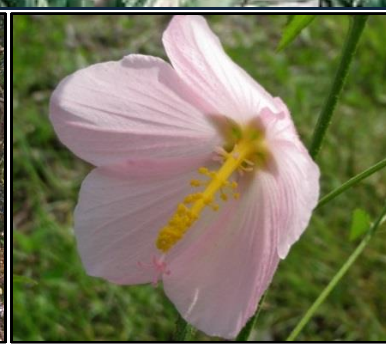
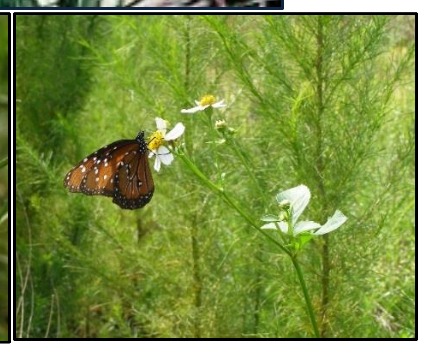
Deep Lagoon Preserve

Land Management Plan

Second Edition



Prepared by the Conservation 20/20 Land Management Section
of the Lee County Department of Parks and Recreation

Approved by the Lee County Board of County Commissioners: **02/19/2019**

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Hank Forehand

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List of Acronyms

ATV	All-terrain vehicle
C20/20	Conservation 20/20
DHR	Division of Historical Resources - Florida Department of State
DLP	Deep Lagoon Preserve
FDACS	Florida Department of Agriculture and Consumer Services
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FFS	Florida Forest Service
FLEPPC	Florida Exotic Pest Plant Council
FNAI	Florida Natural Areas Inventory
FWC	Florida Fish and Wildlife Conservation Commission
IDD	Iona Drainage District
JEI	Johnson Engineering, Inc.
LCCD	Lee County Community Development
LCDAS	Lee County Domestic Animal Services
LCNR	Lee County Natural Resources
LCPR	Lee County Parks and Recreation
LDOT	Lee County Department of Transportation
LIDAR	Light Detection and Ranging
LMP	Land Management Plan
LSOM	Land Stewardship Operations Manual
MU	Management Unit
NMFS	National Marine Fisheries Service
SFWMD	South Florida Water Management District
STRAP	Section-Township-Range-Area-Block.Lot
USACOE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service

VISION STATEMENT

It is the vision of the Lee County Department of Parks and Recreation and Conservation 20/20 program staff to conserve, protect and restore the natural resources at Deep Lagoon Preserve so that they are productive, functional and viable.
As restoration occurs, the preserve will become a tremendous haven for wildlife and will serve as a critical component in a wildlife corridor stretching from Estero Bay, in southwest Lee County, north to the Caloosahatchee River. The preserve will also provide scenic opportunities for paddlers and boaters on the Caloosahatchee River.

I. EXECUTIVE SUMMARY

Deep Lagoon Preserve (DLP) is a 406-acre preserve located south of the Caloosahatchee River, extending south from the river to Summerlin Road in southwest Fort Myers, in western Lee County. The preserve is separated into Deep Lagoon in the north and Cow Slough to the south.

The Deep Lagoon portion of the preserve consists of four nominations (77, 78, 116, and 199-2) that were acquired through the Conservation 20/20 program between 1999 and 2006, for a total of $4,525,864.23 with a combined acreage of 274 acres. Conservation 20/20 was established in 1996 when Lee County voters approved a referendum to fund a conservation land acquisition program to protect environmentally critical land in Lee County. In 2016, Lee County voters returned to the ballot box and voted overwhelmingly for the program to continue.

The Cow Slough portion of the preserve includes 132 acres acquired before Conservation 20/20 was established. This land was purchased for various purposes, including use as a county landfill. Over the years, the Lee County Department of Parks and Recreation was tasked to manage these parcels as a preserve.

Conservation 20/20 staff develops a land management plan for each Conservation 20/20 preserve to document its natural resources and ecosystems, and identify any plans for restoration and public recreation. These plans are updated every 10 years. The goal of this land management plan is to identify and develop strategies to continue to protect the resources of DLP and restore the preserve to a productive, functional and viable ecosystem, while ensuring it is managed in accordance with the Lee County Department of Parks & Recreation Land Stewardship Operations Manual. This document is available online at:
https://www.leegov.com/conservation2020/Documents/LSOM.pdf.

DLP provides for the protection of critical mangrove swamp, coastal grasslands, hammocks, and flatwoods that are habitat for a variety of freshwater and saltwater aquatic organisms, as well as many species of wildlife and birds. Once restoration efforts are complete, this preserve will once again resemble the natural system that originally covered this area.

Natural trends and disturbances influencing native communities and management at DLP include the pattern of wet and dry periods, flooding, occasional freezes, hurricanes, wildfire, and fluctuations in salinity.

Lee County is located within the Gulf Coastal Lowlands of Florida that extend around the coastal periphery of the state, where elevations are generally below 100 feet. The natural elevations at DLP range from sea level in southern portions to more than 12 feet above sea level in northeastern areas of the preserve. The contour lines in the area of the preserve indicate it is sloped gradually toward both the Caloosahatchee River and Estero Bay in the south.

There are eight soil types found at DLP, all of which are considered nearly level and poorly drained. The most common soils include Matlacha Gravelly Fine Sand; Hallandale Fine Sand; Boca Fine Sand; Isles Fine Sand, Depressional; and Pompano Fine Sand, Depressional.

The preserve consists of nine natural plant communities described by the Florida Natural Areas Inventory, of which mangrove swamp is the most common plant community. There are twelve additional communities within the preserve which contain various degrees of historic disturbance.

Restoration activities on the preserve have included the removal of exotic plants and debris, and hydrological restoration through the filling of ditches and pasture restoration.

Although no public recreation amenities exist or have been proposed at DLP, kayakers/canoers are known to stop at the northern shoreline on the Caloosahatchee. This is due to its designation as a Category 2 – Limited Use Preserve and close proximity to nearby Lee County Department of Parks & Recreation locations with established recreation facilities, including Wa-Ke Hatchee Recreation Center, Kelly Road Soccer Fields, Lakes Regional Park and Harlem Heights Community Park. Estero Bay Preserve State Park, located south of the preserve, also offers hiking trails through similar natural communities as those found on DLP.

This is the second edition of the land management plan for DLP. This plan is scheduled to be updated in 2028.

Table 1: Management Work Summary (2005-2018)

Natural Resource Management

- ✓ Invasive exotic plant species have been treated throughout much of the preserve. Most of the preserve is at maintenance-level for exotic plants. See below for additional exotic treatments.

Large-scale Restoration Projects

- ✓ 2007: Lands north of McGregor Boulevard cleared of exotics. This area was last retreated in 2017.
- ✓ 2008: Native plantings Site 116.
- ✓ 2009: Removal of stands of Australian pine in portions of the preserve south of McGregor Boulevard and along the Caloosahatchee River.
- ✓ 2009-2010: Completion of a hydrological improvement and habitat restoration project (including native wetland plantings) impacting approximately 20 acres in the middle of the preserve (Site 78).
- ✓ 2009: Cordgrass (*Spartina*) was planted in southern portion of Site 116 (MU2) in areas cleared of exotics.
- ✓ 2009: Roller-chopping palmetto off Willems Road, Site 116 (MU2).

Overall Protection

- ✓ Cows removed in 2006 prior to hydrological restoration.
- ✓ Small debris has been removed from the preserve during staff and volunteer workdays.
- ✓ Perimeter boundary signs have been installed and replaced as needed.
- ✓ Tri-annual site inspections have been conducted.
- ✓ Fences have been installed where access and trash dumping problems occurred. Cross fencing was removed where no longer needed.

Building Maintenance

- ✓ General maintenance of doors, roof and perimeter grounds of warehouse building.

Public Use

- ✓ No designated public access points with amenities were installed at the site since it is primarily wetland communities and recreation opportunities occur nearby at county and state facilities.

Volunteers

- ✓ Individual volunteers, volunteer groups, students, and community service workers have assisted in exotic plant control, interior fence removal from a former cattle pasture, and debris removal.

II. INTRODUCTION

DLP was acquired through a property transfer as well as Conservation 20/20 (C20/20) acquisitions between 1999 and 2006. The non-C20/20 portions (MU 7 through MU 10) were acquired by Lee County in 1972 and 1976, and later added to the Conservation Lands Program. DLP totals 406 acres and is located in south Fort Myers between the Caloosahatchee River and Summerlin Road in western Lee County.

Many changes to what is now DLP happened prior to recent aerial photography. Historic aerial photography from 1944 to 2018 shows evidence of several anthropogenic influences on the preserve; these range from agricultural uses in the central part of the preserve, to the dumping of spoil, landfilling, ditching, and canals created along the Caloosahatchee River. More recently, land uses included continued agricultural use and the creation of drainage ditches and roadways. The Land Use History section of this land management plan (LMP) shows the progression of agricultural uses in the areas surrounding the preserve, as well as the dredging of canals from the Caloosahatchee River.

Land management activities for the site will include additional invasive exotic plant and animal control, enhancing hydrologic features and wildlife habitat, and debris removal. DLP contains one structure onsite: a warehouse building used to store equipment for the county's Conservation Lands operations. There is low potential for public access, as detailed in the Public Access and Resource-Based Recreation section of this LMP.

The preserve consists of 21 natural or altered plant communities described by the Florida Natural Areas Inventory (FNAI), of which 74% are wetland communities. Mangrove swamp is the most common plant community, covering 50% of the preserve. DLP's ecosystems were dramatically impacted by internal alterations and surrounding land uses that changed the composition of the plant communities.

At the time of acquisition, approximately 50 acres of the preserve were identified as containing 75-100% coverage of invasive exotic vegetation. Through mechanical work and herbicide treatments, invasive exotic vegetation coverage has been significantly reduced to less than 15% across the entire preserve.

The purpose of this LMP is to define conservation goals for the preserve and serve as a guide for Lee County Department of Parks & Recreation (LCPR) staff to use best management practices to ensure proper management and protection of the preserve. A significant number of field surveys were conducted, along with the review of scientific literature and historical records, to understand how the preserve functions within the ecosystem, which wildlife and plants are found within its boundaries, and how the preserve has been impacted by human disturbance. This allows the plan to serve as a reference guide for anyone interested to learn more about the preserve and the land management efforts in Lee County.

III. LOCATION AND SITE DESCRIPTION

DLP contains three different geographic areas spread along a 3-mile corridor in west-central Lee County (Figures 1 & 2) in Sections 20, 29 and 32, Township 45 South, Range 24 East and Section 5, Township 46 South, Range 24 East. Although these three areas are not contiguous, they are managed together as one preserve, since they are part of the same historic slough system and help to create a wildlife corridor from the Caloosahatchee River to Estero Bay. McGregor Boulevard bisects the northernmost portion of the preserve, known as the peninsula or Site 116. To the north of McGregor Boulevard, the preserve is surrounded by water, consisting of a canal to the west, the Caloosahatchee River to the north, and Deep Lagoon to the east. To the south of McGregor Boulevard, the preserve has residential housing to the west, a canal on the south border and developed residential area to the east, known as the Lucaya development. The middle geographic area, known as Sites 77 and 78, are bordered by A&W Bulb Road and Gladiolus Drive to the east and south, respectively. The northern boundary of this portion of the preserve consists of residential housing and the Temple Judea. The west boundary is the Lucaya housing development. Site 78 includes a warehouse just off of A&W Bulb Road.

The final southern geographic portion of DLP is located south of Gladiolus Drive. Site 199-2 is comprised of the last parcels acquired through Lee County's C20/20 program. Additional parcels acquired before the program was established have historically been referred to as the Cow Slough and extend to private lands, and also includes lands south of the east-west canal south to Summerlin Road. Between these parcels are private lands, county lands managed by Lee County Community Development (LCCD) as a Lee County Department of Transportation (LDOT) mitigation parcel, and an old LDOT borrow pit. These county-owned parcels are not currently part of the preserve but are included in the north-south corridor. The southern boundary is Summerlin Road; HealthPark lies to the east; and undeveloped lands currently lie to the west (Figure 2).

The preserve has undergone tremendous alterations from human-related activities. Approximately 2% of DLP consists of ditches created for mosquito control and as part of the Iona Drainage District. Four percent (4%) is pasture that has been restored. This land and area in Lee County was previously used for growing gladiolus flowers and then as cattle grazing land. Approximately 6% of the preserve consists of invasive exotic plant monocultures, primarily Australian pines (*Casuarina equisetifolia*), Brazilian pepper (*Schinus terebinthifolius*) and melaleuca (*Melaleuca quinquenervia*). These invasive species are scattered throughout all sections of the preserve. Natural plant communities found at DLP include mangrove swamps, salt marshes, coastal grasslands, hammocks and mesic flatwoods. These community designations are based on the Florida Natural Areas Inventory Guide to the Natural Communities of Florida (2010).

Figure 1: Location Map

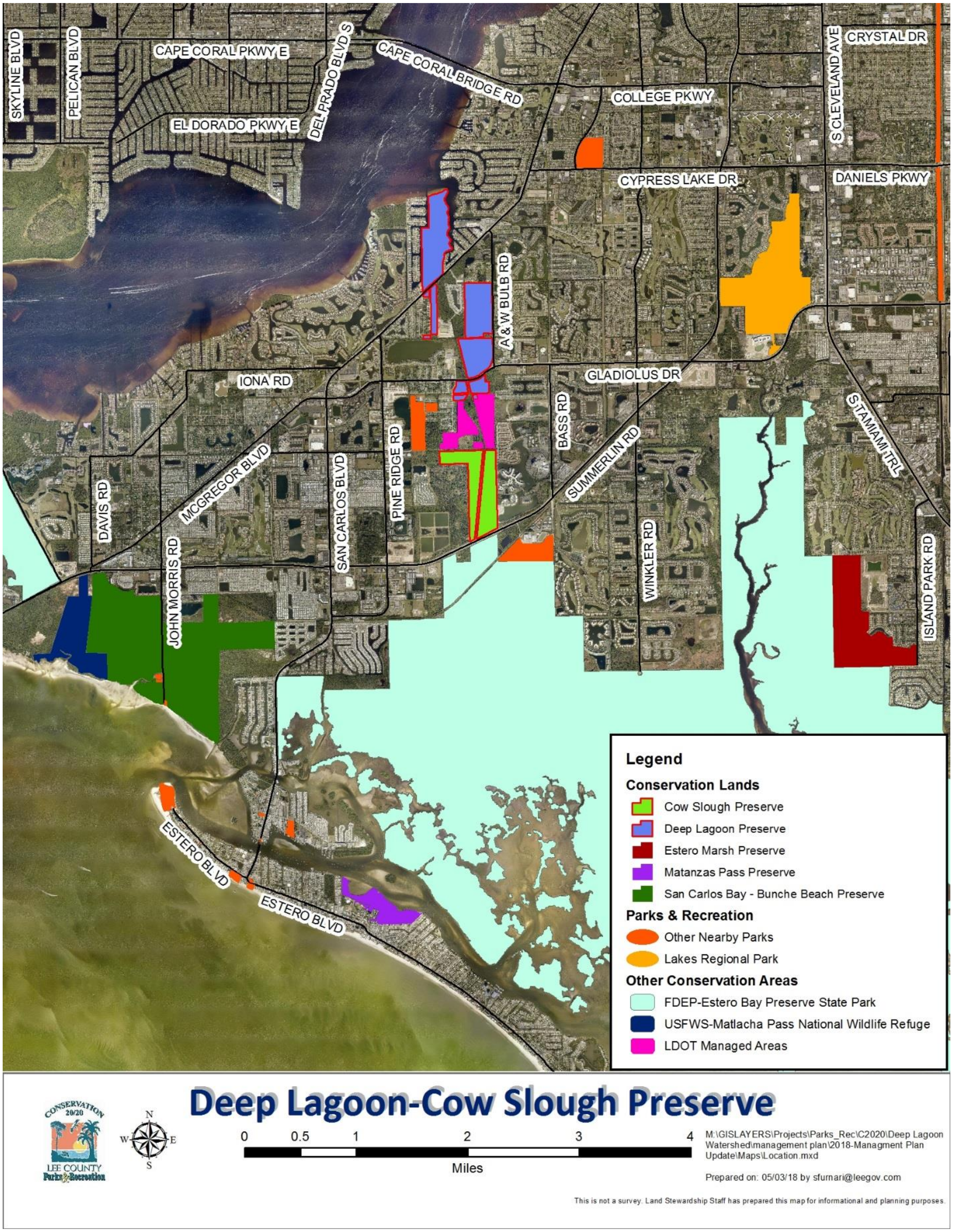


Figure 2: 2018 Aerial Map

IV. NATURAL RESOURCES DESCRIPTION

A. Physical Resources

i. Climate

General information on the climate of Southwest Florida is located in the Land Stewardship Operations Manual (LSOM) section titled Land Stewardship Plan Development and Supplemental Information.

ii. Geology

Specific information about geologic features, such as physiographic regions, formations and maps can be found in the LSOM section titled Land Stewardship Plan Development and Supplemental Information.

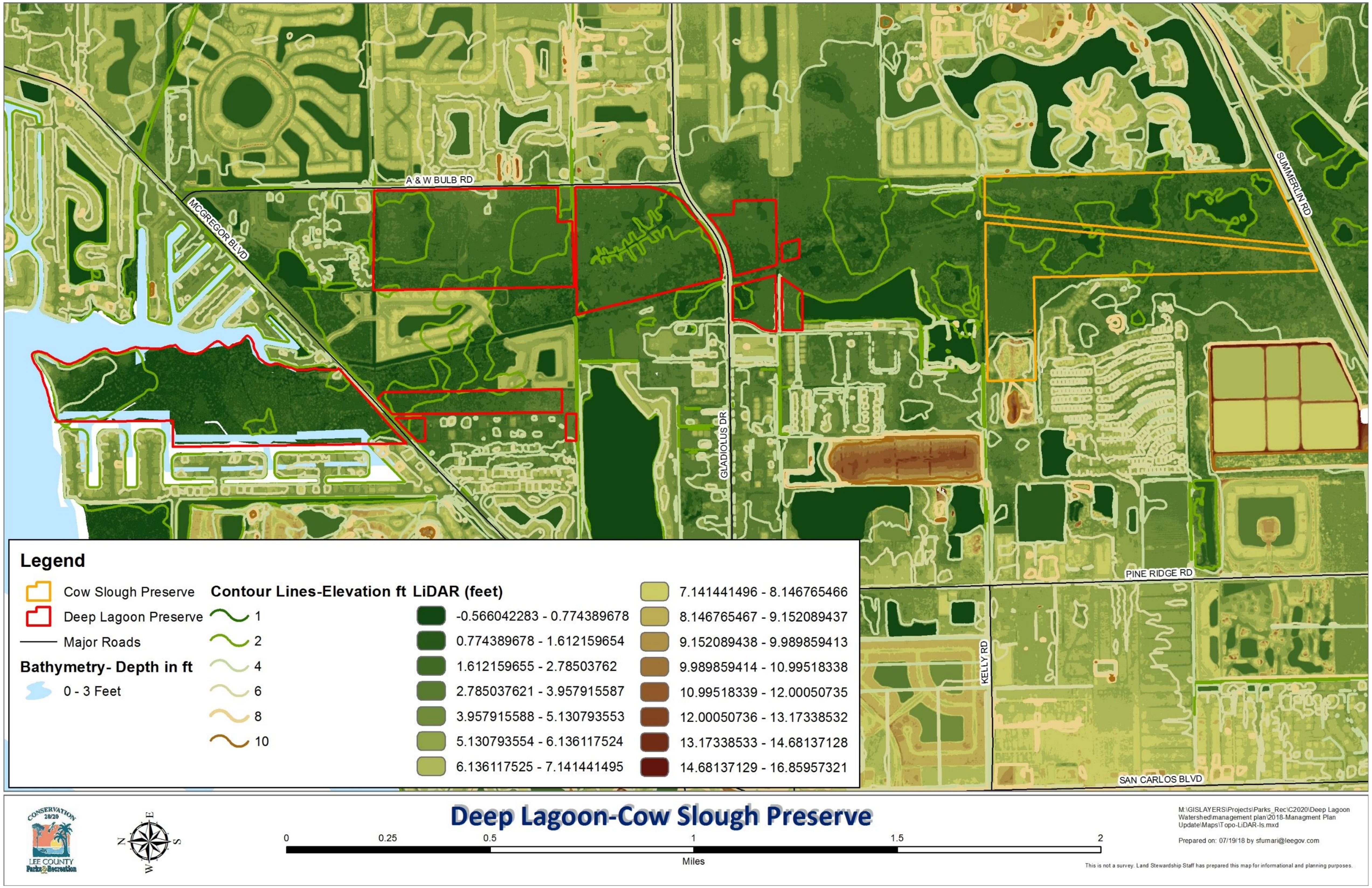
iii. Topography

Topographic maps are the two dimensional representations of the three dimensional surfaces of the earth. Topographic maps depict elevations of land starting at its height above sea level. Contour lines represent land surface elevations on topographic maps. A contour line is a continuous, connecting line of an area that indicates the elevation of the land above sea level within the line.

The topography of DLP is mainly low and near sea level (Figure 3). The majority of the preserve is approximately 4 feet above sea level, with its wetlands dropping to approximately 2 feet. There is one small portion of the southern Cow Slough arm that rises to 6 feet. The portion of DLP that is north of McGregor Boulevard is at sea level on the southern two thirds, with the northern third, which consists of Coastal Strand, ranging from 2-4 feet in elevation. All elevations are based on National Geodetic Vertical Datum.

The light detecting and ranging (LiDAR) data is an optical remote sensing technology measuring properties of scattered light to find range and/or other information of a distant target that shows elevation ranges from low to high. Figure 3 depicts both topographic contour lines and LiDAR data.

Figure 3: Topography and LiDAR Map



iv. Soils

The 1984 “Soil Survey of Lee County, Florida” (Henderson 1984) was designed to identify soil behavior, physical and chemical properties, land use limitations, potential impacts and environmental protection qualities of the local soils. This information was created by gathering hundreds of soil samples to study the soil profile. A predictive model of soil formations throughout the county was created by applying geology, land forms, relief, climate, and vegetation.

There are eight different soil types at DLP (Figure 4). The following section is a summary of the soil types as described in the Soil Survey of Lee County, Florida (Henderson 1984). All soils found at DLP are considered nearly level and poorly drained.

Matlacha Gravelly Fine Sand is formed by filling and earthmoving operations and found on the arm of the Cow Slough portion of the preserve. The depth of the water table varies with the amount of fill material, typically a minimum of 24 inches below the surface. Most of the natural vegetation is removed; what remains are typically slash pines (*Pinus elliottii*) and weeds. It is poorly suited to most plants, unless topsoil is spread over the surface deep enough to form a suitable root zone. This soil is considered to have severe limitations for sanitary facilities and recreational uses, and moderate limitations for most building site development.

Hallandale Fine Sand is found on the upland portions of Site 116, the majority of Site 78, the outer fringes of Site 77 and a very small portion of the Cow Slough parcel. The water table is less than 10 inches below the surface for 1-3 months of the year. This condition is not optimal for agricultural uses, which is surprising, given the gladiolus farms which formerly dominated Site 78. Gladiolus bulbs typically require well drained soils to grow in. Native plants expected to be present on this type of soil are saw palmetto (*Serenoa repens*), threeawn (*Aristida spp.*), bluestem (*Andropogon spp.*), panicums (*Panicum spp.*) and slash pine. It is considered to have severe limitations for urban use because of the shallowness to the bedrock as well as for wetness.

Boca Fine Sand is an additional upland soil found on Sites 77 and 78 and Cow Slough portions of the preserve. The water table is slightly higher than the Hallandale Fine Sand and has similar native plants, with the addition of wax myrtle (*Myrica cerifera*). This soil is considered to have severe limitations for sanitary facilities, building site development and recreational uses, due to the high water table.

Isles Fine Sand – Depressional is restricted to Site 77, is nearly level to concave, and is expected to have standing water for 3-6 months of the year. Native plants expected to be found in these soils include cabbage palm (*Sabal palmetto*), cypress (*Taxodium distichum*), ferns, and popash (*Fraxinus caroliniana*). This soil is severely limited for urban and recreational uses because of ponding, and is excellent habitat for wading birds and other wetland wildlife.

Pompano Fine Sand – Depressional is found on portions of Site 116 and Cow Slough in concave areas. The water table is above the surface for 3 months of the year and within the surface for 2-4 months. St. John's wort (*Hypericum spp.*) and wax myrtle are typical native plants found growing in these soils. This soil has severe limitations for septic tank absorption fields, dwellings without basements, small commercial buildings and local roads and streets.

The final three soils, Kesson Fine Sand, Isles Muck and Wulfert Muck, are all associated with tidal swamps. They are all subject to tidal flooding and, typically, the water levels fluctuate with the tide. Native plants associated with these soils include black mangrove (*Avicennia germinans*) and red mangrove (*Rhizophora mangle*). They all have severe limitations for urban and recreational development because of flooding and the high salt/sulfur content of the soils. Kesson Fine Sand is located on Site 116 of the preserve. Additional native plants typically found in these areas are oxeye daisy (*Borrichia frutescens*) and batis (*Batis maritima*). Isles Muck, found on the west portion of Site 77 and throughout the Cow Slough area of the preserve, often has batis and sea purslane (*Sesuvium portulacastrum*) in addition to mangroves. Finally, Wulfurt Muck, which is found in the northern portion of Site 116, is dominated by needlerush (*Juncus roemerianus*).

For additional information on soil types and limitation, refer to the Land Stewardship Operations Manual (LSOM) section titled Land Stewardship Plan Development and Supplemental Information.

Table 2: Soil Attributes

Soil Characteristics Table

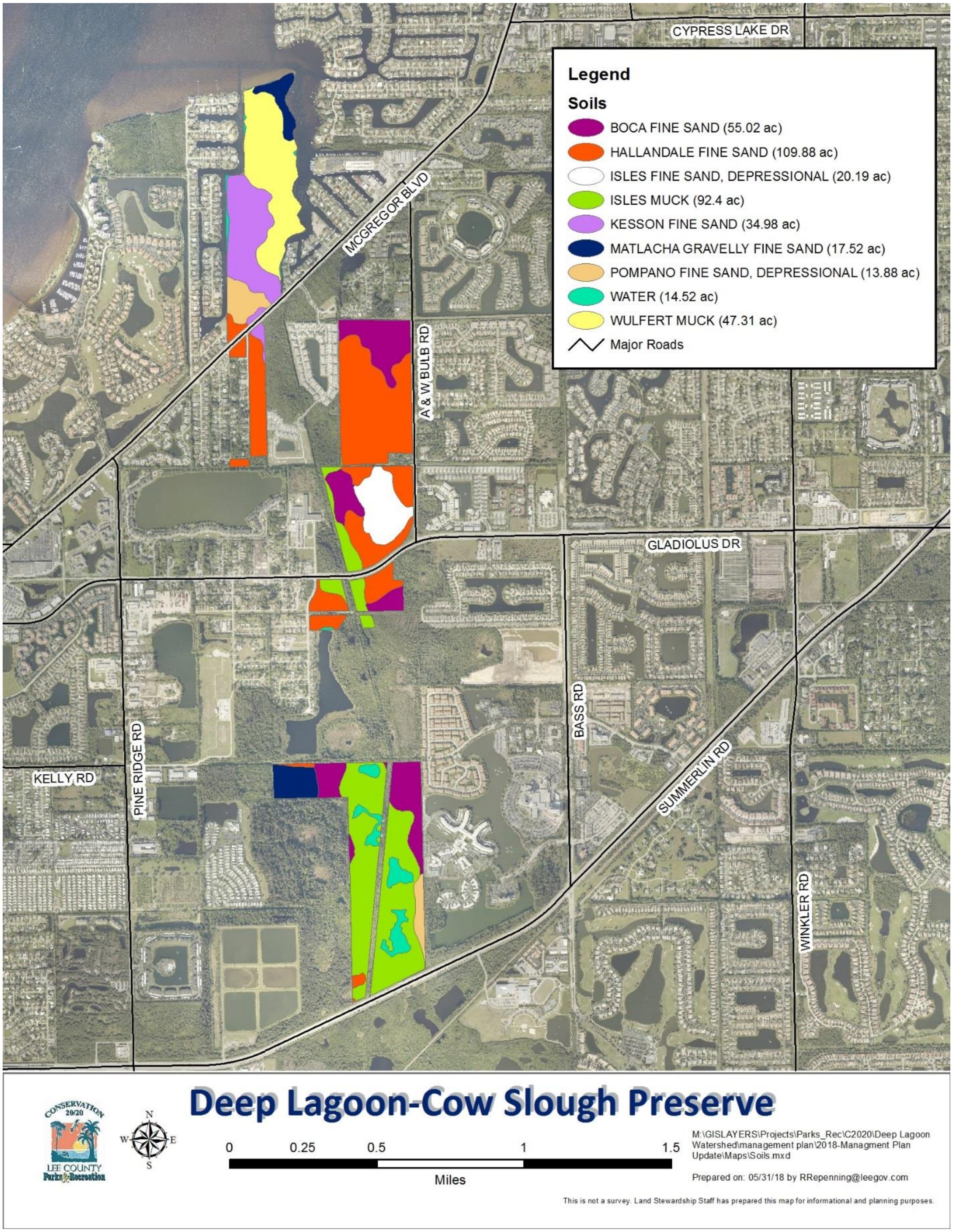
					Physical Attributes			*Biological Attributes*				
Soil Types	**Map Symbol**	**Total Acres**	**% of Preserve**	**Habitats (Range Site)**	**Wetland Class (1)**	**Hydrologic Group (2)**	**% Organic Matter**	**Potential as habitat for wildlife in--**				**Limitations for Recreational Paths & Trails**
								Openland	**Woodland**	**Wetland**	**Rangeland**	
Boca Fine Sand	13	55.02	14.1	South Florida flatwoods		B/D	1-3%	fair	poor	fair	good	Severe: wetness, too sandy
Hallandale Fine Sand	6	109.88	28.1	South Florida flatwoods		B/D	2-5%	poor	poor	fair	poor	Severe: wetness, too sandy
Isles Fine Sand, Depressional	39	20.19	5.2	freshwater marshes/ponds	P	D *	1-2%	very poor	very poor	good	--	Severe: wetness, too sandy
Isles Muck	56	92.4	23.6	salt water marsh	F	D	20-30%	very poor	very poor	fair	poor	Severe: wetness, too sandy
Kesson Fine Sand	24	34.96	8.9	salt water marsh/tidal swamps	P	D	--	very poor	very poor	fair	--	Severe: wetness, too sandy
Matlacha Gravelly Fine Sand	69	17.52	4.5	manmade areas		C	not estimated	--	--	--	--	Severe: too sandy
Pompano Fine Sand, Depressional	27	13.88	3.5	freshwater marshes/ponds		B/D *	1-5%	very poor	poor	good	--	Severe: ponding, too sandy
Wulfert Muck	23	47.31	12.1	salt water marsh	F	D	--	very poor	very poor	fair	--	Severe: wetness, excess humus

Color Key:
- Upland
- Wetlands Rarely Present (Under 20%)
- Wetlands Sometimes Present (20-40%)
- Wetlands Often Present (75-95%)
- Wetlands Very Often Present (100%)

(1) F - Flooding: The temporary inundation of an area caused by overflowing streams, runoff from adjacent slopes or tides.
S - Slough (sheet flow): A broad nearly level, poorly defined drainage way that is subject to sheet-flow during the rainy season.
P - Ponding: Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

(2) * Water table is above the surface of soil
B - Soils having a moderate infiltration rate (low to moderate runoff potential) when thoroughly wet.
C - Soils having a slow infiltration rate (moderate to high runoff potential) when thoroughly wet.
D - Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet.

Figure 4: Soils Map



v. Hydrologic Components and Watershed

DLP lies within the seven square mile Deep Lagoon Watershed (Figure 5). This watershed was channelized in the 1920s from Deep Lagoon and the Caloosahatchee River to the north, and the Florida Power and Light power line easement south of Summerlin Road. These canals were created as part of the Iona Drainage District (IDD) to drain the surrounding lands for farming and low-density residential housing. The maintenance and operation of the IDD canals are now the responsibility of the Lee County Department of Transportation. There is a main canal (“C”) that runs south/north in addition to 11 side canals (Figure 6). Several of these canals are either within the preserve, or form boundaries of the preserve. Before the digging of these canals, the waters of the Deep Lagoon Watershed and Cow Slough Watershed would only connect during extreme tidal events. Canal “C” created a direct link between the watersheds that has led to salt water intrusion into historically freshwater systems. By blocking portions of the canals, upstream (further south) portions would become fresher and help with restoration. HealthPark’s water management system, which filled canals “C-6” and “C-8” to detain water, has improved the water quality of the lakes within their property (JEI 2002). Typically, water flows north from Summerlin Road through the canal system to Deep Lagoon. Water south of Summerlin Road heads south to Estero Bay.

In addition to the IDD canals, there are several ditch systems located within the northern and central portions of the preserve. The two ditches located in the area of Site 78 that was historically agricultural field were created for additional drainage. These two ditches have been removed and the area has been restored into marshes. Although an exact date for the creation of these ditches was not available, historical aerials indicate that this field was farmed since at least 1944. The southern ditch system and the numerous ditches north of McGregor Boulevard were created for mosquito control. The southern mosquito ditches are heavily impacted with exotics (Figure 7). The southern end of this ditch was historically a small natural wetland and Land Management staff has recorded the presence of numerous water birds and fresh water turtles.

In June 2000, LCPR and the Lee County Department of Natural Resources (LCNR) commissioned JEI to conduct a 16-month environmental study on DLP to determine how these wetlands would best be restored. Both departments believed this study was essential to maintain or increase the hydraulic capacity of this system in accordance with the Lee County Surface Water Master Plan. The resulting study, Deep Lagoon Preserve Environmental and Hydrologic Assessment, included an extensive hydrologic analysis. Five monitoring wells were located within the watershed: DL 1-3 in Canal C; DL-5 in adjacent wetland on the central portion of the preserve; and DL-4 at the north end of the Cow Slough watershed (Figure 5). Additionally, a rain gauge was installed near DL-5. The data collected allowed engineers to verify the boundary between the two watersheds, as well as confirm the un-natural connection between the two watersheds. The monitoring well located at the north end of the watershed (DL-1) is primarily influenced by tidal fluctuations. The other gauges are primarily influenced by rainfall and runoff. However, during the dry season of 2001-2002, DL-2 was also influenced by the tide. This study will continue to be a guide for hydrological restoration at DLP.

Later, in 2017, LCNR commissioned Waldrop Engineering to help determine levels of nitrogen in the area in order to address the lower Caloosahatchee Basin Management Action Plan. It was determined that the high nitrogen levels in the watershed and likely on the preserve are the result of land use, percolation ponds, septic tanks and canal sediments (Waldrop 2017). These findings and suggestions are addressed in phases II and III of the study (Appendices A and B). LCNR is currently considering a water quality project on a portion or the preserve. Conservation 20/20 program funding will not be used for cleaning up the excessive nitrogen in the area.

Figure 5: Watershed Map

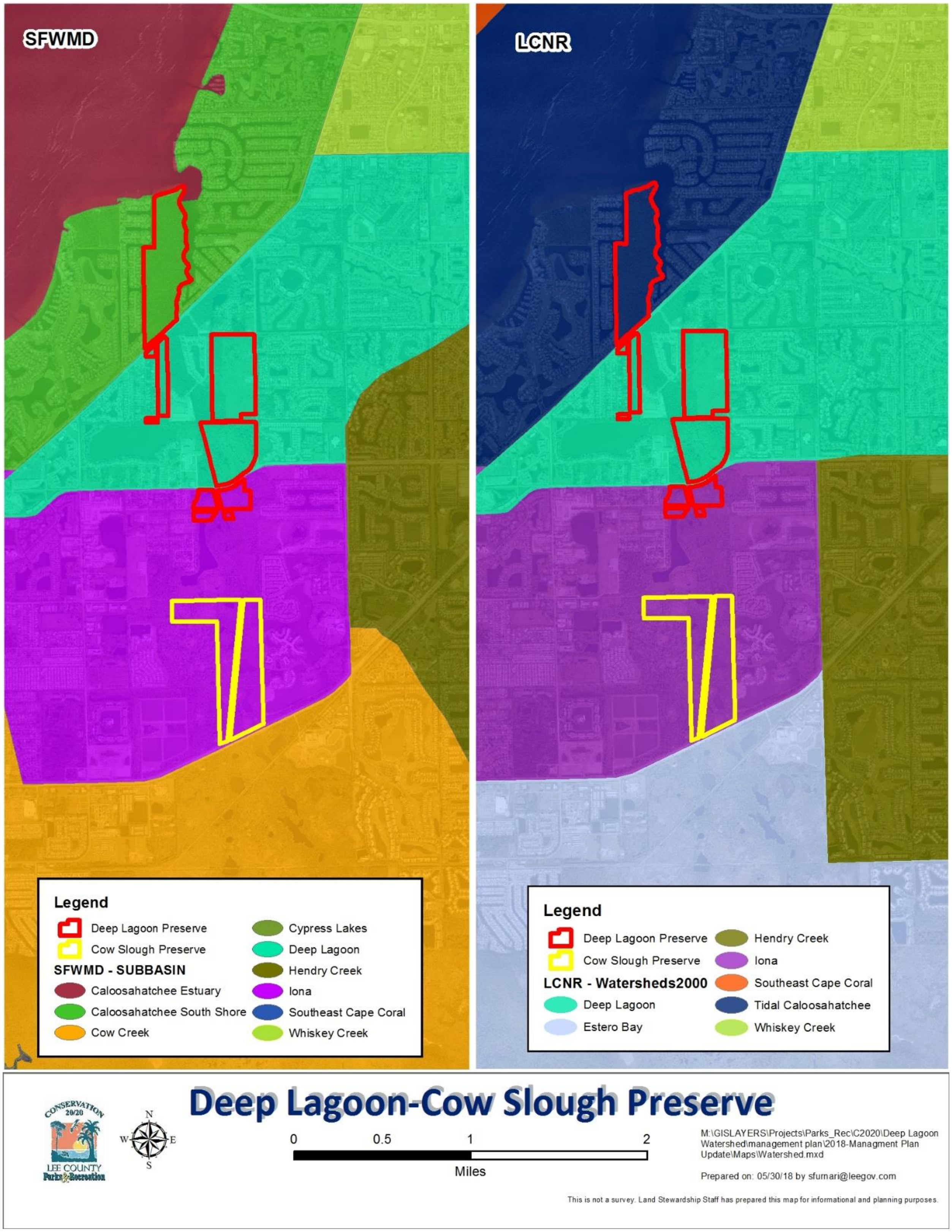
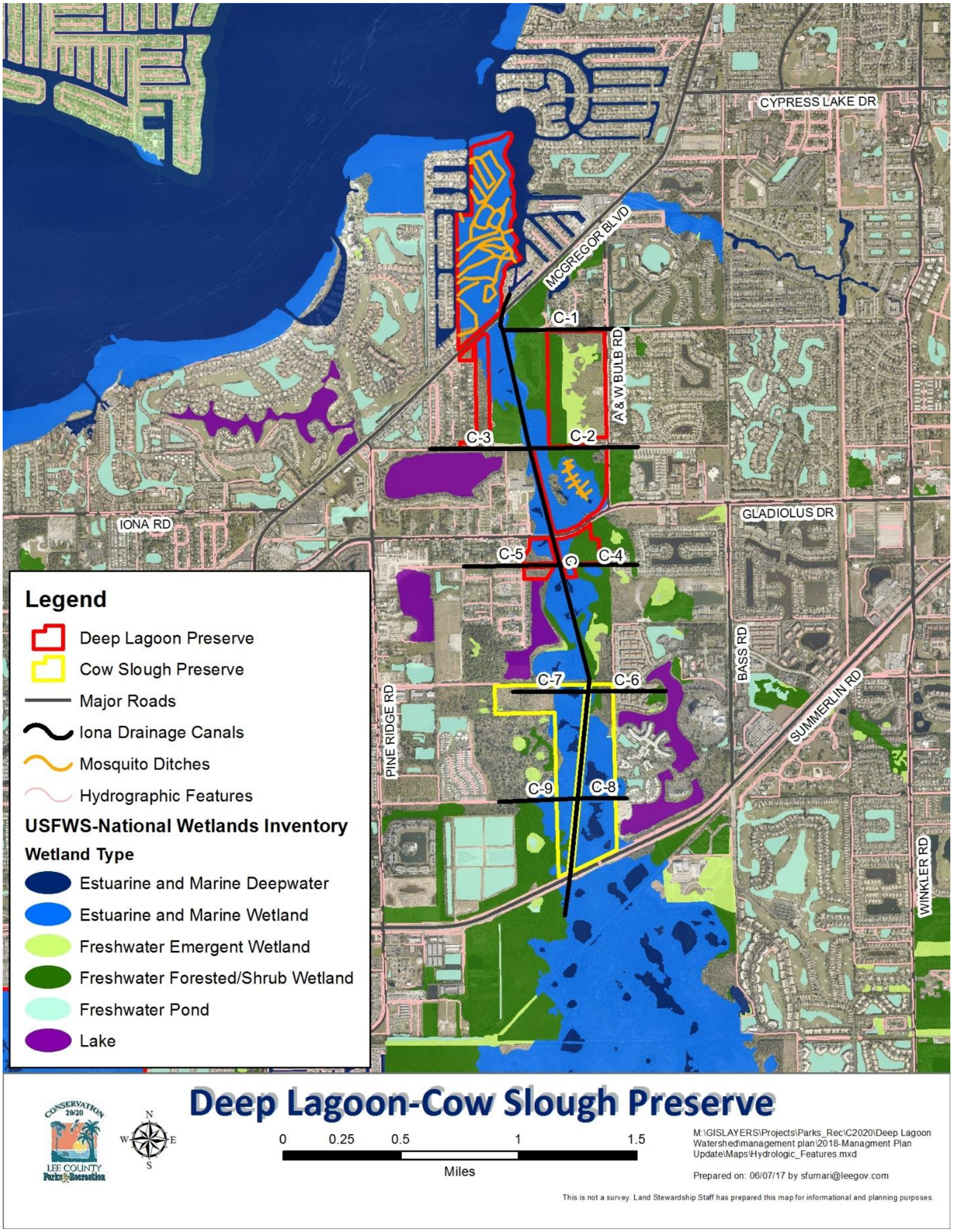


Figure 6: Hydrological Components Map



B. Biological Resources

i. Ecosystem Function

A mangrove swamp, such as that found at the north end of DLP, is a significant plant community due to its function as a nursery ground for most of Florida's commercially and recreationally important fish and shellfish. Mangrove swamps also provide breeding grounds for substantial populations of wading birds, shorebirds and other animals (FNAI 2010). Although nesting has not been confirmed, it is possible that mangrove cuckoos (*Coccyzus minor*), black-whiskered vireos (*Vireo altiloquus*) and gray kingbirds (*Tyrannus dominicensis*) may utilize the mangrove swamps found throughout the preserve for nesting. These three species are dependent on mangroves and their numbers are jeopardized by the fragmentation of mangrove habitat. Although they have not been documented at the preserve, there are several wildlife species that are found exclusively in mangrove swamps, including mangrove salt marsh snakes (*Nerodia clarkii compressicauda*) and at least two butterfly species: the mangrove skipper (*Phocides pigmalion*) and the mangrove buckeye (*Junonia evarete*), both of which depend on mangroves as a larval food source (Minno et al. 2005). Additionally, mangroves can produce up to 80% of the total organic material available in the aquatic food web through the continuous shedding of its leaves and other plant components (FNAI 2010).

The upland coastal communities, especially the coastal berm and strand, act as shoreline stabilizers that also help to protect inland communities from the most severe damage of storms. This protection is dependent on the heavy vegetation and, therefore, damage to these areas during restoration must be minimized. Unlike the strand and berm, the coastal grassland community requires periodic overwash during extreme high tides and storms. These flooding events bring in sand, which over time becomes covered with pioneer species. On the northern portion of the preserve, the coastal grassland areas that are dominated by needlerush are particularly important. The high density of plant stems provides abundant cover for wildlife. Additionally, the rate of net primary production in these needlerush marshes is among the highest in any of the world's ecosystems (Myers and Ewel 1990). There are many terrestrial (insects, spiders, passerine birds) and marine (microalgae and organic detritus, phytoplankton, zooplankton, filter-feeding bivalves, fiddler crabs, snails) food webs occurring within these areas.

The freshwater wetlands of south Florida are important to a variety of wildlife. Birds feed and breed, as do fish and frogs, and people rely on these marshes to improve water quality. During the late spring and summer months, the rain begins to fall and the wetlands fill to capacity. Fish populations begin to increase in number and biomass. In the fall when the rains end, the water recedes and the fish are concentrated in shallow marshes. At the same time, fall high tides let some fish back into the bays, where they contribute to the commercial and recreational fisheries. The wading birds then come in to feast which aids the remaining fish by decreasing the density and increasing the availability of dissolved oxygen. Most wildlife utilizing these communities are adapted to migrate from one wetland to another as the shallow ones dry up. DLP has a mixture of temporary and more permanent wetlands for wildlife to utilize. The deepest areas provide critical habitat for wintering waterfowl, such as blue-winged teal (*Anas discors*). Plants in these areas also benefit from the seasonal wet/dry fluctuation. Most aquatic plants cannot germinate under water and require this drying phase. The plants located in the wetlands that do become completely dry die, decay and release nutrients that are bound in their tissues. This makes the soils highly productive for the next wet season. Typically, these plants have low nutrient requirements, so they stockpile the excess, which is beneficial to herbivores feeding upon them. When the nutrient loads become too high, cattails (*Typha latifolia*) increase (Myers and Ewel 1990), which is evident in the furthest south portion of the preserve.

The flatwoods and hammocks that surround these wetlands also serve as important habitat. Several species of birds find shelter in the palmetto understory, nest in the tall pines and forage in the grasses. Many wading birds feed in the wetlands and roost/nest in the adjacent swamps and forests. Hammocks are also unique in south Florida, as they provide the base for the highest number of epiphytic ferns, bromeliads and orchids in the continental United States (Myers and Ewel 1990). Many bromeliads collect water between their leaves, serving as a habitat for small animals and a water source in drier months.

ii. Natural Plant Communities

DLP consists of nine natural plant communities described by FNAI, as well as several altered habitats. Figure 7 illustrate the location of each community within the preserve. The natural communities found at DLP are defined using the Florida Natural Area Guide to the Natural Communities of Florida (2010). Appendix C contains a complete list of plant species identified on numerous site inspections to DLP, but not necessarily a comprehensive list for the entire preserve.

Canal/Ditch - 6.9 acres, 2% coverage of DLP

There are mosquito ditches, IDD canals and other areas dug for drainage and discussed in the hydrology section of this stewardship plan.

Clearing/Regeneration - 6.5 acres, 2% coverage of DLP

These are areas consisting mostly of the historic landfill in Cow Slough that were cleared of exotics and are in the process of regenerating to natural plant communities. These included monocultures of Australian pine and Brazilian pepper.

Coastal Berm – 0.5 acres, less than 1% coverage of DLP

This plant community is found in a small area on the western boundary of DLP adjacent to a canal leading to the Caloosahatchee River that was dug between 1966 and 1972. Typically, this plant community originates from storm deposited sand, shells and debris; although, in this case, some of it may be artificial. This plant community consists of dense thickets of large shrubs and small trees. The dominant plant in this area is cabbage palm. This community is often associated with and grades into tidal swamp, which occurs at the preserve.

Coastal Hydric Hammock – 17.6 acres, 8% coverage of DLP

DLP has hydric hammock on both the central and southern portions. Hydric hammocks are characterized as well developed hardwoods and cabbage palms, with an understory of palmetto and ferns. Typical plant species found on DLP include live oak (*Quercus virginiana*), cabbage palm, saw palmetto, myrsine (*Rapanea punctata*), poison ivy (*Toxicodendron radicans*) and swamp fern (*Blechnum serrulatum*). Additionally, Brazilian pepper has been found to invade this plant community. Typically, the areas dominated by pepper have minimal understory and scattered palms. There remains 14.9 acres of this community that is disturbed and awaiting restoration.

Wildlife typically associated with this type of plant community includes green anoles (*Anolis carolinensis*), flycatchers (*Family Tyrannidae*), warblers (*Family Parulidae*), and gray squirrels (*Sciurus carolinensis*).

Coastal Strand – 6.2 acres, less than 2% coverage of DLP

This plant community is characterized as stabilized, wind-deposited coastal dunes that are vegetated with a dense thicket of salt-tolerant shrubs, especially saw palmetto. Additional plant species found at the preserve and considered indicators of this plant community include cabbage palm, sea grape (*Coccoloba uvifera*), lantana (*Lantana camara*), greenbriar (*Smilax sp.*), gray nicker (*Caesalpinia bonduc*), coin vine (*Dalbergia ecastaphyllum*) and Spanish bayonet (*Yucca aloifolia*). This plant community also contains a large amount of the native rouge plant (*Rivina humilis*). This plant community is restricted to the northern edge of DLP on the shores of the Caloosahatchee River.

Typical wildlife expected in this plant community includes gopher tortoise (*Gopherus polyphemus*), and six-lined racerunner (*Cnemidophorus sexlineatus sexlineatus*). Due to its isolation, these species are not likely to reside in this portion of DLP; however, numerous birds have been documented, including blue-gray gnatcatcher (*Polioptila caerulea*), gray catbird (*Dumetella carolinensis*) and downy woodpecker (*Picoides pubescens*).

Depressional Marsh- 12 acres, 3% coverage at DLP

There are several irregularly-shaped depressions occurring in the central and southern portion of the preserve. These areas, like the cattail marshes, are remnants of a former large tidal basin.

Typical plants found growing on the edges of these water bodies are cattail, sawgrass (*Cladium jamaicense*), leatherfern and mangroves. This community is an important breeding area for numerous insects which form the base of many food chains. They are also critical watering holes for many mammals and birds. Typical animal species observed at the preserve include mosquitofish (*Gambusia affinis*), sailfin molly (*Poecilia *latipinna*), common gallinule (*Gallinula galeata*), blue-winged teal, and little blue heron (*Egretta caerulea*).

Developed - 1.4 acres, less than 1% coverage at DLP

The vegetated field surrounding the warehouse, and enclosed by fencing, contains Bahiagrass (*Paspalum notatum*), dog fennel (*Eupatorium capillifolium*), ragweed (*Ambrosia artemisifolia*), star rush (*Rhynchospora colorata*), creeping oxeye (*Sphagneticola trilobata*), and Bermudagrass (*Cynodon dactylon*).

Freshwater Tidal Marsh - 26.4 acres, 6% coverage at DLP

This area along A&W Bulb Road is former pasture/farm field. It is restored to freshwater marsh relying on rainwater to hydrate it. Many of the plant species found here are early successional and serve to build an organic soil base for the marsh plants that will soon dominate the site. Cotton rat (*Sigmodon hispidus*) and marsh rabbit (*Sylvilagus palustris*) inhabit this community, forming a prey base for predators such as red-tailed hawk (*Buteo jamaicensis*) and bobcat (*Lynx rufus*).

Impoundment/Artificial Pond – 1.7 aces less than 1% of DLP

This small pond is adjacent to and receives runoff from the Cypress Cove development in the HealthPark. It has a fringe of cattails.

Invasive Exotic Monoculture – 34.4 acres, 8% of DLP

These remaining areas in need of restoration are mainly north and south of Gladiolus Drive and are predominately monocultures of Brazilian pepper and Australian pine.

Mangrove Swamp – 174.9 acres, 43% coverage of DLP; with an additional 29.8 acres of disturbed mangroves, 7% coverage of DLP

Mangrove swamps are characterized as dense forests located along the shorelines of southern Florida. The dominant plants in this community are black mangrove, red mangrove, white mangrove (*Laguncularia racemosa*), and buttonwood (*Conocarpus erectus*). The dominant species of mangrove found in different areas is dependent on abiotic factors such as tidal flushing and salinity.

At DLP, the peninsular portion is dominated by red mangroves and scattered black mangroves. This area is the least disturbed of the tidal swamp communities, although there are scattered Brazilian pepper, melaleuca and Australian pine growing on the spoil piles associated with the mosquito ditches dug in this area. White mangroves are the dominant plant found in the tidal swamps adjacent to McGregor Boulevard. Scattered melaleuca and Australian pines are both present in this portion of the preserve.

For the central portion of the preserve, there is a general trend of white mangroves to the north and buttonwood to the south. Australian pines, melaleuca and Brazilian pepper are dominant in these areas. The “tidal swamp, mixed exotics” community, found in the central portion, has very few mangroves or other native species. The western side of this section is characterized by red, black and white mangroves, Brazilian pepper, and leather fern.

The southern section of the preserve has a combination of white, red and black mangroves mixed with Brazilian pepper, cabbage palm and leather fern. Historically, according to aerial photography, most of the area was a marsh community. Channelization may have contributed to the spread of mangrove propagules from the south. Now, the community is dominated primarily by white mangrove hammocks that are several feet above the average water level. The white mangroves in the hammocks have developed extensive adventitious roots that are uncommon.

A variety of animals utilize this community, including osprey (*Pandion haliaetus*), bald eagle (*Haliaeetus leucocephalus*), yellow-crowned night heron (*Nyctanassa violacea*), pileated woodpecker (*Dryocopus pileatus*), prairie warbler (*Setophaga discolor*) and mourning dove (*Zenaida macroura*).

The southern portion of Site 116 was planted with *Spartina* in 2009. This area has since filled in with mangroves and other woody species.

Mesic Flatwoods Community – 10.1 acres, 2% coverage at DLP

The mesic flatwoods community is found in two small portions of the preserve. Mesic flatwoods occur on relatively flat, moderately to poorly drained soils. Standing water is common for brief periods during the rainy season. Mesic flatwoods are characterized by an open canopy with widely spaced pine trees and a dense ground cover of herbs and shrubs. Typical plants growing in these communities at DLP include slash pine, saw palmetto, staggerbush (*Lyonia fruticosa*) and wax myrtle. The flatwoods found on the preserve are disturbed with invasive exotic plants, including melaleuca and Brazilian pepper.

Wildlife associated with this community that would likely be encountered at the preserve include black racer (*Coluber constrictor priapus*), pine warbler (*Setophaga pinus*), hispid cotton rat (*Sigmodon hispidus*), raccoon (*Procyon lotor*), and bobcat.

Mesic Hammock - 1.2 acres, less than an acre of DLP

This community occurs in a small strip on spoil likely dredged up years ago. The community is dominated by cabbage palms and oaks. Typical animals found in this community include green anole, blue-gray gnatcatcher and cotton mouse *(Peromyscus gossypinus)*.

Restoration/Transitional – 17.1 acres, 4% of DLP

This is a historic pasture/farm field area that was cleared of exotics and is being allowed to naturally revegetate. It is too new to determine which community it will become, but replanting efforts will help diversify existing herbaceous species with woody trees and shrubs.

Road - 0.01 acres less than 1% of DLP

This is the entrance road to the barn off of A&W Bulb Road and at the corner of Willems Drive.

Salt Marsh – 25.8 acres, 6% of DLP

Characterized as having soils with high salinity and regular tidal inundation, the salt marsh is the second largest natural plant community found at DLP. Overall, the salt marsh has recovered from the historical disturbances and can be found in an early successional stage.

Consisting of low shrubs and no canopy, with the majority of the vegetation that makes up the marsh includes species of saltwater rushes and sedges. The dominant plant species found in this community at the preserve is needle rush (*Juncus roemerianus*). Wildlife found in this community includes the marsh rabbit, white ibis and raccoon.

Spoil Area – 0.1 acres, less than 1 acre of DLP

Spoil area consists of dredge materials deposited next to impoundment/artificial ponds on site. These are often vegetated in invasive exotic plants.

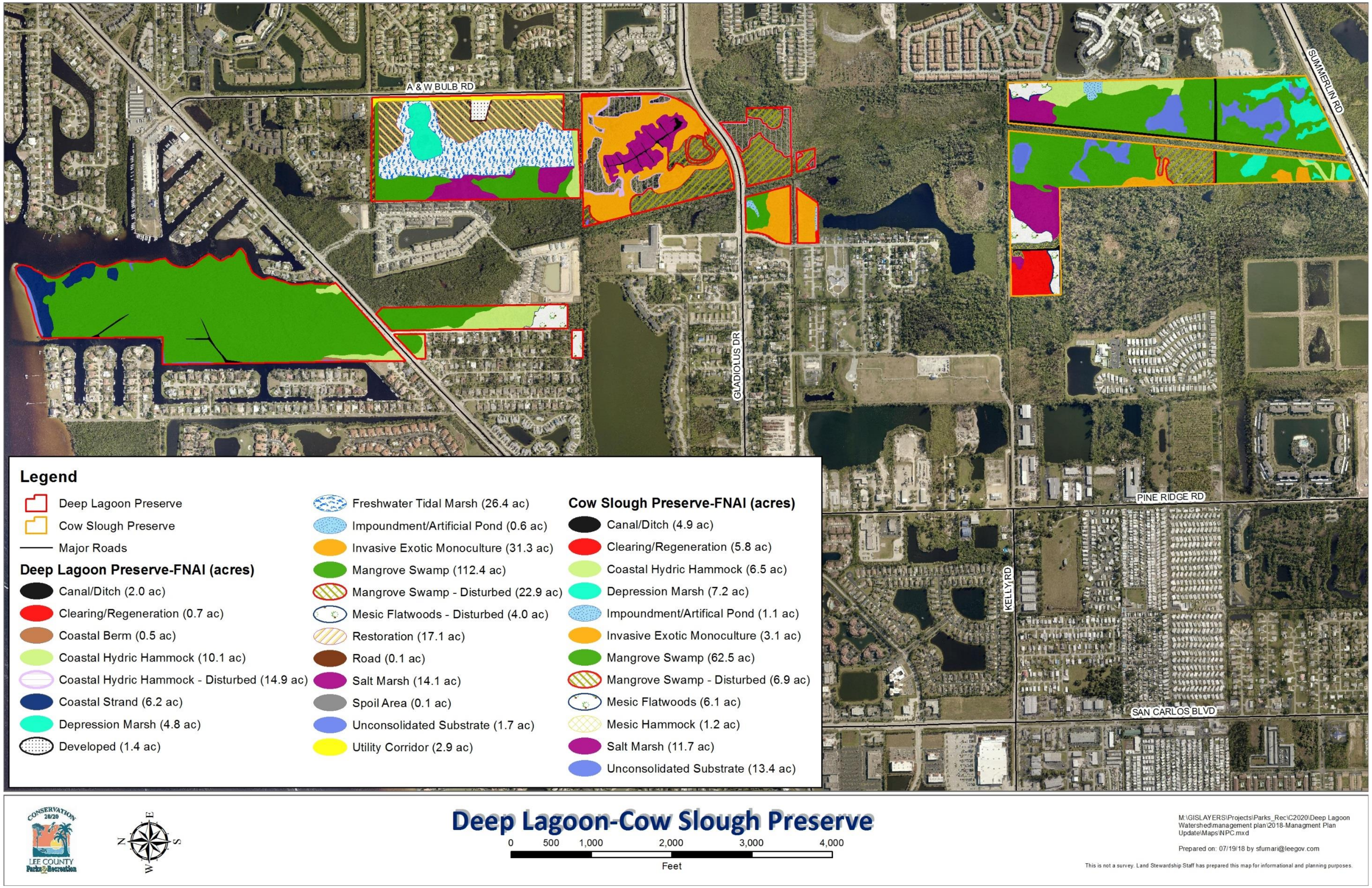
Unconsolidated substrate – 15.1 acres, 3% of DLP

This community occurs as a small strip along the Caloosahatchee River as well as the seasonal ponded areas north of Summerlin Road. It for the most part lacks vegetation because of the frequent inundation of water and high soil salinities.

Utility Corridor – 2.9 acres, less than 1% of DLP

This corridor is an easement along the northern and eastern boundary of Site 78. The easement also goes west to a utility pole that services the barn onsite.

Figure 7: Plant Communities Map



iii. Fauna

DLP provides habitat for a wide variety of wildlife. Species occurring at the preserve were recorded during tri-annual site inspections by staff and Lee County Bird Patrol volunteers. Future sightings will continue to be recorded. See Appendix D for a complete list of wildlife documented at the preserve.

The mangrove swamp community consists mainly of red, white, and black mangrove, and buttonwood. It is a vital habitat to many animals, such as turtles, frogs, snakes, lizards, raccoons, river otters, birds, and fish. Many fish take advantage of the protection that the mangroves provide for their nurseries. Wading birds, such as wood storks (*Mycteria americana*), white ibis and roseate spoonbills (*Platalea ajaja*) use large mangroves as nesting and roosting sites. Although these species have not been documented utilizing the preserve for this purpose, both yellow-crowned night heron and mourning dove nests have been documented.

There are a few small, scattered areas of the coastal grassland community. A few animals have adapted to this unstable area that often fluctuates between dry periods and inundation, but most are simply transients that visit the area. Some examples of these animals include ghost crabs (*Ocypode quadrata*), red-winged blackbirds and raccoons.

The tidal marsh community provides abundant food and cover for a variety of wildlife; however, the harsh environmental conditions reduce the overall diversity as compared to other habitats. Salt marsh invertebrates such as Atlantic grasshoppers (*Paroxya atlantica*), juice-feeding plant hoppers (*Prokelesia marginata)*, and salt marsh periwinkles (*Littorina irrorata*) are permanent residents of this community (Myers 1990, Capinera 2001). A number of birds utilize this community to forage on these invertebrates.

There are numerous freshwater communities scattered throughout DLP. Turtles have been documented in these areas, as well as using nearby high spots for nesting. Waterbirds, such as mottled duck (*Anas fulvigula*) and common gallinule, are typically found in the deeper aquatic habitats. Wet prairie communities typically have small, minnow-sized species of fish, such as mosquitofish and least killifish (*Heterandria formosa*). Amphibians utilize these habitats for breeding and laying eggs. Some waterbirds, such as green herons (*Butorides striatus*), white ibis, red-winged blackbirds and boat-tailed grackles (*Quiscalus major*), are particularly dependent on freshwater marshes (Myers 1990).

The upland portions of the preserve, mesic hammock and mesic flatwoods, are impacted with invasive exotics but still contain a diversity of wildlife. Both the green treefrog (*Hyla cinerea*) and squirrel treefrog (*Hyla squirella*) have been documented calling from these communities. A variety of smaller birds, such as flycatchers, woodpeckers and warblers, utilize these plant communities.

There are a few areas in DLP that are primarily monocultures of Australian pine, Brazilian pepper and/or melaleuca. These areas provide diminished habitat value for native wildlife and, thus, exhibit low biodiversity. Work will take place in these areas to remove exotics to improve the habitat.

iv. Designated Species

There are a variety of listed plant and wildlife species found at DLP. Although all native plant and wildlife species found at the preserve have some protection due to the preservation of this property, certain species require additional attention. For management purposes, all plants and wildlife listed by the United States Fish and Wildlife Service (USFWS), Florida Fish and Wildlife Conservation Commission (FWC), Florida Department of Agriculture and Consumer Services (FDACS), FNAI and the National Marine Fisheries Service (NMFS) will be given special consideration.

Typically, designated species will benefit from proper management of the biological communities in which they occur. However, some species may require additional measures to ensure their protection. C20/20 staff consistently evaluate if these management techniques are effective. A variety of management practices at the preserve will help to protect these species, including exotic plant control; prescribed fire and/or mechanical brush reduction; wildlife monitoring; restricting work in certain areas; the enforcement of regulations prohibiting littering, hunting and weapons, and unauthorized motorized vehicle access. Finally, in areas where extensive exotic plants are removed, the area may be replanted with native plants.

Table 3 documents listed species both known and expected to be found at DLP. These are followed by a brief summary of each species to explain why they are in decline and the specific management measures at the preserve that will be used to protect them. If additional listed species are documented on the preserve, these species will be added to the list.

Table 3: Designated Species

Scientific Name	Common Name	FDACS	FNAI	FWC	NMFS	USFWS	Occurrence
FISHES							
Pristis pectinata	smalltooth sawfish				E	E	confirmed
REPTILES							
Alligator mississippiensis	American alligator		G5/S4			T (S/A)	confirmed
BIRDS							
Egretta caerulea	little blue heron		G5/S4	T			confirmed
Egretta tricolor	tricolored heron		G5/S4	T			confirmed
Platalea ajaja	roseate spoonbill		G5/S2	T			confirmed
PLANTS							
Acrostichum aureum	golden leather fern	T					confirmed
Encyclia tampensis	Florida butterfly orchid	CE					confirmed
Tillandsia balbisiana	northern needleleaf	T					confirmed
Tillandsia fasciculata	cardinal airplant	E					confirmed
Tillandsia flexuosa	twisted airplant	T					confirmed
Tillandsia utriculata	giant airplant	E					confirmed

Key

FDACS = Florida Department of Agriculture and Consumer Services

FNAI = Florida Natural Areas Inventory

FWC = Florida Fish and Wildlife Conservation Commission

NMFS = National Marine Fisheries Service

USFWS = United States Fish & Wildlife Service

E = Endangered
T = Threatened
SSC = Species of Special Concern
CE = Commercially Exploited
G5 = Globally Secure
G4 = Globally Apparently Secure
T3 = Subspecies of Special Population Rare
T2 = Subspecies of Special Population Imperiled

T (S/A) = Threatened due to Similarity of Appearance

S4 = Florida Apparently Secure
S3 = Florida Rare
S2 = Florida Imperiled

The following are brief descriptions of the species listed in Table 3, as well as management recommendations for DLP in regards to the life history needs of each species.

Smalltooth Sawfish

A small group of smalltooth sawfish (*Pristis pectinata*) has been observed once along the coast of DLP (Smith, pers. comm.). According to the NMFS, this species is vulnerable to overexploitation due to its propensity to entangle in fishing nets, slow rate of growth (10 years to become sexually mature), and limited habitat, living in shallow waters very close to shore over muddy and sandy bottoms. The primary conservation concerns for this federally listed endangered species are bycatch in various fisheries and habitat degradation.

The state of Florida prohibits the taking or harvest of smalltooth sawfish. If a smalltooth sawfish is observed in the waters off DLP, C20/20 staff will promptly report it to FWC following the instructions outlined at: http://myfwc.com/research/saltwater/fish/sawfish/.

American Alligator

The American alligator (*Alligator mississippiensis*) has recovered significantly since the 1960s. There are now some populations large enough to support limited harvests. Pollution and destruction of wetlands are currently the main threat to this species. Protecting wetlands from ditching, filling and pollution are the management recommendations for this species (Hipes et al. 2010).

Little Blue Heron, Tricolored Heron, Roseate spoonbill

Little blue heron (*Egretta caerulea*), tricolored heron (*E. tricolor*), and roseate spoonbill populations are in decline due to loss of wetlands and the alteration of wetland hydroperiods. There are also indications that pesticides and heavy metal contamination may affect these species.

Removing invasive exotic plants, restoring the improved pasture and hydrologic restoration activities will benefit these species.

Golden Leather Fern

Golden leather fern is found in mangrove swamps, saltwater and brackish marshes and coastal hammocks. Its range is restricted to the southern coastal regions of Florida. It has been documented in several portions of DLP.

There appears to be a healthy population of this fern at the preserve. During exotic plant removal or other restoration activities, staff will survey the area before work commences to look for and mark, if necessary, areas to avoid.

Florida Butterfly Orchid

Although locally abundant (Brown 2002), the Florida butterfly orchid (*Encyclia tampensis*) is designated as “Commercially Exploited” by the FDACS. A plant that has this designation is considered to be threatened by commercial exploitation. Butterfly orchids are not allowed to be collected, injured or destroyed on public lands and strict limits for collection are permitted on private lands (with permission from the land owner).

Florida butterfly orchids are scattered in a few areas of DLP. If any public access hiking trails are created in the future, consideration will be made to avoid areas where these plants are growing. If the plants will be damaged during restoration activities, a permit will be obtained from FDA to remove them before work commences. Plants growing on invasive exotic vegetation destined to be destroyed will be relocated onsite, if economically feasible.

Tillandsia Species

The northern needleleaf (*Tillandsia balbisiana*), cardinal airplant (*T. fasciculata var. densispica*), twisted airplant (*T. flexuosa*) and giant airplant (*T. utriculata*) are all found in scattered populations throughout the preserve. Threats to this species include illegal collecting, the exotic Mexican bromeliad weevil (*Metamasius callizana*) and habitat destruction. All four species were considered to be fairly common before the introduction of the weevil (Save 2004).

During exotic plant removal, staff will survey the area before work commences to look for and mark, if necessary, areas to avoid. Plants growing on invasive exotic vegetation destined to be destroyed will be relocated on the site if economically feasible. Currently, scientists are researching biological control agents for the exotic Mexican bromeliad weevil. Staff will monitor these research developments and coordinate with scientists in the future if it is determined that these insects are affecting epiphytes at DLP and the USDA is in need of release sites.

v. Biological Diversity

General information on biological diversity and measures used to promote biological diversity can be found in the LSOM Land Management Plan Development and Supplemental Information section. The integrity and diversity of DLP must be protected whenever possible. Land management staff will perform the following actions in this regard:

- Control of invasive exotic vegetation followed by regular maintenance to provide more suitable habitat for native aquatic and terrestrial species.
- Maintain boundaries with signs to eliminate illegal access to the preserve and protect fragile ecosystems.
- Prevent and prosecute poaching and illegal removal activities (e.g. palmetto berry harvesting, illegal hunting, and orchid collection).
- Remove any trash debris and prevent future dumping within the boundary line.

- Conduct ongoing species surveys to catalog and monitor plant and wildlife diversity.
- Reduce canopy cover in appropriate habitats to promote herbaceous plant diversity.
- Use adaptive management if monitoring of current techniques indicates a change may be necessary.

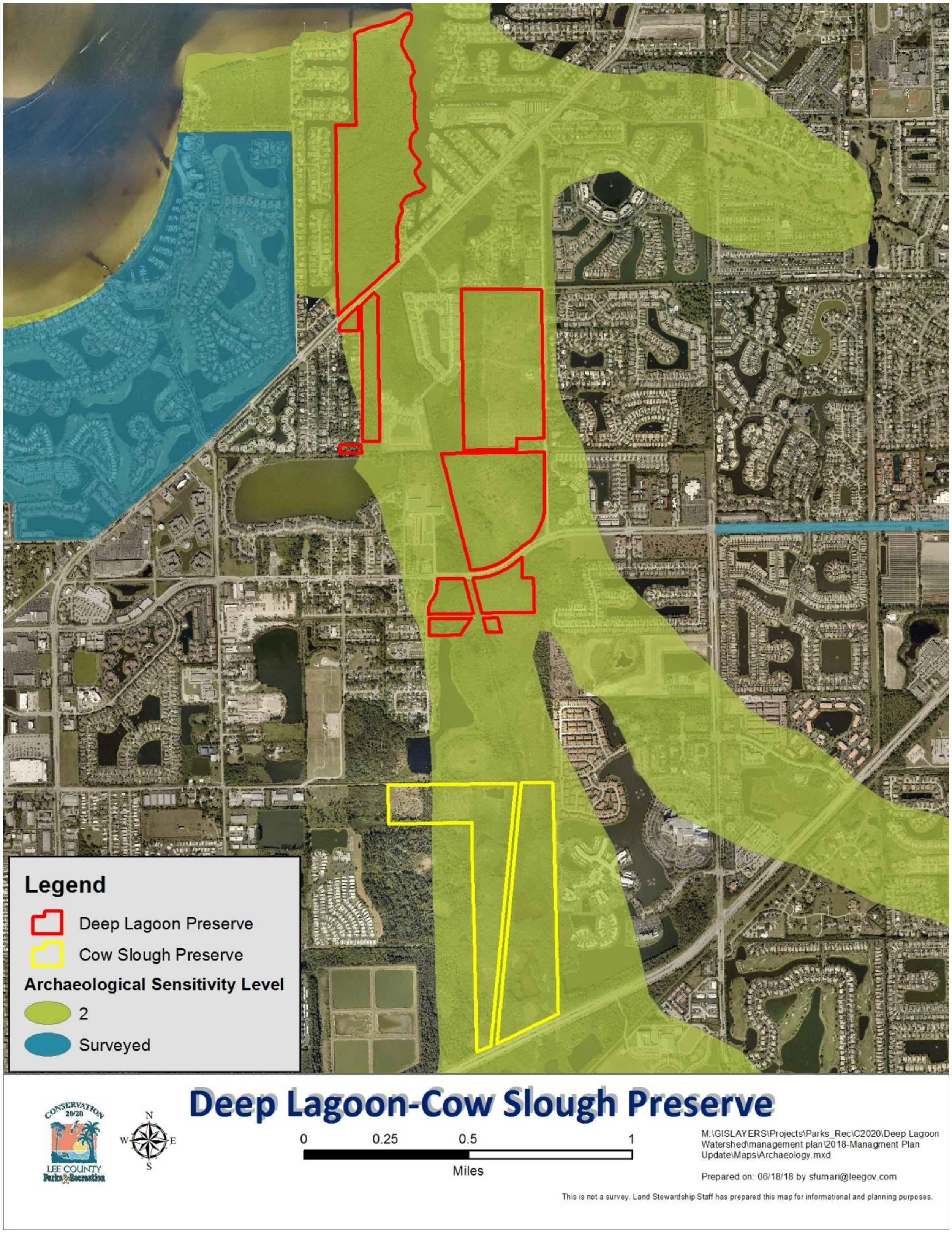
C. Cultural Resources

i. Archaeological Features

In 1987, Piper Archaeological Research, Inc. conducted an archaeological site inventory of Lee County. This inventory identified 53 new sites, increasing the total number of known archaeological sites in Lee County to 204. A site predictive model and archaeological sensitivity map was created for the county to highlight potential areas likely to contain additional archaeological sites. The majority of DLP lies within the study's "Sensitivity Level 2" area (Figure 8). The study defines this level as "areas that contain known archaeological sites that have not been assessed for significance and/or conform to the site predictive model in such a way that there is a high likelihood that unrecorded sites of potential significance are present. If these areas are to be impacted, then they should be subjected to a cultural resource assessment survey by a qualified professional archaeologist in order to 1) determine the presence of any archaeological sites in the impact area and/or 2) assess the significance of these sites" (Austin 1987).

If there will be any major soil disturbance during restoration of the preserve, a professional archaeologist will be hired to conduct a survey of the area to be impacted. If evidence of shell middens or other artifacts are discovered, the Florida Department of State Division of Historical Resources (DHR) will immediately be contacted and protection procedures will comply with the provision of Chapter 267, Florida Statutes, Sections 267.061 2(a) and (b). Collection of artifacts and/or any disturbance to the archaeological site will be prohibited, unless prior authorization has been obtained from DHR. Additionally, the site will be managed in coordination with recommendations from DHR and, if necessary, the site will be kept confidential with periodic monitoring for impacts. If any significant archaeological resources are found and confidentiality is not determined to be necessary, these will be incorporated into the public education program.

Figure 8: Archaeological Features Map



ii. Land Use History

People have impacted DLP since the 1920s, when the entire watershed was channelized to drain the land for farming and low-density residential development. Historical aerials, Figures 9 through 11, show some of the changes that occurred between 1944 and 1958.

The northern portion of DLP, which today is a peninsula, was part of the mainland until sometime between 1966 and 1972 when a canal was dug, separating most of that portion of the preserve from adjacent residential development. Between 1972 and 1977, the canal was extended to the Caloosahatchee River and a deeper channel was dug, creating the peninsula. Other changes included the extensive ditching for mosquito control as well as the clearing of the northeast corner of the preserve between 1953 and 1958. This area re-vegetated with Australian pines and Brazilian peppers between 1958 and 1966. A final development impact on this portion of the preserve occurred between 1996 and 1999, associated with the widening of McGregor Boulevard. A spoil pile was deposited on the preserve, adjacent to the road, where it remains today. A natural impact to the peninsula occurred as a result of Hurricane Charley in August 2004. Numerous Australian pines were blown down during the storm, especially in the peninsula. These pines were subsequently removed and the area was treated for exotics.

Immediately to the south of this section of the preserve is a narrow strip that previously consisted of tidal swamp and flatwoods that were very open with widely scattered pine trees. Between 1953 and 1958, Willems Road was constructed on the west boundary of the preserve and, between 1966 and 1972, a road and ditch were constructed on a portion of the eastern boundary, which was not maintained. Between the boundary roads, no development took place; however, after 1972, there was an increase in the amount of canopy trees, including both native slash pine and invasive exotics.

Mosquito ditching continue south to Gladiolus Boulevard between 1968 (Figure 12) and 1975 (Figure 13) and the areas east of A&W Bulb Road were converted almost entirely to agriculture. North of McGregor Boulevard nearly all the mangroves around the preserve had been cleared and development started and/or completed. In the south Cow Slough in the northwest corner the landfill was started.

The central improved pasture portion (now consisting of restored marshes and transitional restored habitat), was farmed by A & W Glads, Inc. from the mid-1930s to the mid-1980s. The existing warehouse on this portion of the preserve was originally built for the sorting and packing of gladiolus flowers. The existing warehouse was one of several buildings on this portion of the property used for gladiolus bulb storage, most of which were demolished between 1984 and 1990. Farm residences were built between 1958 and 1966 on the north end of the fields that were removed during the same time as the bulb storage buildings. Between 1944 and 1953, an airstrip was cleared which was used for insecticide and fungicide application on gladiolus fields in the area. The last chemical mixing and loading on the property would have happened in the late

1980s and there is minimal risk of these chemicals remaining in the environment because of the low half-lives of the chemicals used (Water 1999).

In 1990, Southern Yacht Sales owned the property comprising the central portion of the preserve fronting A&W Bulb Road. During the two years that they owned the property, a 1,000-gallon gasoline underground storage tank was removed, along with 12 tons of contaminated soil. By 1993, the Florida Department of Environmental Protection (FDEP) issued a “No Further Action” letter stating the site had been adequately cleaned up. A final point of interest upon reviewing the historical aerials of this portion of the preserve is the obvious increase in Brazilian pepper, Australian pine and melaleuca from 1966 until county ownership.

Directly to the south of the area described above is a portion of the property that has had comparatively few impacts. In addition to the ditches on the west and north boundaries that were dug in the 1920s, the only development was an irregularly shaped mosquito ditch dug between 1966 and 1972. The aerials from 1972 to the present show an increase in Brazilian pepper from the ditches outward, as well as an increase in melaleuca and Australian pines.

The Cow Slough property (furthest south) had very few changes after the IDD canals were dug in the 1920s beyond an increase in invasive exotic plants. The arm of this property was acquired by Lee County in 1972 for use as a landfill. This area had previously been used as a landfill prior to the County purchasing the property. However, the site was not permitted for further use as a landfill and was instead transferred to LCPR. The site was capped with dirt and its surface is now in the process of being restored to a semi-natural system. There are no plans to excavate the landfill. LCPR staff will work with staff from FDEP should any issues arise in the future related to the landfill. Figures 15-18 show the progression of the HealthPark development to the east of Cow Slough.

Figure 9: 1944 Aerial Map

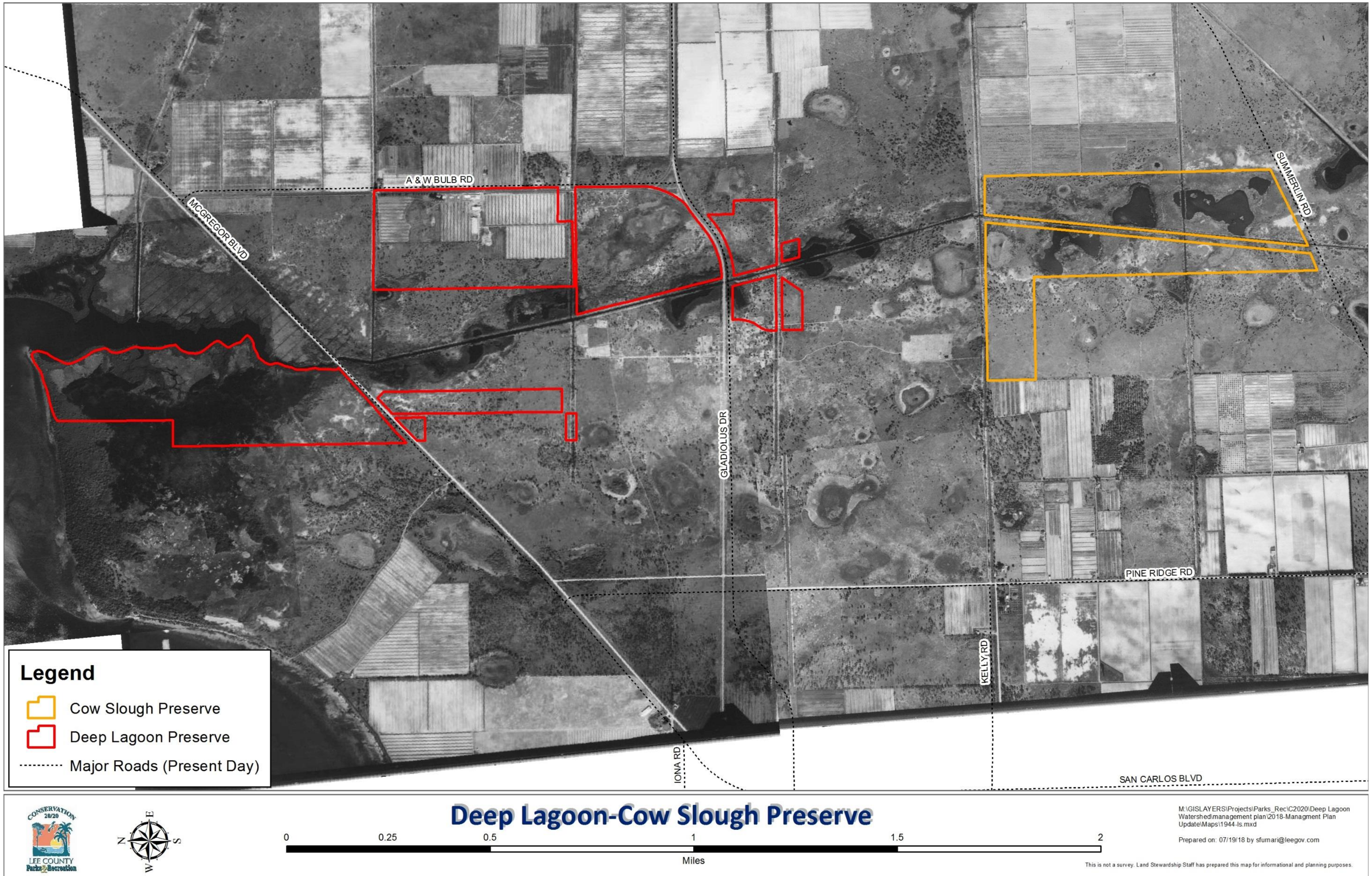


Figure 10: 1953 Aerial Map

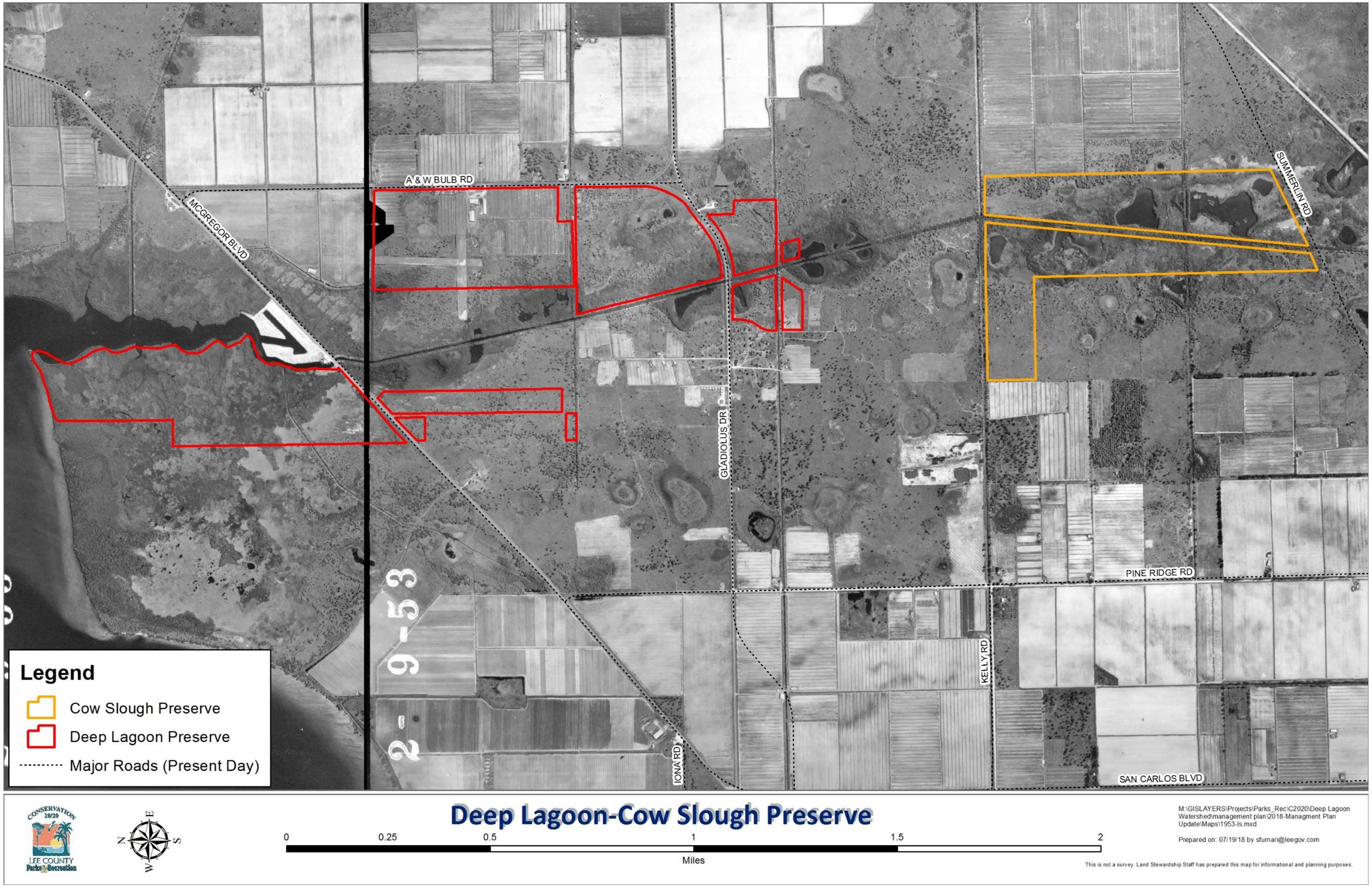


Figure 11: 1958 Aerial Map

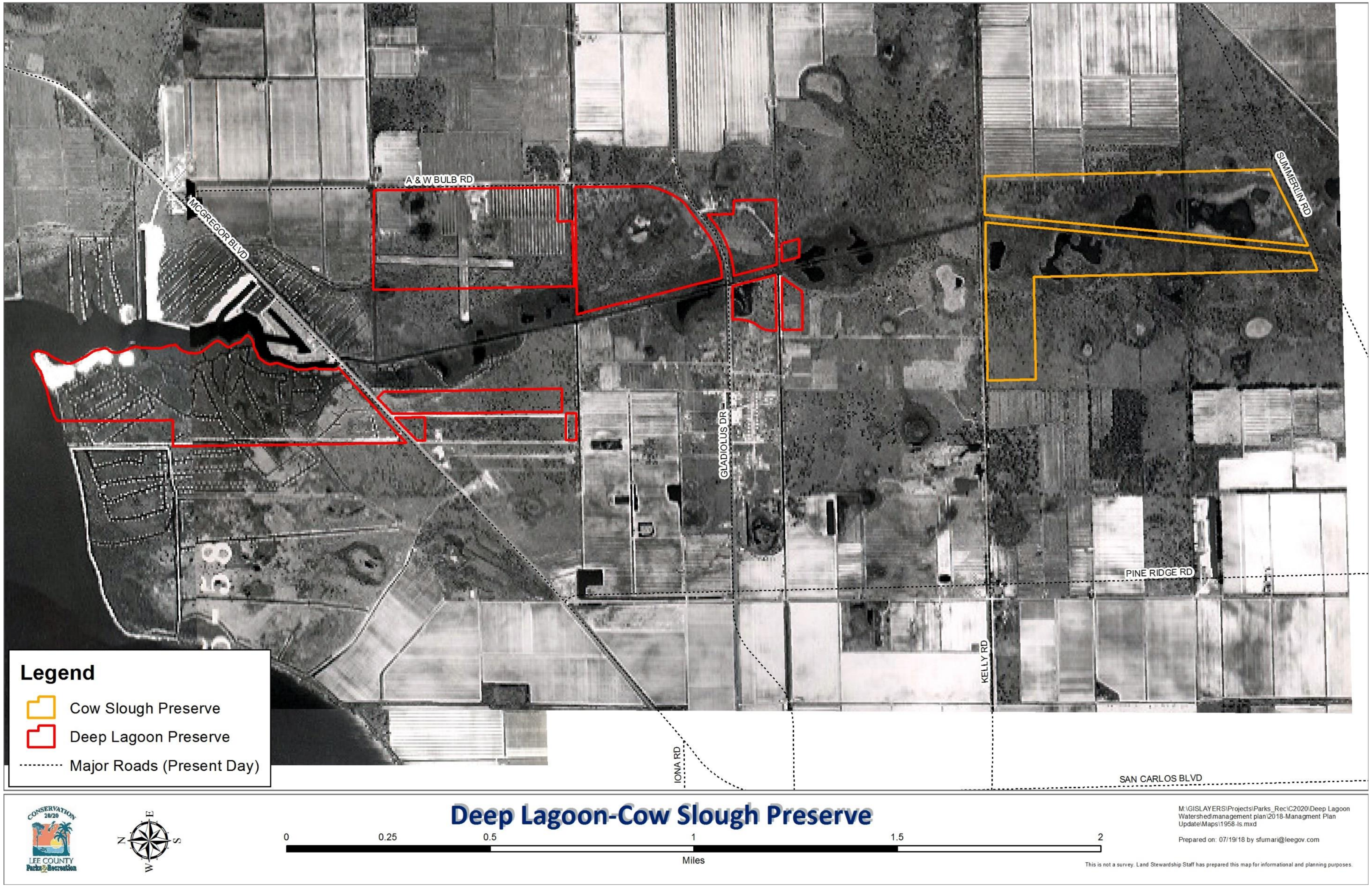


Figure 12: 1968 Aerial Map

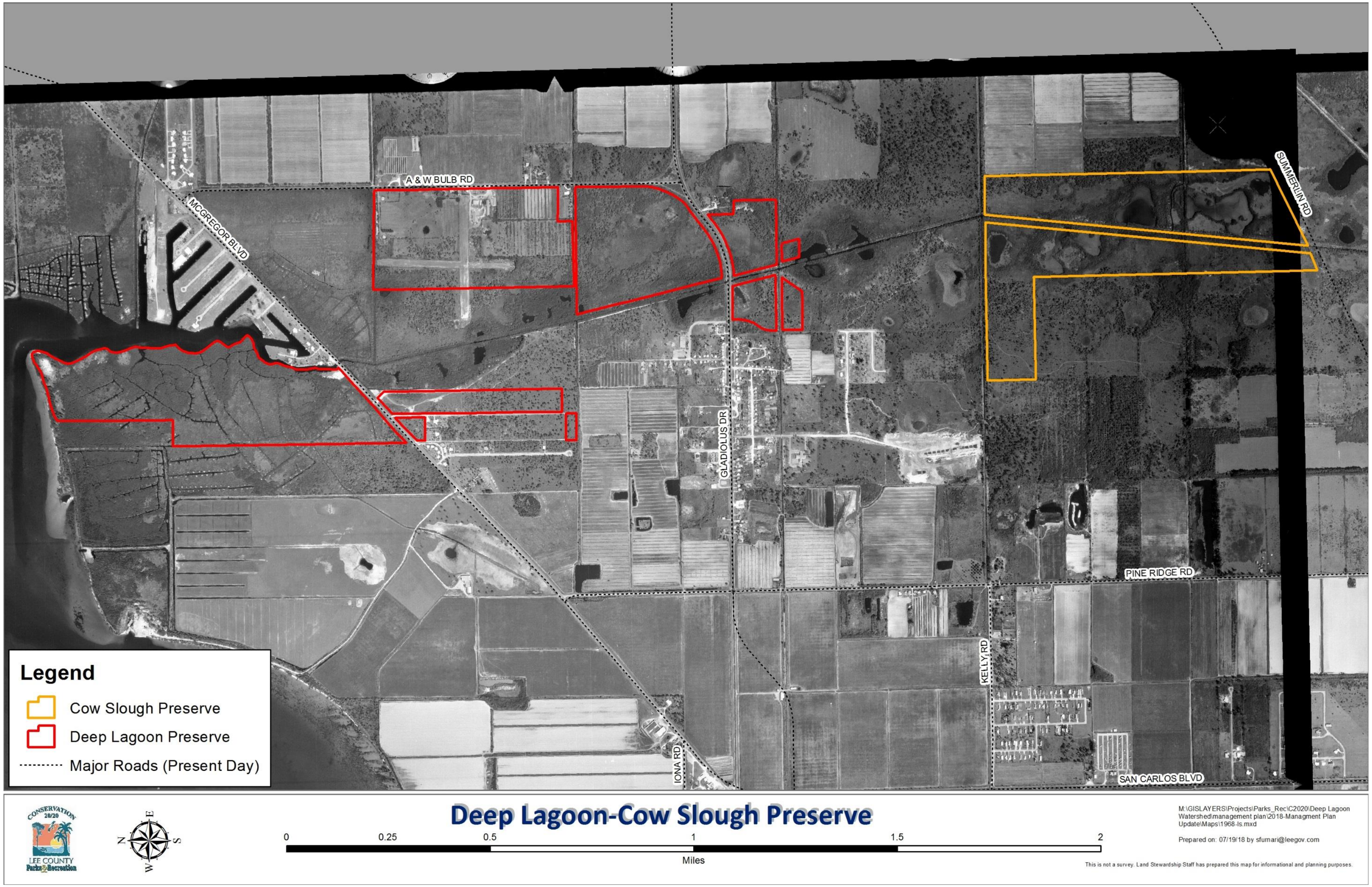


Figure 13: 1975 Aerial Map

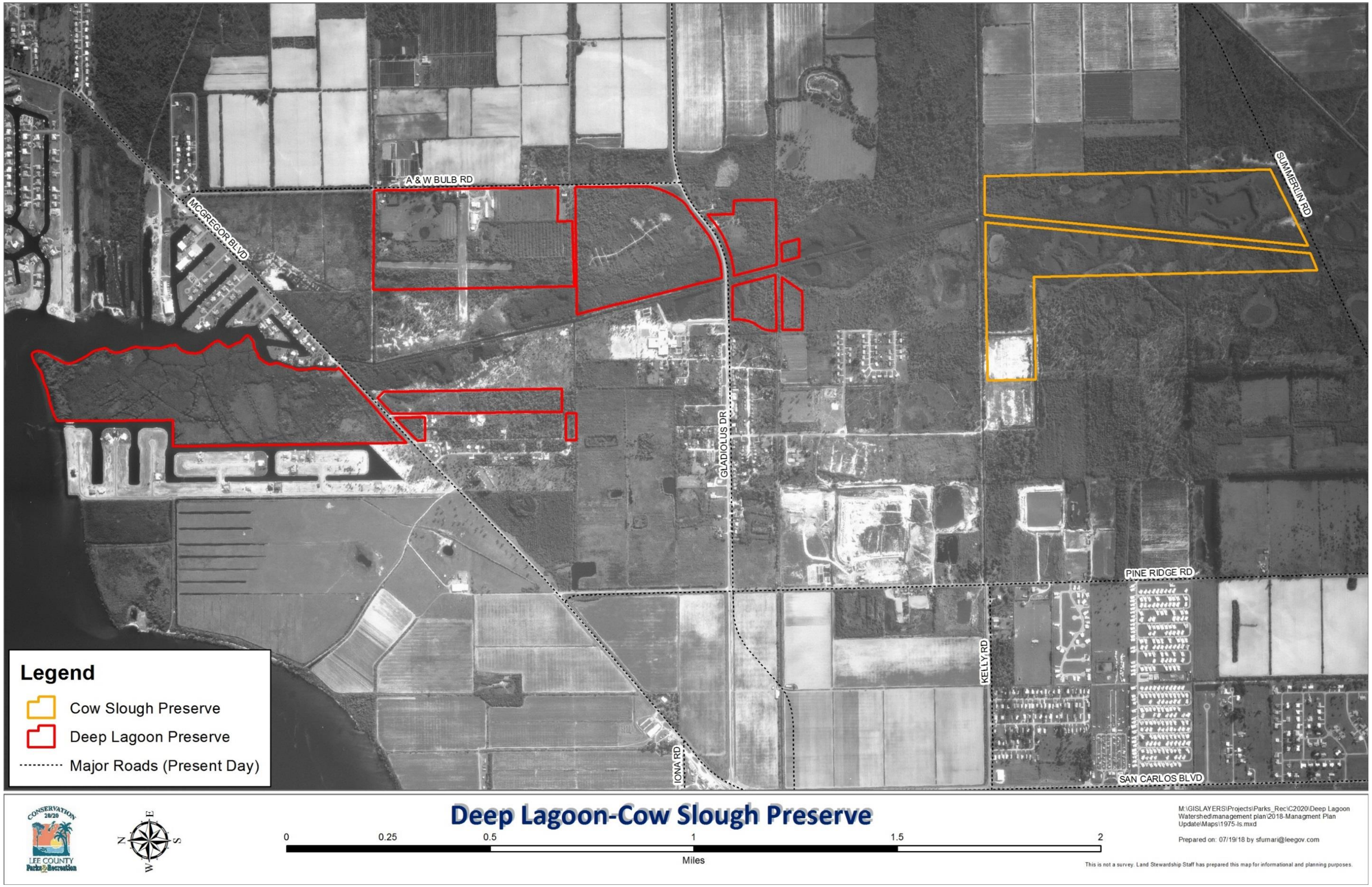


Figure 14: 1986 Aerial Map

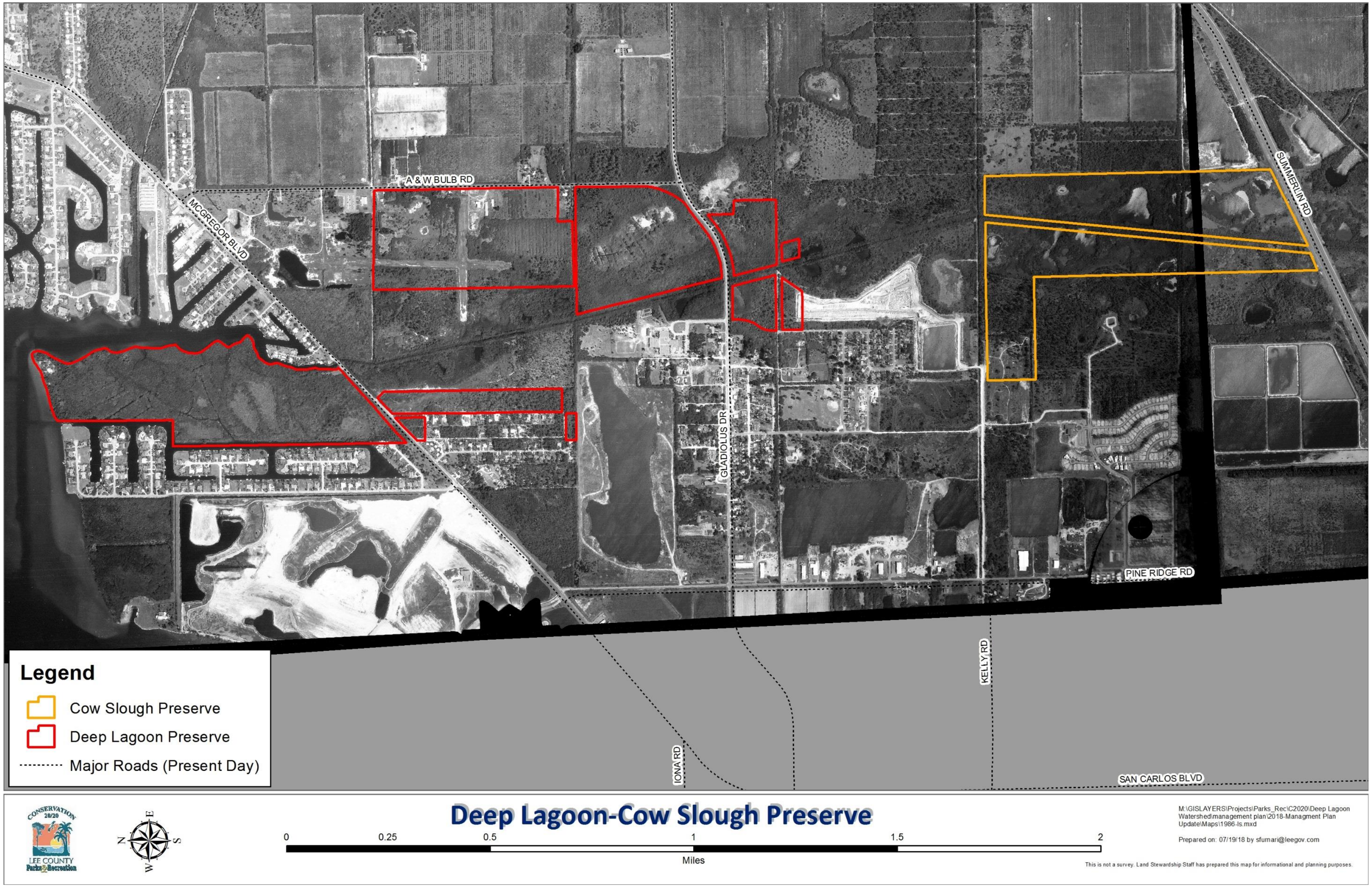


Figure 15: 1998 Aerial Map

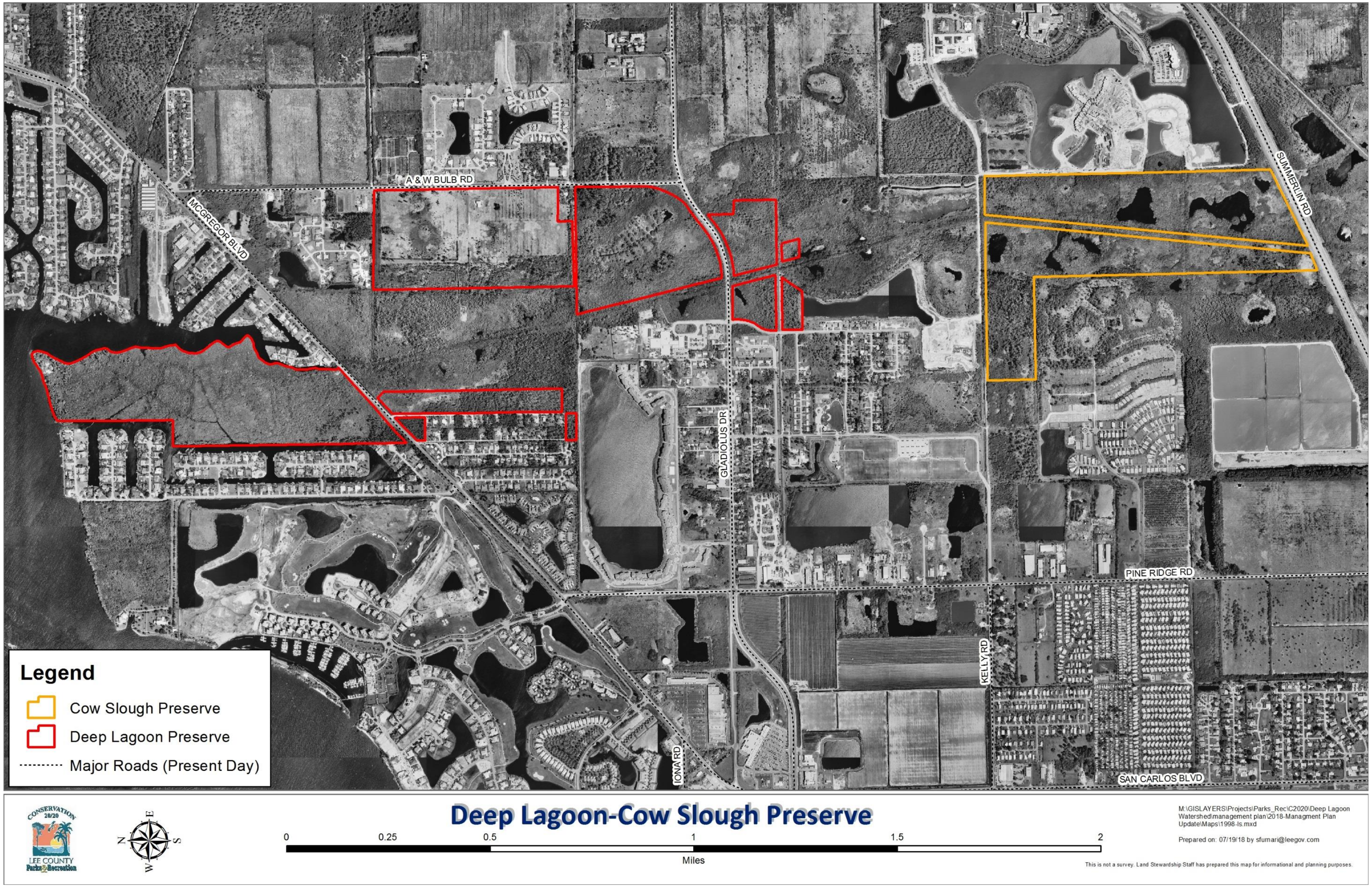


Figure 16: 2002 Aerial Map

Figure 17: 2006 Aerial Map

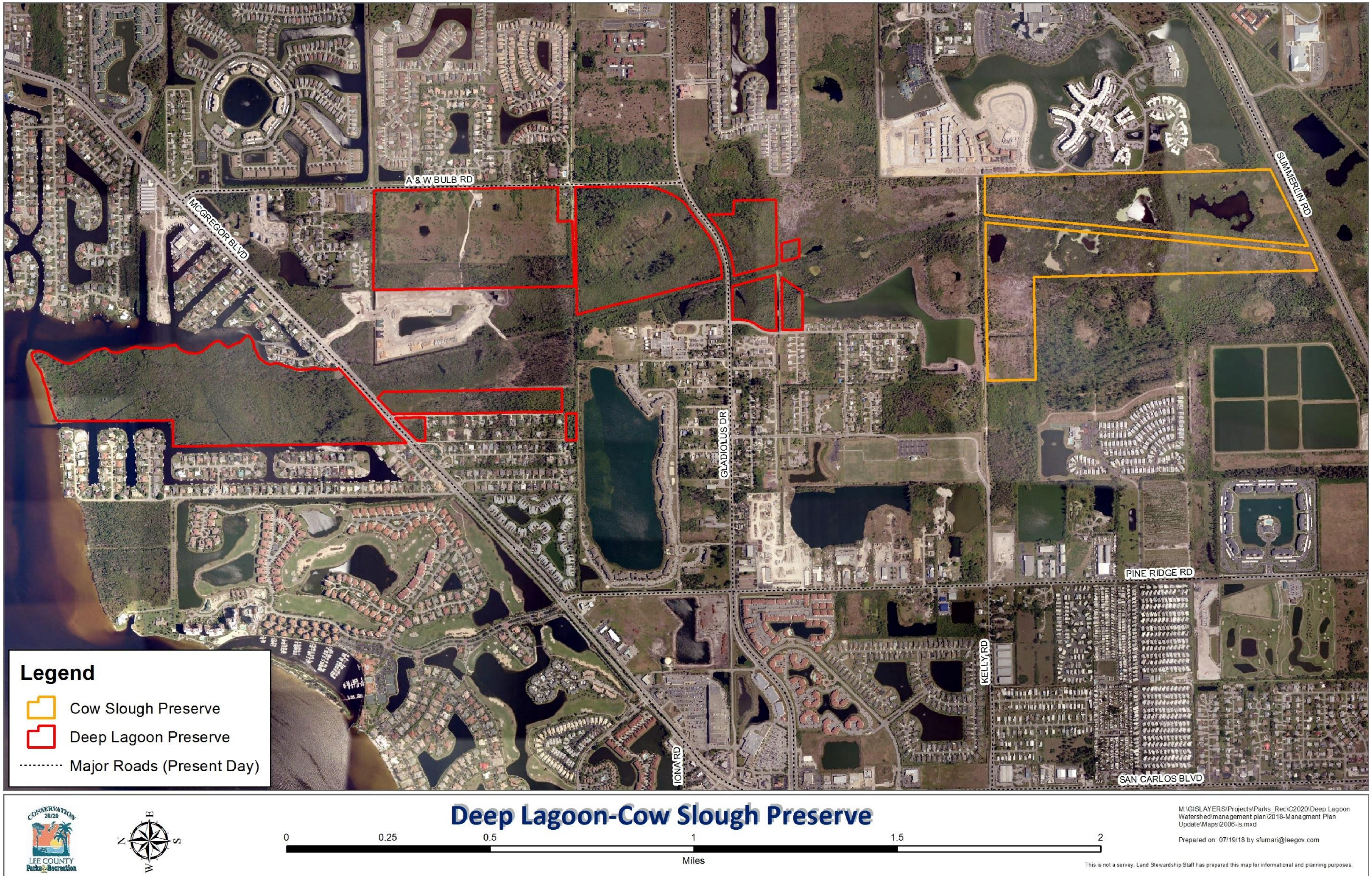


Figure 18: 2012 Aerial Map

iii. Public Interest

Since acquiring DLP, there has been occasional contact from the public regarding the preserve. The two most common inquiries have been related to the bald eagle nest, which was previously located on the central portion of the preserve, and concerns with the boundary adjacent to Willems Road. Staff also receive numerous calls from private contractors interested in renting or purchasing the storage building located in the central portion of the preserve and fronting on A&W Bulb Road. These individuals are advised that the storage building is for management of its conservation land and therefore is not available for rent or sale.

LCPR has a very active group of volunteers called the Lee County Bird Patrol, which monitors parks and preserves to record bird observations to a national online database known as eBird (www.ebird.org) that is used by land management staff.

Neighbors living adjacent to DLP along Willems Road, a privately-maintained road, have called on occasion to request trimming of vegetation on the west boundary of the preserve, as well as to report management concerns, especially dumping. In response to neighbors' requests, staff cleared the invasive exotic plants from the boundary adjacent to Willems Road in September 2003 and in subsequent years as needed. Additionally, a newsletter was mailed to all residents of Willems Road that addressed topics including:

- Horticultural and other dumping
- Complaints about flooding and digging out the ditch (the ditch is not county-owned)
- Motor vehicle use
- Melaleuca psyllids – biological control agent

Although problems with dumping continue on occasion, staff will continue to work with neighbors to prevent dumping and protect the preserve.

V. FACTORS INFLUENCING MANAGEMENT

A. Natural Trends and Disturbances

Natural trends influencing land management at DLP include hurricanes, flooding, the pattern of wet and dry seasons, wildfire, and eagle nesting season. Construction of potential facilities will need to take into consideration the possibility of tropical storms and flooding. A significant storm could damage the vegetation and it may be necessary to bring in heavy equipment to remove vegetation after a storm. An additional impact from hurricanes is the increased fuel loads from downed trees. The pattern of wet and dry seasons will be most influential on exotic plant removal projects due to access and to ensure that herbicide is not washed off during a typical summer thunderstorm. Also, herbicide usage plans will need to take into consideration flooding and submerged vegetation. Heavy equipment will only be able to access most areas of the preserve during the dry season.

Wildfires caused by lightning are a natural occurrence in Florida. The northern portion of the preserve creates a challenge due to the dense palmetto growth and proximity of residential communities. This area is not very conducive to using prescribed fires as a management tool. As an alternative, a mechanical fuel reduction program will be established. The timing of mechanical or hand brush removal will also be influenced by seasonal rain patterns and any wildlife nesting in the area.

Currently, no bald eagles nest in the preserve, however there are several territories nearby which could impact management activities. Eagles could establish a nest in areas that are not easily visible until the exotic vegetation is removed.

B. Internal Influences

There are a variety of human influences that impact DLP from within. Ditches have been dug for mosquito control and drainage. The central area has been farmed since the 1920s and there is a warehouse on the preserve located in a disturbed field near A&W Bulb Road. Trash accumulates on the northern peninsula, washing in from the Caloosahatchee River. The following section will help to explain these issues further and specify management measures to reduce or eliminate these problems.

As already discussed in the Hydrology and Land Use History sections, numerous ditches have been dug throughout the preserve. The mosquito ditches in the mangrove swamps of the north portion of the preserve (Site 116) have associated spoil mounds where Brazilian pepper and a few Australian pines grew. These were treated in place. Brazilian pepper was mechanically removed from the spoil piles associated with the mosquito ditch on the central portion of DLP. The ditches created for drainage in the historic pasture area on Site 78 have been restored. The ditches were filled and the area has transitioned to a marsh habitat.

Staff has pursued restoration of sub-ditches of the Iona Drainage District ditches C-1 and C-3. The JEI report recommends as part of restoration to this watershed “eliminating (where possible) historic IDD canals and eliminating the spoil associated with past ditching activities.” This complex project will require intensive studies of the potential effects on the resources of adjacent properties, which are low in elevation and vulnerable to flooding.

The IDD canals are managed by LDOT and will likely remain for drainage. The general area is known to flood and the canals will likely be needed to convey high water away from built up areas. Other, dead-end canals and ditches may be filled or altered to provide more natural topography and wetland benefits. C20/20 staff will continue to look at hydrological restoration opportunities on the preserve to rehydrate drained wetlands, enhance water quality and reduce localized flooding. Projects that are considered will ultimately enhance natural communities onsite.

The improved pasture located between the aforementioned canals has been cleared since the 1920s (see Land Use History section). It also contained a grass airstrip formerly used for treating crops in the area. This area is very wet during the spring and summer and the scattered native plants are more associated with wetland plant communities. However, the soils indicate that the area was once a pine flatwoods community. This could be a result of the tremendous change in hydrology to the preserve over the last 80 years. Restoration of the western portion of the field into marsh habitat was conducted from 2009-2010 (SFWMD Permit 36-07271-P/ACOE permit SAJ-2009-03597). The Management Action Plan may be referenced for specific details.

The warehouse and surrounding cleared field will be left alone. The warehouse is used to store equipment used by the Conservation Lands maintenance group. There are no similar buildings located at any of the C20/20 preserves. This building allows for easier access to equipment on the western side of the County. This small 48,000-square foot fenced in area was used in 2017 and early 2018 to collect and process vegetative debris from Hurricane Irma. This impact has been largely restored.

In 2003, Lee County Lands staff retained Water Resource Solutions to conduct a Phase I and Phase II Environmental Assessment on the 20-acre parcel on Kelly Road (the western arm of Cow Slough), which had been used as a landfill between 1973 and 1974. Twelve test pits were dug to identify the type of trash. No hazardous substance containers were observed; only residual debris (Water Resource Solutions, Inc. 2003).

Cow Slough was transferred to LCPR for management when the Utilities and Solid Waste projects did not happen. Conservation Lands staff has diligently treated the exotic invasive plants and removed household trash that is uncovered. Conservation Lands staff does not intend to excavate the household garbage.

A final internal influence is trash. Trash has accumulated on the peninsula of DLP, most of which likely washed up during storms and tidal events. Staff will conduct an annual clean-up of this area, hopefully coordinating with the Annual Coastal Cleanup event organized by Keep Lee County Beautiful. In addition, the portion of Cow Slough that was a reported landfill has debris and there has been tires and other debris uncovered during major exotic removal projects in the southern parcels of the preserve. No efforts to excavate this area are planned since the Phase I and II Environmental Assessment performed by Water Resource Solutions (2003) did not observe on or off site indicators of hazardous substance or petroleum products.

C. External Influences

The general area is known to flood and the IDD canals that bisect portions of the preserve will likely need to remain to convey high water. C20/20 staff will continue to look at hydrological restoration opportunities on the preserve to rehydrate drained wetlands, enhance water quality and reduce localized flooding. Projects that are considered will enhance the natural communities onsite and not destroy intact vegetation communities.

Several of the restoration projects (mentioned in the first edition of the DLP LMP) by Johnson Engineering are still viable (e.g. backfilling portions of canals and adding weirs) to reduce saltwater intrusion into freshwater wetlands and to reduce nutrient movement, as well as restoring groundwater elevations.

Homes along Willems Road were built before it was common practice for large fill pads. As a result, these homes are susceptible to flooding as the floodplain continues to be developed and as sea levels rise. Willems Road is a private road, as is the ditch on the eastern side of the road. C20/20 staff has removed vegetation from the ditch on an occasional basis, although the ditch is not on the County's property. This practice should not continue, since it is not land owned or maintained by Lee County.

The preserve and much of the surrounding area in the Caloosahatchee River Estuary Basin Management Action Plan have high nitrogen levels which must be reduced over time. LCNR staff hired an engineering firm in 2017 to look at the nitrogen levels within the Deep Lagoon Watershed. The high nitrogen levels in the watershed and preserve likely come from land use, percolation ponds, septic tanks and canal sediments. Several remedies to reduce nitrogen levels were presented. LCNR is currently considering a project to reduce nitrogen on a portion of the preserve. LCNR staff will continue to work on nitrogen reduction plans within the Deep Lagoon Watershed (Appendices A and B).

Another significant external influence to DLP is horticultural and trash dumping from adjacent neighbors. There have been occasional problems with dumping on the preserve adjacent to Willems Road and off Hagie Drive. A fence installed on Hagie Drive in 2012 has helped with this issue. Staff has posted boundary signs and sent all the residents in the area a newsletter about the preserve, mentioning the impact of dumping horticultural debris. The Lucaya residential community has been constructed between the Willems Road portion of the preserve and the central portion. During routine site inspections staff will monitor all areas of the preserve adjacent to residential areas for possible dumping or encroachment concerns and a combination of signs and public education will be used if necessary to alleviate any future problems.

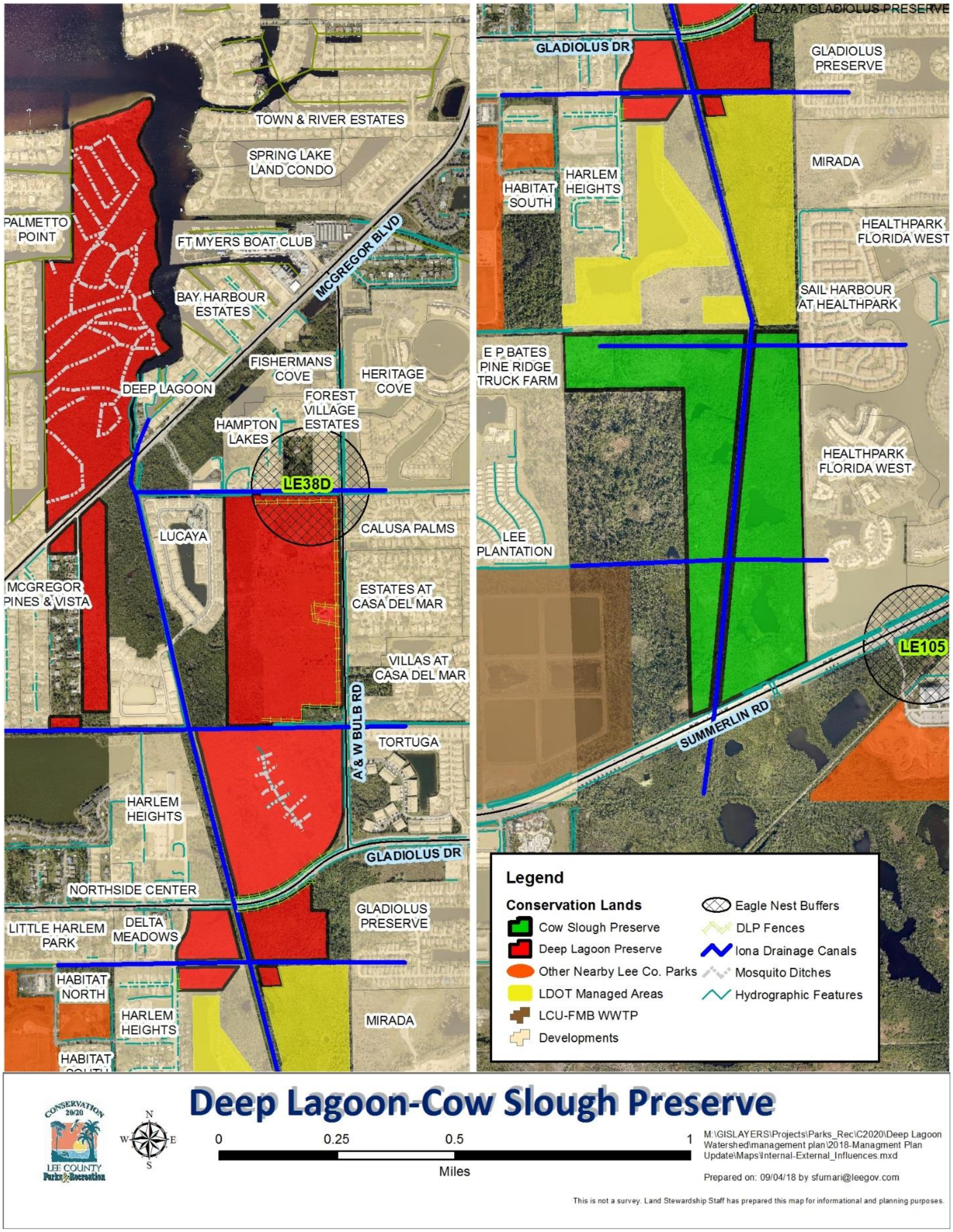
There are multiple roadways (McGregor Boulevard, A&W Bulb Road, Summerlin Road, Gladiolus Drive) that separate parcels of the preserve, reducing available wildlife corridors. These roadways, similar to the canals, have disrupted some of the natural water flows to the preserve and may convey pollutants from the road to the preserve.

The surrounding development and roadways impact the ability to utilize prescribe fire to improve and maintain such native habitats as mesic flatwoods. The surrounding residential developments are also a seed source for exotic plants and may convey pollutants from septic tanks, lawn care and household chemicals.

Additionally, active bald eagle nests currently exist on property adjacent to the preserve. Eagle nests have also occurred at DLP in the past and may still occur in the future. For any active nests within DLP and on adjacent property near the preserve boundary, protection zones will be provided and the timing of projects that may disturb the nests will be delayed.

Figure 19 summarizes the internal and external influences for the preserve.

Figure 19: Internal and External Influences Map



D. Legal Obligations and Constraints

i. Permitting

Land management activities at DLP may involve obtaining permits from appropriate agencies. Prescribed fires will require permits from the Florida Forest Service (FFS). Exotic plant removal other land alterations will require permits to be obtained from various agencies, including the Florida Department of Environmental Protection (FDEP), South Florida Water Management District (SFWMD), and U.S. Army Corps of Engineers (USACOE). A consultant will be hired to assist with the permitting process, particularly with construction of any hydrological improvements. The construction of facilities in either upland or wetland portions of the preserve will require additional permitting, although none are proposed in this plan.

The Deep Lagoon Preserve Environmental and Hydrologic Assessment, conducted by JEI, researched what permits might be required for hydrologic restoration activities on the preserve. A meeting was conducted with representatives from LCPR, JEI and SFWMD on March 8, 2001 (JEI 2002). Possible restoration activities include filling of some of the IDD canals with the adjacent spoil, as well as the removal of invasive exotic plants. SFWMD staff expressed concern for exacerbating flooding issues for adjacent neighborhoods but believed some activities might qualify for a de minimis exemption. It was decided that in order to determine permit requirements, a letter with an explanation and methodology for any restoration work be submitted to the SFWMD. Upon review of the letter, the SFWMD will be better able to determine the types of permits that might be required.

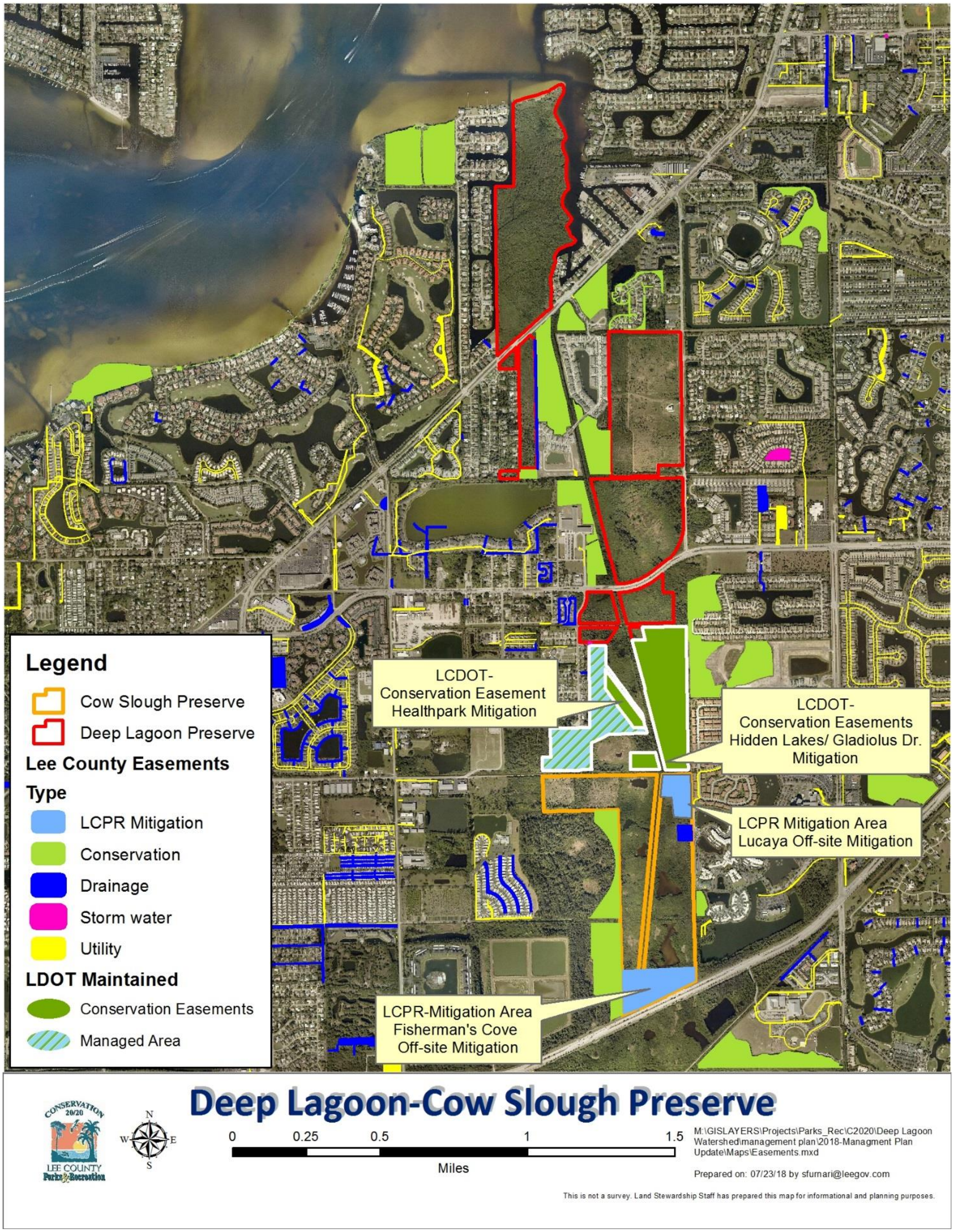
Past ditching and road development impacted the wetlands on the Cow Slough portion of the preserve (MUs 7-10). To correct these impacts, permitting will be needed. A portion of the preserve (north east corner of MU-9 and all of MU-10) are off-site mitigation parcels under permits for two nearby developments (Fisherman's Cove and Lucaya).The maintenance of these mitigation lands is required by the permit but is something county staff otherwise perform. Any hydrological work in these MUs may be conducted as a modification of these existing permits.

ii. Other Legal Constraints

Land management activities at DLP will continue to involve obtaining permits from appropriate agencies. Exotic plant removal in the wetland portions of the preserve has required permits to be obtained from various agencies, including the FDEP, SFWMD, and USACOE, which has caused restoration delays in Management Unit 4. If necessary, a consultant will be hired to assist with the permitting process, particularly with construction of hydrological improvements.

The preserve is surrounded by various easements (Figure 20). Within the preserve there is a drainage easement and two off-site mitigation areas, one for the Fisherman's Cove Community and one for Lucaya Community. The offsite mitigation areas are now the maintenance responsibility of the county, since the county accepted the mitigation and compliance was met. The Fisherman's Cove 13.6-acre mitigation area is mangrove lands along Summerlin Road and the 10-acre Lucaya mitigation area is mesic flatwoods and salt marsh. Both areas are incorporated into the management of the preserve. Both mitigation parcels received some funds for long-term management, but the funds have been spent.

Figure 20: Easements Map



iii. Relationship to Other Plans

The Lee Plan, Lee County's comprehensive plan, is designed to depict Lee County as it will appear in the year 2020. Several themes have been identified as having "great importance as Lee County approaches the planning horizon" (Lee County 2018).

- The growth patterns of the County will continue to be dictated by the Future Land Use map.
- The continued protection of the County's natural resource base.
- The diversification of the County's traditional economic base.
- The expansion of cultural, educational and recreational opportunities.
- A significant expansion in the County's physical and social infrastructure.

The Lee Plan's land use accommodation is based on an aggregation of allocations for 22 Planning Communities. These communities have been designed to capture the unique character of each of these areas of the County. While Sites 77 & 78 (northeastern areas) fall within the South Fort Myers Planning Community, the remaining portions of the preserve lie within the Iona/McGregor Planning Community.

The entire Lee Plan can be accessed online at:
http://www.leegov.com/dcd/Documents/Planning/LeePlan/Leeplan.pdf

The three chapters that affect the management of DLP are Chapter IV – Community Facilities and Services; Chapter V – Parks, Recreation and Open Space; and Chapter VII – Conservation and Coastal Management.

E. Management Constraints

The main management constraints for DLP are encroaching development, the brief dry season, wetland soils and plant communities, access across drainage ditches, roads, and the presence of an inactive eagle nest adjacent to the preserve. Coordination with other agencies and adjacent landowners will be an important part of managing the preserve.

All hydrologic restoration will be limited to areas where the resulting return to natural water flow will not affect residential communities surrounding the preserve.

DLP is very wet during most of the year. Most restoration efforts will be limited to the dry months, typically between December and May. If vehicular access is necessary for management when water levels are high, lower-impact vehicles such as ATVs will be used.

Prescribed fire for management of the flatwoods and marsh habitat is limited due to smoke management, access and proximity to residential developments restricts management to mechanical mowing or hand removal instead of burning.

F. Public Access and Resource-Based Recreation

Historically, there has been minimal recreational activity at DLP. Since Lee County acquired the preserve, there has been evidence of fishing, fires, and possible hunting and camping on the north end of the preserve, on the peninsula.

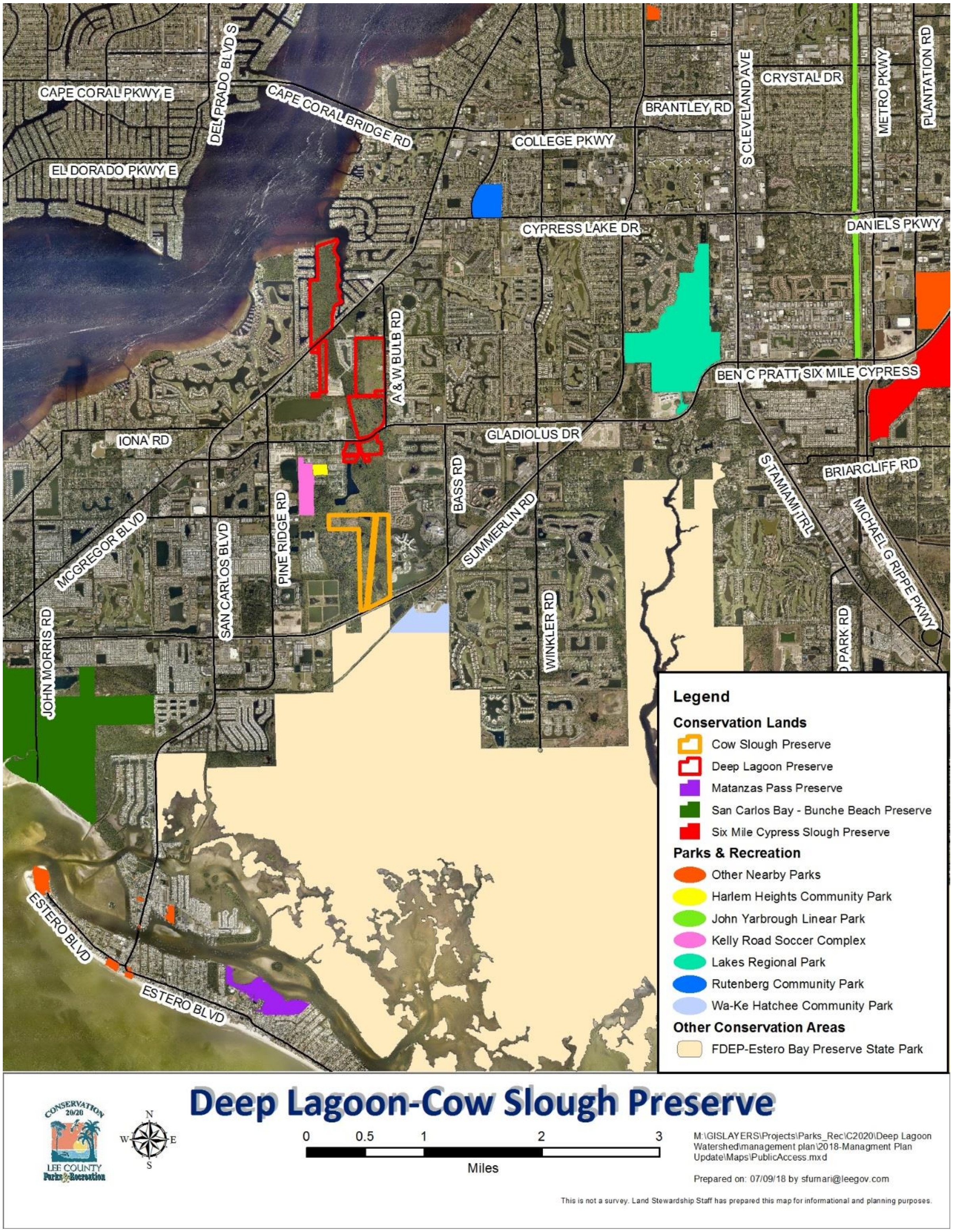
The Lee County Parks and Recreation Ordinance, Chapter 251/2, prohibits these activities, except in designated areas: https://library.municode.com/fl/lee_county/codes/code_of_ordinances?nodeId=PTIICO_CH25_1-2PARE

If future site inspections continue to show the preserve is being used in this manner, a sign will be posted to alert the public that these activities are not permitted.

The north tip of Site 116 is identified as a 'water access only' stop-over point on the Lee County Great Calusa Blueway paddling trail. Information on this paddling trail can be found at http://www.leegov.com/parks/Blueway.

Currently, there are no specific planned public recreation amenities proposed for the preserve. The preserve parcels are not all connected and some are difficult to access. In addition, a majority of the site contains wetlands. Refer to Figure 21 for existing nearby county and/or state-managed park and preserve locations with public access. These include Wa-Ke Hatchee Community Park (2 miles south), Lakes Regional Park (3 miles east), San Carlos Bay - Bunche Beach Preserve (4 miles southwest), Matanzas Pass Preserve (7 miles southwest) and state-managed Estero Bay Preserve State Park (3 miles southeast). All of these offer hiking trails and similar plant community exploration opportunities.

Figure 21: Public Access Map



G. Acquisition

For purposes of this plan, the portions of DLP purchased through C20/20 and Cow Slough Preserve which was acquired prior to the C20/20 program have been combined and referred to as Deep Lagoon Preserve. The C20/20 portion of DLP consists of four separate nominations purchased through C20/20 between 1999 and 2006 (See Table 4 and Figure 22). Sites 77 and 78 were both nominated to C20/20 in April 1998. The total acreage for the two properties is almost 130 acres and were both purchased in July 1999 for $2,851,875. The third 119.1-acre parcel, Site 116, was purchased for $1,198,000 in May 2001 after being nominated to the program two years earlier. Site 199-2 was acquired in 2006 for $425,789. It is south of Gladiolus Drive.

In 2010, 1.41 acres of Site 77 was transferred to LDOT for the Gladiolus Drive widening, and $37,630 in funds were transferred to the acquisition fund.

The arm of Cow Slough was purchased by Lee County in 1972 for use as a landfill (Lee County Solid Waste). The remaining portion was donated in 1976 for sewage treatment ponds for the Fort Myers Beach Sewage Treatment Plant on Pine Ridge Road. These ponds were never created because the land was unsuitable, since it consisted almost entirely of wetlands. After several years, Lee County Utilities Division gave the property to LCPR, creating the Cow Slough Preserve. Lee County has donated the southernmost portion, located south of Summerlin Road, to FDEP to be incorporated into Estero Bay Preserve State Park. After the purchase of the C20/20 lands to the north, management staff decided to incorporate Cow Slough into DLP for management purposes. Refer to Appendix E for acquired parcels' legal descriptions.

The future land use designations for the majority of the preserve have been changed to "Conservation Uplands" and "Conservation Wetlands," except for one parcel on Cow Slough which is still categorized as "Public Facilities" (Figure 23). Staff will coordinate with LCCD staff to update the land use and zoning designation of DLP. Currently, zoning for Cow Slough Sites 77 and 116, located north of McGregor Boulevard, is agriculture (AG-2); Site 78 is residential planned development (RPD); and Site 116, south of McGregor Boulevard, is residential single family (RS-1). Conservation Lands staff will work with LCCD staff to change the zoning to "Environmentally Critical" and FLU to "Conservation Lands," where possible (Figure 24).

LDOT acquired the former Hidden Lakes development within the HealthPark Development of Regional Impact. The existing lake is being used for stormwater management and water quality treatment in conjunction with the widening of Gladiolus Drive. The property was acquired with an agreement that LDOT will assume the responsibilities for the removal of exotics, maintenance and monitoring of mitigation areas under the USACOE and SFWMD permits. Eventually, this property may be incorporated into the preserve.

Table 4: Nominations Acquisition Summary

Site ID	Acres	Acquisition Cost	Acquisition Date	Details	STRAP Numbers
116	119.1	$1,198,000.00	5/21/2001	North and south of McGregor Blvd.	20-45-24-00-00004.0000; 29-45-24-00-00003.0000, 29-45-24-00-00003.0420; 29-45-24-00-00003.020A
77	54.5*	$970,375.00	9/13/1999	Off A&W Bulb Rd.	32-45-24-01-000L0.0010
78	74.68	$1,881,500.00	7/13/1999	Off A&W Bulb Rd.	29-45-24-00-00008.0000
199-2	25.76	$425,789.23	8/11/2006	South of Gladiolus Dr.	32-45-24-01-000N0.0010; 32-45-24-01-0000F.0010; 32-45-24-01-00000.0010; 32-45-24-01-0000F.0030
MU-7	19.07	$50,000.00	11/1/1972	Access via Kelly Rd.	05-46-24-00-00001.0010
MU-8-10	112.54	$200.00**	10/8/2005	North of Summerlin Rd.	05-46-24-00-00002.0020, 05-46-24-00-00002.0000
Totals	**405.65**	**$4,525,864.23**			

*In 2010, 1.41 acres was removed for LDOT Gladiolus Road widening & $37,630 was added back into acquisition fund.

**Split from other county owned parcels.

GIS acreage does not always match official survey acreage numbers primarily due to water bodies not being included.

Figure 22: Acquisition & STRAP Map

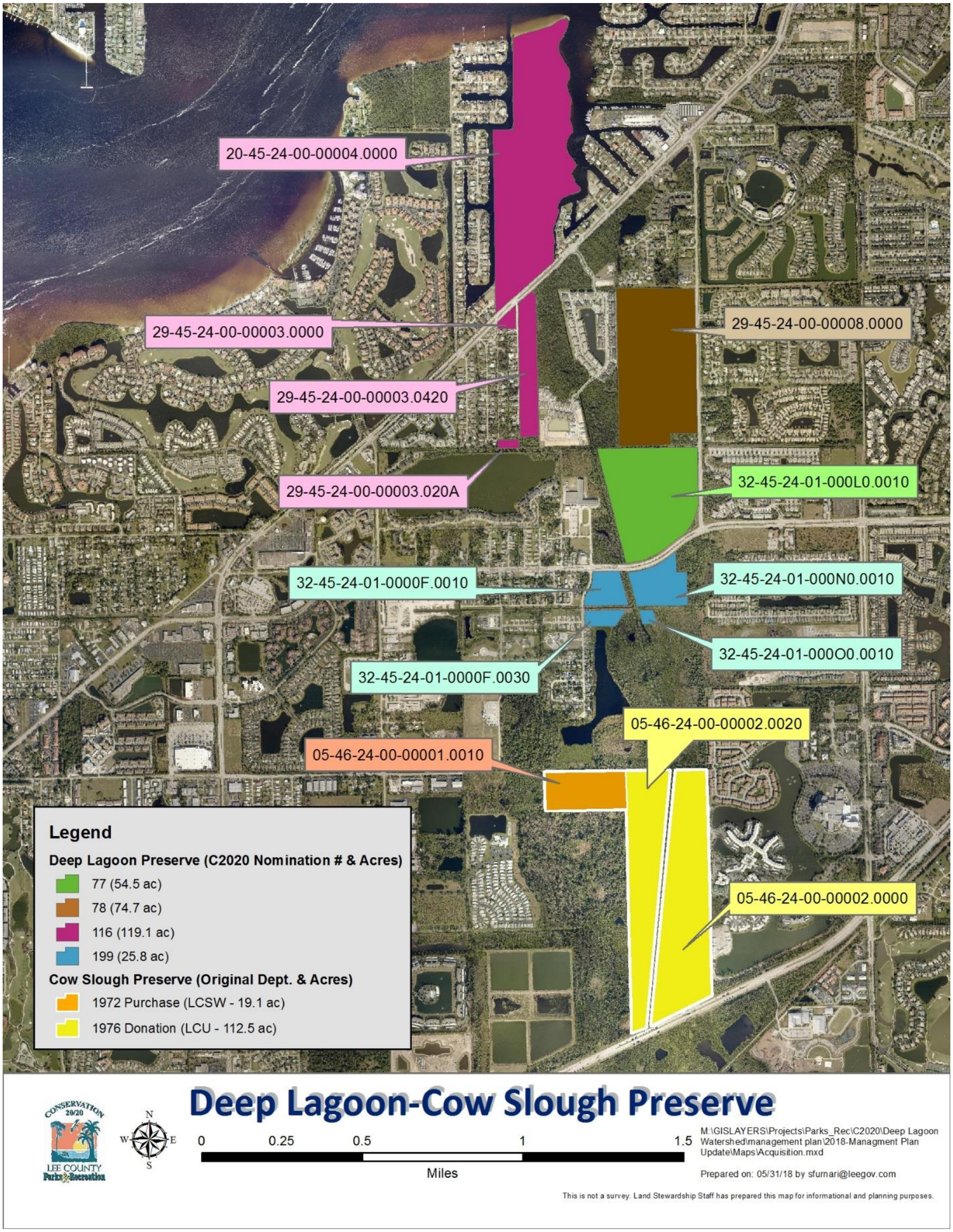


Figure 23: Future Land Uses Map

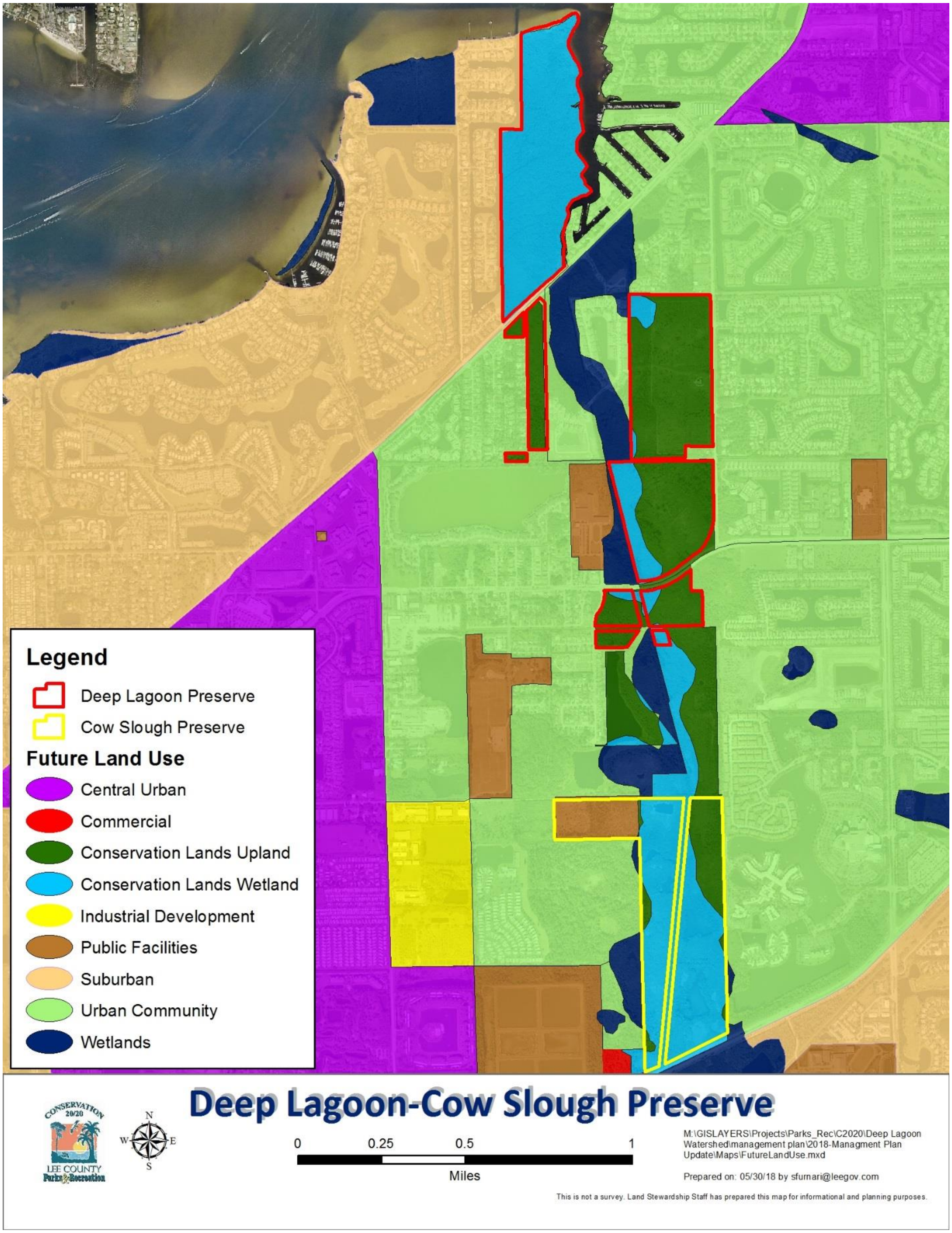
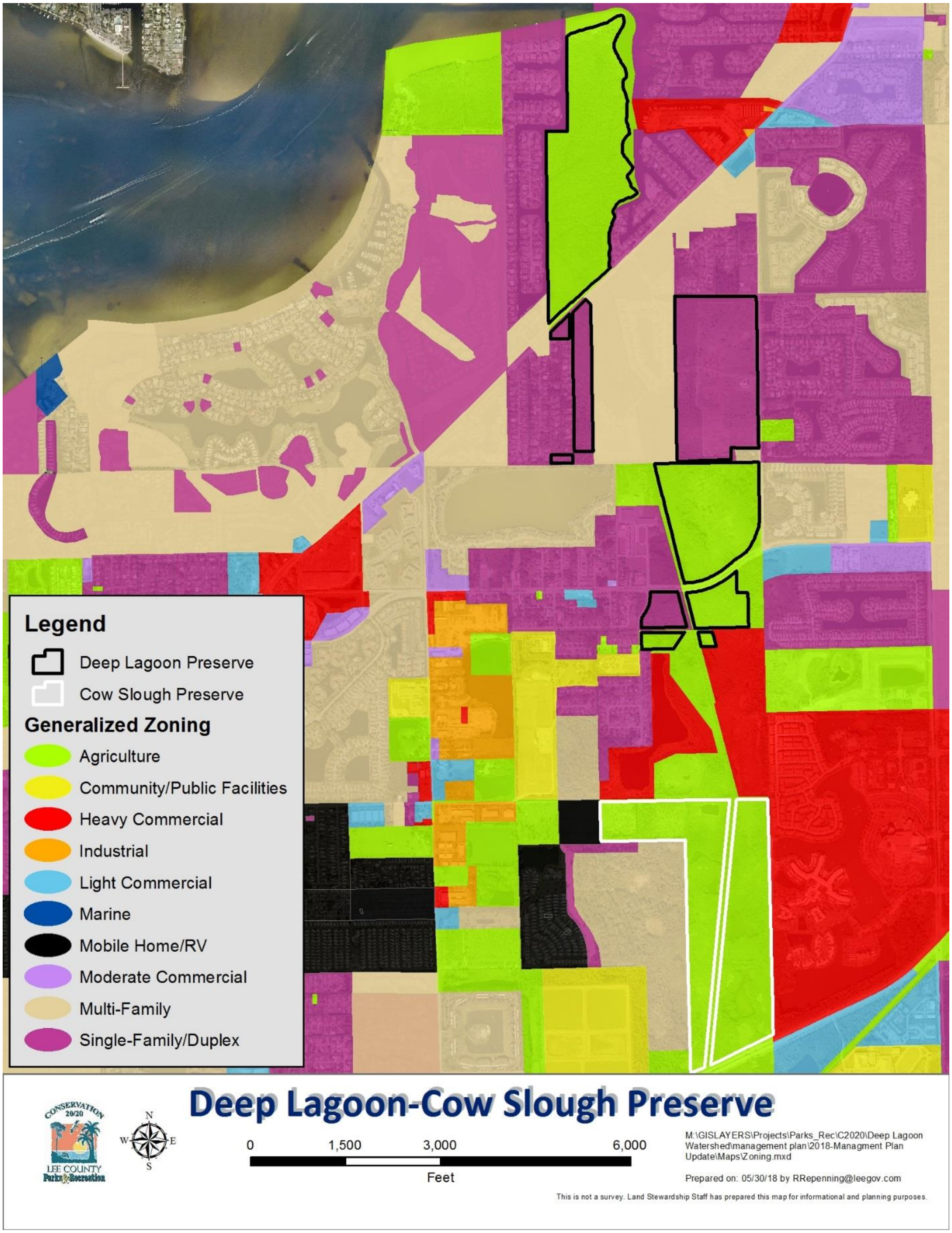


Figure 24: Zoning Map



VI. MANAGEMENT ACTION PLAN

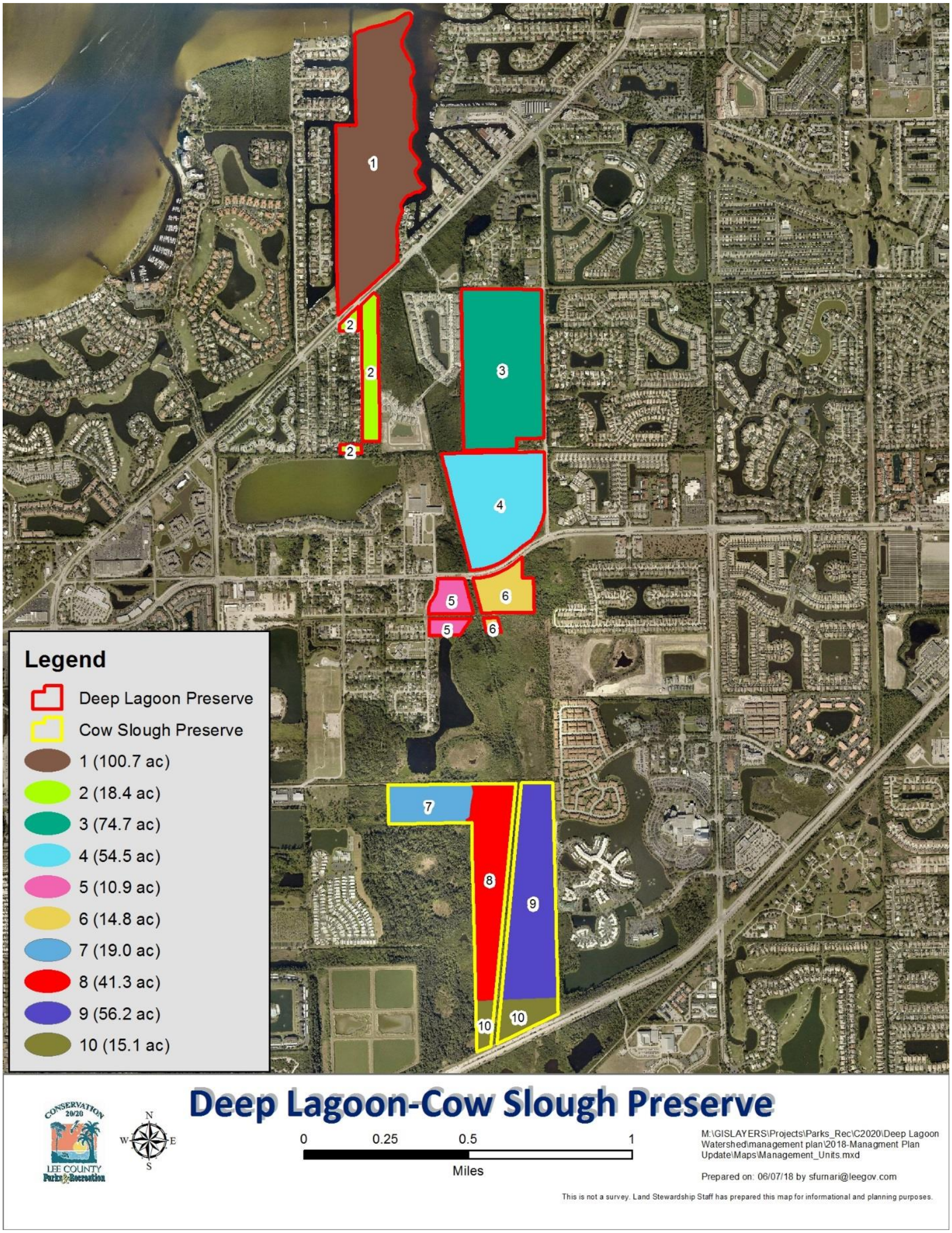
A. Management Unit Descriptions

DLP is divided into 10 management units (MU) to better organize and achieve management goals. These represent the combination of previous MUs that were identified in the first edition of the LMP for DLP and the addition of additional parcels bought in the last 10 years. Figure 25 delineates the current MUs that were created based on existing roads, canals and habitat types.

- Management Unit 1 (100.7 acres) is located between the Caloosahatchee River to the north and McGregor Boulevard to the south. It is bordered by water on three sides. This MU consists of almost entirely of mangroves, with coastal hydric hammock, coastal strand, and unconsolidated substrate. Initial exotic treatments, including mechanical removal of exotics began in 2003 and continued through 2009. Additional exotic treatments occurred in 2010, 2011, 2013, and 2017.
- Management Unit 2 (18.4 acres) is south of McGregor Boulevard. It consists of mangrove, coastal hydric hammock, and mesic flatwoods. The east and west boundaries are residential communities and Willems Road, and the south boundary is a canal. Exotic treatment occurred in 2009, 2011, 2013, and 2017. Cordgrass *(Spartina)* was planted in this unit to help promote native ground cover in areas where exotics had been removed. This area has since filled in with mangroves and other woody species.
- Management Unit 3 (74.7 acres) is located south of McGregor Boulevard, with residential communities to the west, A&W Bulb Road to the east, and an IDD canal to the south. The perimeter fence for this unit is to the inside from the property boundary; the boundary includes the canal and road frontage. The plant communities in this MU are restored pasture/freshwater marsh, depression marsh, mangroves, coastal hydric hammock, and salt marsh. An initial exotic treatment took place in 2006. Australian pines were logged and Brazilian pepper hedges were mulched in this unit in 2008 and 2009. Additional exotic treatments occurred in 2011, 2014, 2017 and 2018. In addition to exotic vegetation removal, restoration of the marsh consisted of installing a ditch plug and planting cordgrass. Additional native plantings may be necessary in the eastern portion of the site were restoration of the historic gladiolus fields is still in progress. This unit also includes the warehouse building.
- Management Unit 4 (54.5 acres) borders IDD canals to the north and west, A&W Bulb Road to the east, and Gladiolus Drive to the south. It contains disturbed mangroves, coastal grassland, disturbed salt marsh, coastal hydric hammock, and mosquito ditches. A Brazilian pepper monoculture around the edge of A&W Bulb and Gladiolus Drive in the eastern boundary of this unit as well as exotics approximately 25-ft into the preserve were treated in 2017. A plan to mechanically remove the remaining heavy exotic vegetation infested areas is planned for the 2019 dry season once agency permit(s) are approved.

- Management Unit 5 (10.9 acres) is south of Gladiolus Boulevard, with Hague Drive to the west, and the IDD Canal “C” to the east. Another east west canal divides it into two parcels. The MU is bisected both to the north, east, south and west by canals. The site is mangroves with a small pond and habitat dominated by exotics. A hired contractor treated most of the exotic plants in 2018, although it needs another follow up performed due to the previous near monoculture conditions.
- Management Unit 6 (14.8 acres) is south of Gladiolus Boulevard and west of the IDD Canal “C”. It is east of MU 5. Another east-west canal divides it into two parcels. The boundary on the east is private lands, as is the western part of the southern boundary. The unit is coastal hydric hammock and mangroves heavily infested with exotics. Contracts to remove and treat the exotics in this unit are planned for 2019.
- Management Unit 7 (19.0 acres) is the west arm of Cow Slough. Access is via a road along a LDOT canal off Kelly Road, just before the western entrance to the Kelly Road Soccer Complex. The western half of this MU was dominated by invasive exotic plants; these were removed in 2004, and again in 2016. The western half of this MU has variable topography, with a few oaks and cabbage palms. The eastern half of this MU is salt marsh and mesic flatwoods. The western half may require additional native plantings in order to transition this portion to a more natural plant community.
- Management Unit 8 (41.3 acres) is bordered on the east by IDD Canal “C” and to the north by an old road along the property boundary. The western boundary is private lands dominated by exotics and to the south by MU 10. The majority of this MU is mangroves with depression marsh, salt marsh and mesic flatwoods.
- Management Unit 9 (56.2 acres) is located along the eastern side of Cow Slough. To the west, it is bordered by IDD Canal “C” and MU 8. The eastern border are the communities include Cypress Cove and Sail Harbour at HealthPark. The primary plant communities are mangroves, salt marsh, mesic flatwoods and coastal hydric hammock. MU 10 is located to the south. This MU has already had exotic plant removal conducted, but is in need of maintenance. There is offsite mitigation located in the north east corner that was for the Lucaya development. Supplemental native plantings were installed as a part of the mitigation.
- Management Unit 10 (15.1 acres) is bordered by Summerlin Road to the south and MUs 8 & 9 to the north. This MU has also been used for off-site mitigation, and exotic plant removal has already occurred. The last treatment was in 2015, as a response to a non-compliance letter from the SFWMD as a requirement of the permit for the Fisherman’s Cove development. The plant communities are mostly mangrove swamp and depression marsh/ponds. Hydrological repairs could be done along the southern boundary to separate the ponds from the drainage ditch on Summerlin Road, which drains the ponds and reduces the salinity and hydrology, allowing cattails to dominate. Without the connection to this drainage ditch, these marshes/ponds would be isolated ponds like the one in the northern half of the unit.

Figure 25: Management Units Map



B. Management Work-to-Date

DLP has benefitted from numerous projects, ranging from regular exotic plant control to a hydrologic improvement project. Management projects began on the preserve in 2007, when contractors were hired to do the initial exotic plant control in MU 1 along the shoreline of the Caloosahatchee River on the north side of the preserve. This work of mulching and removing mature exotic trees, primarily Brazilian pepper and Australian pine, continued into 2010 throughout the preserve and was funded by a FFS post-Hurricane Charley grant. Re-treatment of restored areas of the preserve continues today. Recent treatments have occurred in MU 1-3, 7 and 10.

In 2009, a FFS management project removed stands of Australian pine and Brazilian pepper from MU 3. Mechanical reduction in vegetation was conducted in MU 2 in 2009. Some areas within this Management Unit that were cleared of exotics were replanted with cordgrass. In 2010, a portion of MU 3 underwent a hydrologic restoration. The project involved plugging ditches to restore natural tidal flushing of wetlands. The second part of this project involved removing exotic vegetation, minor disking to re-contour the area, and replanting to create marshes. Installation of fencing along the southwestern boundary of Site 199 along Hagie Road was installed in 2012 to prevent dumping and unauthorized access. In 2016, the western portion of MU 7 was treated for exotic plants with funding from the FWC Upland Invasive Plant Program. Removal of Australian pine, melaleuca and Brazilian pepper work continued in 2017 along the roadway edge of MU 4 and all of heavily infested MU 5. In 2018, another follow up treatment occurred in MU 3.

In addition to exotic plant management, the interior barbed wire fences have been removed as part of the restoration activity.

C. Goals and Strategies

The following are the ongoing and long-term goals for the preserve:

Natural Resource Management

- ✓ Exotic plant control and maintenance
- ✓ Habitat and hydrologic restoration
- ✓ Monitor and protect listed species
- ✓ Exotic and feral animal removal

Overall Protection

- ✓ General building and ground maintenance
- ✓ Debris removal and dumping prevention
- ✓ Boundary fence maintenance and installation
- ✓ Boundary and preserve sign installation
- ✓ Change land use and zoning

Volunteers

- ✓ Assist volunteer groups

The following is a description of how each of these goals will be implemented, the success criteria used to measure accomplishments of each goal and a projected timetable outlining the MUs in which each activity will take place.

Natural Resource Management

Exotic plant control and maintenance

The most current FLEPPC "List of Invasive Species" will be consulted to determine the invasive exotic plants to be controlled in each MU. The goal is to continue to control these exotic species by conducting semi-annual or "as needed" treatments of exotic plant regrowth and perform initial treatments of newly discovered species. This goal will strive to maintain the entire preserve at a maintenance-level for exotic species, defined as having less than 5% invasive exotic plant coverage. Contracted treatments have been included in the projected financial considerations to occur three times over the next 10 years to treat exotic vegetation re-growth. Each contracted project requires a completed Herbicide Prescription Form to be filled out by C20/20 staff, and then completed by the contractor as work is completed; copies of these forms are available in the LSOM. Completed forms are kept by land managers and used to help prepare future treatments.

Habitat and hydrologic restoration

Hydrologic restoration projects have been implemented on both the mid and southern portion of DLP. Additional hydrologic restoration projects may take place based on coordination with the LCNR and SFWMD. All future hydrologic restoration projects will be evaluated based on the potential benefit to the native plant communities and wildlife in the preserve.

There is the potential for habitat restoration projects within MUs that contain disturbed or non-native habitats, including remnant spoil pile or abandoned agricultural areas and an old landfill.

The restored marshes in MU 3 may benefit from prescribed fire, but there are currently no plans to do so because of continued growth and urban interface issues. The use of this management tool will be explored during the next few years. Mechanical reduction of fuel in MU 2 will help maintain the flatwoods and reduce wildfire risk.

Monitor and protect listed species

As discussed in the Designated Species section, there are several listed species that have been documented on the preserve, including bald eagle, tricolored heron and white ibis. These species will benefit from restoration activities such as hydrologic improvements and exotic plant control activities. During management activities, efforts will be made to minimize any negative impact to listed species.

DLP is part of a countywide tri-annual site inspection program conducted for all C20/20 preserves. These inspections allow staff to monitor for impacts or changes on the site, and to update wildlife and plant species lists. During these inspections, if staff finds FNAI-listed species not previously documented, these observations will be reported using the appropriate forms.

Exotic and feral animal removal

Ten exotic wildlife species have been recorded on DLP (see Wildlife Species List, Appendix D), including the feral hog in MU-7. Since the removal of all hogs is an unreasonable goal, hog trapping as a control method will be implemented on a long-term basis. Hog trapping is the approved method for hog removal on C20/20 preserves. If practical, a methodology will also be established and implemented against other unwanted exotic animal species.

Two non-native insects have been documented at the preserve: melaleuca psyllids and air potato beetles. These insects are beneficial biological as control agents that target the invasive melaleuca trees and air potato vines.

Although not noted at DLP, this preserve does not contain any feral cat colonies. FWC's Feral and Free Ranging Cats policy is "To protect native wildlife from predation, disease, and other impacts presented by feral and free-ranging cats" (FWC 2003). Any feral cats will be collected and delivered to Lee County Domestic Animal Services (LCDAS). C20/20 staff will continue to partner with LCDAS staff to prevent the establishment of any feral cat colonies adjacent to preserves.

Land management staff will continue to investigate the feasibility to control other exotic species. If practical, a methodology will be established and implemented.

Overall Protection

General Building and Ground Maintenance

Site 78 contains a warehouse building used by C20/20 staff to store boats, LCPR Ranger ATVs/trailers, vehicles, herbicides, stockpiled materials (fences, kiosks, gates) and equipment for maintaining the perimeter grounds. Lee County Facilities has replaced the building's roof and made minor adjustments to the large slider doors. The building has running water and electric for maintaining equipment.

Debris removal and dumping prevention

The removal of trash will remain an ongoing management activity at DLP. Debris (e.g. household, tires) was noted in MU 5 and should be removed when treating exotic plants. When necessary, debris clean-ups will be organized with land management staff and volunteers. During site inspections and ranger patrols, smaller objects that are encountered will be removed.

Boundary fence installation and repair

Portions of the preserve's perimeter boundary is fenced. Where needed, additional boundary fencing and signage will be added to further protect areas of the preserve.

Boundary and preserve sign installation

Boundary signs have been installed to further protect and delineate the preserve. Missing or damaged signs will be replaced. C20/20 staff and rangers will consistently monitor for the presence of boundary signs during patrols and replace any missing boundary signs as needed. Boundary signs will be placed every 500 feet along all boundaries.

Change Land Use and Zoning

Staff will coordinate with LCCD staff to update the land use and zoning designation of DLP. If possible, the Land Use category for MU7 will be changed from Public Facilities to Conservation Lands. The zoning categories will be changed to "Environmentally Critical" from Agriculture and Single-Family. These changes will better protect the conservation of the property into the future and reflect the goals of the C20/20 program.

Volunteers

Volunteer assistance

The LSOM identifies the Land Management Volunteer Program's mission statement as: "To aid in the management and preservation of Lee County resource-based public parks and preserves and to provide volunteers with rewarding experiences in nature." Staff will continue to coordinate with volunteer groups at DLP to assist with activities such as trash debris removal, wildlife monitoring, and other land management projects.

VII. PROJECTED TIMETABLE FOR IMPLEMENTATION

The following timetable is based on obtaining necessary funding for numerous land management projects. Implementation of these goals may be delayed due to changes in staff, extreme weather conditions, or a change in priorities on properties managed by Lee County. Details on each management activity are found in the Management Action Plan section.

Table 5: Projected Timetable for Implementation

Management Activity	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Natural Resources Management										
Maintenance (Ongoing/Annual)										
Initial Exotic Plant Control Work		MUs 4, 6, 8								
Kill Guinea grass on MU 1 and 3	X	X								
Exotic Plant Species Maintenance	MU 3	MUs 5, 7, 9	MUs 1, 2, 4, 6, & 8-10	MUs 1-4	MUs 5-8	MUs 9-10	MUs 1-4	MUs 5-8	MUs 9-10	MUs 1-3
Maintain & Mow fencelines (MU3, southwest MU5 – Hagie Rd, future MU 7)	Ongoing	→	→	→	→	→	→	→	→	→
Exotic animal monitor &/or removal	Ongoing for all Units	→	→	→	→	→	→	→	→	→
Monitor & Protect Listed Species	Ongoing for all Units	→	→	→	→	→	→	→	→	→
Habitat Improvement										
Revegetate MU-7 (west half)		X								
Revegetate eastern portion of MU-3			X							
Pile Burning		MU 3	MU 5	MUs 4 & 6						
Mechanical Brush Reduction		MU 2	MU 3		MU 7		MU 2			
Hydrologic Components										
Dam the north side of ditch along Summerlin Road-MU 10 (seek funding) (alternative project MU 3-4)				X						
Permitting				X	X	X				
Construction						X				
Overall Protection										
General building & ground maintenance	Ongoing	→	→	→	→	→	→	→	→	→
Debris Removal - General	MU 3	MU 5	Ongoing for all Units	→	→	→	→	→	→	→
Debris Removal – Coastal Cleanup Days		MU 1		MU 1		MU 1		MU 1		MU 1
Change FLU & Zoning Categories		X	X							

Boundary Sign Installation & Maintenance	MU 6	Ongoing for all Units	→	→	→	→	→	→	→	→
Fence Installation/Replacement			MU 5	MU 7		MU 3				
Volunteers										
Assist Volunteer Groups	Ongoing	→	→	→	→	→	→	→	→	→

→ = project continues

VIII. FINANCIAL CONSIDERATIONS

Funding for management comes out of Lee County's General Revenue Fund. This funding serves to meet the operational needs of the Management section of the Conservation Lands Program, but is allocated on a year-to-year basis. Program funding will be supplemented through pursuing appropriate grants or other sources of funding, such as, but not limited to; grants from FWC, FFS, FWS, or the Land and Water Conservation Fund.

The Florida Department of Forestry (renamed to FFS) provided a $131,250 grant for the removal of mature Australian pines between 2005 and 2006, following Hurricane Charley. The SFWMD provided $102,072 in grant money for the hydrologic and habitat restoration on Site 78 from 2007 to 2010. In 2009, a FDEP former Bureau of Invasive Plant Management Grant funded invasive plant removal at $21,900.

Expended and projected costs and funding sources are listed in Appendix F.

IX. LITERATURE CITED

Austin, Robert J. 1987. An Archaeological Site Inventory and Zone Management Plan for Lee County, Florida. Performed for the Lee County Department of Community Development, Division of Planning. On file, BHSP.

Brown PM. 2002. Wild Orchids of Florida. Gainesville: University Press of Florida. 409 p.

(FNAI) Florida Natural Areas Inventory. 2010. Guide to the Natural Communities of Florida. Tallahassee. 278 p.

Henderson WG (Soil Conservation Service). 1984. Soil Survey of Lee County, Florida. U.S. Department of Agriculture/Soil Conservation Service in cooperation with University of Florida Institute of Food and Agricultural Sciences, Agricultural Experiment Stations and Soil Science Department, and Florida Department of Agriculture and Consumer Services. 185 p.

Hipes D, Jackson DR, NeSmith K, Printiss D, Brandt K. 2001. Field Guide to the Rare Animals of Florida. Tallahassee: Florida Natural Areas Inventory. 122 p.

(JEI) Johnson Engineering, Inc. 2002. Deep Lagoon Preserve Environmental and Hydrologic Assessment. Fort Myers: Johnson Engineering, Inc. 33 p.

Lee County Department of Community Development (LCCD). The Lee Plan 2018 Codification As Amended through April 2018 [internet]. Ft. Myers: Lee County Department of Community Development; 2018. Available from: http://www.leegov.com/dcd/Documents/Planning/LeePlan/Leeplan.pdf

Minno M, Butler J & Hall D. 2005. Florida Butterfly Caterpillars and Their Host Plants. Gainesville: University Press of Florida.

Myers RL & Ewel JJ, editors. 1990. Ecosystems of Florida. Orlando: University of Central Florida Press. 765 p.

Rodgers JA Jr, Kale HW II, & Smith HT, editors. 1996. Rare and Endangered Biota of Florida. Volume V Birds. Gainesville: University Press of Florida. 688 p.

Save Florida's Native Bromeliads: Conservation of Endangered Airplants Through Biological Control and Seed Collection [Internet]. Gainesville (FL): University of Florida Institute of Food and Agriculture Sciences. [cited 2004 Nov 8]. Available from: http://savebromeliads.ifas.ufl.edu

Waldrop Engineering. 2017. Deep Lagoon Pollutant Load Reduction Study: Phases II and III - Water Quality Recommendations. Bonita Springs: Waldrop Engineering. 4 p., 33 p.

Water Resource Solutions, Inc. [WRSI]. 1999 July. Phase I Environmental Site Assessment Report for the Conservation 2020 Parcel #78, Fort Myers, Florida; Project Number LC-03943.E1. Cape Coral (FL): WRSI. 19 p.

Water Resource Solutions, Inc. [WRSI]. 2003 December. Phase I Environmental Site Assessment Report for the 20 acre Parcel on Kelly Road, Fort Myers, Lee County Florida; Project Number LC-04618.E1. Cape Coral (FL): WRSI. 17 p.

X. APPENDICES

Appendix A: Waldrop Engineering Pollutant Load Reduction Study Phase II

Appendix B: Waldrop Engineering Pollutant Load Reduction Study Phase III

Appendix C: Plant Species List

Appendix D: Wildlife Species List

Appendix E: Legal Descriptions

Appendix F: Expended and Projected Costs and Funding Sources

Appendix A: Waldrop Engineering Pollutant Load Reduction Study Phase II

Deep Lagoon Pollutant Load Reduction Study

Phase 2 - Watershed Analysis Report

May 16, 2017

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Executive Summary:

Federal regulations through Section 303(d) of the Clean Water Act (CWA) require each state to identify surface waters that do not meet water quality standards, defined as impaired. States are then required to establish a Total Maximum Daily Load (TMDL) for each impaired water body. The TMDL is the maximum amount of a pollutant that can be discharged to the water body without causing an exceedance of water quality standards.

The Caloosahatchee River Estuary was identified as impaired by FDEP and a TMDL was subsequently established. The TMDL for the Caloosahatchee Estuary requires a 23% reduction in total nitrogen (TN) loads throughout the watershed.

The entire Caloosahatchee Estuary and approximately 34 miles of the Caloosahatchee River runs through Lee County. Lee County is directly impacted by the water quality within the Caloosahatchee River Estuary and is a source of nitrogen loads to the estuary. As such, Lee County is one of the key stake holders for the river. As a stake holder, Lee County is required to participate in the TN load reduction required by the TMDL Report.

This Deep Lagoon Pollutant Load Reduction project not only identifies potential nitrogen sources from the Deep Lagoon Watershed that are likely contributing to the Caloosahatchee River Estuary nitrogen load, but also recommends projects to reduce the load. A summary of each phase is provided below:

1. Background Data (Completed) - Identifies existing and historical conditions that could be contributing nitrogen loads to the watershed.
2. Analysis (Subject of the Report) - Detailed analysis of the data which provides estimated nitrogen loads from sources within the watershed that can be calculated.
3. Recommendations - Identifies best management practices to reduce nitrogen loading.

The goal of this study is to identify nitrogen sources and obtain data to understand impacts, as well as determine the sources that are contributing the highest loads, identify water quality improvement projects, and recommend best management practices to improve water quality.

The project study area is defined by the Iona Drainage District (IDD) Canal C watershed. Canal C directs stormwater runoff to Deep Lagoon.

Lee County water quality monitoring stations DEEPGR50 and DEEPGR90 are located in IDD Canal C at Gladiolus Drive and Summerlin Road, respectively. Data from October 1990 through June of 2016 was reviewed as part of this report. Water quality data at both monitoring stations indicates a trend of increasing TN concentration until the first half of 2014; There is a sharp decrease in concentration after the first half of 2014. This abrupt change could be due to the shift in Lee County Lab's Total Kjeldahl Nitrogen catalyst from Mercuric Oxide to Copper, which occurred around this date. Future TN data should continue to be analyzed to determine if the increasing trend continues. The increasing TN concentration trend is an indication that there is an active source of TN that will continue to degrade water quality until it is controlled.

The total phosphorus data indicates a decreasing concentration trend. The decreasing trend provides assurance that TP concentration will likely continue to decrease or level off unless new sources are added to the watershed. Due to this decreasing trend, no additional investigation of TP sources is recommended for this watershed.

When the two monitoring stations are compared, TN concentrations at DEEPGR90 are consistently higher than those at DEEPGR50. This likely indicates a nitrogen source is located close to DEEPGR90. Some potential sources located near DEEPGR90 include, HealthPark, The Fort Myers Beach WWTP Percolation Ponds, a tree farm, Thunderbird Community, Summerlin Road, and Lee Plantation Community.

Potential nutrient sources for the entire watershed include; change in land use, reclaimed irrigation water, irrigation storage ponds, percolation ponds, septic tanks, and legacy sources. Each of these sources was investigated as part of this project.

<u>Land Use</u>

Agriculture, residential, commercial or industrial land uses typically increase nutrient loading rates to a watershed. This is due to increased nutrient production and reduced nutrient uptake. The impact these increased loading rates have on the watershed was estimated using the methodology outlined in *Evaluation of Current Stormwater Design Criteria within the State of Florida*, prepared by Harvey, H. Harper, Ph.D., P.E. and David M. Baker, P.E. of Environmental Research & Design, Inc. Loading rates were calculated for each sub-basin within the watershed. The highest nutrient loading rates are sub-basins C-3, C-1, C-5 and C-2 and the highest concentrations are found in drainage basins C-7, C-1, C-2 and C-3. The location of these watersheds has been included in Appendix G - Canal Sub-Basin Map.

<u>Reclaimed Irrigation Water & Irrigation Water Storage Ponds</u>

Water from the Fort Myers Beach Waste Water Treatment Plant and Fiesta Village Advanced Waste Water Treatment Plant is used for irrigation and stored in ponds throughout the Deep Lagoon watershed. Reclaimed water has a higher concentration of TN and TP than typical surface water, potentially increasing nutrient loads to the watershed. The water quality in the irrigation storage ponds and stormwater outfall lakes at three residential developments (Gulf Harbour, Crown Colony, and Heritage Cove) was monitored for one year to identify potential differences. Gulf Harbour is a residential golf course community that receives reclaimed water from the Fort Myers Waste Water Treatment Plant and Crown Colony is a residential golf course community that receives reclaimed water from the Fiesta Village Advanced Waste Water Treatment Plant. Heritage Cove is a residential community (without a golf course) that does not receive reclaimed water, and is used to estimate a background concentration. Water quality monitoring sites were established at the Gulf Harbour and Crown Colony reclaimed irrigation water storage ponds, as well as at the Gulf Harbour, Crown Colony and Heritage Cove stormwater outfall ponds.

Both Crown Colony sites had detectable concentrations of Sucralose in two of the three samples taken. The Gulf Harbour reclaimed water storage pond had detectable concentration in one sample. Sucralose does not have any natural sources. Its presence indicates a human source, likely treated or untreated wastewater. As expected, this indicates the Crown Colony and Gulf Harbour lakes receive water from a wastewater source. The presence in the Crown Colony outfall lake indicates reclaimed water is entering the stormwater management system.

The highest TN concentrations were found in the two effluent storage ponds. This indicates that the nitrogen levels in the reclaimed water are likely affecting the water quality within the storage ponds.

The potential impacts on the surrounding groundwater table were not specifically investigated for the storage ponds due to time and budget constraints.

Both the Crown Colony and Gulf Harbour outfall lakes have very similar concentrations, which are much lower than the effluent storage ponds. These concentrations are only slightly higher than the Heritage Cove TN concentrations. Both Gulf Harbour and Crown Colony have 18-hole golf courses which are expected to contribute to a higher TN loading. Heritage Cove does not have a golf course. The higher concentrations at Crown Colony and Gulf Harbour could be from the golf course or reclaimed irrigation water. Further studies would be required to determine potential contributions from the golf course and irrigation water.

<u>Percolation Ponds</u>

The percolation ponds can impact surface water quality by sending higher concentration water into the groundwater table. Due to the high groundwater table within the Deep Lagoon Watershed groundwater can flow into surface water through ditches, canals, and wetlands. Which is comment, especially during the wet season.

Previous percolation pond studies indicated there were elevated nitrogen levels around the percolation ponds with the higher concentrations located in the predominant direction of groundwater flow from the ponds. This indicates the ponds are a likely source of TN. But it does not quantify the contribution. Additional water quality monitoring was performed around the percolation ponds to determine if these elevated levels still exist. Five surface water and four groundwater monitoring site were established for this project. Like the previous studies, higher nitrogen levels were found in the direction of groundwater flow from the percolation ponds. Four surface water and two groundwater monitoring sites were analyzed for sucralose on three different dates. All samples had detectable levels of sucralose, except one sample south of Pond F and all three samples taken in Canal C. The area south of Pond F is not located in the main groundwater flow direction from the ponds and Canal C is located furthest from the Ponds and receives flows from other areas. This data indicates water is still flowing from the percolation ponds into the surrounding groundwater and surface water

Due to time, scope, and budget constraints a detailed loading rate for the ponds was not able to be prepared as part of this project. However, preliminary estimates have been prepared with the following assumptions:

- Flow from percolation ponds to groundwater equals the calculated flow to the ponds (estimated 149.5 MG/yr.)
- TN concentration equals the average ground concentration (9.26 mg/L)

The estimated total groundwater loading equals 11,488 lb. N/year.

The amount that eventually enters surface water flows is not known but will be less than the groundwater loading. An estimated range is 1,149 lb./yr. to 10,339 lb./yr. based on 10% to 90% getting to surface water. The equals between 6% and 54% of the land use loading.

<u>Septic Tanks</u>

Similar to the percolation ponds, septic tanks to contribute to the watersheds nitrogen load by discharging nitrogen to the groundwater table. Due to the high groundwater table within the Deep Lagoon Watershed, groundwater flow into surface waters, especially during the wet season. There are two areas of relatively high density septic tank usage in the Deep Lagoon Watershed. They are located along McGregor Blvd. near Willems Road and off Pine Ridge Road in the Coastal Estates Community. A water quality monitoring program was implemented to try to determine if these areas are likely contributing to the watershed's nitrogen load.

Acetaminophen, which is a manmade compound often found in wastewater was detected on one date in the three-monitoring site located near the McGregor Blvd septic tanks. The other two site near Coastal Estates did not have detectable levels of acetaminophen. Detectable levels of sucralose were only found in one sample just downstream of Coastal Estates and one in each of the two further monitoring sites near the McGregor septic tanks.

The highest surface water TN concentrations were found at the monitoring site located closest to the Coastal Estates septic tanks and the highest groundwater concentration was found at the monitoring sites located closest to the septic tanks. This provides an indication that the septic tanks are likely contributing to the watershed nitrogen loading.

The extent to which the septic tanks are contributing to the loading rate is not known. However, a simplistic loading calculations was prepared to provide an idea of the potential loading. The loading from the septic tanks to groundwater was estimated to be 29 lb. N/yr. (HSA Engineers & Scientist, 2009) with 80% reaching the groundwater table. For the 62 septic tanks near McGregor and the 95 septic tanks in Coastal Estates the estimated loading is 3,642 lb. N/yr. Only a portion of this groundwater loading will get into the stormwater. A range of 364 lb. N/yr. to 3278 lb. N/yr. is estimated based on 10% and 90% of the loading reaching stormwater.

<u>Legacy Sources</u>

Nitrogen sources that no longer exist can continue to provide a loading to the watershed by releasing nitrogen from relatively high concentration soils into relatively low concentration water. Potential sources within the Deep Lagoon watershed are canal sediment and the soil on historically agriculture properties.

To help understand potential loads, sediment samples were taking in Canal C, in an historically farmed property and in a natural area. In additional, groundwater monitoring was performed down gradient from a historically farmed area.

The sediment samples identified higher nitrogen concentrations in the Canal C sediment at McGregor Blvd and Summerlin Road and in the historic farm field. The samples in Canal C at Gladiolus Drive and in the non-farmed area were much lower. The high concentration in Canal C have a high potential to add nutrients because of its continuous contact with stormwater. Nitrogen can leach out of the soil into the water.

The farm field sediment is not continuously in contact with stormwater runoff. However, it could contribute loads in groundwater flow. The groundwater monitoring well located down gradient from the farm field generally had the lowest nitrogen concentration of any other groundwater well monitored with this report. This provides an indication that the farm field soils may no longer be a significant source of nitrogen in the watershed.

The sources that are likely contributing the loads to the watershed are land use, percolation ponds, septic tanks and canal sediment.

The final phase of this project Water Quality Recommendation will identify project to reduce the nitrogen loads to the watershed. The recommendations will consider potential load reductions as well as cost to provide the most cost effective solutions.

Project Description:

Federal regulations through Section 303(d) of the Clean Water Act (CWA) require each state to identify surface waters that do not meet water quality standards. The list of surface waters not meeting water quality standards is known as the 303(d) list or impaired waters. States are required to establish a Total Maximum Daily Load (TMDL) for each impaired water body. The TMDL is the maximum amount of a pollutant that can be discharged to the water body without causing an exceedance of water quality standards.

The Caloosahatchee River Estuary was identified as impaired by FDEP, and a TMDL was subsequently established in *The Nutrient TMDL for the Caloosahatchee Estuary Report* prepared by FDEP. The TMDL for the Caloosahatchee Estuary calls for a 23% reduction in Total Nitrogen (TN) loads throughout the watershed. This pollutant reduction applies throughout the watershed to each drainage area individually.

Implementation of the nutrient load reduction is delegated to the local stake holders through the National Pollution Discharge Elimination System (NPDES) Program and the Basin Management Action Plan (BMAP). For the Caloosahatchee River Estuary, local stake holders include Cities, Counties, Water Management Districts, and Florida Department of Transportation, among others. The BMAP is prepared by FDEP with assistance from each stake holder. Within the BMAP, each stake holder identifies how they will meet the pollutant reduction goals. The BMAP provides a road map as to how the TMDL will be met, and the water quality impairment reduced or eliminated.

The entire Caloosahatchee River Estuary and approximately 34 miles of the Caloosahatchee River runs through Lee County. Lee County is directly impacted by the water quality within the Caloosahatchee River Estuary, and is a source of nutrient loads to the estuary. As such, Lee County is one of the key stake holders for the river. Lee County is, as a stake holder, required to participate in the TN load reduction required by the TMDL Report. A key first step in reducing nitrogen loads is to understand where the TN loads are coming from, and then identify practices that will reduce those loads on a watershed by watershed basis. The Pollutant Load Reduction Study will accomplish this for the Deep Lagoon Watershed.

Lee County selected the Deep Lagoon Watershed as the subject of this pollutant load reduction study not only because it is part of the Caloosahatchee River Estuary TMDL and BMAP, but also because it has relatively high nutrient levels. In addition, The Deep Lagoon Watershed includes significant areas of publicly owned land through the center of the watershed. This could facilitate the implementation of structural best management practices, should they be required.

This Deep Lagoon Pollutant Load Reduction Study will consist of three phases, including Background Data, Analysis, Recommendation, and Report. A summary of each phase is provided below:

1. Background Data (completed previously) - This first task obtained background data for the Deep Lagoon Watershed. The background data identified existing and historical conditions that could be contributing nitrogen loads to the watershed and ultimately contributing to the watershed's impairment.
2. Analysis (Subject of the Report) - The second phase includes a detailed analysis of the data and provides estimated nitrogen loads from sources within the watershed that can be calculated.

This phase identifies the sources that are likely contributing the highest nitrogen loads to the watershed.

3. Recommendations - The third phase of the study identifies best management practices, including structural and non-structural, to reduce nitrogen loads. It then prioritizes these practices based on County Staff input. This includes preliminary conceptual designs for each BMP as well as design, permitting and construction cost estimates.
4. Report – The fourth and final phase of the study is a report that summarizes each of the three previous phases.

Project Goals:

The goals for The Deep Lagoon Pollutant Load Reduction Study are as follows:

1. Identify nitrogen sources within the watershed. Potential sources include stormwater runoff, fertilizers, septic tank effluent, reclaimed irrigation water, direct or indirect wastewater discharge, and legacy nutrients.
2. Obtain additional data to better understand the impacts that nitrogen sources have on the watershed's water quality.
3. Analyze nutrient sources to determine those that are contributing the highest loads.
4. Identify structural and non-structural best management practices to improve water quality.
5. Recommend and prioritize best management practices to improve water quality.

Sub-Watersheds:

The project study area, which is defined by the Iona Drainage District (IDD) Canal C watershed, was delineated as part of the Phase 1 Background Data Report. While all areas within the watershed contribute nutrients to the watershed, each area does not provide the same load. Some areas likely provide higher loads than other areas. In an effort to better understand where the higher and lower nutrient loads originate, the main watershed has been broken down into smaller sub-watersheds. Nutrient loads for each sub-watershed will be calculated later in this report.

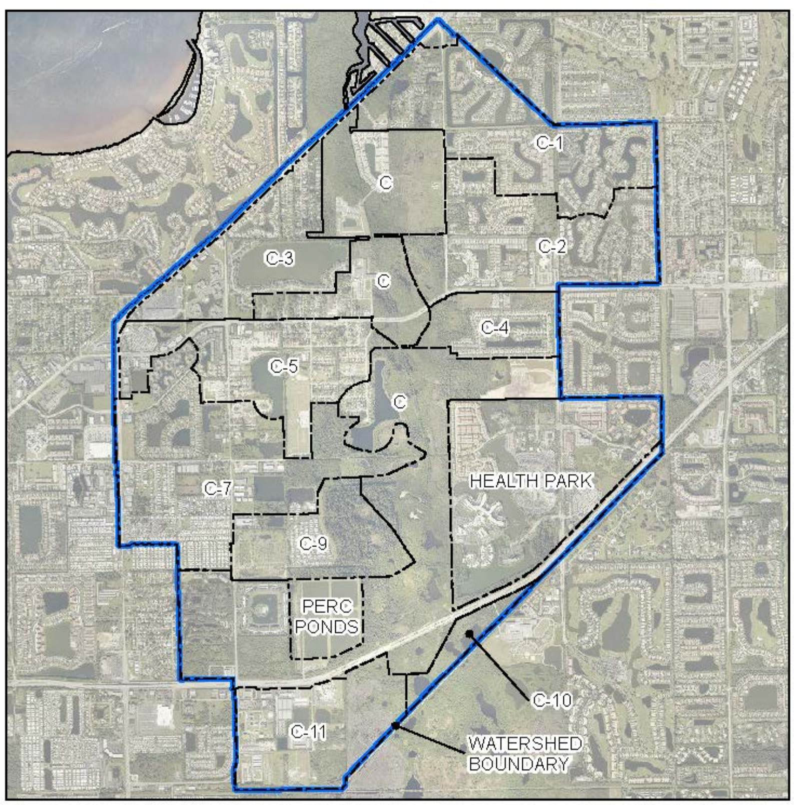


Figure 1 - Sub-Watershed Map

Sub-watershed boundaries were identified using aerial photographs, SFWMD permit records, IDD Canal Design Plans, and site visits. A map showing the limits of each sub-watershed is included below, as well as in Appendix A - Watershed Boundary Map.

A brief description of each sub-watershed is provided below:

Canal C – This is the main canal that runs north-south within the Deep Lagoon Watershed. It is the outfall for the other canals within the watershed and discharges directly to Deep Lagoon. The drainage area generally consists of the areas that are directly adjacent to the Canal. Land uses include undeveloped land, preserve areas, residential developments and an elementary school.

Canal C-1 – This is the northernmost secondary canal located along the eastern side of Canal C. Land uses within this sub-watershed include residential communities (Lucaya, Heritage Cove, Calusa Palms, and Parker Lakes), Temple Judea Conservative, and undeveloped lands that were previously used for agriculture. A portion of the Deep Lagoon Preserve drains to this Canal.

Canal C-2 – This canal is located south of C-1, also on the eastern side of Canal C. Land uses include undeveloped land, single and multi-family residential communities (including Venetian Village, Parker Lakes, Tortuga, and Villages of Ascot), and Lakes Regional Library. Runoff from each development is treated and attenuated before it is discharged to Canal C-2.

Canal C-3 – This is the northernmost canal on the western side of Canal C. Land uses include commercial developments between McGregor Blvd. and Gladiolus Drive, single family residential communities along McGregor Blvd., and multi-family residential communities west of Pine Ridge Road. Stormwater runoff from the multi-family residential parcels is treated and attenuated before it discharges into the canal. The single family stormwater runoff is not treated. Stormwater runoff from the commercial parcels is only partially treated and most areas are not treated.

Canal C-4 – This canal is located just south of Gladiolus Drive on the eastern side of Canal C. This canal was filled with the development of Gladiolus Preserve. Land uses include residential (Gladiolus Preserve), commercial development, undeveloped lands, as well as preserve.

Canal C-5 – This Canal is located south of Gladiolus Drive on the western side of Canal C. Land uses within this sub-watershed include residential, commercial and industrial. This sub-watershed is the most highly developed sub-watershed. Most developments were built prior to stormwater treatment and attenuation requirements. As a result, most do not provide treatment or attenuation for stormwater runoff prior to discharging into the canal.

Canal C-6 – This Canal, located on the eastern side of Canal C, was filled as part of the HealthPark development. Runoff from this area discharges into Canal C via overland flow. Land uses within this sub-watershed include multi-family residential, commercial, institutional (HealthPark) and preserve.

Canal C-7 – This canal is located along Kelly Road, south of the Kelly Road Soccer Complex on the western side of Canal C. Land uses include undeveloped land, trailer parks, single family residential, multi-family residential, commercial and industrial. This canal is the most diverse sub-basin in the watershed in terms of land uses.

Canal C-8 – This canal, located on the eastern side of Canal C, just north of Summerlin Road was filled as part of the HealthPark Development. The drainage area is significantly reduced from its original design and now only includes preserve areas along Canal C. For calculation purposes, Canal C-8 has been included within the Canal C drainage area.

Canal C-9 – This canal is located along the northern side of the Fort Myers Beach Water Treatment Plant Percolation ponds on the western side of Canal C. Land uses within this sub-watershed include a trailer park (Lee Plantation), tree nursery and undeveloped lands.

Canal C-10 – This canal is the upstream most secondary canal located on the eastern side of Canal C. It is bisected by the old railroad grade, so only a small portion of the canal discharges to the Deep Lagoon Watershed. This portion located within the Deep Lagoon Watershed is entirely undeveloped.

Canal C-11 – This is the upstream most secondary canal on the western side of Canal C. The drainage area for this canal has been altered by the addition of large ditches along Summerlin road. Much of the runoff now discharges to Canal C through the Summerlin Road Ditch.

HealthPark – HealthPark is a large mixed us development located at the southeastern corner of the Deep Lagoon Watershed. A part of the project, IDD Canals C-8 and C-6 were filled. Due to its size and direct discharge to Canal C, HealthPark has been included as its own sub-watershed.

Water Quality Data:

As part of the Background Summary Report water quality data was obtained for monitoring stations DEEPGR50 and DEEPGR90. The data ranges from October 1990 to April 2014. The sample locations are shown in Appendix A - Watershed Boundary Map. This previously presented data was updated for this report to include May 2014 through June 2016.

The following *Table 1 - Data Summary* provides the maximum and average nutrient concentrations at each location.

Table 1 - Data Summary

Station	TN (mg/L as N)		Phosphorus (mg/L as P)		TKN (mg/L as N)		Ammonia (mg/L as N)		Nitrate+Nitrite (mg/L as N)		Organic N (mg/L as N)	
	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.
DEEPGR50	1.41	9.1	0.24	1.96	1.34	4.6	0.14	0.94	0.16	4.5	1.32	2.1
DEEPGR90	1.66*	6.63*	0.22	1.93	1.61	9.2	0.21	9.2	0.17**	1.63**	1.52	2.7

Data from October 16, 1999 to June 7, 2016

* Potential outlier concentration of 26.0 mg/L excluded

** Potential outlier concentration of 16.8 mg/L excluded

In addition to the Caloosahatchee River Estuary TMDL, FDEP has established state numeric nutrient standards for many water bodies throughout Florida, including TP and Chlorophyll-A levels within the Lower Caloosahatchee River Estuary. While they do not all directly apply to the Deep Lagoon Watershed, the state standards for Peninsular Streams, and San Carlos Bay Estuary have been provided for reference purposes. These standards are summarized in *Table 2 - Florida Water Quality Standards*.

FDEP did not establish a nitrogen numeric standard for TN in The Caloosahatchee River Estuary as it already had a TMDL. Any water body that has a TMDL was excluded from the Numeric Nutrient Standard development.

Table 2 - Florida Water Quality Standards

State Standard	TN (mg/L as N)	TP (mg/L as P)	Chlorophyll-a (ug/L)
Stream – Peninsular	1.54	0.12	N/A
Lower Caloosahatchee River Estuary	N/A	0.040	5.6
San Carlos Bay Estuary	0.44	0.045	3.7

For streams, the geometric annual mean is not to be exceeded more than once per 3-year period. For estuaries, the annual arithmetic mean is not to be exceeded more than once per 3-year period. It is important to note the difference between a geometric mean and an arithmetic mean. An arithmetic mean is the “mean” that is most commonly known. The formula involves adding up all the values and dividing the total by the total number of values in the series. The geometric mean is the product of the number series taken to the root of the total number of values in the series. For example, the geometric mean of 1, 2, and 5 is $\sqrt[3]{1 * 2 * 5} = 2.15$.

Several water quality data graphs were created to help better understand potential water quality patterns and trends. Each of these graphs is shown below, accompanied by a brief explanation. A larger version of each graph is provided in Appendix B - Deep Lagoon Water Quality Graphs.

Deep Lagoon – TN Graph (1993-2016)

Data from 1991 to 1993 was excluded from this graph to eliminate the affect the relative high concentrations during that period have on the trend lines.

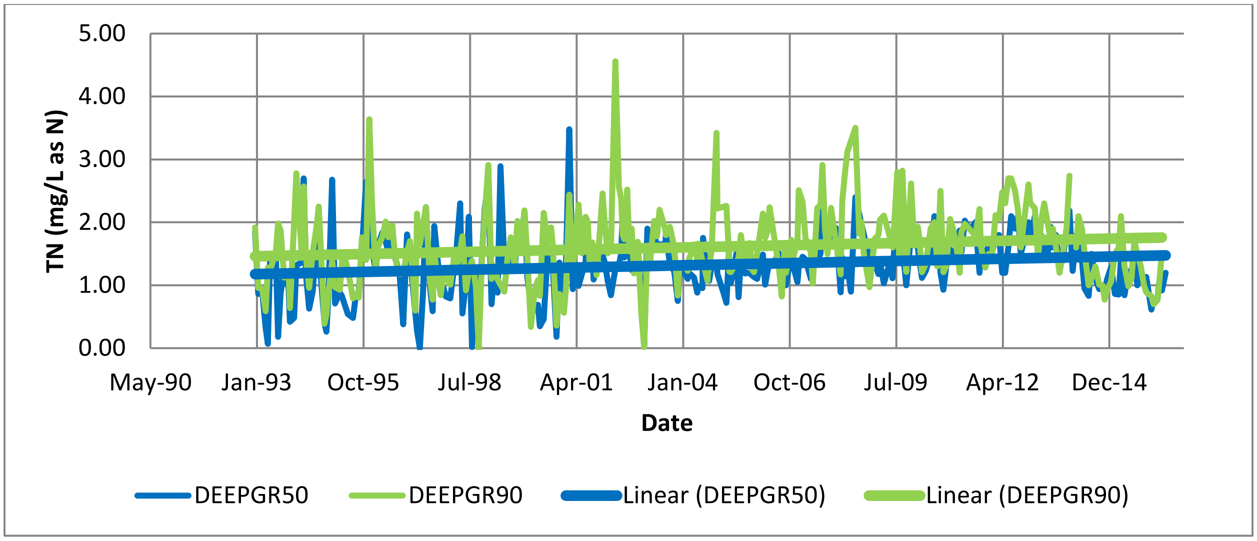


Figure 2 - Deep Lagoon - TN Graph (1993-2016)

This graph shows a trend of increasing TN concentration, reflecting worsening water quality for both sample locations. This indicates there are active nitrogen sources within the watershed that are contributing to the increasing nitrogen levels. This trend does not indicate historical legacy pollutant sources, as those would exhibit a reducing concentration trend.

TN concentrations are generally higher at DEEPGR90 than at DEEPGR50. This could indicate the main source of nitrogen, or even several sources, are located near DEEPGR90.

It should be noted that between 2014 and 2016, the TN levels are generally lower than the previous 6-years. There is a relatively abrupt decline in TN concentration in early 2014. The reason for this is not known, but may be related to Lee County Lab's change in Total Kjeldahl Nitrogen catalyst from Mercuric Oxide to Copper. Per County Staff, this shift occurred on April 1, 2014, and many areas of the County saw a decrease in TN concentrations following the change in catalyst. Additional conversations with County Staff revealed side-by-side tests that showed reduced concentrations when using the Copper catalyst. While the graphs appear to indicate reduced nitrogen concentrations over the 3-year period, this is likely due to a change in testing procedures, rather than an actual reduction in nitrogen concentrations. It will be important to continue to monitor the Deep Lagoon TN trend to determine if this trend continues.

Deep Lagoon Annual Geometric Mean TN (1991-2016)

This graph includes the geometric mean concentration for each year at both water quality monitoring locations and the numeric nutrient criteria for streams.

The stream criterion is based on the annual geometric mean for the water body. It cannot be exceeded more than once in any three-year period.

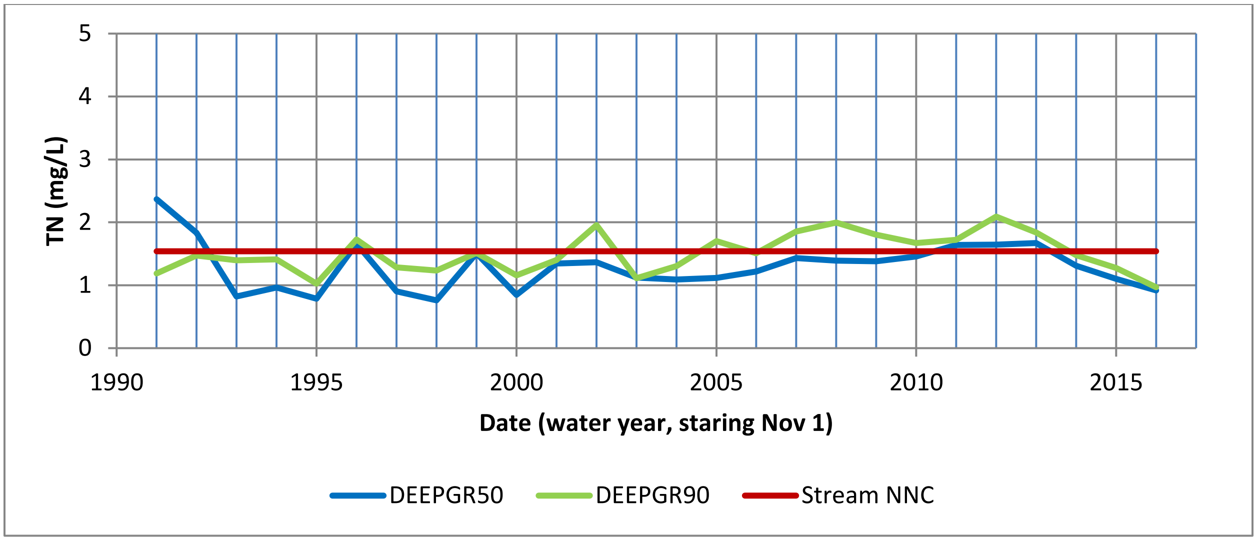


Figure 3 - Deep Lagoon Annual Geometric Mean TN (1991-2016)

From 1992 to 2002, it appears both monitoring locations were generally meeting the numeric standard. However, beginning around 2002, DEEPGR90 began to exceed the standard, followed by DEEPGR50 around 2010. In approximately 2014, the geometric mean concentration fell below the Stream NNC, where it has remained.

As with other graphs, TN concentrations are generally higher at DEEPGR90 than at DEEPGR50. This could indicate the main source of nitrogen is located close to DEEPGR90 or more nitrogen sources are in closer proximity to DEEPGR90.

Like the TN Graph above, the annual geometric mean TN concentrations have declined over the past 3-years. As discussed previously, this is likely due to a change in TKN catalyst as suggested by County Staff and may not be an actual reduction in nitrogen levels.

Deep Lagoon Annual Arithmetic Mean TN (1991-2016)

This graph includes the arithmetic mean concentration for each year at both water quality monitoring locations and the numeric nutrient criteria for San Carlos Bay. The San Carlos Bay criterion is based on the annual arithmetic mean for the water body. It cannot be exceeded more than once in any three-year period.

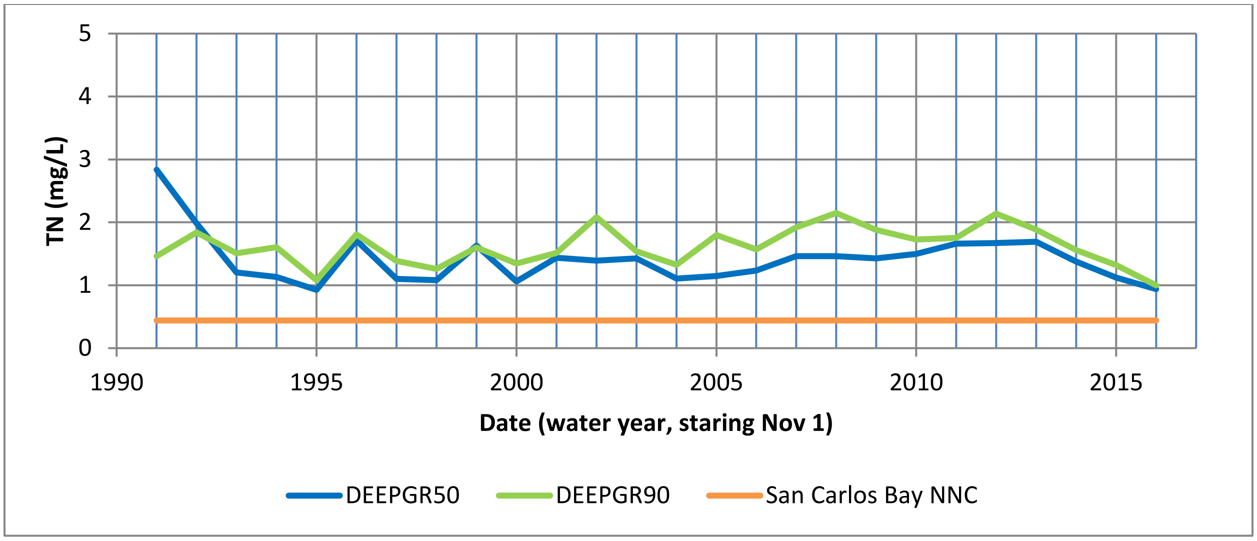


Figure 4 - Deep Lagoon Annual Arithmetic Mean TN (1991-2016)

San Carlos Bay NNC provided for reference purposes only. It does not apply directly to the Deep Lagoon Watershed.

Both water quality monitoring locations have exceeded the San Carlos Bay standard since 1991, the period of record.

TN concentrations at DEEPGR90 are generally higher than the concentration at DEEPGR50.

Similar to the TN Graph above, the annual geometric mean TN concentrations have declined over the past 3-years. This is likely due to a change in TKN catalyst as suggested by County Staff and may not be an actual reduction in nitrogen levels.

For all graphs, TN concentrations at DEEPGR50 are generally lower than the concentrations at DEEPGR90. This indicates that higher TN loads are likely located around DEEPGR90. While investigating potential nitrogen sources, special attention should be paid to areas that drain to IDD Canal C near Summerlin Road. A few properties that are located within proximity to this area include HealthPark, The Fort Myers Beach WWTP Percolation ponds, a tree farm, Thunderbird Community, and Lee Plantation Community. The potential loading rates from HealthPark, the tree farm, Thunderbird Community and Lee Plantation Community are included in the land use loading rates presented later within this report. The potential contribution from the percolation ponds is discussed in the Fort Myers Beach Waste Water Treatment Plant (WWTP) Percolation Ponds section of this report.

TN concentrations were increasing from 1993 to 2013 and begin to decline sharply in 2014. The increasing concentrations indicate active sources of nitrogen within the watershed that are discharging at an increasing rate. Potential sources within the watershed include stormwater runoff (including fertilizer), septic tank leachate, reclaimed water, and legacy nutrient in soils and sediment. These potential sources are discussed in more detail later in this report.

Deep Lagoon TP Graph (1990-2016)

This graph includes DEEPGR50 and DEEPGR90 TP concentrations from 1990 to 2016. Trend lines for both sample locations have also been included.

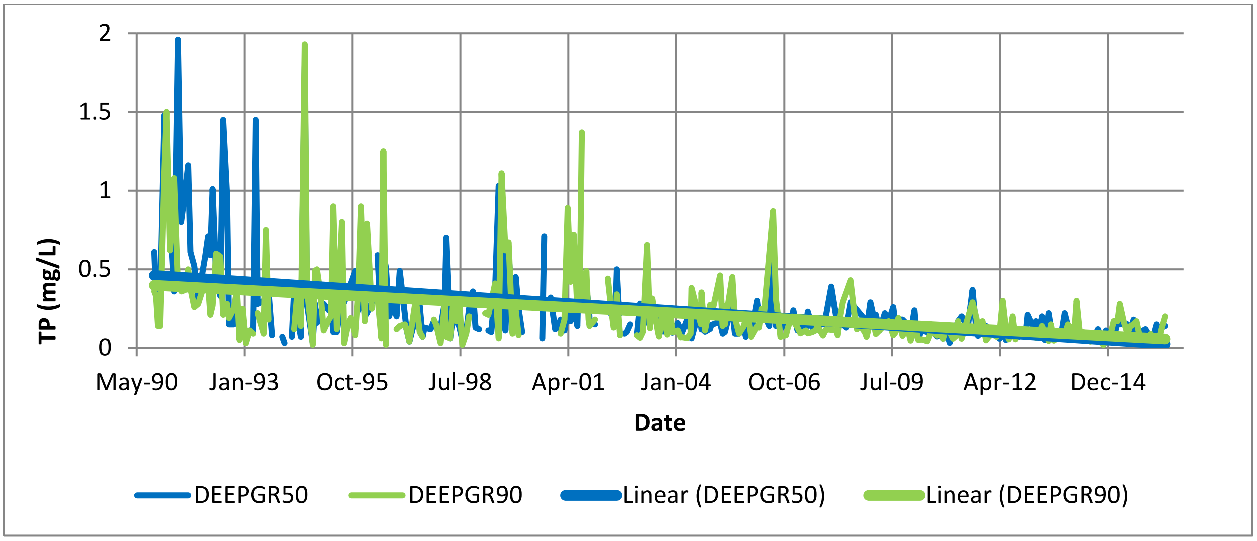


Figure 5 - Deep Lagoon TP Graph (1991-2016)

Trend lines for both sample locations indicate TP concentrations are decreasing over time. This indicates there is improving water quality as it related to TP. It also shows that the historical TP source within the watershed has been removed and/or the source has reduced its TP discharge.

TP concentrations vary between the two sample locations and don't appear to show a trend of one location being higher than the other. This indicates the TP sources are likely distributed more evenly throughout the watershed.

Deep Lagoon Annual Geometric Mean TP (1991-2016)

This graph includes the geometric mean TP concentration from 1991 to 2016 for both DEEPGR50 and DEEPGR90 and the stream numeric nutrient criteria. The stream criterion is based on the annual geometric mean for the water body. It cannot be exceeded more than once in any three-year period.

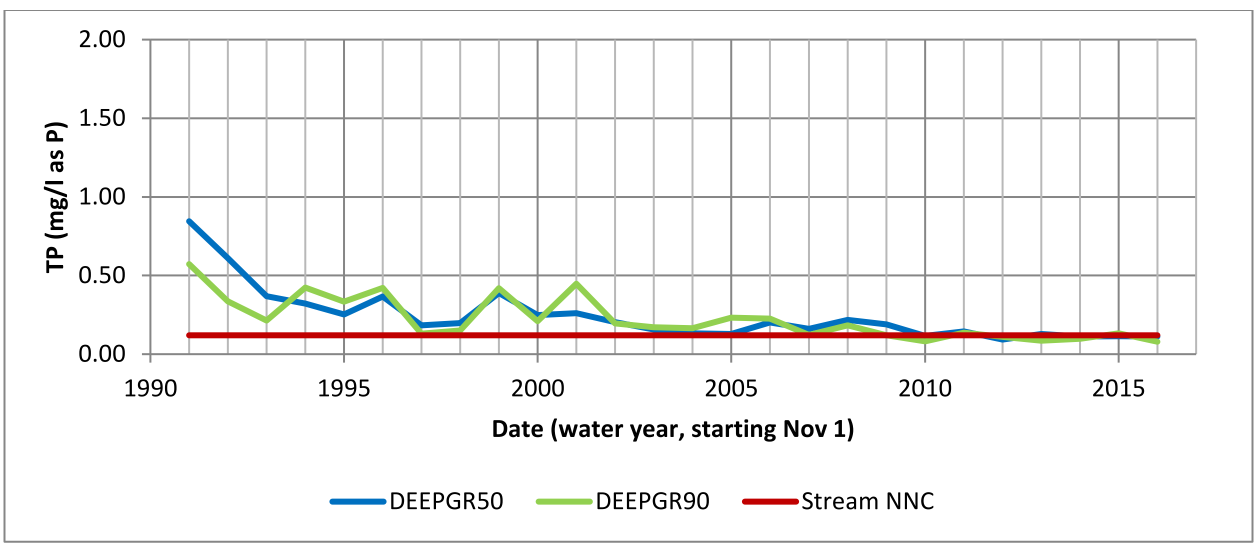
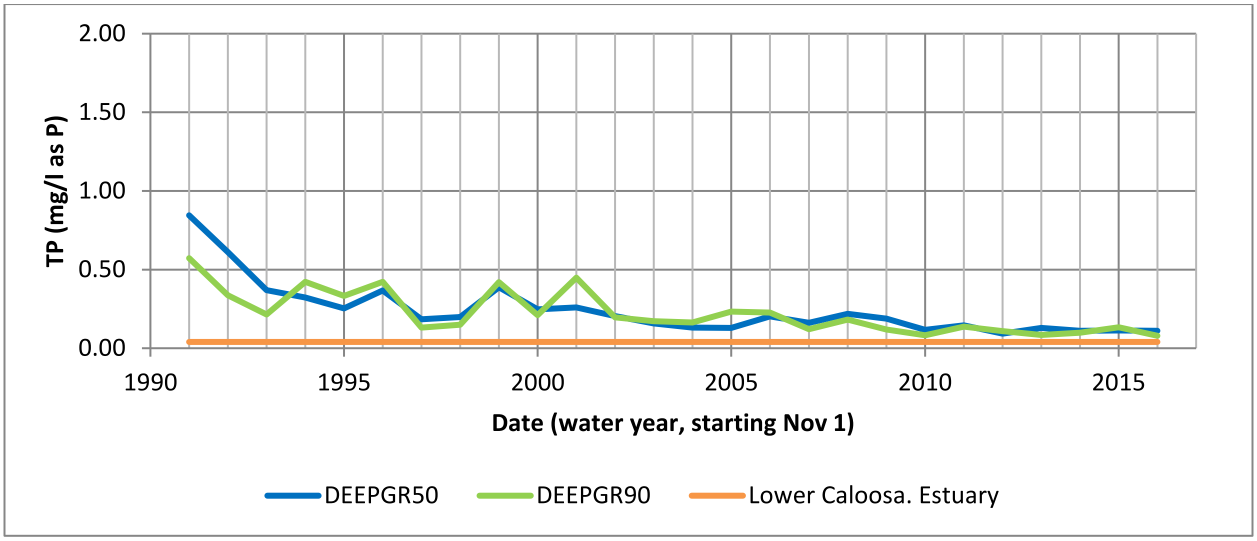


Figure 6 - Deep Lagoon Annual Geometric Mean TP (1991-2016)

Water quality concentrations exceeded the stream standard each year until 2009 and 2010, where DEEPGR90 and DEEPGR50 concentration fell below the standard. Since 2010, concentrations at both monitoring locations have been near or below the standard. Both sample locations show decreasing TP concentrations, indicating improvement in the water quality.

Deep Lagoon Annual Arithmetic Mean TP (1991-2016)

This graph includes the arithmetic mean TP concentration from 1991 to 2016 at both DEEPGR50 and DEEPGR90 and the numeric nutrient criteria for San Carlos Bay. The San Carlos Bay criterion is based on the annual arithmetic mean for the water body. It cannot be exceeded more than once in any three-year period.



San Carlos Bay NNC provided for reference purposes only. It does not apply directly to the Deep Lagoon Watershed.

Figure 7 - Deep Lagoon Annual Arithmetic Mean TP (1991-2016)

Both water quality monitoring locations have exceeded the Lower Caloosahatchee Estuary standard since 1991. However, both show trends of improving water quality. Concentrations over the last several years are very close to the NNC standard.

TP concentrations have generally been decreasing for the entire period of record. Potential reasons for this trend include:

- Existing phosphorus sources are reducing their loads annually
- Loads from historical legacy sources are decreasing
- A combination of both.

From the water quality data, it appears TP sources within the watershed are under control and do not warrant further investigation now. Monitoring of TP levels should continue to ensure any future increasing trends are identified.

Potential Nutrient Sources

Potential nutrient sources within the Deep Lagoon Watershed include the following:

- Land use – The transition from natural areas to developed areas increases the nutrient load from a property and reduces the nutrient uptake provided by the property.
- Reclaimed irrigation water – The use of reclaimed water for irrigation has the potential to introduce a new nutrient source to the watershed.
- Irrigation storage ponds – Irrigation storage ponds, especially unlined ponds, have the potential to introduce additional nutrients through groundwater flows and surface water discharges.
- Effluent percolation ponds – Unlined effluent percolation ponds could introduce additional nutrients to the groundwater table.
- Septic tanks – Like the effluent percolation ponds, septic tanks can potentially add nutrients to the groundwater table.
- Legacy sources – Historical sources can continue to contribute loads within the system several years after the source is removed.

To better understand water quality impacts from some of these potential nutrient sources within the watershed, additional water quality monitoring was performed by Lee County at several locations throughout the watershed from October 2015 – December 2016. The monitoring was focused around the following locations:

- Septic tanks near McGregor Blvd and Willems Road
- Septic tanks near C-7 Canal
- Fort Myers Beach effluent percolation ponds
- Irrigation storage ponds
- Historical farm fields
- Canal sediment

The water quality monitoring locations are shown in Appendix C - Deep Lagoon Monitoring Locations. A list of the parameters analyzed at each location is provided below.

Sucralose

Sucralose (Splenda) is an artificial sweetener that is used in variety of drinks and foods. It was approved for general use in the U.S. in 1998 (FDA, 2017). There are no natural sources of sucralose; It is an entirely man-made substance. When ingested, sucralose is not efficiently broken down by the human body; Much of it goes through the digestive system and exits through human waste. In addition, sucralose is not effectively metabolized by waste water treatment plants (Fitzpatrick, 2014). Due to its wide spread use, it is typically present at detectable levels in waste water treatment plant effluent. Sucralose has an environmental half-life of 1-2 years and can be detected at concentrations as low as 10 ng/L (Fitzpatrick). The presence of sucralose indicates the presence of human waste, septic tank effluent or waste water treatment plant effluent.

Due to the high costs associated with sucralose testing, only the septic tank and percolation pond samples were analyzed for sucralose. In addition, they were only analyzed for the October 12, 2016, December 16, 2015, and July 27, 2016 sample dates.

Acetaminophen

Acetaminophen is a pain relieving medicine that is found in Tylenol and other medications. Acetaminophen is a man-made substance that does not have any natural sources. Like sucralose, acetaminophen is not broken down in the human body, and passes through the digestive system at detectable levels. However, unlike sucralose, acetaminophen is readily removed by waste water treatment plants (Whiting, 2014). The presence of Acetaminophen in stormwater can indicate the presence of waste water that has not gone through a waste water treatment plant. Sources could include untreated waste water or septic tank effluent.

Due to the high costs associated with testing, only the septic tank and percolation pond samples were analyzed for acetaminophen. In addition, they were only analyzed for the October 12, 2016, December 16, 2015, and July 27, 2016 sample dates.

Total Phosphorus

Phosphorus is an essential element for plant growth. However, an excessive amount can cause increased excessive plant growth leading to reduced dissolved oxygen levels. A numeric nutrient criterion of 0.04 Mg/L as P has been established for the Lower Caloosahatchee River Estuary.

Total Kjeldahl Nitrogen (TKN)

TKN is the combination of ammonia and organic nitrogen. TKN concentrations plus Nitrate+Nitrite concentrations equal the total nitrogen concentration. As with phosphorus, nitrogen is an essential element required for plant growth. But, to much of it can lead to overgrowth and reduce dissolved oxygen levels.

Ammonia

Ammonia is the NH_4 portion of the total nitrogen.

Nitrate+Nitrite

Nitrate+Nitrite is the NO_2 and NO_3 portion of the total nitrogen. Nitrate+Nitrite concentrations plus TKN concentrations equal the total nitrogen concentration.

Chlorophyll-A

Chlorophyll is the green pigment in plants. When measured within the water column, this provides a measured estimate of the plant activity within the water column. High Chlorophyll levels indicate high plant productivity which can indicate high nutrient levels.

Dissolved Oxygen (DO)

DO is a measure of the amount of oxygen within the water column. Low levels within the water column can indicate high plant productivity that could be caused by high nutrient levels.

DO Saturation Percentage

DO concentrations are affected by water temperature. High water temperatures will result in lower DO levels. Measuring DO only in a warm water body could indicate low DO levels, which could be attributed to water temperature, and not water quality. The DO saturation percentage corrects for the water temperature.

pH

pH is the unit of measure for water's acidity or alkalinity. For natural waterbodies, pH ranges from 6 – 9 (Snoeyink & Jenkins, 1980). Higher or lower levels can indicate a pollution source.

Specific Conductance

Specific conductance is a measure of the ability of water to conduct electricity. In natural waterbodies, this measurement is used as a surrogate for water salinity. This provides an indication of tidal water influence. A high specific conductance indicates high salinity and a likely influence from tidal waters. Changes in specific conductance at a monitoring site can indicate changes from tidal to freshwater influence.

Total Nitrogen

Total nitrogen is the measure of all nitrogen compounds within a water sample including organic, ammonia and Nitrate + Nitrite. There is no single test to determine the total nitrogen concentration. TN concentrations are determined by adding the TKN (organic + ammonia) concentration to the Nitrate + Nitrite concentration. TN is the regulated surface water concentration. The Cocohatchee River Estuary has been identified as impaired for nitrogen, and a reduction goal of 23% has been established.

A detailed explanation of the monitoring results is provided later in this report.

Land Use

As a watershed transitions from native vegetation to agricultural, residential, commercial, or industrial land uses, nutrient loading rates typically increase. This is due to a combination of increased nutrient production and reduced nutrient uptake. Increased nutrient loads can be created through the use of fertilizers and the discharge of waste water effluent. Fertilizers are applied extensively within agricultural, golf course, and residential lands uses. While still used within commercial and industrial land uses, the rate and frequency of applications are typically much less.

Within the Deep Lagoon Study area, waste water effluent is potentially introduced into the stormwater system through septic tank leachate, use of reclaimed water for irrigation, and storage of reclaimed water in unlined ponds. The extent to which waste water impacts stormwater quality is not included within the land use nutrient loading analysis. Its impacts are estimated and addressed within other sections of this report.

Reduced nutrient uptake is the result of impervious areas replacing pervious areas and native vegetation. Impervious areas prevent rainfall from percolating into the surrounding soil. This increases the volume of stormwater runoff and the associated nutrients, resulting in higher nutrient loads. As vegetation is cleared, the natural nutrient uptake from the plants is removed from the landscape. Nutrients that were previously stored in the soil or used by plants to grow now discharge downstream, further increasing the nutrient loads.

Nutrient loading rates within the study area were estimated using the methodology outlined in *Evaluation of Current Stormwater Design Criteria within the State of Florida*, prepared by Harvey, H. Harper, Ph.D., P.E. and David M. Baker, P.E. of Environmental Research & Design, Inc. This methodology estimates the nutrient concentration and loading rate based on land use type and expected runoff characteristics. Nutrient Loading calculations have been provided in Appendix H - Nutrient Loading Calculations. To simplify the estimated loading rate calculations within this report, the treatment efficiency for stormwater treatment systems was estimated to be 40% for TN and 60% for TP. It is not practical to provide detailed treatment efficiency calculations within the scope of this project. The nutrient loading rates were estimated using ARC-GIS software. Loading rates and runoff coefficients were applied to each property based on its specific land use. Nutrient removal credit for stormwater treatment was taken for those properties that have lakes within their stormwater management system. The loading rates in lb./yr. were then added together for each drainage basin giving a total loading rate. This loading rate was then divided by the contributing area to get the loading rate per ac. The estimated concentration was also calculated by dividing the loading rate by the estimated volume of stormwater runoff.

A summary of loading rates for each sub-watershed and the entire Deep Lagoon Study area has been provided in Table 3 - IDD Canal Pollutant Loading Summary. It is important to note that these loading rates are for typical land uses, and do not consider any unique sources, such as septic tanks or percolation ponds, that could be present within the watershed.

Table 3 - IDD Canal Pollutant Loading Summary

	Nitrogen					Phosphorous				
Basin	Load (kg/yr)[3]	Load per Ac. (kg/yr/ac)	Rank	Conc. (mg/L)	Rank	Load (kg/yr)[3]	Load per Ac. (kg/yr/ac)	Rank	Conc. (mg/L)	Rank
C	1,928	2.1	7	1.38	1	185	0.20	9	0.13	6
C-1	1,047	3.2	2	1.34	3	139	0.42	2	0.18	2
C-2	872	2.8	5	1.27	4	105	0.34	6	0.15	4
C-3	778	3.4	1	1.26	5	107	0.47	1	0.17	3
C-4	233	2.1	8	1.24	6	23	0.21	8	0.12	9
C-5	786	3.0	4	1.11	9	103	0.39	4	0.15	5
C-6	-	-	-	-	-	-	-	-	-	-
C-7	1,212	2.8	6	1.35	2	164	0.38	5	0.18	1
C-8	-	-	-	-	-	-	-	-	-	-
C-9	260	1.6	10	1.17	7	28	0.17	10	0.13	8
C-10	41	0.9	11	1.15	8	2	0.04	11	0.06	11
C-11	390	1.8	9	0.98	11	46	0.21	7	0.12	10
Health Park	1,242	3.1	3	1.03	10	159	0.40	3	0.13	7
Total	**8,790**	**5.7**		**1.23**		**1,062**	**0.31**		**0.15**	

Each basin has been ranked based on TN and TP loading rate per acre (kg./yr./ac) and concentration (mg/L). The highest ranked basins are colored red, and the lowest are colored green.

For TN, the highest loading rates are drainage basins C-3, C-1, HealthPark, and C-5. The highest concentrations are found in drainage basins C, C-7, C-1, and C-2. Efforts to provide structural BMPs to remove TN loads from the Deep Lagoon Watershed should consider treating the water from these drainage basins.

The highest TP loading rates are found in drainage basins C-3, C-1, HealthPark, and C-5. The highest concentrations are in drainage basins C-7, C-1, C-3 and C-2. Efforts to provide structural BMPs to remove TN loads from the Deep Lagoon Watershed should consider treating the water from these drainage basins.

Reclaimed Irrigation Water

Reclaimed water is used within and adjacent to the Deep Lagoon Study area for landscape irrigation. Reclaimed water is provided by two sources, Fort Myers Beach Waste Water Treatment Plant and Fiesta Village Advanced Waste Water Treatment Plant.

Reclaimed waste water has the potential to impact surface water quality when it is used for irrigation. Nutrients within the irrigation water, if not utilized by vegetation, can flow off the irrigated land and discharge to surface water bodies. This increases the nutrient load to the water body, potentially contributing to nutrient enrichment.

Fort Myers Beach WWTP is a conventional treatment plant that does not provide advanced treatment for nutrient reduction. It has relatively high nutrient concentration when compared to typical surface water concentrations. Effluent water quality data from the discharge monitoring report is provided in Appendix I - Fort Myers Beach WWTP Effluent Water Quality Data. A summary of this data is provided below.

Table 4 – Fort Myers Beach WWTP Effluent WQ Summary

	TN (mg/L)	TP (mg/L)
Average	10.24	4.10
Max.	18.48	7.20

(Data from FDEP Discharge Monitoring Reports Jan 2014 to Oct 2014, excluding Sept 2014 data not available)

Both TN and TP concentrations are higher than typical surface water concentrations. These concentrations are five to sixteen times the average concentrations within the Deep Lagoon Watershed.

As an advanced waste water treatment plant, Fiesta Village provides additional nutrient removal, producing a higher quality effluent. Effluent water quality data from the discharge monitoring report is provided in Appendix J - Fiesta Village AWWTP Effluent Water Quality Data. A summary of this data is provided below.

Table 5 – Fiesta Village AWWTP Effluent WQ Summary

	TN (mg/L)	TP (mg/L)
Average	0.76	0.1
Max.	1.17	0.41

(Data from FDEP Discharge Monitoring Reports Jan 2014 to Sept 2014, excluding March 2014 data not available)

The effluent water quality from the Fiesta Village treatment plant is similar to the NNC for freshwater streams within Lee County. However, they are a little higher than the San Carlos Bay Estuary NNC of TN=0.44 and TP=0.045 mg/L and the Caloosahatchee River Estuary TP NNC of 0.04 mg/L.

To better understand the potential impacts irrigation water could have on water quality, monitoring stations were established at three sites: Gulf Harbour, Crown Colony and Heritage Cove. Gulf Harbour is a residential golf course community that receives reclaimed water from the Fort Myers Waste Water Treatment Plant, and Crown Colony is a residential golf course community that receives reclaimed water from the Fiesta Village Advanced Waste Water Treatment Plant. Heritage Cove is a residential community (without a golf course) that does not receive reclaimed water, and is used to estimate a background concentration. The approximate monitoring locations are identified on Figure 8 - Irrigation Water Storage Pond Monitoring and Appendix C - Deep Lagoon Monitoring Locations.

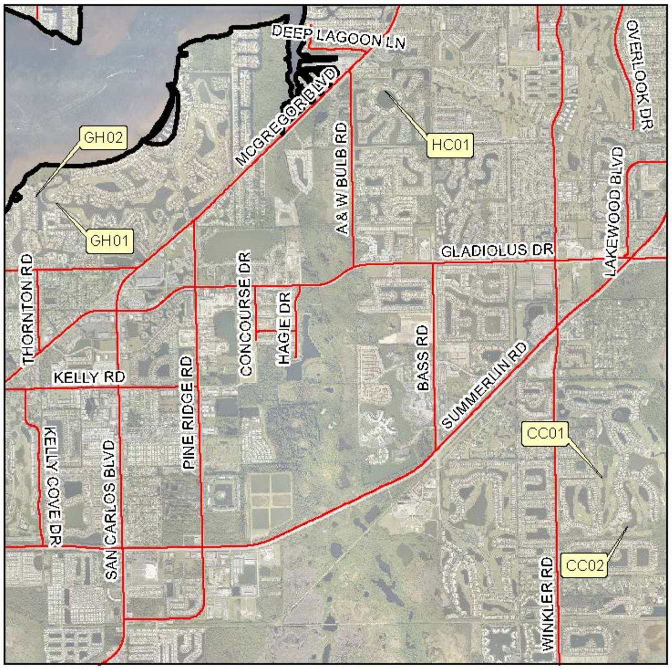


Figure 8 - Irrigation Water Storage Pond Monitoring

CC02 – Crown Colony outfall pond
GH02 – Gulf Harbour outfall pond
HC01 – Heritage Cove outfall pond

At all three sites, the samples were taken at the project's outfall lake. Water quality samples were obtained from October 2015 through September 2016. Two monthly samples were obtained during the wet season months of May, September, and one monthly sample during the dry season months of October - April. Each sample was analyzed for Total Phosphorus, Total Kjeldahl Nitrogen, Ammonia, Nitrate + Nitrite, Chlorophyll-A, Dissolved Oxygen, pH and Specific Conductance. Due to high costs, sucralose and acetaminophen were only analyzed for the October 12, 2016, December 16, 2015, and July 27, 2016 samples. Summary graphs for each parameter are provided below and included in Appendix K - Irrigation Pond Graphs. The following is a summary of the results:

<u>Note: Graph scales differ between sample locations</u>.

Acetaminophen: The October 12th samples identified Acetaminophen being present in the CC02 sample only. The source of Acetaminophen in the samples is not known, as no obvious sources are located nearby.

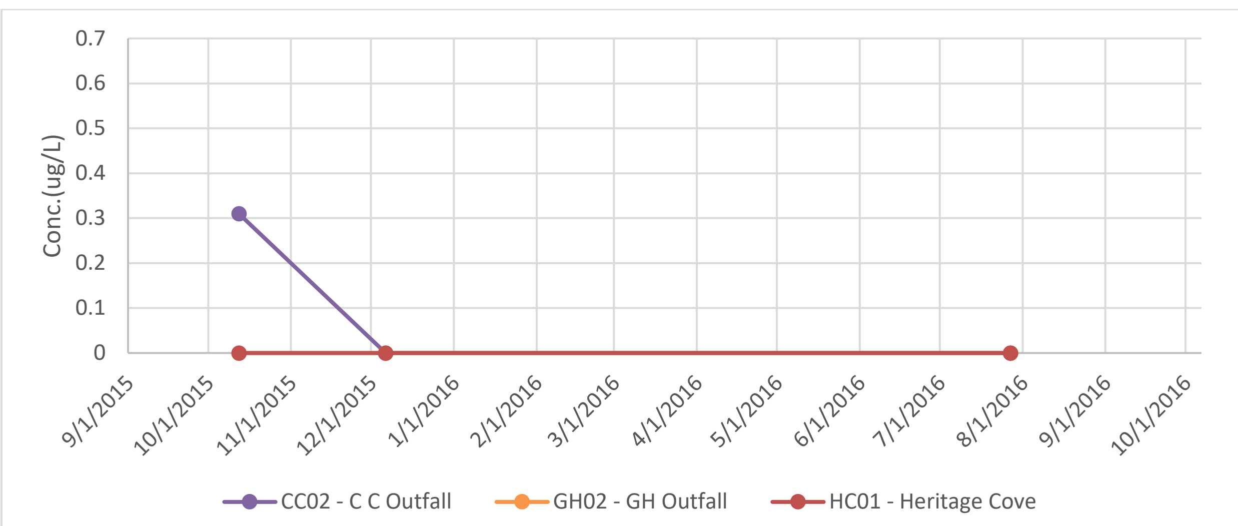


Figure 9 - Irrigation Site Acetaminophen

Sucralose: The CC02 monitoring site had detectable concentrations of Sucralose in two of the three samples taken. There were no samples at GH02 or HC01 that had levels of Sucralose above the minimum detection limits.

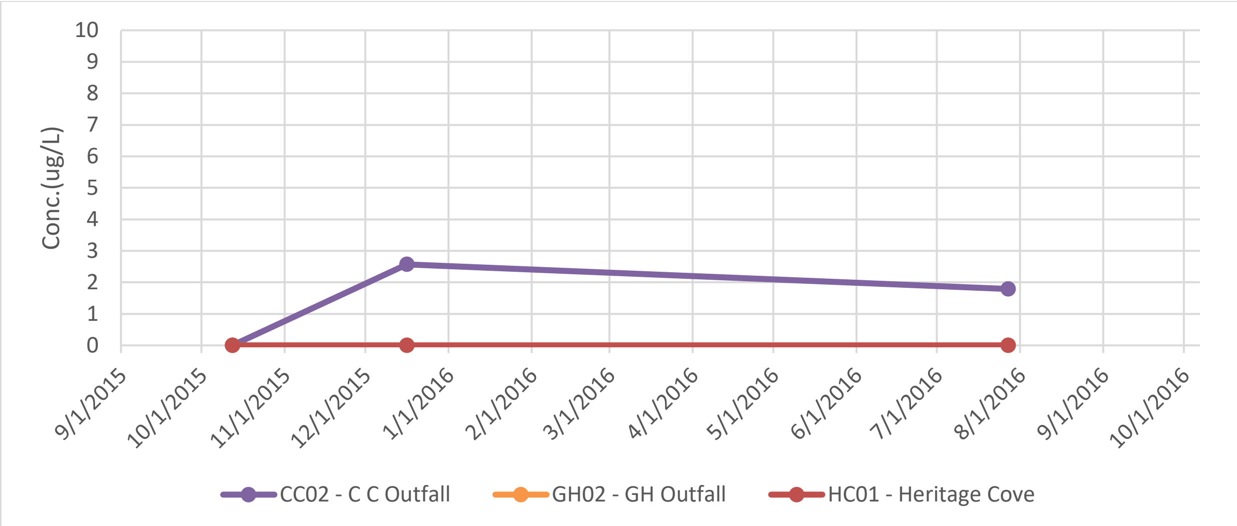


Figure 10 - Irrigation Site Sucralose

Sucralose does not have any natural sources. Its presence indicates as human source, likely treated or untreated wastewater. Its presence in the Crown Colony outfall pond indicated reclaimed water is likely getting into the stormwater system.

Total Nitrogen: The total nitrogen concentrations were all relatively consistent and below 2.0 mg/L in all samples.

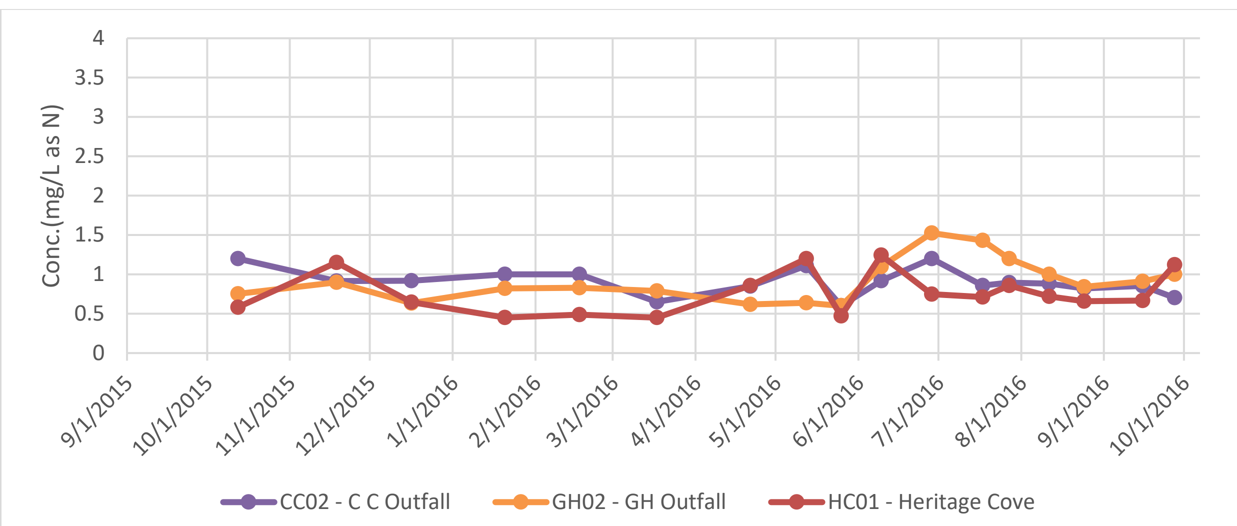


Figure 11 - Irrigation Site TN

The average concentration at each location are as follows:

CC02 – 0.91 mg/L as N
GH02 – 0.92 mg/L as N
HC01 – 0.77 mg/L as N

While water quality standards do not directly apply to these lakes, a comparison is provided for reference purposes. The average concentrations were all below the numeric nutrient criteria (NNC) for peninsular streams of 1.54 mg/L as N. However, they were all above the San Carlos Bay Estuary NNCs of 0.44 mg/L as N.

Both the Crown Colony (CC02) and Gulf Harbour (GH02) outfall lakes have somewhat higher concentrations than the Heritage Cove lake (HC01), which does not receive reclaimed water. Both Gulf Harbour and Crown Colony have 18-hole golf courses, which would be expected to contribute to the TN loading. Heritage Cove does not have a golf course. The higher TN concentrations at Crown Colony could be the result of the golf course, or irrigation water, or a combination of both. Additional study would be required to determine the source.

It is important to note that the significantly different TN concentrations going to each site do not appear to impact TN levels. Gulf Harbour receives much higher TN concentrations from the Fort Myers Beach WWTP than Crown Colony does from the Fiesta Village plant. However, TN concentrations within Gulf Harbour are basically the same at Crown Colony. This could be due to assimilation within the ponds and/or the larger mixing volume within the Gulf Harbour lake.

Total Phosphorus: The TP levels were the highest within Gulf Harbour (GH02) lake. Heritage Cove (HC01) has the lowest concentrations but the Crown Colony outfall lake (CC02) had very similar concentrations.

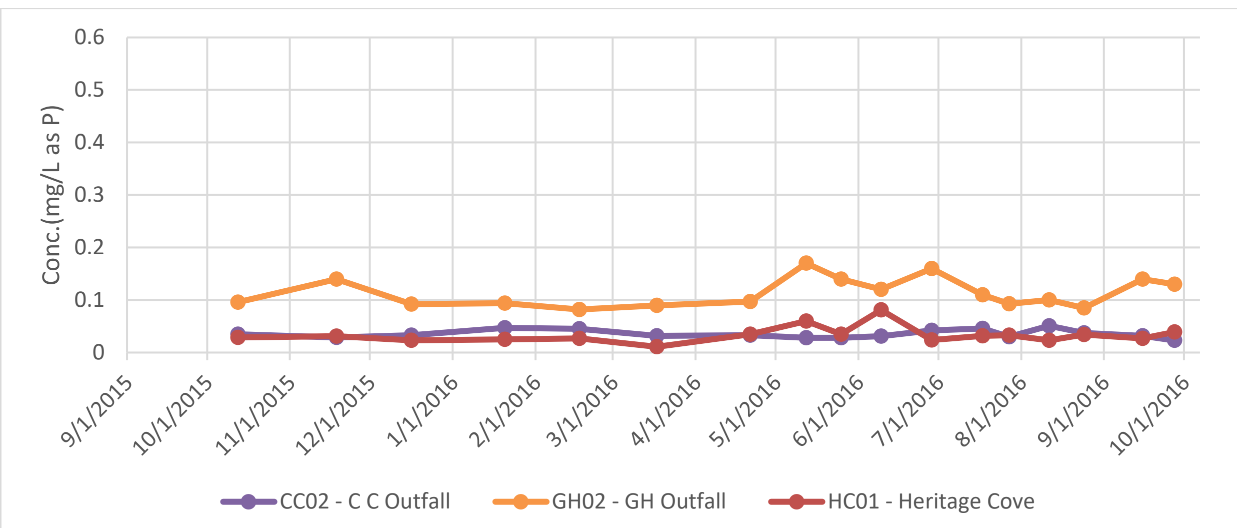


Figure 12 - Irrigation Site TP

Following is a summary of the average concentrations.
CC02 – 0.04 mg/L as P

GH02 – 0.11 mg/L as P
HC01 – 0.03 mg/L as P

The higher TP concentrations within the Gulf Harbour lakes could be a result of the higher TP concentrations within the Fort Myers Beach Plant water or a result of different operational practices on the property. The outfall lake (GH02) has significantly lower TP concentration, potentially indicating the high TP is from the plant effluent.

At Crown Colony, concentrations in the outfall lake are similar to the concentrations at Heritage Cove.

Ammonia: Concentrations at all locations were below 0.2 mg/L as N in all samples. Many of the samples did not have detectable levels of ammonia.

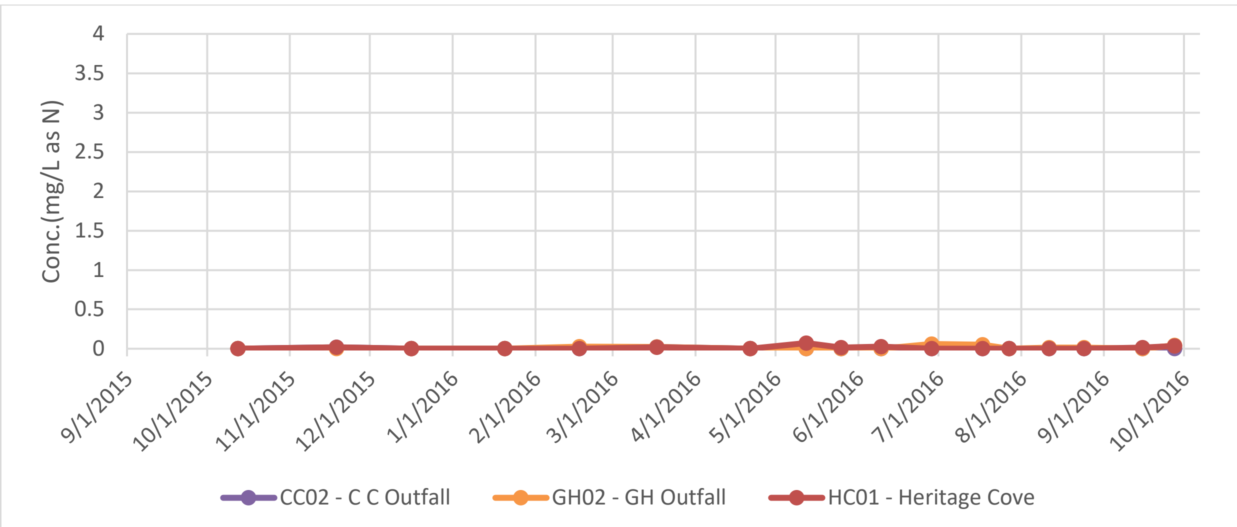


Figure 13 - Irrigation Site Ammonia

The following is a summary of the average concentrations:
CC02 – 0.00 mg/L as N
GH02 – 0.01 mg/L as N
HC01 – 0.01 mg/L as N

Most of the nitrogen found within the ponds is not in the form of ammonia.

Nitrate + Nitrite: Similar to ammonia, concentrations at all locations were low or below the minimum detection limits. There was a spike of N+N levels in CC01 in the 11/18, 12/16, 1/20 and 2/17 samples with a peak of 0.43 mg/L as N. All other samples were below 0.1 mg/L as N.

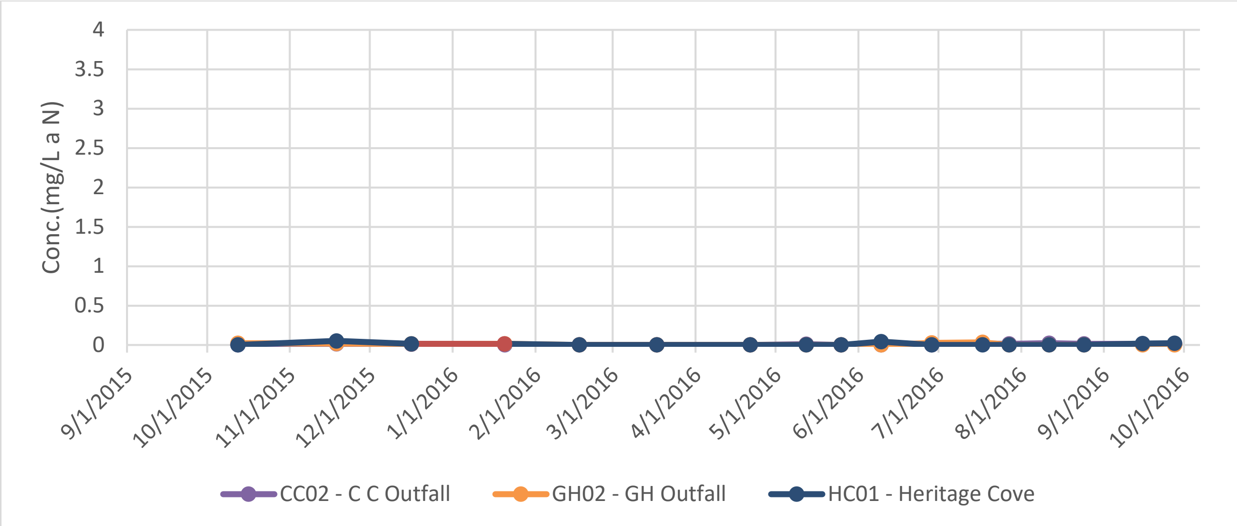


Figure 14 - Irrigation Sites N + N

The following is a summary of the average concentrations.

CC02 – 0.01 mg/L as N
GH02 – 0.01 mg/L as N
HC01 – 0.01 mg/L as N

Most the nitrogen found within the ponds is not in the form of Nitrate + Nitrite.

Total Kjeldahl Nitrogen: Individual and average concentrations for each sample are similar to TN concentrations, indicating most the TN is in the form of ammonia or organic nitrogen.

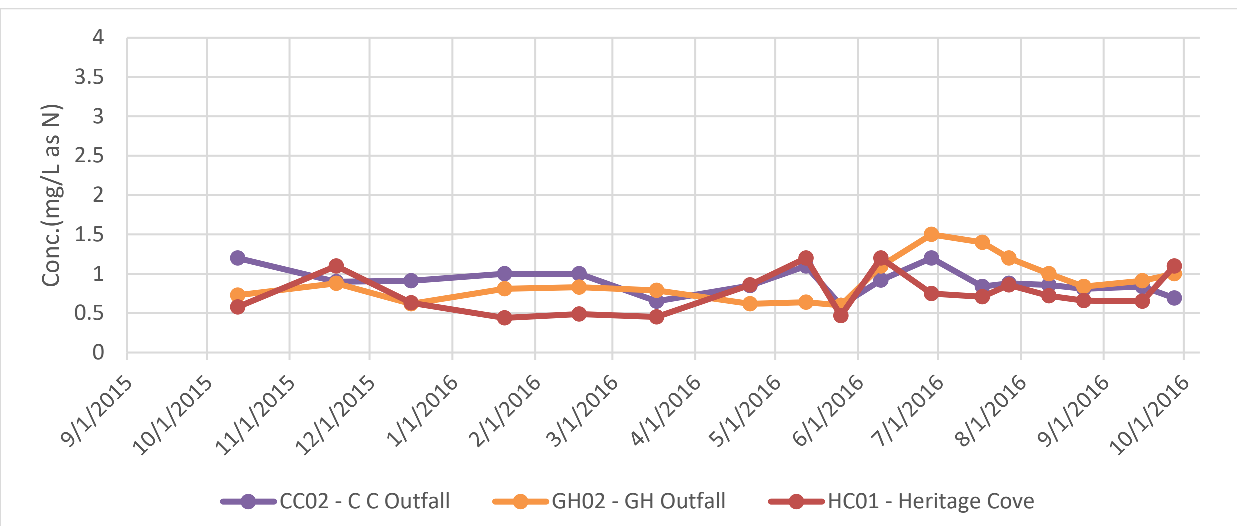


Figure 15 - Irrigation Site TKN

The following is a summary of the average concentrations:
CC02 – 0.90 mg/L as N
GH02 – 0.91 mg/L as N
HC01 – 0.76 mg/L as N

Organic Nitrogen: Individual and average concentrations for each sample are similar to TN concentrations, indicating most of the TN is in the form organic nitrogen.

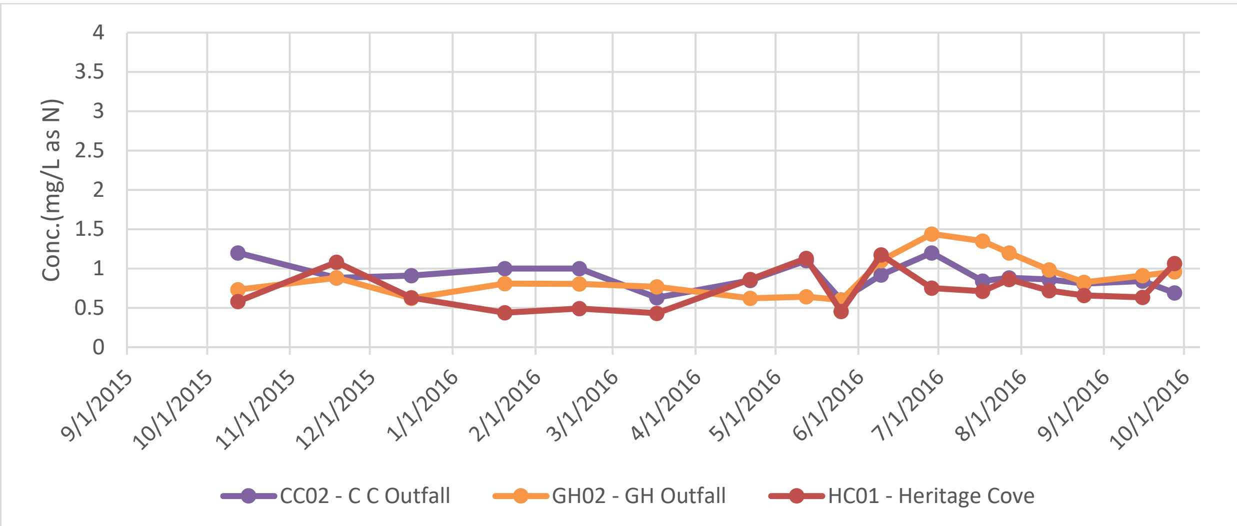


Figure 16 - Irrigation Site Organic N

The following is a summary of the average concentrations:
CC01 – 0.89 mg/L as N
GH01 – 0.90 mg/L as N
HC01 – 0.75 mg/L as N

Chlorophyll A: During the monitoring period, Chlorophyll A levels were generally higher during the dry season, and lower during the wet season.

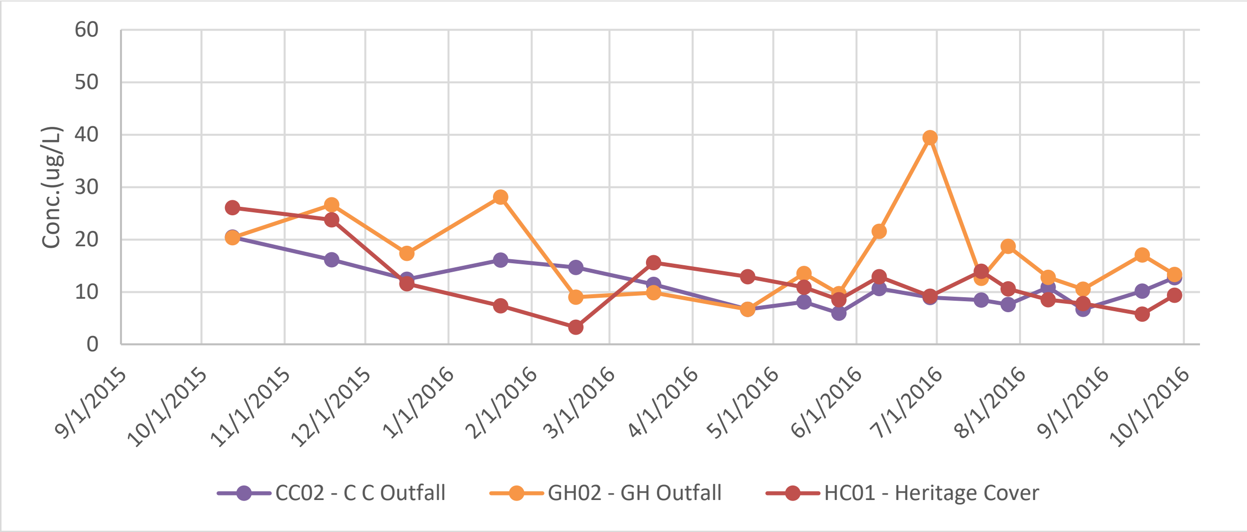


Figure 17 - Irrigation Site Chlorophyll A

The following is a summary of the average concentrations:

CC01 – 11.1 ug/L
GH01 – 16.9 ug/L
HC01 – 11.6 ug/L

Specific Conductance: Specific conductance was very consistent at each monitoring locations. The stable levels indicate a relatively consistent influence or non-influence from tidal water bodies.

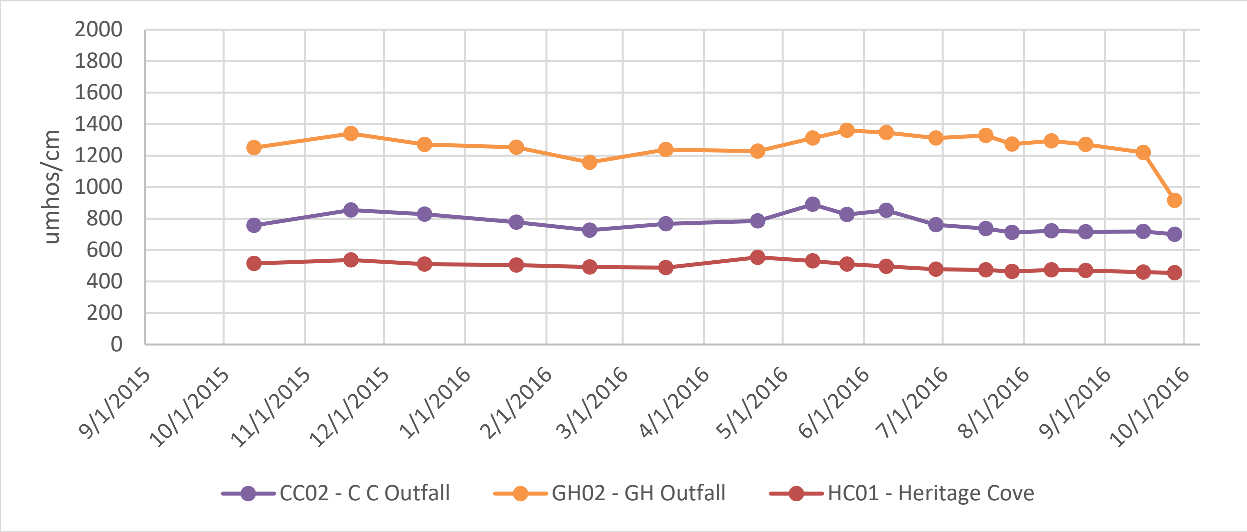


Figure 18 - Irrigation Site Specific Conductance

The following is a summary of the average specific conductance:

CC02 – 772 umhos/cm
GH02 – 1257 umhos/cm
HC01 – 495 umhos/cm

The higher levels at Gulf Harbour indicate more tidal influences than at Crown Colony or Heritage Cove. This is expected due to the proximity of Gulf Harbour to the Caloosahatchee River.

Irrigation Water Storage Ponds

Reclaimed water is stored within lined and unlined storage ponds throughout and adjacent to the Deep Lagoon Watershed. These ponds have the potential to impact nutrient levels in the surrounding groundwater and surface water. The extent of any impacts is determined by the nutrient levels in each pond and the soil properties surrounding each pond. High nutrient concentrations within a pond and soils that allow high groundwater flows could lead to water quality impacts in the surrounding groundwater and surface water. Meanwhile, ponds with low nutrient levels and soils that allow less groundwater flow will likely lead to minor or no impacts to the surrounding groundwater and surface water. If a lake/pond liner is installed and maintained correctly, lined storage ponds should have no impact on the surrounding groundwater or surface water quality.

There are several ponds within the Deep Lagoon Watershed that store reclaimed water for irrigation purposes. The extent to which these ponds could impact water quality is not fully known. To better understand their potential impacts on surface water quality, pond water quality was monitored at three sites: Gulf Harbour, Crown Colony and Heritage Cove. Groundwater flows from these ponds were not investigated; Only water quality within the ponds was monitored. Gulf Harbour is a residential golf course community that receives reclaimed water from the Fort Myers Waste Water Treatment Plant and Crown Colony is a residential golf course community that receives reclaimed water from the Fiesta Village Advanced Waste Water Treatment Plant. Heritage Cove is a residential community (without a golf course) that does not receive reclaimed water and is used to estimate a background concentration. The approximate sampling locations are identified on Figure 19 - Irrigation Water Storage Pond Monitoring Sites and Appendix C - Deep Lagoon Monitoring Locations.

CC01 – Crown Colony reclaimed water storage pond.
GH01 – Gulf Harbour reclaimed water storage pond
HC01 – Heritage Cove outfall pond

Monitoring locations were established at the Gulf Harbour, Crown Colony, and Heritage Cove sites. At Gulf Harbour and Crown Colony, the monitoring site was in the reclaimed water storage ponds. The Heritage Cove sample was taken at the project's outfall lake. Water quality samples were obtained from October 2015 through September 2016. Two monthly samples were obtained during the wet season months of May - September and one monthly sample during the dry season months of October - April. Each sample was analyzed for Total Phosphorus, Total Kjeldahl Nitrogen, Ammonia, Nitrate + Nitrite, Chlorophyll-A, Dissolved Oxygen, pH and Specific Conductance. Due to high costs, sucralose and acetaminophen were only analyzed for the October 12, 2016, December 16, 2015, and July 27, 2016 samples. Summary graphs for each parameter are provided below and included in Appendix K - Irrigation Pond Graphs. The following is a summary of the results:

Acetaminophen: The October 12th samples identified Acetaminophen being present in the CC01 and GH01 samples. The only other sample found to have Acetaminophen present was the July 27th sample in the GH01 monitoring location. The source of Acetaminophen in the samples is not known, as no obvious sources are located nearby.

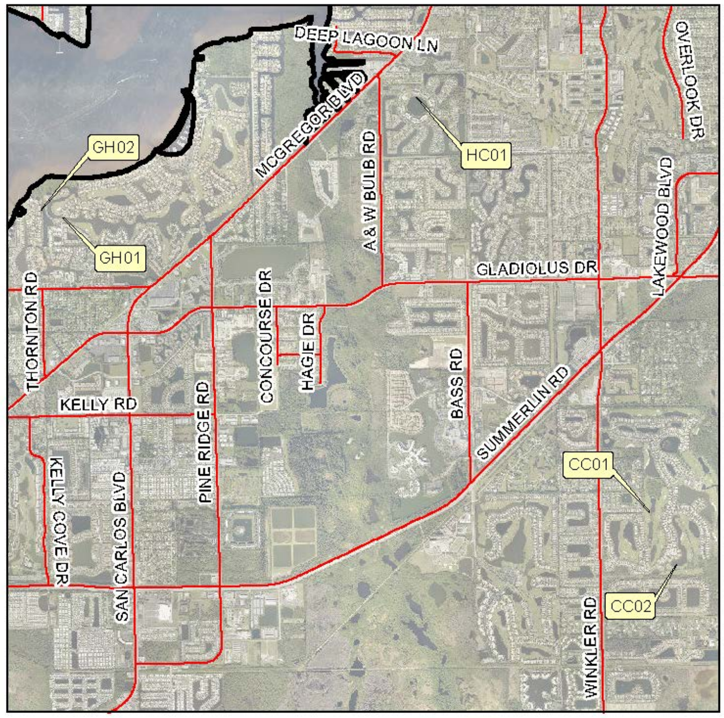


Figure 19 - Irrigation Water Storage Pond Monitoring Sites

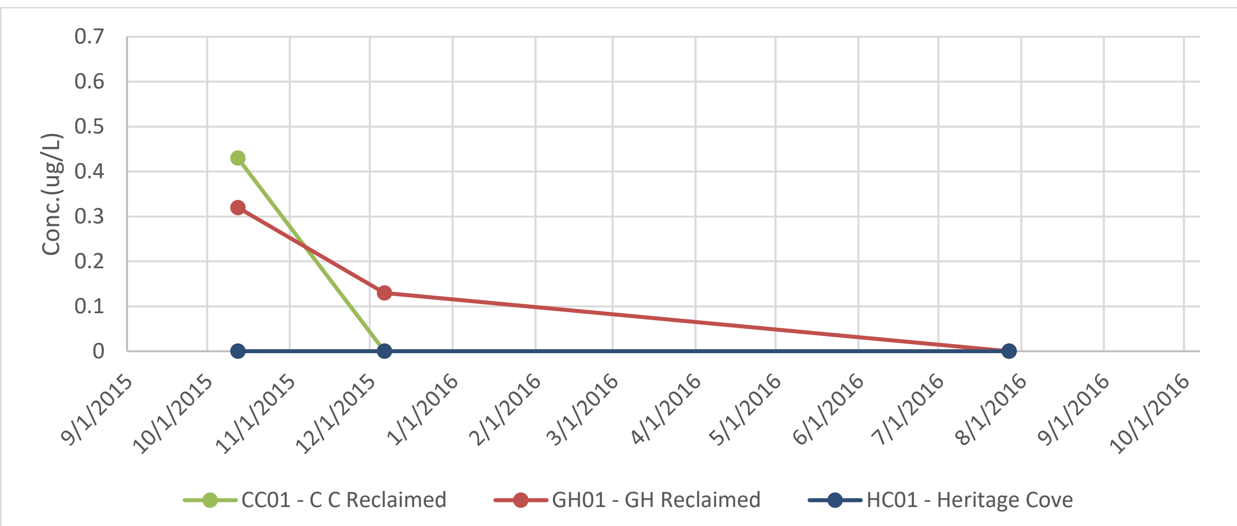


Figure 20 - Irrigation Pond Acetaminophen

Sucralose: The CC01 monitoring site had detectable concentrations of Sucralose in two of the three samples taken. GH01 had detectable concentration in one sample. There were no samples at HC01 that had levels of Sucralose above the minimum detection limits. The highest concentrations were found in the July samples at CC01 and GH01. These are the lakes that directly receive reclaimed water. None of the Heritage Cove samples contained detectable levels of sucralose.

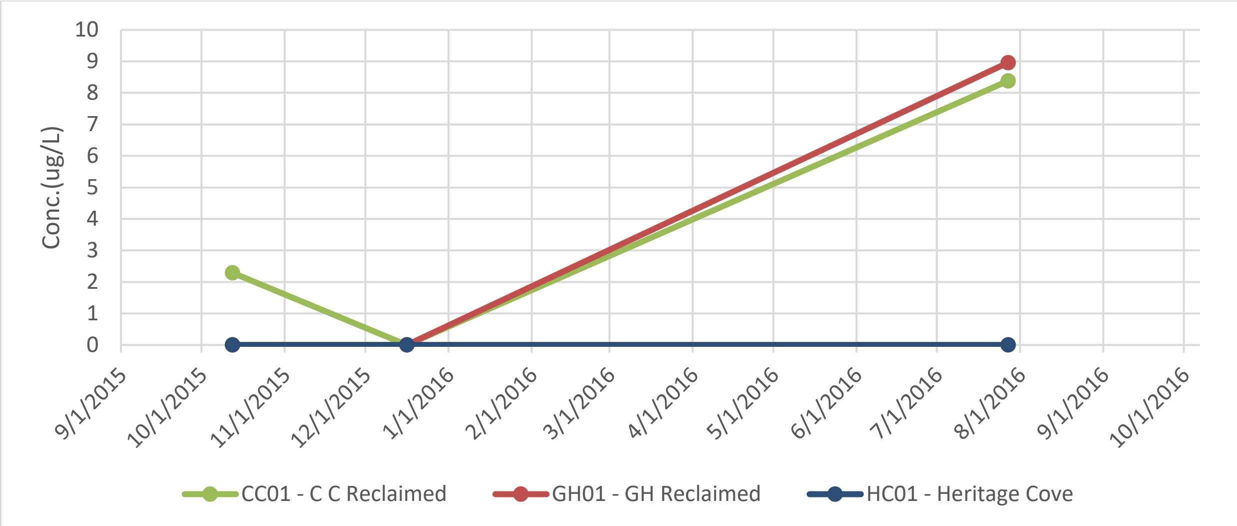


Figure 21 - Irrigation Pond Sucralose

Sucralose does not have any natural sources. Its presence indicates as human source, likely treated or untreated wastewater. As expected, this indicates the Crown Colony and Gulf Harbour lakes receive water from a wastewater source. In this case, it is from the reclaimed water from the Fort Myers Beach WWTP that is used for onsite irrigation. The presence in the Crown Colony outfall pond indicated reclaimed water is likely getting into the stormwater system.

Total Nitrogen: The total nitrogen concentrations were all relatively consistent and below 2.0 mg/L in all samples.

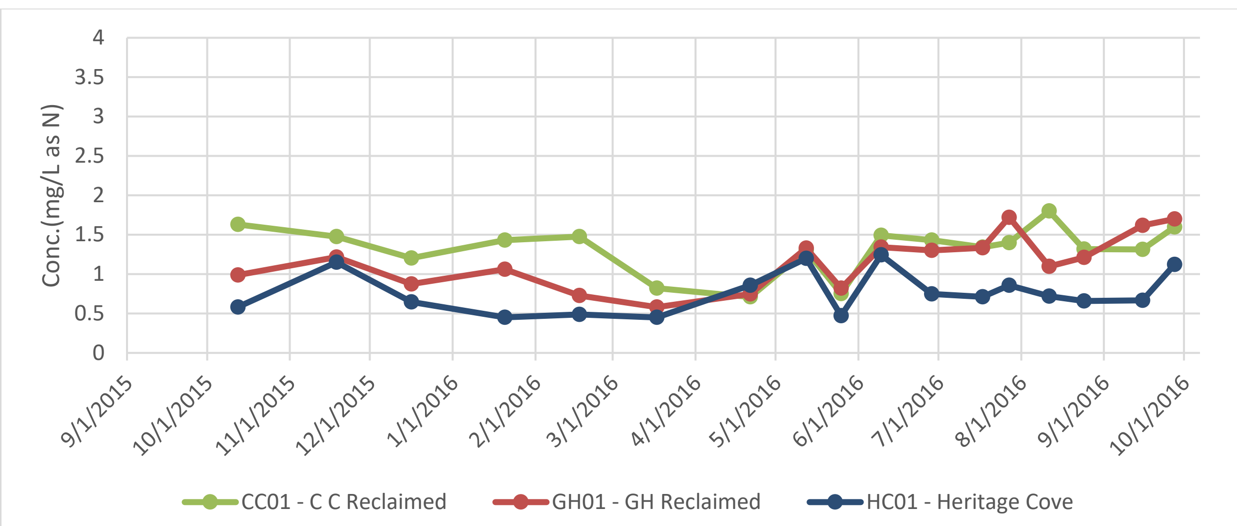


Figure 22 - Irrigation Pond Total Nitrogen

The average concentrations at each location are as follows:

CC01 – 1.32 mg/L as N
GH01 – 1.16 mg/L as N
HC01 – 0.77 mg/L as N

While water quality standards do not directly apply to these lakes, a comparison is provided for reference purposes. The average concentrations were all below the numeric nutrient criteria (NNC) for peninsular streams of 1.54 mg/L as N. However, they were all above the San Carlos Bay Estuary NNCs of 0.44 mg/L as N.

The highest TN concentrations were found in the effluent storage ponds (CC01 & GH01). This indicates the nitrogen levels in the reclaimed water are likely affecting the water quality within the storage ponds. However, it is important to note that the significantly different TN concentrations of the reclaimed water does not appear to impact the TN concentrations within the lakes. Gulf Harbour receives much higher TN concentrations from the Fort Myers Beach WWTP than Crown Colony does from the Fiesta Village plant, however, TN concentrations within Gulf Harbour are somewhat lower. This could be due to assimilation within the ponds and/or the larger mixing volume within the Gulf Harbour lake.

The TN concentrations in the Gulf Harbour and Crown Colony irrigation storage ponds are lower than the concentrations in the Fort Myers Beach WWTP Percolation Ponds. The irrigation ponds also use the storage water in the pond regularly for irrigation, reducing the potential for flow into the groundwater table. For these reasons, the water quality impacts for reclaimed water irrigation ponds are expected to be less than those from the percolation ponds.

Total Phosphorus: The TP levels were the highest within the Gulf Harbour lake.

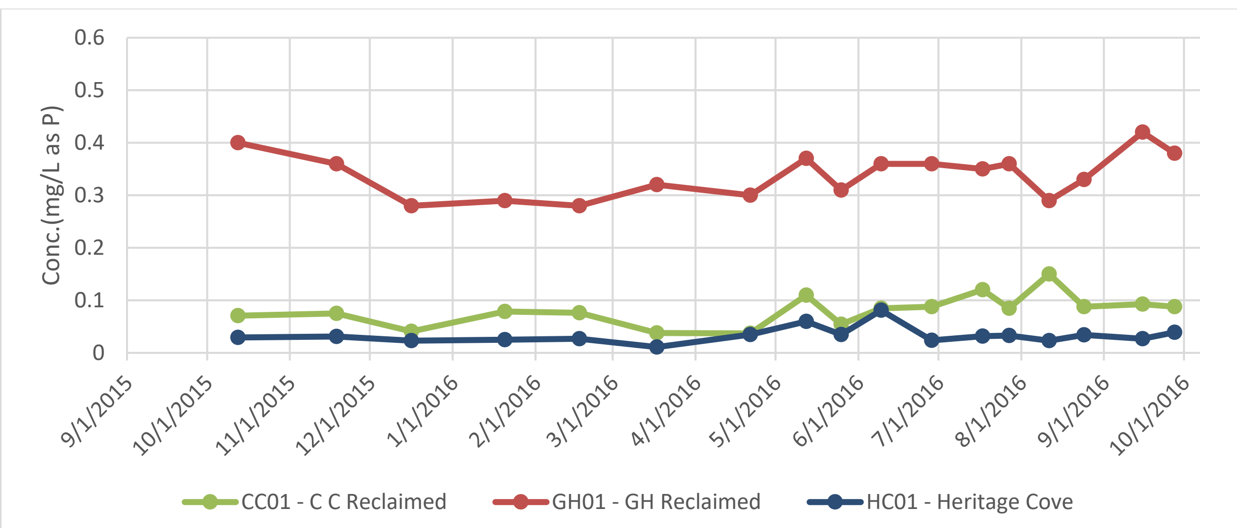


Figure 23 - Irrigation Pond Total Phosphorus

The following is a summary of the average concentrations:

CC01 – 0.08 mg/L as P
GH01 – 0.34 mg/L as P
HC01 – 0.03 mg/L as P

The much higher TP concentrations within the Gulf Harbour lake could be a result of the higher TP concentrations within the Fort Myers Beach Plant water or a result of different operational practices on the property. The outfall lake (GH02) has significantly lower TP concentration, indicating the high TP is likely from the plant effluent.

At Crown Colony, the somewhat elevated TP concentrations at the storage pond do not show up within the outfall lake. Concentrations at the outfall are similar to the concentrations at Heritage Cove.

Ammonia: Concentrations at all locations were below 0.2 mg/L as N in all samples. Many of the samples did not have detectable levels of ammonia.

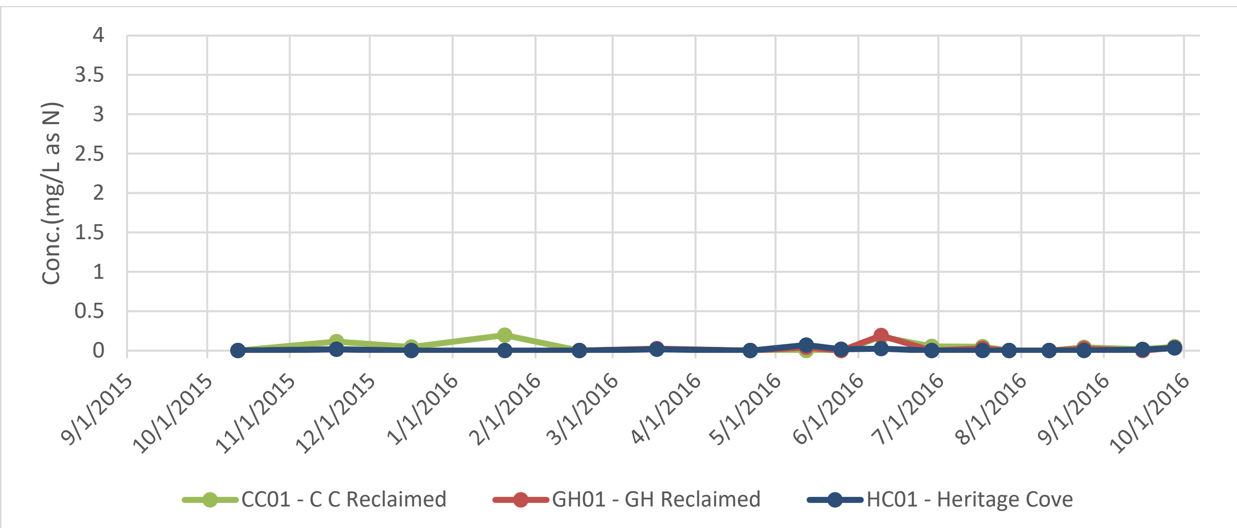


Figure 24 - Irrigation Pond Ammonia

The following is a summary of the average concentrations:

CC01 – 0.04 mg/L as N
GH01 – 0.02 mg/L as N
HC01 – 0.01 mg/L as N

While all average concentrations are low, the highest average concentrations are found in the two reclaimed water storage ponds (CC01 & GH01).

Most of the nitrogen found within the ponds is not in the form of ammonia.

Nitrate + Nitrite: Similar to ammonia, concentrations at all locations were low or below the minimum detection limits. There was a spike of N+N levels in CC01 in the 11/18, 12/16, 1/20 and 2/17 samples with a peak of 0.43 mg/L as N. All other samples were below 0.1 mg/L as N.

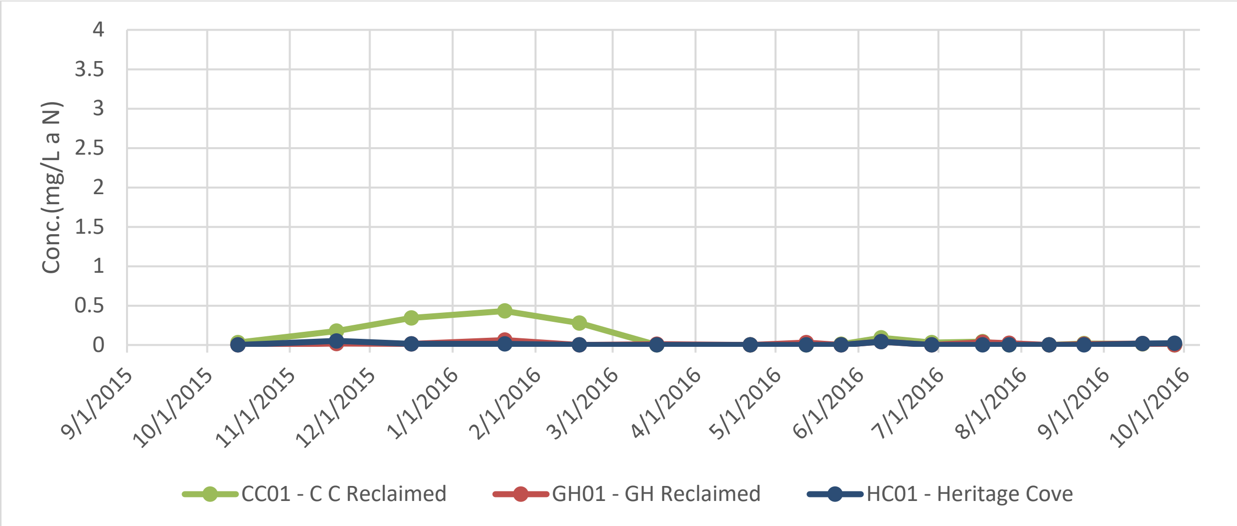


Figure 25 - Irrigation Pond Nitrate + Nitrite

The following is a summary of the average concentrations:

CC01 – 0.09 mg/L as N
GH01 – 0.02 mg/L as N
HC01 – 0.01 mg/L as N

While all average concentrations are low, the highest average concentrations are found in the two reclaimed water storage ponds (CC01 & GH01).

The majority of the nitrogen found within the ponds is not in the form of Nitrate + Nitrite.

Total Kjeldahl Nitrogen: Individual and average concentrations for each sample are similar to TN concentrations, indicating most of the TN is in the form of ammonia or organic nitrogen.

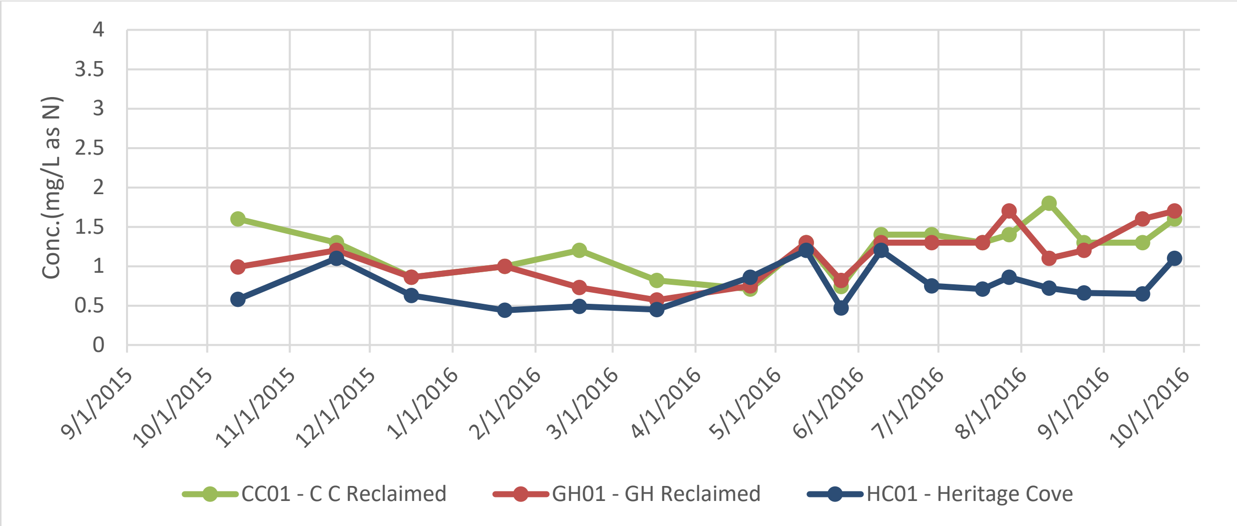


Figure 26 - Irrigation Pond TKN

The following is a summary of the average concentrations:

CC01 – 1.24 mg/L as N
GH01 – 1.14 mg/L as N
HC01 – 0.76 mg/L as N

Organic Nitrogen: Individual and average concentrations for each sample are similar to TN concentrations, indicating most of the TN is in the form organic nitrogen.

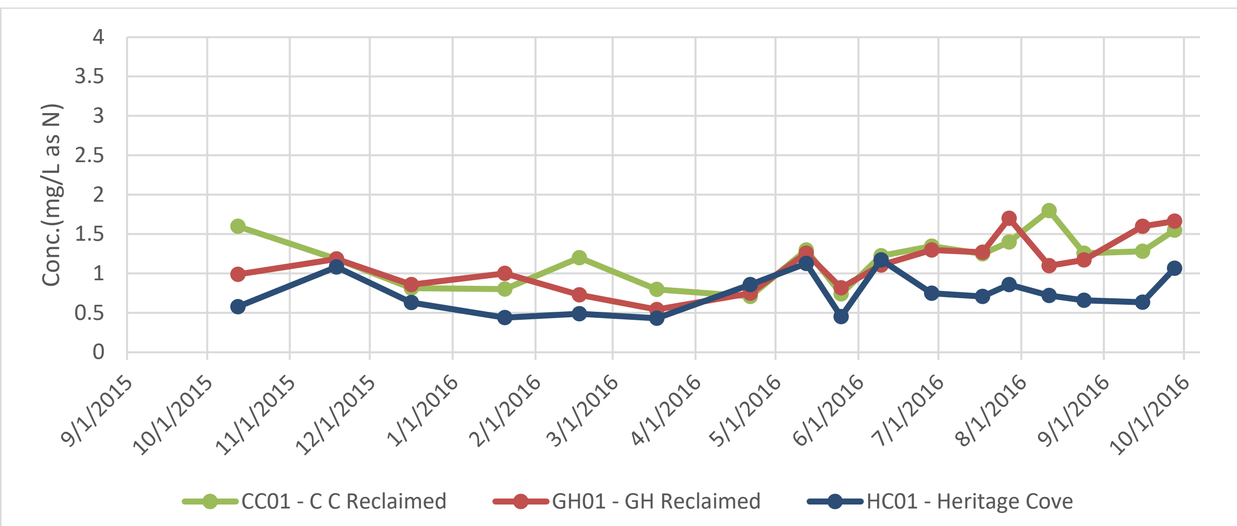


Figure 27 - Irrigation Pond Organic Nitrogen

The following is a summary of the average concentrations:

CC01 – 1.19 mg/L as N
GH01 – 1.12 mg/L as N
HC01 – 0.75 mg/L as N

Chlorophyll A: During the monitoring period, Chlorophyll A levels were generally higher during the dry season and lower during the wet season.

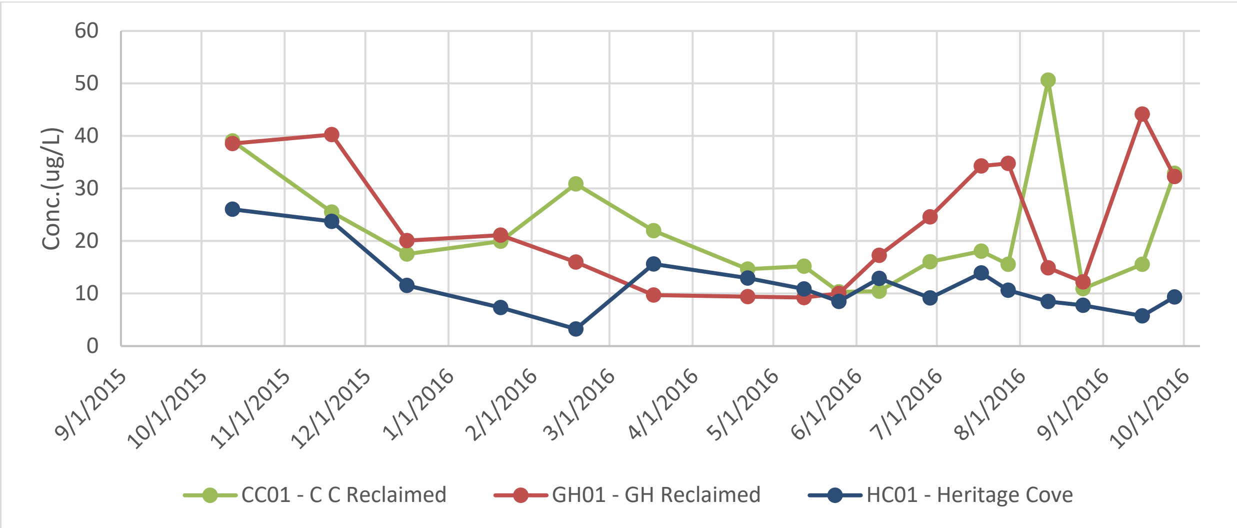


Figure 28 - Irrigation Pond Chlorophyll A

The following is a summary of the average concentrations:

CC01 – 21.5 ug/L
GH01 – 22.9 ug/L
HC01 – 11.6 ug/L

The highest levels were found within the two reclaimed water storage ponds, and were approximately double the levels found within the Heritage Cove Lake. This indicates there is more plant production within these lakes.

Specific Conductance: Specific conductance was very consistent at each monitoring location. There was only one measurement at GH01 that varied significantly from the other reading at the location. The GH01 reading on 3/17/2016 was 23, compared to an average of 1290 at the same location. However, this reading is potentially faulty. The stable levels indicate a relatively consistent influence or non-influence from tidal water bodies.

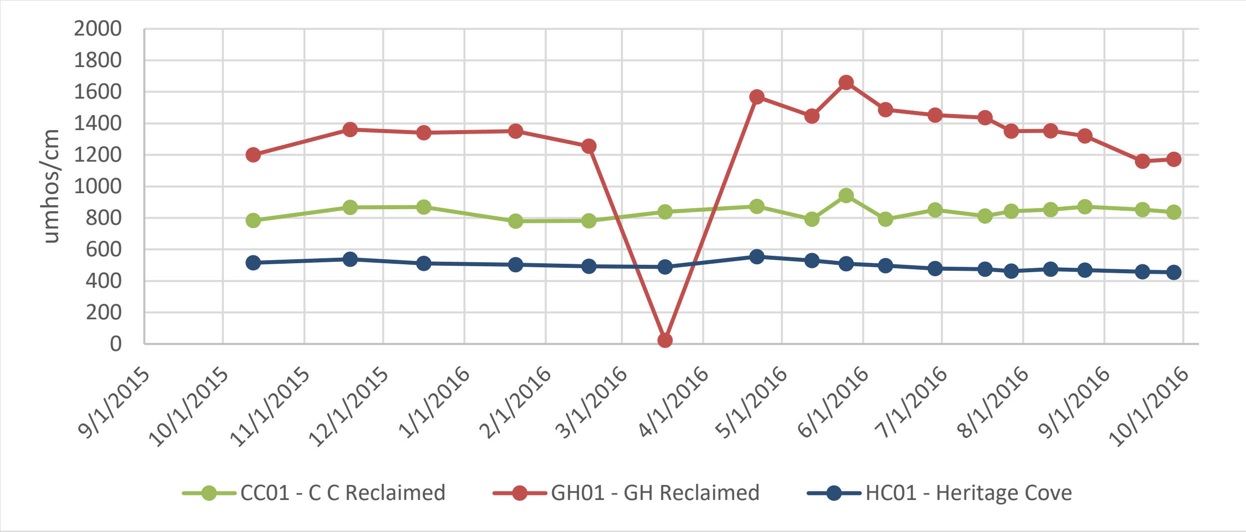


Figure 29 - Irrigation Pond Specific Conductance

The following is a summary of the average specific conductance:

CC01 – 837 umhos/cm
GH01 – 1290 umhos/cm
HC01 – 495 umhos/cm

The higher levels at Gulf Harbour indicate more tidal influences than at Crown Colony or Heritage Cove. This is expected due to the proximity of Gulf Harbour to the Caloosahatchee River.

Fort Myers Beach Waste Water Treatment Plant (WWTP) Percolation Ponds

The Fort Myers Beach WWTP utilizes six (6) percolation ponds located north of Summerlin Road, approximately 0.25 miles east of Pine Ridge Road, to hold reclaimed irrigation water when the supply exceeds demand. If needed, the water is later routed back to the treatment plant and distributed for irrigation when irrigation demand exceeds the available supply.

Similar to the irrigation water storage ponds, these percolation ponds can potentially impact surface water quality. Reclaimed water can flow out of these ponds through the surrounding soil and into the groundwater table. The groundwater table is very high at the percolation pond site, and the groundwater and surface water are often hydraulically connected during the wet season. The hydraulic connection could allow the reclaimed water and the associated nutrients to flow into and become surface water.

The ponds were originally constructed as the only effluent disposal method for the plant. However, as the treatment plant expanded, additional effluent disposal methods have been added, including reclaimed water irrigation and a deep injection well. While the ponds are still utilized, they are no longer the primary method of disposal. In addition, from an operation standpoint, they are only used for reclaimed water storage. Percolation is no longer required, and the ponds are no longer maintained as percolation ponds. The pond bottoms have not been maintained to improve percolation rates. Without maintenance, the percolation rate from the ponds is expected to decrease over time.

In 2000 and 2006, Lee County Utilities (LCU) prepared reports that investigated the nutrient levels around the percolation ponds. The 2000 study, *Nitrate Level Study,* was prepared by LCU, and focused on permit compliance with Nitrate limits of 10 mg/L. The report investigated nitrate concentration in the groundwater surrounding the ponds. Nitrate levels were well below the permit threshold in all locations. While the report focused on Nitrate levels, the report also included water quality data for Total Nitrogen. The locations for each sample point are identified in Figure 30 - Nitrate Level Study Location Map.

The data from these monitoring locations is included in the following Figure 31 - Nitrate Level Study Pond TN Concentrations & Figure 32 - Nitrate Level Study Well TN Concentrations.

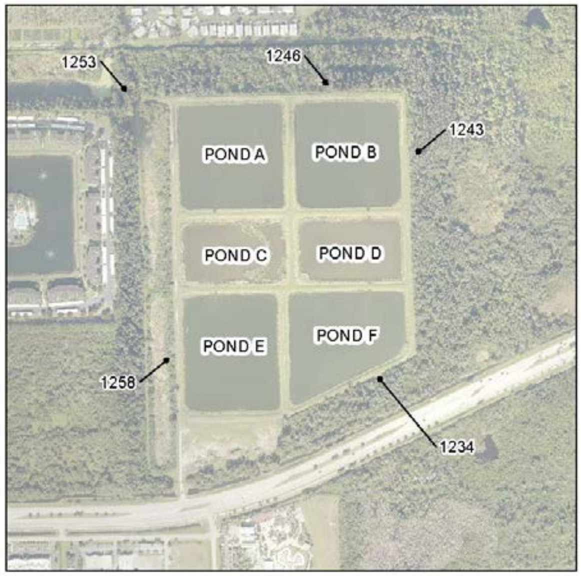


Figure 30 - Nitrate Level Study Location Map

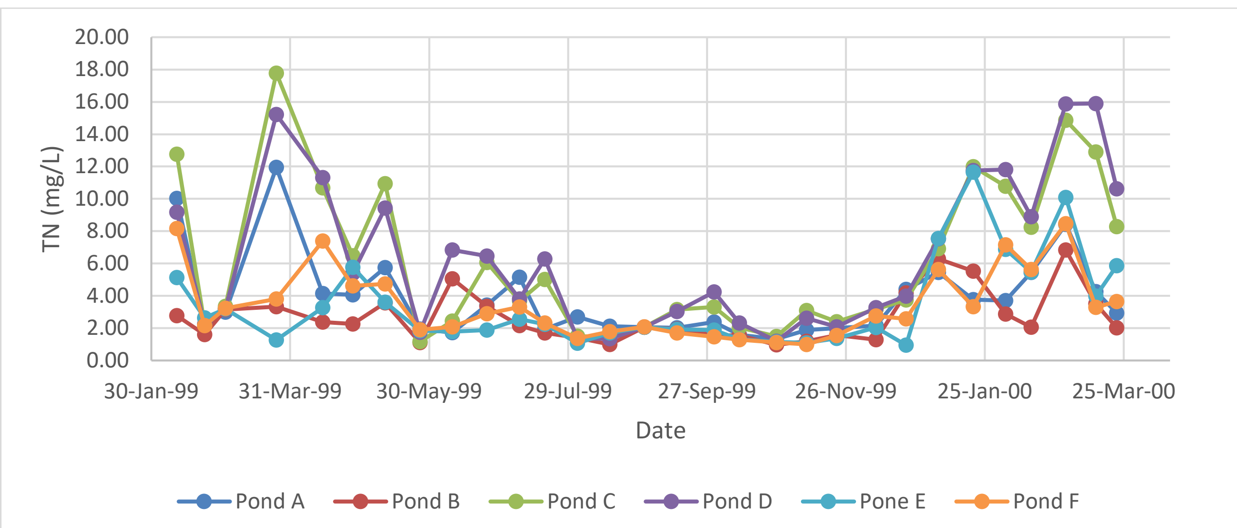


Figure 31 - Nitrate Level Study Pond TN Concentrations

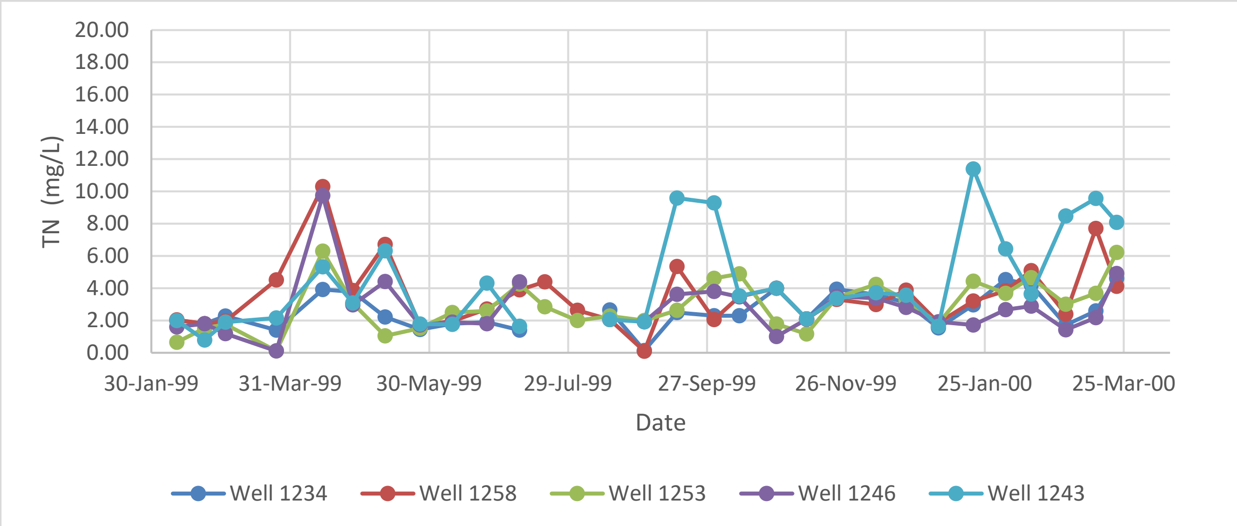


Figure 32 - Nitrate Level Study Well TN Concentrations

For the data period, the ponds, especially the unlined ponds C & D, followed a pattern of high concentration during the dry season, when more residents are contributing flows to the treatment plant, and lower concentration during the wet season, when there are fewer resident. This could be caused by a combination of higher effluent flows and less rainfall during the dry season months of December through May, and lower effluent flows and more rainfall during the wet season months. Due to the relatively short period of record, the applicability of this potential trend from year to year is not known with certainty. Generally, Ponds C & D exhibited the highest TN concentration. This was expected because treatment plant effluent enters Ponds C & D before it is distributed to the other ponds.

The groundwater well data did not follow as drastic of a pattern as the ponds. From March through May, wells 1258 (west of ponds) and 1246 (north of ponds) had the highest TN concentrations. During the wet season and the beginning of the following dry season, all wells had similar concentration between 2 mg/L and 4 mg/L. There were two September concentrations at well 1243 (east of ponds), where concentrations were above 9.0 mg/L. At the end of the sample period, January through March, TN concentrations were generally highest in Well 1243 (east of ponds). The average TN concentrations at each well location are summarized in Table 6.

Table 6 - Nitrate Level Study Well TN Concentrations

Well	Average TN Concentration (mg/L)
1234	2.6
1258	3.54
1253	2.93
1246	2.78
1243	4.41

The highest TN concentrations are located to the north east of the ponds (1243) and the second highest is located within the dry overflow pond to the west of the wet ponds (1258). The lowest concentration is to the south of the ponds (1253). The location of the highest concentration north of the pond and lowest concentration south of the pond closely reflect the groundwater flow directions identified in the 2006 study. This could provide an indication that the percolation ponds are contributing to the elevated TN levels.

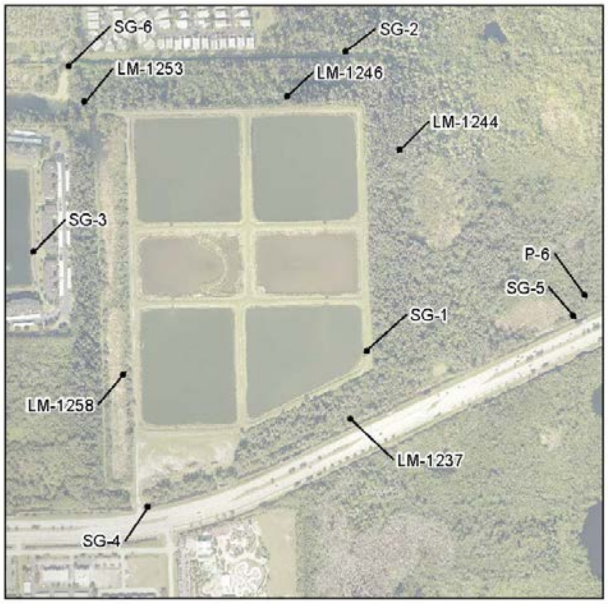


Figure 33 - 2006 Study Monitoring Sites

The 2006 Study was prepared by Water Resource Solutions. This report focused on nutrient levels, as well as groundwater flow patterns. The monitoring locations have been shown in Figure 33 - 2006 Study Monitoring Sites.

Some key findings of the report are summarized below:

- Nitrate levels were well below the drinking water standard.
- Results indicate un-regulated nitrogen compound (TKN & ammonia) concentrations are highest to the east-northeast (15 mg/L) of the percolation ponds, followed by the southeast area (10 mg/L) and lowest to the west (6 mg/L).
- Background total nitrogen concentrations were estimated to be 5 mg/L, using a monitoring well location near Canal C.
- Total Nitrogen concentration for the north ditch in the northeast area of the percolation ponds was determined to be three times higher than the background station.
- Total Nitrogen concentration for the south ditch was about 1.6 times higher than the background concentration.
- Water level contour maps for the monitoring period indicate the main groundwater flow direction is to the east-north east, followed by the southeast, with minor flow to the south.
- The area NE of the ponds is characterized by relatively high hydraulic conductivity values.
- The area SE and S of the ponds is characterized by medium hydraulic conductivity values.
- The area W-NW of the ponds is characterized by low hydraulic conductivity values.
- A groundwater flow model was created and calibrated with the study data. The results corroborated the groundwater flow directions obtained using the groundwater data.
- Higher nutrient concentrations were found in the areas where higher groundwater flow from the pond was indicated by the model and data.
- During the nine-month monitoring period, an estimated 93 MG moved from the percolation ponds to the water table aquifer.
- Travel time for the longest travel distance of 1050 ft (NE) was estimated to be 6 years. No travel time was given for the shortened travel distances of 700 ft (SE), 500 ft (SW) and 150 ft (WNW).
- The estimate pond disposal capacity is 0.55 MGD.

The report included several summary graphs. The two graphs specifically reviewed for this report included Figure 4-36: Plot of Total Nitrogen for the Surface Water Monitoring Stations and Figure 4-32: Plot of Total Nitrogen for the Groundwater Monitoring Stations. Copies of both are provided below.

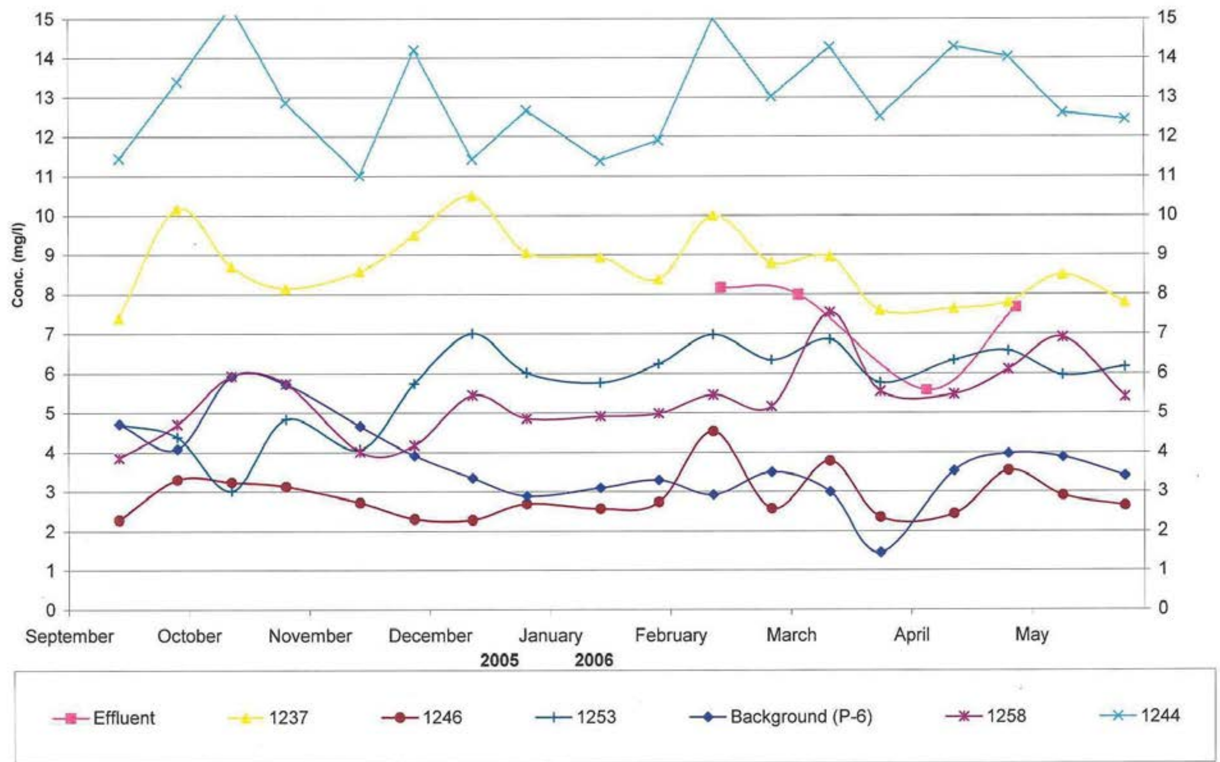


Figure 34 - Hydrogeological Investigation 2006 Groundwater TN

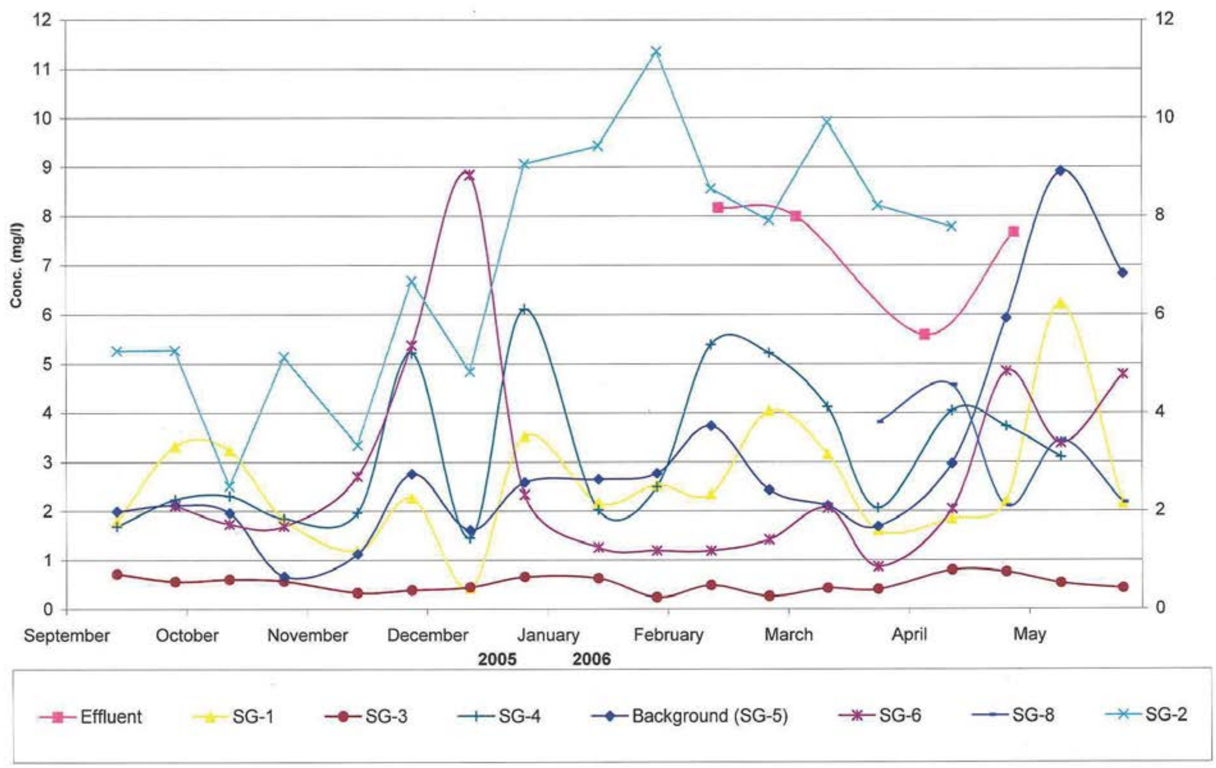


Figure 35 - Hydrogeological Investigation 2006 Surface Water TN

The surface water graph generally indicates SG-2 (north of ponds) has the highest TN concentration during the study period, 2.5 mg/L to over 11 mg/L. The second highest concentrations were found at the background station located within Canal C. The lowest concentrations were found at SG-3 (west of the ponds in Heritage Point), below 1 mg/L.

There are two surface water monitoring stations located to the north of the ponds in IDD Canal C-9. The western station SG-6 generally has lower TN concentrations than the eastern station SG-2. Water in the canal flows from west to east, toward Canal C. This likely indicates there is a nitrogen source between the two monitoring stations. Between the stations is the Lee Plantation residential community to the north of the canal, and the Fort Myers Beach WWTP percolation ponds to the south. One or both properties could be contributing nutrients to the canal. Per County records, Lee Plantation is on central water and sewer, so septic tanks from this community are not a potential nutrient source. Stormwater runoff from Lee Plantation is directed to swales that discharge to the canal. This stormwater runoff could be a potential source of nutrients. The percolations ponds retain all rainfall and treatment plant effluent on site. The only discharges from the ponds are through evaporation and percolations into the groundwater table. Flows from the percolation ponds through the groundwater table provide a potential source of nutrients to the canal.

The groundwater monitoring stations provided more consistent results throughout the study period. well 1244 located east of ponds consistently had the highest TN concentrations with values between 11.0 mg/L to above 15 mg/L. The second highest concentrations are found in well 1237, located south of the ponds.

The higher nutrient concentrations in the areas of higher groundwater flows from the ponds likely indicates the ponds are a nutrient source in those areas.

To obtain more recent water quality data and better understand the potential influence the percolation ponds have on the groundwater table, a water quality monitoring plan around the percolation ponds was prepared and implemented from September 2015 through November 2016. The approximate monitoring locations are identified in Figure 36 - Percolation Pond Monitoring Sites and Appendix C - Deep Lagoon Monitoring Locations.

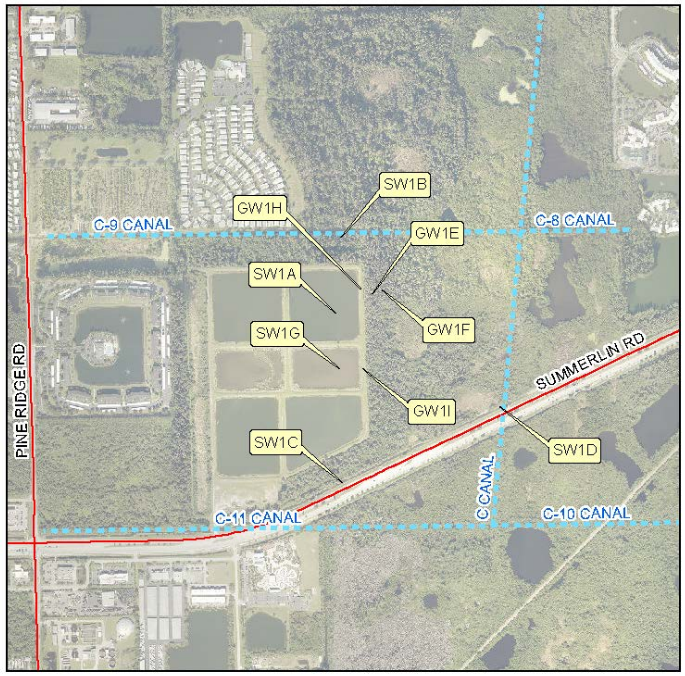


Figure 36 - Percolation Pond Monitoring Sites

SW1A (Located in Pond B) – Surface water monitoring station in one of the unlined percolation ponds.

SW1B (Located in Canal C-9) – Surface water monitoring station in the canal north of the ponds.

SW1C (Located south of Pond) – Surface water monitoring station in the canal south of the ponds.

SW1D (IDD Canal C) – Surface water monitoring station in the main Deep Lagoon outfall canal approximately 1,200 ft east of the ponds. This is at the same location as the County's DEEPGR90 monitoring station.

GW1E (Near Pond B) – Groundwater monitoring station east of Pond B.

GW1F (East of GW1E) – Groundwater water monitoring station located further east than GW1E; Used to potentially identify an increasing or decreasing groundwater gradient.

SW1G (Pond D) – Groundwater water monitoring station in one of the lined percolation ponds.

GW1H (Pond B Bank) – Groundwater water monitoring station in the bank of Pond B; Used to help identify groundwater gradients.

GW1I (East of Pond D) – Groundwater water monitoring station adjacent to the eastern most lined percolation pond.

The monitoring program began with one groundwater monitoring station and four surface water monitoring stations. One additional surface water and three additional groundwater monitoring stations were added during the monitoring period to better understand the site conditions. Water quality samples were taken from October 2015 through December 2016. Two monthly samples were obtained during the wet season months May through September, and one monthly sample was obtained during the dry season months October through April. After September 2016, samples were only taken from selected sites to better understand flows from the ponds into the groundwater table. Each sample was analyzed for Total Phosphorus, Total Kjeldahl Nitrogen, Ammonia, Nitrate + Nitrite, Chlorophyll-A, Dissolved Oxygen, pH and Specific Conductance. Due to high costs, sucralose and acetaminophen were only analyzed for the October 12, 2016, December 16, 2015, and July 27, 2016 samples. Summary graphs for each parameter are included in Appendix L - Percolation Pond Graphs. The following is a summary of the results:

Acetaminophen: The only sample that had detectable levels of acetaminophen was the 10/12/2015 sample at GW1E, located east of Pond B. All other samples were either not present or below the minimum detection limits. The lack of acetaminophen provides an indication that flows from septic tank effluent or untreated sewage are likely not present at these locations.

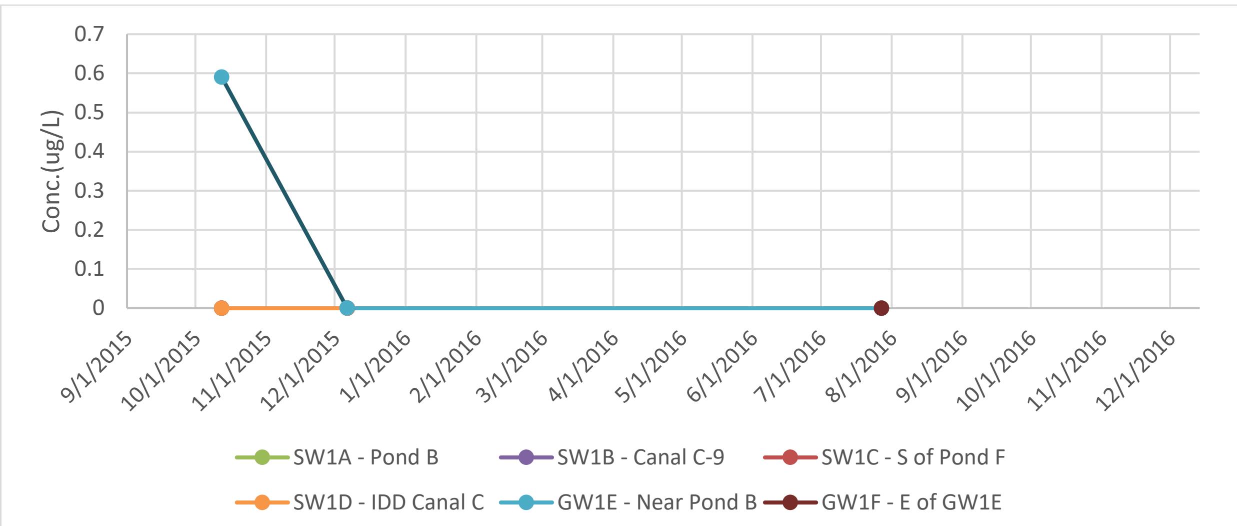


Figure 37 - Percolation Pond Acetaminophen

Sucralose: All samples included detectable levels of sucralose except the July 27th SW1C (South of Pond F) sample and all the samples at SW1D (Canal C). The presence of sucralose in most samples provides an indicator that water from the percolation ponds is influencing both groundwater and surface water around the ponds. The relative concentration of sucralose can provide an estimate as to the magnitude of the influence. The higher the concentration, the higher the influence. It is important to note that surface water concentration in the canals will typically be lower than groundwater samples due to dilution from larger volume of stormwater flows. On the one date that both GW1E and GW1F were sampled, GW1E has a higher concentration, indicating flow away from the ponds.

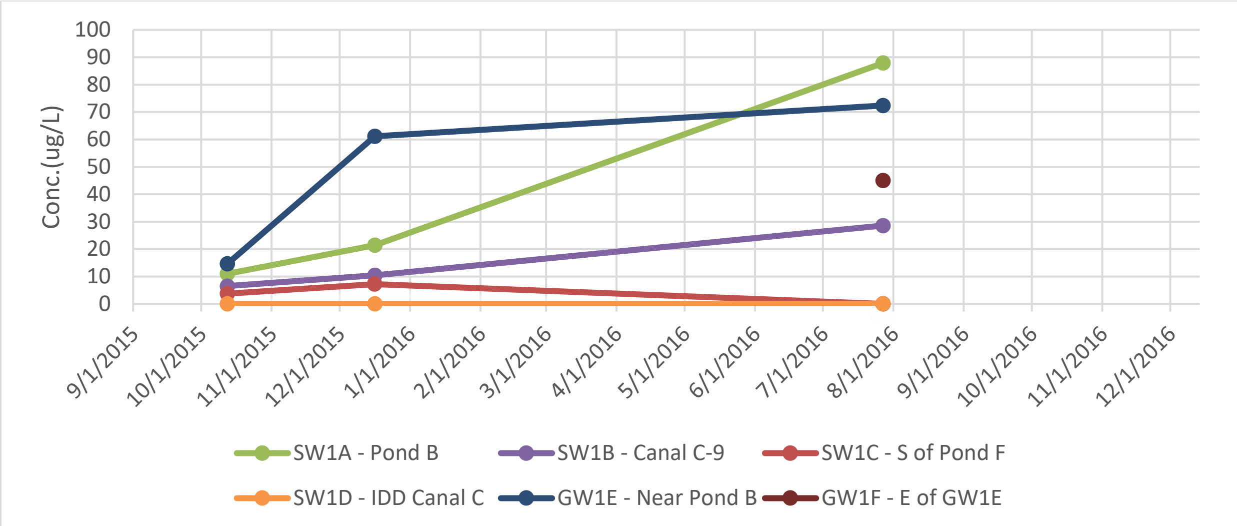


Figure 38 - Percolation Pond Sucralose

The following are the average sucralose concentrations at each sample location:

SW1A – 40.2 ug/L
SW1B – 15.2 ug/L
SW1C – 3.7 ug/L
SW1D – 0.0 ug/L
GW1E – 49.4 ug/L
GW1F – 45.0 ug/L

The highest average concentrations are located within Pond B (SW1A) and the groundwater wells located near Pond B (GW1E & GW1F). The groundwater wells had higher concentration than Pond B. This could indicate higher concentration flowed from the ponds into the groundwater table in the past. The sample located furthest from the percolation ponds, SW1D has an average concentration of 0.0 ug/L. SW1B, located north of the ponds, had a higher concentration than SW1C, located to the south of the ponds. This coincides well with the major groundwater flow direction to the northeast and a minor flow to the south.

Total Nitrogen: The surface water samples were relatively consistent, with SW1B and SW1G generally having the highest concentration, followed by SW1C and SW1A. The lowest concentration was found at SW1D. One sample taken on May 25, 2016 at SW1D was higher than all other sample concentrations; This appears to be an outlier.

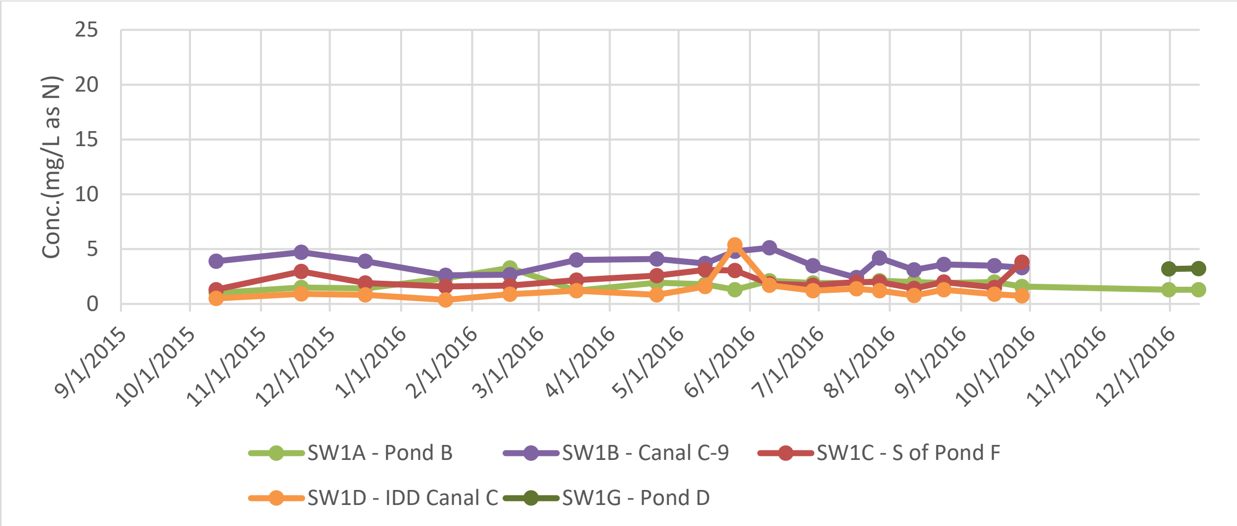


Figure 39 - Perc. Pond TN - Surface Water

The following is a summary of the average concentrations:

SW1A – 1.78 mg/L
SW1B – 3.32 mg/L
SW1C – 1.92 mg/L
SW1D – 1.15 mg/L
SW1G – 3.21 mg/L

The highest average TN concentrations were found in Canal C-9 north of Pond B (SW1B), and in Percolation Pond D (SW1G). These average concentrations are more than double typical surface concentrations. SW1G is where effluent water enters the ponds, and SW1B is in the main direction of groundwater flow from the ponds. The surface water concentrations generally decrease as samples are taken further away from the percolation ponds.

The groundwater sample concentrations were relatively consistent throughout the monitoring period. The concentrations at GW1E and GW1F (both located east of Pond B) were similar, with GW1F typically being somewhat higher. GW1H, located closest to Pond B, had much lower concentrations. The highest concentrations were found at GW1I, which is located next to the lined Pond B. This was unexpected, as the pond liner was expected to prevent pond water from entering the groundwater table at this location.

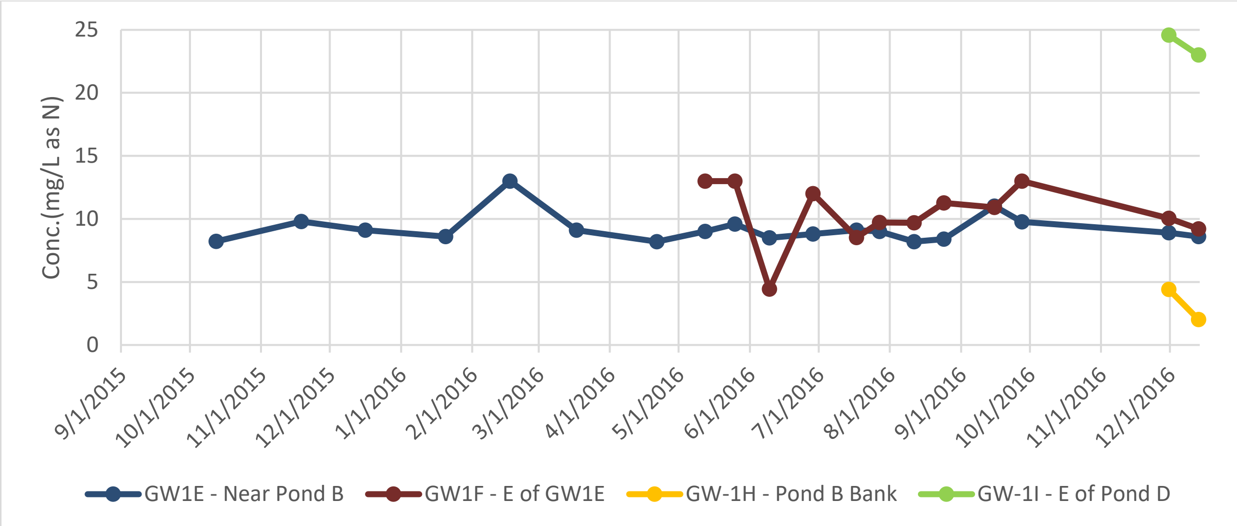


Figure 40 - Perc. Pond TN - Groundwater

The following is a summary of the average groundwater concentrations around the ponds:

GW1E – 9.21 mg/L
GW1F – 10.40 mg/L
GW1H – 3.21 mg/L
GW1I – 23.79 mg/L

The highest average concentration is located next to the lined Pond B (GW1I). This may be an indication that the pond liner is not preventing the flow of pond water into the surrounding groundwater. Further investigation would be required to confirm this. The other three wells are all located next to Pond D. The well located closest to the pond has the lowest average concentration; It is about 1/3 of the other concentrations. The water that is closer to the ponds would have come from the ponds more recently than the water located further away from the ponds. This could be an indication that the higher TN concentrations came from historical sources, as opposed to the current pond water.

Total Phosphorus: The highest surface water sample concentrations were at SW1G located in Pond D followed by SW1B (in Canal C-9). The other sample locations varied depending on sample date.

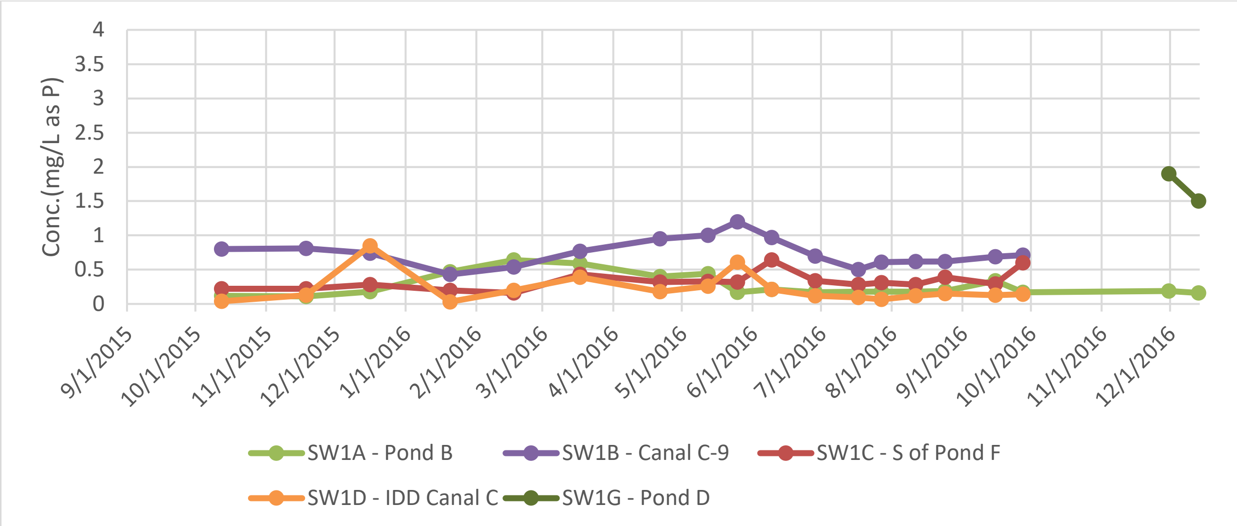


Figure 41 - Perc. Pond TP - Surface Water

Following is a summary of the average concentrations.

SW1A – 0.27 mg/L
SW1B – 0.67 mg/L
SW1C – 0.30 mg/L
SW1D – 0.20 mg/L
SW1G – 1.70 mg/L

The highest average concentration is in Pond D (SW1G), which is expected, as this is the location where the treatment plant effluent enters the percolation ponds. The second highest concentration is in Canal C-9 (SW1B), just north of the percolation ponds. This monitoring station is located along the major groundwater flow direction from the ponds. The concentrations in Pond B (SW1A) and south of Pond F (SW1C) have similar concentrations. The lowest concentration is found in Canal C (SW1D), which is located the furthest from the ponds.

The groundwater TP concentrations were very consistent at all locations except GW1H, located in the Pond B bank. Concentrations at this location were the highest, and varied from about 1.8 mg/L to 3.5 mg/L.

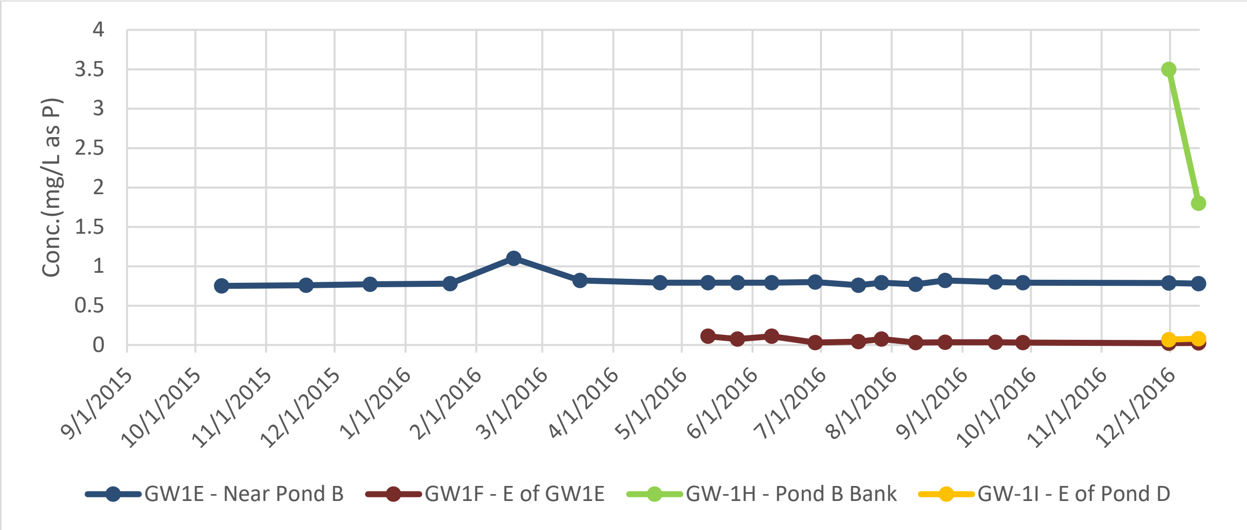


Figure 42 - Perc. Pond TP - Groundwater

The following is a summary of the average groundwater concentrations around the ponds:

GW1E – 0.80 mg/L
GW1F – 0.05 mg/L
GW1H – 2.65 mg/L
GW1I – 0.07 mg/L

The highest average concentration is located at GW1H located next to Pond B. This concentration was much higher than all other groundwater concentration

Average concentrations are higher than the 0.04 mg/L numeric nutrient criteria for the Lower Caloosahatchee River Estuary at all locations. GW1F and GW1I are closest to the criteria at 0.05 mg/L and 0.07 mg/L, respectively. The other two locations are significantly higher.

Ammonia: The highest surface water ammonia concentrations were found at SW1B in canal C-9 north of the ponds, followed by SW1C located south of the ponds. Both were higher than the concentrations in either Pond B or Pond D.

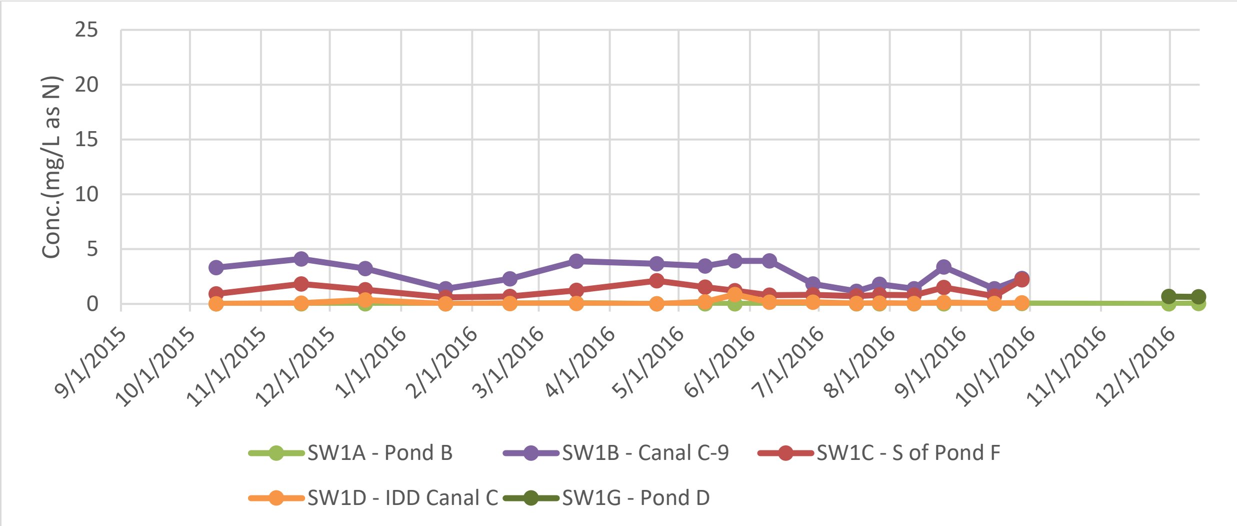


Figure 43 - Perc. Pond Ammonia - Surface Water

The following is a summary of the average concentrations with the percentage of TN in parentheses:

SW1A – 0.01 mg/L (0.7%)
SW1B – 2.44 mg/L (73.6%)
SW1C – 1.04 mg/L (54.3 %)
SW1D – 0.12 mg/L (10.4%)
SW1G – 0.66 mg/L (20.4%)

The highest average ammonia concentration at SW1B is over double the concentration at any other monitoring location.

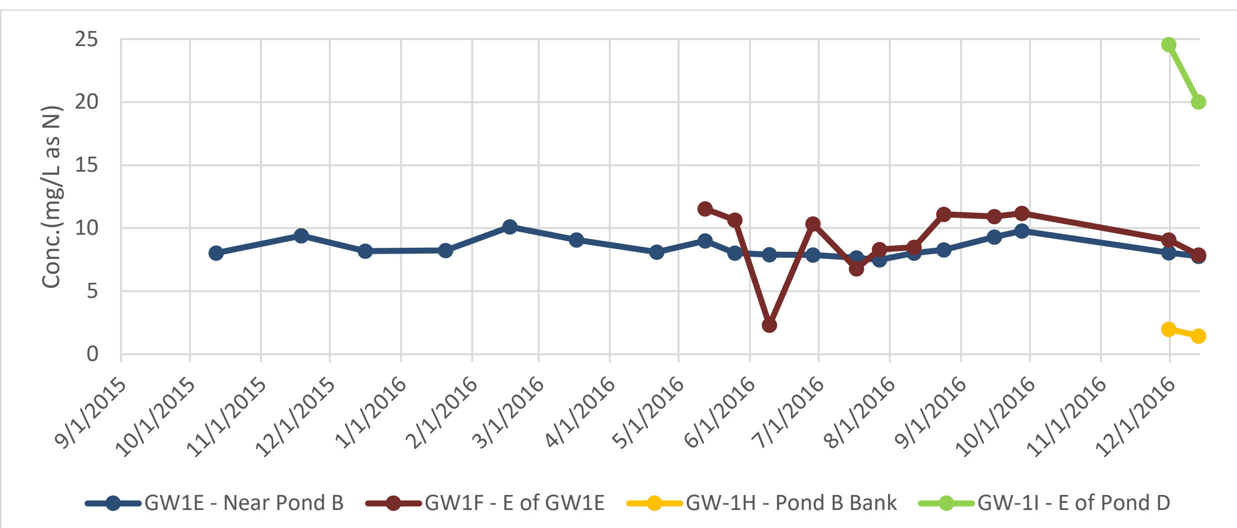


Figure 44 - Perc. Pond Ammonia - Groundwater

The following is a summary of the average groundwater concentrations around the ponds with the percentage of TN in parentheses:

GW1E – 8.46 mg/L (91.9%)
GW1F – 9.05 mg/L (87.0%)
GW1H – 1.73 mg/L (53.8%)
GW1I – 22.30 mg/L (93.7%)

The highest groundwater concentrations are located next to Pond D (GW1I). This was unexpected, as Pond D is lined. Of the three monitoring locations near Pond B, the closest well has the lowest concentration. This could be an indicator that Pond D is now less of a source than it has been in the past. The higher concentrations found further away from the pond are a possible indication of higher loads in the past.

Nitrate + Nitrite: Both the groundwater and surface water N+N concentrations were low throughout the monitoring period. None of the monitoring locations were consistently higher than the others.

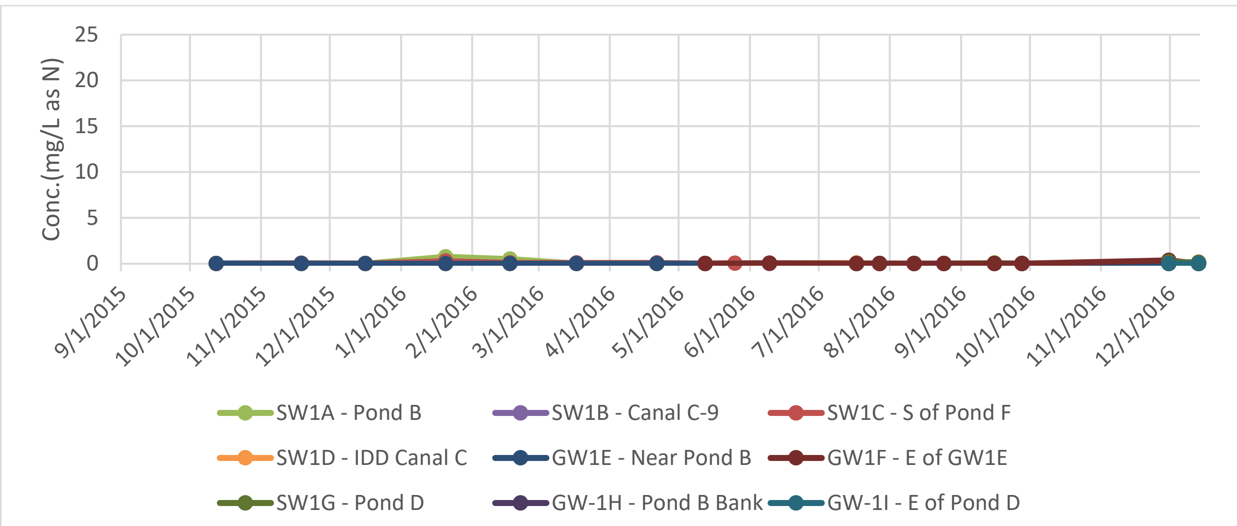


Figure 45 - Perc. Pond Nitrate + Nitrite

The following is a summary of the average concentrations with the percentage of TN in parentheses:

SW1A – 0.07 mg/L (4.1%)
SW1B – 0.01 mg/L (0.2%)
SW1C – 0.03 mg/L (1.7%)
SW1D – 0.01 mg/L (0.5%)
SW1G – 0.16 mg/L (5.1%)
GW1E – 0.00 mg/L (0.0%)
GW1F – 0.04 mg/L (0.3%)
GW1H – 0.01 mg/L (0.3%)
GW1I – 0.00 mg/L (0.0%)

Nitrate + Nitrate concentration did not provide a significant portion of the Total Nitrogen at any monitoring location.

Total Kjeldahl Nitrogen: TKN concentrations and trends following those for TN very closely.

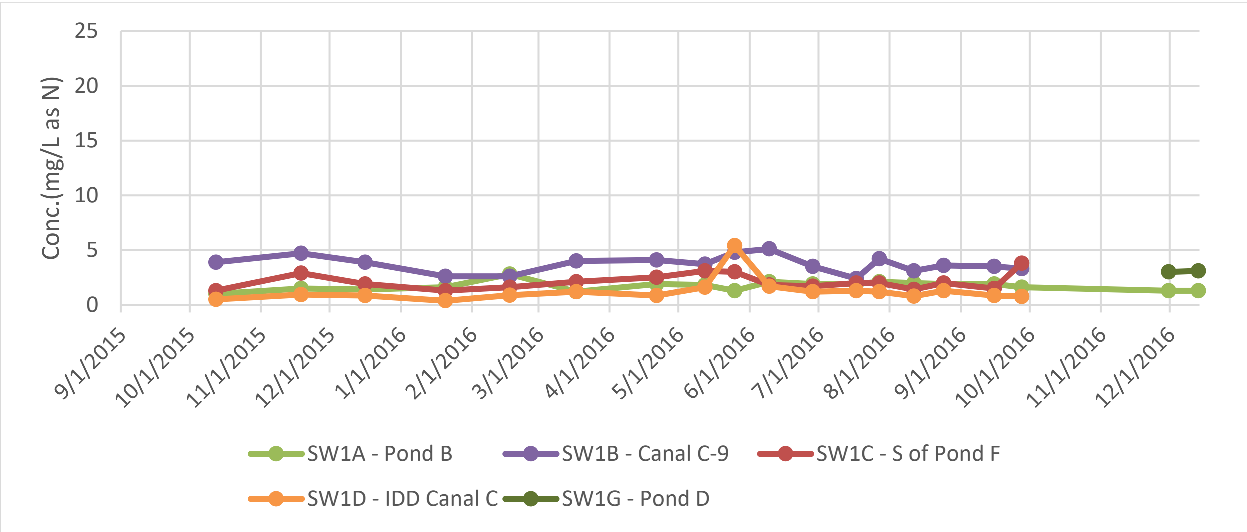


Figure 46 - Perc. Pond TKN - Surface Water

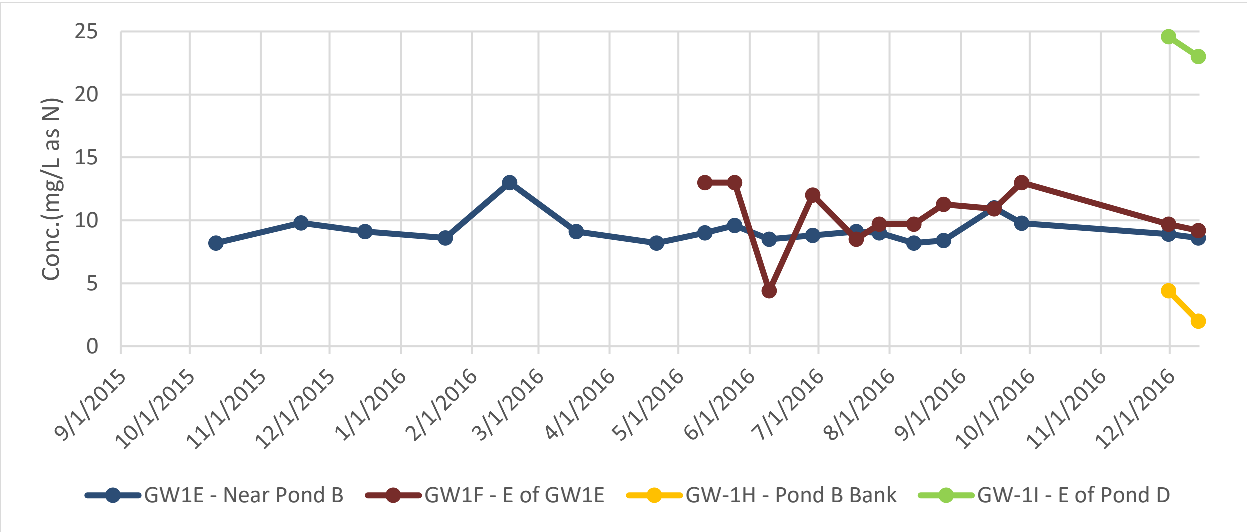


Figure 47 - Perc. Pond TKN - Groundwater

The following is a summary of the average concentrations with the percentage of TN in parentheses:

SW1A – 1.71 mg/L (95.9%)
SW1B – 3.32 mg/L (99.8%)
SW1C – 1.89 mg/L (98.3%)
SW1D – 1.14 mg/L (99.5%)
SW1G – 3.05 mg/L (94.9%)
GW1E – 9.24 mg/L (100%)
GW1F – 10.37 mg/L (99.7%)
GW1H – 3.20 mg/L (99.7%)
GW1I – 23.79 mg/L (100%)

TKN is most of TN at all monitoring locations. This means ammonia and organic nitrogen constitutes most of the TN at each location.

Organic Nitrogen: The highest surface water concentrations were generally found in the two effluent percolation ponds SW1G and SW1A.

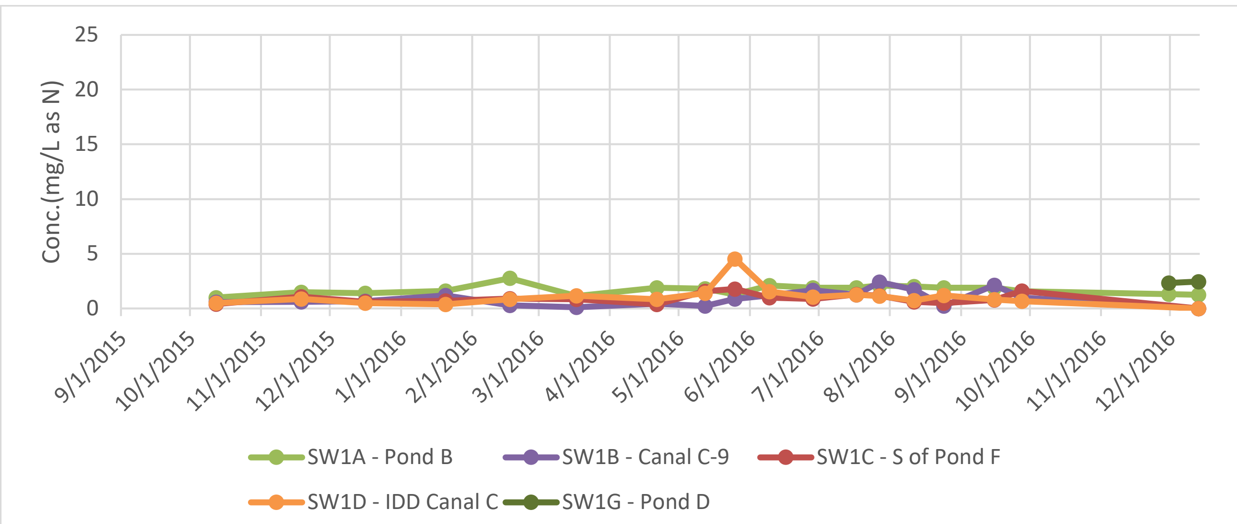


Figure 48 - Perc. Pond Organic Nitrogen - Surface Water

The following is a summary of the average concentrations with the percentage of TN in parentheses:

SW1A – 1.70 mg/L (95.2%)
SW1B – 0.87 mg/L (26.3%)
SW1C – 0.85 mg/L (44.0%)
SW1D – 1.02 mg/L (89.1%)
SW1G – 2.39 mg/L (74.5%)

The highest average concentrations were found in the effluent percolation ponds (SW1A & SW1G). The lowest average concentrations were found in the canals located to the north and south of the ponds.

The lowest groundwater concentrations were found at GW1E. The other three monitoring locations had similar concentrations.

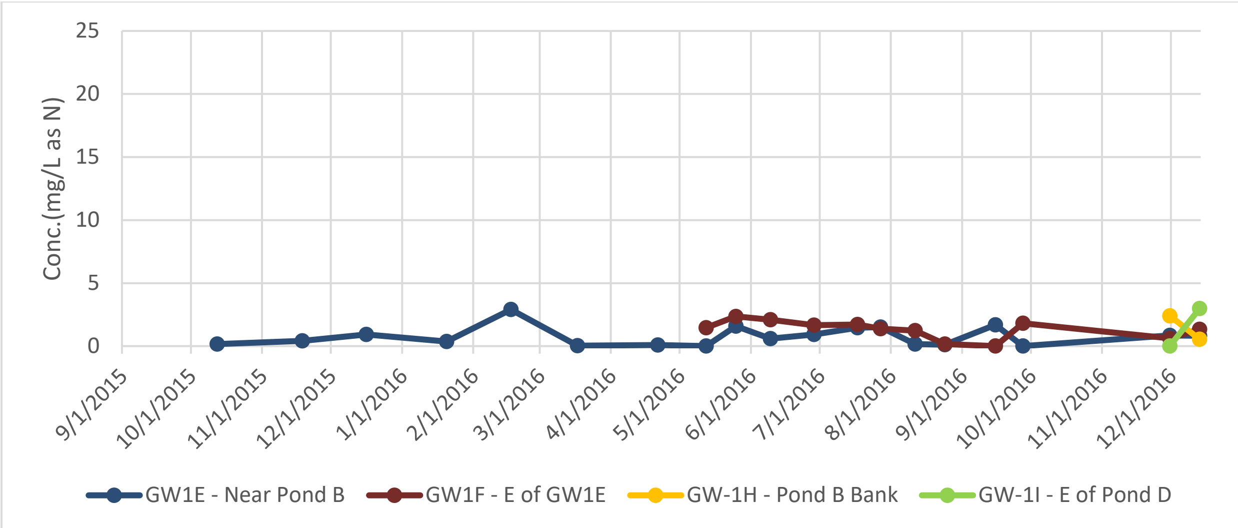


Figure 49 - Perc. Pond Organic Nitrogen - Groundwater

The following is a summary of the average groundwater concentrations around the ponds with the percentage of TN in parentheses:

GW1E – 0.77 mg/L (8.4%)
GW1F – 1.32 mg/L (12.7%)
GW1H – 1.47 mg/L (45.9%)
GW1I – 1.49 mg/L (6.3%)

The lowest average concentration was found at GW1E. The concentration at this location was about half the other three locations.

Chlorophyll A: The Chlorophyll A concentration was not consistent through the monitoring period. SW1B (Canal C-9) had the highest concentration at some points, while SW1A (Pond B) or SW1D (IDD Canal C) had the highest concentration at others.

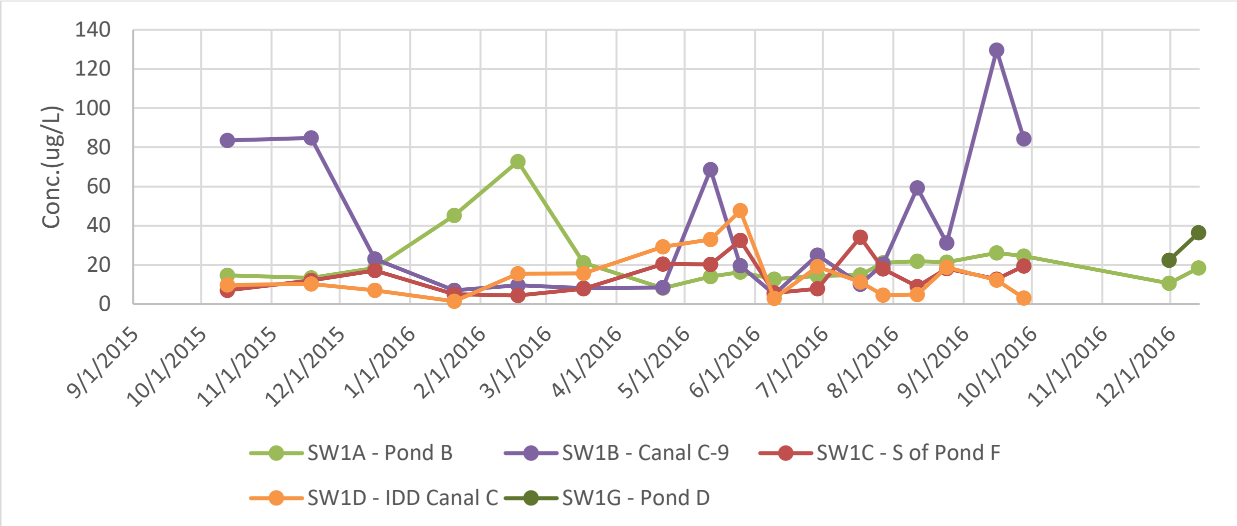


Figure 50 - Perc. Pond Chlorophyll A

The following is a summary of the average concentrations:

SW1A – 21.52 ug/L
SW1B – 35.63 ug/L
SW1C – 13.17 ug/L
SW1D – 12.89 ug/L
SW1G – 29.31 ug/L

The highest average concentration was found at SW1B (Canal C-9), followed by SW1G (Pond D) and SW1A (Pond B). This indicated Canal C-9 has the highest plant productivity.

All locations are significantly higher than the 5.6 ug/L numeric nutrient criteria limit established for the Lower Caloosahatchee River Estuary.

Specific Conductance: The groundwater samples exhibited consistent specific conductance, with SW1D (IDD Canal C) experiencing the most fluctuation. This was expected, as it would have the most influence from tidal fluctuations.

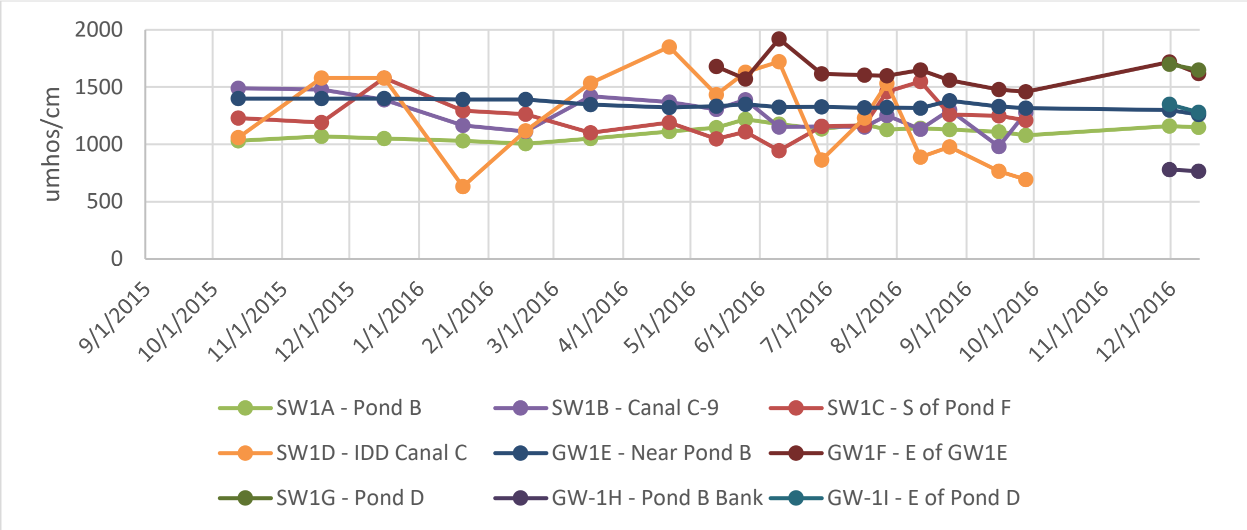


Figure 51 - Perc. Pond Specific Conductance

The following is a summary of the average specific conductance:

SW1A – 1110 umhos/cm
SW1B – 1133 umhos/cm
SW1C – 1106 umhos/cm
SW1D – 1110 umhos/cm
SW1G – 1675 umhos/cm
GW1E – 1345 umhos/cm
GW1F – 1623 umhos/cm
GW1H – 773 umhos/cm
GW1I – 1315 umhos/cm

The nitrogen loading rates from the percolation ponds to the Deep Lagoon watershed were estimated using available data. No additional groundwater modeling was performed to estimate the loading. Flows to the groundwater table were estimated to be equal to the flows from the waste water treatment plant to the percolation ponds as reported in the FDEP Annual Reuse Reports. The estimated flow is 149.5 MG/yr. The TN concentrations within in the groundwater table were estimated to be the average concentration in well GW1E located west of the ponds. The following Table 7 - Percolation Pond Loading Estimate summarizes the estimated loading rate from the percolation ponds to the groundwater table.

Table 7 - Percolation Pond Loading Estimate

Flow		Total Nitrogen	
		Conc.	Loading
gal/yr.	ac-ft/yr.	mg/L	lb./yr.
149,500,000	459	9.21	11,488

It is important to note that this table only estimates the loading from the percolation ponds to the groundwater table. It does not estimate the amount of water that eventually makes its way into surface water flows.

Estimating the percentage of flow from the groundwater table that ultimately enters the surrounding canals is outside the scope of this project. However, creating a hydrologic model that can quantify the flow and loading from groundwater to surface water is recommended. The results of this modeling effort would provide a more accurate estimate of nutrient loading that could be used to better understand potential impacts and expected improvements that could be used to obtain FDEP removal credits.

To provide an estimate of potential nitrogen loading rates to adjacent surface waters, the following Table 8 – Percolation Pond Surface Water Loading Rate Estimates was created. This table provides estimated loading rates if 10%, 50%, or 90% of the groundwater loading rates make it to surface water flows.

Table 8 – Percolation Pond Surface Water Loading Rate Estimates

Percent of Loading	Loading Rate (lb./yr.)	Percentage of Land Use Loading
10%	1,149	6%
50%	5,744	30%
90%	10,339	54%

For comparison purposes the percolation pond potential surface water loading rate estimates were compared to the land use loading rate of 19,302 lb./yr. as a percentage of the land use loading in Table 8 – Percolation Pond Surface Water Loading Rate Estimates.

Septic Tanks

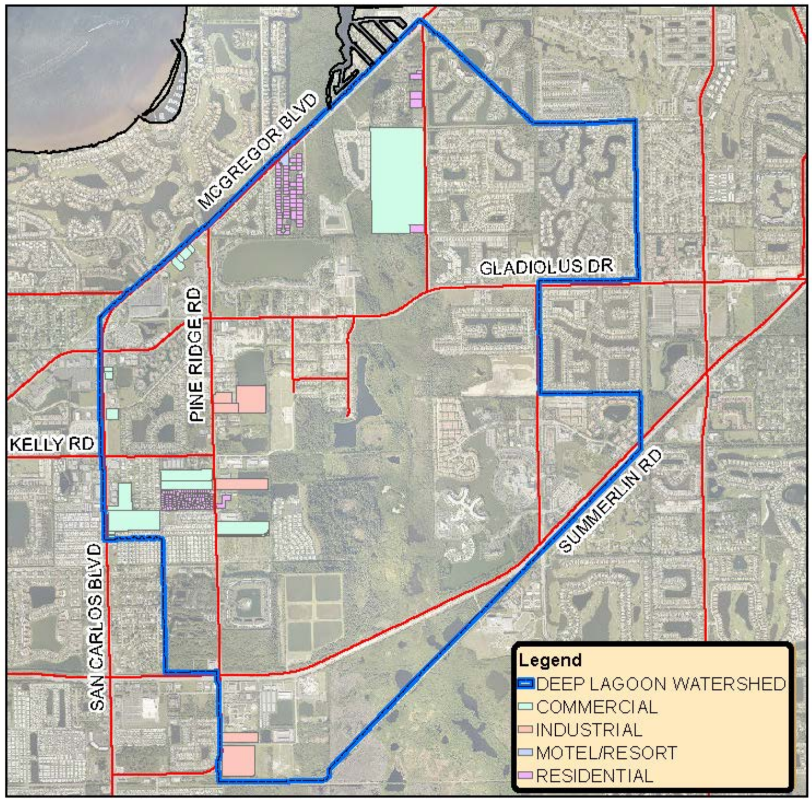


Figure 52 - Septic Tank Location Map

Developments within The Deep Lagoon watershed are generally serviced by central water and sewer. However, there are a few properties that utilize septic tanks for waste water disposal. They are generally located along the northern and west sides of the study area. Figure 52 - Septic Tank Location Map shows the general septic tank location. A more detailed map showing the location of known septic tanks has been included in Appendix E - Septic Tanks Location Map.

While septic tanks provide some treatment, effluent remains high in nutrients. The septic tanks discharge their effluent through a drain field to the surrounding soil and groundwater. The high groundwater table within the watershed can prevent the effluent from flowing down through the soil and force it laterally into the surface water. When this occurs, the septic tank effluent becomes part of the surface water runoff, potentially discharging to the receiving water body. This increases the surface water's nutrient concentration and nutrient load.

Many of the properties shown are residential, except for approximately eight commercial properties, two resort/motel properties, and two industrial properties. The largest number of parcels utilizing septic tanks is located along Willems Drive, Martin Drive and Kimberly Lane, just south of McGregor Blvd. and the Coastal Estates Community.

The impact septic tanks will have on water quality is site specific. Impacts depend on a variety of factors, including distance from surface water, sewage load, drain field design, soils, and groundwater elevation. Due to the high groundwater table (typically within 1 ft of natural ground during the wet season throughout the study area) septic tanks are not expected to function optimally unless they have been artificially raised above the groundwater table. Many of the more densely clustered areas, such as Willems Road, Coral Estates, and Fort Myers Beach RV Resort, do not appear to have raised septic tanks. This increases their likelihood of discharging higher nutrient loads.

The Willems Road area, which includes 62 septic tanks over approximately 55 acres, is of special concern, as it is located within close proximity to The Deep Lagoon Preserve and IDD Canal C. This area has the highest potential of contributing pollutants to Deep Lagoon.

Per Lee County Utilities Staff, there are no current plans to connect any of these properties to central sewer.

To determine if septic tanks are contributing to the Deep Lagoon nutrient load, a water quality monitoring plan was created and implemented from October 2015 – December 2016. The plan included the installation of three groundwater monitoring wells located between Willems Road and IDD Canal C, as well as two surface water monitoring stations along ICC Canal C-7. The approximate monitoring locations are identified in Figure 53 - Septic Tank Monitoring Site Location Map and Appendix C - Deep Lagoon Monitoring Locations.

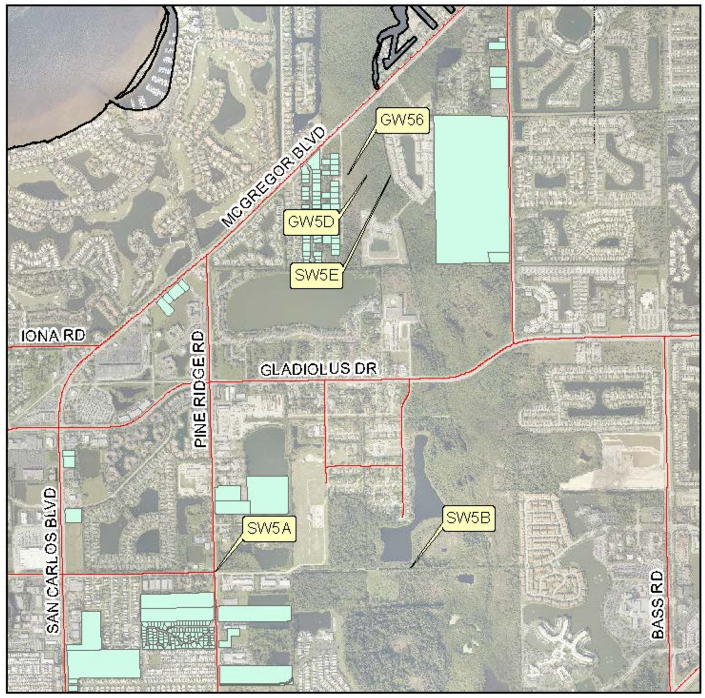


Figure 53 - Septic Tank Monitoring Site Location Map

SW5A: Surface water sample in IDD C-7 Canal within close proximity to the 95 septic tanks in the Coastal Estates Community.

SW5B: Surface water sample in IDD C-7 Canal closer to C Canal. The location of this samples is used as a comparison to SW5A. If SW5A is a source, concentration at SW5B should be lower.

GW5C: Groundwater sample west of Willems Road, closest to the septic tanks along McGregor Blvd.

GW5D: Groundwater sample between Willems Road and C Canal, between GW5C and GW5E.

GW5E: Groundwater sample near C Canal.

Water quality samples were taken from October 2015 through September 2016. Two monthly samples were obtained during the wet season months of May through September, and one monthly sample was obtained during the dry season months of October through April. Each sample was analyzed for Total Phosphorus, Total Kjeldahl Nitrogen, Ammonia, Nitrate + Nitrite, Chlorophyll-A, Dissolved Oxygen, pH and Specific Conductance. Due to high costs, sucralose and acetaminophen were only analyzed for the October 12, 2016, December 16, 2015, and July 27, 2016 samples. Summary graphs for each parameter are included in Appendix M - Septic Tank Graphs. The following is a summary of the results:

Acetaminophen: Three monitoring sites (GW5C, GW5D and SW5E) had detectable levels of acetaminophen for the October 12, 2015 sample date. These monitoring sites are all located near the McGregor Blvd. septic tanks. No other monitoring location or sample date had detectable levels of Acetaminophen.

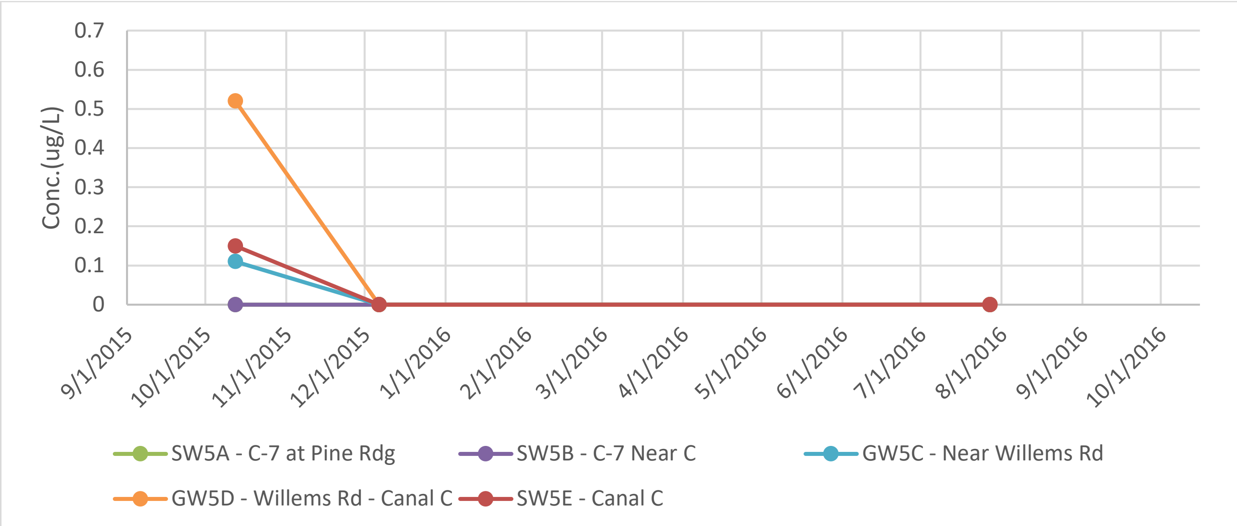


Figure 54 - Septic Tank Acetaminophen

Sucralose: Three monitoring sites had detectable levels of sucralose for one sample date. GW5D had detectable levels on October 12, 2015, and SW5A and SW5E had detectable levels on July 27, 2016.

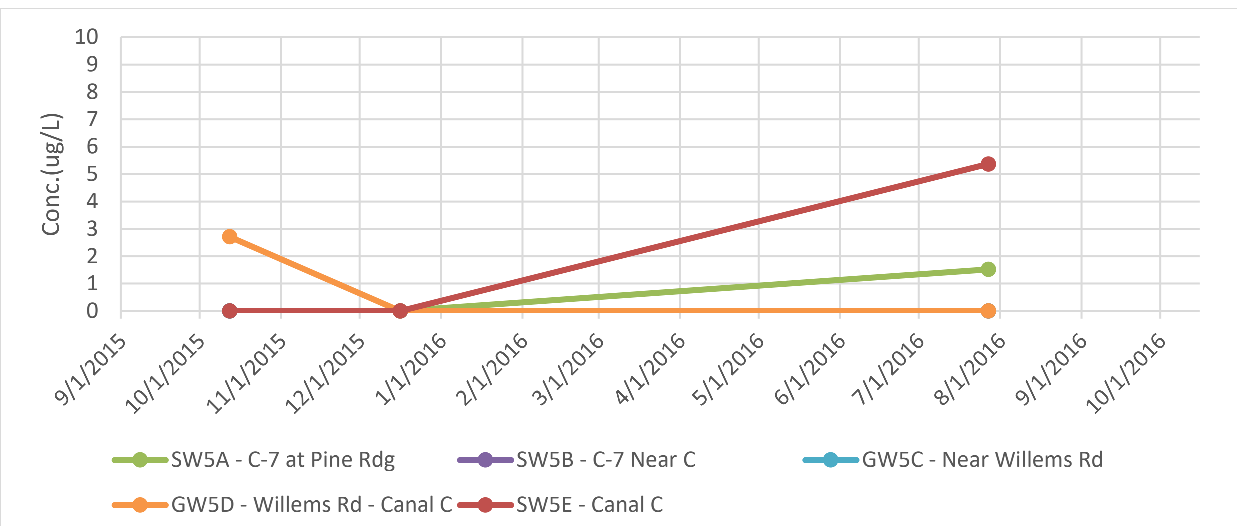


Figure 55 - Septic Tank Sucralose

Total Nitrogen: The TN concentration at all three surface water monitoring locations is relatively similar, with SW5A being slightly higher on most sample dates.

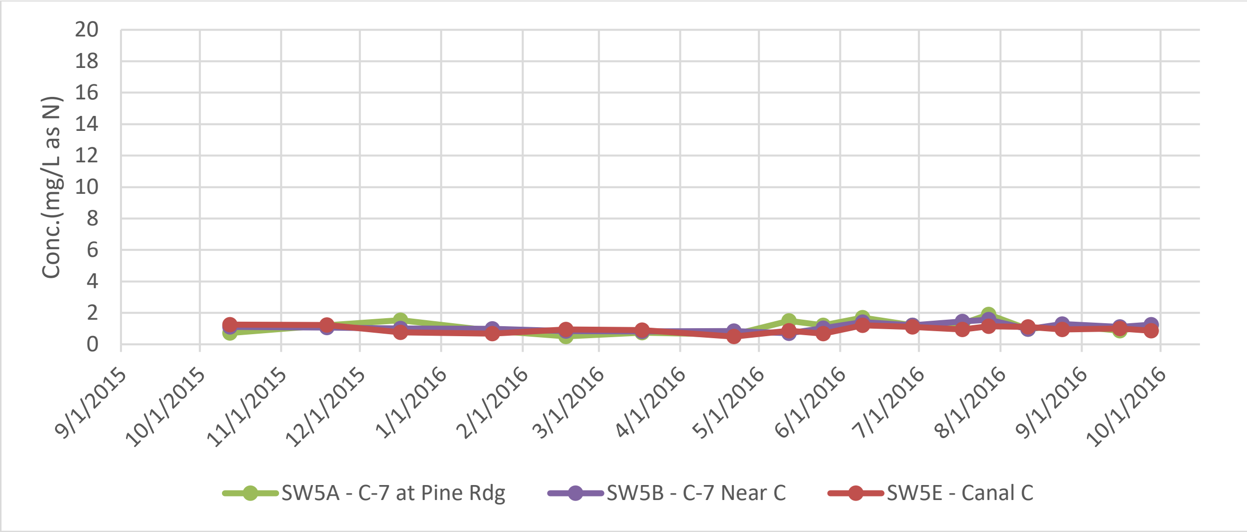


Figure 56 - Septic Tank TN - Surface Water

The following is a summary of the average concentrations:

SW5A – 1.13 mg/L
SW5B – 1.10 mg/L
SW5E – 0.95 mg/L

The average concentrations are very similar, with the concentration at SW5A being slightly higher than the other two. The lowest concentration is at SW5E, in Canal C near McGregor Blvd. SW5A is the closest monitoring location to the Coastal Estates septic tanks.

The groundwater concentrations at GW5C are much higher than GW5D. GW5C is located close to the septic tanks.

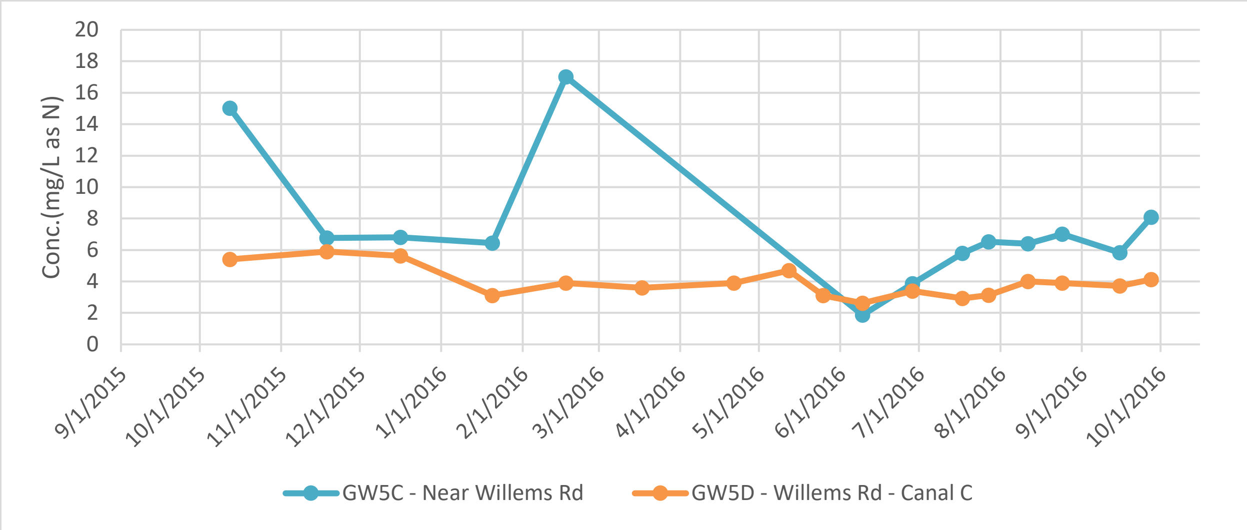


Figure 57 - Septic Tank TN - Groundwater

The following is a summary of the average concentrations:

GW5C – 7.49 mg/L
GW5D – 3.94 mg/L

The average concentration at GW5C is almost double the concentration at GW5D. The concentration is much higher closer to the septic tanks. The increase in concentrations within close range to the septic tanks is an indicator that the tanks are likely a TN source.

Total Phosphorus: The TP surface water concentrations were similar throughout the first half of the monitoring period. About halfway through, the concentrations at SW5A exceeded the other two locations.

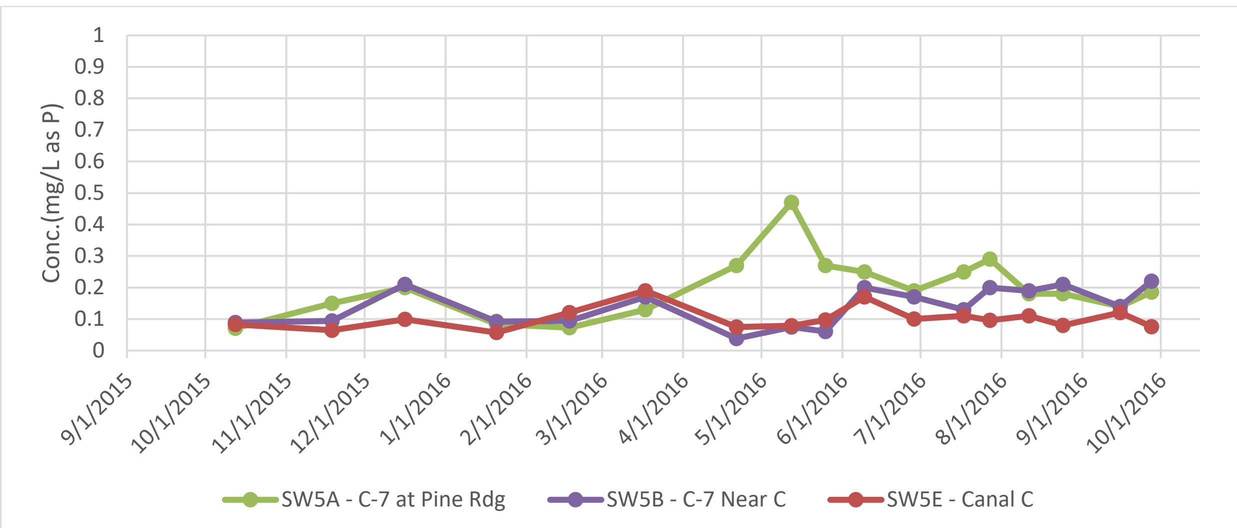


Figure 58 - Septic Tank TP - Surface Water

The following is a summary of the average concentrations:

SW5A – 0.20 mg/L
SW5B – 0.14 mg/L
SW5E – 0.10 mg/L

The highest average concentration is located at SW5A, which is closest to the Coastal Estates septic tanks. The lowest average concentration is located at SW5E, which is the most downstream surface water monitoring location.

The groundwater concentrations at GW5D are much higher than the concentration at GW5C on all sample dates.

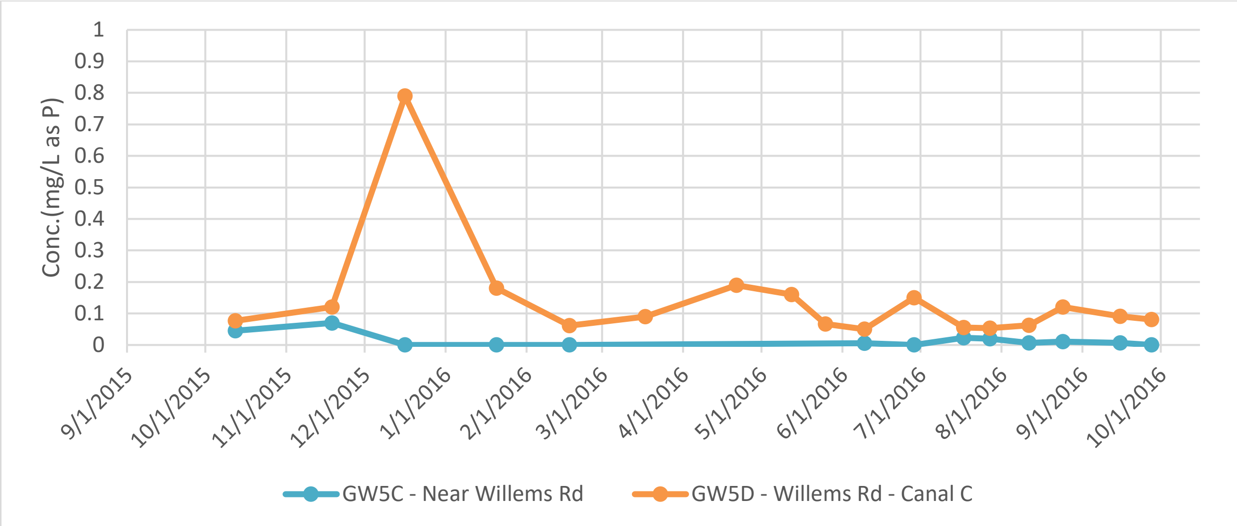


Figure 59 - Septic Tank TP - Groundwater

The following is a summary of the average concentrations:

GW5C – 0.01 mg/L
GW5D – 0.14 mg/L

The average concentration at GW5D is much higher than the concentration at GW5C. GW5D is located further from the McGregor Blvd. septic tanks, making them an unlikely source for the elevated TP levels.

Ammonia: The ammonia concentrations were very low at all monitoring sites for the first half of the monitoring period. SW5A and SW5B had increased concentrations for the second half of the monitoring period.

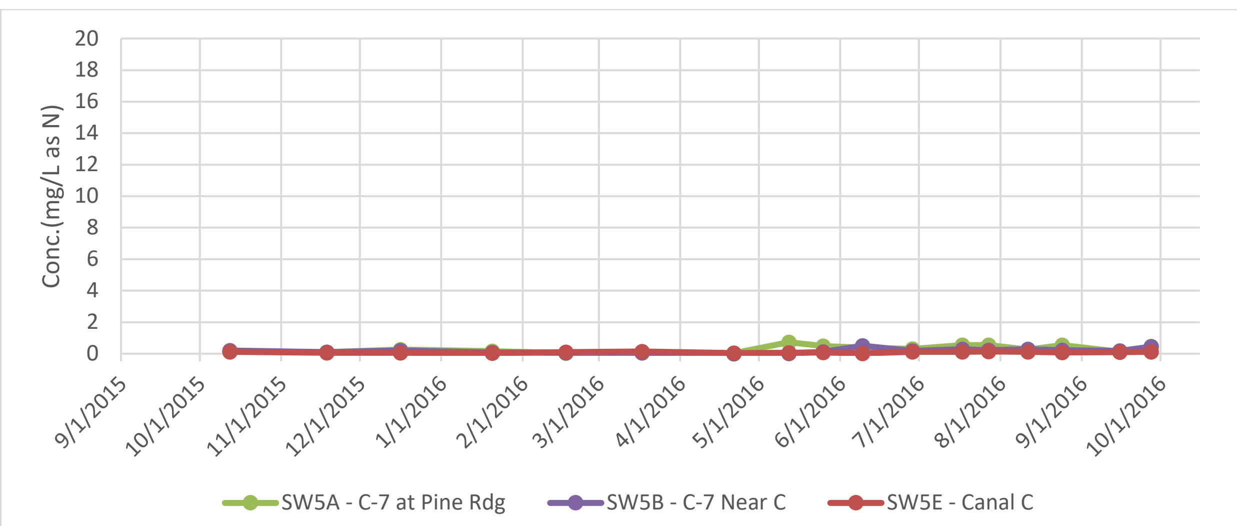


Figure 60 - Septic Tank Ammonia - Surface Water

The following is a summary of the average concentrations:

SW5A – 0.31 mg/L
SW5B – 0.19 mg/L
SW5E – 0.09 mg/L

The average concentrations at SW5A was much higher than the other concentrations. The lowest concentration was at SW5E.

Ammonia groundwater concentrations at GW5C were much higher than the concentrations at GW5D.

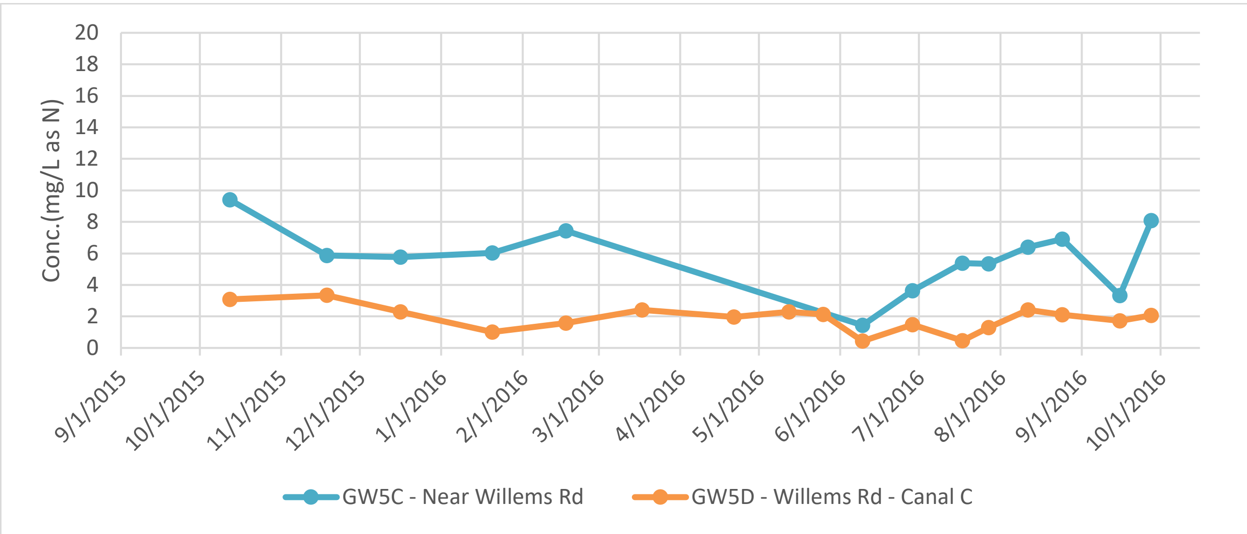


Figure 61 - Septic Tank Ammonia - Groundwater

The following is a summary of the average concentrations:

GW5C – 5.77 mg/L
GW5D – 1.89 mg/L

The average concentration at GW5C, located closest to the septic tanks, was more than 3 times the concentration at GW5D.

Nitrate + Nitrite: The N+N concentrations at all surface water and groundwater monitoring sites were very low, and only made up a small portion of the TN concentration for each sample.

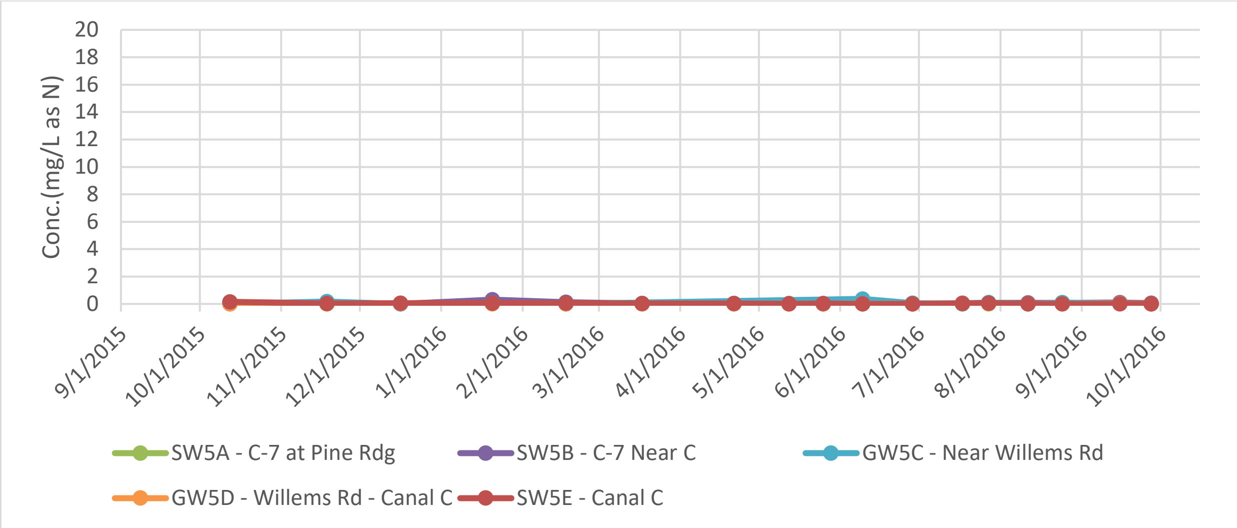


Figure 62 - Septic Tank Nitrate+Nitrite

The following is a summary of the average concentrations:

SW5A – 0.04 mg/L
SW5B – 0.07 mg/L
SW5E – 0.03 mg/L
GW5C – 0.07 mg/L
GW5D – 0.01 mg/L

Total Kjeldahl Nitrogen: The TKN concentrations were similar to the TN concentrations. Most of the TN in all samples was either ammonia or organic N.

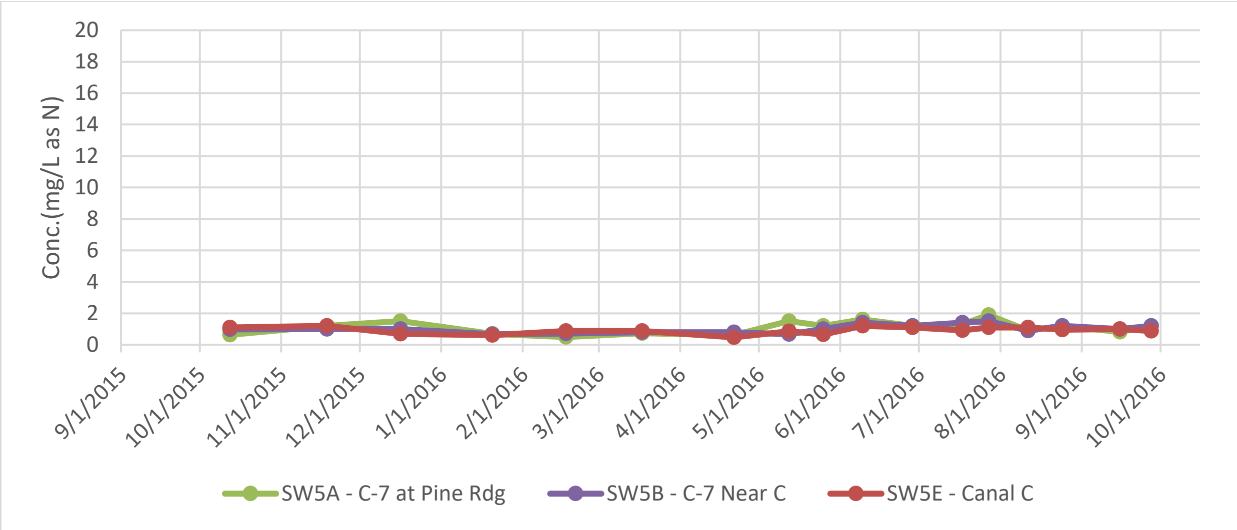


Figure 63 - Septic Tank TKN - Surface Water

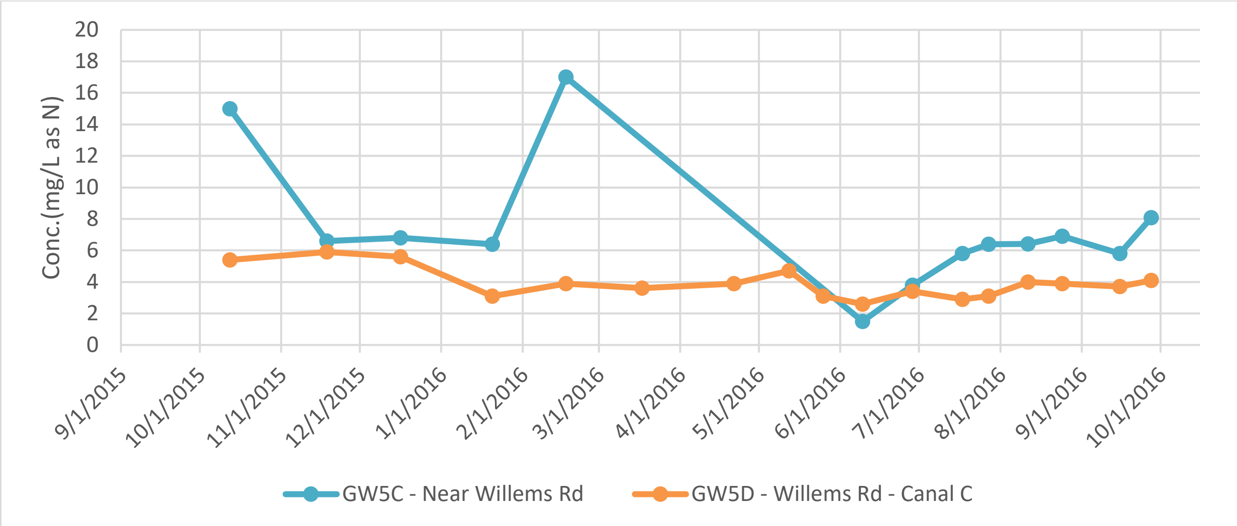


Figure 64 - Septic Tank TKN - Groundwater

The following is a summary of the average concentrations:

SW5A – 1.10 mg/L
SW5B – 1.02 mg/L
SW5E – 0.92 mg/L
GW5C – 7.42 mg/L
GW5D – 3.94 mg/L

Organic Nitrogen: The organic N concentration at the surface water monitoring sites was generally similar for each sample date.

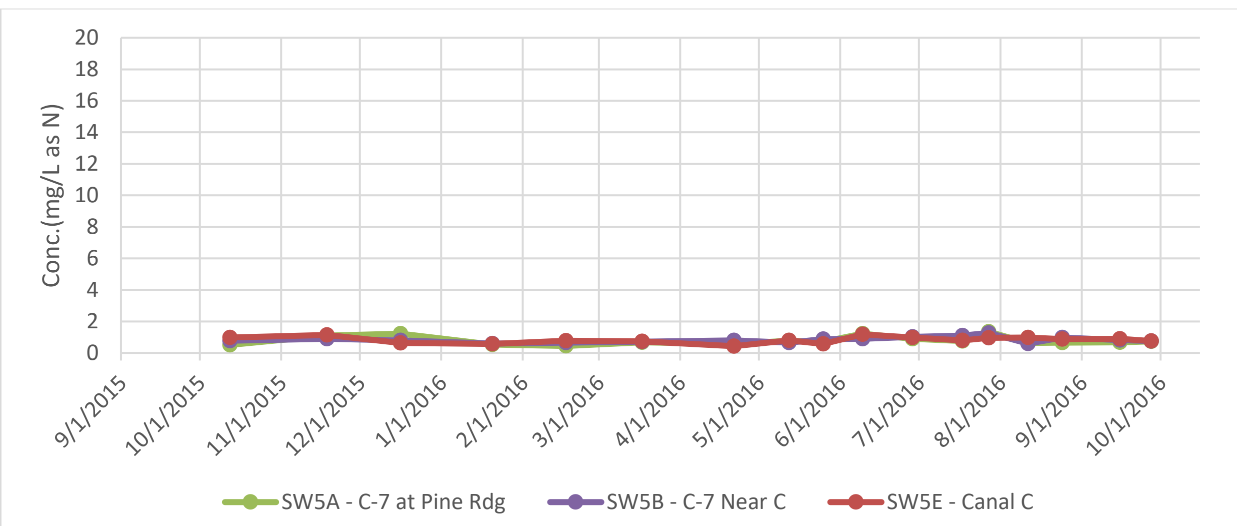


Figure 65 - Septic Tank Organic Nitrogen - Surface Water

The following is a summary of the average concentrations:

SW5A – 0.79 mg/L
SW5B – 0.84 mg/L
SW5E – 0.83 mg/L

GW5D generally had higher organic N concentrations than GW5C, except for three sample dates.

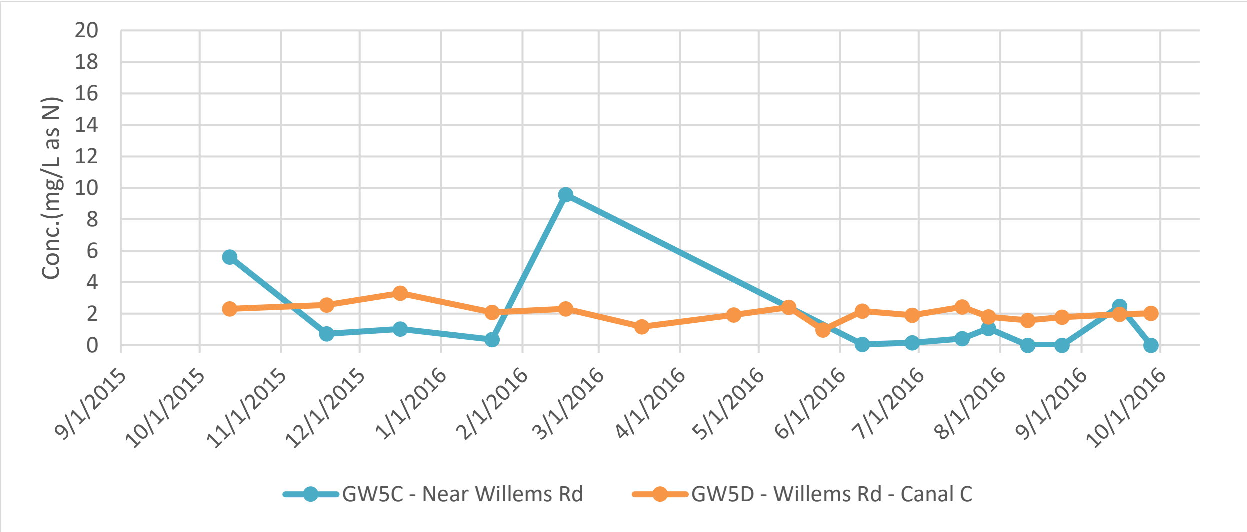


Figure 66 - Septic Tank Organic Nitrogen - Groundwater

The following is a summary of the average concentrations:

GW5C – 1.65 mg/L
GW5D – 2.05 mg/L

The average organic concentration at GW5D was approximately 25% higher than the concentration at GW5C.

Chlorophyll A: The lowest Chlorophyll A concentrations were found at SW5E. SW5A and SW5B generally had the highest concentrations, depending on the sample date.

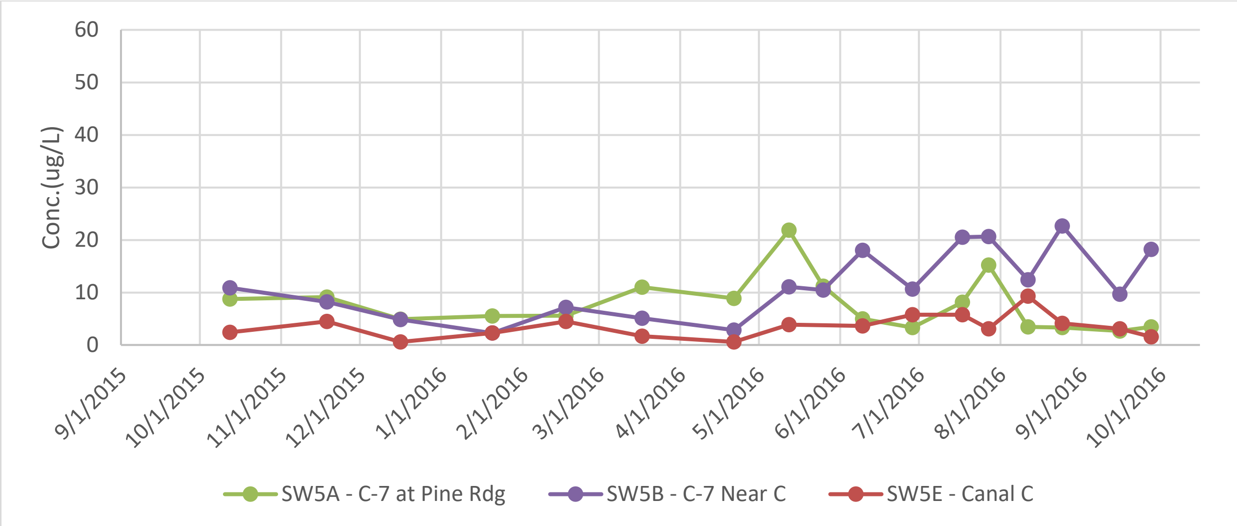


Figure 67 - Septic Tank Chlorophyll A - Surface Water

The following is a summary of the average concentrations:

SW5A – 7.72 ug/L
SW5B – 11.51 ug/L
SW5E – 3.52 ug/L

The average concentration at SW5B was the highest, followed by SW5B. These sample sites are located the furthest upstream, closest to the Coastal Estates septic tanks.

Specific Conductance: The highest specific conductance was located at GW5D, closest to canal C. Values also fluctuated the most at this location, indicating varying tidal influence. The other groundwater monitoring wells had much lower specific conductance values, and these values were very consistent. The specific conductance values at SW5E (in Canal C) also fluctuated, indicating varying tidal influence. The lowest values were found at SW5B and SW5A located on canal C-7. The low values and minimal fluctuation at these locations indicates little tidal influence.

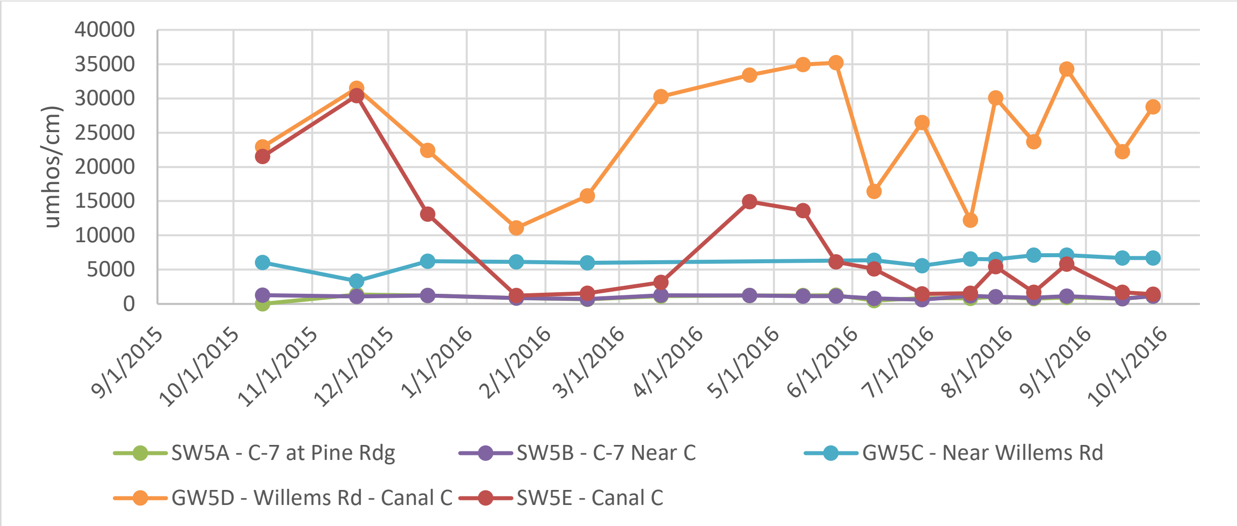


Figure 68 - Septic Tank Specific Conductance

Following is a summary of the average concentrations.

SW5A – 930 umhos/cm
SW5B – 1,031 umhos/cm
SW5E – 7,635 umhos/cm
GW5C – 6,179 umhos/cm
GW5D – 25,387 umhos/cm

The above monitoring results indicates septic tanks are likely a source of nitrogen with the Deep Lagoon Watershed. However, the data does not quantify the loading to the watershed. While a detailed analysis is outside the scope of this report, a simplistic estimate has been prepared below.

Septic tank loading rates were estimated by HSA Engineering & Scientists in their 2009 report titled "*Phase I Report Identification of Non-Point Source Nutrient & Fecal Coliform Contributors for the Hendry Creek and Mullock Creek Basins*." In this report, septic tanks were estimated to discharge approximately 29 lb./year, of which 77% was estimated to reach the groundwater table. The 77% rate was estimated using a range of 50% - 90% in a Florida Department of Health Report "*Nitrogen Impact of Onsite Sewage Treatment and Disposal System in the Wekiva Study areas.*" For the Deep Lagoon Watershed, 80% of the nitrogen load was estimated to reach the groundwater table. This relatively high rate was selected due to the high groundwater table throughout the watershed, and specifically in the area close to the septic tanks.

Loading Rate (McGregor & Willems Road & Coastal Estates Community):

Septic tank discharge (R) = 29 lb N/yr
Percent reaching groundwater (%) = 80%
Number of Septic Tanks (ST) = 62 + 95 = 157

Loading to groundwater = R * ST * % = 29 * 157 * 0.8 = 3,642.4 lb N / yr

The loading rate to the groundwater table does not necessarily represent the loading rate to surrounding surface waters. Some of the nutrients within the groundwater table will be removed as the water flows through the soil and root systems. Estimating the precise amount of nitrogen that leaves the groundwater table and enters surface water is outside the scope of this report. However, to provide a very basic understanding of potential discharges to the surface water, the following Table 9 – Septic Tank Potential Surface Water Loading Rate has been provided with a range of discharge percentages. For comparison purposes, the septic tank potential surface water loading rates were compared to the land use loading rate of 19,302 lb./year as a percentage of the land use loading.

Table 9 – Septic Tank Potential Surface Water Loading Rates

Loading Percentage from Groundwater to Surface Water	Loading Rate (lb N/yr)	Percentage of Land Use Loading
10%	364.2	0.2 %
50%	1,821.2	9.4%
90%	3,278.2	17.0%

Legacy Sources

Historical land use practices have the potential to impact water quality through legacy pollutants found in the soil strata. After years of adding fertilizer, nutrient concentrations can build up in the soil of agricultural properties. These nutrients can be released into the surface water or groundwater years after farming has ended. High-nutrient sediments within ponds or canals can also release nutrients back into the water column if the sediment has higher concentrations than the overlying water.

In areas where legacy pollutants are a main contributor to pollutant loads, one would expect to see a trend toward decreasing water quality concentrations. Water quality data reviewed for this report indicates that TP concentrations within the study area show a decreasing trend. This could be an indication that TP sources include a legacy source or a source that is decreasing in volume or concentration. However, there is an increasing trend regarding TN concentrations. This potentially indicates legacy sources are not a primary source of the increasing TN concentrations. However, it is possible that they may still be contributing to the overall nitrogen load.

To help understand the potential impact legacy sources could be having on the watershed, sediment samples were obtained and analyzed at three IDD Canal locations and at one historically farmed property. An additional sample was taken in an un-cleared area that has not been farmed to establish background results for comparison. Three sediment samples were taken at each location, and an average value was calculated to represent each location. In addition, a groundwater monitoring station was established downstream of the historically farmed property to help understand if legacy nutrients from the farm field sediment are migrating through the groundwater table. The location of these samples is identified in Figure 69 - Sediment Sample Location Map and Appendix C - Deep Lagoon Monitoring Locations.

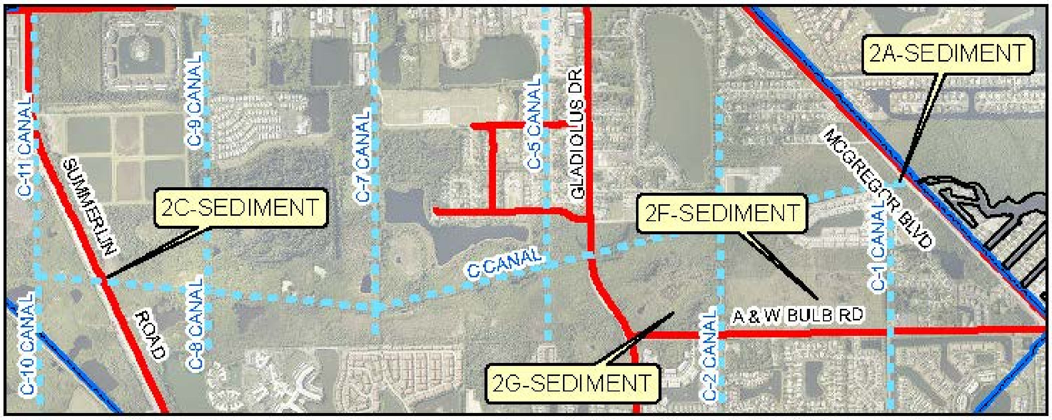


Figure 69 - Sediment Sample Location Map

The sediment sample results are summarized in the following Figure 70 - Figure 72.

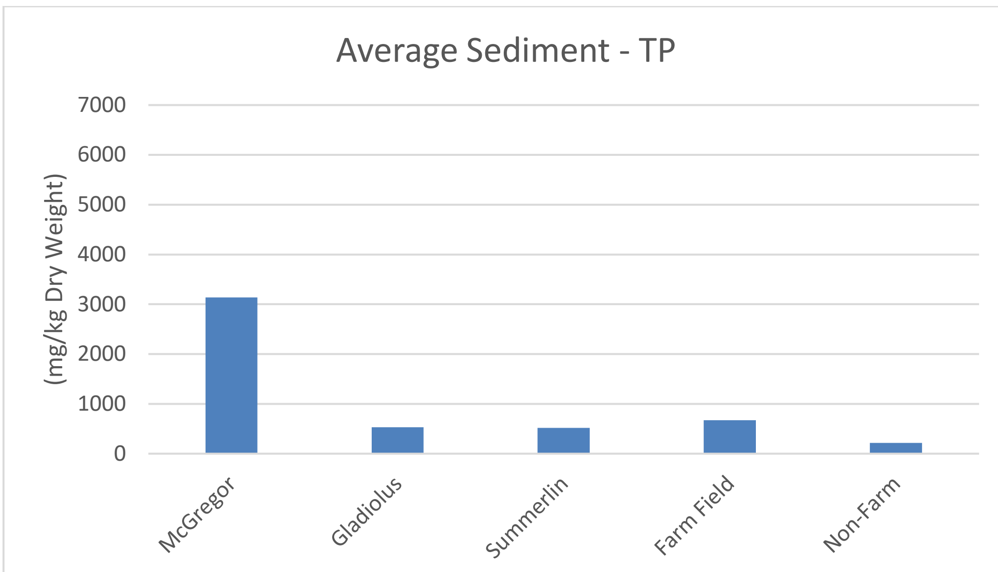


Figure 70 - Average Sediment TP Concentration

As indicated in Figure 7, the highest TP concentration of 3137 mg/kg dry weight is located at McGregor Blvd. Concentrations at both Gladiolus Drive and Summerlin Road were significantly lower, at 530 and 517 mg/kg dry weight respectively. The farm field had the second highest TP concentration, at 670 mg/kg. For reference purposes, the estimated background concentration in the non-farmed area was 213 mg/kg. All locations had TP concentrations much higher than the background concentration.

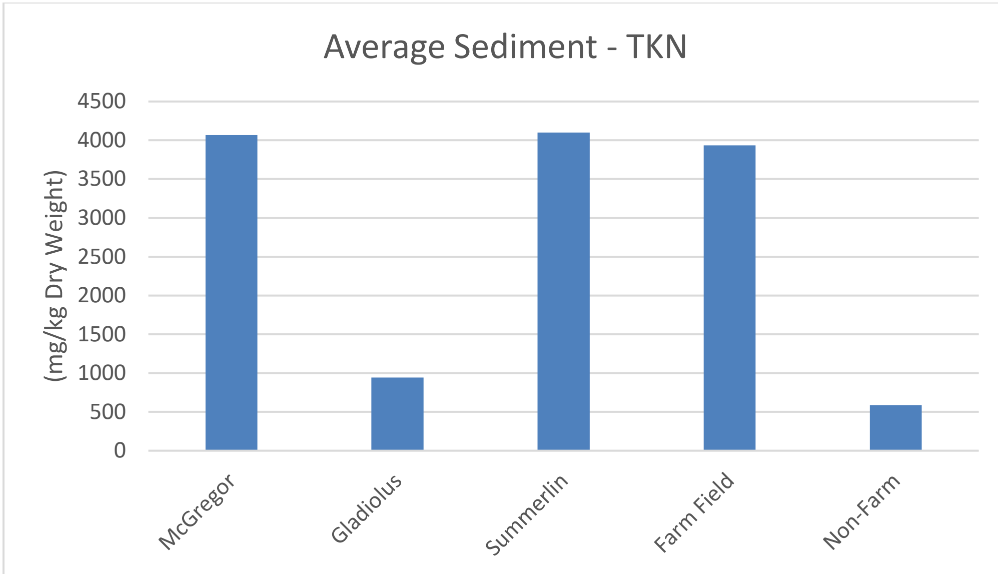


Figure 71 - Average Sediment TKN Concentration

The TKN concentrations at Summerlin Road, McGregor Blvd., and the farm field are the highest, with concentrations of 4100 mg/kg, 4067 mg/kg, and 3933 mg/kg respectively. The concentration at Gladiolus Drive is about ¼ of these, at 943 mg/kg. The non-farmed soils, representing background concentration, have a lower concentration of 587 mg/kg. All locations have TKN values much higher than the estimated background location on the non-farmed property.

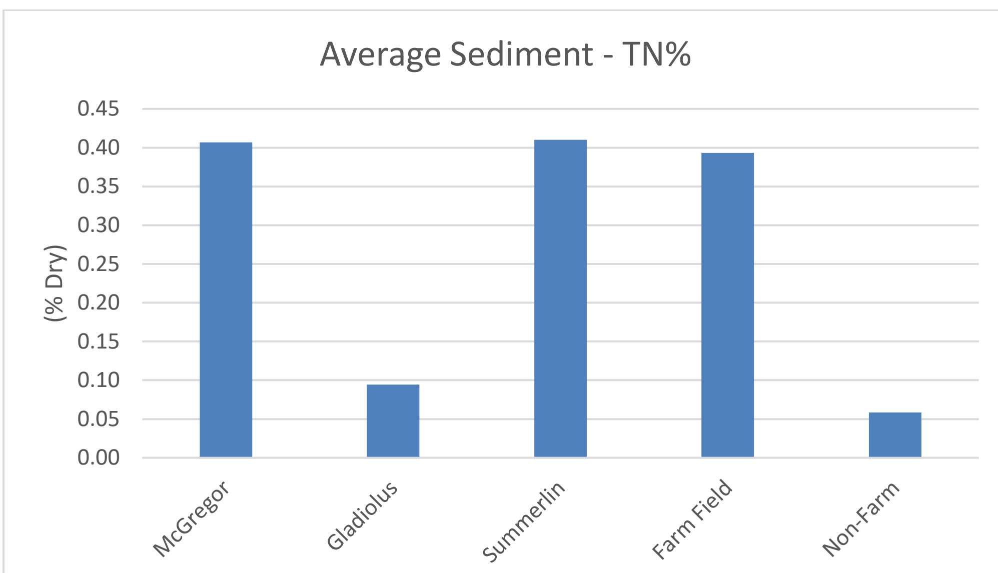


Figure 72 - Average Sediment % TN

The sediment percent TN distribution between sample locations is similar to the TKN concentrations. The McGregor Blvd, Summerlin Road and farm field samples are significantly higher than the other two locations.

The high nitrogen concentrations at McGregor Blvd and Summerlin Road, along with the high phosphorus concentration at McGregor Blvd., are likely a nutrient source for Deep Lagoon, as these soils interact directly with the Canal C stormwater flow.

While the farm field soil has high nitrogen concentrations, it is not in direct contact with stormwater flows. For nutrients to enter the IDD canal, they would need to be carried via groundwater flows. To identify potential groundwater impacts, a groundwater monitoring well (GW3A) was placed down gradient of the farm field site. The approximate monitoring location is identified on Figure 73 - Farm Field Groundwater Well Location Map and Appendix C - Deep Lagoon Monitoring Locations.

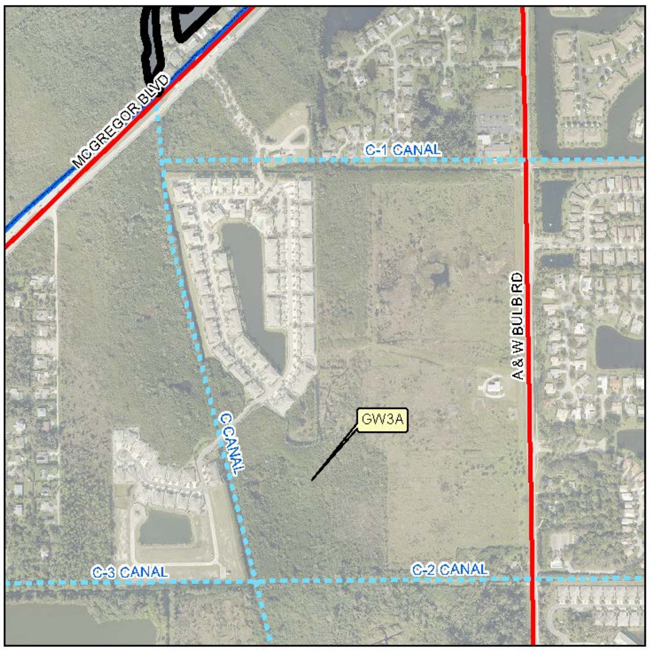


Figure 73 - Farm Field Groundwater Well Location Map

Water quality samples were taken from October 2015 through September 2016. Two monthly samples were obtained during the wet season months May through September, and one monthly sample was obtained during the dry season months October through April. Each sample was analyzed for Total Phosphorus, Total Kjeldahl Nitrogen, Ammonia, Nitrate + Nitrite, Chlorophyll-A, Dissolved Oxygen, pH and Specific Conductance. Due to high costs, sucralose and acetaminophen were only analyzed for the October 12, 2016, December 16, 2015, and July 27, 2016 samples. Summary graphs for each parameter are included in Appendix N - Farm Field Graphs. The following is a summary of the results:

Total Nitrogen: The total nitrogen concentration at GW3A was generally lower than all other groundwater monitoring sites within this report. The average concentration is 3.5 mg/L as N, and the closest average concentration was 3.94 mg/L at GW5D located between Willems Rd. and Canal C. This indicates there is likely less loading from the groundwater at the farm field than other locations.

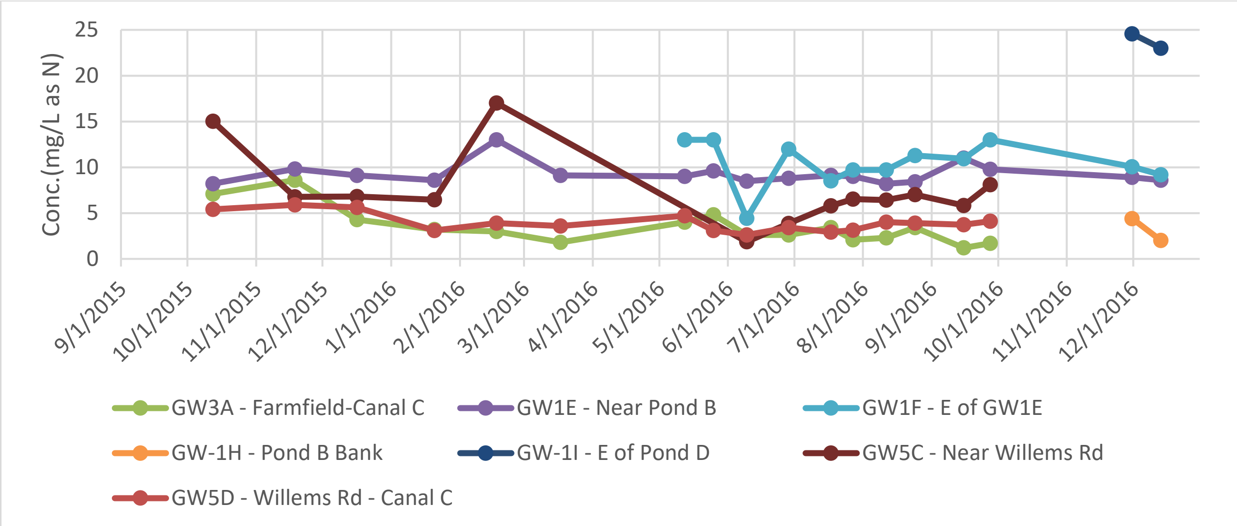


Figure 74 - Groundwater Sample TN

The average concentration of 3.5 mg/L is similar to the background groundwater concentration in the 2006 Water Resource Solutions Report of 3.74 mg/L.

Total Phosphorus: The total phosphorus concentration at GW3A was typically the second highest groundwater concentration for most sample dates. The average concentration for GW3A was also the second highest of the groundwater monitoring locations. The only location with higher TP concentration was GW1E located near Pond B. The higher TP concentrations could be an indicator that the groundwater flows from the farm field, and may be a TP source to the watershed.

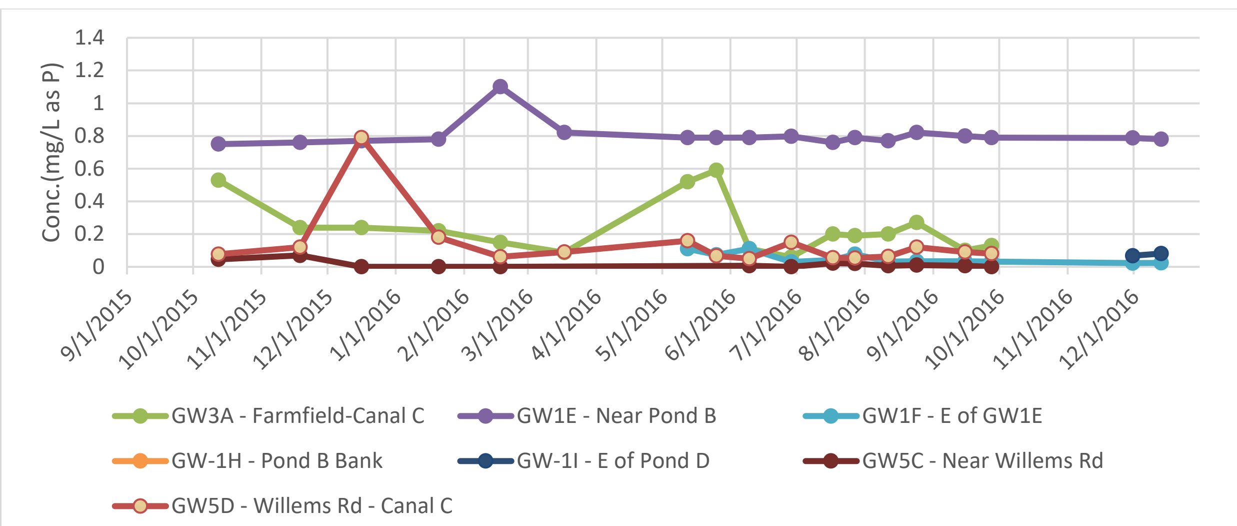


Figure 75 - Groundwater Sample TP

Ammonia: Approximately 64% of the TN at GW3A is in the form of ammonia.

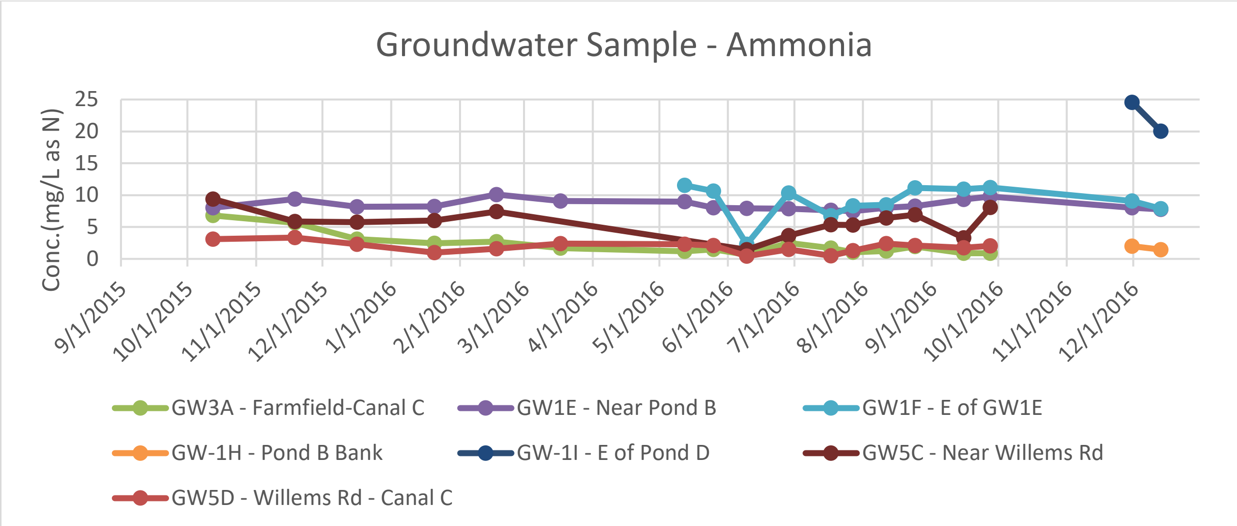


Figure 76 - Groundwater Sample Ammonia

Nitrate + Nitrite: Nitrate + Nitrite concentrations for all sample dates were below detectable levels.

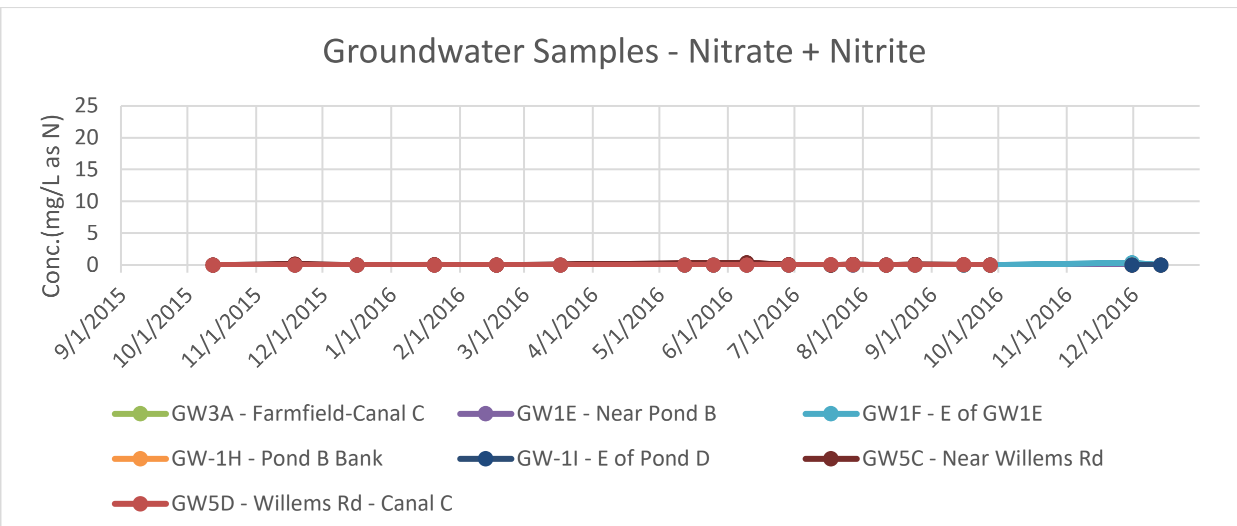


Figure 77 - Groundwater Samples Nitrate+Nitrite

Total Kjeldahl Nitrogen: 100% of all the TN at monitoring site GW3A is TKN, ammonia plus organic nitrogen.

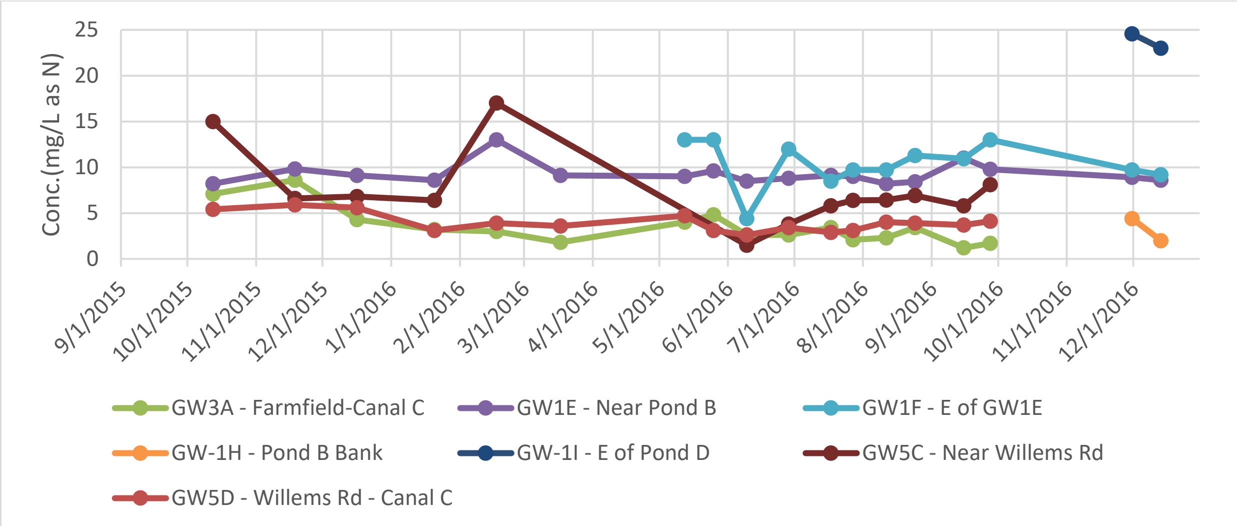


Figure 78 - Groundwater Sample TKN

Organic Nitrogen: Approximately 36% of the TN at GW3A in in the form of organic nitrogen.

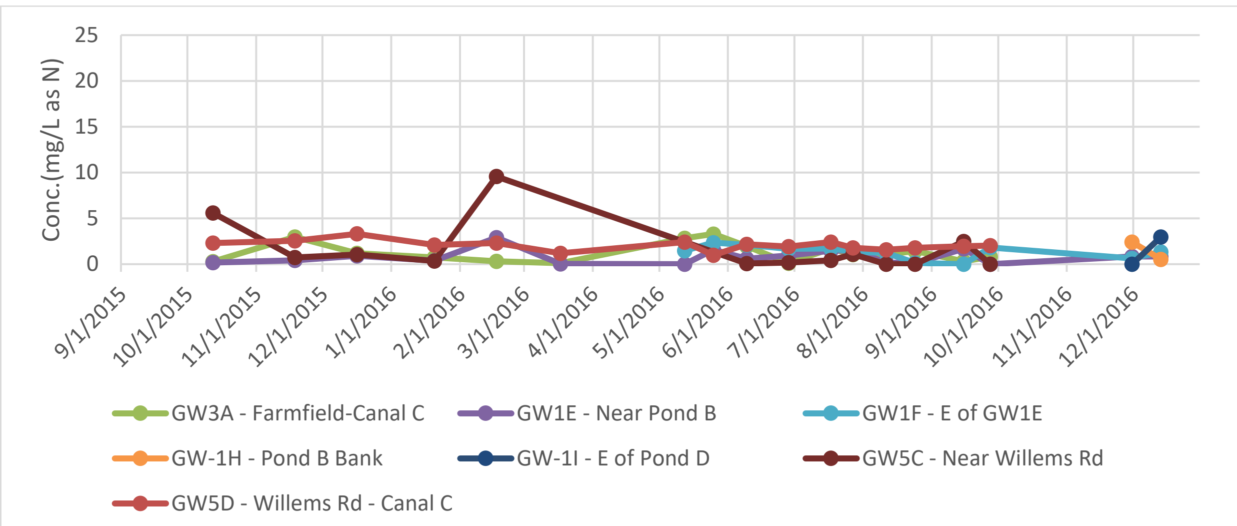


Figure 79 - Groundwater Sample Organic Nitrogen

Over the monitoring period, well GW3A generally had the lowest TN concentration of any groundwater well sampled within this report. In addition, the GW3A concentrations were similar to the background concentration at Piezometer P-6 in the 2006 Water Resource Solution Study. The average concentration at GW3A was 3.50 mg/L, and the average concentration at P-6 was 3.74 mg/L.

The low TN concentrations downstream of the farm field indicate the legacy nitrogen within the farm fields soils is not likely a major source of nitrogen to the watershed.

Summary

The Caloosahatchee River Estuary has been defined as impaired, and a TMDL has been set that requires a basin-wide reduction for total nitrogen of 23%. As a stakeholder, Lee County is required to contribute to this overall reduction, and must reduce its loading by 23%.

The two water quality monitoring stations within the Deep Lagoon Watershed indicate elevated TN levels that have shown an increasing trend over the past 23 years. This makes the Deep Lagoon Watershed a good candidate to reduce nitrogen loading rates.

The potential nitrogen sources within the watershed have been discussed and investigated as part of this report. Those sources include land use, reclaimed water irrigation, reclaimed irrigation water storage ponds, percolation ponds, septic tanks and legacy sources.

The sources that are likely contributing the largest loads to the watershed are land use, percolation ponds, septic tanks and canal sediment. The extent to which reclaimed water irrigation and reclaimed irrigation water storage ponds could be contributing to the nitrogen load was not fully investigated in this report, and could be investigated further to understand their impact on the overall basin. They likely contribute a smaller load than those sources identified above.

Water quality improvement projects investigated in the final phase of this project should focus on quantifying the load from land uses, percolation ponds, septic tanks, and canal sediment, as well as ways to control or reduce their contribution. The recommended projects will focus on the most cost-effective methods to reduce nitrogen concentrations.

References

FDA. (2017, February 16). *Additional Information about High-Intensity Sweeteners Permitted for use in Food in the United States*. Retrieved from U.S. Food & Drug Administration: http://www.fda.gov/food/ingredientspackaginglabeling/foodadditivesingredients/ucm397725.htm

Fitzpatrick, T. W. (2014). Sucralose as an Effective and Sensitive Tracer for Domestic Wastewater. *FSEA Spring Meeting*. Florida.

HSA Engineers & Scientist. (2009). *Identification of Non-Point Source Nutrient & Fecal Coliform Contributions for the Hendry Creek & Mullock Creek Basins.* Fort Myers.

Lee County Utilities. (2000). Nitrate Level Study.

Snoeyink, V. L., & Jenkins, D. (1980). *Water Chemistry.* New York: John Wiley & Sons.

Water Resource Solutions. (2006). Hydrological Investigation for the LCU FMB WWTP Perc. Ponds.

Whiting, D. (2014, October 23). FDEP's Application of Molecular and Chemical Markers for Water Impaired for Fecal Coliforms. *FDEP Biocriteria Meeting*.

Appendix B: Waldrop Engineering Pollutant Load Reduction Study Phase III

Deep Lagoon Pollutant Load Reduction Study

Phase 3 - Water Quality Recommendations

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1 Executive Summary

Federal regulations through Section 303(d) of the Clean Water Act (CWA) require each state to identify surface waters that do not meet water quality standards, defined as impaired. States are then required to establish a Total Maximum Daily Load (TMDL) for each impaired water body. The TMDL is the maximum amount of a pollutant that can be discharged to the water body without causing an exceedance of water quality standards.

The Caloosahatchee River Estuary was identified as impaired by FDEP and a TMDL was subsequently established. The TMDL for the Caloosahatchee Estuary requires a 23% reduction in total nitrogen (TN) loads throughout the watershed.

The entire Caloosahatchee Estuary and approximately 34 miles of the Caloosahatchee River runs through Lee County. Lee County is directly impacted by the water quality within the Caloosahatchee River Estuary and is a source of nitrogen loads to the estuary. As such, Lee County is one of the key stake holders for the river. As a stake holder, Lee County is required to participate in the TN load reduction required by the TMDL Report.

This Deep Lagoon Pollutant Load Reduction project not only identifies potential nitrogen sources from the Deep Lagoon Watershed that are likely contributing to the Caloosahatchee River Estuary nitrogen load, but also recommends projects to reduce the load. A summary of each phase is provided below:

1. Background Data (Completed) - Identifies existing and historical conditions that could be contributing nitrogen loads to the watershed.
2. Analysis (Complete) - Detailed analysis of the data which provides estimated nitrogen loads from sources within the watershed that can be calculated.
3. Recommendations (Subject of this Report)- Identifies best management practices to reduce nitrogen loading.

The goal of this study is to identify nitrogen sources and obtain data to understand impacts, as well as determine the sources that are contributing the highest loads, identify water quality improvement projects, and recommend best management practices to improve water quality.

The project study area is defined by the Iona Drainage District (IDD) Canal C watershed. Canal C directs stormwater runoff to Deep Lagoon.

Previous project reports identified potential watershed nutrient sources of; change in land use, reclaimed water irrigation, irrigation percolation ponds, effluent percolation ponds, septic tanks, and legacy sources.

To help reduce the nitrogen loading from these sources, the following projects were investigated.

- Canal C Weirs/Marshes
- Hagie Road FDOT Pond
- A&W Bulb 20/20 Parcel Rehydration
- Lago Del Sol Pond
- Percolation Pond Sediment Removal

- Percolation Pond Liner
- Percolation Pond Treatment in Place
- Percolation Pond Increased Flow Path
- Septic Tanks – Connect to Sewer
- Canal Sediment Removal
- Canal Sediment Chemical Treatment

Using the Alternatives Matrix shown in Appendix G the list of potential projects was reduced to the five projects that likely provided the most benefit at the least cost. The five projects are:

- McGregor Blvd. Weir
- Canal C9 Weir
- A&W Bulb Parcel Rehydration
- Hagie Road Pond
- Lago Del Sol Pond

Preliminary conceptual designs were prepared for each project. The designs were used to estimate the nitrogen load reduction and preliminary construction costs to help identify the project that are potentially the most cost effective at removing nitrogen. The load reduction, costs and $/load reduction are provided in Section 7 Nutrient Load Reduction Project.

The estimated costs for each alternative is summarized in Table 3 – McGregor Weir Loading below.

Table 1 - Estimated Cost per Pound of Nitrogen Removed

Alternative	Cost per lb of Nitrogen
McGregor Blvd Weir	$ 217 / lb
Canal C9 Weir	$ 224 / lb
A&W Bulb Rehydration	$ 414 / lb
Hagie Rd Pond	$ 200 / lb
Lago Del Sol Pond	$ 144 / lb

It is recommended the McGregor Blvd Weir, Canal C9 Weir, Hagie Road Pond, and Lago Del Sol Pond project be investigated further. Each project is expected to improve water quality at a similar cost. More detailed calculations will provide more exact costs, benefits and challenges.

The A&W Bulb Rehydration project is not recommended for further investigation at this time due to the much higher cost per pound of nitrogen removed compared to the other projects.

The two weir projects should be investigated together along with other potential weir options to identify the one that will provide the most benefit.

2 Project Description

Federal regulations through Section 303(d) of the Clean Water Act (CWA) require each state to identify surface waters that do not meet water quality standards. The list of surface waters not meeting water quality standards is known as the 303(d) list or impaired waters. States are required to establish a Total Maximum Daily Load (TMDL) for each impaired water body. The TMDL is the maximum amount of a pollutant that can be discharged to the water body without causing an exceedance of water quality standards.

The Caloosahatchee River Estuary was identified as impaired by FDEP, and a TMDL was subsequently established in *The Nutrient TMDL for the Caloosahatchee Estuary Report* prepared by FDEP. The TMDL for the Caloosahatchee Estuary calls for a 23% reduction in Total Nitrogen (TN) loads throughout the watershed. This pollutant reduction applies throughout the watershed to each drainage area individually.

Implementation of the nutrient load reduction is delegated to the local stake holders through the National Pollution Discharge Elimination System (NPDES) Program and the Basin Management Action Plan (BMAP). For the Caloosahatchee River Estuary, local stake holders include Cities, Counties, Water Management Districts, and Florida Department of Transportation, among others. The BMAP is prepared by FDEP with assistance from each stake holder. Within the BMAP, each stake holder identifies how they will meet the pollutant reduction goals. The BMAP provides a road map as to how the TMDL will be met, and the water quality impairment reduced or eliminated.

The entire Caloosahatchee River Estuary and approximately 34 miles of the Caloosahatchee River runs through Lee County. Lee County is directly impacted by the water quality within the Caloosahatchee River Estuary, and is a source of nutrient loads to the estuary. As such, Lee County is one of the key stake holders for the river. Lee County is, as a stake holder, required to participate in the TN load reduction required by the TMDL Report. A key first step in reducing nitrogen loads is to understand where the TN loads are coming from, and then identify practices that will reduce those loads on a watershed by watershed basis. The Pollutant Load Reduction Study will accomplish this for the Deep Lagoon Watershed.

Lee County selected the Deep Lagoon Watershed as the subject of this pollutant load reduction study not only because it is part of the Caloosahatchee River Estuary TMDL and BMAP, but also because it has relatively high nutrient levels. In addition, The Deep Lagoon Watershed includes significant areas of publicly owned land through the center of the watershed. This could facilitate the implementation of structural best management practices, should they be required.

This Deep Lagoon Pollutant Load Reduction Study will consist of three phases, including Background Data, Analysis, Recommendation, and Report. A summary of each phase is provided below:

1. Background Data (completed previously) - This first task obtained background data for the Deep Lagoon Watershed. The background data identified existing and historical conditions that could be contributing nitrogen loads to the watershed and ultimately contributing to the watershed's impairment.
2. Analysis (completed previously) - The second phase includes a detailed analysis of the data and provides estimated nitrogen loads from sources within the watershed that can be calculated.

This phase identified the sources that are likely contributing the highest nitrogen loads to the watershed.

3. Recommendations (subject of this report) - The phase identified several best management practices, that could help reduce nitrogen loads. It then prioritizes these practices using an alternative matrix based on County Staff input. The matrix used to narrow the larger list of projects to 4-5 that can be analyzed in more detail. Preliminary designs for these 4-5 projects were created and used to estimate nitrogen load reductions and construction cost estimates.

3 Project Goals

The goals for The Deep Lagoon Pollutant Load Reduction Study are as follows:

1. Identify nitrogen sources within the watershed. Potential sources include stormwater runoff, fertilizers, septic tank effluent, reclaimed water irrigation, direct or indirect wastewater discharge, and legacy nutrients.
2. Obtain additional data to better understand the impacts that nitrogen sources have on the watershed's water quality.
3. Analyze nutrient sources to determine those that are contributing the highest loads.
4. Identify structural and non-structural best management practices to improve water quality.
5. Recommend and prioritize best management practices to improve water quality.

4 Nitrogen Sources

All watersheds include a variety of nitrogen sources. The Deep Lagoon Watershed is no different. Previous reports investigated numerous potential nitrogen sources. These sources were narrowed down to the four sources that are likely providing the largest contribution of nitrogen to the watershed. These sources included Land Use, Percolation Ponds, Septic Tanks and Canal Sediment. Determining the exact contribution from each is outside the scope of this project. However, water quality monitoring and nutrient loading calculations performed for this and other projects have provided indications that these sources likely provide increased loads to the watershed.

4.1 Land Use

As watersheds transition from native vegetation to agricultural, residential, commercial, or industrial land uses, nutrient loading rates typically increase. This is due to a combination of increased nutrient production and reduced nutrient uptake. Increased nutrient loads can be created using fertilizers and the discharge of waste water effluent. Fertilizers are applied extensively within agricultural, golf course, and residential lands uses. While still used within commercial and industrial land uses, the rate and frequency of applications are typically much less.

Reduced nutrient uptake is the result of impervious areas replacing pervious areas and native vegetation. Impervious areas prevent rainfall from percolating into the surrounding soil. This increases the volume of stormwater runoff and the associated nutrients, resulting in higher nutrient loads. As vegetation is cleared, the natural nutrient uptake from the plants is removed from the landscape.

Nutrients that were previously stored in the soil or used by plants to grow now discharge downstream, further increasing the nutrient loads.

The previously completed Deep Lagoon Pollutant Load Reduction Phase 2 – Watershed Analysis Report estimated nutrient loads using the methodology outlined in *Evaluation of Current Stormwater Design Criteria within the State of Florida*, prepared by Harvey, H. Harper, Ph.D., P.E. and David M. Baker, P.E. of Environmental Research & Design, Inc. Following is a summary of the report's findings.

A summary of loading rates for each sub-watershed and the entire Deep Lagoon Study area has been provided in Table 2 - IDD Canal Pollutant Loading Summary. It is important to note that these loading rates are for typical land uses, and do not consider any unique sources, such as septic tanks or percolation ponds, that could be present within the watershed.

Table 2 - IDD Canal Pollutant Loading Summary

	Nitrogen					Phosphorous				
Basin	Load (kg/yr)[3]	Load per Ac. (kg/yr/ac)	Rank	Conc. (mg/L)	Rank	Load (kg/yr)[3]	Load per Ac. (kg/yr/ac)	Rank	Conc. (mg/L)	Rank
C	1,928	2.1	7	1.38	1	185	0.20	9	0.13	6
C-1	1,047	3.2	2	1.34	3	139	0.42	2	0.18	2
C-2	872	2.8	5	1.27	4	105	0.34	6	0.15	4
C-3	778	3.4	1	1.26	5	107	0.47	1	0.17	3
C-4	233	2.1	8	1.24	6	23	0.21	8	0.12	9
C-5	786	3.0	4	1.11	9	103	0.39	4	0.15	5
C-6	-	-	-	-	-	-	-	-	-	-
C-7	1,212	2.8	6	1.35	2	164	0.38	5	0.18	1
C-8	-	-	-	-	-	-	-	-	-	-
C-9	260	1.6	10	1.17	7	28	0.17	10	0.13	8
C-10	41	0.9	11	1.15	8	2	0.04	11	0.06	11
C-11	390	1.8	9	0.98	11	46	0.21	7	0.12	10
Health Park	1,242	3.1	3	1.03	10	159	0.40	3	0.13	7
Total	**8,790**	**5.7**		**1.23**		**1,062**	**0.31**		**0.15**	

Each basin has been ranked based on TN and TP loading rate per acre (kg/yr/ac) and concentration (mg/L). The highest ranked basins are colored red, and the lowest are colored green.

For TN, the highest loading rates are drainage basins C-3, C-1, Health Park, and C-5. The highest concentrations are found in drainage basins C, C-7, C-1, and C-2. Efforts to provide structural BMPs to remove TN loads from the Deep Lagoon Watershed should consider treating the water from these drainage basins.

The highest TP loading rates are found in drainage basins C-3, C-1, Health Park, and C-5. The highest concentrations are in drainage basins C-7, C-1, C-3 and C-2. Efforts to provide structural BMPs to remove TN loads from the Deep Lagoon Watershed should consider treating the water from these drainage basins.

Nutrient loads from land use changes can be difficult to control due to the distributed nature. Potential load reduction efforts could include source control by limiting nutrients added to the watershed through fertilization or construction of stormwater BMPs such as lakes or treatment wetlands to remove the nutrients after they enter stormwater.

4.2 Percolation Ponds

The Fort Myers Beach WWTP utilizes six (6) percolation ponds located north of Summerlin Road, approximately 0.25 miles east of Pine Ridge Road, to hold reclaimed irrigation water when the supply exceeds demand. If needed, the water is later routed back to the treatment plant and distributed for irrigation when irrigation demand exceeds the available supply.

The percolation ponds can potentially impact groundwater and surface water quality by discharging from the ponds into the surrounding groundwater table. The groundwater table is very high at the percolation pond site, and the groundwater and surface water are often hydraulically connected during the wet season. The hydraulic connection could allow the reclaimed water and the associated nutrients to flow into and become surface water.

The ponds were originally constructed as the only effluent disposal method for the plant. However, as the treatment plant expanded, additional effluent disposal methods have been added, including reclaimed water irrigation and a deep injection well. While the ponds are still utilized, they are no longer the primary method of disposal. In addition, from an operation standpoint, they are only used for reclaimed water storage. Percolation is no longer required, and the ponds are no longer maintained as percolation ponds. The pond bottoms have not been maintained to improve percolation rates. Without maintenance, the percolation rate from the ponds is expected to decrease over time.

Within the Phase 2 – Watershed Analysis Report a detailed discussion of the water quality monitoring program and potential water quality impacts from the percolations ponds was provided. The monitoring program determine water from the percolation ponds is likely entering surface water via groundwater flows through the containment berm and pond bottoms. The highest nitrogen concentrations within the watershed are located within the Canal C9, located just north of the ponds. The extent to which the ponds influence water quality within the watershed is not known.

A few potential projects to prevent nutrients from the percolation ponds from influences stormwater include the following.

- Remove pond sediment regularly
- Line ponds so they are evaporation ponds and water no longer flows to the groundwater or surface water
- Treat nutrients in the groundwater before they can enter surface waters
- Increased pond the flow path within the ponds to reduce nutrient levels in the ponds

4.3 Septic Tanks

Developments within The Deep Lagoon watershed are generally serviced by central water and sewer. However, there are a few properties that utilize septic tanks for waste water disposal. They are generally located along the northern and west sides of the study area.

While septic tanks provide some treatment, effluent remains high in nutrients. The septic tanks discharge their effluent through a drain field to the surrounding soil and groundwater. The high groundwater table within the watershed can prevent the effluent from flowing down through the soil and force it laterally into the surface water. When this occurs, the septic tank effluent becomes part of the surface water runoff, potentially discharging to the receiving water body. This increases the surface water's nutrient concentration and nutrient load.

The potential impacts of septic tanks on the watershed's water quality was discussed within the Phase 2 – Watershed Analysis Report. The water quality monitoring performed around the septic tanks indicate they are likely source of nutrients to the watershed. However, the extent to which they are a source is not fully known at this time. Detailed estimates are outside the scope of this project.

Improving operation and maintenance of the existing septic tanks can reduce the nutrient load from septic tanks. However, due to the high groundwater table and proximity of some septic tanks to the Deep Lagoon canals the only way to eliminate them as a source is to connect the homes to central sewer.

4.4 Canal Sediment

Historical land use practices have the potential to impact water quality through legacy pollutants found in the soil strata. After years of provided elevated nutrient loads, nutrient concentrations can build up in the soil of properties or drainage canal. These nutrients can be released into the surface water or groundwater years after the source has been eliminated.

Sediments samples obtained and summarized in the Phase 2 – Watershed Analysis Report indicate there are elevated TN levels within the Canal C sediment at McGregor Blvd and Summerlin Road and in the historically farmed area sampled. Samples taken in an un-farmed property and within Canal C at Gladiolus Drive had much lower TN concentrations.

To help understand any impacts elevated TN levels within the farm field may have on water quality, a groundwater sampling station was established down gradient of groundwater flow. TN concentration within the groundwater samples did not show elevated levels. The TN concentration at this sample location were among the lowest obtained as part of this project. This indicates the elevated TN levels within the farm field may not be impacting groundwater or surface water levels.

The potential flux of nutrients from the canal sediment to the canal stormwater could be eliminated by removing the nutrient rich sediment or adding chemical binders. The initial project would provide the most benefit. However, it may be needed on a regular basis to prevent future buildup of nutrient rich sediment that could become a nutrient source.

5 Nutrient Reduction Alternatives

The Deep Lagoon Pollutant Load Reduction Phase 2 -Watershed Analysis Report identified several potential nitrogen sources within the Deep Lagoon Watershed. As discussed above, they include land use, septic tanks, percolation ponds, and canal sediment. Twelve potential projects have been identified to help reduce these nitrogen loads. Each potential project has been briefly discussed below.

1. **Canal C Weirs/Marshes**

   Source Addressed: All sources after they have entered the Canal system.

   Install weirs in Canal C to hold back water and prevent tidal flows from entering the canal. This will promote groundwater recharge and increase stormwater detention times. Nitrogen loads will be reduced by reducing the overall flows and improving nutrient uptake within the Canals.

   Where practical, marshes could be created to enhance habitats and further improved water quality.

2. **Hagie Rd FDOT Pond**

   Source Addressed: All sources after they have entered the Canal system.

   FDOT currently owns a pond which is located between Hagie Road and Canal C, north of Canal C7. Stormwater from Canal C and Canal C7 could be diverted into the pond, either by gravity flow using a weir or pumps. Water could then flow through the pond and discharge to Canal C5 or Canal C. The ponds would detain the water, allowing more time for water to evaporate and percolate as well as allow chemical and biological process to remove nutrients from the water.

3. **A&W Bulb Parcel rehydration**

   Source Addressed: All sources after they have entered the Canal system.

   Conservation 20/20 owns approximately 133.6 ac to the west of A&W Bulb Road. This property is bounded by Canal C1 to the north and Gladiolus Drive the south. The property is dissection by Canal C2. The portion of the property location north of Canal C was initially farmed prior to 1944. Aerial photographs indicate only a portion of the property was never used for agricultural purposes. The portion located south of Canal C2 has remained mostly undeveloped.

   Water from the canals could be conveyed to the parcels to increase stormwater flows, increasing the parcel's hydroperiod. This would increase the hydroperiod of any wetlands while improving water quality and reducing fresh was flows to the River.

4. **Lago Del Sol Pond**

   Source Addressed: All sources after they have entered the Canal system.

   Lago Del Sol is a multi-family residential community located west of Pine Road and north of Gladiolus Drive, south of Canal C3 and west of Canal C. The development includes a very large stormwater management lake which is surrounded by the multi-family buildings.

Water from Canal C could be directed to the lake where it will be detained. The size of the lake would allow for a relatively large detention time. This would provide several benefits including increased infiltration, increased evaporation, settling out of nutrient and assimilation of nutrients by organisms in the lake. This would improve water quality and reduce the volume of water discharging from the watershed.

5. **Perc. Pond – Sediment Removal**
   Source Addressed: Percolation pond sediment nitrogen contribution.

   A potential source of nutrients from the percolation ponds is the pond sediment. The pond sediment is likely high in nutrients. As pond water passes through the sediment on its way to the groundwater table it picks up nutrients from the sediment and carries them to the groundwater table.

   Removing the pond sediment would remove this potential source. Sediment would need to be removed regularly to prevent future sediment buildup from becoming a nutrient source.

6. **Perc. Pond Liner**
   Source Addressed: Percolation ponds.

   Preventing water from leaving the percolation ponds would prevent the pond water from becoming a potential groundwater/surface source of nutrients. Eliminating the flow from the ponds could be accomplished by lining all the ponds.

7. **Perc. Pond Treat in Place**
   Source Addressed: Percolation ponds

   When water from the percolation ponds enters the groundwater table, it only becomes a TMDL issue when it enters a surface water. If any elevated nutrient levels were bound up or treated in the soil they would not harm surface water bodies.

   To prevent any elevated groundwater table nutrient levels from entering the surface water, ground water could be treated in place or chemically bound in the soils.

8. **Perc. Pond Increased Flow Path**
   Source Addressed: Percolation ponds

   As indicated by the water quality data from the percolation ponds, the percolation ponds themselves are providing some water treatment. The TN concentrations in the middle ponds, where the effluent enters, are higher than the other ponds. Treatment in the ponds is influenced by the length of time water is in a pond. One way to increase the detention time it to increase the water's travel distance. To help the percolation ponds improve their TN removal efficiency the flow paths could be increased.

9. **Septic Tank Conversion**
   Source Addressed: Septic Tanks

   To eliminate the septic tank contributions to the TN loads, the septic tanks could be hooked up to central sewer. This will eliminate further loading to the watershed.

10. **Canal Sediment Removal**
    Source Addressed: Canal Sediment

    Canal C sediment at Summerlin Road and McGregor Blvd. contained high levels of nitrogen. The high levels of nitrogen have the potential to leach back into the water column. Removing the sediment will remove the potential source.

11. **Canal Sediment Chemical Treatment**
    Source Addressed: Canal Sediment

    Instead of removing the sediments chemical additives could be used to bind the nutrients to the soil, prevented them from reentering the water column.

12. **Fort Myers Beach Advanced Waste Water Treatment (AWWT)**
    Source Addressed: Percolation ponds, irrigation storage ponds, & irrigation water

    Expand the Fort Myers Beach Waste Water Treatment Plant to add advanced waste water treatment to reduce nutrient levels. Nutrient levels would be similar to those at the Fiesta Village AWWTP. This will reduce the nutrient loading to the percolation ponds and the nutrient loading from irrigation water and irrigation water storage ponds.

6 Alternatives Matrix

It is not practical to investigate all twelve projects in detail at one time. In an effort to prioritize the projects that should be investigate first, an Alternatives Matrix has been created. This matrix ranks each project based on their expected relative costs and benefits. A score is given to each project for each category and each category is given a relative weight, which is based on the categories importance. The weighted score for each category is then added to create a total weighted score for each project. The project with the highest score is expected to provide the most benefit for the lowest cost and should be the first project that is investigated in more detail.

The following sections describe the ranking categories, category weighting, and project scores used to rank the projects.

6.1 Ranking Categories

The first step in creating the alternatives matrix is to identify that categories that will be used to select the best project alternatives. The categories import for Deep Lagoon were coordinated with Lee County Staff to identify those that are the most import to the County when selecting a water quality improvement project. The following list of categories was selected as those which are important in selectin a project within the Deep Lagoon Watershed.

1. Land + Construction Cost Per TN Removal
   This is a relative ranking based on expected costs per expected nitrogen removed. No detailed calculations have been performed due to score and budget constraints. The projects have only been ranked base on expected relatively costs. The higher the costs the lower the score.

2. Operation Cost
   The expected reoccurring operation costs for the project. The higher the operation costs the lower the score.

3. Water Quality Improvement
   The amount of nitrogen expected to be removed by the project. This higher the volume removed the higher the score.

4. WQ Improvement Time Lag
   Some projects will remove the nitrogen load immediately while others will remove the load over a period of time and may only provide minimal improvements at first. Priority will be given to those projects that remove loads earlier and don't exhibit a time lag. The longer the lag time the lower the score

5. Ecological Improvement
   A large portion of the Deep Lagoon Watershed is located adjacent to Canal C. Many properties located along Canal C are publicly owned as preserve land or under conservation easement. Enhancing these preserve lands will provide an overall benefit to the watershed. Some examples of ecological improvement are improved or expanded habitat, improved hydroperiod, or removal of exotic vegetation. This category gives priority to those projects that will likely provide an ecological benefit to the watershed. The higher the ecological improvement the higher the score.

6. Park Amenities
   With limited funding, it is beneficial for Lee County to have stormwater improvement projects also provide park amenities, where practical. This category gives priority to those projects that could provide park or passive recreation amenities in concert with stormwater improvement. The more amenities created the higher the score.

7. Miscellaneous Benefits
   Some projects will provide additional benefits that do not fit into a typical category. For those projects, additional benefits are included in the misc. benefits category. The two projects that will provide additional benefits are the following:

6 – Perc Pond – Liner: This project will prevent water from moving from the percolation ponds to the groundwater table. This will increase the volume of water that can be sold to irrigation customers and reduce the volume of irrigation water from other sources.

9 – Septic Tanks – Connect to Central Sewer: Connecting the septic tanks to central sewer would provide additional utility customers and irrigation water volumes.

6.2 Category Weighting

While we have seven categories to rank each project, the categories are not equal in importance. To account for the differences in importance, each category is weighted using a weighting factor of 1 to 5. A factor of 5 indicates is it the most important category and 1 means it is the least important.

1. Land + Construction Cost Per TN Removal
   The cost to build a project per the project's benefit is the most important factor for any water quality project. If a project is to costly it will never be built. In addition, with the limited funds available for stormwater projects, it is critical for each project be cost effective considering the amount of nitrogen removed. For these reasons, this category has been weighted as a 5, the most important.

2. Operation Cost
   Operational costs are typically much less than initial construction costs. They are also often addressed with other operational costs, reducing their overall impact. When compared to other categories, operation costs are not a critical factor in selecting a project. The category weight has been set at 1.

3. Water Quality Improvement
   The entire intent of these projects is to improve water quality. Since this is the focus of the projects, this category has been weighted as 5.

4. WQ Improvement Time Lag
   While not the most important category, realizing the water quality improvements in a relatively short time frame are important. Spending money on a project that will not provide improvements for many years is not the type of project the County is looking to implement. This category has been assigned a weight of 3.

5. Ecological Improvement
   While ecological improvements are not the focus of the project, the extensive amount of conservation land within the Deep Lagoon watershed makes it important to at least consider ecological improvement within the project selection. The weight of 3 signifies that this category is an important factor but not the most important factor.

6. Park Amenities
   Park amenities are not a priority for Deep Lagoon due to limited existing access. As such, this category has been given a weight of 1.

7. Misc. Benefits
   The miscellaneous benefits will provide additional benefits to the watershed that are not directly related to water quality but they are important to the watershed. This category has been given a weight of 3 to demonstrate the importance to the watershed.

6.3 Project Scores

Each project is scored relative to the other projects for each selection category. Following is a discussion of how the scores were determined.

1. Land + Construction Cost Per TN Removal
   Projects 6 – Perc Pond Liner and 12 - Fort Myers Beach AWWT are expected to be more expensive than the other projects without a large water quality improvement. These projects were assigned a score of 1.

   Project 8 Perc. Pond – Increase Flow Path was also given a score of 1. However, its low score is due to the only limited water quality improvement expected for the project.

   The highest score of 5 was assigned to the following project:

   2 – Hagie Road FDOT Pond
   4 – Lago Del Sol Pond

   These projects are expected to provide the most benefit with the lowest cost. They are existing lakes where stormwater will be diverted into them.

   Construction of weirs and marshes along Canal are expected to be relatively expensive due to lack of access and overgrowth along the canals. Because of these higher costs project 1 - Canal C Weirs/Marshes could not be given a score of 5. It was given a score of 4.

   The remaining projects are expected to have similar costs per TN removed. They were all given a score of 3. A list of the projects is provided below.

   3 – A&W Build Parcel Rehydration.
   5 – Perc Pond – Sediment Removal
   7 – Perc Pond – Treat in Place
   9 – Septic Tanks – Connect to Central Sewer
   10 – Canal Sediment Removal
   11 – Canal Sediment Chemical Binders

2. Operation Cost
   Projects 6 – Perc Pond – Liner, 9- Septic Tanks – Connect to Central Sewer, and 12 - Fort Myers Beach AWWT are not expected to have reoccurring costs to the County. As such, they have been assigned a score of 5. While connection to Septic Tanks and Fort Myers Beach AWWT will have costs, they will be paid for by the utility end users not the County directly.

The projects that will only have limited on going operational costs were given scores of 3 or 4. Those given a score of 4 are expected to have marginally less maintenance. Those assigned score of 4 are:

2 – Hagie Road FDOT Pond
4 – Lago Del Sol Pond

These ponds typically only require infrequent removal of sediment. The expected additional maintenance required for these existing ponds is limited.

Those assigned a score of 3 are:

5 – Perc Pond – Sediment Removal
8 – Per Pond Increased Flow Path
10 – Canal Sediment Removal
11 – Canal Sediment Chemical Binders

Each of these projects will require more frequent maintenance in order to continue to see their benefits. Sediment is expected to continue to build up in the Canal system and percolation ponds. To prevent this sediment from becoming a nutrient source in the future additional costs will be required.

The Canal C Weirs/ Marshes project will require maintenance of the expected pump system and vegetation. This project was assigned a score of 2.

The projects that are expected to require the highest operation costs were given a score of 1. These projects are:

3 – A&W Bulb Parcel Rehydration
7 - Per Pond – Treat in Place,

3. Water Quality Improvement
The projects expected to provide the highest TN reduction were given a score of 5. The projects that are located near the downstream end of the watershed and are expected to detain a large volume of the entire watershed were given this score. These projects are listed below.

1 – Canal C Weirs/Marshes
2 – Hagie Rd FDOT Pond
4 – Lago Del Sol Pond

Project 3 – A&W Bulb Parcel Rehydration is located near the downstream end of the project but is not expected to detain as much water as the other projects. As a result, it was given a score of 4

Project 8 – Perc Pond – Increase Flow Path is only expected to have marginal water quality improvements. While water quality in the perc ponds will be improved, the existing ponds are already providing improvement. The addition treatment is not expected to significantly impact the quality of water leaving the ponds through the groundwater. As such, it was given a score of 1.

Of the remaining projects, the following are expected to remove slightly more TN than the others and were given a score of 3.

5 – Perc Pond – Sediment Removal
6 – Perc Pond Liner
9 -Septic Tanks – Connect to Central Sewer
12 – Fort Myers Beach AWWT

The rest of the projects, listed below, were given a score of 2.

7 – Perc Pond – Treat in Place
10 – Canal Sediment Removal
11 – Canal Sediment Chemical Binders

4. WQ Improvement Time Lag
The projects that are not expected to have a water quality improvement time lag were scored 5. These projects are:

1 – Canal C Weirs/Marshes
2 – Hagie Rd FDOT Pond
3 – A&W Bulb Parcel Rehydration
4 – Lago Del Sol Pond
10 – Canal Sediment Removal
11 – Canal Sediment Chemical Binders

Projects that area expected to have some lag time before their full improvement will be realizes but will have some improvement from the start were given a score of 4. Those projects that scored 4 are:

6 – Perc Pond Liner
9 – Septic Tanks – Connect to Central Sewer

Both projects involve removing the nutrient source and the additional flow that increases their flow through the groundwater. While the elevated groundwater levels will remain for years, the additional flow that pushes them though the soil faster will have been removed.

Fort Myers Beach AWWT will have a lag time with respect to its impact on the percolation pond loading. However, the reduction in nutrient within irrigation water could have a more immediate impact on water quality. For these reasons, it was assigned a score of 2.

Projects that will have a significant time lag before any of the improvements are seen were given a score of 1. Those projects that score 1 are:

5 – Perc Pond Sediment Removal
7 – Perc Pond Treat in Place
8 – Perc Pond Increase Flow Path

Each of these projects will reduce or remove the nutrient source but don't address the legacy nutrients already in the groundwater table. They also don't reduce the volume of water that is pushing the nutrient load through the groundwater table.

5. Ecological Improvement
Most the projects are not expected to provide a significant ecological benefit. These projects were given a score of 1.

2 – Hagie Rd FDOT Pond
4 – Lago Del Sol Pond
5 – Perc Pond - Sediment Removal
6 – Perc Pond - Liner
7 – Perc Pond – Treat in Place
8 – Perc Pond- Increase Flow Path
9 – Septic Tanks – Connect to Central Sewer
11 – Canal Sediment Chemical Binders
12 – Fort Myers Beach AWWT

Project 10 – Canal Sediment Removal is expected to provide some minimal ecological benefit. It was given a score of 2 to reflect this minimal benefit.

Projects that include the most ecological benefit were given a score of 5. These projects are:

1 – Canal C Weirs/Marshes
3 – A&W Bulb Parcel Rehydration

6. Park Amenities
Park amenities is not a focus of the proposed projects. Thus, most of them do not provide park amenities. Those projects that don't provide park amenities were given a score of 1. These projects are:

2 – Hagie Rd FDOT Pond
4 – Lago Del Sol Pond

5 – Perc Pond - Sediment Removal
6 – Perc Pond - Liner
7 – Perc Pond – Treat in Place
8 – Perc Pond- Increase Flow Path
9 – Septic Tanks – Connect to Central Sewer
10 – Canal Sediment Removal
11 – Canal Sediment Chemical Binders
12 – Fort Myers Beach AWWT

The two projects that could provide park amenities were given a score of 5. These projects are:

1 – Canal C Weirs/Marshes
3 – A&W Bulb Parcel Rehydration

7. Miscellaneous Benefits.
Some of the projects provide benefits in additional to those that would directly benefit the Deep Lagoon nitrogen reduction goals. These additional benefits are provided scores within this section.

Both the Percolation Pond Liner and Septic Tanks – Connect to Central Sewer are expected to provide a water supply benefit. They will both allow Lee County Utilities to use water the historically been lost to the groundwater table for irrigation. Project 6 – Perc Pond – Liner is expected to save significantly more water than the septic tanks. As such, it has been given a score of 5. Project 9 – Septic Tanks – Connect to Central Sewer has been given a score of 3. This reflects it is much better than all the other projects but not a good as the Perc Pond – Liner.

Using the categories, weights and scores discussed above, total scores for each project were calculated in Alternatives Matrix located in Appendix G. The four highest scoring projects were:

- Canal C Weirs/Marshes
- Hagie Road FDOT Pond
- Lago Del Sol Pond
- A&M Bulb Parcel Rehydration

Each of these projects will be investigated further to identify preliminary designs, estimate nutrient load reductions and estimate construction costs.

7 Nutrient Reduction Projects

The previous section of this report narrowed the list of potential projects down from twelve to four. Each of the four remaining projects will be investigated in more detail to determine which provides the most benefit at the lowest cost.

Each analysis includes a preliminary conceptual design, estimated nitrogen removal, and construction cost estimate. The end of this section provides a summary of each design along with the design/location that it likely to provide the most benefit without causing additional flooding.

7.1 Canal C Weirs & Marsh

Installing weirs in the existing Canal C main canal and/or side canals has the potential to provide many benefits to the watershed including reduced tidal influence, increased percolation and improved water quality. While this is listed as one project, it is actually several potential projects as weirs could be placed in many canal locations. Several locations will be investigated within this section.

This is not a new concept for the watershed as it was contemplated previously within the Deep Lagoon Preserve Land Stewardship Plan, 2005 (Lee County Parks & Recreation, 2005) and the Lee County Surface Water Management Master Plan for the Deep Lagoon Watershed prepared by Johnson Engineering in 1992 (Johnson Engineering, 1992). Following are a few statements from these sources.

> "Before the digging of these canals, the waters of Deep Lagoon Watershed and Cow Slough Watershed would only connect during extreme tidal events. Canal "C" created a direct link between watersheds that had led to saltwater intrusion into historically freshwater systems. By Blocking portions of the canals, upstream portions would become fresher and would help with restoration." (Lee County Parks & Recreation, 2005).
>
> "pushing the soil piles back into the canal, if followed up with native plantings, will eliminate disturbed areas in which exotic plants tend to thrive" (Lee County Parks & Recreation, 2005)
>
> Recommendation 3 "Require weirs in the tributary canals to partially restore groundwater elevations." (Johnson Engineering, 1992)
>
> "Low weirs on tributaries would raise the water level and freshen the water quality. Both results would be beneficial to environmental conditions, but may also affect flooding in the area." (Johnson Engineering, 1992)
>
> "Johnson Engineering's Deep Lagoon Preserve Environmental and Hydrologic Assessment Study concluded that filling canals C-1, C-2, C-3, C-4, C-6, C-8, C-10 and C-11 would significantly enhance the wetland hydroperiod within the watershed" (Lee County Parks & Recreation, 2005)

Conservation 20/20 Staff is expected to support these projects as they will help implement a portion of their Deep Lagoon Land Stewardship Plan.

Each weir will provide improvements by holding back stormwater and preventing tidal water from pushing back up the canal system. Holding back stormwater will improve water quality by reducing the volume of water discharging from the watershed and reducing the nutrient concentration in the water that is discharged. The volume will be reduced by increasing groundwater recharge caused by the increased water levels in the canal and increased evapotranspiration. Nutrient concentrations will be reduced by the increased detention time in the canals. The increased detention time will promote more sedimentation and allow chemical and biological process more time to remove nutrients.

In addition to the water quality benefits, the weirs will also increase wetland hydroperiods and decrease the influence from tidal fluctuations. According to (Lee County Parks & Recreation, 2005), the land located south of McGregor Blvd. was only influenced by tidal flow during extreme tidal events. The introduction of regular tidal flows associated with the canals has promoted exotic infestation. Cutting off these flows could slow or stop the spread of exotics.

The design of any weir will require careful analysis of existing and proposed flood elevations. The construction of a weir could create or increase flooding. The weir must be designed to increase water levels without increasing flooding of any nearby roadways, parking lots, or buildings. While the following analysis provides general discussions on potential flooding impacts any design must include a detailed analysis to ensure no additional flooding occurs because of any weir construction.

When initially built, spoil from the canal construction was placed along both sides of the canal. This spoil has created upland areas that have mostly been infested with exotic vegetation. These spoil areas could be removed as part of any weir construction. This could provide several benefits including removal of exotic vegetation, removing impediments to flow, and expand the canals storage volume. Canal spoil removal, regrading and planting has been included in the following designs as a potential design options.

Weirs could be placed at many locations within the main Canal C or any of the side canals. There are more than ten potential locations. It is not practical to fully investigate each location as part of this report. If weirs are ultimately selected to move forward with final design, permitting and construction, final site selection should be included within the scope of services. This will allow a more detailed analysis of each potential location which can weight potential costs and benefits of each. For this report two potential locations were analyzed. The locations were selected to treat the largest areas and the highest nitrogen concentrations. The first is located in Canal C at McGregor Blvd (McGregor Blvd. Weir). This location will control the water from the entire watershed and most effectively cut of tidal flows. The second location is in Canal C9 (Canal C9 Weir). This weir is located within the canal that receives groundwater flows from the Fort Myers Beach Waste Water Treatment Plant Percolation Ponds. TN concentrations identified within this canal are much higher than the concentrations found in other locations within the watershed.

7.1.1 McGregor Blvd. Weir

Canal C is the main canal for the Deep Lagoon Watershed. All lateral canals discharge into Canal C before water eventually flowing to the Caloosahatchee River. Treating stormwater within Canal C will allow stormwater from the entire watershed to be treated. This provides the benefit of treating a larger volume of water, but also provides a challenge of lower concentration, potentially reducing the overall treatment efficiency. In addition, any increases in storm elevations could impact a larger area.

The most downstream location appropriate for the construction of a weir is south of McGregor Blvd. This location will allow the largest volume of water to be treatment and stop tidal flows from entering the entire canal system.

A detailed design of McGregor Blvd. Weir is outside the scope of this report. If this BMP is selected for future investigation, a detailed analysis of the canal and surrounding properties should be prepared that include a final design for the weir. This analysis should demonstrate the proposed water levels outside the preserve will not create of increase flooding.

To estimate treatment efficiency and construction costs a preliminary weir design has been created. According to Lee County LiDAR data, topographic elevations in the area west of Willems Drive range from approximately 2.0 ft. NAVD to 5.0 ft., NAVD. To help ensure no additional flooding occurs, the preliminary weir has been set at 1.0 ft., NAVD, slightly below existing ground elevations. As more detailed calculations are prepared the weir invert elevations should be adjusted. The weir width is expected to extend from one side of the canal to the other, approximately 130 ft.

The existing canal conditions are not known, as recent survey cross sections have not been obtained and are outside the scope of this preliminary design. The original canal design plans were used to create the base line work for the proposed canal improvements. According to the design plans, the canal generally only takes up a portion of the canal right-of-way. Spoil from the canal excavation was generally placed next to the canal. According to, Deep Lagoon Preserve Land Stewardship Plan – 2005, the spoil areas are mostly covered with exotic vegetation.

To improve the treatment provided by the weir, Canal C is proposed be expanded to increase the wetland/water area available to provide treatment. A typical section has been provided in the conceptual design plans included in Appendix G. To help reduce construction costs and treat the largest volume of water, Canal C improvements have been limited to the area located between McGregor Blvd and Gladiolus Drive. The expansion will increase the conveyance capacity of the canal and reduce the expected roughness coefficient in the canal. This typical section will increase the treatment area within Canal C to approximately 9.9 ac.

To allow operational flexibility within the canal, one gate is proposed within the weir structure. This will allow the County to draw down water levels in the canal system to provide additional storage in anticipation of a large rainfall events or allow canal maintenance.

7.1.1.1 Water Treatment

Stormwater treatment is provided by the volume of water that is detained behind the weir. Physical, chemical and biological processed will remove nutrient from the water and discharge a smaller volume of better quality water.

The removal efficiency was estimate using the PKC* Model outlined in (Kadlec & Wallace, 2009) . This model estimates the removal efficiency using the following formula.

$$\frac{Co - C*}{Ci - C*} = \frac{1}{(1 + \frac{k}{Pq})^P}$$

Co = Outlet concentration (mg/L)
Ci = Inlet concentration (mg/L)
C* = background concentration (mg/L)
k = modified first order aerial constant, m/d
P = apparent number of tanks in series
q = hydraulic loading rate m/d

The background concentration (C*) provided for total nitrogen in (Kadlec & Wallace, 2009) is 1.5 mg/L. This is the lowest concentration a treatment wetland is expected attain. It is important to note that that the inflow concentrations of the wetlands studies were all greater than 5 mg/L. This is much higher than the inflow concentration of 1.32 mg/L (DEEPGR50) and 1.54 mg/L (DEEPGR90) in Canal C. As such, the background concentration for any deep lagoon wetlands are expected to be lower than 1.5 mg/L.

According to (Johnson Engineering, 2016) average outlet concentrations at the Ten Mile Canal Filter Marsh are 0.82 mg/L and 0.75 mg/L with average inflow concentrations of 1.01 mg/L. The background concentration (C*) for treatment ponds or treatment wetlands has been estimated to be 0.9 mg/L. This is slightly higher than the average outlet concentration at the Ten Mile Canal Filter Marsh.

The inlet concentration (Ci) is estimated to be the existing TN concentration at DEEPGR50, 1.32, mg/L.

Modified first order aerial constant (k) has been estimated to by 5.3 m/yr. This represents the 0.2 percentile provided in Table 9.18 of (Kadlec & Wallace, 2009).

The apparent number of tanks in series (P) is estimated to be 3 per table 9.18 of (Kadlec & Wallace, 2009).

The only remaining parameter to be calculated in order to solve for the outlet concentration (Co) is the hydraulic loading rate (q). The hydraulic loading rate is the estimated flow from the watershed divided by the area of pond or wetland.

The stormwater flow (Q) was estimated to be the 1-year design storm flow. This represents the flow through the canal for a typical wet season. The 1-year flow according to (Johnson Engineering, 1992) is 90 cfs.

The treatment area (a) will depend on the final canal cross section for Canal C. The expanded canal could provide approximately 9.9 ac of wetland treatment area. If the canal were not expanded the removal efficiency would be reduced.

q = Q / a = 90 cfs / 9.9 ac * $\frac{1\,ac}{43560\,sf} * \frac{86400\,s}{day} * \frac{m}{3.25\,ft}$

q = 5.1 m / d

Ci = 1.32 mg/L
C* = 0.9 mg/L
k = 5.3 m/d
P = 3
q = 9.1 m/d

$$\frac{Co - 0.9}{1.32 - 0.9} = \frac{1}{(1 + \frac{5.3}{3 * 5.1})^3}$$

Co = 1.08 mg/L

The estimated loading rates and loading rate reductions are provided in Table 3 below. The annual runoff volume has been estimated using the runoff volumes calculated in the nutrient loading calculations.

Table 3 – McGregor Weir Loading

	Concentration (mg/L)	Annual Runoff (ac-ft/yr)	Loading	
			(kg/yr)	(lb/yr)
Existing	1.32	5,787	9,422	20,729
Proposed	1.08	5,787	7,709	16,960
		Reduction	1,713	3,769

7.1.1.2 Cost Estimate
Costs are expected to include the design, permitting, construction of the proposed weir and expansion of Canal C. The following table estimates these costs.

Table 4 - McGregor Weir Cost Estimate

Description	Estimated Quantity	Unit	Unit Price	Amount
Weir				
Weir Structure	34	CY	$1,200.00	$41,066.67
Gates	1	EA	$10,000.00	$10,000.00
Rip-Rap	667	TN	$125.00	$83,333.33
Canal Expansion				
Silt Fence	12,000	LF	$1.75	$21,000.00
Clearing	11	AC	$6,000.00	$68,870.52
Excavation	72,222	CY	$4.00	$288,888.89
Grading	9	AC	$1,500.00	$13,774.10
Plantings	200,000	SF	$0.50	$100,000.00
Sod	22,222	SY	$4.00	$88,888.89
Design/Permitting				
Construction Plans	1	EA	$50,000.00	$50,000.00
Surveying	1	EA	$20,000.00	$20,000.00
Eng Permit Coordination	1	EA	$10,000.00	$10,000.00
Env Permit Coordination	1	EA	$20,000.00	$20,000.00

TOTAL = $815,822.41

The estimated cost per pound removed is $815,822.41 / 3,769 lb/yr = $217 per lb/year.

7.1.2 Canal C9 Weir
According to the nutrient loading calculations, the Canal C9 watershed has the tenth highest TN load per acre, seventh highest concentration, and ninth highest total load. This would typically indicate Canal C9 is not a good candidate for stormwater BMPs. However, the nutrient loading calculations only account for typical nutrient loads based on land use. Canal C9 is located adjacent to the Fort Myers Beach Wastewater Treatment Plant percolation ponds. Any nutrient loads from these ponds would not be included in the nutrient loading calculations. Water samples taken in Canal C9 show concentrations ranging from 2.40 mg/L – 5.12 mg/L (average = 3.71 mg/L). This is much higher than any other surface

water samples obtained within the water. This indicates there is a nitrogen source that drains to the canal. Due to its close proximity to the canal and the presence of sucralose in Canal C9 samples, the percolation ponds are likely a nitrogen source to the canal that is not accounted for the nutrient loading calculations. A potential project to help reduce nitrogen loads within Canal C9 is to turn the canal into a treatment system. This would include installing a weir near the eastern end of the canal and modifying the canal cross section to detain and treat water before it discharges to Canal C.

The Canal C9 weir should be placed as far east in the canal as practical. This will provide the largest treatment volume within the canal upstream of the weir and ensure as much of the groundwater flow from the percolation ponds is intercepted.

The detailed design of Canal C9 Weir is outside the scope of this report. If this BMP is selected for future investigation, a detailed analysis of the canal and surrounding properties should be prepared that include a final design for the weir. This analysis should demonstrate the proposed water levels outside the preserve do not create or increase flooding.

To estimate treatment efficiency and construction costs, a preliminary weir design has been created. According to Lee County LiDAR data, topographic elevations in the area range from approximately 2.0 ft NAVD to 7.0 ft, NAVD with the berm along the percolation ponds extending above 10.0 ft, NAVD. To help ensure no additional flooding occurs, the preliminary weir has been set at 1.0 ft, NAVD, slightly below existing ground elevations. As more detailed calculations are prepared the weir invert elevations should be adjusted. The weir width is expected to extend from one side of the canal to the other, approximately 130 ft.

Canal C9 was originally designed with a canal bottom sloped from west to east. Canal bottom elevations vary from -0.5 ft, NGVD to 2.5 ft, NGVD (-1.68 ft, NAVD to 1.32). This slope will reduce the volume/area available for treatment of water within the canal. To maximize treatment within the canal, the canal bottom is proposed to be flattened as much as possible and the canal width widened while still providing 10-ft maintenance areas on each side of the canal. A canal typical section has been included in the Conceptual Design Plans located in Appendix H.

To allow operational flexibility within the canal one gate is proposed within the weir structure. This will allow the County to draw down water levels in the canal system to provide additional storage in anticipation of a large rainfall event or allow canal maintenance.

7.1.2.1 Water Treatment

A discussed previously, the PkC* has been used to estimate the stormwater treatment improvement water treatment. Following is a discussion of the parameters used for the Canal C9 Weir.

As discussed above, the background concentration (C*) for treatment ponds or treatment wetlands has been estimated to be 0.9 mg/L.

The inlet concentration (Ci) is estimated to be the average existing TN concentration at sample location SW1B located in Canal C9. The average concentration is 3.71 mg/L

Modified first order aerial constant (k) has been estimated to by 5.3 m/yr. This represents the 0.2 percentile provided in Table 9.18 of (Kadlec & Wallace, 2009).

The apparent number of tanks in series (P) is estimated to be 3 per table 9.18 of (Kadlec & Wallace, 2009).

The hydraulic loading rate is the estimate flow from the watershed divided by the area of pond or wetland.

The stormwater flow (Q) was estimated to be the 1-year design storm flow. This represents an average flow through for a typical wet season. The 1-year flow for the entire watershed according to (Johnson Engineering, 1992) is 90 cfs. For the 4480-ac watershed with equates to approximately 0.02 cfs/ac. For Canal C9 (168 ac) the estimated flow will be 3.36 cfs.

The treatment area (a) will depend on the final canal cross section for Canal C. The expanded canal design shown in Appendix H would provide approximately 4.3 ac of wetland treatment areas. If the canal were not expanded the removal efficiency would be reduced.

q = Q / a = 3.36 cfs / 4.33 ac * $\frac{1\,ac}{43560\,sf} * \frac{86400\,s}{day} * \frac{m}{3.25\,ft}$

q = 0.47 m / d

Ci = 3.71 mg/L
C* = 0.9 mg/L
k = 5.3 m/d
P = 3
q = 0.47 m/d

$$\frac{Co - 0.9}{3.71 - 0.9} = \frac{1}{(1 + \frac{5.3}{3 * 0.47})^3}$$

Co = 0.93 mg/L

The estimated loading rates and loading rate reductions are provided in Table 5 – Canal C9 Weir Loading below. The annual runoff volume has been estimated using the runoff volumes calculated in the nutrient loading calculations.

Table 5 – Canal C9 Weir Loading

	Concentration (mg/L)	Annual Runoff (ac-ft/yr)	Loading	
			(kg/yr)	(lb/yr)
Existing	3.71	180	824	1812
Proposed	0.93	180	206	454
		Reduction	617	1358

7.1.2.2 Cost Estimate

Costs are expected to include the design, permitting, construction of the proposed weir and expansion of Canal C9. The following table estimates these costs.

Table 6 - Canal C9 Weir Cost Estimate

Description	Estimated Quantity	Unit	Unit Price	Amount
Weir				
C-1 Weir Structure	19	CY	$1,200.00	$22,400.00
C-2 Weir Structure	19	CY	$1,200.00	$22,400.00
Gates	1	EA	$10,000.00	$10,000.00
Rip-Rap	222	TN	$125.00	$27,777.78
Canal C9 Expansion				
Silt Fence	7,120	LF	$1.75	$12,460.00
Clearing	3	AC	$6,000.00	$19,283.75
Excavation	7,778	CY	$4.00	$31,111.11
Grading	3	AC	$1,500.00	$4,820.94
Plantings	70,000	SF	$0.50	$35,000.00
Sod	15,556	SY	$4.00	$62,222.22
Design/Permitting				
Construction Plans	1	EA	$30,000.00	$30,000.00
Surveying	1	EA	$10,000.00	$10,000.00
Eng Permit Coordination	1	EA	$8,000.00	$8,000.00
Env Permit Coordination	1	EA	$8,000.00	$8,000.00

TOTAL = $303,475.79

The estimated cost per pound removed is $303,475.79 / 1,358 lb/yr = $224 per lb/year.

7.2 A&W Bulb Parcel Rehydration

Lee County Conservation 20/20 owns approximately 78 ac of land along the west side of A&W Bulb Road between Canal C1 and C2. This land was historically used for agricultural purposes and is now part of the County's Conservation 20/20 program.

The property is located within both primary and secondary Eagle nest protection zones for two eagle nests. Any construction on the site will need to be coordinate with eagle nest protection requirements.

Water quality could be improved by diverting water from Canal C1 and Canal C2 to the parcel either using gravity flow or pumps. Using gravity flow would require regrading the site to allow sufficient flow without increasing upstream water levels. This would significantly increase construction costs and conflict with Conservation 20/20's plans for the parcel. For these reasons gravity flow hasn't been proposed for this property.

Use of pumps would reduce the extent of site modifications required and could provide a more consistent flow. But pumps would require ongoing electrical and pump maintenance costs.

For this application pumps are recommended to allow water to be conveyed to the existing wetland while not increasing water levels updated within Canals C1 and C2.

This project would improve water quality by increasing percolation, increasing evapotranspiration, detaining water longer, and allow nutrient uptake by plants.

In order to ensure a consistent water supply and prevent salt water entering the source water, weirs are proposed within Canals C1 and C2, east of A&W Bulb Blvd as part of the project. This will hold back freshwater, increasing the volume available for treatment, reducing the volume discharged to the River without treatment.

Both Canal C1 and Canal C2 were designed to slope from east to west with design elevations of -5.18 ft, NAVD to approximately 2.32 ft, NAVD. The slopes reduce the volume of water that can stored in the canal. To increase the volume of water the canal bottom is proposed to be flattened and the canal cross section is proposed to be expanded as much as possible while preserving 10-ft maintenance areas on both sides of the canal. The proposed typical section is provided on the Conceptual Plans included in Appendix I.

The design of weir in Canals C1 and C2 is outside the scope of this report. If this BMP is selected for future investigation, a detailed analysis of the canal and surrounding properties should be prepared that include a final design for the weir. This analysis should demonstrate the proposed water levels outside the preserve will not create or increase flooding.

To estimate treatment efficiency and construction costs, a preliminary weir design has been created. According to Lee County LiDAR data, topographic elevations in the area range from approximately 4.0 ft NAVD to 7.0 ft., NAVD. To help ensure no additional flooding occurs, the preliminary weir has been set at 2.0 ft., NAVD, slightly below existing ground elevations. As more detailed calculations are prepared the weir invert elevations should be adjusted. The weir width extends from one side of the canal to the other, approximately 110 ft.

To allow operational flexibility within the canal one gate is proposed within the weir structure. This will allow the County to draw down water levels in the canal system to provide additional storage in anticipation of a large rainfall event or allow canal maintenance.

7.2.1.1 Water Treatment

A discussed previously, the PkC* has been used to estimate the stormwater treatment improvement water treatment. Following is a discussion of the parameters used for the A&W Bulb Parcel Rehydration.

As discussed previously, the background concentration (C*) for treatment ponds or treatment wetlands has been estimated to be 0.9 mg/L.

The inlet concentration (Ci) is estimated to be existing TN concentration at DEEPGR50 (1.32 mg/L).

Modified first order aerial constant (k) has been estimated to by 5.3 m/yr. This represents the 0.2 percentile provided in Table 9.18 of (Kadlec & Wallace, 2009).

The apparent number of tanks in series (P) is estimated to be 3 per table 9.18 of (Kadlec & Wallace, 2009).

The hydraulic loading rate is the estimate flow from the watershed divided by the area of pond or wetland.

The stormwater flow (Q) was estimated to the 1-year design storm flow. This represents an average flow through for a typical wet season. The 1-year flow for the entire watershed according to (Johnson Engineering, 1992) is 90 cfs. For the 4480-ac watershed with equates to approximately 0.02 cfs/ac. For the project's drainage area of approximately 647 ac the estimated flow is 12.9 cfs.

The treatment area (a) is the area of the parcel that will be used to treatment. The treatment area is proposed to include the existing wetland areas on the site plus some of the adjacent improved pasture (converted back to wetland), approximately 10 ac.

$$q = Q / a = 12.9 \text{ cfs} / 10 \text{ ac} * \frac{1\,ac}{43560\,sf} * \frac{86400\,s}{day} * \frac{m}{3.25\,ft}$$

q = 0.79m / d

Ci = 1.32 mg/L
C* = 0.9 mg/L
k = 5.3 m/d
P = 3
q = 0.421 m/d

$$\frac{Co - 0.9}{1.32 - 0.9} = \frac{1}{(1 + \frac{5.3}{3 * 0.79})^3}$$

Co = 0.94 mg/L

The estimated loading rates and loading rate reductions are provided in Table 7 – A&W Bulb Parcel Loading Table 3 – McGregor Weir Loading below. The annual runoff volume has been estimated using the runoff volumes calculated in the nutrient loading calculations.

Table 7 – A&W Bulb Parcel Loading

	Concentration (mg/L)	Annual Runoff (ac-ft/yr)	Loading	
			(kg/yr)	(lb/yr)
Existing	1.32	1190	1938	4263
Proposed	0.94	1190	1380	3036
		Reduction	558	1227

7.2.1.2 Cost Estimate

Costs are expected to include the design, permitting, construction of the proposed weir and expansion of Canal C9. The following table estimates these costs.

Table 8 - A&W Bulb Parcel Cost Estimate

Description	Estimated Quantity	Unit	Unit Price	Amount
Parcel Modifications				
Silt Fence	7,500	LF	$1.75	$13,125.00
Clearing	1.00	AC	$6,000.00	$6,000.00
Grading	1.00	AC	$1,500.00	$1,500.00
Sod	4,840	SY	$4.00	$19,360.00
Canal Weir/Pumps				
Weir Structure - 01	19	CY	$1,200.00	$22,400.00
Weir Structure - 02	19	CY	$1,200.00	$22,400.00
Gates	2	EA	$10,000.00	$20,000.00
Pumps - complete	2	EA	$20,000.00	$40,000.00
Rip-Rap	444	TN	$125.00	$55,555.56
Canal Expansion				
Silt Fence	11,440	LF	$1.75	$20,020.00
Clearing	4	AC	$6,000.00	$23,140.50
Excavation	16,593	CY	$4.00	$66,370.37
Grading	8	AC	$1,500.00	$11,570.25
Plantings	56,000	SF	$0.50	$28,000.00
Sod	18,667	SY	$4.00	$74,666.67
Design/Permitting				
Construction Plans	1	EA	$50,000.00	$50,000.00
Surveying	1	EA	$15,000.00	$15,000.00
Eng Permit Coordination	1	EA	$10,000.00	$10,000.00
Env Permit Coordination	1	EA	$10,000.00	$10,000.00
			TOTAL =	**$509,108.34**

The estimated cost per pound removed is $509,108.34 / 1227 lb./yr. = $415 per lb./year.

7.3 Hagie Road Pond

The pond located along the southern and eastern side of Hagie Drive could provide treatment for canal runoff, if water is diverted to the pond. Water could be diverted from Canal C and Canal C7 to the pond by installing a weir in Canal C just north of Canal C7 and regrading Canal C7. Water would be diverted from Canal C, upstream of the weir, and Canal C7 to the pond where it will be stored and treated.

The pond is partially surrounded by a conservation easement. This would make any construction next to the pond difficult. Prior to any further work on this property it will be important to understand the interface between the pond and preserve. Is there a berm or does the pond flow directly into the preserve? This will have an impact on the final design.

This section of Canal C is generally surrounded by preserve, undeveloped areas and Health Park. Canal C7 receives stormwater runoff from Kelly Road and the adjacent properties. The design must ensure any increase in water levels will not adversely impact any adjacent properties. The final weir design is outside the scope of this report. If this BMP is selected for future investigation, a detailed analysis of the canal and surrounding properties should be prepared that include a final design for the weir. This analysis should demonstrate the proposed water levels outside the preserve will not create or increase flooding.

To estimate treatment efficiency and construction costs, a preliminary weir design has been created. According to Lee County LiDAR data, topographic elevations in the area upstream of the proposed weir range from approximately 2.0 ft, NAVD within the preserve/conservation areas to 5.0 ft, NAVD at the edges of existing development. To help ensure no additional flooding occurs, the preliminary weir has been set at 1.0 ft, NAVD, slightly below existing ground elevations. As more detailed calculations are prepared the weir invert elevation should be adjusted. The weir width is expected to extend from one side of the canal to the other, approximately 125 ft.

To allow operational flexibility within the canal, one gate is proposed within the weir structure. This will allow the County to draw down water levels in the canal system to provide additional storage in anticipation of large rainfall events or allow canal maintenance.

To help water flow from Canal C to the Hagie Road Pond, Canal C7 is proposed to be regraded. The canal bottom will be graded flat from Canal C to the pond inflow pipes/swale. Details are provided within the conceptual design plans located in Appendix J.

7.3.1.1 Water Treatment

Water treatment within the pond is estimated using the methodology outlined by Harvey H. Harper, Ph.D., P.E. and David M. Baker, P.E. in *Evaluation of Current Stormwater Design Criteria within the State of Florida*. This methodology is often referred to as the Harper Method. This methodology estimates the pond removal efficiency using the estimate annual runoff to the pond and the storage volume in the pond to calculate the water residence time. The residence time is then used in the following formulas to calculate the pond's total nitrogen removal efficiency.

The existing TN concentration was estimated to equal the concentration at DEEPGR90, 1.54, mg/L.

$$Percent\ Removal = \frac{43.75 * t_d}{4.38 + t_d}$$

$$t_d = detention\ time\ (year) = \frac{pond\ volume\ (ac - ft)}{runoff\ \left(\frac{ac - ft}{year}\right)}$$

runoff = volume of runoff calculated in nutrient loading calculations = 1881 ac-ft/yr (2,320,179,333 L/yr)

pond volume = permanent pool volume = 171.9 ac-ft (calculated using 4:1 slopes and 12 ft lake depth. These assumptions should be confirmed with any future analysis)

$$t_d = detention\ time\ (year) = \frac{171.9\ (ac - ft)}{1881\ \left(\frac{ac - ft}{year}\right)}$$

$t_d = 0.091\ yr = 33.4\ days$

$$Percent\ Removal = \frac{43.75 * 33.4}{4.38 + 33.4}$$

$$Percent\ Removal = 39\%$$

Existing Nitrogen Load = Runoff Volume x Runoff Concentration

= 2,320,179,333 L/yr * 1.54 mg/L / 1,000,000 = 3573.1 kg/yr

Proposed Nitrogen Load = Existing Nitrogen Load * (1-Percent Removal)

= 3573.1 kg/yr * (1-0.39) = 2191.3 kg/yr

Nitrogen Reduction = 3573.1 kg/yr – 2191.3 kg/yr

= 1381.8 kg/yr

7.3.1.2 Cost Estimate

Costs are expected to include the design, permitting, construction of the proposed weir and expansion of Canal C9. The following table estimates these costs.

Table 9 - Hagie Road Pond Cost Estimate

Description	Estimated Quantity	Unit	Unit Price	Amount
Canal Weirs				
Weir Structure	19	CY	$1,200.00	$22,400.00
Gates	1	EA	$10,000.00	$10,000.00
Rip-Rap	667	TN	$125.00	$83,333.33
Canal Modifications				
Silt Fence	4,100	LF	$1.75	$7,175.00
Clearing	2	AC	$6,000.00	$13,774.10
Excavation	5,926	CY	$4.00	$23,703.70
Grading	3	AC	$1,500.00	$4,132.23
Plantings	40,000	SF	$0.50	$20,000.00
Sod	8,889	SY	$4.00	$35,555.56
Design/Permitting				
Construction Plans	1	EA	$30,000.00	$30,000.00
Surveying	1	EA	$8,000.00	$8,000.00
Eng Permit Coordination	1	EA	$5,000.00	$5,000.00
Env Permit Coordination	1	EA	$12,000.00	$12,000.00

TOTAL = $275,073.93

The estimated cost per pound removed is $275,073.93 / 1,381.80 lb/yr = $200 per lb/year.

7.4 Lago Del Sol Pond

Water from Canal C could be diverted into the Lago Del Sol Apartments stormwater pond for treatment. The Lago Del Sol Apartments are located around an approximately 46.4 ac pond. The pond was excavated before the apartments were built and likely used for offsite fill material. The lake is much larger than would typically be required to provide stormwater management for the apartments. Following is a summary of the projects permitted design parameters:

Control Elevation:	2.9 ft, NGVD (1.72 ft, NAVD)
5-Year Peak Stage:	3.6 ft, NGVD (2.42 ft, NAVD)
Minimum Rd:	5.5 ft, NGVD (4.37 ft, NAVD)
100-Year Peak Stage:	4.99 ft, NGVD (3.81 ft, NAVD)
Minimum Finished Floor:	8.0 ft, NGVD (6.82 ft, NAVD)

Due to the large pond size, minimum roadway and finished floor elevations were set by requirements other than the peak stormwater elevation in the pond. There is approximately 1.9 ft of freeboard between the 5-yr peak stage and the minimum roadway and more than 3.0 ft of freeboard between the 100-year peak stage and the minimum finished floor elevation. A portion of this freeboard could be used to provide storage and treatment for offsite storm water.

The location of the pond near the downstream end of the watershed would provide treatment for a large portion of the watershed. Larger volumes of water would be treated, increasing the amount of nitrogen removed.

The Lago Del Sol pond has an existing control elevation of 1.72 ft, NAVD. This elevation is similar to the elevation the Canal C weir would likely be set. This could make gravity flow into the pond difficult. Additional coordination with the property owner and SFWMD would be required to make gravity flow possible. For this report, pump flow has been used for the preliminary design and cost estimating purposes.

Lago Del Sol is not located adjacent to Canal C. To convey water from Canal C to the Pond, water will need to be piped along the edge of Canal C3 or across the Height Elementary School property.

A weir located in Canal C just upstream of Canal C3 will allow water to be diverted from the Canal C to the pond and maintain a positive outfall for Canal C3 and the pond. The weir will also create a storage volume that will provide a more consistent water supply to the pond.

To allow operational flexibility within the canal, one gate is proposed within the weir structure. This will allow the County to draw down water levels in the canal system to provide additional storage in anticipation of large rainfall events or allow canal maintenance.

The final design of the Canals C weir is outside the scope of this report. If this BMP is selected for future investigation, a detailed analysis of the canal and surrounding properties should be prepared that includes a final design for the weir. This analysis should demonstrate the proposed water levels outside the preserve will not create or increase flooding.

To estimate treatment efficiency and construction costs a preliminary weir design has been created. According to Lee County LiDAR data, topographic elevations upstream of the proposed weir range from approximately 2.0 ft, NAVD within the preserve to 4.0 ft to 5.0 ft, NAVD along adjacent developments. To help ensure no additional flooding occurs, the preliminary weir has been set at 1.0 ft, NAVD, slightly below existing ground elevations. As more detailed calculations are prepared, the weir invert elevation should be adjusted. The weir width is expected to extend from one side of the canal to the other, approximately 120 ft.

7.4.1.1 Water Treatment

Water treatment within the pond is estimated using the methodology outlined by Harvey H. Harper, Ph.D., P.E. and David M. Baker, P.E. in *Evaluation of Current Stormwater Design Criteria within the State of Florida*. This methodology is often referred to as the Harper Method. This methodology estimates the pond removal efficiency using the estimate annual runoff to the pond and the storage volume in the pond to calculate the water residence time. The residence time is then used in the following formulas to calculate the pond's total nitrogen removal efficiency.

The existing TN concentration was estimated to equal the concentration at DEEPGR50, 1.32, mg/L.

$$Percent\ Removal = \frac{43.75 * t_d}{4.38 + t_d}$$

$$t_d = detention\ time\ (year) = \frac{pond\ volume\ (ac - ft)}{runoff\ \left(\frac{ac - ft}{year}\right)}$$

runoff = estimated volume of runoff calculated in nutrient loading calculations = 3813 ac-ft/yr (4,703,266,241 L/yr)

pond volume = permanent pool volume = 513.2 ac-ft (calculated using 4:1 slopes and 12 ft lake depth. These assumptions should be confirmed with any future analysis)

$$t_d = detention\ time\ (year) = \frac{513.2\ (ac - ft)}{3813\ \left(\frac{ac - ft}{year}\right)}$$

$$t_d = 0.135\ yr = 49.1\ days$$

$$Percent\ Removal = \frac{43.75 * 49.1}{4.38 + 49.1}$$

$$Percent\ Removal = 40\%$$

Existing Nitrogen Load = Runoff Volume x Runoff Concentration

= 4,703,266,241 L/yr * 1.32 mg/L / 1,000,000 = 6208.3 kg/yr

Proposed Nitrogen Load = Existing Nitrogen Load * (1-Percent Removal)

= 6208.3 kg/yr * (1-0.40) = 3714.5 kg/yr

Nitrogen Reduction = 6208.3 kg/yr – 3714.5 kg/yr

= 2493.8 kg/yr

7.4.1.2 Cost Estimate

Costs are expected to include the design, permitting, construction of the proposed weir and expansion of Canal C9. The following table estimates these costs.

Table 10 - Lago Del Sol Pond Cost Estimate

Description	Estimated Quantity	Unit	Unit Price	Amount
Pond Modifications				
Silt Fence	2,300	LF	$1.75	$4,025.00
Control Structure	1	EA	$5,000.00	$5,000.00
Easement*	1	EA	$50,000.00	$50,000.00
Pump				
Intake pipe	100	LF	$30.00	$3,000.00
Wet well	1	EA	$20,000.00	$20,000.00
Pump	2	EA	$5,000.00	$10,000.00
Discharge pipe	900	LF	$20.00	$18,000.00
Rip-Rap	267	TN	$125.00	$33,333.33
Canal Weirs				
Weir Structure	19	CY	$1,200.00	$22,400.00
Gates	1	EA	$10,000.00	$10,000.00
Rip-Rap	667	TN	$125.00	$83,333.33
Design/Permitting				
Construction Plans	1	EA	$30,000.00	$30,000.00
Surveying	1	EA	$5,000.00	$5,000.00
Eng Permit Coordination	1	EA	$5,000.00	$5,000.00
Env Permit Coordination	1	EA	$8,000.00	$8,000.00

*easement cost will depend on negotiations with property owner.

TOTAL = $357,091.67

The estimated cost per pound removed is $307,091.67 / 2,493.8 lb/yr = $144 per lb/year.

It is important to note that Lee County does not own the Casa Del Lago. An agreement with the current owner, Pacifica Edisto Lakes LLC would be required to start any further investigation into the project and its viability.

8 Recommendations

The estimated costs for each alternative is summarized in Table 11 - Estimated Cost per Pond of Nitrogen Removed below.

Table 11 - Estimated Cost per Pond of Nitrogen Removed

Alternative	Cost per lb of Nitrogen
McGregor Blvd Weir	$ 217 / lb

Canal C9 Weir	$ 224 / lb
A&W Bulb Rehydration	$ 414 / lb
Hagie Rd Pond	$ 200 / lb
Lago Del Sol Pond	$ 144 / lb

The projects recommended for further consideration are the McGregor Blvd Weir, Canal C9 Weir, Hagie Road Pond, and Lago Del Sol Pond project be investigated further. The A&W Bulb Rehydration project is not recommended for further investigation at this time due to the much higher cost per pound of nitrogen removed compared to the other projects.

The Lago Del Sol Pond project is the only one located on property that is not currently controlled by Lee County. The pond is owned by Pacifica Edisto Lakes LLC. If additional work is performed on this project, it is recommended that Pacifica Edisto Lakes LLC be notified about the project to gauge their interest in cooperating with the County's efforts. It is important to gain buy-in from the landowner before additional effort is spent pursing the project. If they are not interested in working with the County, the project should not be pursued any further. In addition, any costs associated with gaining access to the pond in excess of the estimate easement cost included in the cost estimate would change the cost effectiveness of the project. This could potentially make the project cost prohibitive.

Each the three other recommended projects are controlled by the County and are expected to improve water quality at a similar cost.

The two weir projects should be investigated together along with other potential weir options to identify the one or two weir projects that will provide the most benefit at the lowest cost.

Appendix A – Watershed Boundary Map

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DEEP LAGOON POLLUTANT LOAD EDUCTION STUDY

APPENDIX A

ATE SHED BOUNDA Y AP

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Appendix B – Canal Sub-Basin Map

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CANAL SUB-BASIN AP

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Appendix C – Land Use Map

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EXISTING LAND USE AP

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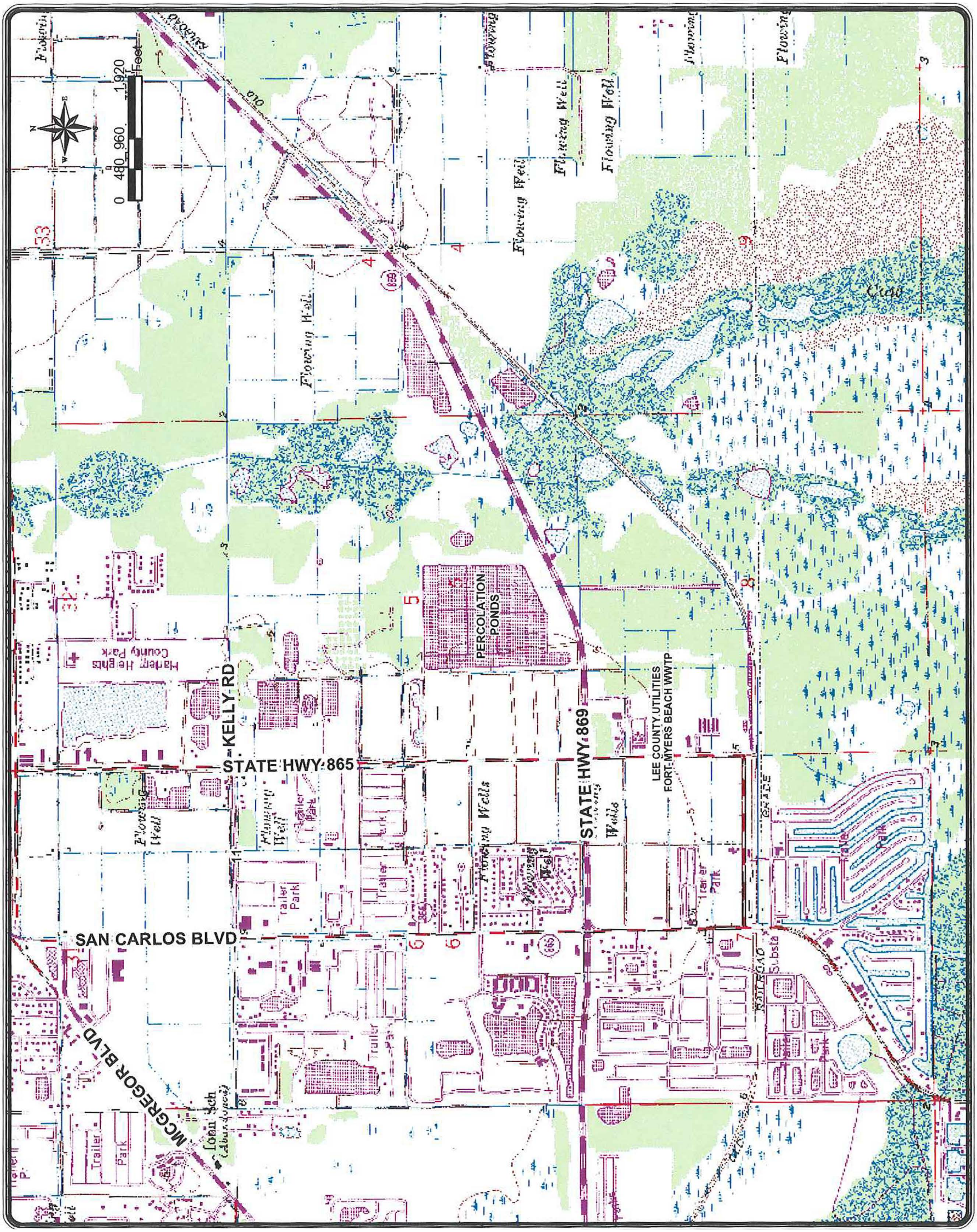
Appendix D – Percolation Pond Location Map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Feet
KELLY RD
STATE HWY 865
SAN CARLOS BLVD
MCGREGOR BLVD
PERCOLATION PONDS
STATE HWY 869
LEE COUNTY UTILITIES
FORT MYERS BEACH WWTP

Appendix E – Septic Tank Location Map

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DEEP LAGOON FEASIBILITY STUDY

APPENDIX E
SEPTIC TANK LOCATIONS

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Appendix F – Alternatives Matrix

Deep Lagoon Pollutant Load Reduction - Alternatives Matrix

	Project	Land + Construction Cost per TN removal		Operation Cost		WQ Improvement		WQ Improvement Time Lag		Ecological Improvement		Park Amenities		Misc. Benefits		Total Weighted Score	Rank
		Weight = 5		Weight = 1		Weight = 5		Weight = 3		Weight = 3		Weight = 1		Weight = 3			
		Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score		
1	Canal C Weirs/Marshes	4	20	2	2	5	25	5	15	5	15	5	5	1	3	85	1
2	Hagie Rd FDOT Pond	5	25	4	4	5	25	5	15	1	3	1	1	1	3	76	2
3	A&W Bulb Parcel Rehydration	3	15	1	1	4	20	5	15	5	15	5	5	1	3	74	4
4	Lago Del Sol Pond	5	25	4	4	5	25	5	15	1	3	1	1	1	3	76	2
5	Perc Pond - Sediment Removal	3	15	3	3	3	15	1	3	1	3	1	1	1	3	43	9
6	Perc Pond - Liner	1	5	5	5	3	15	4	12	1	3	1	1	5	15	56	6
7	Perc Pond - Treat in place	3	15	1	1	2	10	1	3	1	3	1	1	1	3	36	11
8	Perc Pond - Increase Flow Path	1	5	3	3	1	5	1	3	1	3	1	1	1	3	23	12
9	Septic Tanks - Connect to Central Sewer	3	15	5	5	3	15	4	12	1	3	1	1	3	9	60	5
10	Canal Sediment Removal	3	15	3	3	2	10	5	15	2	6	1	1	1	3	53	7
11	Canal Sediment Chemical Binders	3	15	3	3	2	10	5	15	1	3	1	1	1	3	50	8
12	Fort Myers Beach AWWT	1	5	5	5	3	15	2	6	1	3	1	1	1	3	38	10

Excellent - 5
Very Good - 4
Good - 3
Fair - 2
Poor - 1

Appendix G – McGregor Weir Conceptual Design Plans

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DEEP LAGOON FEASIBILITY STUDY

MCGREGOR WEIR LOCATION MAP

PLAN REVISIONS

REV00 <<SUBMITTED / BID SET>> XX/XX/XX

0 30 60 120
SCALE IN FEET

FLORIDA CERTIFICATE OF AUTHORIZATION #8636

DAVID V. WILLEMS, P.E.
FL LICENSE NO. 57634

SET NUMBER: 402-01-01

SHEET : 1 OF 2

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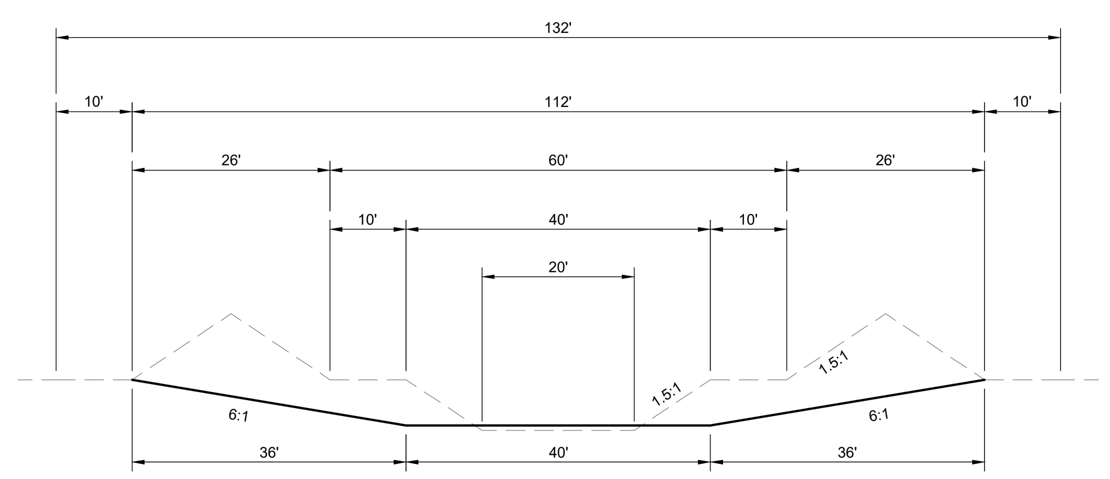

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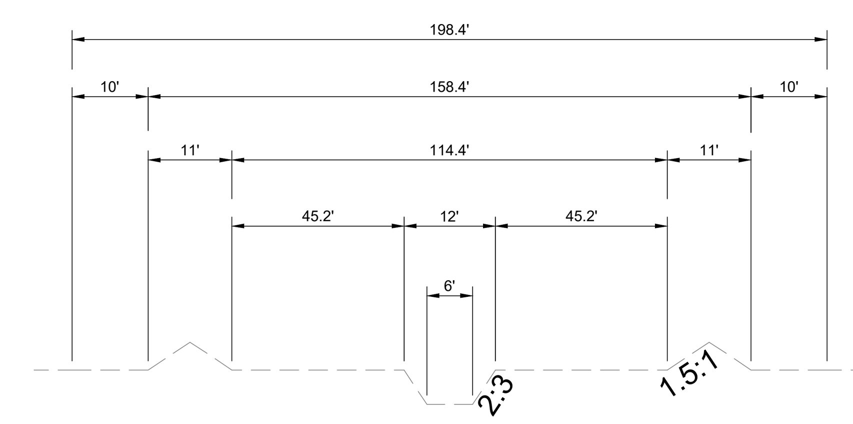

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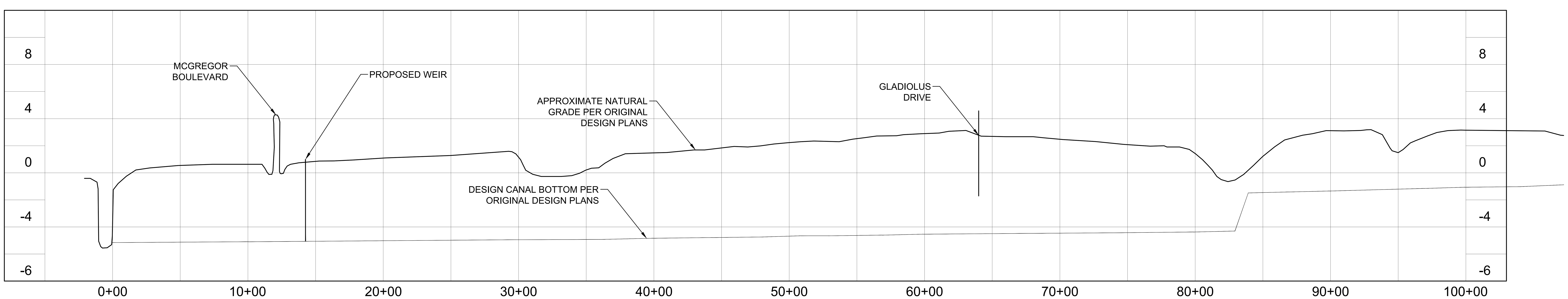

VERTICAL ELEVATIONS BASED ON: NAVD-88

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DEEP LAGOON FEASIBILITY STUDY

PLAN & PROFILE CANAL "C" (1)

PLAN REVISIONS

REV00 <<SUBMITTED / BID SET>> XX/XX/XX

0 200 400 800
SCALE IN FEET

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SHEET :	2 OF 2

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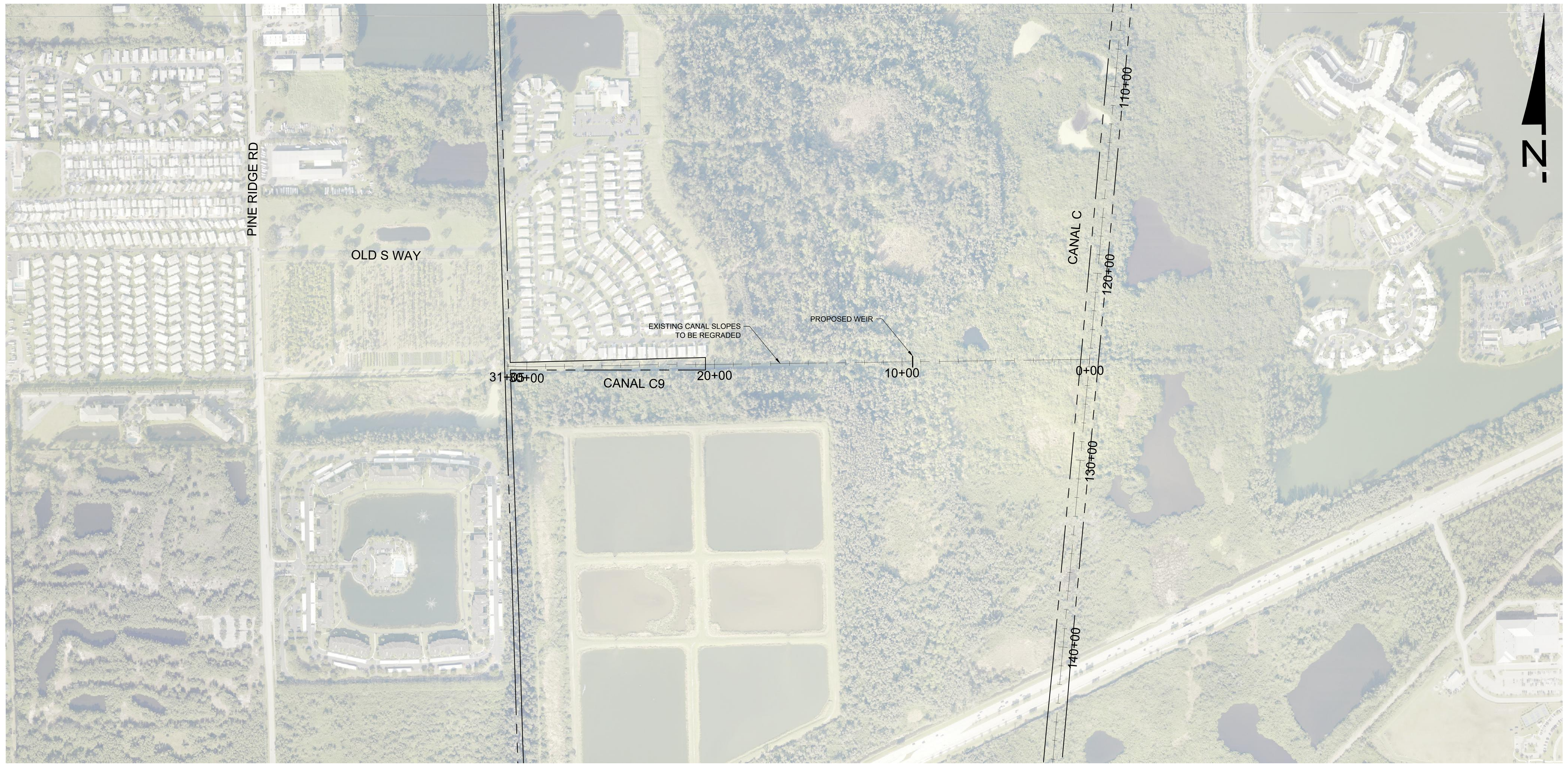
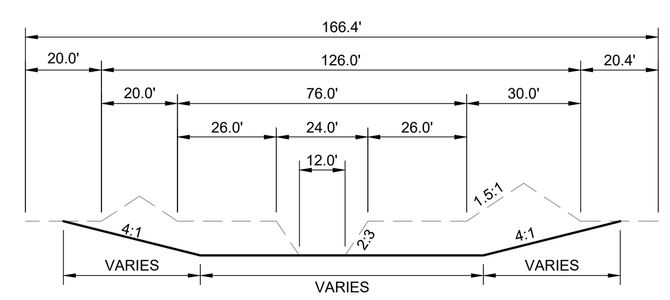
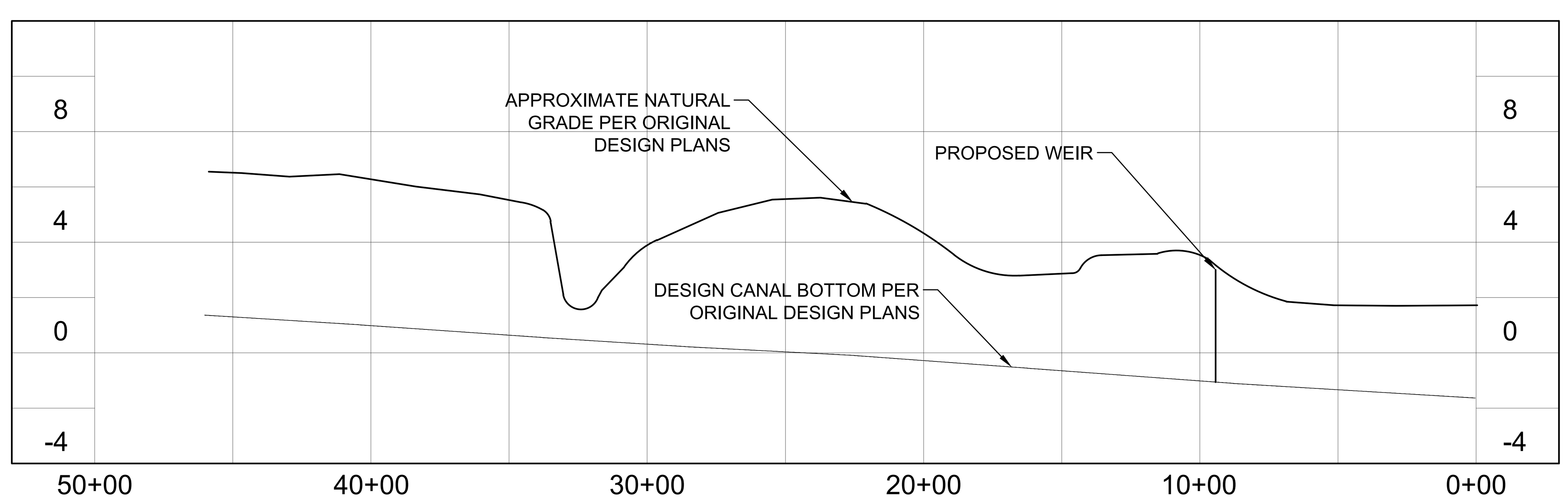
Appendix H – Canal C9 Weir Conceptual Design Plans





TYPICAL SECTION (CANAL C9)
NTS



VERTICAL ELEVATIONS BASED ON: NAVD-88

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DEEP LAGOON FEASIBILITY STUDY

CANAL C9 WEIR

PLAN REVISIONS
REV00 <<SUBMITTED / BID SET>> XX/XX/XX

0 200 400 800
SCALE IN FEET

FLORIDA CERTIFICATE OF AUTHORIZATION #8636

DAVID V. WILLEMS, P.E.
FL LICENSE NO. 57634

SET NUMBER: 402-01-01
SHEET : 1 OF 1

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Appendix I – A&W Bulb Rehydration Conceptual Design Plans

INSET A
SCALE 1" = 40'

INSET B
SCALE 1" = 50'

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DEEP LAGOON FEASIBILITY STUDY

A&W BLVD PARCEL REHYDRATION LOCATION MAP

PLAN REVISIONS
REV00 <<SUBMITTED / BID SET>> XX/XX/XX

0 100 200 400
SCALE IN FEET

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SET NUMBER: 402-01-01
SHEET: 1 OF 2

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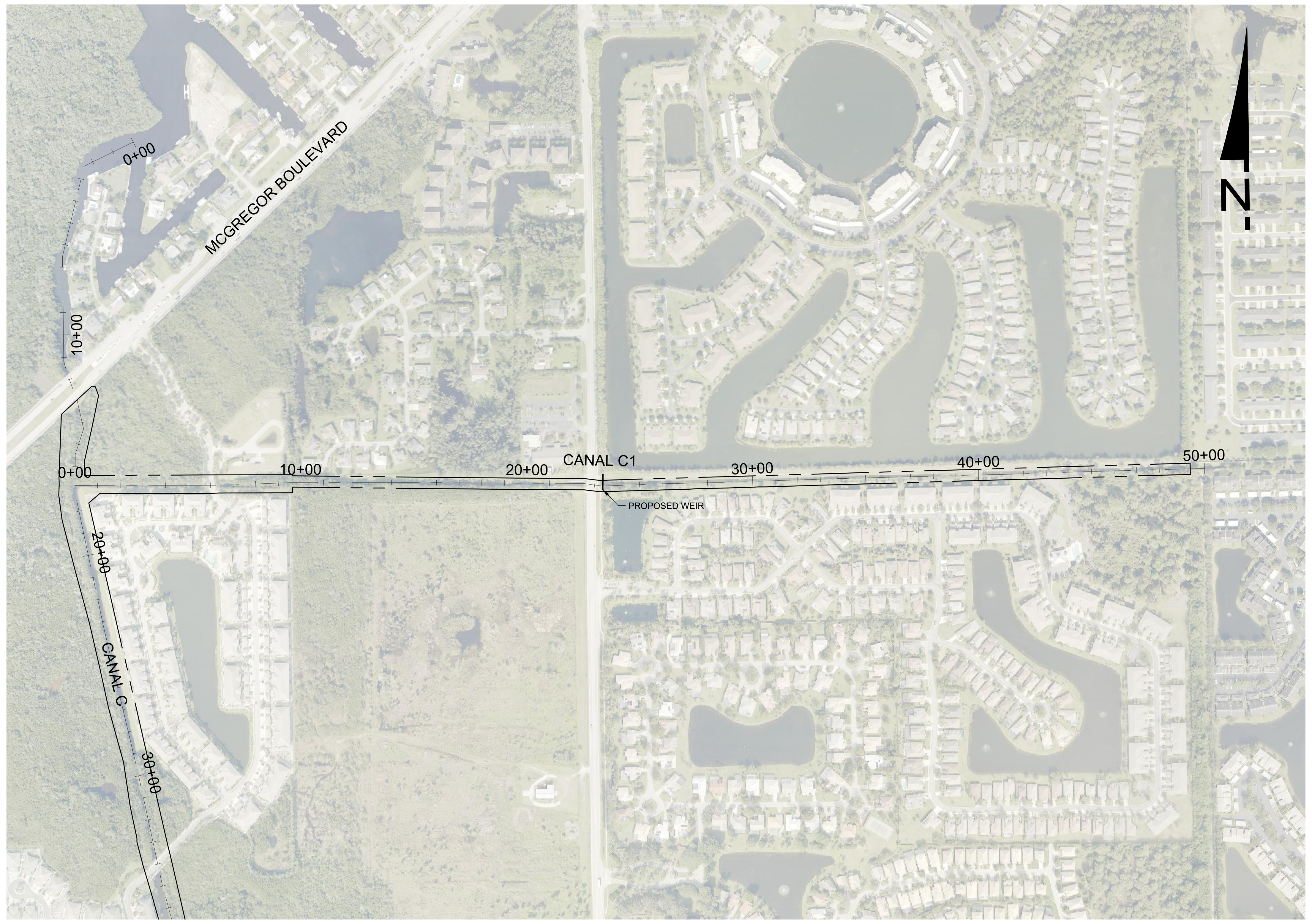
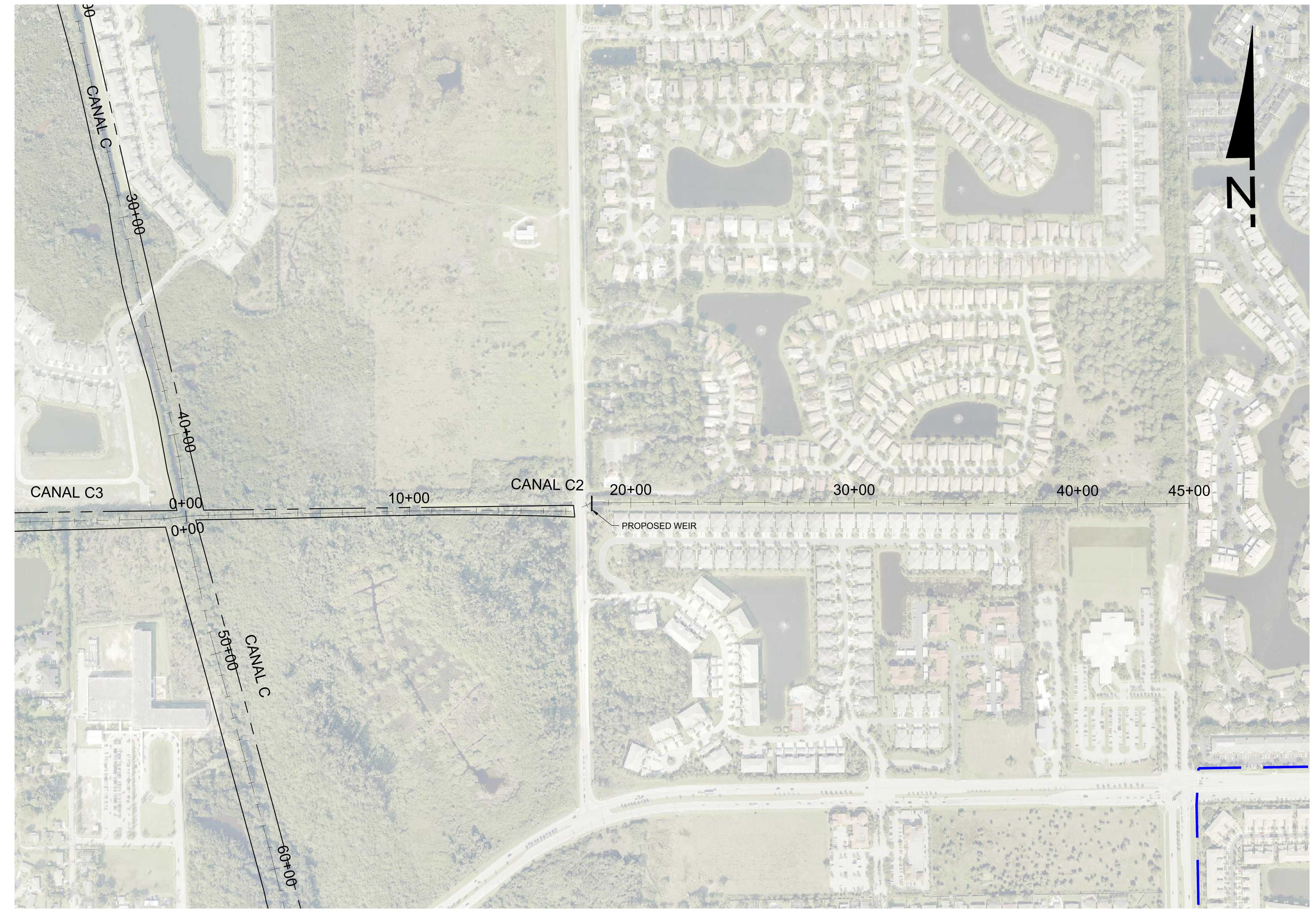
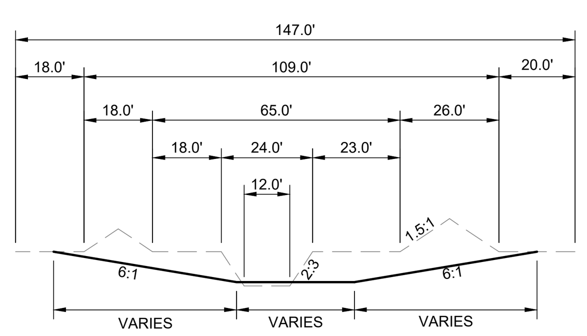
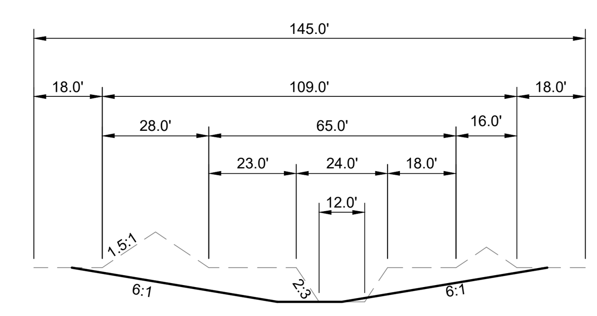






TYPICAL SECTION (CANAL C1)
NTS



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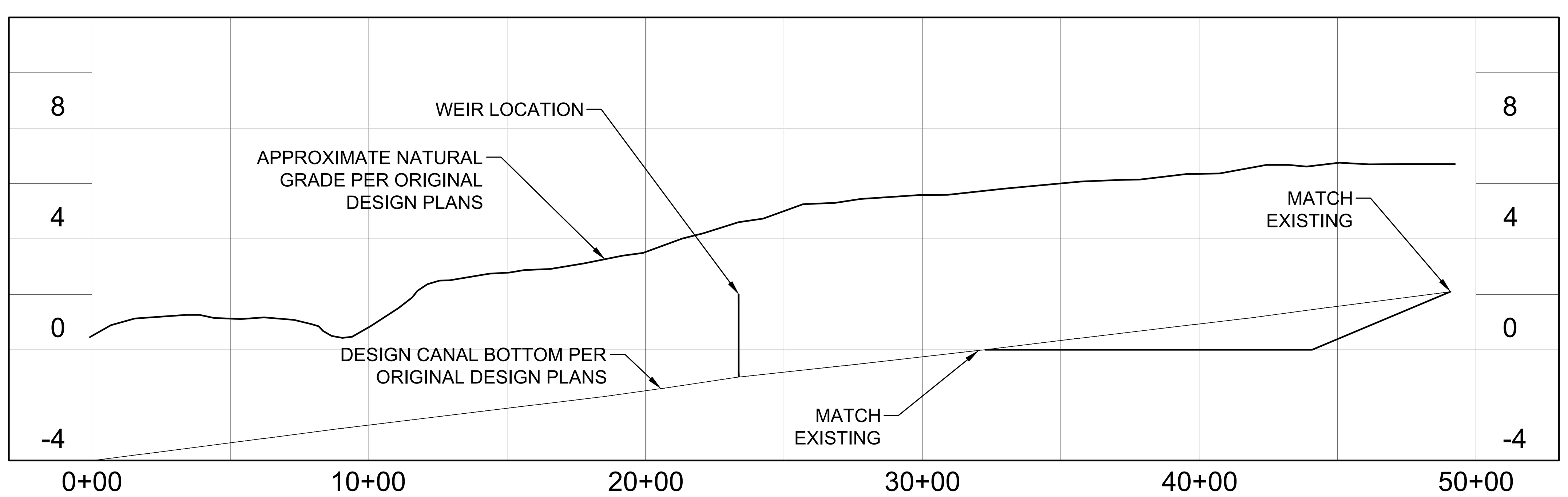

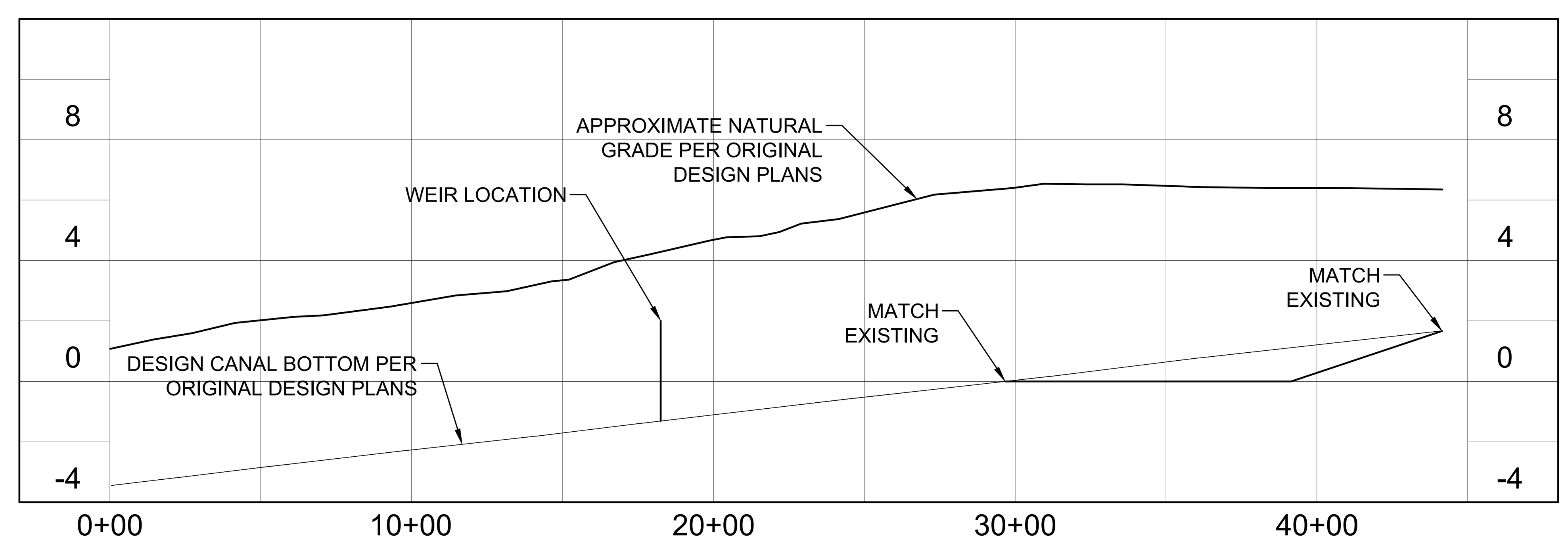

VERTICAL ELEVATIONS BASED ON: NAVD-88

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DEEP LAGOON FEASIBILITY STUDY

PLAN & PROFILE CANALS "C1" & "C2"

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0 200 400 800
SCALE IN FEET

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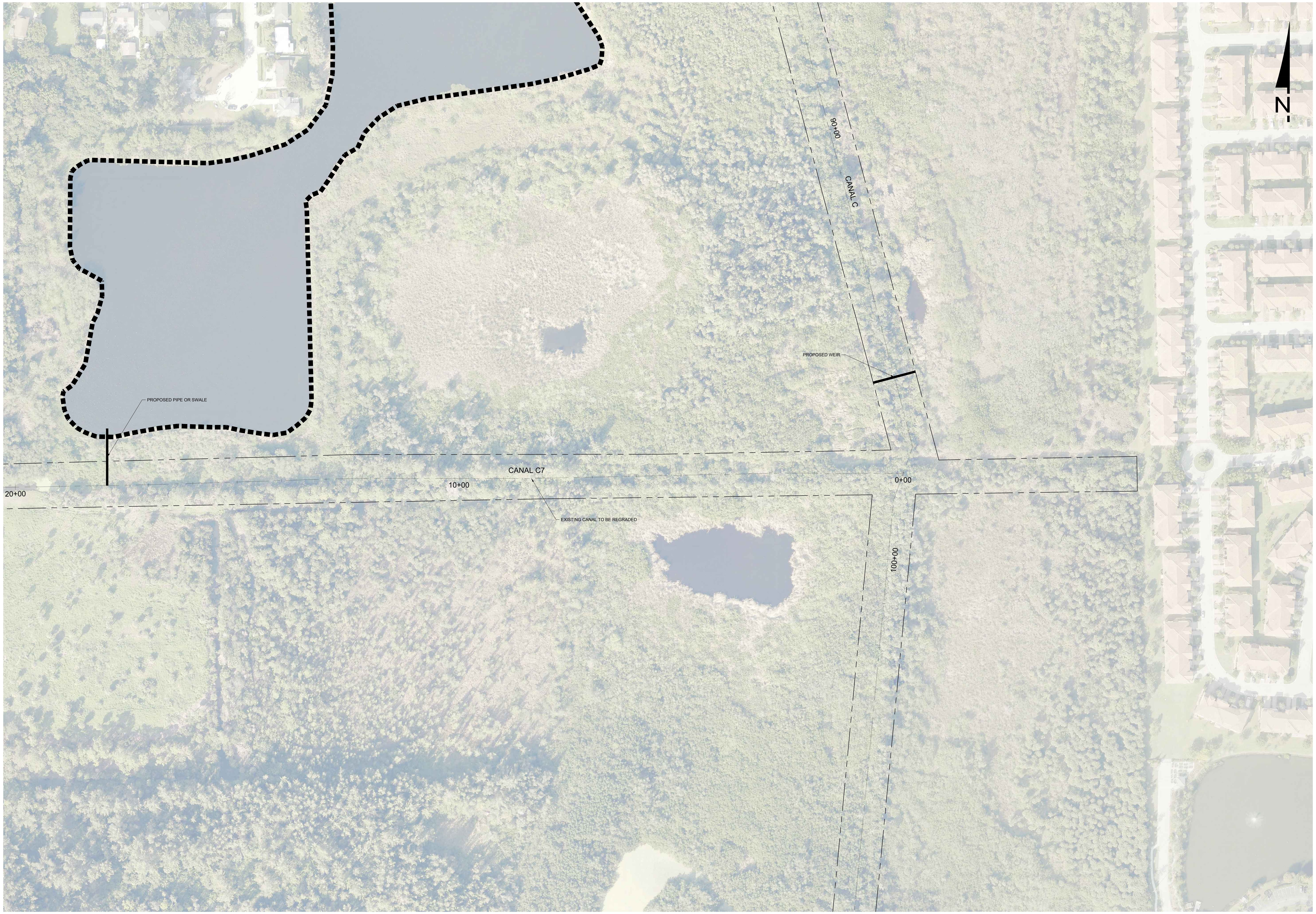
Appendix J – Hagie Road Pond Conceptual Design Plans



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DEEP LAGOON FEASIBILITY STUDY

HAGIE DRIVE POND WEIR LOCATION MAP

PLAN REVISIONS

REV00 <<SUBMITTED / BID SET>> XX/XX/XX

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SCALE IN FEET

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SHEET : 1 OF 3

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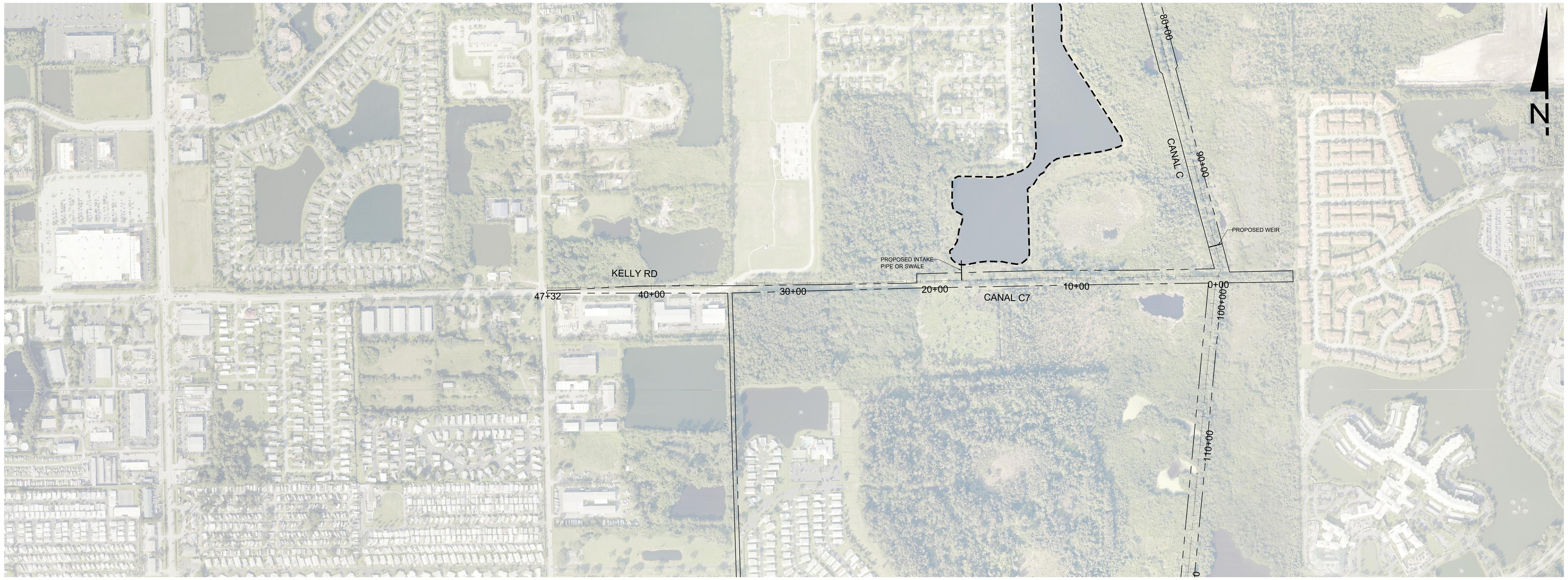

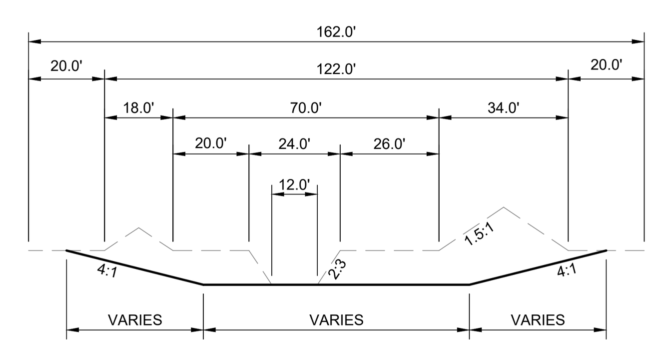

TYPICAL SECTION CANAL C7 (STA. 0+00 TO 19+00)
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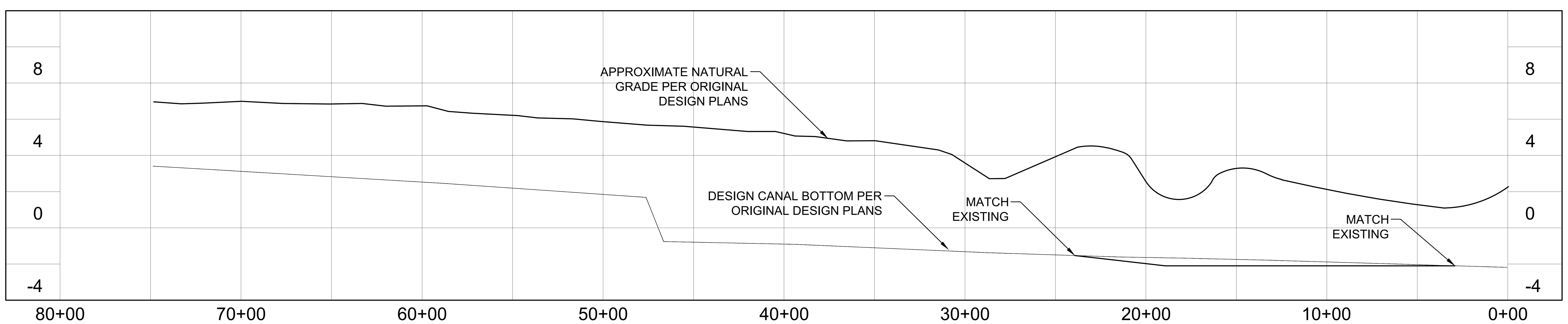

VERTICAL ELEVATIONS BASED ON: NAVD-88

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DEEP LAGOON FEASIBILITY STUDY

PLAN & PROFILE CANAL "C7"

PLAN REVISIONS

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SCALE IN FEET

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SET NUMBER:	402-01-01
SHEET :	2 OF 3

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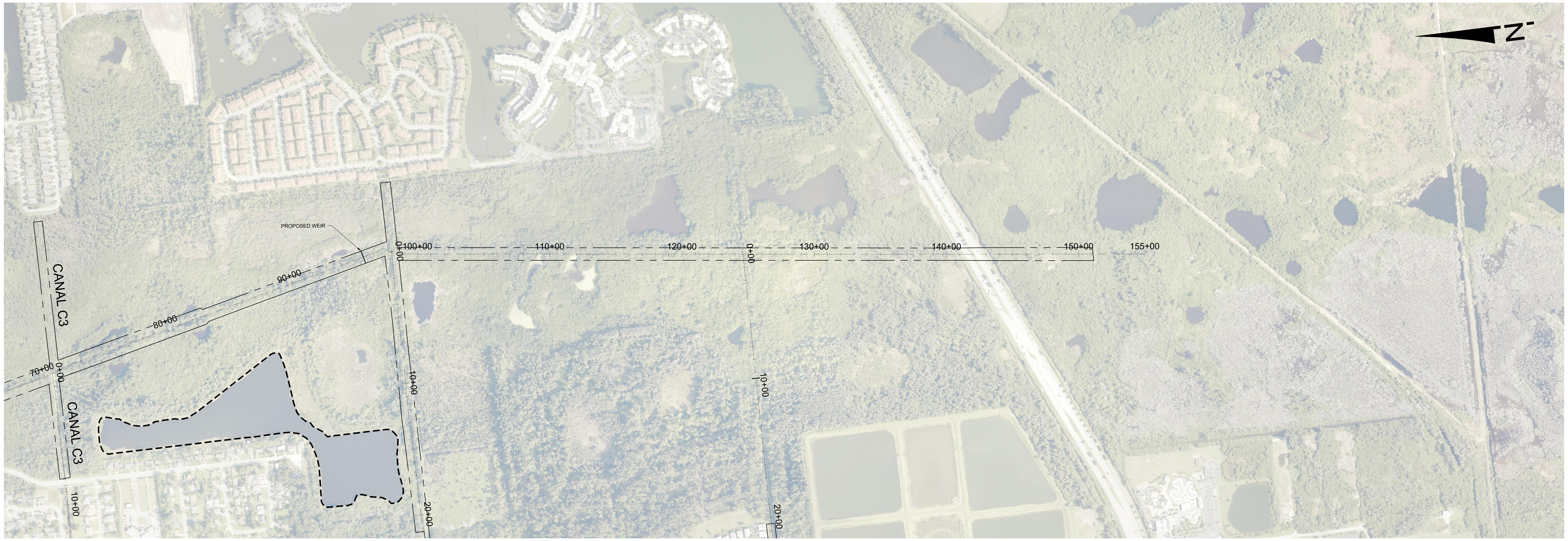

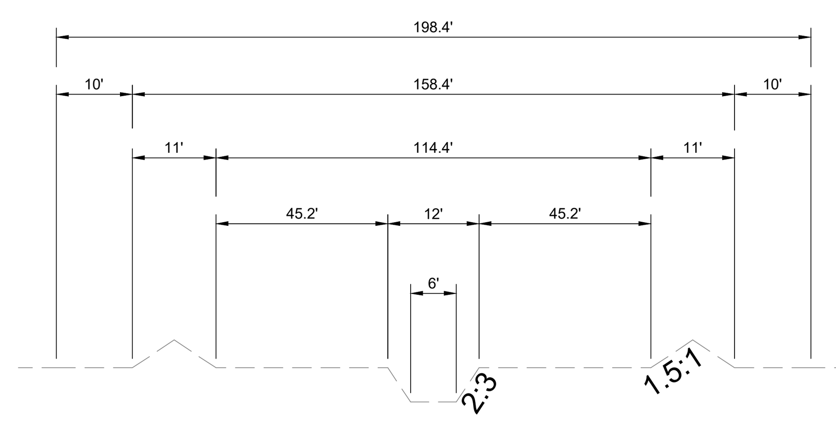

TYPICAL SECTION (STA. 84+00 TO END)
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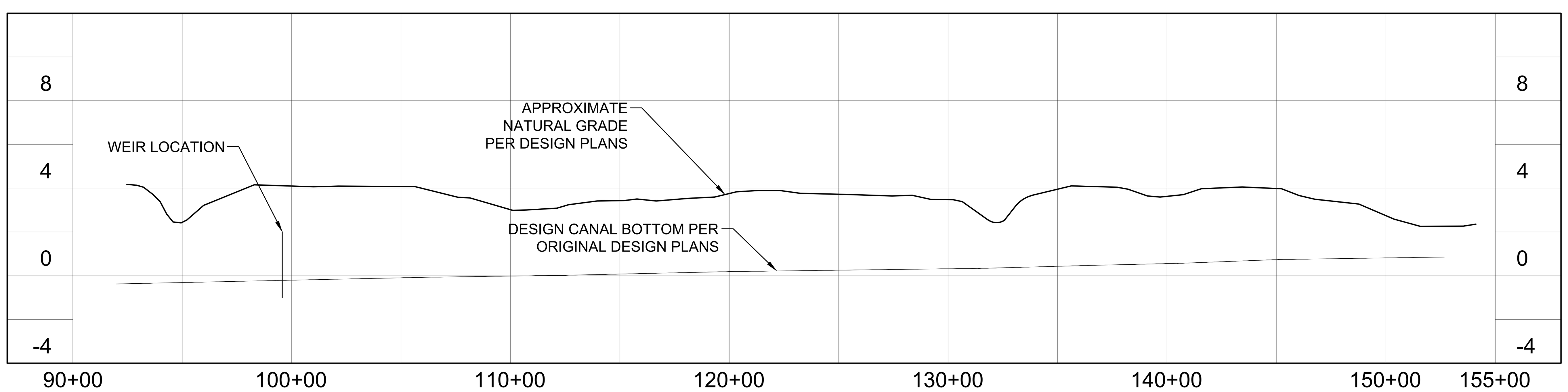

VERTICAL ELEVATIONS BASED ON: NAVD-88

DEEP LAGOON FEASIBILITY STUDY

PLAN & PROFILE CANAL "C" (2)

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PLAN REVISIONS
REV00 <<SUBMITTED / BID SET>> XX/XX/XX

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SCALE IN FEET

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SET NUMBER: 402-01-01

SHEET : 3 OF 3

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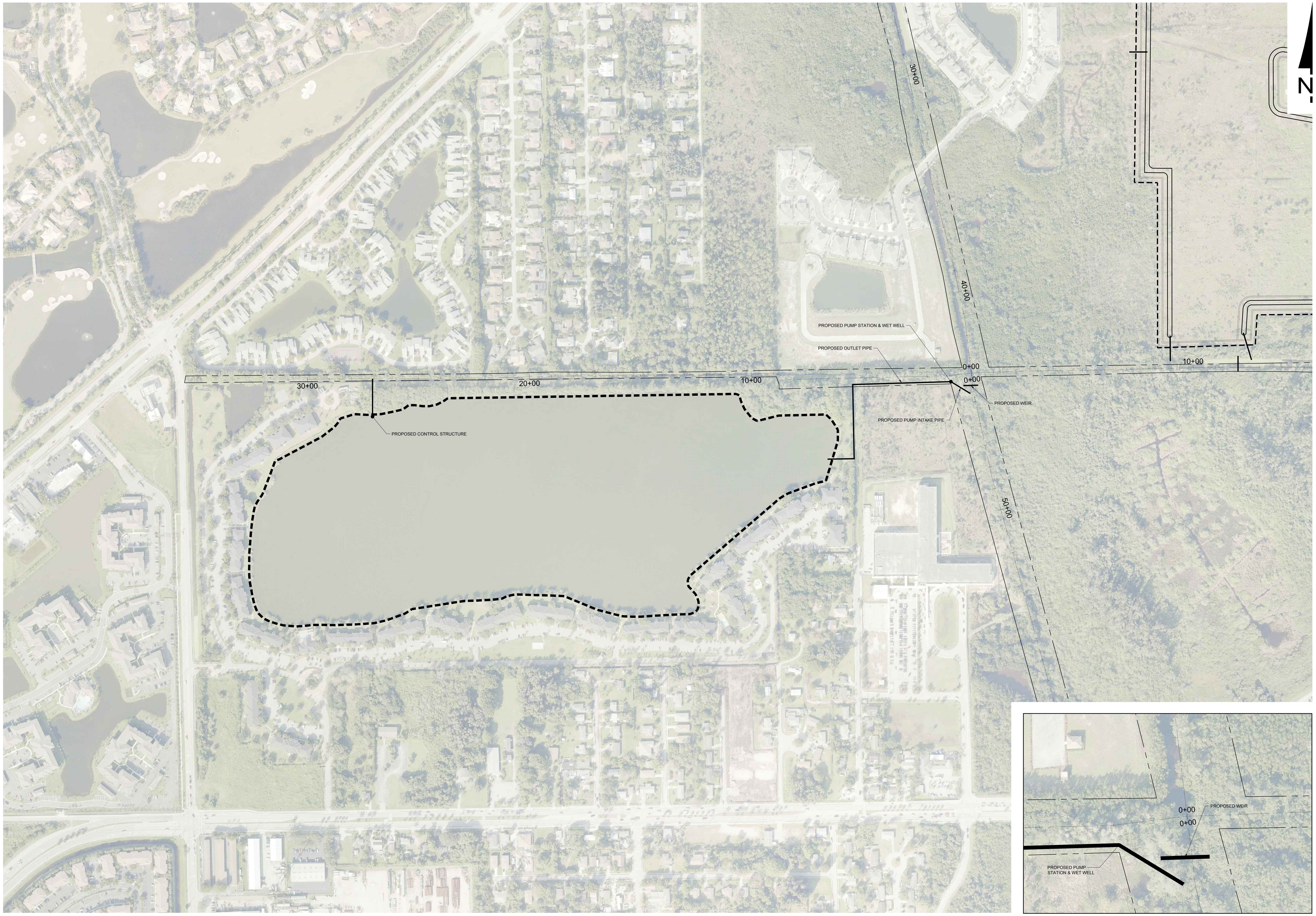
Appendix K – Lago Del Sol Pond Conceptual Design Plans



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DEEP LAGOON FEASIBILITY STUDY

LAGO DEL SOL POND LOCATION MAP

PLAN REVISIONS

REV00 <<SUBMITTED / BID SET>> XX/XX/XX

0 100 200 400
SCALE IN FEET

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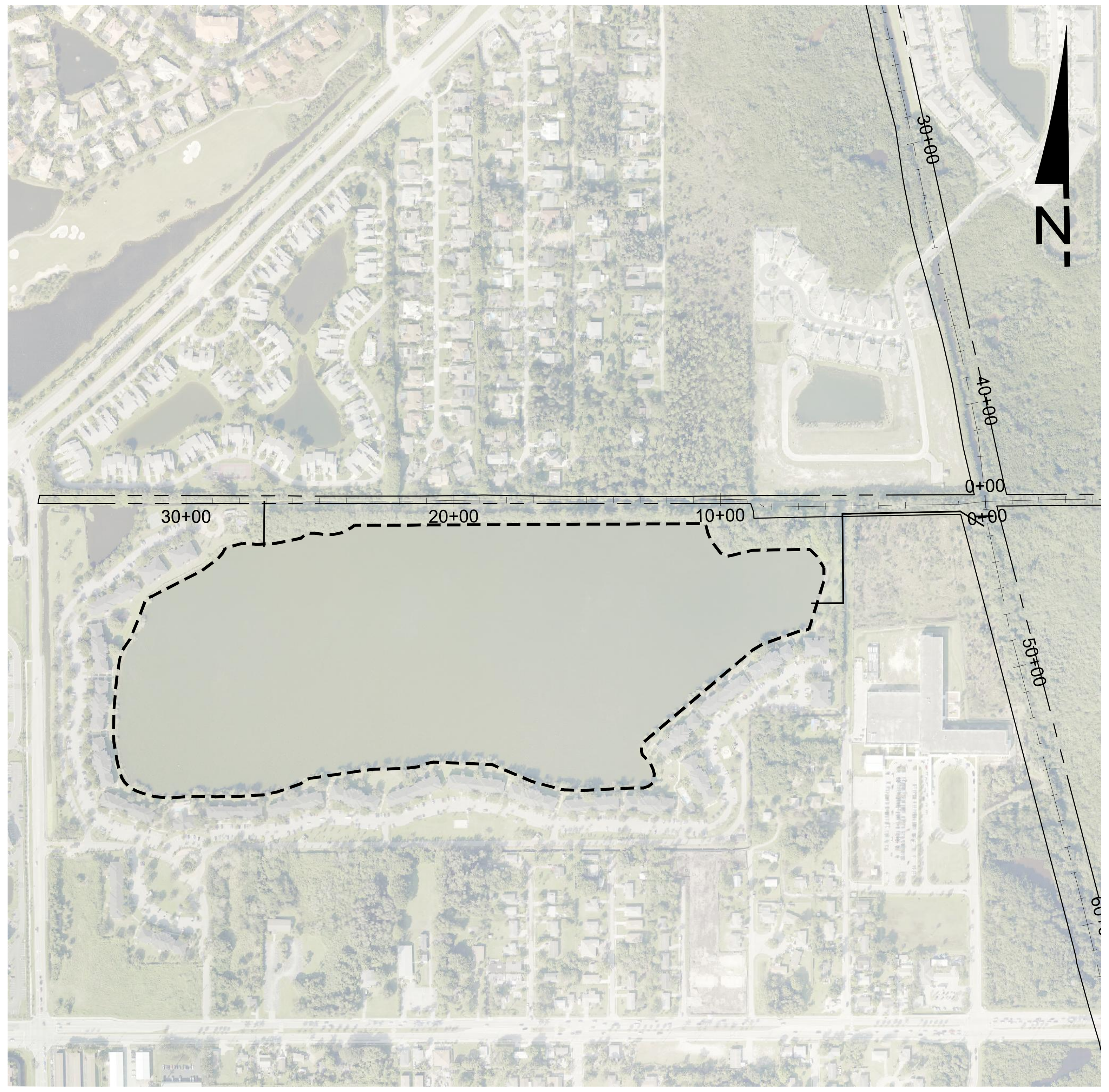

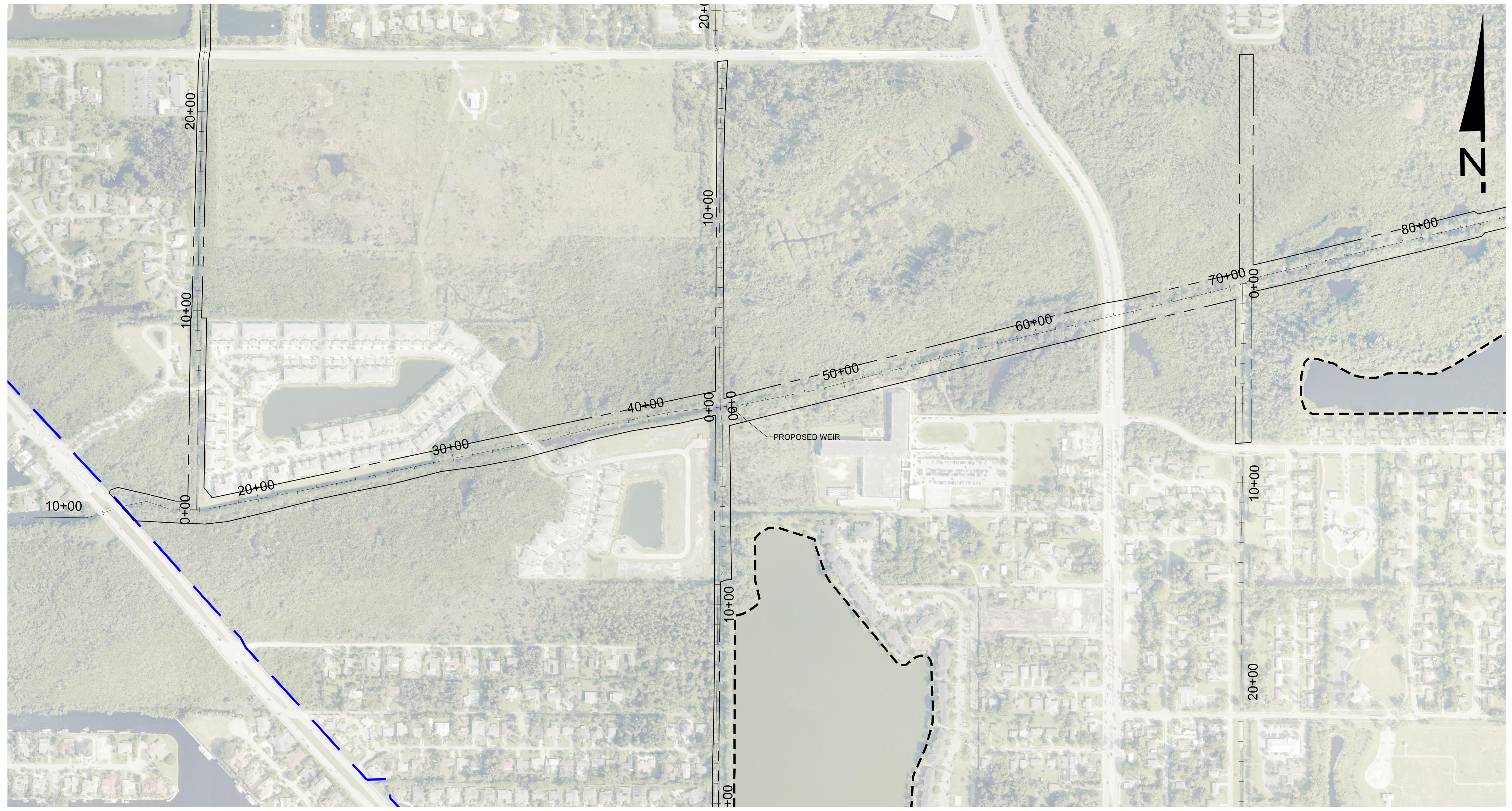

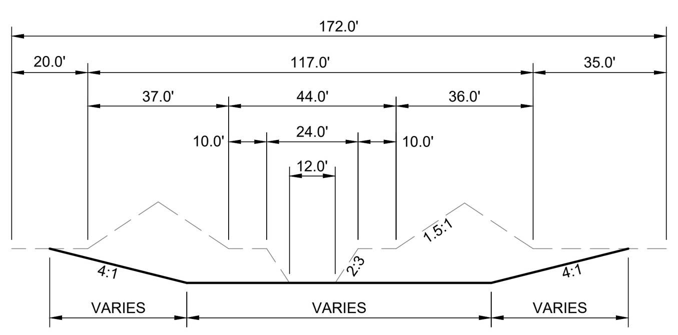

TYPICAL SECTION (CANAL C3)
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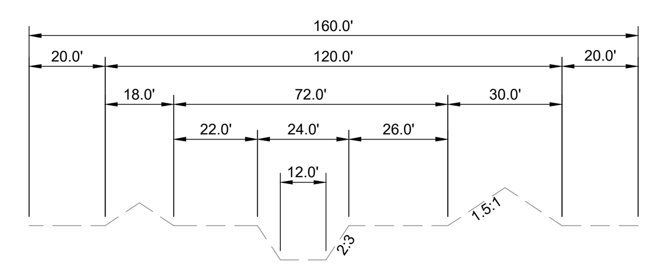
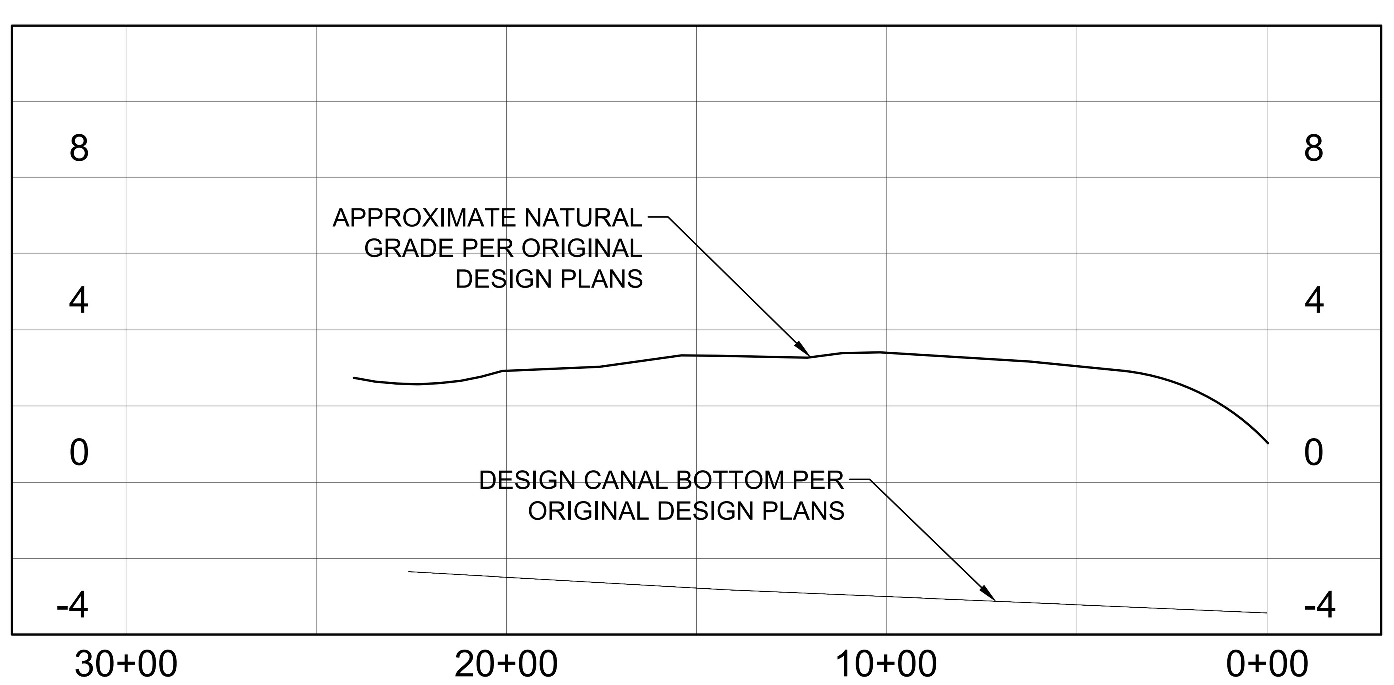
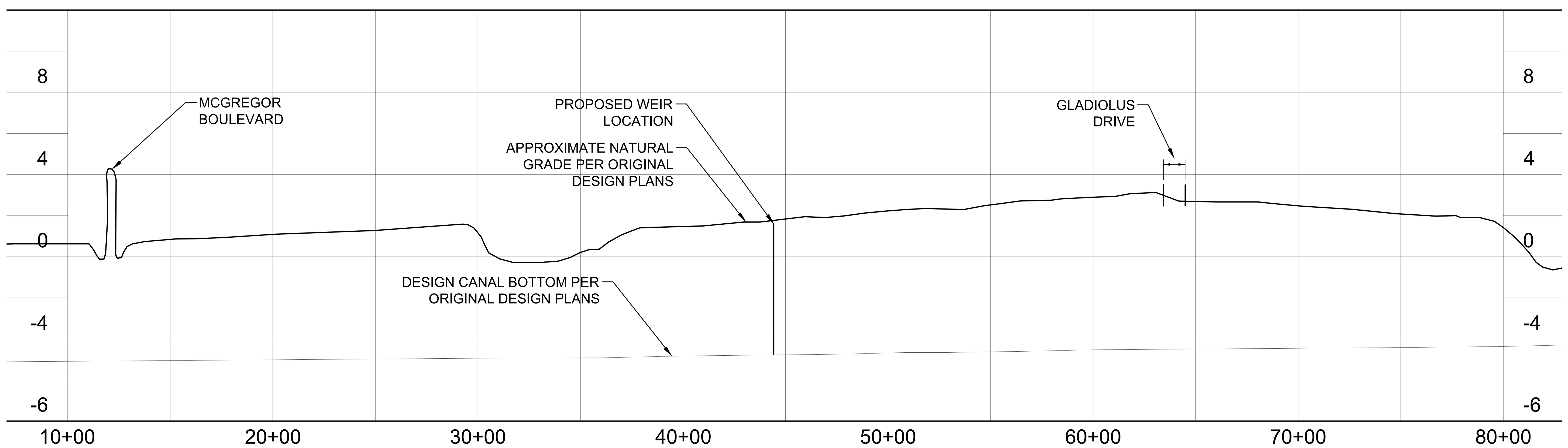


TYPICAL SECTION CANAL C (STA. 0+00 TO 84+00)
NTS





VERTICAL ELEVATIONS BASED ON: NAVD-88

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DEEP LAGOON FEASIBILITY STUDY

PLAN & PROFILE CANALS "C3" & "C5"

PLAN REVISIONS
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SCALE IN FEET

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SET NUMBER: 402-01-01
SHEET : 10

Appendix C: Plant Species List

Plant Species List for Deep Lagoon Preserve

Common and scientific names for this list were obtained from Wunderlin and Hansen, 2013.

Scientific Name	Common Name	Native Status	EPPC	FDACS	IRC	FNAI
Family: Blechnaceae (midsorus fern)						
Telmatoblechnum serrulatum	swamp fern	native				
Family: Polypodiaceae (polypody)						
Phlebodium aureum	golden polypody	native				
Family: Pteridaceae (brake fern)						
Acrostichum aureum	golden leather fern	native		T	R	G3/S3
Acrostichum danaeifolium	giant leather fern	native				
Family: Salvinaceae (floating fern)						
Salvinia minima	water spangles	exotic				
Family: Thelypteridaceae (marsh fern)						
Thelypteris kunthii	widespread maiden fern	native				
Family: Vittariaceae (shoestring fern)						
Vittaria lineata	shoestring fern	native				
Family: Pinaceae (pine)						
Pinus elliottii	slash pine	native				
Family: Agavaceae (agave)						
Yucca aloifolia	Spanish bayonet	exotic				
Family: Alismataceae (water plantain)						
Sagittaria latifolia	duck potato	native				
Family: Amaryllidaceae (amaryllis)						
Crinum americanum	string-lily	native				
Family: Araceae						
Colocasia esculenta	wild taro	exotic	I			
Epipremnum pinnatum	golden pothos	exotic	II			
Syngonium podophyllum	American evergreen	exotic	I			
Family: Arecaceae (palm)						
Cocos nucifera	coconut palm	exotic				
Phoenix reclinata	Senegal date palm	exotic	II			
Sabal palmetto	cabbage palm	native				
Serenoa repens	saw palmetto	native				
Washingtonia robusta	Washingtonia fan palm	exotic	II			
Family: Bromeliaceae (pineapple)						
Tillandsia balbisiana	northern needleleaf	native		T		
Tillandsia fasciculata	cardinal airplant	native		E		
Tillandsia flexuosa	twisted airplant	native		T	R	G5/S3
Tillandsia recurvata	ball moss	native				
Tillandsia setacea	southern needleleaf	native				
Tillandsia usneoides	Spanish moss	native				
Tillandsia utriculata	giant airplant	native		E		
Family: Cannaceae (canna)						
Canna flaccida	bandana-of-the-Everglades	native				
Family: Commelinaceae (spiderwort)						
Commelina diffusa var. diffusa	common dayflower	exotic				
Tradescantia spathacea	oyster-plant	exotic	I			
Family: Cyperaceae (sedge)						
Cladium jamaicense	Jamaica swamp sawgrass	native				
Cyperus articulatus	jointed flatsedge	native			I	
Cyperus distinctus	swamp flatsedge	native			I	
Cyperus involucratus	umbrella plant	exotic	II			
Cyperus ligularis	swamp flatsedge	native				
Eleocharis cellulosa	gulf coast spikerush	native				

Plant Species List for Deep Lagoon Preserve

Common and scientific names for this list were obtained from Wunderlin and Hansen, 2013.

Scientific Name	Common Name	Native Status	EPPC	FDACS	IRC	FNAI
Eleocharis geniculata	Canadian spikerush	native				
Fimbristylis cymosa	hurricanegrass	native				
Fimbristylis spadicea	marsh fimbry	native				
Rhynchospora colorata	starrush whitetop	native				
Rhynchospora latifolia	giant whitetop	native			R	
Scirpus tabernaemontani	softstem bulrush	native			R	
Family: Iridaceae (iris)						
Sisyrinchium angustifolium	narrowleaf blue-eyed grass	native			R	
Family: Juncaceae (rush)						
Juncus roemerianus	needle rush	native			R	
Family: Musaceae (banana)						
Musa acuminata	dwarf banana	exotic				
Family: Orchidaceae (orchid)						
Encyclia tampensis	Florida butterfly orchid	native		CE		
Zeuxine strateumatica	lawn orchid	exotic				
Family: Poaceae (grass)						
Andropogon glomeratus var. pumilus	bushy bluestem	native				
Cenchrus echinatus	southern sandbur	native				
Cynodon dactylon	bermudagrass	exotic				
Dactyloctenium aegyptium	durban crowfootgrass	exotic				
Distichlis spicata	saltgrass	native			R	
Echinochloa crus-galli	barnyardgrass	exotic				
Echinochloa walteri	coast cockspur	native				
Eustachys petraea	pinewoods fingergrass	native				
Panicum hemitomon	maidencane	native				
Panicum repens	torpedograss	exotic	I			
Panicum virgatum	switchgrass	native				
Paspalum notatum	bahiagrass	exotic				
Paspalum urviellei	vaseygrass	exotic				
Paspalum vaginatum	seashore paspalum	native				
Pennisetum purpureum	elephantgrass	exotic	I			
Rhynchelytrum repens	rose natalgrass	exotic	I			
Saccharum officinarum	sugarcane	exotic				
Setaria parviflora	knotroot foxtail	native				
Spartina bakeri	sand cordgrass	native				
Spartina patens	saltmeadow cordgrass	native				
Sporobolus indicus	smutgrass	exotic				
Sporobolus virginicus	seashore dropseed	native				
Stenotaphrum secundatum	St. Augustinegrass	exotic				
Urochloa maxima	guineagrass	exotic	II			
Family: Ruscaceae (*butcher's broom* ***)***						
Sansevieria hyacinthoides	bowstring hemp	exotic	II			
Family: Typhaceae (cattail)						
Typha domingensis	southern cattail	native				
Family: Acanthaceae (acanthus)						
Ruellia blechum	green shrimp plant	exotic	II			
Ruellia caroliniensis	Carolina wild petunia	native			I	
Thunbergia fragrans	whitelady	exotic				
Family: Aizoaceae (mesembryanthemum)						
Sesuvium portulacastrum	shoreline seapurslane	native				

Plant Species List for Deep Lagoon Preserve

Common and scientific names for this list were obtained from Wunderlin and Hansen, 2013.

Scientific Name	Common Name	Native Status	EPPC	FDACS	IRC	FNAI
Family: Amaranthaceae (amaranth)						
Amaranthus australis	southern amaranth	native			R	
Blutaparon vermiculare	silverhead	native				
Salicornia ambiqua	perennial glasswort	native				
Family: Anacardiaceae (cashew)						
Schinus terebinthifolius	Brazilian pepper	exotic	I			
Toxicodendron radicans	eastern poison ivy	native				
Family: Apiaceae (carrot)						
Lilaeopsis chinensis	eastern grasswort	native				
Family: Apocynaceae (dogbane)						
Rhabdadenia biflora	rubbervine	native				
Family: Araliaceae (ginseng)						
Centella asiatica	spadeleaf	native				
Schefflera actinophylla	Australian umbrella tree	exotic	I			
Family: Asteraceae (aster)						
Ambrosia artemisiifolia	common ragweed	native				
Baccharis angustifolia	saltwater falsewillow	native			R	
Baccharis halimifolia	groundsel tree	native				
Bidens alba	beggarticks	native				
Borrichia frutescens	bushy seaside oxeye	native				
Cirsium nuttallii	Nuttall's thistle	native			I	
Conyza canadensis var. pusilla	dwarf Canadian horseweed	native				
Coreopsis leavenworthii	Leavenworth's tickseed	native				
Erechtites hieraciifolius	fireweed	native				
Erigeron quercifolius	oakleaf fleabane	native				
Eupatorium capillifolium	dogfennel	native				
Eupatorium mohrii	mohr's thoroughwort	native			R	
Flaveria linearis	narrowleaf yellowtops	native				
Mikania cordifolia	Florida Keys hempvine	native			R	
Mikania scandens	climbing hempvine	native				
Packera glabella	butterweed	native			R	
Pluchea carolinensis	cure-for-all	native				
Pluchea foetida	stinking camphorweed	native			R	
Pluchea odorata	sweetscent	native				
Pluchea rosea	rosy camphorweed	native				
Solidago fistulosa	pinebarren goldenrod	native			R	
Solidago sempervirens	seaside goldenrod	native			R	
Sphagneticola trilobata	creeping oxeye	exotic	II			
Youngia japonica	Oriental false hawksbeard	exotic				
Family: Avicenniaceae (black mangrove)						
Avicennia germinans	black mangrove	native				
Family: Bataceae (saltwort)						
Batis maritima	saltwort	native				
Family: Boraginaceae (borage)						
Heliotropium angiospermum	scorpionstail	native				
Family: Cactaceae (cactus)						
Opuntia humifusa	pricklypear	native				
Family: Campanulaceae (bellflower)						
Lobelia feayana	bay lobelia	native			I	
Family: Caricaceae (papaya)						
Carica papaya	papaya	exotic				

Plant Species List for Deep Lagoon Preserve

Common and scientific names for this list were obtained from Wunderlin and Hansen, 2013.

Scientific Name	Common Name	Native Status	EPPC	FDACS	IRC	FNAI
Family: Casuarinaceae (sheoak)						
Casuarina equisetifolia	Australian-pine	exotic	I			
Family: Chrysobalanceae (coco plum family)						
Chrysobalanus icaco	Coco plum	native				
Family: Clusiaceae (mangosteen)						
Hypericum tetrapetalum	fourpetal St. John's wort	native				
Family: Combretaceae (combretum)						
Conocarpus erectus	buttonwood	native				
Laguncularia racemosa	white mangrove	native				
Bucida buceras	Shady Lady black olive tree	exotic				
Family: Convolvulaceae (morning-glory)						
Ipomoea alba	moonflowers	native				
Ipomoea cordatotriloba	tievine	native			R	
Ipomoea indica var. acuminata	oceanblue morning-glory	native				
Ipomoea pes-caprae	railroad vine	native				
Ipomoea quamoclit	cypressvine	exotic				
Family: Crassulaceae (orpine)						
Kalanchoe delagoensis	chandelier plant	exotic				
Family: Cucurbitaceae (gourd)						
Melothria pendula	creeping cucumber	native				
Momordica charantia	balsampear	exotic				
Family: Euphorbiaceae (spurge)						
Bischofia javanica	Javanese bishopwood	exotic	I			
Euphorbia cyathophora	paintedleaf; fire-on-the-mountain	native				
Ricinus communis	castorbean	exotic	II			
Family: Fabaceae (pea)						
Abrus precatorius	rosary pea	exotic	I			
Acacia auriculiformis	earleaf acacia	exotic	I			
Aeschynomene americana	shyleaf	native			R	
Albizia lebbeck	woman's tongue	exotic	I			
Caesalpinia bonduc	gray nicker	native				
Chamaecrista fasciculata	partridge pea	native				
Crotalaria pallida	smooth rattlebox	exotic				
Dalbergia ecastaphyllum	coinvine	native				
Indigofera hirsuta	hairy indigo	exotic				
Leucaena leucocephala	white leadtree	exotic	II			
Macroptilium lathyroides	wild bushbean	exotic				
Mimosa quadrivalvis	sensitive brier	native				
Neptunia pubescens	tropical puff	native				
Senna pendula	valamuerto	exotic	I			
Sesbania herbacea	danglepod	native				
Sesbania punicea	rattlebox	exotic	II			
Vigna luteola	hairypod cowpea	native				
Family: Fagaceae (beech)						
Quercus virginiana	Virginia live oak	native				
Quercus laurifolia	laurel oak	native				
Family: Lamiaceae (mint)						
Callicarpa americana	American beautyberry	native				
Family: Lauraceae (laurel)						
Cassytha filiformis	love vine	native				

Plant Species List for Deep Lagoon Preserve

Common and scientific names for this list were obtained from Wunderlin and Hansen, 2013.

Scientific Name	Common Name	Native Status	EPPC	FDACS	IRC	FNAI
Family: Lythraceae (loosestrife)						
Ammannia latifolia	toothcups	native			R	
Lythrum alatum	winged loosestrife	native			R	
Family: Malvaceae (mallow)						
Hibiscus acetosella	African rosemallow	exotic				
Kosteletzkya pentagonocarpus	Virginia saltmarsh mallow	native				
Malachra fasciata	roadside leafbract	native			I	
Melochia corchorifolia	chocolateweed	exotic				
Melochia spicata	bretonica peluda	native				
Sida cordifolia	llima	exotic	II			
Talipariti tiliaceum	mahoe; sea hibiscus	exotic	II			
Urena lobata	caesarweed	exotic	I			
Family: Melastomataceae (melastome)						
Rhexia cubensis	West Indian meadowbeauty	native			I	
Family: Meliaceae (mahogany)						
Swietenia mahagoni	West Indian mahogany	native				
Family: Moraceae (mulberry)						
Ficus spp.	unknown fig	exotic				
Ficus aurea	strangler fig	native				
Family: Myricaceae (bayberry)						
Myrica cerifera	wax myrtle	native				
Family: Myrsinaceae (myrsine)						
Myrsine cubana	myrsine	native				
Family: Myrtaceae (myrtle)						
Melaleuca quinquenervia	punktree	exotic	I			
Psidium cattleianum	strawberry guava	exotic	I			
Syzygium cumini	java plum	exotic	I			
Family: Onagraceae (eveningprimrose)						
Oenothera simulans	southern beeblossom	native				
Ludwigia octovalvis	mexican primrosewillow	native				
Family: Orobanchaceae (broomrape)						
Agalinis maritima	saltmarsh false foxglove	native				
Buchnera americana	American bluehearts	native				
Family: Passifloraceae (passionflower)						
Passiflora incarnata	purple passionflower	native			I	
Passiflora suberosa	corkystem passionflower	native				
Family: Phytolaccaceae (pokeweed)						
Rivina humilis	rougeplant	native				
Family: Plantaginaceae (speedwell)						
Bacopa monnieri	herb-of-grace	native				
Scoparia dulcis	licoriceweed	native				
Family: Plumbaginaceae (leadwort)						
Limonium carolinianum	Carolina sealavender	native			R	
Family: Polygonaceae (buckwheat)						
Coccoloba uvifera	seagrape	native				
Persicaria hydropiperoides	oakleaf fleabane	native				
Rumex verticillatus	swamp dock	native			I	
Family: Portulacaceae (purslane)						
Portulaca oleracea	little hogweed	exotic				
Portulaca pilosa	pink purslane	native				

Plant Species List for Deep Lagoon Preserve

Common and scientific names for this list were obtained from Wunderlin and Hansen, 2013.

Scientific Name	Common Name	Native Status	EPPC	FDACS	IRC	FNAI
Family: Rhizophoraceae (mangrove)						
Rhizophora mangle	red mangrove	native				
Family: Rubiaceae (madder)						
Chiococca alba	snowberry	native				
Psychotria nervosa	wild coffee	native				
Randia aculeata	white indigoberry	native				
Family: Salicaceae (willow)						
Salix caroliniana	Carolina willow	native				
Family: Samolaceae (primrose)						
Samolus ebracteatus	water pimpernel	native	I			
Family: Sapindaceae (soapberry)						
Cupaniopsis anacardioides	carrotwood	exotic	I			
Family: Solanaceae (nightshade)						
Lycium carolinianum	christmasberry	native				
Physalis angulata	cutleaf groundcherry	native			R	
Solanum americanum	American black nightshade	native				
Solanum diphyllum	twoleaf nightshade	exotic	II			
Solanum tampicense	aquatic soda apple	exotic	I			
Solanum viarum	tropical sodal apple	exotic	I			
Family: Tetrachondraceae (tetrachondra)						
Polypremum procumbens	rustweed	native				
Family: Verbenaceae (vervain)						
Lantana strigocamara	lantana	exotic	I			
Phyla nodiflora	capeweed	native				
Family: Vitaceae (grape)						
Parthenocissus quinquefolia	Virginia creeper	native				
Vitis rotundifolia	muscadine	native				

<u>Key</u>

Florida EPPC Status

I = species that are invading and disrupting native plant communities
II = species that have shown a potential to disrupt native plant communities

FDACS (Florida Department of Agriculture and Consumer Services)

E = Endangered
T = Threatened
CE = Commercially Exploited

IRC (Institute for Regional Conservation)

CI = Critically Imperiled
I = Imperiled
R = Rare

FNAI (Florida Natural Areas Inventory)

G= Global Status
T= Threatened
CE= Commercially Exploited

1= Critically imperiled because of extreme rarity (5 or fewer occurrences or less than 1000 individuals) or because of extreme vulnerbility to extinction due to some natural or man-made factor.
2= Imperiled because of rarity (6 to 20 occurrences or less than 3000 individuals) or because of vulnerbility to extinction due to some natural or man-made factor.
3= Either very rare and local throughout its range (21-200 occurences or less than 10,000 individuals) or found locally in a restricted range or vulnerable to extinction from other factors.
4= Apparently secure
5= Demonstrably secure

Appendix D: Wildlife Species List

Wildlife Species List for Deep Lagoon Preserve

Scientific Name	Common Name	Designated Status		
		FWC	FWS	FNAI
MAMMALS				
Family: Didelphidae (opossums)				
Didelphis virginiana	Virginia opossum			
Family: Trichechidae (manatees)				
Trichechus manatus	West Indian manatee	FE	E	G2/S2
Family: Sciuridae (squirrels and their allies)				
Sciurus carolinensis	eastern gray squirrel			
Family: Leporidae (rabbits and hares)				
Sylvilagus palustris	marsh rabbit			
Sylvilagus floridanus	eastern cottontail			
Family: Felidae (cats)				
Lynx rufus	bobcat			
Family: Procyonidae (raccoons)				
Procyon lotor	raccoon			
Family: Mustelidae (weasels, otters and relatives)				
Lutra canadensis	northern river otter			
Family: Delphinidae (oceanic dolphins)				
Tursiops truncatus	common bottlenose dolphin			
BIRDS				
Family: Anatidae (swans, geese and ducks)				
Subfamily: Anatinae				
Cairina moschata	muscovy duck *			
Anas platyrhynchos	mallard			
Anas fulvigula	mottled duck			
Anas crecca	green-winged teal			
Anas discors	blue-winged teal			
Mergus serrator	red-breasted merganser			
Family: Phasianidae (pheasant, grouse, turkeys and their allies)				
Subfamily: Meleagridinae (turkeys)				
Meleagris gallopavo	wild turkey			
Family: Podicipedidae (grebes)				
Podilymbus podiceps	pied-billed grebe			
Family: Ciconiidae (storks)				
Mycteria americana	wood stork	FT	FT	G4/S2
Family: Fregatidae (frigatebirds)				
Fregata magnificens	magnificent frigatebird			G5/S1
Family: Phalacrocoracidae (cormorants)				
Phalacrocorax auritus	double-crested cormorant			
Family: Anhingidae (anhingas)				
Anhinga anhinga	anhinga			
Family: Pelecanidae (pelicans)				
Pelecanus occidentalis	brown pelican			G4/S3
Family: Ardeidae (herons, egrets, bitterns)				
Ardea herodius	great blue heron			
Ardea alba	great egret			G5/S4
Egretta thula	snowy egret			G5/S3
Egretta caerulea	little blue heron	T		G5/S4
Egretta tricolor	tricolored heron	T		G5/S4
Bubulcus ibis	cattle egret			
Butorides virescens	green heron			
Nycticorax nycticorax	black-crowned night heron			G5/S3
Nyctanassa violacea	yellow-crowned night heron			G5/S3

Wildlife Species List for Deep Lagoon Preserve

		Designated Status		
Scientific Name	**Common Name**	**FWC**	**FWS**	**FNAI**
Family: Threskiornithidae (ibises and spoonbills)				
Subfamily: Threshiornithinae				
Eudocimus albus	white ibis			G5/S4
Plegadis falcinellus	glossy ibis			G5/S3
Subfamily: Plataleinae				
Platalea ajaja	roseate spoonbill	T		G5/S2
Family: Cathartidae (new world vultures)				
Coragyps atratus	black vulture			
Cathartes aura	turkey vulture			
Family: Pandionidae (ospreys)				
Pandion haliaetus	osprey			G5/S3S4
Family: Accipitridae (hawks, kites, accipiters, harriers, eagles)				
Elanoides forficatus	swallow-tailed kite			G5/S2
Accipiter cooperii	Cooper's hawk			G5/S3
Hailaeetus leucocephalus	bald eagle			G5/S3
Buteo lineatus	red-shouldered hawk			
Buteo jamaicensis	red-tailed hawk			
Family: Rallidae (coots and gallinules)				
Gallinula galeata	common gallinule			
Family: Gruidae (cranes)				
Subfamily: Gruinae				
Grus canadensis pratensis	Florida sandhill crane	T		G5T2T3/S2S3
Family: Recurvirostridae (avocets and stilts)				
Himantopus mexicanus	black-necked stilt			
Family: Charadriidae (plovers)				
Subfamily: Charadriinae				
Charadrius vociferus	killdeer			
Family: Scolopacidae (sandpipers and phalaropes)				
Subfamily: Scolopacinae				
Actitis macularia	spotted sandpiper			
Tringa solitaria	solitary sandpiper			
Calidris minutilla	least sandpiper			
Limnodromus griseus	short-billed dowitcher			
Gallinago delicata	Wilson's snipe			
Family: Laridae (gulls)				
Subfamily: Larinae				
Larus atricilla	laughing gull			
Larus delawarensis	ring-billed gull			
Subfamily: Sterninae (terns)				
Sterna antillarum	least tern	T		G4/S3
Thalasseus maxima	royal tern			G5/S3
Family: Columbidae (pigeons and doves)				
Streptopelia decaocto	Eurasian collared-dove *			
Zenaida macroura	mourning dove			
Columbina passerina	common ground-dove			
Family: Cuculidae (cuckoos and their allies)				
Subfamily: Crotophaginae				
Crotophaga ani	smooth-billed ani			
Family: Apodidae (swifts)				
Subfamily: Chaeturinae				
Chaetura pelagica	chimney swift			
Family: Alcedinidae (kingfishers)				
Ceryle alcyon	belted kingfisher			

Wildlife Species List for Deep Lagoon Preserve

		Designated Status		
Scientific Name	**Common Name**	**FWC**	**FWS**	**FNAI**
Family: Picidae (woodpeckers)				
Subfamily: Picinae				
Melanerpes erythrocephalus	red-headed woodpecker			
Melanerpes carolinus	red-bellied woodpecker			
Picoides pubescens	downy woodpecker			
Colaptes auratus	northern flicker			
Dryocopus pileatus	pileated woodpecker			
Family: Falconidae (falcons)				
Subfamily: Falconinae (falcons)				
Falco sparverius	American kestrel			
Family: Cacatuidae (cockatoos)				
Nymphicus hollandicus	cockatiel *			
Family: Tyrannidae (tyrant flycatchers)				
Subfamily: Fluvicolinae				
Sayornis phoebe	eastern phoebe			
Myiarchus crinicensis	great-crested flycatcher			
Tyrannus verticalis	western kingbird			
Tyrannus tyrannus	eastern kingbird			
Tyrannus dominicensis	gray kingbird			
Family: Laniidae (shrikes)				
Lanius ludovicianus	loggerhead shrike			
Family: Vireonidae (vireos)				
Vireo griseus	white-eyed vireo			
Family: Corvidae (crows, jays, etc.)				
Cyanocitta cristata	blue jay			
Corvus brachyrhyncos	American crow			
Corvus ossifragus	fish crow			
Family: Hirundinidae (swallows)				
Subfamily: Hirundinidae				
Progne subis	purple martin			
Tachycineta bicolor	tree swallow			
Hirundo rustica	barn swallow			
Stelgidopteryx serripennis	northern rough-winged swallow			
Petrochelidon pyrrhonota	cliff swallow			
Family: Troglodytidae (wrens)				
Troglodytes aedon	house wren			
Thryothorus ludovicianus	Carolina wren			
Family: Polioptilidae				
Polioptila caerulea	blue-gray gnatcatcher			
Family: Turdidae (thrushes)				
Catharus ustulatus	Swainson's thrush			
Family: Mimidae (mockingbirds and thrashers)				
Dumetella carolinensis	gray catbird			
Toxostoma rufum	brown thrasher			
Mimus polyglottos	northern mockingbird			
Family: Sturnidae (starlings)				
Sturnus vulgaris	European starling *			
Family: Parulidae (wood-warblers)				
Vermivora pinus	blue-winged warbler			
Mniotilta varia	black-and-white warbler			
Geothlypis tristis	common yellowthroat			
Setophaga ruticilla	American redstart			
Setophaga palmarum	palm warbler			
Setophaga pinus	pine warbler			
Setophaga coronata	yellow-rumped warbler			

Wildlife Species List for Deep Lagoon Preserve

		Designated Status		
Scientific Name	**Common Name**	**FWC**	**FWS**	**FNAI**
Setophaga dominica	yellow-throated warbler			
Setophaga discolor	prairie warbler			
Family: Emberizine (sparrows and their allies)				
Passerculus sandwichensis	Savannah sparrow			
Family: Cardinalidae (cardinals, some grosbeaks, new world buntings, etc.)				
Cardinalis cardinalis	northern cardinal			
Family: Icteridae (blackbirds, orioles, etc.)				
Agelaius phoeniceus	red-winged blackbird			
Quiscalus quiscula	common grackle			
Quiscalus major	boat-tailed grackle			
Molothrus ater	brown-headed cowbird			
REPTILES				
Family: Alligatoridae (alligator and caiman)				
Alligator mississippiensis	American alligator	FT(SA)	T(SA)	G5/S4
Family: Kinosternidae (musk and mud turtles)				
Kinosternon baurii	striped mud turtle			
Family: Emydidae (box and water turtles)				
Terrapene carolina bauri	Florida box turtle			
Pseudemys nelsoni	Florida redbelly turtle			
Family: Trionychidae (softshell turtles)				
Apalone ferox	Florida softshell			
Family: Polychridae (anoles)				
Anolis carolinensis	green anole			
Anolis sagrei	brown anole *			
Family: Scincidae (skinks)				
Plestiodon inexpectatus	southeastern five-lined skink			
Family: Colubridae (harmless egg-laying snakes)				
Coluber constrictor priapus	southern black racer			
Pantherophis guttatus	eastern corn snake			
Scotophis alleghaniensis	eastern rat snake			
Family Natricidae (harmless live-bearing snakes)				
Nerodia clarkii compressicausa	mangrove salt marsh snake			
AMPHIBIANS				
Family: Eleutherodactylidae (free-toed frogs)				
Eleutherodactylus planirostris	greenhouse frog *			
Family: Bufonidae (toads)				
Anaxyrus terrestris	southern toad			
Family: Hylidae (treefrogs and their allies)				
Hyla cinerea	green treefrog			
Hyla squirella	squirrel treefrog			
Osteopilus septentrionalis	Cuban treefrog *			
Family: Microhylidae (narrowmouth toads)				
Gastrophryne carolinensis	eastern narrowmouth toad			
Family: Ranidae (true frogs)				
Lithobates grylio	pig frog			
Lithobates sphenocephalus sphenocephalus	Florida leopard frog			
FISHES				
Family: Pristidae (sawfishes)				
Pristis pectinata	smalltooth sawfish	FE	E	
Family: Cyprinodontidae (pupfishes)				
Cyprinodon variegatus	sheepshead minnow			
Family: Poeciliidae (livebearers)				
Gambusia holbrooki	eastern mosquitofish			
Family: Sparidae (porgies)				
Archosargus probatocephalus	sheepshead			

Wildlife Species List for Deep Lagoon Preserve

		Designated Status		
Scientific Name	**Common Name**	**FWC**	**FWS**	**FNAI**
INSECTS				
Family: Coenagrionidae (narrow-winged damselflies)				
Ischnura prognata	Rambur's forktail			
Family: Libellulidae (skimmer dragonflies)				
Celithemis eponina	Halloween pennants			
Crocothermis servilia	scarlet skimmer			
Erythemis simplicicollis	eastern pondhawk			
Erythrodiplax umbrata	band-winged dragonlet			
Pachydiplax longipennis	blue dasher			
Tramea carolina	Carolina saddlebags			
Family: Corixidae (water boatmen)				
unknown	water boatman			
Family: Psyllidae (psyllids)				
Boreioglycaspis melaleucae	melaleuca psyllid *			
Family: Chrysomelidae (leaf beetles)				
Subfamily: Criocerinae				
Lilloceris cheni	Air potato leaf beetle *			
Family: Pieridae (whites and sulphurs)				
Subfamily: Pierinae (whites, marbles and orange tips)				
Ascia monuste	great southern white			
Subfamily: Coliadinae (sulphurs)				
Phoebis philea	orange-barred sulphur			
Family: Nymphalidae (brushfoots)				
Subfamily: Heliconiinae (longwings)				
Agraulis vanillae	gulf fritillary			
Subfamily: Nymphalinae (brushfoots)				
Anartia jatrophae	white peacock			
Subfamily: Danaidae (milkweed butterfiles)				
Danaus gilippus	queen			
Family: Apidae (carpenter, digger, bumble and honey bees)				
Xylocopa micans	southern carpenter bee			
Family: Vespidae (wasps)				
Poistes sp.	paper wasp			
CRUSTACEANS				
Family: Grapsidae (marsh, shore and talon crabs)				
Aratus pisoni	mangrove tree crab			
Family: Ocypodoidea (ghost and fiddler crabs)				
Subfamily: Ocypodinae (fiddler crabs)				
Uca stylifera	fiddler crab			
GASTROPODS				
Family: Ampullariidae				
*Pomacea maculata**	island apple snail			

KEY:

FWC = Florida Fish & Wildlife Conservation Commission
FWS = U.S. Fish & Wildlife Service
E - Endangered
T - Threatened
SSC - Species of Special Concern

FNAI = Florida Natural Areas Inventory
G - Global rarity of the species
S - State rarity of the species
T - Subspecies of special population
1 - Critically imperiled
2 - Imperiled
3 - Rare, restricted or otherwise vulnerable to extinction
4 - Apparently secure
5 - Demonstratebly secure

*** = Non-native**

Appendix E: Legal Descriptions

600R
9792.80DS

INSTR # 4722498
OR BK 03170 PG 3676
RECORDED 09/23/99 03:11 PM
CHARLIE GREEN CLERK OF COURT
LEE COUNTY
RECORDING FEE 6.00
DOC TAX PD(F.S.201.02) 6,792.80
DEPUTY CLERK B Cruz

Return to: Stephen E. Dalton
Name: Pavese, Garner
Address: P.O. Drawer 1507
Ft. Myers, FL 33902

This instrument was prepared by: Stephen E. Dalton, Esquire
Name PAVESE, GARNER, HAVERFIELD,
Address DALTON, HARRISON & JENSEN, L.L.P.
1833 Hendry Street
Post Office Drawer 1507
Fort Myers, Florida 33902

Property Appraiser's
Parcel Identification No. 32-45-24-01-000L0.0010

WARRANTY DEED

(STATUTORY FORM - SECTION 689.02, F.S.)

This Indenture, made this 13 day of September 1999, **Between DORIS SWOR, Individually and as Trustee,** whose post office address is 6385 Presidential Court Suite 104, Fort Myers, Florida 33919, grantor*, and **LEE COUNTY, a Political Subdivision of the State of Florida,** whose post office address is c/o Parks and Recreation, P.O. Box 398, Fort Myers, FL 33902, grantee*,

Witnesseth that said grantor, for and in consideration of the sum of TEN AND NO/100 DOLLARS, and other good and valuable considerations to said grantor in hand paid by said grantee, the receipt whereof is hereby acknowledged, has granted, bargained and sold to the said grantee, and grantee's heirs and assigns forever, the following described land, situate, lying and being in Lee County, Florida, to-wit:

Blocks L, and M, Harlem Heights, according to the map or plat thereof filed and recorded in the Office of the Clerk of the Circuit Court, in Plat Book 8, Page 76, LESS land taken for SR S-865 in Case #L-756, all being in the Public Records of Lee County, Florida.

Subject to easements, reservations and restrictions of record and taxes for the current and all subsequent years.

and said grantor does hereby fully warrant the title to said land, and will defend the same against the lawful claims of all persons whomsoever.

*"Grantor" and "grantee" are used for singular or plural, as context requires.

This land is not the homestead of the Grantor, nor contiguous to any homestead of Grantor.

In Witness Whereof, grantor has hereunto set grantor's hand and seal the day and year first above written.

Signed, sealed and delivered in our presence:

Paula B Clark
Witness #1
PAULA B. CLARK
Printed name of Witness #1

Richard E. Meade
Witness #2
RICHARD E. MEADE
Printed name of Witness #2

Doris Swor (Seal)
DORIS SWOR, Individually and as Trustee

Acquisition approved by the Lee County Board of Commissioners action on 8-3-99
and accepted on behalf of the board by
M Shore on 9-23-99
in accordance with ORD 96-12

STATE OF NORTH CAROLINA
COUNTY OF AVERY.

The foregoing instrument was acknowledged before me this 13th day of SEPTEMBER 1999, by DORIS SWOR, Individually and as Trustee, who is personally known to me or who produced ______ as identification.

Paula B Clark
Notary Public
PAULA B. CLARK
Printed name of Notary Public

PAULA B. CLARK NOTARY PUBLIC BURKE COUNTY, N.C.

My Commission Expires: Nov 29, 2001

F:\WPDATA\SED\SWOR\JOHNSON\DEED.CO

600R
1370.50DS

This Warranty Deed

INSTR # 4677967
OR BK 03146 PG 4142
RECORDED 07/19/99 12:52 PM
CHARLIE GREEN CLERK OF COURT
LEE COUNTY
RECORDING FEE 6.00
DOC TAX PD(F.S.201.02) 13,170.50
DEPUTY CLERK V Fuller

Made this 13th day of July A.D. 19 99 by

DONALD B. FISHER and SHARON L. FISHER, Husband and Wife

hereinafter called the grantor, to

LEE COUNTY, A POLITICAL SUBDIVISION OF THE STATE OF FLORIDA

whose post office address is: P.O. BOX 398
FORT MYERS, FL 33902

hereinafter called the grantee:

(Whenever used herein the term "grantor" and "grantee" include all the parties to this instrument and the heirs, legal representatives and assigns of individuals, and the successors and assigns of corporations)

Witnesseth, that the grantor, for and in consideration of the sum of $ 10.00 and other valuable considerations, receipt whereof is hereby acknowledged, hereby grants, bargains, sells, aliens, remises, releases, conveys and confirms unto the grantee, all that certain land situate in LEE County, Florida, viz:

The East half of the Southeast quarter of Section 29, Township 45 South, Range 24 East, Less the South 195' of the East 450', Lee County, Florida.

SUBJECT TO covenants, restrictions, easements of record.

Acquisition approved by the Lee County Board of Commissioners action on 5-25-99
and accepted on behalf of the board by [signature] on 7-16-99
in accordance with FS125+Ord 96-12

Parcel Identification Number: 29-45-24-00-00008.0000

Together with all the tenements, hereditaments and appurtenances thereto belonging or in anywise appertaining.

To Have and to Hold, the same in fee simple forever.

And the grantor hereby covenants with said grantee that the grantor is lawfully seized of said land in fee simple; that the grantor has good right and lawful authority to sell and convey said land; that the grantor hereby fully warrants the title to said land and will defend the same against the lawful claims of all persons whomsoever; and that said land is free of all encumbrances except taxes accruing subsequent to December 31, 19 98

In Witness Whereof, the said grantor has signed and sealed these presents the day and year first above written.

Signed, sealed and delivered in our presence:

Judy K. Bradtmueller Name: Judy K. Bradtmueller	Donald B. Fisher (LS) Name & Address: DONALD B. FISHER P.O. Box 10123; Fort Wayne, IN 46850
Juliann M Henn Name: Juliann M. HENN	Sharon L Fisher (LS) Name & Address: SHARON L. FISHER P.O. Box 10123; Fort Wayne, IN 46850
Name:	Name & Address: (LS)
Name:	Name & Address: (LS)

State of INDIANA
County of ALLEN

The foregoing instrument was acknowledged before me this 13th day of July, 19 99, by

DONALD B. FISHER and SHARON L. FISHER, Husband and Wife

who is personally known to me or who has produced DRIVER LICENSES as identification and who DID NOT take an oath.

Juliann M Henn
Print Name:
Notary Public
My Commission Expires:

SEAL NOTARY PUBLIC INDIANA
JULIANN M. HENN, Notary Public
Allen County, State of Indiana
My Commission #421655
Expires: November 25, 2001

PREPARED BY: CORRINE COLLINS
RECORD & RETURN TO:
First American Title Insurance Co.
8931 Conference Drive, Suite 6
Fort Myers, Florida 33919
File No: T99-27891

WD-1
5/93

Prepared by and Return to:

Joseph A. Furlong, Jr.
FURLONG TITLE COMPANY, INC.
12651 McGregor Blvd., Unit 102
Fort Myers, Fl 33919
GRANTEE TAX ID NUMBER: ___________

INSTR # 5141215
OR BK 03417 PG 2907
RECORDED 05/22/01 11:50 AM
CHARLIE GREEN CLERK OF COURT
LEE COUNTY
RECORDING FEE 19.50
DOC TAX PD(F.S.201.02) 8,386.00
DEPUTY CLERK B Cruz

[Space Above This Line for Recording Data]

WARRANTY DEED

File No. 256709-DJT

THIS INDENTURE, made this 21st day of May, A.D. 2001 between

PATRICIA A. MADER HARTZELL, PERSONAL REPRESENTATIVE FOR THE ESTATE OF LEONA MADER, DECEASED and GEORGE W. EVELEIGH
as Grantor*, whose address is: 785 Long Street, Bridgeport, West Virginia 26330
and

LEE COUNTY, A POLITICAL SUBDIVISION OF THE STATE OF FLORIDA
as Grantee*, whose address is: PO BOX 398 FORT MYERS, FL. 33902

WITNESSETH: That the Grantors, for and in consideration of the sum of TEN AND NO/100 DOLLARS ($10.00) and other valuable considerations to said grantors in hand paid by said grantees, the receipt whereof is hereby acknowledged, has granted, bargained and sold to the grantee and grantee's heirs forever the following described land located in the County of LEE, State of Florida, to-wit:

SEE ATTACHED FOR CONTINUATION OF LEGAL DESCRIPTION

Subject property is vacant land and is not the homestead of the Grantor(s).

Property Tax ID Number: 20-45-24-00-00004.0000

SUBJECT TO easements, restrictions and reservations of record, if any, and taxes for 2001 and subsequent years.

Said grantor does hereby fully warrant the title to said land, and will defend the same against the lawful claims of all persons whomsoever.

*Singular and plural are interchangeable as context requires.

IN WITNESS WHEREOF, Grantor has hereunto set grantor's hand and seal the day and year first above written.
Witnesses

(WITNESS 1) R Linda Stumpf
PRINT OR TYPE NAME: R LINDA Stumpf

Patricia A. Mader Hartzell
PATRICIA A. MADER HARTZELL

(WITNESS 2) Debbie Keen
PRINT OR TYPE NAME: Debbie Keen

George W Eveleigh
GEORGE W. EVELEIGH

(1) Donna Jean Thomas (2) Joseph A. Furlong Jr
WITNESSES AS TO GEORGE W. EVELEIGH
Print Name Donna Jean Thomas
Print Name: JOSEPH A. FURLONG JR

State of West Virginia
County of Harrison

The foregoing instrument was acknowledged before me on this 21st day of May, 2001 by PATRICIA A. MADER HARTZELL and ~~GEORGE W. EVELEIGH~~, who is known to me or who has produced WV Drivers License as identification and did _____ take an oath.

Sheila D Davisson
NOTARY PUBLIC
PRINT OR TYPE NAME: Sheila D. Davisson

My Commission Expires: April 24, 2006
(SEAL)

OFFICIAL SEAL
NOTARY PUBLIC
STATE OF WEST VIRGINIA
SHEILA DAVISSON
Bank One
1507 Johnson Avenue
Bridgeport, West Virginia 26330
My Commission Expires April 24, 2006

Acquisition approved by the Lee County Board of Commissioners action on 2-27-2001
and accepted on behalf of the board by Paul R. Schmidt on 5-21-2001
in accordance with BSH 20010173

CONTINUATION OF WARRANTY DEED
TO INCLUDE NOTARY ACKNOWLEDGMENT
FOR GEORGE W. EVELEIGH

STATE OF FLORIDA

COUNTY OF LEE

The Foregoing Instrument was acknowledged before me on this 21st day of May, 2001, by GEORGE W. EVELEIGH,, who is known to me or who has produced a Florida Driver's License as identification and did NOT take an oath.

My Commission Expires:
10-28-02

NOTARY PUBLIC, State of Florida at Large.
JOSEPH A FURLONG JR

(SEAL)

JOSEPH A. FURLONG, JR.
NOTARY PUBLIC, STATE OF FLORIDA AT LARGE
MY COMMISSION EXPIRES 10-28-2002
COMMISSION NUMBER 415762
BONDING COMPANY: CNA WESTERN SURETY COMPANY

THAT PART OF SECTIONS 20 AND 29, TOWNSHIP 45 SOUTH, RANGE 24 EAST, LEE COUNTY, FLORIDA, LYING NORTHWESTERLY OF MCGREGOR BOULEVARD, EASTERLY OF PALMETTO POINT SUBDIVISION (AS RECORDED IN PLAT BOOK 29 AT PAGES 21, 22, AND 23 OF THE PUBLIC RECORDS OF LEE COUNTY), WESTERLY OF DEEP LAGOON AND SOUTHERLY OF THE CALOOSAHATCHEE RIVER.

A TRACT OR PARCEL OF LAND SITUATED IN THE STATE OF FLORIDA, COUNTY OF LEE, BEING A PART OF DEEP LAGOON HEIGHTS, AN UNRECORDED SUBDIVISION LYING IN SECTION 29, TOWNSHIP 45 SOUTH, RANGE 24 EAST, AND FURTHER BOUNDED AS DESCRIBED AS FOLLOWS: STARTING AT A CONCRETE MONUMENT MARKING THE SOUTHEAST CORNER OF THE SOUTHWEST ONE QUARTER (SW 1/4) OF SAID SECTION 29, THENCE N 01°02'07" W ALONG THE EAST LINE OF SAID FRACTION OF A SECTION, AND AN EXTENSION THEREOF FOR 2676.45 FEET, TO AN INTERSECTION WITH THE SOUTHEASTERLY RIGHT OF WAY LINE OF MCGREGOR BOULEVARD (S.R. 867, 80.00 FEET WIDE); THENCE S 45°48'00" W ALONG SAID SOUTHEASTERLY RIGHT OF WAY FOR 463.51 FEET TO THE POINT OF BEGINNING; THENCE CONTINUE S 45°48'00" W ALONG SAID RIGHT OF WAY FOR 412.53 FEET TO AN INTERSECTION WITH THE EAST LINE OF MARTIN DRIVE (25.00 FEET WIDE); THENCE S 00°51'10" E ALONG SAID EAST LINE FOR 109.08 FEET; THENCE N 88°53'00" E FOR 300.00 FEET TO AN INTERSECTION WITH THE WEST LINE OF WILLEMS DRIVE (50.00 FEET WIDE); THENCE N 00°51'10" W ALONG SAID WEST LINE FOR 390.87 FEET TO THE POINT OF BEGINNING.

A TRACT OR PARCEL OF LAND SITUATED IN THE STATE OF FLORIDA, COUNTY OF LEE, BEING A PART OF DEEP LAGOON HEIGHTS, AN UNRECORDED SUBDIVISION LYING IN SECTION 29, TOWNSHIP 45 SOUTH, RANGE 24 EAST, AND FURTHER BOUNDED AND DESCRIBED AS FOLLOWS: STARTING AT A CONCRETE MONUMENT MARKING THE SOUTHEAST CORNER OF THE SOUTHWEST ONE QUARTER (SW 1/4) OF SAID SECTION 29; THENCE S 88°53'00" W ALONG THE SOUTH LINE OF SAID SECTION 29 FOR 33.00 FEET TO AN INTERSECTION WITH THE WEST LINE OF A PUBLIC ROADWAY (66.00 FEET WIDE) AS SET FORTH IN COUNTY COMMISSIONER'S BOOK 5 AT PAGE 645 OF THE PUBLIC RECORDS OF SAID LEE COUNTY, THENCE N 01°02'07" W ALONG SAID WEST RIGHT OF WAY LINE FOR 1569.00 FEET TO THE POINT OF BEGINNING; THENCE CONTINUE N 01°02'07" W ALONG SAID WEST RIGHT OF WAY LINE FOR 886.87 FEET TO AN INTERSECTION WITH THE SOUTHWESTERLY LINE OF A ROADWAY EASEMENT (50.00 FEET WIDE). THENCE N 44°12'00" W ALONG SAID SOUTHWESTERLY LINE FOR 117.38 FEET TO AN INTERSECTION WITH THE SOUTHEASTERLY RIGHT OF WAY LINE OF MCGREGOR BOULEVARD (S.R. 867, 80.00 FEET WIDE) AS SHOWN ON THE FLORIDA DEPARTMENT OF TRANSPORTATION RIGHT-OF-WAY MAP PROJECT 12040-2515, DATED SEPTEMBER, 1994; THENCE RUNS S 47°14'02" W ALONG SAID SOUTHEASTERLY RIGHT-OF-WAY LINE FOR 234.09 FEET TO AN INTERSECTION WITH THE EAST LINE OF WILLEMS DRIVE (50.00 FEET WIDE); THENCE RUN S 00°51'10" E ALONG SAID EAST LINE FOR 817.05 FEET; THENCE RUN N 88°52'49" E FOR 257.60 FEET TO THE POINT OF BEGINNING.

A TRACT OR PARCEL OF LAND SITUATED IN THE STATE OF FLORIDA, COUNTY OF LEE, BEING A PART OF DEEP LAGOON HEIGHTS, AN UNRECORDED SUBDIVISION LYING IN SECTION 29, TOWNSHIP 45 SOUTH, RANGE 24 EAST, AND FURTHER BOUNDED AND DESCRIBED AS FOLLOWS: STARTING AT A CONCRETE MONUMENT MARKING THE SOUTHEAST CORNER OF THE SOUTHWEST ONE QUARTER (SW 1/4) OF SAID SECTION 29; THENCE S 88°53'00" W ALONG THE SOUTH LINE OF SAID SECTION 29 FOR 33.00 FEET TO AND INTERSECTION WITH THE WEST LINE OF A PUBLIC ROADWAY (66.00 FEET WIDE) AS SET FORTH IN COUNTY COMMISSIONER'S BOOK 5 AT PAGE 645 OF THE PUBLIC RECORDS OF SAID LEE COUNTY, THENCE N 01°02'07 W ALONG SAID WEST RIGHT OF WAY LINE FOR 869.00 FEET TO THE POINT OF BEGINNING; THENCE CONTINUE N 01°02'07" W ALONG SAID WEST RIGHT OF WAY LINE FOR 700.00 FEET; THENCE S 88°52'49" W FOR 257.60 FEET TO AN INTERSECTION WITH THE EAST LINE OF WILLEMS DRIVE (50.00 FEET WIDE); THENCE S 00°51'10" E ALONG SAID EAST LINE FOR 700.00 FEET; THENCE N 88°52'55" E FOR 259.83 FEET TO THE POINT OF BEGINNING.

A TRACT OR PARCEL OF LAND SITUATED IN THE STATE OF FLORIDA, COUNTY OF LEE, BEING A PART OF DEEP LAGOON HEIGHTS, AN UNRECORDED SUBDIVISION LYING IN SECTION 29, TOWNSHIP 45 SOUTH, RANGE 24 EAST, AND FURTHER BOUNDED AND DESCRIBED AS FOLLOWS:

STARTING AT A CONCRETE MONUMENT MARKING THE SOUTHEAST CORNER OF THE SOUTHWEST ONE QUARTER (SW 1/4) OF SAID SECTION 29; THENCE S 88°53'00" W ALONG THE SOUTH LINE OF SAID SECTION 29 FOR 33.00 FEET TO AN INTERSECTION WITH THE WEST LINE OF A PUBLIC ROADWAY (66.00 FEET WIDE) AS SET FORTH IN THE COUNTY COMMISSIONER'S BOOK 5 AT PAGE 645 OF THE PUBLIC RECORDS OF SAID LEE COUNTY, THENCE N 01°02'07" W ALONG SAID WEST RIGHT OF WAY LINE FOR 169.00 FEET TO THE POINT OF BEGINNING; THENCE CONTINUE N 01°02'07" W ALONG SAID WEST RIGHT OF WAY LINE FOR 700.00 FEET; THENCE S 88°52'55" W FOR 259.83 FEET TO AN INTERSECTION WITH THE EAST LINE OF WILLEMS DRIVE (50.00 FEET WIDE); THENCE S 00°51'10" E ALONG SAID EAST LINE FOR 700.00 FEET; THENCE N 88°53'00" E FOR 262.06 FEET TO THE POINT OF BEGINNING.

A TRACT OR PARCEL OF LAND SITUATED IN THE STATE OF FLORIDA, COUNTY OF LEE, BEING A PART OF DEEP LAGOON HEIGHTS, AND UNRECORDED SUBDIVISION LYING IN SECTION 29, TOWNSHIP 45 SOUTH, RANGE 24 EAST, AND FURTHER BOUNDED AND DESCRIBED AS FOLLOWS: STARTING AT A CONCRETE MONUMENT MARKING THE SOUTHEAST CORNER OF THE SOUTHWEST ONE QUARTER (SW 1/4) OF SAID SECTIN 29; THENCE S 88°53'00" W ALONG THE SOUTH LINE OF SAID SECTION 29 FOR 33.00 FEET TO AN INTERSECTION WITH THE WEST LINE OF A PUBLIC ROADWAY (66.00 FEET WIDE) AS SET FORTH IN COUNTY COMMISSIONER'S BOOK 5 AT PAGE 645 OF THE PUBLIC RECORDS OF LEE COUNTY, THENCE CONTINUE S 88°53'00" W ALONG SAID SOUTH SECTION LINE FOR 262.60 FEET TO THE POINT OF BEGINNING. THENCE CONTINUE S 88°53'00" W ALONG SAID SOUTH SECTION LINE FOR 375.00 FEET TO AN INTERSECITON WITH THE EAST LINE OF MCGREGOR VISTA, A SUBDIVISION AS RECORDED IN PLAT BOOK 10 AT PAGE 45 OF SAID PUBLIC RECORDS; THENCE N 00°51'10" W ALONG SAID EAST LINE OF MCGREGOR VISTA FOR 119.00 FEET; THENCE N 88°53'00" E ALONG THE SOUTH LINE OF WILLEMS DRIVE (50.00 FEET WIDE) FOR 375.00 FEET; THENCE S 00°51'10" E FOR 119.00 FEET TO THE POINT OF BEGINNING.

LESS AND EXCEPT THAT PORTION THAT FALLS WITHIN THE FOLLOWING LEGAL DESCRIPTION:

LOT 41 OF DEEP LAGOON HEIGHTS, AN UNRECORDED SUBDIVISION, AS SHOWN IN OFFICIAL RECORDS BOOK 425, PAGE 139 IN THE SOUTHWEST 1/4 OF SECTION 29, TOWNSHIP 45 SOUTH, RANGE 24 EAST, AS PER PUBLIC RECORDS OF LEE COUNTY, FLORIDA.

BEING DESCRIBED AS FOLLOWS:

BEGIN AT THE SOUTHEAST CORNER OF SAID SOUTHWEST 1/4 OF SECTION 29, ALSO BEING THE SOUTHEAST CORNER OF SAID LOT 41; THENCE SOUTH 88°50'32" W, 320.30 FEET ALONG THE SOUTH BOUNDARY OF SAID SECTION 29 AND THE SOUTH LINE OF SAID LOT TO THE SOUTHWEST CORNER OF SAID LOT; THENCE ALONG THE WEST LINE OF SAID LOT THE FOLLOWING COURSES: N 01°03'35" W, 119.00 FEET; N 88°50'32" E, 25.34 FEET; N 00°53'26"W, 50.00 FEET TO THE NORTHWEST CORNER OF SAID LOT; THENCE N 88°50'32" E, 294.81 FEET ALONG THE NORTH LINE OF SAID LOT TO THE NORHTEAST CORNER OF SAID LOT AND THE EAST BOUNDARY OF SAID SOUTHWEST 1/4; THENCE SOUTH 01°03'35" E, 169.00 FEET ALONG SAID EAST BOUNDARY AND THE EAST LINE OF SAID LOT TO THE POINT OF BEGINNING.

INSTR # 2006000352113, Doc Type D, Pages 5, Recorded 09/11/2006 at 04:29 PM, Charlie Green, Lee County Clerk of Circuit Court, Deed Doc. D $3292.80 Rec. Fee $44.00 Deputy Clerk GWAITE

Prepared by:
James Farr, Esquire
Tri-County Title Agency
8860 College Parkway Suite 200
Ft. Myers, Florida 33919

File Number: 06FM0522

Special Warranty Deed

Made this August 11, 2006 A.D. By **BYRON SHINN, INDIVIDUALLY AND AS TRUSTEE OF THE J.V. ELROD TESTAMENTARY TRUST,** whose address is: 1001 3rd Avenue W., Suite 500, Bradenton, Florida 34205, hereinafter called the grantor, to **LEE COUNTY, A Political Subdivision of the State of Florida**, whose post office address is: P.O. Box 398, Fort Myers, Florida 99302, hereinafter called the grantee:

(Whenever used herein the term "grantor" and "grantee" include all the parties to this instrument and the heirs, legal representatives and assigns of individuals, and the successors and assigns of corporations)

Witnesseth, that the grantor, for and in consideration of the sum of Ten Dollars, ($10.00) and other valuable considerations, receipt whereof is hereby acknowledged, hereby grants, bargains, sells, aliens, remises, releases, conveys and confirms unto the grantee, all that certain land situate in Lee County, Florida, viz:

See Attached Exhibit "A"

Parcel ID Number: **32-45-24-01-000N0.0010 and 32-45-24-01-000O0.0010**

Subject to taxes for the current year, limitations, covenants, restrictions and easements of record, if any.

Together with all the tenements, hereditaments and appurtenances thereto belonging or in anywise appertaining.

To Have and to Hold, the same in fee simple forever.

AND the party of the first part hereby covenants with said party of the second part, that it is lawfully seized of said land in fee simple: that it has good right and lawful authority to sell and convey said land; that it hereby fully warrants the title to said land and will defend the same against the lawful claims of all persons claiming by, through or under the party of the first part.

In Witness Whereof, the said grantor has signed and sealed these presents the day and year first above written.

Signed, sealed and delivered in our presence:

Susan E. McLaughlin

Witness Printed Name Susan E. McLaughlin

Witness Printed Name ROBERT F. GREENE

Byron E. Shinn, Trustee

BYRON SHINN, INDIVIDUALLY AND AS TRUSTEE OF THE J.V. ELROD TESTAMENTARY TRUST

Address:

____________________(Seal)

Address:

State of Florida
County of Manatee

The foregoing instrument was acknowledged before me this ~~11~~ 10th day of August, 2006, by BYRON SHINN, INDIVIDUALLY AND AS TRUSTEE OF THE J.V. ELROD TESTAMENTARY TRUST, who is/are personally known to me or who has produced ________ as identification.

Notary Public

Print Name:__________
My Commission Expires:__________
(Seal)

ROBERT F. GREENE
Notary Public, State of Florida
My comm. expires June 12, 2010
Comm. No. DD532226
Bonded Thru RLI Insurance Company/Surety Division

EXHIBIT "A" PAGE 1 OF 4

PARCEL 1
A TRACT OF LAND LYING IN THE STATE OF FLORIDA, COUNTY OF LEE, IN SECTION 32, TOWNSHIP 45 SOUTH, RANGE 24 EAST, LYING IN HARLEM HEIGHTS SUBDIVISION AS RECORDED IN PLAT BOOK 8 PAGE 76 OF THE PUBLIC RECORDS OF LEE COUNTY, BEING MORE PARTICULARLY DESCRIBED AS FOLLOWS:

COMMENCING AT THE NORTHEAST CORNER OF SAID SECTION 32; THENCE S.01°15'51"E. ALONG THE EAST LINE OF SAID SECTION 32 FOR A DISTANCE OF 2,648.53 FEET TO THE SOUTHEAST CORNER OF THE NORTHEAST QUARTER OF SAID SECTION 32; THENCE CONTINUE ALONG THE EAST LINE OF SAID SECTION 32 S.01°02'26"E. FOR A DISTANCE OF 30.00 FEET TO THE NORTHEAST CORNER OF BLOCK "O" HARLEM HEIGHTS SUBDIVISION AS RECORDED IN PLAT BOOK 8 PAGE 76 OF THE PUBLIC RECORDS OF LEE COUNTY AND TO AN INTERSECTION WITH THE SOUTHERLY LINE OF THE IONA DRAINAGE DISTRICT RIGHT-OF-WAY; THENCE S.88°55'32"W. LEAVING SAID EAST LINE AND ALONG SAID SOUTHERLY RIGHT-OF-WAY FOR A DISTANCE OF 837.89 FEET TO THE POINT OF BEGINNING; THENCE S.14°31'42"E. LEAVING SAID SOUTHERLY RIGHT-OF-WAY FOR A DISTANCE OF 234.25 FEET; THENCE S.88°55'32"W. FOR A DISTANCE OF 234.25 FEET TO AN INTERSECTION WITH THE EASTERLY RIGHT-OF-WAY OF BIG SLEW CANAL; THENCE N.14°31'42"W. ALONG SAID EASTERLY RIGHT-OF-WAY FOR A DISTANCE OF 234.25 FEET TO THE NORTHWEST CORNER OF SAID BLOCK "O" OF HARLEM HEIGHTS AND TO AN INTERSECTION WITH THE SAID SOUTHERLY RIGHT-OF-WAY OF IONA DRAINAGE DISTRICT; THENCE N.88°55'32"E. LEAVING SAID EASTERLY RIGHT-OF-WAY AND ALONG SAID SOUTHERLY RIGHT-OF-WAY FOR A DISTANCE OF 234.25 FEET TO THE POINT OF BEGINNING.

PARCEL CONTAINS 53,367 SQUARE FEET OR 1.23 ACRES, MORE OR LESS.

PARCEL SUBJECT TO EASEMENTS, RESTRICTIONS, RESERVATIONS AND RIGHTS-OF-WAY (RECORDED AND UNRECORDED, WRITTEN AND UNWRITTEN)

Acquisition approved by the Lee County Board of Commissioners action on MAY 23, 2006
and accepted on behalf of the board by Paul R. Ehrnfelt **on** AUG. 11, 2006
in accordance with BS 20060526, AGA

PARCEL 2
A TRACT OF LAND LYING IN THE STATE OF FLORIDA, COUNTY OF LEE, IN SECTION 32, TOWNSHIP 45 SOUTH, RANGE 24 EAST, LYING IN HARLEM HEIGHTS SUBDIVISION AS RECORDED IN PLAT BOOK 8 PAGE 76 OF THE PUBLIC RECORDS OF LEE COUNTY, BEING MORE PARTICULARLY DESCRIBED AS FOLLOWS:

COMMENCING AT THE NORTHEAST CORNER OF SAID SECTION 32; THENCE S.01°15'51"E. ALONG THE EAST LINE OF SAID SECTION 32 FOR A DISTANCE OF 2,648.53 FEET TO THE SOUTHEAST CORNER OF THE NORTHEAST QUARTER OF SAID SECTION 32; THENCE CONTINUE ALONG THE EAST LINE OF SAID SECTION 32 S.01°02'26"E. FOR A DISTANCE OF 30.00 FEET TO AN INTERSECTION WITH THE SOUTHERLY LINE OF THE IONA DRAINAGE DISTRICT RIGHT-OF-WAY; THENCE S.88°55'32"W. LEAVING SAID EAST LINE AND ALONG SAID SOUTHERLY RIGHT-OF-WAY FOR A DISTANCE OF 1,257.91 FEET TO THE POINT OF BEGINNING; THENCE S.34°29'27"W. LEAVING SAID SOUTHERLY RIGHT-OF-WAY FOR A DISTANCE OF 324.55 FEET; THENCE S.88°55'33"W. FOR A DISTANCE OF 497.89 TO AN INTERSECTION WITH THE EASTERLY RIGHT OF WAY OF HAGIE DRIVE; THENCE N.01°03'46"W. ALONG SAID EASTERLY RIGHT-OF-WAY FOR A DISTANCE OF 264.01 FEET TO AN INTERSECTION WITH SAID SOUTHERLY RIGHT-OF-WAY OF IONA DRAINAGE DISTRICT; THENCE N.88°55'33"E. ALONG SAID SOUTHERLY RIGHT-OF-WAY FOR A DISTANCE OF 686.60 FEET TO THE POINT OF BEGINNING.

PARCEL CONTAINS 156,356 SQUARE FEET OR 3.59 ACRES, MORE OR LESS.

PARCEL SUBJECT TO EASEMENTS, RESTRICTIONS, RESERVATIONS AND RIGHTS-OF-WAY (RECORDED AND UNRECORDED, WRITTEN AND UNWRITTEN)

PARCEL 3
A TRACT OF LAND LYING IN THE STATE OF FLORIDA, COUNTY OF LEE, IN SECTION 32, TOWNSHIP 45 SOUTH, RANGE 24 EAST, LYING IN HARLEM HEIGHTS SUBDIVISION AS RECORDED IN PLAT BOOK 8 PAGE 76 OF THE PUBLIC RECORDS OF LEE COUNTY, BEING MORE PARTICULARLY DESCRIBED AS FOLLOWS:

COMMENCING AT THE NORTHEAST CORNER OF SAID SECTION 32; THENCE S.01°15'51"E. ALONG THE EAST LINE OF SAID SECTION 32 FOR A DISTANCE OF 2,598.53 FEET TO THE NORTH RIGHT-OF-WAY OF IONA DRAINAGE DISTRICT; THENCE S.88°55'32"W. ALONG SAID NORTHERLY RIGHT-OF-WAY FOR A DISTANCE OF 1,227.02 FEET TO AN INTERSECTION WITH THE WESTERLY RIGHT-OF-WAY OF BIG SLEW CANAL AND THE POINT OF BEGINNING; THENCE CONTINUE S.88°55'32"W. ALONG SAID NORTHERLY RIGHT-OF-WAY FOR A DISTANCE OF 722.47 FEET TO AN INTERSECTION WITH THE EASTERLY RIGHT OF WAY OF HAGIE DRIVE; THENCE N.01°03'12"W. ALONG SAID EASTERLY RIGHT-OF-WAY FOR A DISTANCE OF 45.53 FEET TO THE BEGINNING OF A CURVE TO THE RIGHT HAVING A RADIUS OF 307.03 FEET; THENCE ALONG SAID EASTERLY RIGHT-OF-WAY AND CURVE THROUGH CENTRAL ANGLE OF 38°27'02" AN ARC DISTANCE OF 206.04 FEET TO THE BEGINNING OF A REVERSE CURVE TO THE LEFT HAVING A RADIUS OF 367.03 FEET; THENCE ALONG SAID EASTERLY RIGHT-OF-WAY AND CURVE THROUGH A CENTRAL ANGLE OF 38°27'06" AN ARC LENGTH OF 246.32 FEET; THENCE N.88°56'48"E. ALONG SAID EASTERLY RIGHT-OF-WAY FOR A DISTANCE OF 5.00 FEET; THENCE N.01°03'12"W. ALONG SAID EASTERLY RIGHT-OF-WAY FOR A DISTANCE OF 96.90 FEET TO AN INTERSECTION WITH THE SOUTHERLY RIGHT OF WAY OF GLADIOLUS DRIVE; THENCE N.89°09'33"E. ALONG SAID SOUTHERLY RIGHT-OF-WAY FOR A DISTANCE OF 437.18 FEET TO THE NORTHEAST CORNER OF LOT 27, BLOCK "F" HARLEM HEIGHTS SUBDIVISION AS RECORDED IN PLAT BOOK 8 PAGE 76 OF THE PUBLIC RECORDS OF LEE COUNTY AND TO AN INTERSECTION WITH THE WESTERLY RIGHT-OF-WAY OF BIG SLEW CANAL; THENCE S.14°31'42"E. ALONG SAID WESTERLY RIGHT-OF-WAY FOR A DISTANCE OF 575.55 FEET TO THE SOUTHEAST CORNER OF LOT 16 BLOCK "H" OF SAID HARLEM HEIGHTS SUBDIVISION AND TO THE POINT OF BEGINNING.

PARCEL CONTAINS 321,253 SQUARE FEET OR 7.38 ACRES, MORE OR LESS.

PARCEL SUBJECT TO EASEMENTS, RESTRICTIONS, RESERVATIONS AND RIGHTS-OF-WAY (RECORDED AND UNRECORDED, WRITTEN AND UNWRITTEN)

EXHIBIT A PAGE 4 OF 4

PARCEL 4
A TRACT OF LAND LYING IN THE STATE OF FLORIDA, COUNTY OF LEE, IN SECTION 32, TOWNSHIP 45 SOUTH, RANGE 24 EAST, LYING IN HARLEM HEIGHTS SUBDIVISION AS RECORDED IN PLAT BOOK 8 PAGE 76 OF THE PUBLIC RECORDS OF LEE COUNTY, BEING MORE PARTICULARLY DESCRIBED AS FOLLOWS:

COMMENCING AT THE NORTHEAST CORNER OF SAID SECTION 32; THENCE S.01°15'51"E. ALONG THE EAST LINE OF SAID SECTION 32 FOR A DISTANCE OF 2,598.53 FEET TO THE NORTH RIGHT-OF-WAY OF IONA DRAINAGE DISTRICT; THENCE S.88°55'32"W. ALONG SAID NORTHERLY RIGHT-OF-WAY FOR A DISTANCE OF 250.17 FEET TO THE POINT OF BEGINNING; THENCE CONTINUE S.88°55'32"W. ALONG SAID NORTHERLY RIGHT-OF-WAY FOR A DISTANCE OF 840.13 FEET TO THE SOUTHWEST CORNER OF BLOCK "H" HARLEM HEIGHTS SUBDIVISION AS RECORDED IN PLAT BOOK 8 PAGE 76 OF THE PUBLIC RECORDS OF LEE COUNTY AND TO AN INTERSECTION WITH THE EASTERLY RIGHT-OF-WAY LINE OF BIG SLEW CANAL; THENCE N.14°31'42"W. ALONG SAID EASTERLY RIGHT-OF-WAY FOR A DISTANCE OF 575.70 FEET TO THE NORTHWEST CORNER OF SAID BLOCK "H" AND THE SOUTHERLY RIGHT-OF-WAY OF GLADIOLUS DRIVE AND A NON-TANGENT CURVE TO THE LEFT HAVING A RADIUS OF 1,195.92 FEET; THENCE ALONG SAID SOUTHERLY RIGHT-OF-WAY AND CURVE THROUGH A CENTRAL ANGLE OF 35°35'06" AN ARC DISTANCE OF 742.76 FEET, SAID CURVE HAVING A CHORD BEARING OF N.69°24'05"E. AND A CHORD DISTANCE OF 730.88 FEET, TO A POINT OF TANGENCY OF SAID CURVE; THENCE N.51°36'33"E. ALONG SAID SOUTHERLY RIGHT-OF-WAY FOR A DISTANCE OF 136.16 FEET; THENCE S.01°15'51"E. LEAVING SAID SOUTHERLY RIGHT-OF-WAY FOR A DISTANCE OF 336.71 FEET; THENCE S.88°55'32"E. FOR A DISTANCE OF 175.00 FEET; THENCE S.01°15'51"E. FOR A DISTANCE OF 550.00 FEET TO AN INTERSECTION WITH THE NORTHERLY RIGHT-OF-WAY OF IONA DRAINAGE DISTRICT AND THE POINT OF BEGINNING.

PARCEL CONTAINS 593,418 SQUARE FEET OR 13.62 ACRES, MORE OR LESS.

PARCEL SUBJECT TO EASEMENTS, RESTRICTIONS, RESERVATIONS AND RIGHTS-OF-WAY (RECORDED AND UNRECORDED, WRITTEN AND UNWRITTEN)

4.00 billed
.30
.55

971043

FEE SIMPLE DEED OFF. REC. 1174 PG 1304

RAMCO FORM 34

This Indenture *Made the* 30th *day of* November *A. D. 19* 76 *by*
V.H. Osborn , P.O.Box 10663, Tampa,Fla. 33609

hereinafter called the grantor, to Lee County,
a political subdivision of the State of Florida

whose postoffice address is P.O.Box 398, Ft. Myers,Fla. 33902

hereinafter called the grantee:

(Wherever used herein the terms "grantor" and "grantee" include all the parties to this instrument and the heirs, legal representatives and assigns of individuals, and the successors and assigns of corporations)

Witnesseth: *That the grantor, for and in consideration of the sum of $* 10.00 *and other valuable considerations, receipt whereof is hereby acknowledged, hereby grants, bargains, sells, aliens, remises, releases, and transfers unto the grantee, all that certain land situate in County, Florida, viz:*

The E½ of the E½ of Section 5, Township 46 South, Range 24 East, as recorded in the public records of Lee County in DB 263/474

RECORDED IN OFFICIAL RECORDS
LEE COUNTY, FLORIDA
DEC 27 1 34 PM '76
CLERK OF CIRCUIT COURT

STATE OF FLORIDA
DOCUMENTARY STAMP TAX
DEPT. OF REVENUE
LEE COUNTY
DEC 27 '76
P.B. 11229
= 00.30

DOCUMENTARY SUR TAX
FLORIDA
DEPT. OF REVENUE
LEE COUNTY
DEC 27 '76
P.B. 10828
= 00.55

Together *with all the tenements, hereditaments and appurtenances thereto belonging or in anywise appertaining.*

To Have and to Hold, *the same in fee simple forever.*

In Witness Whereof, *the said grantor has hereunto set* his *hand and seal the day and year first above written.*

Signed, sealed and delivered in our presence.

V.H. Osborn L.S.

L.S.

STATE OF FLORIDA Florida
COUNTY OF Hillsborough

I HEREBY CERTIFY that on this day, before me, an officer duly authorized in the State aforesaid and in the County aforesaid to take acknowledgments, personally appeared
V.H. Osborn
to me known to be the person described in and who executed the foregoing instrument and he acknowledged before me that he executed the same.

WITNESS my hand and official seal in the County and State last aforesaid this 12/1 day of A. D. 19 76

NOTARY PUBLIC STATE OF FLORIDA AT LARGE
MY COMMISSION EXPIRES APR. 27, 1977
BONDED THRU GENERAL INSURANCE UNDERWRITERS

This Instrument prepared by: Seena R. Givens
Address P.O.Box 398
Ft. Myers,Fla.33902

C. Murphy

FORM 1132 FLORIDA Fee Simple Deed

OFF. REC. 877 62 691258

This Indenture.

Wherever used herein, the term "party" shall include the heirs, personal representatives, successors and/or assigns of the respective parties hereto; the use of the singular number shall include the plural, and the plural the singular; the use of any gender shall include all genders; and, if used, the term "note" shall include all the notes herein described if more than one.

Made this *day of* November *A. D. 1972*

Between LESTER A. COGGINS and KATHERINE T. COGGINS, Husband and Wife; and J. WARD MILLER and SARA A. MILLER, Husband and Wife,

of the County of Lee *and State of* Florida
party of the first part, and

LEE COUNTY, a political subdivision of the State of Florida
of the County of Lee *and State of* Florida
party of the second part,

Witnesseth, *that the said party of the first part, for and in consideration of the sum of* TEN AND NO/100 -------------($10.00) and OGVC---- *Dollars, to him in hand paid, the receipt whereof is hereby acknowledged, has granted, bargained, sold and transferred, and by these presents does grant, bargain, sell and transfer unto the said party of the second part all that certain parcel of land lying and being in the County of* Lee *, and State of Florida, more particularly described as follows:*

The North Half (N 1/2) of the Northwest Quarter (NW 1/4) of the Northeast Quarter (NE 1/4), Section Five (5), Township Forty-six (46), Range Twenty-four (24).

LEE COUNTY 07077

FLORIDA DOCUMENTARY SUR TAX DEPT. OF REVENUE NOV28'72 P.B. 10528 55.00

FLORIDA STAMP TAX 5100

FLORIDA STAMP TAX 9900

Together *with all the tenements, hereditaments and appurtenances, with every privilege, right, title, interest and estate, dower and right of dower, reversion, remainder and easement thereto belonging or in anywise appertaining:*

To Have and to Hold *the same in fee simple forever.*

In Witness Whereof, *the said party of the first part has hereunto set his hand and seal the day and year above written.*

Signed, Sealed and Delivered in Our Presence:

Kathleen M. Bush — Lester A. Coggins

Katherine T. Coggins

J. Ward Miller

Sue Harris — Sara A. Miller

This Instrument was Prepared by Pavese, Shields, Garner, Haverfield & Kluttz, P. O. Drawer 1507, Fort Myers, Fla. 33902

By Frank A. Pavese

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State of Florida

County of LEE

I Hereby Certify That on this 15th day of November A. D. 1972, before me personally appeared Lester A. Coggins and Katherine T. Coggins, Husband & Wife; J. Ward Miller and Sara A. Miller, Husband and Wife,

to me known to be the person s described in and who executed the foregoing conveyance to LEE COUNTY, a political subdivision of the State of Florida,

and severally acknowledged the execution thereof to be their free act and deed for the uses and purposes therein mentioned.

Witness my signature and official seal at Fort Myers in the County of Lee and State of Florida, the day and year last aforesaid.

My Commission Expires ____________ Dorothy M. Gilbert

Notary Public

... AT LARGE ... 25, 1974

Deed

FEE SIMPLE

TO

Date

ABSTRACT OF DESCRIPTION

RECORDED IN OFFICIAL RECORDS LEE COUNTY, FLORIDA RECORD VERIFIED

NOV 28 10 17 AM '72

CLERK CIRCUIT COURT

BY ______ D.C.

PAVESE, WALDORF & SHIELDS
ATTORNEYS AT LAW
POST OFFICE DRAWER 1507
FORT MYERS, FLORIDA 33902

Appendix F: Expended and Projected Costs and Funding Sources

Expended Costs 2004-2017

Natural Resource Management		
Item	Funding Source	Costs
Exotic Plant Treatments	C20/20	In House
*Exotic Plant Treatments	Parks	$2,817.00
Contracted Exotic Plant Treatments	C20/20	$169,257.00
*Contracted Exotic Plant Treatments	Mitigation/Grants	$108,963.00
Contracted Exotic Plant Treatments	Grants	$153,150.00
Hydrologic improvements	Grants	$102,072.00
Hydrologic improvements	C20/20	$12,194.00
Consulting ecologist	C20/20	$67,335.00
Contracted Planting	C20/20	$2,560.00
	Total	**$618,348.00**

Building/Facility Maintenance		
Item	Funding Source	Costs
Contracted mowing	C20/20	$13,614.00
Building maintenance	C20/20	$2,435.00
Roof replacement & door rehab	MARS/Parks	$7,213.00
Electric	C20/20/Parks	$2,559.00
Water/Sewer	C20/20	$1,977.00
	Total	**$27,798.00**

Overall Protection		
Item	Funding Source	Costs
Fences and/or Firebreaks	C20/20	$63,137.00
Boundary survey	C20/20	$18,700.00
Debris Removal	C20/20	$765.00
	Total	**$82,602.00**

DLP Preserve Total Expended Cost To Date **$728,748.00**

***Exclusive to Cow Slough only**

Projected Cost Formulas

Natural Resource Management			
Item	Funding Source	Costs	Occurrences
Exotic Plant Treatments	C20/20	In House	30
Initial Contracted Exotic Plant Treatment	C20/20	$212,000.00*****	1
Exotic Plant Treatment Follow-ups	C20/20	$30,450.00	10
Mechanical Brush Reduction (In House)	C20/20	$24,000.00	3
Hydrologic / Habitat Improvement	C20/20	$225,000.00*****	1
Certified Pile burns (In House)	C20/20	$870.00	3

Building/Facility Maintenance			
Item	Funding Source	Costs	Occurrences
Maintenance Supplies (In House)	C20/20	$100.00	10
Contracted Facility Mowing	C20/20	$3,000.00	10
Annual Facility Maintenance & Utilities	C20/20 / MARS	$3,800.00	10

Overall Protection			
Item	Funding Source	Costs	Occurrences
Boundary Sign Replacement	C20/20	$20.00	3
Debris/Trash Removal	C20/20	$350.00	10
Fence Maintenance	C20/20	In House	10
Contracted Fence Installation	C20/20	$63,963.00*	1

Due to the timeframe of this management report, all associated management expenses have been projected over 10 years.

Total costs have been distributed evenly across a 10 year timeframe to generate a projected annual management expense of **$45,167.00 per year**.

Total projected management expense will be **$451,670.00 over 10 years.**

*****Total projected restoration expenses to occur within the timeframe of this plan will be **$212,000.00, $225,000.00, and $63,963.00 are not included in the annual management expenses.**