

Attachment B: Supporting Research

November 24, 2020

Research Review Phase of the IRC Lagoon Management Plan: Update 2

1. Ecosystem Functions and Habitat Use (Part 2)

The ecosystems, habitats, and organisms that make up the Indian River Lagoon all play a unique and important role in the health and sustainability of the Lagoon. All of these elements interconnect to create the biodiverse environment of the Lagoon. As human populations continue to grow and expand, this unique environment faces numerous challenges to its long-term sustainability. This update will focus on mangroves, spoil islands and their importance to bird populations, and species of concern within the County's portion of the Lagoon.

Mangrove fringes along the Lagoon's shoreline are common throughout the County. Studies have shown that mangrove communities support the protection of barrier islands against tidal and wave forces. There are three main types of mangroves: red mangroves, black mangroves, and white mangroves. Red mangroves are typically found growing at or a little above mean sea level, black mangroves are found growing in the upper portions of the intertidal zone, and white mangroves are found growing on higher ground where the soil is seldom flooded. Buttonwood trees are commonly associated as mangroves, but they are not true mangroves. They are often found adjacent to mangroves, and have become the unofficial fourth type of mangrove. Mangroves act as one of the most productive plant communities, supporting high level of animal diversity in a monoculture community. This is due to the complex structures and microhabitats that makeup mangroves. Root structures create nursery and shelter for most of the commercial and recreational fish species in the state. High quality seagrass beds are often found adjacent to mangrove fringes along the shoreline. Mangroves also act as important nutrient sinks in estuaries by removing nutrients from the water, such as nitrogen and phosphorus.

Mangroves are susceptible to natural and human-induced impacts. Since the beginning of the 1900's, Florida has lost approximately 125,000 acres of mangrove forest to waterfront development and mosquito impoundments. Cutting mangroves and dredge and fill projects for development severely damage mangrove forests. Another factor is the manipulation of water management practices. Mangroves rely on a mixture of saltwater and freshwater to grow, and alterations in natural freshwater flow regimes affects the salinity balance and encourages exotic vegetation growth. Florida Fish and Wildlife Conservation Commission estimated the Lagoon as a whole has lost 85% of its mangrove forest. However, most of the mangroves that do remain are located within Indian River County. Agencies in the County actively work to purchase Lagoon-front land in order to keep it natural and prevent it from being developed. Unfortunately, due to human waste, mangroves act as traps for trash, monofilament, and other marine debris that can harm wildlife. Education, enforced regulation, and biodegradable options need to occur to placate the impacts of human actions on the success and growth of mangroves. Sea level rise and warming temperatures are other obstacles mangroves must face. Mangroves will shift inland as their habitat changes and depending on the location of development and/or seawalls, may not have room to retreat inland. Major hurricanes also damage mangroves. Mangroves act as a buffer between the water and land and during hurricanes may be sheared by the storm and/or smothered by accumulation of soil or organic matter over the roots.

The County should continue its measures to protect and sustain its mangrove fringed shorelines of the Lagoon through education and following regulation. FDEP regulates the trimming of mangroves. They have mangrove trimming guidance which explains what is allowed without a permit, and anything beyond that requires a permit for major trimming activities, with fines in place for property owners who do not follow these regulations. Residents should continue to be educated on the importance of mangroves not only for the environment, but also for the protection of shorelines and adjacent property. The County should discourage the placement of hardened structures along the Lagoon's shoreline in order to provide these mangroves with areas to encroach on in order to combat rising water levels. The County should also continue to use mangroves in their living shoreline projects as a method of protecting the shoreline, and encourage and educate Lagoon-front homeowners to do the same as well. Mangrove fringes contribute to the uniqueness of the County, and we should continue to set an example for other areas about the benefits of our unique characteristics.

Compared to other estuaries around Florida, the Lagoon is also unique because of its spoil islands. Spoil islands were created in the 1940s and 1950s by the dredging of the Intracoastal Waterway (ICW) through the Lagoon. The excess materials dredged, known as spoil, was used to supplement natural islands and/or used to create new islands. These islands created out of "waste" material are now important habitat for native species. The Lagoon has numerous spoil islands in its entirety, most of which are owned by the state and managed by the Indian River Lagoon Aquatic Preserves Office (IRLAP) of the Florida Department of Environmental Protection (FDEP). The County has 104 spoil islands in its portion of the Lagoon. These spoil islands are designated as public or private, and are further designated for conservation or recreational use. Conservation islands are islands with special protection because of the benefits they serve to the conservation of important Lagoon species. Boaters should honor the no access signs posted on these islands. People trampling nests and dogs are major threats for bird populations using these conservation islands. Recreation islands are islands used for human recreation, such as picnicking or camping, and boaters are encouraged to clean up after themselves after visiting and enjoying these islands in the Lagoon.

Spoil islands serve as important ecological communities for the Lagoon. They are utilized by various types of invertebrates, reptiles, birds, and mammals, with a cover of vegetation. Spoil islands also support the majority of bird rookeries in the Lagoon system. Within the County, there are various islands with associated productive bird rookeries. One is located at the mouth of the North Relief Canal, one is located at the mouth of the South Relief Canal, and the others are located within the Pelican Island National Wildlife Refuge. It is believed these are not random selections, and that the mouths of the relief canals provide a source of food for the birds. These rookeries are utilized by different state and federally protected bird species. Bird surveys are conducted by the IRLAP office monthly during breeding season, which ranges from March 1st to August 31st. Surveys continue to confirm the productivity of these two canal-based islands as rookeries. Pelican Island National Wildlife Refuge was established in 1903 with over 10,000 pelicans counted during peak nesting season. To this day, more than a dozen species nest on Pelican Island with approximately 100 nesting pairs of pelicans present.

However, spoil islands across the Lagoon are facing numerous threats that are harming bird populations. Spoil islands are prone to erosion because of boat activity and strong storms across the

Lagoon. Islands tend to be erosional on the sides facing the ICW, with accretion occurring on the opposite side of the island. Increasing water levels also contribute to the receding shores of the islands. As water levels rise, low elevation islands become consumed by the water, leaving very little parts, if any, above the water and available for use. Another obstacle to continued productive birding populations is invasive, exotic vegetation. Many spoil islands within the County contain a mixture of native vegetation and invasive vegetation, especially Brazilian pepper and Australian pine. Surveys have shown that most bird species prefer to nest on native vegetation. While some weedy generalist bird species (such as white ibis, cattle egret, and cormorants) will utilize invasive plants for their nesting habitat, this is not typical for the majority of birds found within the Lagoon. As invasive plants outcompete mangroves and other native vegetation on islands, birds will have to find other areas to nest. Nesting areas for these coastal birds have already been constantly changing because of various pressures such as coastal development and food availability. Initially, many of these birds nested on the beach prior to the occurrence of major coastal development. After development, they then moved to the spoil islands of the Lagoon. Recent bird surveys show that these bird populations are now starting to nest on rooftops of businesses and homes because of increased pressures. Loss of habitat and human influences have greatly altered the options for prime nesting habitat for many coastal birds. Finally, monofilament line, primarily used in fishing, is a huge threat to bird populations. Birds can become entangled in the monofilament which prohibits their abilities to fly and eventually leads to a slow death. Within the County, Sebastian Inlet State Park is a very popular fishing area. Surveys have shown that bird deaths related to monofilament entanglement are observed in greater and more frequent quantities on the spoil islands adjacent to the state park when compared with other islands further away. If an angler hooks a bird or a bird becomes entangled in the fishing line, best practices are to reel the bird in an attempt to untangle it instead of cutting the line which will ultimately lead to the bird's death as well as the possibility of other birds to become entangled in the excess line. Anglers are encouraged to utilize Florida Fish and Wildlife Conservation Commission's (FWC) Monofilament Recovery and Recycling Program to discard damaged or used line, which can be found near popular boating and fishing areas on the shoreline of the County.

Based on the information above, the County should continue to work with the IRLAP and FWC teams in order to protect spoil islands and the birding populations that utilize them. Education to visitors and boaters to the Lagoon about visiting the spoil islands and the different designations they have would benefit this habitat. Surveys conducted show that many boaters do not realize that the spoil islands are actively managed and owned by IRLAP and that there are various rules that apply to them. In this effort, the County should support and assist the IRLAP in getting this important message out. The County does manage certain spoil islands throughout the Lagoon. The County is being proactive by consulting with shorebird experts to recommend ways staff can create and provide sustainable shorebird habitat on these conservation areas, such as Lost Tree Island. The County should also encourage the education of anglers on the dangers of monofilament to birds, as well as to other Lagoon organisms. The importance of these monofilament recycling stations and what to do if a bird becomes entangled in monofilament should be highlighted county-wide. Boaters and anglers need to be encouraged and reminded to pick up after themselves and not leave behind any of their debris. The County should look into projects related to protecting spoil islands from erosion, while also promoting biological diversity and integrity. One example of the County working to restore spoil islands can be seen at Lost Tree Island. Parts of the area were restored through the removal of exotic species from portions of the islands, which allows for native

species to re-colonize. Portions have also been re-vegetated with a mixture of native upland and wetland plant species. While removing invasive species and replanting native vegetation is one option, this option can become very expensive with continued monitoring and mass quantities of water needed to ensure viability of these new plants. One alternative option would be to restore the hydroperiod to an island by conducting island scraping and invasive plant removal. St. Lucie County utilized this option as a mitigation project for their spoil island, SL-15, and had very successful results when it came to increased biological diversity and native restoration. However, this option is also very costly and requires numerous studies of various parameters in order to best prepare for project viability and success. Finally, the County should work on promoting and pushing for the designation of IR-26B and IR-37 as Critical Wildlife Areas (CWAs). CWAs are designated by FWC, protected by Florida Administrative Code (FAC), and are closed to public access with the ability for enforcement. These two islands within the County are proven productive and successful rookery locations, including locations for threatened and listed birds, and would benefit from increased protection and regulation.

There are various types of large fauna that play an important role as umbrella species for the overall health of the Lagoon and well-being for other organisms. Visitors come from all over to view manatees, dolphins, and sea turtles that utilize the Lagoon, which contributes to the local economy. Dolphins, manatees, and (some species of) turtles are federally protected species. All of these organisms have experienced habitat degradation because of development around the Lagoon. They each face threats from pollutants of emerging concerns, including pollution ranging from antibiotics to thermal pollution. As a popular boating area, these organisms also can suffer from boat strikes, which is why it is important for boaters to follow speed zones designated throughout the Lagoon. Harmful algal blooms and cold water temperatures also affect these animals, with increased mortality rates correlated to such events.

Numerous dolphin populations live in the Lagoon year-round and show site fidelity, which means they typically stay in the portions of the Lagoon throughout their lives, ranging an average of 17 miles. Health differences have been observed in these populations in relation to the portion of the Lagoon they reside, north versus south. Dolphins found in the northern portions of the Lagoon, the Mosquito Lagoon area and Banana River area, are found to have far greater health issues when compared to dolphins in the southern portions of the Lagoon and the St. Lucie Estuary area. Research conducted recently studied how diseases affecting dolphins are related to potential environmental stressors, such as harmful algal blooms, and how they serve as an early warning system of changes that could affect animal and human health. This study began in 2003 and was a collaborative effort between Florida Atlantic University (FAU) Harbor Branch, Georgia Aquarium, and the National Oceanic and Atmospheric Administration (NOAA) National Ocean Service Center for Coastal Environmental Health and Biomolecular Research. This study is known as the Health and Environmental Risk Assessment (HERA). Another concern for these populations is connected to contaminants of emerging concern. These contaminants do not have assigned regulatory standards and have recently been “discovered” in waters because of improved testing methods. While they may not be new contaminants, their impacts and significance are only now being studied because they were not part of routine monitoring parameters. A recent study conducted by FAU found that of 733 tissue samples taken from dolphins in the Lagoon, 88% were found to contain bacteria resistant to at least one antibiotic, with the most common being erythromycin, which is a drug used in human and veterinary

medicine. The increasing level of antibiotic resistance bacteria found in these dolphins mirror trends seen in human healthcare, and this study highlights the impact human antibiotic use is having on the aquatic environment.

According to statewide manatee surveys conducted by FWC, over 3,000 manatees were observed to be utilizing the Lagoon. Manatee mortality statistics are collected by FWC and have been monitored since 1947 for the County. Mortality rates peaked in 2010, with 55 recorded manatee deaths within the County. Most deaths were caused by cold stress, perinatal factors, or undetermined factors because of high decomposition rates. Recent studies have shown that as manatee populations grow, boat strikes are becoming the leading cause of death around the state. Manatee populations within the County are dependent on a variety of natural and human factors, including location of preferred foraging habitat, adequate water depth, location of deep waters adjacent to feeding areas, freshwater sources, water temperature, and availability of quiet areas. A manatee population study found the most prevalent place for manatees within the County is the St. Sebastian River.

As of 2000, the County created a Manatee Protection and Boating Safety Comprehensive Management Plan with revisions occurring in 2002 and 2004. This plan was specified under Policy 1.7 of the 2010 Comprehensive Plan Coastal Management Element. Since its adoption, additional objectives and policies that address the general aspects of manatee protection, boating safety, and marina facility siting have been incorporated. The Community Development Department of the County predominantly uses this plan to review proposals for new or expanded facilities for multi-slip docking in conjunction with FWC guidelines. As Lagoon conditions have changed, manatee listed status has changed, and more data have been collected, it may be beneficial for the County to complete reoccurring updates to its Manatee Protection Plan to reflect the most current information available. The County should also continue to support FWC in their studies of manatee populations and dynamics within the Lagoon. The County should continue to educate boaters and visitors about the importance of manatees within the Lagoon, and should encourage the regulation of designated manatee speed zones for their protection and potential inclusion of new ones as deemed appropriate by FWC.

Sea turtles that typically frequent the County consist of loggerheads, leatherbacks, and green sea turtles. The Lagoon provides food and protection for juveniles of these species. The most predominant juvenile species found in the Lagoon are green turtles. Juvenile green sea turtles consume seagrasses and algae, making the Lagoon an ideal feeding area. Sea turtles commonly suffer from tumors known as fibropapillomatosis. These tumors affect a turtle's abilities to swim, which can eventually lead to starvation. Pollution likely worsens the tumor's impacts, with indications that presence and growth of these tumors can be correlated to warm water and poor water quality. Research has found that approximately half the green sea turtles in the Lagoon suffer from these tumors, whereas loggerheads in the Lagoon show a much lower rate. In comparison, studies show approximately 22% of green sea turtles suffer from these tumors statewide. This study also found that while the percentage of juveniles impacted is greater in the Lagoon, the growth rates of these juveniles were still larger than in other comparison areas around southeast Florida. It is believed this is because the Lagoon provides more feeding opportunities and quantities when compared to other areas in Florida.

Like other large fauna of the Lagoon, factors related to disease, boat activity, human development, and natural phenomenon contribute to the stranding of sea turtles in the area. Stranding data collected from FWC and the County show an increasing trend in the number of reported inshore strandings. Whether this increasing trend is from an increase in public education and awareness on the procedures of reporting a stranded turtle or from an actual increase in the number of stranded turtles each year has not been determined. It is also important to note that there is often a bias in the locations of the reported strandings as they are often reported in areas more heavily used by the public. Whether this correlates to the areas being more prone to strandings because of human influences, such as boat strikes, because they are more popularly visited areas, or because the public uses these areas more, so a stranded turtle is more likely to be found and reported is inconclusive. The County does play an interactive part in FWC's stranding network. The recovery of a stranded turtle does require authorization under a FWC permit, which the County actively keeps up each year. The County also has a Habitat Conservation Plan for the protection of sea turtles; however, this plan relates to sea turtles found on beaches, and does not directly address sea turtle populations and statistics from the Lagoon. The County should continue to use education and awareness measures to educate the public on the implications of their actions on sea turtle populations within the Lagoon and the importance of using smart boating techniques when enjoying the Lagoon. The County should also continue to collect stranding data on inshore turtles to understand how trends develop over time and continue to educate the public on the proper protocols to take when a stranded turtle is observed.

The Lagoon is home to not only marine turtles, but also other aquatic turtles. Diamondback terrapins are one of the important species of aquatic turtle that utilizes the Lagoon. Diamondback terrapins are indicator species in that they are sensitive to habitat loss and utilize many critical habitats throughout the Lagoon, so when populations decline, this serves as an indicator of declining conditions. Some of the major threats to this species are boat propellers and crab traps. IRLAP surveys terrapin populations, threats, and conservation efforts to understand what these organisms can tell us about the Lagoon. Scientists are unsure how many terrapins remain in the wild, but with ongoing surveys from various organizations, it is hoped that we will soon better understand current populations and status.

2. Harmful Algal Blooms

The Indian River Lagoon is home to a wide variety of algal communities that exist relatively unnoticed under healthy conditions. Once the Lagoon becomes imbalanced due to inflow of freshwater, nutrient inputs, etc., an imbalance can occur causing certain algal species to grow unchecked. These stressors from the environment and excessive growth of algal communities can potentially release toxins into the waters that may be detrimental to the health of the Lagoon. Some of these stressors stem from increasing nutrients in the water such as nitrogen and phosphorus, changing land use practices, development, and issues related to climate change. Not only do these blooms have the potential to harm communities within the Lagoon's ecosystem, the toxins they can produce also has negative impacts on human health and the economy because of impacts to recreational fishing and tourism. Harmful algal blooms are temporary events, and can occur in saltwater, freshwater, or brackish water bodies.

Algal blooms are created through the combination of various factors. Algal blooms are typically experienced after a prolonged dry period followed by periods of rain. This rain increases the freshwater flow in the Lagoon, which brings with it nutrients from the land. Blooms typically occur in warmer months as well, so the combination of eutrophic conditions with warm waters is often a driver for these to occur. Unlike other areas within the Lagoon system, Indian River County sits in an area of the Lagoon with more consistent flushing from the inlets, leading to shorter residence times for polluted waters in the system. Lagoon areas to the north have prolonged residence times, which allow polluted waters to sit longer in the system before they are able to mix with seawater from an inlet or are able to flush out from new freshwater sources. Areas to the south have shorter water residence times, but are affected by releases from Lake Okeechobee when water levels become too high in the lake. While the County still has its fair share of algal bloom concerns, our geographic location acts as a benefit when dealing with the risk and impacts of algal blooms.

Studies conducted by the University of Florida over a ten-year time period show that different sections of the Lagoon are impacted differently by the species of algal blooms produced and the amounts of nutrients received. The County's portion of the Central Lagoon, which ranges from the Sebastian Inlet to the Fort Pierce Inlet, receives consistent freshwater inflow from rivers and canals, with more of an agricultural influence than the northern portions, which includes the Banana River and areas of the main stem of the Lagoon north of the Sebastian Inlet. This study however found that Central Lagoon algal blooms were not tied to periods of high rainfall, but instead, were associated with expanding human development and population growth. In the Central Lagoon, total phosphorus levels were more of a driver of blooms when compared to total nitrogen levels present in the water. However, the opposite was found to be true in the northern portion of the Lagoon. Within the Central Lagoon, strategist species within the phytoplankton community, which are opportunistic species of small size and high growth rates, were found to be favored.

Nutrient limitation also plays an important part in the creation and growth of algal blooms. A nutrient is considered limiting when the addition of that nutrient, or combination of nutrients, results in significantly greater growth rates compared to control samples. Studies showed that the presence of surplus bioavailable nutrients at the time of sampling increased growth rates in the control sample when compared to the initial control sample that did not have excess bioavailable nutrients present. Studies of nitrogen to phosphorus ratios conducted within the County show that our portion of the Lagoon is potentially nitrogen limited, which differs from study areas in the northern portion of the Lagoon, which were found to be potentially phosphorus limited. This study also showed that these northern portions are more susceptible to algal blooms forming at faster rates since excess nutrients do not need to be available in the water over a long period in order for a bloom to occur.

These algal blooms also have a tremendous effect on dissolved oxygen concentrations in the Lagoon. During the day, algal species produce oxygen through photosynthesis. At night, dissolved oxygen levels reduce as no sunlight present results in no photosynthesis. As the algae dies off, it drops to the Lagoon floor, decomposes, and consumes oxygen. This die off can occur from a combination of high cloud cover resulting in reduced photosynthesis and an increase in biological oxygen demand resulting from

decaying algae on the Lagoon's floor. As the algae dies off, a crash in the Lagoon system's dissolved oxygen levels may result.

While algal blooms have occurred throughout history in the Lagoon, one of the most noteworthy blooms was the 2011 Superbloom. This bloom occurred from the southern Banana River to just north of the Fort Pierce Inlet. The previous five years leading up to the bloom were dry years with little rainfall. Water conditions in the Lagoon had atypically high salinity levels and high Chlorophyll A concentrations. This superbloom acted as a tipping point from an environment dominated by benthic aquatic vegetation to a community dominated by planktonic microalgae. The years following 2011 were characterized by intense, recurring, and long-lasting algal blooms; widespread loss of seagrasses; and episodic wildlife mortality events. Shellfish populations were stressed, accumulating toxins and creating the risk for shellfish poisoning if consumed. Large-scale marine mortality occurred, with widespread fish kills in the area. The biodiversity of the system is threatened when algal blooms occur because the presence of these algal communities and the toxins they produce make life unsustainable for other organisms. The 2011 Superbloom exceeded documented past harmful algal bloom events in terms of geographic scale, bloom intensity and duration, and rate and magnitude of seagrass loss. To this day, the Lagoon still has not recovered seagrass populations back to the scale seen before this massive bloom.

The County does have a "Harmful Algal Bloom Response Plan," which sets objectives, potential partners, and response actions for the County in the face of a harmful algal bloom event. These response actions include cleanup efforts, public messaging, and sampling. This plan was created in response to the red tide events of Fall 2018 that impacted the County's beaches. It was last updated in November 2018 and primarily refers to actions taken during a beachside harmful algal bloom event. This plan should be updated regularly with inclusion of lagoon-side harmful algal bloom events and responses.

There are numerous agencies at various government levels that monitor and disseminate information about harmful algal blooms in Florida. Illness reports may be obtained by the public through the Florida Department of Health (FDOH), Florida's Poison Controls Centers and hospitals, and by subscribing to FWC's Red Tide Weekly Report and FDEP's Blue-Green Algae Weekly Reports. Areas that may have potential impacts can be found using NOAA's website (<https://oceanservice.noaa.gov/hazards/hab/>) and Mote Marine's Beach Conditions Reporting System website (<https://mote.org/research/program/environmental-health/beach-conditions-report-red-tide-information>). FDOH maintains a searchable database of bloom records and acts a helpful indicator of HABs in Florida (<http://www.floridahealth.gov/environmental-health/aquatic-toxins/public-access-caspio>). Conditions of beaches, lakes, and rivers may be found through FWC's website (<https://myfwc.com/research/saltwater/health/>). Local harvesting statuses may be found using the Florida Department of Agriculture and Consumer Services (FDACS) website (<https://www.fdacs.gov/Agriculture-Industry/Aquaculture/Shellfish/Shellfish-Harvesting-Area-Maps>). Status reports on HABs in Florida may be found using FDEP's website (<https://floridadep.gov/AlgalBloom>), the Fish and Wildlife Research Institute's (FWRI) website (<http://www.floridahealth.gov/environmental-health/aquatic-toxins/documents/habs-technical-guide.pdf>), and the Mote Marine's Beach Conditions Report website (<https://mote.org/research/program/environmental-health/beach-conditions-report-red-tide-information>). Finally, the Center for Disease Control and Prevention website

(<https://www.cdc.gov/habs/index.html>) may provide more health and safety information on HABs. To report human illnesses caused by HABs, both FDOH (850-245-4401) and Florida's Poison Control Centers (1-800-222-1222) have hotlines to obtain this information. Fish kills may be reported to FWC's hotline (1-800-636-0511) and red tide or blue-green algae blooms may be reported to FDEP's hotline (855-305-3903).

Understanding algal blooms is a complex web of understanding nutrient flux dynamics, diurnal flux in dissolved oxygen, and the role of legacy nutrients within a system, with many researchers devoting their studies to better understanding this complexity. The long-term impacts of these blooms and their toxicities, as well as the interactions of trophic levels and the effects on naturally managing blooms, are also not well understood. Harmful algal blooms can occur and be carried into the Lagoon through outside sources, such as ocean currents, stormwater discharges, or freshwater discharges, so studying these blooms requires looking beyond the Lagoon itself. In the meantime, algal communities should be monitored to predict and prevent harmful algal blooms from growing unchecked. Residents and the County should work to reduce nutrients from external and internal sources to decrease the concentrations that fuel these blooms. Continued research should be encouraged into understanding the causes and impacts of blooms, short and long term. The County should continue to participate in forums and discussions with other agencies about harmful algal blooms, and should continue to update the Harmful Algal Bloom Management Plan as new information arises and be prepared implement this plan if faced with new blooms in the future.

3. State and Regulatory Review of Rules

State and Regulatory Rules play a major role in regulating the levels and sources of nutrients the Lagoon receives from upland sources. Within the County, the Utilities Department and Stormwater Division have to follow various rules and permit conditions to minimize nutrient impacts from their projects and their plants. These permits may require nutrient information to be collected and submitted on various timescales to permitting agencies. State and Regulatory Rules also play a major role in protecting the biological and ecologically diverse habitats of the Lagoon, attempting to ensure viability for these important organisms and ecosystems to survive.

The Clean Water Act (CWA) of 1972 set the federal foundation to implement pollution control programs and develop national water quality criteria for surface water pollutants. Phase II of the CWA requires the County to implement programs and practices to control polluted stormwater runoff, through the requirements of National Pollutant Discharge Elimination System (NPDES) permits. These permits are administered through the Florida Department of Environmental Protection (FDEP), with the County required to record certain information during each permit year and submit yearly reports to FDEP. Environmental Resource Permits (ERPs) can be administered through FDEP and St. Johns River Water Management District (SJRWMD). These permits are issued for activities that alter natural water flow or increase the quantity of stormwater runoff and are intended to prevent adverse flooding, manage surface water, and protect water quality, wetlands, and other surface waters during new development or construction activities. The County is able to review these permits before they are issued to the permittees. Portions of the Lagoon are considered an Outstanding Florida Water, which means regulated activities permitted through ERPs within the Lagoon cannot adversely impact the waters, and must be

activities not contrary to the public interest. Other than federal and state rules and regulations, the County has several local ordinances that discuss or reference stormwater runoff:

Title II – Taxes, Utilities and Special Districts: Chapter 200 – Municipal Service Taxing or Benefit Unit, Part III - Stormwater; *Title III – Police Power Ordinances:* Chapter 316 – Fertilizer and Land Management; Chapter 318 – Illicit Stormwater Discharge; *Title IX – Land Development Regulations:* Chapter 901 – Definitions; Chapter 904 – Nonconformities; Chapter 910 – Concurrency Management System; Chapter 911 – Zoning; Chapter 912 – Single Family Development; Chapter 913 – Subdivisions and Plats; Chapter 914 – Site Plan Review and Approval Procedures; Chapter 915 – Planned Development (P.D.) Process and Standards for Development; Chapter 917 – Accessory Uses and Structures; Chapter 926 – Landscape and Buffer Regulations; Chapter 927 – Tree protection and Land Clearing; Chapter 928 - Wetlands and Deepwater Habitat Protection; Chapter 930 – Stormwater Management and Flood Protection; Chapter 931 - Wellfield and Aquifer Protection; Chapter 932 – Coastal Management; Chapter 934 – Excavation and Mining; Chapter 954 – Off-Street parking; and Chapter 971 – Regulations for Specific Land Uses.

Along with local County ordinances, a special permit is required if an ERP area requires discharge into the Indian River Farms Water Control District’s canals. This permit is known as an “Application for Connection to or use of District Facilities” with required approval from IRFWCD.

One of the major rules and regulations the County must adhere to in regard to protecting Lagoon water quality is FDEP’s Total Maximum Daily Loads (TMDLs). Using information provided from years of studies conducted by SJRWMD, and in accordance with the CWA, FDEP determined that Lagoon waters within the County were impaired by nitrogen and phosphorus concentrations, which has resulted in decreased seagrass coverage in the Lagoon. As a result, a Secretarial Order added these waters to the Verified List of Impaired Waters for the Lagoon Basin on December 12, 2007. After an impaired water designation, a TMDL is established for each pollutant identified to reduce pollutant loadings with the hope of restoring the waterbody. A TMDL represents the maximum amount of a pollutant that a surface water can absorb and still meet the established water quality standards that protect human health and aquatic life. TMDLs for nutrients and dissolved oxygen for the Indian River Lagoon and Banana River Lagoon were adopted by FDEP in March 2009. Nutrient loading targets were established using a three-fold approach. First, regulators established the full-restoration target for seagrass coverage. This target, and nutrient targets, were based on segment-specific seagrass depth limits, and the relationship between seagrass depth limits and model-simulated Total Nitrogen (TN) and Total Phosphorus (TP) loadings. The median seagrass depth target was established at 1.2 meters – 1.7 meters for the Central IRL segments. Second, regulators established the relationship between seagrass depth limit and TN and TP loadings from point and nonpoint sources. Finally, regulators established TN and TP targets based on a 10 percent deviation (shoreward) from the seagrass full-restoration targets and the relationship between seagrass depth limit and nutrient loadings. Based on these test runs, lagoon-wide TN target loading was established at 3.34 lbs/ac/yr and TP target loading was established at 0.546 lbs/ac/yr. Central IRL TN target loading was established at 2.90 lbs/ac/yr and TP target loading was established at 0.574 lbs/ac/yr. According to 62-304.520(8) Florida Administrative Code (F.A.C.), the Central and southern South Lagoon was defined to have TMDLs of 278,273 lbs/year of TN and 53,599 lbs/year of TP. After a TMDL is established, Basin

Management Action Plans (BMAPs) are created, which act as blueprints for restoring impaired waters by requiring the reduction of pollutant loadings to meet the allowable loadings established in a TMDL. BMAPs represent a set of strategies designed to implement the pollutant reductions established in the TMDL.

On June 27, 2018, FDEP adopted a Final Verified List of Impaired Waters for the Group 5 Basins, which includes the County's portion of the Lagoon. Portions of the County's Lagoon are now listed as impaired for copper, iron, and fecal coliform bacteria (in addition to nitrogen and phosphorus). The Lagoon south of State Road 60 is considered impaired by copper (concentrations greater than 3 µg/L) and fecal coliform bacteria (concentrations exceed shellfish evaluation and assessment section thresholds). The Lagoon north of State Road 60 is considered impaired by iron (concentrations greater than 0.3 mg/L). Both of these sections are designated as Class 2 Waterbodies – Shellfish Propagation or Harvesting waters. TMDL allocations for these parameters have not yet been determined.

The County falls within the Indian River Lagoon: Central Indian River Lagoon BMAP, initially adopted in February 2013, which implements TMDLs for the regulation of TN and TP into the central portion of the Lagoon. This area covers approximately 476,469 acres that ultimately drain to the Lagoon. Principal sources of pollution were identified from agriculture, municipal separate storm sewer systems (MS4), point source facilities (like domestic and industrial wastewater facilities), and stormwater sources (like cities, towns, and water control districts). At the time the BMAP was implemented for the Central IRL, no assigned allocations were determined based on FDEP's evaluation. A two-step process was used to assess progress in the IRL Basin towards the median seagrass depth limit target. FDEP conducted this evaluation using seagrass data from 2003, 2005, 2006, 2007, and 2009. All project zones within the Central IRL were found to be compliant with their two-step evaluation process, meaning stakeholders in this area were not required to make additional reductions at the that time. The BMAP was initially anticipated to cover a five-year period but has not been updated since its adoption in 2013. Any projects completed during this time period were not considered requirements of the BMAP. The County completed various Lagoon improvement projects since 2013, even though it was not a regulatory requirement of them.

Since the BMAP's creation, FDEP has been in communication with the County about their intentions to set new, updated BMAP allocations for the County to follow. This effort has especially picked up since early 2020, with FDEP's push forward of new allocations using a new modeling system. Updates are forthcoming on the amounts of nitrogen and phosphorus the County will be expected to remove from waters before they reach the Lagoon. The revised BMAP will have some changes from what was completed in previous BMAPs. In addition to the model being used to determine allocations being different from what was previously used, the BMAP boundaries have been modified to better match the specific model boundaries. The results produced from the model are supposed to take into account acreages and loading estimates, which will produce the reduction requirements for each entity involved in the BMAP area. FDEP has the authority to regulate these amounts and can enforce penalties if they are not met by each entity. The BMAP is further broken down into project zones, with the County falling into Project Zones B, SEB, and SIRL. In Project Zone B, as of the most recent **draft** allocation numbers, the County has a required reduction of 165,800 lbs/yr of TN and 21,562 lbs/yr of TP. In Project Zone SEB, as of most recent draft allocation numbers, the County has a required reduction of 44,893 lbs/yr of TN and

8,087 lbs/yr of TP. In Project Zone S1RL, as of most recent draft allocation numbers, the County has a required reduction of 2 lbs/yr of TN and 1 lbs/yr of TP. This brings the County's total reductions to 210,695 lbs/yr of TN and 29,649 lbs/yr of TP, well in excess of the initial numbers discussed during TMDL development under the previous model.

FDEP's statewide ruling on biosolids is currently under revision and has the potential to impact the health of the Lagoon through surface water and groundwater transport of excess nutrients. FDEP is developing these amendments to ensure the proper management, use, and land application of biosolids to protect waters of the state from nutrient pollution, and in a manner that minimizes the migration of nutrients to prevent the impairment of waterbodies. Draft revisions include changes to the nutrient management plans (NMP), which includes updates to the criteria used for determining biosolids application rates, descriptions on how it complies with any applicable BMAPs, requirement for (at least) annual soil fertility testing, provisions for septage application rates, and annual requirements to review NMPs and make revisions as applicable. These draft revisions also include changes to monitoring, record keeping, reporting, and notification of biosolid application. These changes include methods for water extractable phosphorus (WEP), required monitoring of WEPs in biosolids, required soil fertility testing to use the "Phosphorus Index" test provided by the University of Florida's Institute of Food and Agricultural Services (IFAS) Extension Lab, revised groundwater monitoring requirements, and the inclusion of surface water monitoring for sites next to surface waters. The draft revisions also include changes to the requirements for land application of biosolids, which includes prohibition of land application on soils having a seasonal high water table less than 15 cm from soil surface or within 15 cm of the intended depth of biosolids placement. Finally, the changes included some septage provisions, and provisions related to the public interest of biosolid permit applications. However, these changes still allow local governments to keep existing biosolid ordinances, so it is recommended that the County continue their moratorium on the land application of biosolids in order to protect the Lagoon.

With an update effective as of July 1, 2020, Senate Bill 712, "The Clean Waterways Act," takes a step towards protecting water quality and conserving natural resources in the state by minimizing impacts of known sources of nutrient pollutions. This update provides changes to protocols for the following topics: onsite sewage treatment and disposal systems, wastewater treatment, stormwater, agriculture, biosolids, fines and penalties, water quality monitoring, bottle water, and golf courses. The updates from this bill are as follows:

- Onsite sewage treatment and disposal systems
 - Transfers the Onsite Sewage Program from the Department of Health (DOH) to FDEP starting in 2021, with a temporary advisory committee
 - Requires local governments to create septic remediation plans for areas falling within certain BMAPs
 - Fast tracks the approval process for nutrient reducing septic systems
 - Revises provisions relating to septic system setback rules
- Wastewater treatment
 - Requires local governments to create wastewater treatment plans for certain BMAP areas

- Creates a wastewater grant program to provide grants for projects within BMAP areas, with alternative restoration plans, or in rural areas of opportunities
- Prioritizes funding for certain wastewater projects in the grant program
- Starting July 1, 2025, it prohibits wastewater treatment facilities from discharging into the Lagoon without providing advanced waste treatment
- Imposes new requirements on wastewater facilities and FDEP to prevent sanitary sewer overflows and underground pipe leaks
- Stormwater
 - Requires FDEP to:
 - Update its stormwater design and operations rules and Environmental Resource Permit Applicant's Handbook
 - Make revisions to its local pollution control staff training
 - Evaluate the self-certification process for the construction, alteration, and maintenance of a stormwater management system
 - Revise the model stormwater management program
- Agriculture
 - Requires the Florida Department of Agriculture and Consumer Services (FDACS) to perform onsite inspections at least every 2 years for agricultural producers enrolled in best management practices (BMPs)
 - Must be prioritized for producers in the BMAPs for Lake Okeechobee, the Indian River Lagoon, the Caloosahatchee River and Estuary, and Silver Springs
 - Creates a cooperative agricultural regional water quality improvement element as part of a BMAP where agriculture is a significant source of pollution
 - Projects included in this area could include conservation easements and dispersed water management
 - Requires FDACS to annually develop research plans and legislative budget requests to address agricultural runoff
- Biosolids
 - Requires enrollment in FDACS's BMP program
 - Prohibits the application of Class A or Class B biosolids within 6 inches of the seasonal high water table, unless a nutrient management plan and water quality monitoring plan provides reasonable assurances that the application will not cause or contribute to water quality violations
 - Permits must comply with the statute within 2 years and with FDEP's biosolids rule within 2 years of it being effective
 - Allows local governments to keep existing biosolid ordinances
- Fines and penalties
 - Doubles the fines for wastewater violations
 - Increases the cap on total administrative penalties that may be assessed by FDEP
- Water quality monitoring program
 - Requires FDEP to establish a real-time water quality monitoring program
- Bottled water

- Requires FDEP to conduct a study on the bottle water industry in the state
- Golf Courses
 - Requires FDEP to work with IFAS and regulated entities to consider the adoption by rule of BMPs for nutrient impacts from golf courses
 - Requires FDEP to complete rulemaking to implement several provisions and imposes numerous reporting requirements

The County will continue to provide input to the FDEP during applicable rulemaking workshops in order to provide specific input in regard to protecting the County's resources and minimizing nutrient impacts from known nutrient sources. Continued communication with FDEP is necessary until a final BMAP allocation is determined to ensure the County is appropriately represented throughout the process. The County should also continue its active awareness and required changes necessary stemming from the passing of Senate Bill 712. While most of these changes impact organizations at the state-level, the County will still feel some impacts from these updates throughout various departments. While the County may not always have a large role in the creation or updates to the rules and regulations, the County should continue to have as much awareness and involvement as possible so that necessary inputs may be expressed as these rules and regulations are created and evolve. The County should also continually update its own rules and regulations in regard to Lagoon protection and the permitting process so that this resource is properly protected to the best extent possible from development and changes for future generations.

4. Total Nitrogen and Total Phosphorus

Nitrogen and phosphorus concentrations are essential in the Lagoon in order to have a productive and diverse ecosystem. Organisms need these nutrients to survive in their habitats and are required for certain life processes, at the proper ratios. This ratio is known as Redfield's Ratio, which states that the ratio of carbon to nitrogen to phosphorus should be 106:16:1. These two nutrients receive a bad reputation in relation to the Lagoon because excess amounts of them can push the Lagoon system out of balance. These sources of nutrients stem from point sources and non-point sources and typically result from human development and expansion.

Nitrogen is essential for plants and animals, but too much of it can damage aquatic environments. Excessive amounts of nitrogen in waterbodies can create algae blooms and result in low dissolved oxygen levels, and harm plants and other living organisms. Nitrogen in the water comes from a variety of sources, such as phytoplankton, bacteria, and fertilizer. Sewage, erosion, and stormwater runoff can also increase nitrogen levels in the water, especially in areas with high levels of development. As aquatic life decays, it can add nitrogen back into the system. Nitrogen in water is commonly reported as total nitrogen. Total nitrogen is the sum of Total Kjeldahl Nitrogen (TKN) and nitrate+ nitrite nitrogen ($\text{NO}_x\text{-N}$). TKN is the sum of the organically bound nitrogen (such as amino acids) and ammonia nitrogen. Ammonia and nitrate are considered the forms available for direct biological uptake, and these are the forms of nitrogen that can be detrimental in high concentrations, leading to the formation of harmful algal blooms. Ammonia is one of the main sources of nitrogen that can be found in wastewater, but proper wastewater treatment methods remove the majority of ammonia concentrations before discharge. Various types of bacteria will

reduce certain forms of nitrogen to simpler forms – for example, ammonia is converted to nitrite nitrogen which is easily converted to nitrate nitrogen; the nitrogen in nitrate may be further reduced to nitrogen gas. The concentration of reduced forms of nitrogen in the ecosystem may also negatively impact ecosystem health, with excess amounts becoming toxic to certain plant species and leading to shortages of usable nitrogen in the ecosystem.

Phosphorus occurs naturally in soils, rocks, and organic matter, and it is a nutrient required for basic life processes. High concentrations in surface waters may indicate the presence of fertilizer runoff, discharge from wastewater treatment facilities or septic tanks, industrial chemicals, or detergents. Total phosphorus is the sum of inorganic phosphorus (dissolved orthophosphate), dissolved organic phosphorus compounds, and particulate phosphorus. In water quality samples, TP is mostly made up of orthophosphate concentrations. In water, phosphorus can be dissolved or be present as a particulate. It is important to take into account both dissolved and particulate concentrations because both can have an impact on water quality. Particulate phosphorus includes living and dead plankton, precipitates of phosphorus, and phosphorus adsorbed to particulates. Dissolved phosphorus can be organic phosphorus or inorganic phosphorus. Organic phosphorus is generally formed by biological processes and is bound to plant and animal tissues. It can occur from sewage and the breakdown of organic pesticides that contain phosphorus. Organic phosphorus can be soluble, present as loose fragments, or in bodies of aquatic organisms.

Most areas of the Lagoon are sensitive to sudden influxes of nutrients and other pollutants because of the location of the inlets. The areas further from inlets depend on wind-driven circulation patterns to circulate water. The areas to the north have much longer residence times compared to areas in the central and southern portions of the Lagoon. According to the IRLNEP Comprehensive Conservation and Management Plan, the residence times in northern areas are in the range of 148 days to 3 days, in the central areas are in the range of 12 days to 1 day, and in the southern areas average about 16 days for water to flow through each specific area. Since the County has an inlet to the north and to the south, our waters are classified more as tidal-driven circulation than wind-driven circulation, and we have much lower residence times because of the location of the inlets. Residence times in Vero are approximately 10 days, and residence times in Sebastian are approximately 5 days. Nutrients in the Lagoon have been increasing from historical values because of increasing population growth and human development. Atmospheric deposition has also contributed to increasing TN concentrations in the Lagoon because of an increase in natural and human-made sources. Human-made sources include the burning of fossil fuels and agricultural activities. Natural sources include lightning (which increases the deposition of nitrogen in rainwater during the summer season), natural burns (such as wildfires), and microbial activities. Atmospheric deposition sources can be local sources, stationary sources, or mobile sources (such as automobiles). Assessing the impacts atmospheric deposition have on nutrient levels in the Lagoon is difficult since the process by which air pollution is transferred to water bodies and the watershed which surround them are not well understood, but Brevard County has estimated that approximately 19% of TN concentrations and 3% of TP concentrations in the Lagoon can be attributed to atmospheric deposition.

Seagrasses act as a good indicator species of excess nutrients. However, seagrasses do require certain levels of nitrogen and phosphorus in order to grow and survive, so completely depleting these

concentrations is not a realistic goal to have. Studies have shown that seagrass growth is limited by the amount of nutrients in the water compared to carbon concentrations in their environment. There is reasonable evidence to indicate that there is a lower limit to the nutrient content needed for seagrass survival, meaning seagrass cannot grow and survive without appropriate levels of nitrogen and phosphorus in their ecosystem. It is difficult to determine critical nutrient concentrations required for seagrass growth since this will vary among species and with changes in growth conditions.

Studies of tributaries conducted throughout the Lagoon system show that within the Central Indian River Lagoon area, the Sebastian River produces the highest annual loadings of TN and TP into the central Lagoon basin. This is believed to be caused by the rapid increase in human population growth and activities throughout the Sebastian River drainage basin. Another source for TN and TP concentrations comes from groundwater seepage from the surficial aquifer. Seepage rates are variable throughout the Lagoon and vary spatially and temporally across the Lagoon’s basin. Finally, nutrient flux rates, or the rate of transfer of nutrients from sediments to the water, vary based on materials present on the Lagoon’s floor. One study found that muck fluxes for nitrogen can be 3,372% greater when compared to nitrogen fluxes from sandy sediments. Similarly, phosphorus fluxes from muck can be 1,566% more when compared to phosphorus fluxes from sandy sediments.

The County has three major stormwater canals that transfer runoff and stormwater from within the County, out to the Lagoon. The canals are situated with one in the northern portion of the County, one in the central portion of the County, and one in the southern portion of the County. The County began sampling water from the Indian River Farms Water Control District’s Main Relief Canal, North Relief Canal, and South Relief Canal on May 22, 2014. Water samples are collected weekly in each canal near their crossing under U.S. Highway 1. At these locations, additional downstream stormwater input into the canals is considered negligible. All three canals discharge directly in the Lagoon, and collectively, represent the majority of groundwater and stormwater flow into the Lagoon. In general, except after heavy rainfall events, the nutrients remain relatively low. Average results from May 22, 2014 through July 22, 2020 are listed below:

Average Nitrogen and Phosphorus Levels in IRFWCD Relief Canals (May 22, 2014 through July 22, 2020)

Parameter	North Relief Canal	Main Relief Canal	South Relief Canal
Nitrate/Nitrite Nitrogen (mg/L)	0.27	0.19	0.19
Total Kjeldahl Nitrogen (mg/L)	0.73	0.66	0.71
TN (mg/L)	0.99	0.85	0.89
TP (mg/L)	0.17	0.11	0.12

The U.S. Geological Surveys (USGS) maintains monitoring stations on each of the Relief Canals. The stations do not record all canal flows, but can give an indication of the average canal flows over various time periods. From 2014 through 2018, the approximate average flows in million gallons per day (MGD) in the three Relief Canals were:

- North Relief Canal = 28.3 MGD
- Main Relief Canal = 45.0 MGD
- South Relief Canal = 39.7 MGD

The average pounds of nutrients discharged into the Lagoon per year can be estimated using the data above as:

- North Relief Canal = 85,287 pounds/year of TN and 14,645 pounds/year of TP
- Main Relief Canal = 116,437 pounds/year of TN and 15,068 pounds/year of TP
- South Relief Canal = 107,557 pounds/year of TN and 14,502 pounds/year of TP

The County has undertaken some regional scale nitrogen and phosphorus reducing projects such as Osprey Acres, Osprey Marsh, Spoonbill Marsh, and Egret Marsh. It is estimated that the County removes approximately 80,170 pounds/year of TN and 12,123 pounds/year of TP from reaching the Lagoon through these facilities. The County should continue to promote and expand education efforts surrounding the removal of excess nutrients, such as the continuation of the fertilizer ordinance, the education of residents to be mindful of storm drains and the impacts of what goes down them, and Florida Friendly Yards. The County is proactive in removing excess nutrients, with the continued creation and completion of projects aimed at lessening the load of nutrients from wastewater and stormwater. These projects can be costly, so the County should continue to pursue grants in order to help fund these initiatives.

Once the runoff enters into the Lagoon, various water quality monitoring stations from different entities track water quality trends measured. Some of these entities include Florida Atlantic University’s Harbor Branch, Ocean Research & Conservation Association (ORCA), SJRWMD, and FDEP. The data measured by these entities are available on their respective websites. Using SJRWMD data, average nutrient levels for 2020 data collected thus far are listed below:

Average Nitrogen and Phosphorus Levels Measured in the Lagoon by SJRWMD (January 2020 through July 2020)

Parameter	IRLIRJ01 – North	IRLIRJ04 – Central	IRLIRJ08 – South
Total Kjeldahl Nitrogen (mg/L)	0.41	0.51	0.47
TP (mg/L)	0.05	0.08	0.06

As stated earlier, the County currently does not have a set value from FDEP on the mass of nitrogen and phosphorus that can be discharged into the water and still maintain a healthy ecosystem. For these reasons, the County currently relies on the numeric nutrient criteria set for the peninsular region of Florida by FDEP. Using this rule, TN concentrations should not exceed 1.54 mg/L and TP concentrations should not exceed 0.12 mg/L.

One area that may benefit the County, and is currently lacking, is monitoring of groundwater nutrient concentrations. This information would not only benefit the County, it would also be pertinent to regulatory agencies in setting nutrient criteria. Whether this should be a task the County takes on or state-level regulatory agencies take on is undetermined. The County would also benefit from studying legacy loading to the Lagoon and understanding how many excess nutrients are being added to the system from historical uses surrounding the Lagoon area. The County should continue to support the Indian River Lagoon National Estuary Program (IRLNEP) in their studies about atmospheric deposition. Atmospheric deposition is starting to be studied at a greater extent, and these studies will hopefully add to the knowledge base of this subject. Finally, it is important for the County to continue to partner and support other entities within the Lagoon basin. Nutrients do not recognize municipal or county boundaries, and the reduction of excess nutrients throughout the system as a whole will benefit the health and prosperity of organisms in the Lagoon.

5. Land Use Changes (Part 2)

In order to develop a parcel of land within the County, various permits and approvals must be obtained from different levels of government. These permits cover numerous topics, but one important topic needing approval is for the management of stormwater as it changes with changing land use. The management of stormwater is important in the Lagoon's watershed to make sure pollutants and excess nutrients have time to filter and settle out of the water before eventually making its way into the Lagoon. The County regulates stormwater runoff through local ordinances and the issuance of stormwater management system permits for construction projects administered through the Public Works Engineering Division, Land Development section.

The County's Stormwater Management and Flood Protection Ordinance (Chapter 930) was created to protect the health, safety, and welfare of the citizens of the County; to implement those policies and objectives found in the drainage sub-element of the County's comprehensive plan; to ensure protection of land and improvements together with natural resources through the use of responsible stormwater management and flood protection practices; to ensure replenishment of the County's aquifer systems to provide a continuing usable water supply; to reduce stormwater pollutant loading of the Lagoon; and to provide proper flood management. There are three types of stormwater permits that may be obtained at the County level: Type A (stormwater management system), Type B (flood protection-stormwater management system), and Type C (flood management system). Type A encompasses projects not located in flood hazard zones, whereas Types B and C encompass projects in flood hazard zones. In general, lands east of U.S. 1 throughout the County are located in flood hazard zones, as well as areas west of U.S. 1 located between C.R. 512 and S.R. 60. These permits require the submittal of various hydraulic data and calculations in order to ensure that they meet local ordinances for protection. Once received by the County, staff review the application and plans with other applicable permitting agencies, and with the

engineer of the project to ensure appropriate nutrient levels are being removed via retention times and to ensure proper water volumes are being treated by the stormwater system.

State water quality standards established by the FDEP are set forth in chapters 62-4, 62-302, 62-520, and 62-550, F.A.C. These standards are regulated at the state-level review process for permits. Surface and groundwater discharges from stormwater management systems, works, and other projects may not cause or contribute to a violation of state water quality standards. Once the loading is set by the state, County reviewers determine if the treatment is appropriate for the levels needing to be obtained. The engineer of the project determines how much water needs to be held by the stormwater system to reach these levels, and communicates this as part of the County's permit application. County reviewers will communicate back-and-forth with the engineer until adequate revisions have been made based on these calculations.

The County should continue to enforce and update its stormwater management-related ordinances as new practices and technologies emerge. The County should also continue working relationships with state reviewers to ensure proper nutrient removal levels and practices are achieved throughout the permitting process as state rules and regulations change. It is important to maintain flood prevention not only for buildings and for homes, but also to reduce the amount of runoff that flows into the canals before having adequate time for nutrients to settle. Excess, untreated stormwater can be detrimental to the Lagoon, so it is especially important to issue, maintain, and verify compliance for these permits throughout their lifecycles to protect and positively impact the quality of the Lagoon.