675,986**	**$1,675,986**	**$6,286,242**	**$6,286,242**
4. Performance					
a. Volume Retained (acre-feet per year)	6,792	8,601	13,046	33,175	40,572
b. AWS (ac-ft/yr)	0	0	6,238	0	13,543
c. TN Reduced (lbs)	-	10,456	3,637	41,426	19,528
d. TP Reduced (lbs)	-	1,637	569	6,484	3,056

[29] The estimated component costs for the Scott 6000 and 2000 Groves operating together are derived from the studies by Velez Engineering of the Scott 6000 and 2000 Groves. Additionally, the alternative cost estimates shown for categorical totals and the performance values are from the 2015 Hazen and Sawyer review of the Velez Engineering studies, for Evans Properties. Estimated costs reported by Hazen and Sawyer are in 2015 dollars. The Retention Only water farming scenario was not included in Hazen's review of the Velez studies (presented on 7/27/15) and thus RO was omitted from this table.

[30] Alternative estimate for initial capital is from Hazen's review and update of Velez Engineering studies.

[31] Alternative estimate for annual costs is from Hazen's review and update of Velez Engineering studies.

Table 6c. Estimated Costs for Evans Properties' Projects: Unit Costs and Projections

	Unit Costs			Ten and 20-Year Projections		
Grove Name and Project Scenarios	Total Initial Capital per Acre[32]	O&M per Acre per Year[33]	Total Annual (Recurring) Costs/Acre[34]	Initial Capital Plus Total Annual (10 years)	Cost per Acre-Foot of Water Storage (10 years)	Cost/A-F Storage with Close-Out Costs Incl. (20 years)[35]
Bluefield Grove (6,602 acres)						
Retention Only	$219.51	$9.61	$509.46	$35,083,696	$147.79	$154.90
Retention & Storage	$549.78	$44.34	$544.34	$39,566,900	$113.65	$115.37
R & S + AWS	$549.78	$49.18	$549.18	$39,886,900	$110.78	$112.25
Average: 3 Scenarios	**$439.69**	**$34.38**	**$534.33**	**$38,179,165**	**$124.07**	**$127.51**
Scott 6000 Grove (5,683 acres)						
Retention Only	$617.80	$25.45	$525.45	$33,372,364	$177.39	
Retention & Storage	$1,211.42	$94.23	$594.23	$40,654,870	$165.44	
R & S + AWS	$1,211.42	$97.12	$597.12	$40,819,120	$148.29	$144.16
Average: 3 Scenarios	**$1,013.55**	**$72.27**	**$572.27**	**$38,282,118**	**$163.71**	N/A
Scott 2000 Grove (2,032 acres)						
Retention Only	$374.00	$28.69	$528.68	$11,448,016	$168.55	
Retention & Storage	$1,218.35	$93.95	$593.95	$14,544,762	$169.10	
R & S + AWS	$1,218.35	$110.79	$610.79	$14,887,062	$114.11	$119.87[36]
Average: 3 Scenarios	**$927.90**	**$77.81**	**$577.80**	**$13,626,613**	**$150.59**	N/A
Scott 6000 and 2000 (7,715 acres)						
Retention & Storage	$1,213.24	$94.16	$594.16	$55,199,632	$166.39	
R & S + AWS	$1,213.24	$100.72	$600.72	$55,706,182	$137.30	$167.70[37]
Average: 2 Scenarios	**$1,213.24**	**$97.44**	**$597.44**	**$55,452,907**	**$151.85**	N/A

[32] Total initial capital (values shown in row 1d in Tables 6a and 6b) divided by total project acreage.
[33] Operations and maintenance (values shown in row 2c in Tables 6a and 6b) divided by total project acreage.
[34] Total annual (recurring) costs (values shown in row 2e in Tables 6a and 6b) inclusive of participation payment of $500 per acre per year, as proposed by Evans Properties, divided by total project acreage.
[35] For 20-year unit costs for an acre-foot of volume retained, the sum of the total initial costs plus the total annual costs (x 20) plus the total close-out costs for reversion was divided by the product of the estimated average annual volume retained (x 20).
[36] 20-year projected costs use Alternative Estimates of costs as shown in Table 6b, rows 1e and 2f.
[37] 20-year projected costs use Alternative Estimates of costs as shown in Table 6b, rows 1e and 2f.

Water farms are intended to have no releases of water during the wet season, except in exceptional storm events. All water farming projects are designed with emergency overflow structures, to operate in such events. The preliminary engineering studies done on the Evans projects found, in a 10-year look-back, there would be some years in which wet season releases would likely occur.

The 10-year look-back, in which the performance of proposed projects was simulated, conformed to a protocol to accept inflows from a regional canal *only on days when the canal was discharging to the coast at a minimum flow of 200 cfs*. This restriction means that the water farms would be filled with inflows that would otherwise be lost to tide. This restriction also removes the possibility that a water farm would be filled with irrigation water that was desired by agricultural producers at that time; instead, only surplus water would be stored. This protocol could be modified in the future, however, if water farms should be operated to *prevent* canal discharges and/or to reduce the volume of the discharges as often as possible. Given demand for irrigation supply has been lower in recent years, a protocol change may be reasonable. And if or when irrigation demand increases in the future, the farming community could be consulted on a modification of a protocol, which could include returning stored water to canals once levels have receded.

Project Expansion Proposed by the Caulkins Citrus Company

The Caulkins Citrus Company proposes to devote the remainder of its property, located along the north side of the C-44 Canal in Indiantown, to water farming for at least the next ten years. The proposed project expansion would add nearly 2,600 acres to the 413-acre water farming pilot site, for a total project size of about 3,000 acres. All of the Caulkins property is on deep, unconfined, sandy soils, which has enabled the pilot project to exceed expectations for how much water it could take in from the C-44 Canal. The expansion would add four water containment areas, or cells, similar to the pilot project impoundment. There is also an aim is to nearly quadruple the pumping capacity from the current 60 cfs now, at the pilot site, to 230 cfs in an expanded site. The increase would enable the project expansion to take in far more inflows from the C-44 at a much faster rate: up to 460 acre-feet per day. The MilCor Group, Inc. has completed a preliminary engineering design and has estimated project costs.

The Caulkins Citrus Company has proposed two different ways to be paid for operating the expansion project; both methods were proposed in 2015. The initial proposal was to be paid an annual participation or service fee, based on $700 per acre of land involved in the project, plus $65,000 per month for O & M. The $700 per acre price is equivalent to the per acre rental fee Caulkins receives to rent land to vegetable farmers. Later in the year, an alternative proposal was proffered to be paid based on the amount of water that is stored each year at an all-inclusive rate of $100 per acre-foot of water. That means no additional reimbursement for O & M. That also means the payments would be variable. The second proposal was in part a response to a criticism of water farming that has occasionally been expressed in public forums: that water farmers would be paid the same amount every year whether they store any water or not.

The concept of variable payments, pegged to measured storage performance, is appealing to some citizens who resent the idea of doling out public dollars to water farmers in a drought, when storage is not needed. But would a variable method of payment cost fewer public dollars than a fixed price method of payment? A comparison of the two proposed methods, plus additional payment scenarios, is shown in **Table 7**. This table is similar to **Table 6c**, which provided unit cost comparisons for the different water farming project sites and operational scenarios proposed by Evans Properties, with 10-year and 20-year projections.

Table 7 differs from **Table 6c** in that it omits a column for the unit cost of initial capital expenses per project acre. In the case of the Caulkins expansion project, that unit cost does not vary. It is $1,596 per acre, based on the total start-up costs of $4,789,180 (the sum of the estimated costs for planning and

Table 7. Estimated Costs for Caulkins Proposed Expansion: Unit Costs and Projections

Payment Scenarios For Caulkins Expansion (3,000 Acres)	**Total Annual Costs per Acre**	**Ten and 20-Year Projections**		
Variable Payments, per Acre-Foot (ac-ft) of Water Storage		Initial Capital Plus Total Annual Costs (**10** Years)	Cost/ ac-ft of Storage (**10** Years)	Cost/ ac-ft of Storage with Additional Front End Costs Incl. (**20** Years)
1. $100/ac-ft for 30,000 acre-feet	$1,000	$34,789,180	$116	$112
2. $100/ac-ft for 55,000 acre-feet	$1,833	$59,789,180	$109	$107
3. $100/ ac-ft for 80,000 acre-feet	$2,666	$84,789,180	$106	$105
4. $43.42/ac-ft Plus O & M, for 80,000 ac-ft	$1,418	$47,325,180	$59	$58
Fixed Price Payments per Acre of Land				
5. $700/Acre plus O & M, at 30,000 ac-ft	$960	$33,589,180	$112	$108
6. $700/Acre plus O & M, at 55,000 ac-ft	$960	$33,589,180	$61	$59
7. $500/Acre plus O & M, at 55,000 ac-ft	$760	$27,589,180	$50	$48

design of $235,000, and the costs for site development and construction of $4,118,800, plus a ten percent contingency of $435,380). **Table 7** also omits a column for the unit cost of operations and maintenance per acre. That cost is invariably $260 per project acre, but is not applicable in scenarios 1—3 in which a proposed payment of $100 per acre-foot of water storage would be a singular annual payment inclusive of O & M. The column showing the total annual recurring costs per project acre is included in **Table 7** (as it is in **Table 6c**), and that unit cost ranges from $760 per acre in scenario 7 to $2,666 per acre in scenario 3.

For all scenarios (1—7), projected costs are shown for the total annual costs for ten years of operations at the storage volume listed in the scenario—*if it were held constant at that level for each of the ten years*—plus the standard start-up costs (initial capital). The 10-year total shown is then divided by the amount of storage there would be over ten years (for example, 300,000 acre-feet in scenario 1) to arrive at the unit cost per acre-foot for 10 years of operations. The far right column shows a 20-year projection of all costs divided by the total storage volume over twenty years to arrive at a unit cost per acre-foot. The far right column includes, in the total costs, two additional up-front payments which are requested by Caulkins: 1) a payment of $570,000 to buy out the leases of the vegetable farmers presently renting land on the property, and, 2) a land rental payment of $2,100,000 for compensation while the expansion project is under construction (for about one year). Instead of requesting coverage for the cost of reversion, at the end of the contract period, which is customary in the SFWMD's dispersed water management program, Caulkins is asking for coverage for front-end expenses, including $700 per acre in rent, which is atypical.

The first three scenarios display the costs based on the Caulkins Citrus Company's most recent proposal, to be paid one annual all-inclusive fee of $100 per acre-foot of water—per the total volume stored each year. Scenario 1 shows the units costs, with projections, if the project stores 30,000 acre-feet per year, which is thought to be the minimum amount the project will store. (Store means pumped in from the C-44 Canal.) The unit price over ten years of $116 per acre-foot is higher than $100 because the start-up costs are included.

Scenario 2, with storage of 55,000 acre-feet per year, is highlighted because this is the midpoint between the expected minimum storage amount of 30,000 acre-feet and the expected maximum amount of 80,000 acre-feet per year. In scenario 2, the Caulkins Citrus Company would earn $59,789,180 over a 10-year contract period (if the storage is 55,000 acre-feet each year). That amount would be fairly comparable to the 10-year contract cost for the proposed combination project sites of Evans Scott 6000 and 2000, as was shown in **Table 6c**.

If Caulkins is under a contract that does not have a ceiling, or a cap on how much can be paid to the company per year, and 80,000 acre-feet—or possibly more—is stored each year, the 10-year total would be close to $85 million, as shown in scenario 3 in **Table 7**. That would be a $50 million dollar increase over scenario 1, for instance.

Scenario 4 shows what the costs would be if payments for the Caulkins expansion project mirrored the basis of payment for the Caulkins pilot project: that is, an annual participation fee based on $43.42 per acre-foot of storage (for a specific storage goal, in the case of the pilot project), plus coverage for O & M (at a previously proposed $65,000 per month, or $780,000 per year for the expansion project). The unit cost of storage in that scenario would be $59 per acre-foot in the 10-year projection. The unit price would be similar, at $61 per acre-foot, in scenario 6 which shows the cost for 55,000 acre-feet per year of storage at the originally proposed price of $700 per project acre of land plus O & M.

If the price for the Caulkins expansion project was the same price proposed by Evans Properties for their projects—$500 per acre plus O & M—the unit cost for 55,000 acre feet of storage per year would be $50 per acre-foot in the 10-year projection and $48 per acre-foot over 20 years, as shown in scenario 7 in **Table 7**.

Water farming is a new practice. *There is not a standard way to pay for the service.* Before a precedent is set to contract for the service with an open-ended payment amount for storage volume, instead of setting a reasonable minimum and maximum amount that could be paid in a year—if not a fixed price—one ought to consider whether the additional public cost for a bumper crop of storage would be worth the premium in a very wet year, and whether the premium would be balanced out by lower payments in very dry years. It is an open question whether citizens who would object to paying for water farming in a drought would, on the other hand, support much higher annual payments for maximizing storage that may be of marginal benefit to the SLE in wet years which include exceptionally high volume releases from Lake Okeechobee, such as in 2013 (encompassing the *lost summer*) and again, now, in 2016.

Long-Term Cost Projections for the Caulkins Expansion and for Bluefield

Although water farming has often been regarded as an interim storage option to employ before the public regional reservoirs and STAs are constructed as part of the IRL-S recommended plan, it is conceivable that some water farms could operate long term as supplemental storage or as an alternative to one or more of the three additional R/STA projects (aside from the C-44 R/STA under construction) in the IRL-S plan.

Table 8 shows the estimated unit costs of storage for the Caulkins Citrus Company's expansion project and for Evans' Bluefield Grove water farm in two time horizons: a 15-year and a 50-year projection. The 15-year period was used because that could be the initial term for which a large water farm would be constructed and operated under contract. However, a ten-year term, potentially with an option to renew, is another solid possibility. (Ten-year and 20-year projections were used in the profiles of the Evans and

Caulkins projects presented previously in this Appendix.) A 50-year period was also used because that is usually the basis for calculating the unit costs of the public regional projects, per their useful life. It makes sense to consider the unit costs and total costs of water farming on private lands on that time scale as well.

The annual water storage volumes shown for the water farms in **Table 8** are not their maximum storage potential. Rather, the estimated average annual retained volume is shown for Bluefield, not counting the additional AWS volume that could be released during the dry season to supplement surface water supply in the regional system. Although 36,065 acre-feet per year of storage is shown for Bluefield, that project might also be able to release on average 6,174 acre-feet per year of AWS, per preliminary engineering estimates. However, SFWMD is not confident about the potential for AWS on water farms at this time.

For the Caulkins project, the 40,000 acre-feet of annual storage shown in **Table 8** may be more of a reasonable estimate of a *median* storage volume. Storage volume is harder to predict for this project because of the high percolation rate of the sandy-soil site. Initial engineering assessments suggest that the project could in some years pump in 80,000 acre-feet or possibly more. (The Caulkins project is not expected to include an AWS component because of the high percolation rate.) For both of the proposed water farms (Bluefield and Caulkins), the performance assumptions must be tested in field operations, and storage performance will be affected by variables including pumping capacity and precipitation/weather.

The estimated storage volumes of the two proposed water farms are comparable to the estimated storage volume of a public regional R/STA. For example, the University of Florida Water Institute reported the annual storage volume to be 40,000 acre-feet in the C-44 regional reservoir,[203] which could be the average annual amount expected for that component of the R/STA facility and is the same volume used in **Table 8** for the Caulkins expansion project.

The annual storage volumes shown in **Table 8** were held constant (assumed to be the same every year) in the calculation of projected unit costs for storage. The Caulkins Citrus Company is requesting a variable payment based on an inclusive service payment of $100 per acre-foot of canal inflows, but variability is not factored in to the projections. Instead, the Total Annual Costs shown in **Table 8** for each project are simply multiplied by the number of years in each projection. Although Evans Properties has proposed to be paid a fixed fee per project acre, independent of storage volumes, annual payments for the Caulkins project, if variable, could range well above those calculated for the cost projections in **Table 8** if there is no ceiling for payments based on acre-feet of storage per year, as previously mentioned as a possibility.

Table 8. Unit Cost Projections for Storage on the Proposed Caulkins Expansion and Evans Bluefield Grove Water Farms

	Caulkins Citrus Co. Expansion (3,000 acres)	Evans Properties Bluefield Grove (6,602 acres)
Public Land Acquisition	N/A	N/A
Planning and Engineering Design	$235,000	$905,640
Site Development and Construction	$4,554,180	$2,724,020
Total Start-Up: Initial Capital Expenditures	$7,459,180[38]	$3,629,660
Total Annual Costs: O & M + Participation Payment/Service Fee	$4,000,000[39]	$3,625,724[40]
Annual Water Storage Volume in Acre-Feet (average or median)	40,000 [41]	36,065 [42] **plus** AWS
Unit Cost of Storage: 15-Year Projection	**$112**/ Acre-Foot[43]	**$107**/ Acre-Foot[44]
Unit Cost of Storage: 50-Year Projection	**$104**/ Acre-Foot	**$102**/ Acre-Foot

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[38]To the start-up expenses subtotal of $4,789,180 for planning, design, site development and construction is added two proposed (by Caulkins) payments: 1) $570,000 to buy out the leases of vegetable farmers on the property and 2) $2,100,000 for rental of the Caulkins property during construction of the expansion project (for about one year).

[39]Total annual costs proposed by Caulkins is a service payment (inclusive of O & M) of $100 per acre-foot of water pumped in from the C-44 Canal. $100/ac-ft is applied to the *conservative* storage estimate of 40,000 ac-ft/year.

[40] Total annual costs proposed by Evans Properties include $324,724 for O & M and a $500 per acre Participation Payment ($500 x 6,602 acres = $3,301,000/year).

[41] This is a conservative estimate of the annual storage volume that is expected to be a minimum of 30,000 acre-feet/year and could range beyond 55,000 ac-ft/year—potentially up to 80,000 ac-ft/year, or possibly more.

[42] This is the estimated *average annual* storage volume, per a water budget analysis using a 10-year local historical record. This storage calculation factors in a potential dry season release to the regional system (generally in April) of 6,174 ac-ft per year for Alternative Water Supply. (*The ability to provide AWS has not been empirically verified*.)

[43] The 15-year unit cost would be $107.98 for Caulkins *without* the two additional front-end lease-related costs.

[44] The 15-year unit cost would be $116.27 for Evans if the potential/proposed cost for site *reversion* is added in.

As shown in **Table 8**, the projected unit costs for water storage are comparable for both projects. In the 15-year projection, the unit costs are $112 per acre-foot for Caulkins and $107 per acre-foot for Bluefield. In the 50-year projection, the unit costs drop by four to seven percent, to $104 for Caulkins and $102 for Bluefield. *Those projections do not take inflation factors into account*, however. If they did, the modest drop in unit costs in the longer time horizon would most likely be reduced or lost. Water farmers have the right to request a percentage increase in annual payments over time, for instance, and it is safe to assume the cost of O & M will not hold steady over 50 years for the projects. Inflation percentages (rates) can be arbitrary, in some cases up to contract negotiations, and therefore difficult to accurately forecast. It should be considered that the future costs of the projects will likely be higher than shown in **Table 8**.

All *start-up* costs for the Caulkins project were included in the cost calculations (including the requested $2,670,000 for a land rental fee of $2,100,000 during construction of the project and $570,000 to buy out the current leases of the vegetable farmers renting land from Caulkins). If those additional lease-related front-end expenses requested by Caulkins are omitted, the 15-year projected unit cost for storage would be $107.98—almost matching the 15-year projected unit cost for Bluefield of $107 shown in **Table 8**.

The potential *close-out* cost of the Bluefield project of $4,882,944 for site reversion was not included in the calculations used for **Table 8**. When that one-time cost is included in the calculations, the unit cost of water storage for Bluefield Grove increases nine dollars, from $107 to $116 per acre foot, in the 15-year projection and increases three dollars in the 50-year projection, from $102 to $105 per acre-foot.

The total costs of the water farms, with *all* proposed expenses factored in (including the front-end costs requested for the Caulkins project and the cost of site reversion requested for the Bluefield project) are as follows (for capital costs, participation payments and O & M if/as proposed):

- 15-year *total* costs are an estimated $67,459,180 for Caulkins and $62,898,464 for Bluefield.
- 50-year *total* costs are an estimated $207,459,180 for Caulkins and $189,789,804 for Bluefield.

In short, it could cost roughly $200 million to build and run one of these large water farms **for 50 years**. To put that total in perspective, it cost about $200 million to buy the land for the public C-44 R/STA.[204]

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Appendix 2: Details on Assumptions Used for Estimates in Table 4

Table 9. Average Capital Cost per Project Acre

Initial Capital (Total Start-Up Costs)	**Capital Costs per Project Acre**
Estimates for 3 projects proposed by Evans Properties (from "R & S + AWS" scenarios shown in Table 6c in Appendix 1. *That scenario is used for the projects proposed by Evans Properties in all of the tables in Appendix 2*.):	
1. Estimated: Bluefield Grove	$549.78
2. Estimated: Scott 6000 Grove	$1,211.42
3. Estimated: Scott 2000 Grove	$1,218.35
4. Estimated: Caulkins Citrus Company's expansion (to 3,000 acres)	$1,596.00
5. Actual: Spur Land & Cattle water farming pilot project	$2,267.00
6. Actual: Caulkins Company water farming pilot project	$1,313.00
AVERAGE cost per acre (column total of $8,155.55 divided by 6)	**$1,359.26**

Table 10. Average Cost for O & M per Acre

Operations and Maintenance	**O & M per Acre per Year**
1. Estimated: Bluefield Grove	$49.18
2. Estimated: Scott 6000 Grove	$97.12
3. Estimated: Scott 2000 Grove	$110.79
4. Estimated: Caulkins expansion	$260.00
AVERAGE cost per acre (column total of $517.09 divided by 4)	**$129.27**

Table 11. Canal Inflows as a Percentage of Total Storage

Percentage of Total Storage due to Canal Inflows, based on the pilot monitoring records. (Guide for calculating nutrient reduction estimates.)	**Total Storage** in acre-feet	**Canal Inflows:** Acre-feet and percentage of the total	**Rain:** Acre-feet and percentage of the total
Caulkins Pilot Project (22.5 month record)	28,483 100%	25,605 **90%**	2,878 10%
Spur Land & Cattle Pilot Project (12 month record)	799 100%	592 **74%**	207 26%

Table 12. Average Annual Volume Refills

Volume Refills	**Ave. Annual Storage Volume**[45] in acre-feet	**Project Acres**	**Static Fill Volume** (Project Acres X 4 Feet) in acre-feet	**Refills** (Annual Storage Volume Divided by Static Fill Volume)
1. Estimated: Bluefield	36,065	6,591[46]	26,364	1.368
2. Estimated: Scott 6000	27,526	5,503[47]	22,012	1.250
3. Estimated: Scott 2000	13,046	2,032	8,128	1.605
4. Estimated: Caulkins Expansion	40,000	3,000	12,000	3.333
5. Actual: Spur Land & Cattle pilot [48]	799	60	240	3.329
6. Actual: Ideal 1000 pilot project [49](Alternative # 1, up to two feet deep)	2571	900	1800	1.428
7. Actual: Caulkins pilot project	14,241[50]	413	1,652	8.620
From AECOM's 2012 estimates:				
8. Estimated: Four Palms Grove	1,076	200	800	1.345
9. Estimated: Evans Ideal 1000 (Alternative # 2, up to four feet deep)	5,784	900	3,600	1.607
AVERAGE refill rate (column total of 23.885 divided by 9)				**2.654**
Average number of volume refills without the Caulkins Pilot Project				**1.908**
Average number of volume refills without Caulkins and Ideal 1000 Pilots				**1.977**

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[45] From preliminary engineering studies done for proposed projects, or actual amounts for the water farming pilot projects**. The estimated and actual values shown are based on an operating protocol that allows inflows from a canal to the water farm only on the days the canal is discharging to coastal waters (and at a minimum of 200 cfs, in the case of the projects proposed by Evans Properties: 1-3 in Table 12). If the protocol is modified to optimize operations in an aim to prevent canal discharges, the average annual volumes would likely increase.**

[46] Size of the proposed water farm impoundment, which is less acreage than total project acres shown in Table 6a.

[47] Size of the proposed water farm impoundment, which is less acreage than total project acres shown in Table 6a.

[48] Actual total volume of storage in 12 months, based on monitoring record.

[49] Actual storage of 2,571 ac-ft in only 4 months, based on monitoring record. The static fill volume is estimated.

[50] Average annual storage shown for the Caulkins pilot is based on the total volume actually stored in a 22.5-month monitoring record (28,483 ac-ft) divided by 24 months (=1,186.791) x 12 months = 14,241.5 acre-feet per year (an *approximate* annual).

Table 13. Estimated Storage on 20,000 Acres of Proposed Water Farms

Project Name (and Project Acres)	Static Fill Volume in acre-feet	Number of Volume Refills per Year[51]	Total Storage Volume per Year in acre-feet	Alternative Estimates in acre-feet
Adams Ranch - Four Palms Grove (193)	772	2	1,544	
Blue Goose Growers (319)	1,276	2	2,552	
Caulkins Expansion (3,000)	12,000	4 (Four is less than half of the observed refill rate of the pilot project)	48,000	60,000 at 5 refills[52] (+12,000)
Bluefield Grove (6,591)	26,364	1.4	36,910	39,546 at 1.5 refills (+2,636)[53]
Scott 6000 Grove (5,503)	22,012	1.3	28,616	33,018 at 1.5 refills (+4,402)
Greene Groves & Ranch (1,736)	6,944	2	13,888	
Old Chester (864)	3,456	2	6,912	
Scott-Schuman Grove (235)	940	2	1,880	
Sunlight Ranch (797)	3,188	2	6,376	
Varn Family Trust (113)	452	2	904	
Vero Producers - VPI 1 Grove (464)	1,856	2	3,712	
Totals:				
Total Project Acres: 19,815	**Total Static Fill Volume:79,260**	**Average Number of Refills: 2.064**	**Total Storage: 151,294**	**Alternative Total Storage: 170,332**

[51] The proposed Caulkins, Bluefield and Scott 6000 projects are exceptional enough (in large size, in the case of the latter two, and in uncommonly high infiltration rate, in the case of Caulkins), to warrant individualized estimates of refill rates. The balance of the proposed projects are assigned the same average annual refill rate of 2, which is based on the averages shown in Table 12 and a rule of thumb for agricultural reservoirs in the region of 2.5—3 refills/year.

[52] The Caulkins Citrus Company's proposed 3,000-acre expansion project is 7.26 times larger than the current 413-acre pilot project, which has had an average annual total storage volume of 14,241 acre-feet (as shown in Table 12). 14,241 multiplied by 7.26 = 103,390 acre-feet, which suggests that the 60,000 acre-feet of annual storage in the Alternative Estimate in Table 13 is a reasonable assumption for average annual storage volume for that project. The expansion project site is on deep unconfined sand, similar to the pilot project site. One important potential limiting factor to realizing multiple volume refills will be the capacity of the inflow pumps, which is expected to increase as part of the proposed project expansion, as was mentioned in the case study of the Caulkins project in Appendix 1.

[53] The refill rate for both the Bluefield and Scott 6000 proposed projects is likely to edge up to an average of 1.5, or possibly modestly more, if the projects are operated to proactively *prevent* canal discharges as much as practicable.

Table 14. Average Nutrient Concentrations

Nutrient Concentrations observed in the pilot project monitoring data from Feb. 2014 to December 31, 2015	**Average TP Concentration** in mg/L	**Average TN Concentration** in mg/L
C-44 Canal	0.168	1.233
C-23 Canal	0.421	1.903
C-24 Canal	0.511	2.231
AVERAGE Concentrations*	**0.367**	**1.789**

*These average concentration values are within the historical range of concentrations, from Water Year 1997 to Water Year 2014, from the following five sources in the SLE Watershed *combined*: C-44/S-153, C-23, C-24, Ten Mile Creek, and Lake Okeechobee. The reported historical range for TN concentrations is 0.71 to 2.61 mg/L, and the reported historical range for TP concentrations is 0.05 to 0.66 mg/L (South Florida Water Management District, *2016 South Florida Environmental Report*, chapter 10, page 10-33).

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Notes

Executive Summary

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

[2] Treadway, Tyler, Our Indian River Lagoon: "State of Emergency Declared," *Indian River Press Journal*, February 27, 2016, page 10A; and Treadway, Tyler, "Look North for Fish Kill Warning," *Indian River Press Journal,* April 3, 2016, page 1A; and Smart, Gil, "Fiscal Impact of Lake O[keechobee] Discharges Should Get Lawmakers' Attention, *Indian River Press Journal,* April 3, 2016, page 14A.

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

Introduction

[4] 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.

[5] 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, pg 10-2.

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

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

[8] The altered hydrology/canal density graphic was produced by Michael Spontak, a geographic information systems (GIS) specialist and private consultant to the University of Florida Center for Landscape Conservation Planning. The Figure 3 graphic is the output of an analysis that considered line density of NHD canals and ditches in Florida.

[9] 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 10-3.

An acre-foot is the volume of water required to cover one acre to the depth of one foot. One acre-foot = 325,851 gallons. The abbreviation for acre-foot, and acre-feet, is ac-ft.

[10] 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.

[11] 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, Lead Environmental Scientist, DWM Unit of the SFWMD (and project manager of the water farming pilot project), June 25, 2015, at the SFWMD's Upper East Coast Water Supply Plan Update Kick-Off Workshop, Stuart City Hall.

[12] Grant Gilmore, then head of Harbor Branch Oceanographic Institute in Fort Pierce and now a senior scientist at Estuarine, Coastal and Ocean Science in Vero Beach, Florida.

[13] Treasure Coast Newspapers, *Indian River Press Journal,* "Is Lagoon Still Diverse?", June 14, 2015, front page.

Treadway, Tyler, "Is Lagoon Still One of Most Diverse Waterways in U.S.?", *Indian River Press Journal,* June 14, 2015, page 10A.

[14] Lush, Tamara, "Winter is Coming, and So Is An El Nino Pattern in Florida," *TCPalm.com,* November 16, 2015.

[15] Treadway, Tyler, Our Indian River Lagoon: "Algae Attack in North," February 14, 2016, page 6A. And Thomas, Steven, "Brown Tide in Lagoon Creeps Toward Vero," *Vero News/Sebastian River News,* February 12, 2016, pg. 5.

[16] Waymer, Jim, "What We Know About the Indian River Lagoon Fish Kill," *Florida Today*, March 23, 2016; and Waymer, Jim, "What's Next for the Indian River Lagoon?", *Florida Today,* April 4, 2016.

[17] South Florida Water Management District, Canals in South Florida: a Technical Support Document, April 28, 2010, page 74; and Treadway, Tyler, "Lake Okeechobee Discharges Could Last for Months," *TCPalm.com*, January 30, 2016.

[18] Waymer, Jim, "Indian River Lagoon Reaches a Tipping Point: The Indian River Lagoon Teeters on the Brink, But Experts Say it Can Recover," *Florida Today*, 2015 www.floridatoday.com; and public comment by Martin County Commissioner Ed Fielding, relating Grant Gilmore's assessment of local waters, Martin County Commission meeting, November 11, 2015; and quote from Edie Widder, Director of the Ocean Research and Conservation Association (ORCA; Fort Pierce, FL), in Clowdus, Barbara, "Attention, Legislators: Caulkins Water Farm Offers New Hope to Estuaries," *Sunshine State News*, June 9, 2015.

[19]Allen, Greg, "How Long Can Florida's Citrus Industry Survive?", NPR, November 27, 2015.

[20] Rusnak, Paul, "Season's First Florida Citrus Forecast is a Stunner," GrowingProduce.com, October 9, 2015. Spreen, Thomas, "Feeling the Squeeze, Florida Citrus Taking Stock of Future," *Florida Grower,* August 12, 2015.

[21] Ivice, Paul, "Grapefruit Forecast Pretty Sweet," *Treasure Cost Newspapers,* October 14, 2015.

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

[23] Data source for Figures 4 and 5: Florida Citrus Production Areas (Multiblocks) 2006 and 2014 (November, 2014), Florida Department of Agriculture and Consumer Services. Graphics produced by Michael Spontak, GIS consultant to the University of Florida Center for Landscape Conservation Planning, using spatial data provided by Craig Smith of Evans Properties, Inc.

[24] Florida Department of Agriculture, DPI, Florida Citrus Production Areas (Multiblocks), 2006 and 2014.

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

Chapter 1: The Water Farming Demonstration Project

[26] Ulevich, Robert (Bob), Regional Restoration through Innovative Water Management, Creative Solutions to Complex Problems, Addressing Matters of Water Quality, Water Quantity, Groundwater and Flood Control through Regional Attenuation/Deep Water Storage & Water Farming/Dispersed Water Management, white paper, 2015.

[27] (1) PBSJ, Summary and Methodology, C-25 Basin and Upper St. Johns River Basin Reconnection, St. Lucie and Indian River Counties, Prepared for SJRWMD and SFWMD, January 26, 2006, Orlando, FL; and (2) HDR, St. Lucie and Indian River Counties Water Resources Study, Final Summary Report, Prepared for SJRWMD and SFWMD, November 2009. The water management districts have also contributed to and supported cooperative funding of studies of a reconnection project in the C-25 basin proposed by Evans Properties, Inc. (owner of the Ideal 1000 Grove, one of the water farming pilot projects), including the Hazen and Sawyer Financial Feasibility Study of the Grove Land Reservoir and Stormwater Treatment Area, completed August 2014 for Grove Land Utilities, LLC.

[28] Ulevich, Bob, Regional Restoration through Innovative Water Management, 2015 white paper, pg. 8.

[29] HDR, *St. Lucie and Indian River Counties Water Resources Study*, Final Summary Report, Prepared for SJRWMD and SFWMD, November 2009.

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

[31] 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.

[32] AECOM, *Assessment of Water Farming on Agricultural Lands*, May 1, 2012, page 87. Withdrawals from the C-canals are not allowed when the canal drops below a specified "regulatory stage." A timely release from a water farm can raise the surface elevation in the canal back up to a level that allows permitted users to withdraw water.

[33] Personal communication with Melissa Meeker, Executive Director of the SFWMD, Vero Beach, March 26, 2013.

[34] Beirnes, Timothy and Bhagudas, J., *Audit of Dispersed Water Management Program*, Office of the Inspector General, South Florida Water Management District, November 13, 2014; derived from the table on page 36. The ten NE-PES projects on ranchlands listed in the table have an estimated total average annual retention of 8,636 acre-feet. The estimated total average annual retention of the three water farming pilot projects was listed as 11,285 acre-feet.

[35] Beirnes, Timothy and Bhagudas, J., *Audit of Dispersed Water Management Program*, Office of the Inspector General, South Florida Water Management District, November 13, 2014, page 36.

[36] The map of the SFWMD's dispersed water management project locations throughout the Northern Everglades is also available on the District's Water Storage Strategies webpage at http://www.sfwmd.gov/portal/page/portal/xrepository/sfwmd_repository_pdf/map_dispersed_water_management_projects.pdf

[37] 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.

[38] South Florida Water Management District, "News Release: SFWMD Water Farming Pilot Project to Benefit St. Lucie Estuary; Project goals include reducing flow to the estuary by increasing water storage on land," August 19, 2013.

[39] 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."

[40] Milcor Group, Inc., Dispersed Water Management Northern Everglades Invitation for Water Farming Pilot Project (Proposal for SFWMD's Solicitation [RFP] Number 6000000576), submitted on behalf of Caulkins Citrus Company, Ltd., May 22, 2013, page 13: summarized findings from a limited subsurface exploration of the Caulkins site performed by Andersen Andre Consulting Engineers in September 2006.

[41] Brown, Christopher, *An Independent Technical Assessment of Martin County, Florida Water Farming Pilot Project: Final Summary Report*, May 15, 2015.

[42] Brown, C., Final Summary Report, page 3.

[43] 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.

[44] South Florida Water Management District, First Annual Report, Technical Publication WS-37, page 48.

[45] Holfelder, Jacklyn, "Keep Martin Beautiful Environmental Stewardship Awards," *Luminaries,* Treasure Coast Newspapers, February 22, 2016, page 16.

[46] Carlton, Wes, "Bull Hammock Ranch, LTD., Dispersed Water Management—Water Farming Pilot Project" [Proposal for SFWMD's Solicitation (RFP) Number 6000000576], [updated] June 2013, Attachment 4.1: Respondent Team Summary.

[47] Personal communication with Wes Carlton, April 1, 2015, on site visit with US Fish and Wildlife Service staff.

[48] Personal communication with Boyd Gunsalus, Lead Environmental Scientist, project and contract manager of the water farming demonstration project for the South Florida Water Management District.

[49] AECOM, *Assessment of Water Farming on Agricultural Lands*, Prepared for the Indian River Citrus League, May 1, 2012, Palm City, Florida, page 13.

[50] AECOM, Assessment of Water Farming, May 1, 2012, page 10.

[51] Evans Properties, Inc., "Alternatives E-1 and E-1a Water Retention, Evans Ideal 1000 Grove, St. Lucie County, Florida," Solicitation Submittal for the Dispersed Water Management Northern Everglades Water Farming Pilot Project, June 5, 2013.

[52] AECOM, Assessment of Water Farming, May 1, 2012, page 68.

[53] Personal communication with Boyd Gunsalus, water farming pilot project manager for SFWMD, May 2, 2016.

[54] Milcor Group, Inc., Dispersed Water Management Northern Everglades Invitation for Water Farming Pilot Project (Proposal for SFWMD's Solicitation [RFP] Number 6000000576), submitted on behalf of Caulkins Citrus Company, Ltd., May 22, 2013, Table 3.5, page 32.

Chapter 2: Regional Water Storage and Quality Goals: Could Water Farming Help?

[55] University of Florida Water Institute, *Options to Reduce High Volume Freshwater Flows to the St. Lucie and Caloosahatchee Estuaries and Move More Water from Lake Okeechobee to the Southern Everglades: An Independent Technical Review by the University of Florida Water Institute*, March 2015, pages 28-30. http://www.flsenate.gov/UserContent/Topics/WLC/UF-WaterInstituteFinalReportMarch2015.pdf

[56] 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.

[57] Final IRL-South PIR and EIS, March 2004, page 6-124.

[58] Final IRL-South PIR and EIS, March 2004, page S-v – S-vi.

[59] A Total Maximum Daily Load (TMDL) is a regulatory term in the U.S. Clean Water Act, describing a value of the maximum amount of a pollutant that a body of water can receive while still meeting water quality standards.

[60] South Florida Water Management District, *2015 South Florida Environmental Report*, Volume I, Chapter 10: St. Lucie and Caloosahatchee River Watershed Protection Plan Annual and Three-Year Updates, page 10-12.

[61]Stein, Letitia, "In Tampa Bay, Rare Environmental Win Measured in Seagrass," *Reuters*, June 9, 2015. http://uk.reuters.com/article/us-usa-environment-tampabay-idUKKBN0OP13Z20150609

[62]Final IRL-South PIR and EIS, Appendix E: Environmental Effects, March 2004, page E-103.

[63] Although the SLE BMAP also considers levels of Dissolved Oxygen (DO).

[64] 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*, Appendix A: Plan Formulation and Evaluation, March 2004, page A-131.

[65] Agriculture is spelled with a capital A when referred to, specifically, as a stakeholder group in a Florida DEP Basin Management Action Plan (BMAP).

[66] Personal communication with staff of the Florida Department of Agriculture and Consumer Services Office of Agricultural Water Policy, including Katie Hallas (formerly of FDEP and the coordinator for the St. Lucie BMAP), September 16, 2015, Tallahassee.

[67] The Florida Department of Environmental Protection defines *de minimus* as a contributor of less than 0.5% of the starting load for both TN and TP. A de minimus designation in the first five-year iteration of the BMAP does not rule out the possibility of having a required reduction in future BMAP iterations.

[68] Credits are most often based on estimates, although some BMAP credits are based on measured reductions. This can happen, for example, when a project is funded by a Section 319 grant which requires water quality monitoring.

[69] Florida Department of Environmental Protection, Tallahassee, *Final Basin Management Action Plan for the Implementation of Total Maximum Daily Loads for Nutrients and Dissolved Oxygen by the Florida Department of Environmental Protection in the St. Lucie River and Estuary Basin*, developed by the St. Lucie River and Estuary Basin Technical Team in Cooperation with the Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration, Tallahassee, May 2013, Table 24, page 59.

[70] Florida Department of Environmental Protection, Tallahassee, *2015 Progress Report for the St. Lucie River and Estuary Basin Management Action Plan*, December 2015, pages 5, 7. The submission by a producer to FDCAS of a Notice of Intent to implement BMPs counts as an enrollment in the BMP program in the St. Lucie BMAP process.

[71] SFWMD, FDEP, and FDACS with Tetra-Tech, Inc., *The St. Lucie River Watershed Protection Plan*, Appendix E: Research and Water Quality Monitoring Program, January 2009, page 3-35.

[72] 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, Appendix A: Plan Formulation and Evaluation, March 2004, page A-87.

[73] Personal communication with Gary Roderick, who served on the technical committee for the IRL-South study; April 28, 2015.

[74] 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 [PIR] and Environmental Impact Statement [EIS], Appendix A: Plan Formulation and Evaluation, March 2004, page A-113.

[75] Final IRL-South PIR and EIS, Appendix A, March 2004, page A-144.

[76] University of Florida Water Institute, *Options to Reduce High Volume Freshwater Flows to the St. Lucie and Caloosahatchee Estuaries and Move More Water from Lake Okeechobee to the Southern Everglades*: An Independent Technical Review by the University of Florida Water Institute, March 2015, page 7.

[77] Doug Bournique, Executive Vice President of the Indian River Citrus League, publicly mentioned this research finding at the meeting held for agricultural representatives by the South Florida Water Management District on January 26, 2015 in Fort Pierce, to discuss the updated modeling of the Floridan Aquifer System in the Upper East Coast Region. Mr. Bournique's comment was made in response to the District's modelers' verbal report on the trend of increasing total dissolved solids, chlorides and salinity in the groundwater system. Mr. Bournique said we are now at the threshold when more groundwater withdrawals for public water supply will degrade the groundwater for agriculture to where it cannot be used for agriculture. He then announced the relevant news he had recently learned from citrus researchers that greening disease has been exacerbated by the poor water quality of the Floridan aquifer, particularly the water's high salinity levels and especially its higher than desirable pH. He explained that fresh surface water is the preferred choice among citrus producers and added that water farming could increase the source of the surface water supply, which could preserve the Floridan for public supply.

[78] Final IRL-South PIR and EIS, March 2004, page S-ix.

[79] U.S Army Corps of Engineers, Jacksonville District, Fact Sheet, Comprehensive Everglades Restoration Plan, Indian River Lagoon-South, CESAJ-PM (Cong), March 2015. http://www.saj.usace.army.mil/Portals/44/docs/CongressionalFS/2015/CERP_Indian_River_Lagoon-South_(C)_CFS15.pdf. The 2014 Fact Sheet showing the lower cost estimate can be viewed at: http://www.saj.usace.army.mil/Portals/44/docs/CongressionalFS/C/CERP_Indian_River_Lagoon_-_South_C_CFS14.pdf. The 2013 cost estimate was published in the December 30, 2013 update to the Indian River Lagoon-South Project Management Plan, page 26. The original (revised) cost estimate in 2004 was published in an August 2004 Addendum to the March 2004 IRL-S Final PIR and EIS Report, Table 7, Addendum page 6.

[80] Boyd Gunsalus, Lead Environmental Scientist, Dispersed Water Management Unit, SFWMD, presentation on a Dispersed Water Management Update at the Water Resources Advisory Commission Upper East Coast Water Supply Plan Update Kick-Off Workshop, Stuart City Hall, June 25, 2015.

[81] Personal communication with Boyd Gunsalus, Okeechobee, July, 22, 2015.

[82] Personal communication with Steve Traxler, Senior Biologist, U.S. Fish and Wildlife Service, Vero Beach, 2014.

[83]Florida Farm Bureau (FFB), "Recognizing Conservation by Private Landowners;" essay on FFB website, accessed October 21, 2015.

[84] The approximate $200 million cost of the land acquisition includes Martin County's contribution of $27.4 million. The SFWMD paid $168,994,039 (total) for the land needed for the C-44 reservoir and the east and west STAs, per the SFWMD's Section Administrator of the Real Estate Division, Ray Palmer, in 2016. The District's land costs for the C-44 R/STA have been reported elsewhere to total $179 million, such as by Hazen and Sawyer in *Compilation of Benefits and Costs of STA and Reservoir Projects in the South Florida Water Management District—Final Report*—Prepared by Hazen and Sawyer for the World Wildlife Fund acting on behalf of the Florida Ranchlands Environmental Services Project, July 2011, page 6-3 (Table 6.2). The total of Martin County's cost and the SFWMD cost is either $196,394,039 or $206,400,000, if per the higher District costs reported by Hazen & Sawyer (in 2011).

[85] Final IRL-South PIR and EIS ADDENDUM, August 2004, Table 7-4 (Revised: Estimated Initial Costs for Construction Features), page 6. This estimate for the total initial cost of the C-44 Reservoir and STA was $244,738,375 ($125,879,375 for real estate and $118,859,000 for construction) using 2003 price levels.

Chapter 3: Potential Water Farms in the St. Lucie River Watershed

[86] The *maximum* estimated annual storage volume of the C-44 R/STA facility is 60,500 acre-feet, which is the sum of a maximum of 50,600 acre-feet in the 3,400-acre reservoir filled near its capacity of 15 feet, and 9,900 acre-feet in the 6,300-acre stormwater treatment area, per the U.S. Army Corps of Engineers' Press Release no. 14-041,

posted July 31, 2014. The University of Florida Water Institute reported the annual storage volume in the C-44 reservoir to be 40,000 acre-feet, in *Options to Reduce High Volume Freshwater Flows to the St. Lucie and Caloosahatchee Estuaries and Move More Water from Lake Okeechobee to the Southern Everglades*: An Independent Technical Review by the University of Florida Water Institute, March 2015, page 34. The estimate of 40,000 acre-feet might be an average annual volume for the reservoir (and might not include the STA component). In comparison, the two largest of the proposed water farms profiled in Appendix 1 have estimated average annual, or median, storage volumes of over 36,000 acre-feet (see Table 8 in Appendix 1).

[87] The acreage listed with properties E-Q (in the map legend) is approximate for a potential project site, and may differ from acreage that would be specified in a water farming proposal from the grove owners.

[88] The Milcor Group, Inc., Sunlight Ranch Water Dispersion Project Summary Report, Prepared for Burg & Company, for Review by the South Florida Water Management District, March 2014; from Executive Summary.

[89] Personal communication with Gary Roderick, formerly with Martin County, now consulting for Sunlight Ranch, July 21, 2015.

[90] AECOM, *Assessment of Water Farming*, May 1, 2012, page 55.

[91]Personal communication with Mike Adams, President of Adams Ranch, Inc., Fort Pierce, September 28, 2015.

[92] Central Florida Water Initiative, Solutions Strategies, Volume II, *Regional Water Supply Plan: 2035 Water Resources Protection and Water Supply Strategies*, 2015; A Comprehensive Plan for Orange, Osceola, Polk, Seminole and Southern Lake Counties, pages 66-67. http://cfwiwater.com/pdfs/plans/WRP_VolII_Final_2015-12-16.pdf And South Florida Water Management District, *2016 Upper East Coast Water Supply Plan Update: Appendices*, page 113.

[93] Personal communication with Steven Lamb, of Federico, Lamb & Associates, Inc., who has studied the GLRSTA project for Evans Properties; Stuart, June 3, 2015.

[94] Personal communication with Bob Ulevich of Polymath Consulting Services, based on his discussions about the proposed Greene Groves project with St. Lucie County staff, as a project consultant to Greene Citrus Management.

[95] Keene, Rhett, CAPTEC Engineering, Inc., Greene Groves Ranch Preliminary Water Farming Assessment, May 2015 (Draft), page 13 (adapted from Table 10.1).

[96] Personal communication with Kevin Powers, SFWMD Governing Board Vice Chair, Palm Bay, February 11, 2015.

[97] Valderrama, Alisa, et al, *Creating Clean Water Cash Flows: Developing Private Markets for Green Stormwater Infrastructure in Philadelphia*, NatLab (a collaborative of the Natural Resources Defense Council, The Nature Conservancy, and EKO Asset Management Partners), January 2013, page 7.

[98] Valderrama, Alisa, and Davis, Paul, "*Wanted: Green Acres, How Philadelphia's Greened Acre Retrofit Program is Catalyzing Low-Cost Green Infrastructure Retrofits on Private Property*, Natural Resources Defense Council, NRDC Issue Brief, January 2015, page 4.

.

[99] Not included in the project acreage tally are Evans Properties Scott 2000 Grove, as it is in Indian River County outside of the SLE Watershed, and Fox Brown Grove, which has not been studied yet for potential project size. The proposed project acreage for Greene Groves & Ranch used in the tally is 1,586 acres, which is less than the property size shown in the map legend (of 1,736 acres). The three water farming pilot projects are not included in the tally of proposed project acreage even though those projects could potentially be continued beyond the pilot phase; although the acreage of the Caulkins pilot project is included in the proposed 3,000-acre Caulkins expansion project, which is included in the acreage tally of the prospective projects.

[100] Proposed project acres could otherwise total 19,599, as listed in Table 12 in Appendix 2, when the more precise size of the impoundments of the projects proposed by Evans Properties is used.

[101] The total cost of the entire C-44 R/STA project will be "about $600 million," as stated in the U.S. Army Corps of Engineers, Jacksonville District, news release: "Breaking Ground for the C-44 Reservoir," in the *Eco-Voice Daily Digest* (Eco-Voice.org), October 31, 2015.

[102] The approximate $200 million cost of the land acquisition includes Martin County's contribution of $27.4 million. The SFWMD paid $168,994,039 (total) for the land needed for the C-44 reservoir and the east and west STAs, per the SFWMD's Section Administrator of the Real Estate Division, Ray Palmer, in 2016. The District's land costs for the C-44 R/STA have been reported elsewhere to total $179 million, such as by Hazen and Sawyer in *Compilation of Benefits and Costs of STA and Reservoir Projects in the South Florida Water Management District—Final Report*—Prepared by Hazen and Sawyer for the World Wildlife Fund acting on behalf of the Florida Ranchlands Environmental Services Project, July 2011, page 6-3 (Table 6.2). The total of Martin County's cost and the SFWMD cost is either $196,394,039 or $206,400,000, if per the higher District costs reported by Hazen & Sawyer (in 2011).

[103] The draft land suitability model for water farming was created as part of preliminary development work for a potential new data layer for the Critical Lands and Waters Identification Project (CLIP) statewide database. The model has not been approved by the technical review committee for the development work on a potential Water Restoration data layer for CLIP primarily because the regional focus is inconsistent with the statewide scope of CLIP. Michael Spontak, under subcontract with the University of Florida Center for Landscape Conservation Planning to assist in the development work for potential updates to the CLIP database, produced the draft model.

Chapter 4: Federal and State Policies to Support an Expansion of Water Farming and Related Practices

[104] Ikenson, Ben, "Ranching for Longhorns *and* Wildlife," *Endangered Species Bulletin*, January/April 2000, Volume XXV No. 1-2, U.S. Fish and Wildlife Service.

A USFWS fact sheet on Safe Harbor Agreements is available at:
http://www.fws.gov/endangered/esa-library/pdf/harborqa.pdf

[105] U.S. Fish & Wildlife Service, Safe Harbor Agreement for Private Landowners, fact sheet, July 2011:
http://www.fws.gov/endangered/esa-library/pdf/harborqa.pdf

[106] Dave Hankla, a consultant to USFWS, proposed the alternative approach to a Safe Harbor Agreement, along with Bob Progulske, USFWS Everglades Program Supervisor, at a meeting with SFWMD and SJRWMD staff hosted by the Indian River Citrus League to discuss water farming and the reconnection project, in Vero Beach, July 27, 2015.

[107] Audubon Florida, "Dispersed Water Management Offers Everglades Solutions," Northern Everglades in *State of the Everglades,* Spring 2012, page 8.

[108] Florida Department of Environmental Protection Office of Water Policy, *Report of Expansion of Beneficial Use of Reclaimed Water, Stormwater and Excess Surface Water (Senate Bill 536)*, December 1, 2015, Tallahassee; page 94.

[109] The Northern Everglades and Estuaries Protection Program (NEEPP) "coordinating agencies" are the Department of Agriculture and Consumer Services, the Department of Environmental Protection, and the South Florida Water Management District.

Chapter 5: Funding for Water Farming and Related Practices

[110] Treadway, Tyler, Our Indian River Lagoon: "State of Emergency Declared," *Indian River Press Journal*, February 27, 2016, page 10A.

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

[112] https://ballotpedia.org/Florida_Water_and_Land_Conservation_Initiative,_Amendment_1_(2014)

[113] From CS for SB 552 (enrolled, 2016 Legislature), lines 2179-2186.

[114] East Central Florida Regional Planning Council and the Treasure Coast Regional Planning Council, *Impediments to Implementation of the Indian River Lagoon Basin Management Action Plans*, May 27, 2015; page 6. http://www.tcrpc.org/special_projects/BMAP/BMAP%20Impediments%20Final%20Report%2005-27-2015.pdf

[115] Florida Department of Environmental Protection, Tallahassee, *2015 Progress Report for the St. Lucie River and Estuary Basin Management Action Plan*, December 2015, pages 20-35.

[116] Treadway, Tyler, "Martin County Commissioners to Consider $31 Million Septic-to-Sewer Switch," *TCPalm Journal Interactive*, October 30, 2015; and "Research: Septic Systems 'Primary' Source of River, Reef Pollution," *TCPalm Journal Interactive*, October 25, 2015.

[117] The cost of Martin County's septic to central sewer program reported in the 2015 progress report for the SLE BMAP on page 28 ($28,678,946 for project MC-16) was incorrect, according to Dianne Hughes and colleagues of Martin County. Martin County staff discovered the error in March 2016. The correct cost is shown in Table 5 ($7,089,742). The number of TN credits for MC-16 is correct as reported in the 2015 BMAP progress report.

[118] Personal communication with Dianne Hughes, Senior Ecosystem Specialist in Martin County's Ecosystem Restoration and Management unit in the Engineering Department; March 18, 2016.

[119] http://www.cityofpsl.com/parks-recreation/parks/mccarty_ranch.html

[120] U.S. Environmental Protection Agency, 319 Grant Program for States and Territories, 319 Grant Funds History.

[121] Florida Department of Environmental Protection, Memorandum to Applicants for Section 319 Grant Funding for the 2017 Federal Fiscal Year, Application Guidance, February 5, 2016: http://www.dep.state.fl.us/water/nonpoint/docs/319h/fy2017-319_solicitation%20guidance_attachements.pdf

[122] SJRWMD Governing Board Chairman John Miklos, quoted in St. Johns River Water Management News Release, Pilot Projects to Reduce Nutrients, Runoff to Indian River Lagoon, January 12, 2016: http://webapub.sjrwmd.com/agws10/news_release/ViewNews.aspx?nrd=nr16-003

[123] Southwest Florida Water Management District, **F**acilitating **A**gricultural **R**esource **M**anagement **S**ystems (FARMS) Program, Fiscal Year 2014 Annual Report, October 2015, pages 6 (Figure 2) and 11-12 (Table 1).

[124] St. Johns River Water Management District, 'Cost-Share Opportunities for Growers: District-Wide Agricultural Cost-Share,' accessed at http://floridaswater.com/agriculture/costshare.html September 6, 2015.

[125] U.S. Fish & Wildlife Service, "Strategically Conserving Habitat," in *Refuge Update:* National Wildlife Refuge System, September/October 2015, Vol. 12, No. 5, page 7.

[126] USDA Natural Resources Conservation Service fact sheet, "Strengthening Conservation with Regional Partnerships: Regional Conservation Partnership Program." And use the following link to find more information: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/newsroom/releases/?cid=nrcseprd624406

[127] Personal communication with Roney Gutierrez and Nina Bhattacharyya of the NRCS state office in Gainesville, Florida, August 17, 2015.

[128] Personal communication with Roney Gutierrez and Nina Bhattacharyya of the NRCS state office in Gainesville, Florida, August 17, 2015.

[129] Roney Gutierrez of NRCS would be the point of contact for discussing how WRE could work with DWM.

[130] Lines 1194-1198 in the comprehensive water bill, CS for SB 552, that was passed into law in January 2016.

Chapter 6: New Funding Opportunities through USDA Farm Service Agency Programs

[131]Stubbs, Megan, Conservation Provisions in the 2014 Farm Bill (P.L. 113-79), April 24, 2014, Congressional Research Service (www.crs.gov).
The Conservation Reserve Program is administered by USDA's Farm Service Agency through USDA's Commodity Credit Corporation (USDA/CCC).

[132] USDA FSA webpage: Celebrating 30 Years of the Conservation Reserve Program, with examples given of a variety of CRP practices implemented across the United States: http://usdaonline.maps.arcgis.com/apps/MapTour/index.html?appid=588d05579d3045479e36d2abf6ab5456 .

[133] USDA FSA webpage: CRP Practices Library: http://www.fsa.usda.gov/programs-and-services/conservation-programs/crp-practices-library/index .

[134] The 10 CRP initiatives, which usually target a region of the country (which can be multi-state), are listed in the following USDA webpage and are listed below (as hyperlinks to a fact sheets about each initiative): http://www.fsa.usda.gov/programs-and-services/conservation-programs/conservation-reserve-program/index

- Bottomland Hardwoods Initiative
- Duck Habitat Initiative
- Floodplain Wetland Initiative
- Highly Erodible Land Initiative
- Honeybee Habitat Initiative
- Longleaf Pine Initiative
- Non-Floodplain and Playa Lakes Wetland Initiative
- Pollinator Habitat Initiative
- State Acres for Wildlife Enhancement (SAFE) Initiative
- Upland Bird Habitat Initiative

[135]Megan Stubbs, Conservation Reserve Program (CRP): Status and Issues, August 29, 2014, Congressional Research Service.

[136] Farm Service Agency, Conservation Reserve Program: Summary and Enrollment Statistics, FY 2006.

[137] Stubbs, Megan, Conservation Reserve Program (CRP): Status and Issues, August 29, 2014, Congressional Research Service, pages 4 and 5.

[138] Stubbs, Megan, Conservation Provisions in the 2014 Farm Bill (P.L. 113-79), April 24, 2014, Congressional Research Service (www.crs.gov).

[139] Ibidem.

[140] Ibid., page 3.

[141] Stubbs, Megan, Conservation Reserve Program (CRP): Status and Issues, August 29, 2014, Congressional Research Service, page 12 and in Summary section.

[142] Personal communication with Amy Roller, CRP Specialist for the Farm Service Agency in FSA's Florida State Office in Gainesville, September 25, 2015.

[143] Map image among the Florida CREP Agreement documents from the FSA office in Gainesville, Florida.

[144] The Agreement between the State of Florida and the U.S. Department of Agriculture/Commodity Credit Corporation Concerning the Implementation of the Florida Conservation Reserve Enhancement Program, October 28, 2002.

[145] USDA FSA, Fact Sheet: Conservation Reserve Enhancement Program Florida State, February 2011.

https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/Conservation/PDF/crepflfactsheet.pdf

[146] The Agreement between the State of Florida and the U.S. Department of Agriculture/Commodity Credit Corporation Concerning the Implementation of the Florida Conservation Reserve Enhancement Program, October 28, 2002, section VI. K., page 7.

[147] Personal communication with Amy Roller of FSA, December 9, 2015.

[148] National rental rates from Stubbs, Megan, Conservation Reserve Program (CRP): Status and Issues, August 29, 2014, Congressional Research Service, page 11; Florida rental rates from personal communication with Amy Roller, FSA, September 23, 2015. Soil rental rate increase requests would need to be submitted by the FSA County Office Committee (COC) in each county. In late 2015, the Farm Service Agency State Executive Director for the State of Florida, Rick Dantzler, encouraged the COCs in the region to update soil rental rates at the next opportunity to do so (which would presumably be in 2016 or 2017), per personal communication with Amy Roller, December 9, 2015.

[149] Personal communication with Tom Kenny, project supervisor for Caulkins Citrus Company's water farm, 2015.

[150] Personal communication with Amy Roller of FSA, in Gainesville meeting, October 14, 2015.

[151] Personal communication with Amy Roller of FSA, October 9, 2015.

[152] USDA, CREP State Updates: https://www.fsa.usda.gov/programs-and-services/conservation-programs/crep-state-updates/index

[153] USDA, News Release, "USDA Expands Conservation Reserve Enhancement Program by 20,000 Acres to Benefit Chesapeake Bay Watershed in Mid-Atlantic States," June 1, 2012.

[154] USDA, News Release (Conservation Success Stories), "Conservation Stewardship Yields Healthier Chesapeake Bay."

[155] As cited in the National Academy of Public Administration, "Taking Environmental Protection to the Next Level: An Assessment of the U.S. Environmental Delivery System, for Agriculture, Wastewater Treatment and Urban Development," April 2007.

[156] USDA, News Release (Conservation Success Stories), "Big Apple Shines Thanks to CREP." And Cosman, David, et al, "How Water Utilities Can Spearhead Natural Capital Accounting," *Solutions*, Volume 2, Issue 6, January 2012, page 28-31.

[157] Idaho One Plan: Helping Farmers Move into the Future (at www.oneplan.org); and Minnesota Department of Natural Resources, Water Quality Buffer Initiative Common Questions and Answers, June 18, 2015 (at www.dnr.state.mn.us/buffers/index.html).

[158] The required reductions remaining for Agriculture in 2015 before the 90 percent BMP enrollment goal is reached.

[159] Florida CREP Agreement: Florida—USDA—CCC, 2-CRP (Rev. 5), FL Amend. 1, August 24, 2010, pages 3 and 4.

[160] Personal communication with Mike Adams, President of the Treasure Coast Resource Conservation and Development Council (RCDC), and President of Adams Ranch, with RCDC colleagues Donna Smith (hydrologist) and Misty Spada, Fort Pierce meeting, September 28, 2015. The RCDC is a not-for-profit organization based in St. Lucie County that is familiar with helping local agricultural landowners work with USDA cost-share programs.

[161] Personal communication with Brian Boman, Professor, University of Florida Indian River Research and Education Center, Fort Pierce, October 27, 2015. A summary of Dr. Boman's collaborative experience developing in the Treasure Coast region what eventually evolved into the statewide agricultural BMP program in Florida is available at this link: http://abe.ufl.edu/people/directory/faculty-profiles/boman_brian.shtml.

[162] Personal communication with Kelly Morgan, Professor (the lead within IFAS on the BMP program), University of Florida Southwest Florida Research and Education Center, February 16, 2016.

[163] Osmond, Deanna; D. Meals; D. Hoag; and M. Arabi, editors, *How to Build Better Agricultural Conservation Programs to Protect Water Quality: The NIFA-CEAP Experience*; Soil and Water Conservation Society, 2012, page 160.

[164] Mausbach, Maurice and Dedrick, Allen, "The Length We Go: Measuring Environmental Benefits of Conservation Practices," *Journal of Soil and Water Conservation*, 2004, Volume 59, Number 5.

[165] USDA NRCS, NIFA [National Institute of Food and Agriculture] CEAP Watershed Assessment Studies, Identifying Critical Source Areas, Fact Sheet 7: http://www.soil.ncsu.edu/publications/NIFACEAP/Factsheet_7.pdf

[166] Ibid, page 5; and Osmond, Deanna, et al., "Improving Conservation Practices Programming to Protect Water Quality in Agricultural Watersheds: Lessons Learned from the National Institute of Food and Agriculture – Conservation Effects Assessment Project," *Journal of Soil and Water Conservation*, September/October 2012, Vol. 67, No. 5.

[167] Personal communication with Brian Boman, Professor, University of Florida, IFAS, Fort Pierce, October 27, 2015. Dr. Boman strongly believes soil types should be added to the watershed model used for the SLE BMAP.

Chapter 7: Options and Opportunities Assessment Summation

[168] U.S. EPA task group quoted in Dexter, Jessica, et al., *Cultivating Clean Water: State-Based Regulation of Agricultural Runoff Pollution*; Environmental Law & Policy Center and the Mississippi River Collaborative, 2010.

[169] Ibid, page 2.

[170] "The Clean Water Act does not include regulation or enforcement mechanisms for nonpoint source control…The primary mechanism in the Clean Water Act for addressing nonpoint sources is through the TMDL process…The TMDL concept and process were included in the original Clean Water Act passed in 1972, but they have only been put to use in earnest since the late 1990s as a result of legal actions requiring EPA and states to do so." Dzombak, David, "Nutrient Control in Large-Scale U.S. Watersheds: The Chesapeake Bay and Northern Gulf of Mexico," in *The Bridge*, National Academy of Engineering of the National Academies, Volume 41, Number 4, Winter 2011 (Sustainability of Water Resources), pages 14-20.

[171]Rockefeller Foundation Evaluation Office, *Incentive-Based Instruments for Water Management*; Pacific Institute, December 2015, page 42. http://pacinst.org/wp-content/uploads/sites/21/2016/02/issuelab_23697.pdf

[172] Ibid.

[173] U.S. EPA News Release, "USDA and EPA Sign Water Quality Credit Trading Agreement: Agreement Offers Farmers and Ranchers Market-based Incentives to Improve Water Quality," October 13, 2006.

[174] Rockefeller Foundation, *Incentive-Based Instruments for Water Management;* Pacific Institute, 2015, page xiii.

[175] Ibid., page 30.

[176] Calvache, A., et al, *Water Funds: Conserving Green Infrastructure*: A Guide for Design, Creation and Operation; The Nature Conservancy, March 2012.

[177] Rockefeller Foundation, *Incentive-Based Instruments for Water Management*; Pacific Institute, 2015, page xiii.

[178] National Research Council, *Watershed Management for Potable Water Supply: Assessing New York City Strategy*; National Academy Press, 2000. See also Platt, Rutherford, "Managing Sustainable Water Supplies: The New York City and Metropolitan Boston Experience," *The Bridge*, National Academy of Engineering of the National Academies, Volume 41, Number 4, Winter 2011 (Sustainability of Water Resources), pages 23-28.

[179] Nagourney, Adam, "A Parched California Turns to Storm Water for Salvation: Runoff, Long a Nuisance Flushed Away, Is a Well of Potential in a Changing Network," *New York Times*, February 21, 2016, page 14. And 'LA's Watershed Protection Program: History,' accessed from www.lastormwater.org August 30, 2015.

[180] National Academies Committee on the Beneficial Use a Graywater and Stormwater, *Using Graywater and Stormwater to Enhance Local Supplies: an Assessment of Risks, Costs and Benefits*, 2016 (via the December 2015 pre-publication copy), National Academy Press, page 12.

[181] Garrison, Noah, and Hobbs, Karen, Philadelphia, Pennsylvania: A Case Study of How Green Infrastructure is Helping Mange Urban Stormwater Challenges, in *Rooftops to Rivers II: Green Strategy for Controlling Stormwater and Combined Sewer Overflows*, Natural Resources Defense Council, 2011.

[182] Water Environment Research Foundation, "Philadelphia, Pennsylvania: Implementing a Multi-Faceted Approach to Stormwater Management," accessed from werf.org February 26, 2016.

[183] Valderrama, Alisa and Davis, Paul, "Wanted: Green Acres; How Philadelphia's Greened Acre Retrofit Program is Catalyzing Low-Cost Green Infrastructure Retrofits on Private Property," Natural Resources Defense Council, NRDC Issue Brief, January 2015. http://www.nrdc.org/water/files/philadelphia-green-infrastructure-retrofits-IB.pdf

[184] Personal communication with Doug Bournique of the Indian River Citrus League, March 11, 2016, Fort Pierce.

[185] U.S Army Corps of Engineers, Jacksonville District, Fact Sheet, Comprehensive Everglades Restoration Plan, Indian River Lagoon-South, CESAJ-PM (Cong), March 2015.
http://www.saj.usace.army.mil/Portals/44/docs/CongressionalFS/2015/CERP_Indian_River_Lagoon-South_(C)_CFS15.pdf

[186] The original (revised) cost estimate in 2004 was published in an August 2004 Addendum to the March 2004 IRLS-S Final PIR and EIS report, Table 7, Addendum page 6.

[187] South Florida Water Management District, St. Lucie Watershed Protection Plan, Appendix E: Research and Water Quality Monitoring Program, 2009, page 3-9.

[188] 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, pages S-xii and S-xiii.

[189] Personal communication with Boyd Gunsalus (SFWMD), in a meeting also including Gary Ritter (Florida Farm Bureau Federation), Vanessa Bessey (FDACS) and Kathy LaMartina (SFWMD), in Okeechobee, July 22, 2015.

[190] One of the five features in the IRL-S Recommended Plan is Diversion: "The diversion of existing flows via a canal connection and operating rules on new reservoirs and STAs would reduce negative impacts from C-23 and C-24 to the middle estuary and provide more of a natural freshwater pattern in the North Fork of the St. Lucie River."

[191] U.S. Army Corps of Engineers, and South Florida Water Management District, *Central and Southern Florida Project Indian River Lagoon – South, Final Integrated Project Implementation Report and Environmental Impact Statement*, March 2004, page 6-37.

[192] National Research Council, Committee on Watershed Management, *New Strategies for American Watersheds*, National Academy Press, 1999, page 3.

[193] Osmond, Deanna, et al., Chapter 8: "Synthesizing the Experience of the 13 National Institute of Food and Agriculture-Conservation Effects Assessment Project Watershed Studies: Present and Future," in Osmond, Meals, Hoag, and Arabi, editors, *How to Build Better Agricultural Conservation Programs to Protect Water Quality: The NIFA-CEAP Experience*; Soil and Water Conservation Society, August 2012, pages 166-167.

[194]USDA NRCS, CEAP Synthesis Fact Sheet 4. Effective Education to Promote Conservation Practice Adoption.

[195] Cox, Craig, "Pollution Solutions: Preventing Ag Run-Off," *Iowa Environmental Quarterly*, fall 2008.

[196] Newburn, David and Woodward, Richard, "An Ex Post Evaluation of Ohio's Great Miami Water Quality Trading Program." *Journal of the American Water Resources Association*, February 2012. Vol. 48, No. 1. P. 156. And Zwick, Steve, "Ohio Water Trading: Driving without Drivers, A Conversation with the Miami Conservancy District's Douglas 'Dusty' Hall," *Ecosystem Marketplace*, June 10, 2008.

[197] Personal communication with program coordinator Sarah Hippensteel Hall of the Miami Conservancy District, in Columbus, Ohio, October 5, 2012.

[198] Stakeholders include agriculturalists and their representatives, notably the Ohio Farm Bureau Federation along with the soil and water conservation districts, municipalities, and water utilities. The credit aggregator and manager of the program is the Miami Conservancy District.

[199] Roka, Fritz; Singerman, Ariel; and Muraro, Ronald, "Summary of 2013/14 Production Costs for Indian River Fresh Market Grapefruit and Southwest Florida Juice Oranges," University of Florida IFAS Extension, EDIS publication # FE968, July 2015.

Appendix 1: Profiles of the Largest Proposed Water Farms

[200] Eva Velez, of Velez Engineering, Inc., was the lead investigator of the AECOM *Assessment of Water Farming*, completed in 2012. She followed the protocol developed for the AECOM study to evaluate the Evans project sites. The more recent studies completed by Velez Engineering, Inc. under contract with Evans Properties, Inc., were: "Preliminary Evaluation of Water Farming Bluefield Grove," revised January 14, 2015; "Preliminary Evaluation of Water Farming Scott 6000 Grove," January 21, 2015; and "Preliminary Evaluation of Water Farming Scott 2000 Grove," March 8, 2015.

[201] Personal communication with Daniel Scott, of Scott Groves and Scott Citrus Management, who informs or produces the production reports for the Indian River Citrus League; May 18, 2015.

[202] Personal communication with Ron Edwards, President of Evans Properties, Vero Beach, January 14, 2015.

[203] University of Florida Water Institute, *Options to Reduce High Volume Freshwater Flows to the St. Lucie and Caloosahatchee Estuaries and Move More Water from Lake Okeechobee to the Southern Everglades*: An Independent Technical Review by the University of Florida Water Institute, March 2015, page 34. The *maximum* storage capacity of the reservoir component of the C-44 R/STA project will be 50,600 acre-feet per the USACE.

[204] Please see note 102.