Draft Save Our Indian River Lagoon Project Plan 2023 Update for Brevard County, Florida

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Brevard COUNTY

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- Florida Department of Health
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- Space Coast Tourism Development Council
- St. Johns River Water Management District
- Brevard County Budget Office
- Brevard County Natural Resources Management Department
- Brevard County Property Appraiser Information Technology
- Brevard County Utility Services Department
- City of Melbourne
- City of Palm Bay
- City of Titusville
- City of West Melbourne

Executive Summary

The Indian River Lagoon (IRL) system includes Mosquito Lagoon, Banana River Lagoon, and Indian River. This is a unique and diverse system that connects Volusia, Brevard, Indian River, St. Lucie, Martin, and Palm Beach counties. The IRL is part of the National Estuary Program, one of 28 estuaries of National Significance, and has one of the greatest diversity of plants and animals in the nation. A large portion of the IRL system, 71% of its area and nearly half its length, is within Brevard County (County) and provides County residents and visitors many opportunities and economic benefits.

However, the balance of this delicate ecosystem has been disturbed as development in the area has led to harmful impacts. Stormwater runoff from urban and agricultural areas, wastewater treatment facility discharges, septic systems, and excess fertilizer applications have led to harmful levels of nutrients and sediments entering the lagoon. These pollutants create cloudy conditions in the lagoon and feed algal blooms, both of which negatively affect the seagrass community that provides habitat for much of the lagoon's marine life. In addition, these pollutants lead to muck accumulation, which releases (fluxes) nutrients and hydrogen sulfide, depletes oxygen, and creates a lagoon bottom that is not hospitable to seagrass, shellfish, or other marine life.

Efforts have been ongoing for decades to address these sources of pollution. Despite significant load reductions, in recent years signs of human impact to the IRL system have been magnified. In 2011, the "superbloom" occurred, an intense algal bloom in the Mosquito Lagoon, Banana River Lagoon, and North IRL, as well as a secondary, less intense bloom in the Central IRL. There have also been recurring brown tides; unusual mortalities of dolphins, manatees, and shorebirds; and large fish kills due to low dissolved oxygen from decomposing algae.

Local governments and the St. Johns River Water Management District have been proactive in implementing projects over the last several decades. However, to restore the lagoon to health and prosperity, additional funds were needed to eliminate current excess loading and remove the legacy of previous excess loading. Therefore, the County placed a Save Our Indian River Lagoon 0.5 cent sales tax referendum on the ballot in November 2016, which passed and is providing a funding stream for the types of projects listed in this plan for Brevard County and its municipalities.

The Save Our Indian River Lagoon Project Plan outlines local projects planned to meet water quality targets and improve the health, productivity, aesthetic appeal, and economic value of the lagoon. Implementation of these projects is contingent upon funding raised through the 0.5 cent sales tax. This sales tax funding also allows the County to leverage additional dollars in match funding from state and federal grant programs because the IRL ecosystem is valued not only in Florida but also nationally. Funding implementation of this plan would help to restore this national treasure. Lagoon ecosystem response may lag several years behind completion of nutrient reductions; however, major steps must begin now to advance progress on the long road to recovery.

In the development of this plan, Subject Matter Experts were consulted to provide feedback on the plan elements. The experts all agreed that there is a "critical mass" of nutrient reductions that must be achieved to see a beneficial result in the IRL. This critical level of nutrient reduction will be achieved through the implementation of the projects in this plan. During plan development, it was estimated that the benefit of restoring the lagoon has a present value of $6 billion and a cost of $300 million. Therefore, implementing this plan to restore the IRL is an excellent investment in the future of Brevard County's community and economy with a benefit to cost ratio of 20:1.

To restore the lagoon's balance, Brevard County seeks to accelerate implementation of a multi-pronged approach to **Reduce** pollutant and nutrient inputs to the lagoon from fertilizer and grass clippings, reclaimed water from wastewater treatment facilitates, sprayfields and rapid infiltration basins, package plants, sewer laterals, septic systems, and stormwater; **Remove** the accumulation of muck from the lagoon bottom; **Restore** water-filtering oysters and clams and related lagoon ecosystem services; and monitor progress to **Respond** to changing conditions, technologies, and new information by amending the plan to include actions that will be most successful and cost-effective for significantly improving IRL health, productivity, and natural resilience.

The portfolio of projects in this plan were selected as the most cost-effective suite of options to achieve water quality and biological targets for the lagoon system. Investment has been distributed among a set of project types with complementary benefits to reduce future risk of failure. Approximately 59% (originally one-third) of the effort and expense is split among multiple projects to reduce incoming load to healthy levels. Approximately 36% (originally two-thirds) of the effort and expense is directed toward muck removal to address decades of past excess nutrient loading. Nitrogen and phosphorus released each year as muck decays are now larger than any current source of nutrient pollution to lagoon waters. Less than 5% of tax revenues go towards restoring natural filtration systems; measuring the success of different project types; and responding to new information, technologies, and opportunities with annual plan updates.

The plan projects have been prioritized and ordered to deliver improvements to the lagoon in the most beneficial spatial and temporal sequence so that the implementation of this plan is expected to result in a healthy IRL system. If a future project is ready to move forward earlier than scheduled in the plan, if such advancement is consistent with temporal sequencing goals in the plan and is recommended by the Citizen Oversight Committee, and if there are sufficient Trust Fund dollars available, the County Manager (for budget changes less than $100,000) or Brevard County Commission have the authority to adjust the project schedule at any time to ensure that approved projects funded in the plan move forward as soon as feasible.

This 2023 Update to the Save Our Indian River Lagoon Project Plan contains the seventh set of project updates, new approved projects, and schedule modifications to the plan. Local stakeholders submitted projects annually to Brevard County for inclusion in the plan. The appointed Citizen Oversight Committee reviewed the submitted projects and made a recommendation to the Board of County Commissioners on which projects should be added to the Save Our Indian River Lagoon Project Plan. This update includes those projects that were reviewed by the Citizen Oversight Committee and approved for inclusion by the Board of County Commissioners.

The timing of the projects is shown in **Figure ES-1**. A summary of the types of projects included in the plan, as well as the associated costs and total nitrogen (TN) and total phosphorus (TP) reductions in pounds per year are shown in **Table ES-1**. Despite the considerable cost of restoration, analysis demonstrates that the economic cost of inaction is double the cost of action. Furthermore, although there are many tangible and intangible benefits for saving the lagoon, the readily estimated return on investment for three benefits – tourism, waterfront property values, and commercial fisheries – is approximately 10% to 26%.

Figure ES-1: Save Our Indian River Lagoon Project Implementation Schedule

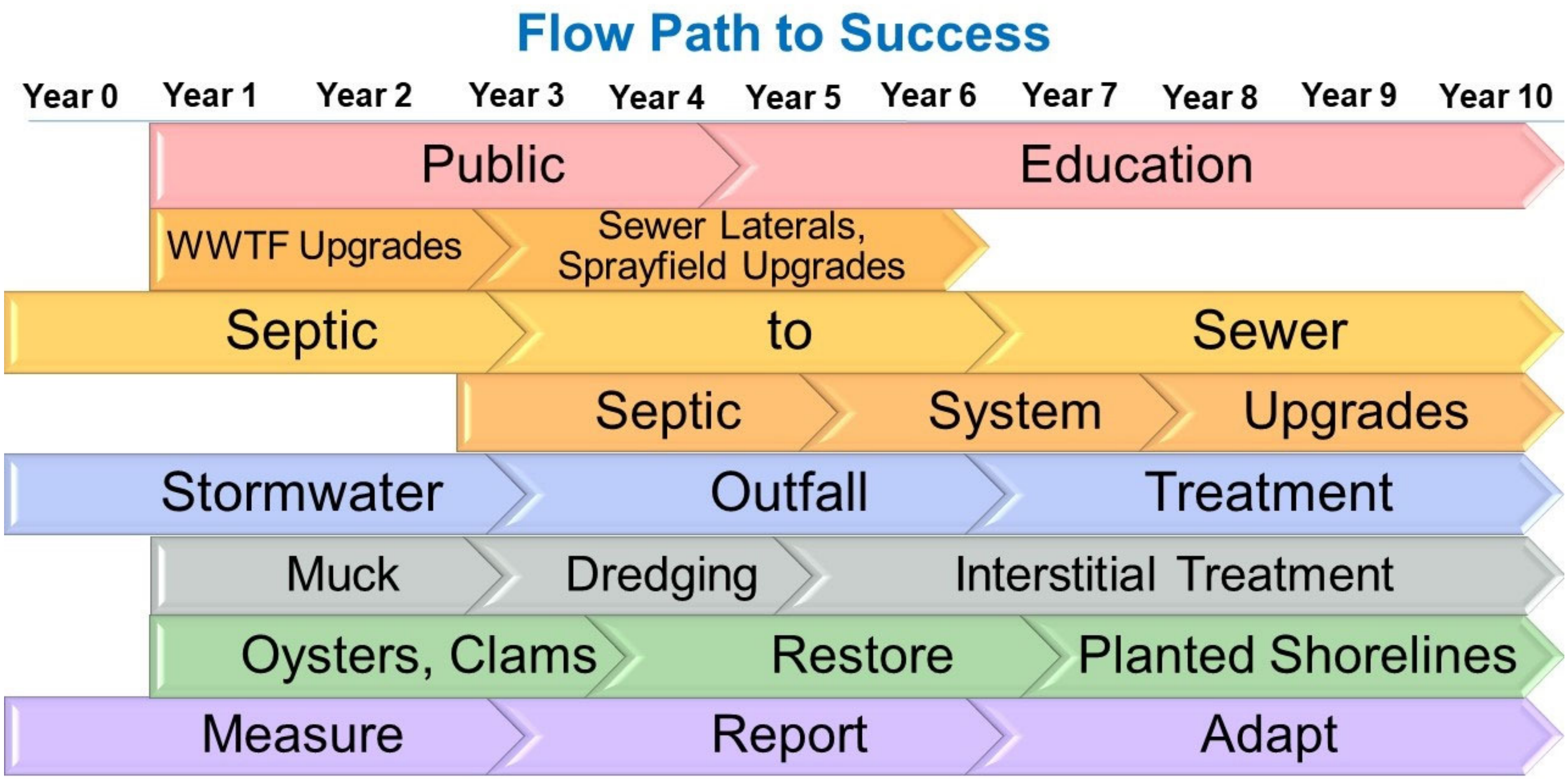


Table ES-1: Summary of Project Types, Costs, and Nutrient Reductions in the 2023 Update of the Save Our Indian River Lagoon Project Plan

Project Category	Project Type	Estimated Total Project Cost	Nitrogen Reductions (pounds per year)	Average Cost per Pound per Year of Total Nitrogen	Phosphorus Reductions (pounds per year)	Average Cost per Pound per Year of Total Phosphorus
Reduce	Public Education	$3,530,000	33,709	$105	2,413	$1,463
Reduce	Wastewater Treatment Facility Upgrades for Reclaimed Water	$28,417,223	74,139	$383	14,623	$1,943
Reduce	Rapid Infiltration Basin/Sprayfield Upgrades	$82,207	317	$259	To be determined	To be determined
Reduce	Package Plant Connection	$2,016,627	1,442	$1,398	To be determined	To be determined
Reduce	Sewer Lateral Rehabilitation	$1,454,498	6,196	$235	188	$7,737
Reduce	Septic-to-Sewer by Extension	$120,686,169	96,119	$1,256	To be determined	To be determined
Reduce	Septic-to-Sewer by Connection	$11,200,379	21,446	$522	To be determined	To be determined
Reduce	Septic System Upgrades	$29,243,590	37,981	$770	To be determined	To be determined
Reduce	Stormwater Projects	$65,821,520	271,713	$242	37,658	$1,748
Reduce	Vegetation Harvesting	$2,243,689	33,111	$68	3,944	$569
Remove	Muck Removal	$113,627,049	223,229	$509	18,210	$6,240
Remove	Treatment of Muck Interstitial Water	$46,977,065	484,332	$97	28,605	$1,642
Restore	Oyster Bars	$9,809,545	24,699	$397	780	$12,576
Restore	Planted Shorelines	$130,560	544	$240	186	$702
Restore	Clam Restoration	$60,000	1,000	$60	To be determined	To be determined
Respond	Projects Monitoring	$10,000,000	-	-	-	-
Respond	Contingency	$20,559,808	-	-	-	-
Respond	Inflation	$120,655,652	-	-	-	-
Total	***Total***	***$586,515,581***	***1,309,977***	***$448 (average)***	***106,607***	***$5,502 (average)***

Section 1. Background

The Indian River Lagoon (IRL) system includes Mosquito Lagoon, Banana River Lagoon, and Indian River. A large portion of the IRL system, 71% of its area and nearly half its length, is within Brevard County (County) and provides County residents and visitors many opportunities.

However, the balance of this delicate ecosystem has been disturbed as development in the area has led to harmful impacts. Stormwater runoff from urban and agricultural areas, wastewater treatment facility discharges, septic systems, and excess fertilizer applications have led to harmful levels of nutrients and sediments entering the lagoon. In addition, these pollutants lead to muck accumulation on the lagoon bottom, which fluxes nutrients and creates a lagoon bottom that is not conducive to seagrass, shellfish, or benthic invertebrate growth.

Efforts have been ongoing to address these sources of pollution. The Indian River Lagoon System and Basin Act of 1990 (Chapter 90-262, Laws of Florida) was enacted to protect the IRL system from wastewater treatment facility discharges and the improper use of septic tanks. The act includes three objectives: elimination of surface water discharges, investigation of feasibility of reuse, and centralization of wastewater collection and treatment facilities (Florida Department of Environmental Protection, 2016). This act led to the removal of effluent discharges to the lagoon from more than 40 wastewater treatment facilities (St. Johns River Water Management District, 2016a).

Stormwater regulations were adopted in unincorporated Brevard County in 1978 and adopted statewide in 1989. Due to stormwater regulations, stormwater treatment systems were constructed along with all new development exceeding size thresholds. Privately owned and operated stormwater treatment systems have prevented more than a million pounds of sediments from entering the lagoon since 1989 (St. Johns River Water Management District, 2016a). Stormwater treatment projects also reduce nutrient inputs to the lagoon. In addition, dredging projects have been ongoing since 1998 to remove muck from the lagoon and major tributaries, including Crane Creek, Turkey Creek, and St. Sebastian River (St. Johns River Water Management District, 2016a). These stormwater treatment and muck removal projects contributed to significant improvements in water quality and water clarity in the lagoon, which allowed for a great expansion of seagrass from 2000–2010.

However, recently, human impacts on the IRL system have been magnified. In 2011, the "superbloom" occurred, an intense algal bloom in the Mosquito Lagoon, Banana River Lagoon, and North IRL, as well as a secondary, less intense bloom in Central IRL. The extent and longevity of the bloom had a detrimental impact on seagrass. There have also been recurring brown tides; unusual mortalities of dolphins, manatees, and shorebirds; and large fish kills due to low dissolved oxygen from decomposing algae.

In 2009, to improve lagoon water quality and restore seagrass, the Florida Department of Environmental Protection adopted total maximum daily loads for total nitrogen (TN) and total phosphorus (TP) allowed to discharge to the Banana River Lagoon, North IRL, and Central IRL. The purpose of these total maximum daily loads is to reduce nutrients that lead to algae growth, which block sunlight from seagrass and create low dissolved oxygen conditions that affect fish in the lagoon. To implement these total maximum daily loads, the Florida Department of Environmental Protection adopted three basin management action plans that outline responsibilities for reductions by the local stakeholders, list projects, and stipulate a timeline for implementation. The intent of the nutrient reductions is to provide water quality conditions that should result in seagrass growth in the lagoon at historical levels. Brevard County has a major responsibility in all three basin management action plans along with its 16 municipalities, Florida Department of Transportation District 5, Patrick Space Force Base, National Aeronautics and Space Administration – Kennedy Space Center, and agriculture. The Florida Department of Environmental Protection updated all three basin management action plans in 2020.

From 2012 to 2015, Brevard County led an effort with its municipalities, Florida Department of Transportation District 5, and Patrick Space Force Base to update the estimates of nutrient loadings to the lagoon. The County and its partners teamed with several consultants to develop the Spatial Watershed Iterative Loading model that revised the estimates of loading by source to the lagoon (refer to **Section 2** for more details). The revised loading estimates were compared to seagrass area to recommend refinement of state and federal approved total maximum daily loads. The loading estimates and total maximum daily load targets referenced in this plan are from these local efforts, as they are based on the most up-to-date data and analyses even though the state and federal total maximum daily loads have not been officially updated.

Damage to the lagoon has been occurring for decades and will require time and money to reverse. An important example is the accumulation of muck on the bottom of 10% of the IRL. This muck kills marine life and releases stored pollutants into the IRL. To address the damage to the IRL system, in 1990, Brevard County implemented a stormwater utility assessment, which established an annual assessment rate of $36 per year per equivalent residential unit that stayed at this level until 2014. The rate increased to $52 per equivalent residential unit for 2014 and 2015 and increased to $64 per equivalent residential unit in 2016. This raised collections from $3.4 million (in 2014) to $6.0 million (in 2016). Of the funding raised, a portion is available for capital improvement programs or other stormwater best management practices and is split between water quality improvement programs and flood control and mitigation programs. In addition, funding is spent on annual program operating expenses. Operation and maintenance includes National Pollutant Discharge Elimination System permit compliance activities (street sweeping, trap and box cleaning, and aquatic weed harvesting), outfall/ditch treatments, small scale oyster restoration, as well as harvesting and replanting of floating vegetative islands.

While revenues from this stormwater assessment have funded many projects, a significant portion of projects have been partially funded by grants. When applicable, federal water quality grants provide up to 60% matching funds, state total maximum daily load grants provide up to 50% match, and St. Johns River Water Management District cost-share grants fund up to 33% of construction. All these grant programs are highly competitive and subject to variable state and federal appropriations, as well as changing priorities.

Due to funding limitations and the continuing degradation of key indicators of health in the IRL, such as seagrass and fish, Brevard County identified a need for additional funding to implement projects identified as critical to lagoon restoration. Therefore, the County placed a Save Our Indian River Lagoon 0.5 cent sales tax referendum on the ballot in November 2016. This referendum passed by more than 60% of the votes and provides a funding mechanism for the projects listed in this plan and annual updates for the County and its municipalities. Revenue collection from the sales tax began in January 2017.

This Save Our Indian River Lagoon Project Plan outlines projects planned to meet updated total maximum daily load targets and improve the health, productivity, aesthetic appeal, and economic value of the lagoon. Almost all these projects require sales tax funding to be implemented. Furthermore, the local sales tax funding is being used to leverage more in match funding from state and federal grant programs. The IRL ecosystem is an asset valued not only in Florida but also nationally; therefore, implementation of this plan would help to restore this national treasure. If additional funding is provided through matching funds from other sources, additional projects may be implemented, which would increase the overall plan cost, and/or project timelines may be moved up to allow the benefits of those projects to occur earlier than planned. Response of the lagoon ecosystem may lag for several years behind completion of nutrient reduction implementation; however, action must be accelerated now to ensure restoration succeeds over time.

1.1. Return on Investment and Economic Value

The economic value of the lagoon system was evaluated during development of this plan. It was estimated that at least a total present value of $6 billion is tied to restoration of the Indian River Lagoon (IRL). There is approximately $2 billion in benefits from restoration and an estimated $4 billion in damages if the IRL is not brought back to health during the next decade. If viewing this project plan purely as a financial investment that pays the $2 billion in benefits alone (i.e., not counting the avoidance of the $4 billion loss), the projected pretax internal rate of return is 10%, if the plan takes 10 years to implement (CloseWaters LLC, 2016).

Table 1-1 documents projections of three economic engines likely to have significant economic impacts on Brevard County residents with positive impacts if the IRL is restored versus negative impacts if the IRL is not restored. Additional detail on each of these impacts is provided in **Section 1.1.1**. The upper part of the table lists the economic benefits for restoring a healthy IRL while the lower part of the table lists the economic costs of declining IRL health in the absence of restoration through plan implementation.

Economic impacts in the table are expressed both as annual cash flows and as the discounted expected present value of those cash flows over a 30-year financial plan period. Expected present value is an economic indicator used in business to express the present monetary value of a future stream of cash flows. This expected monetary value discounts the future stream by an interest rate and discounts it further by a probability factor to account for the uncertainty of future events. Therefore, the expected present value of IRL economic benefits shown in **Table 1-1** is much less than the sum of those future cash flows.

Table 1-1: Economic Impact Scenarios Based Upon the Condition of the IRL

Economic Benefits for Restoring a Healthy IRL and Costs of Declining IRL Health	Annual Cash Flow	Expected Present Value
Tourism and Recreation Growth Benefits	$95 million	$997 million
Property Value Growth Benefits	$81 million	$852 million
Rebirth of Commercial Fishing Benefits (excludes indirect benefits)	$15 million	$159 million
Healthy Residents and Tourists Benefits	Not quantified	Not quantified
Total Benefits	***$191 million***	***$2.01 billion***
Tourism and Recreation at Risk Damages	-$237 million	-$3 billion
Property Value at Risk Damages	-$92 million	-$1.2 billion
Decline of Commercial Fishing (excludes indirect impacts)	-$6 million	-$87 million
Potential Pathogen Impacts to Residents and Tourists	Not quantified	Not quantified
Total Damages	***-$335***	***-$4.29 billion***

Note: Developed by CloseWaters LLC for the original Save Our Indian River Lagoon Project Plan.

Today there is a $6 billion decision point for the IRL. Despite unprecedented algae blooms and fish kills, conditions could become worse. If large-scale fish kills continue with increasing frequency, algae blooms continue or become toxic, or there is a pathogen outbreak, then real estate, tourism, and the quality of life and health for Brevard County residents would likely suffer.

1.1.1 Areas of Economic Value at Risk

The information in this section was developed by CloseWaters LLC for the original Save Our Indian River Lagoon Project Plan in 2016.

Tourism and Recreation
Today's tourism revenue in Brevard County (County) comes primarily from the beaches. To diversify the tourism base and increase revenue, Brevard County has developed a plan to increase ecotourism, a globally growing and high value sector of tourism that depends on restoration and maintenance of a healthy Indian River Lagoon (IRL). High value ecotourism relies on exceptional natural experiences including fishing, bird watching, kayaking, paddle boarding, camping, hiking, and nature tours. In the short-term, there are opportunities for tourists to participate in restoration experiences, such as collecting mangrove seeds by kayak or canoe, planting mangrove seedlings, or establishing colonies of clams, oysters, or mussels. A successful example of Brevard County ecotourism is the world famous annual Space Coast Birding and Wildlife Festival that brings $1.2 million annually to the County and attracts approximately 5,000 visitors.

Property Value
While the economic benefits of IRL restoration are likely to increase property value throughout the County, to be conservative this plan assessed the exposure only to properties with frontage on Mosquito Lagoon, IRL, Banana River Lagoon, Sykes Creek, and connected waterways. Approximately 11.2% of the County's $27 billion in taxable property value is directly on the IRL. Therefore, more than $3 billion in taxable property value is directly at risk with ongoing IRL issues, such as algal blooms and fish kills. Furthermore, a weighted-average millage rate of 18.58 results in an estimated annual tax revenue of $56 million that is also at risk in the absence of IRL restoration. The $852 million of incremental expected present value assumes a 20% improvement in IRL frontage property value, which would be 90% likely after 10 years with the IRL restored.

Consultants for the County surveyed the Space Coast Association of REALTORS® to assess the likely impacts of IRL health on the waterfront property value. Approximately 170 REALTORS® most familiar with the waterfront market replied to the survey. These professionals assessed that waterfront IRL property values would increase 22% on average over five years if the IRL were healthy and would decrease by 25% over five years if the lagoon were not restored.

Commercial Fishing
IRL restoration is critical to the recovery of a once thriving, valuable, and world-class fishery, both commercial and recreational. In 1995, the commercial fish harvest in Brevard County was $22 million annually. While a 1995 ban on commercial net fishing marked economic decline, the degradation of the lagoon system contributed considerably to a severe reduction in value of only $6.7 million annually in 2015, based on Florida Fish and Wildlife Conservation Commission data (see **Figure 1-1**). These numbers do not include the many indirect benefits of a robust commercial fishing industry including fresh local fish for restaurants, employment, commerce of supplies and services for the industry, and benefits of local fresh fish for residents and visitors.

Figure 1-1: Decline of Commercial Fishing in Brevard County

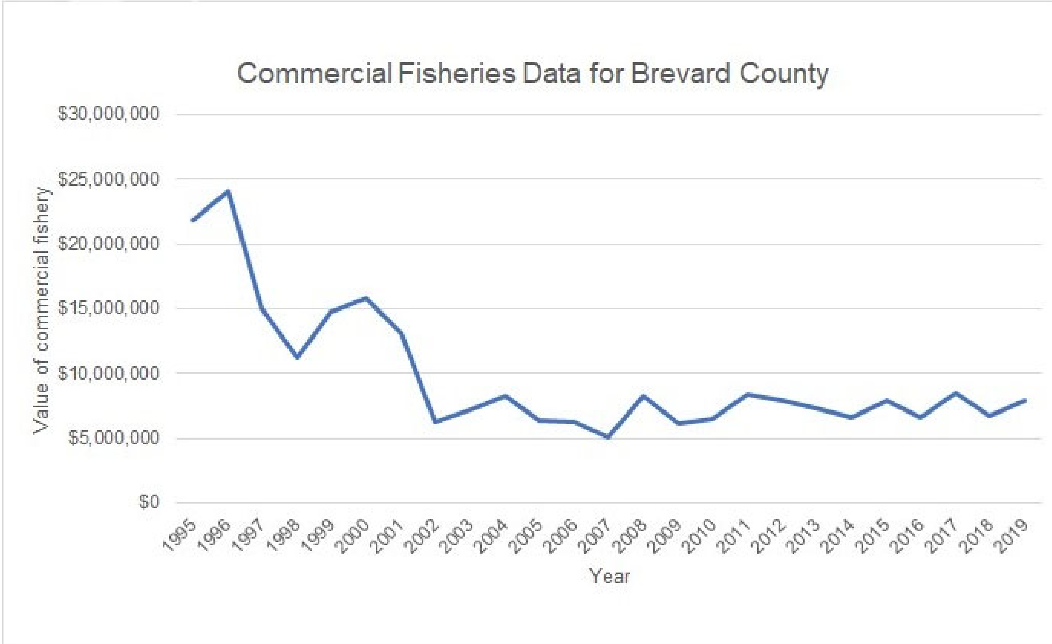


Figure 1-1 Long Description

In addition, a healthy fish population is critical to the brand of any coastal community. Historically Brevard County was once home to a world-class abundance and diversity of rare and widespread species of fish, crabs, shrimp, and clams that made the IRL a global brand. That brand can be restored along with the fish and shellfish of the IRL.

Healthy Residents and Tourists

Septic systems within Brevard County can pollute groundwater that migrates to the lagoon. This groundwater moves slowly toward the lagoon through soils that attenuate some but not all these pollutants. It would cost at least $1.19 billion to convert all 59,500 septic tanks to central sewage treatment. While total conversion is cost prohibitive, this plan targets the septic systems with the highest potential impacts to the lagoon. Targeted action includes connection to the central sewer system or upgrade to advanced treatment systems that remove significantly more nutrients and pathogens than traditional septic systems.

Although there are studies that have identified pathogens migrating from septic systems into waterways, it is not possible to estimate the economic impact of potential disease from these waterborne pathogens. The conversion of septic systems is expensive relative to other types of nutrient reduction projects; however, the additional health benefits associated with septic system upgrades make this option a priority beyond only the abatement of nutrients.

1.2. Maximizing Benefits and Managing Risk

There is much at stake with regard to both economic outcomes and the incremental funding critical to restoration; therefore, Brevard County (County) chose to address the unavoidable risks inherent in a multi-year, large-scale restoration plan in a transparent and objective manner. To help ensure objectivity, the County retained outside consultants to assess risk and to estimate potential positive or negative outcomes.

The approach for this plan to evaluate the different project options included using expected monetary value models; a decision science tool used in business to improve decision-making and planning in a context of unavoidable uncertainty. Expected monetary value is a financial model of probability-weighted outcomes expressed in quantified financial terms that are comparable across multi-year planning periods. To compare outcomes, expected present value was used as a key metric. Expected present value has the benefit of valuing future financial costs and benefits in common present day terms to take into account the value of time and to facilitate comparisons of initiatives spanning long periods of time.

As part of this methodology, consultants engaged Subject Matter Experts to assess the uncertainties of project scenarios. Subject Matter Experts include scientists, property value experts, tourism experts, lagoon advocates, and agency staff. Subject Matter Experts brought expertise in Indian River Lagoon (IRL) science, nutrient reduction technologies, waterborne pathogens, and relevant law or county financial and accounting parameters needed for the expected monetary value models. Information gathered during these assessments was used to document the key interdependence of initiatives, minimize risk, and maximize the likely return on investment (CloseWaters LLC, 2016).

1.2.1 Project Selection to Maximize Return on Investment

Assessment of risk by Subject Matter Experts determined that the amount and speed of nutrient reductions are the two most critical factors affecting the success of restoring Indian River Lagoon (IRL) health. Therefore, those projects with the greatest nutrient reduction benefit for the least cost are recommended for funding and, of those, the projects with the greatest benefits are planned for implementation first. Three other key criteria drove this plan:

1. Achieving sufficient nutrient abatement through a blend of options was a key success factor for restoration.
2. No one type of project alone could achieve an adequate nutrient abatement.
3. The target for nutrient reduction must be sufficient to minimize the need for recurring expensive muck removal, which is important for future cost avoidance.

The plan sequences a diversity of project types, implementing the highest nutrient reduction impact early and implementing other projects concurrently to achieve a multi-pronged blend of total nutrient abatement as quickly as possible with minimal risk. Another important consideration for project sequencing was how quickly projects could produce significant nutrient pollution reduction. For decades, man-made nutrient pollution from fertilizers, septic systems, and stormwater runoff have been introduced at varying distances from the IRL. The soils are still saturated with those nutrients. Therefore, if all sources of nutrient pollution ended today, groundwater would continue to transport nutrients accumulated in the soil into the IRL with every rain event for decades in the future. However, soils next to the IRL will purge themselves quickly, in days or weeks. Septic system conversions near the lagoon or near drainage conduits into the lagoon are likely to produce water quality and reduced pathogen benefits in the lagoon in weeks or months whereas septic conversions more distant from waterways are not anticipated to generate lagoon benefits for several decades. Therefore, whenever possible, project selection and sequencing scheduled nutrient abatements closest to the IRL first.

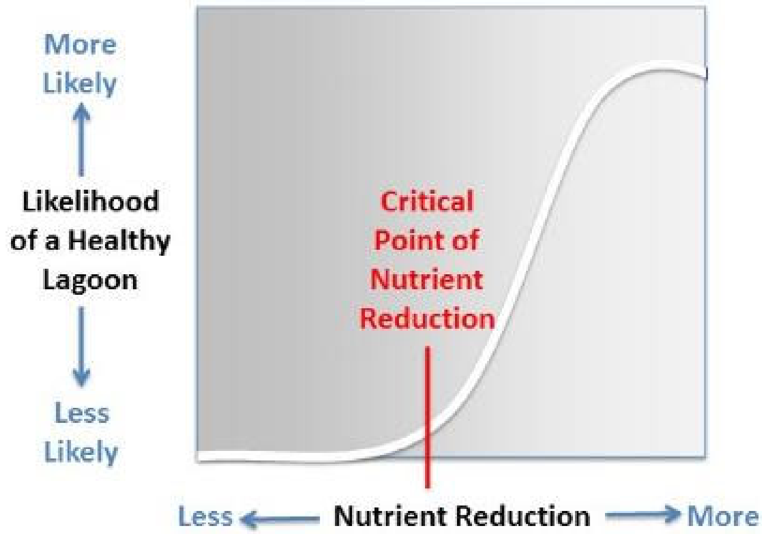
Undoing the damage to a unique and complex biological system as large as the IRL carries inherent risk. The County made the decision to be open and transparent about that risk. Assessing that risk diligently has allowed the County to mitigate and manage risk proactively in the development of this plan.

Two subjective risk assessments were conducted by an independent consultant working with top science Subject Matter Experts most knowledgeable about the IRL. The first assessment was conducted with individual Subject Matter Experts and occurred before plan projects were defined. These experts assessed that the likelihood of a healthy fish population in the IRL would begin to rise faster after reaching a critical point of nutrient reduction. Therefore, there is a "critical mass" of nutrient reduction needed to achieve significant and sustainable IRL health benefits. The Subject Matter Experts also assessed that the likelihood of recovery would continue to improve as more nutrients are removed from the IRL and then begin to decline if too many nutrients were removed. The result of that first risk assessment reinforced the objective of reducing nutrients in the IRL as quickly as possible through the definition and sequencing of the projects in this plan (CloseWaters LLC, 2016).

A second uncertainty assessment was conducted in a meeting at the Florida Institute of Technology with a group of water quality, toxicity, muck, fish, algae, invertebrates, and seagrass Subject Matter Experts. First, the experts were briefed about the projects proposed in this plan. The experts were then asked their subjective assessment of the likelihood of a healthy lagoon after this plan was implemented in each sub-lagoon. Sub-lagoons were assessed because the experts had commented previously that each sub-lagoon functioned differently. This group assessment indicated higher likelihoods of success than the first assessment. However, the scientists continued to voice concern about the restoration of the IRL in the absence of regulatory reform needed to prevent new development from adding more septic system and stormwater pollution to the lagoon. Therefore, updated regulations are needed as a complement to this plan to ensure timely and sustained success in restoring health to the IRL (CloseWaters LLC, 2016).

Figure 1-2 represents the input from the Subject Matter Experts.

Figure 1-2: Likelihood of a Healthy IRL as Nutrients are Removed



There are other large-scale aquatic system restoration efforts that have been successful in achieving restoration. Some of these systems were damaged even more so than the IRL, but they have recovered through the implementation of extensive, multi-year, and multi-pronged restoration plans. These include the Chesapeake Bay, Cuyahoga River, Lake Erie, and Tampa Bay. These areas have reaped enormous economic and quality of life benefits as a result of dedicated investments in their restoration.

Section 2. Approach, Outputs, and Outcomes

The amount and distribution of nutrient loading from the sources described in **Section 3** were examined to determine the key locations where nutrient reduction projects are needed and the extent of reductions required from each source to achieve Brevard County's proposed total maximum daily loads for each sub-lagoon. For each source, a reduction goal is set and projects are proposed to meet the goal. The estimated cost for each project is also included. Information on expected project efficiencies and project costs were gathered from data collected by Brevard County in implementation of similar projects, as well as literature results from studies in Florida, where available, and across the country. The most cost-effective projects are selected and prioritized to maximize the nutrient reductions that can be achieved.

2.1. Plan Focus Area

This plan focuses on projects implemented in three sub-lagoons in the Indian River Lagoon (IRL) system: Banana River Lagoon, North IRL, and Central IRL. **Figure 2-1** shows the locations of these sub-lagoons. All the Banana River Lagoon watershed and the majority of the North IRL watershed are located within Brevard County (County). However, only a portion of the Central IRL watershed is located within the County. As shown in **Figure 2-1**, Central IRL Zone A is located entirely in Brevard County, whereas Zone SEB straddles Brevard and Indian River counties. For Zone SEB, the County has completed several projects in this area and the St. Johns River Water Management District is completing projects along the C-54 Canal and on the Wheeler property to treat the Sottile Canal. The reductions from these projects for total nitrogen and total phosphorus should be sufficient to meet the estimated need for reductions in the Brevard County portion of Zone SEB, as shown in **Table 2-1**. This plan includes some additional beneficial projects located in Zone SEB to help ensure that the necessary reductions are achieved throughout Brevard County; however, most of the projects proposed in this plan for the Central IRL fall within Central IRL Zone A.

Table 2-1: Summary of Load Reductions and Projects in Central IRL Zone SEB

Category	Annual Total Nitrogen Load (pounds per year)	Five-Month Total Nitrogen Load (pounds per year)	Annual Total Phosphorus Load (pounds per year)	Five-Month Total Phosphorus Load (pound per year)
Stormwater and Baseflow Loading	248,233	79,956	34,901	11,242
Atmospheric Deposition Loading	22,371	7,206	404	130
Point Sources Loading	0	0	0	0
Total Loading	270,604	87,162	35,305	11,372
Target Percent Reductions	18.0%	38.0%	16.0%	35.0%
Targeted Reductions	***48,709***	***33,121***	***5,649***	***3,980***
Completed County Projects (2010-February 2016)	29,890	12,454	9,643	4,018
C-54 Project	65,974	27,489	10,558	4,399
Wheeler Property Project	36,582	15,243	21,784	9,077
Total Project Reductions	***132,446***	***55,186***	***41,985***	***17,494***
% of Targeted Reductions Achieved	***271.9%***	***166.6%***	***743.2%***	***439.5%***

In addition, a small portion of the County is located within the Mosquito Lagoon. Brevard County does not have stormwater outfalls, septic systems, or point sources in this sub-lagoon.

Figure 2-1: Locations of the Banana River Lagoon (BRL), North IRL (NIRL), and Central IRL (CIRL) Sub-lagoons

2.2. Plan Outputs and Outcomes

Vision Statement

An Indian River Lagoon teeming with fish, birds, and wildlife that provides recreation, economic vitality, and pride in our community.

Mission Statement

Restoring the Indian River Lagoon through collaborative, science-based projects which Reduce and Remove pollution to benefit our community, economy, and natural resources.

There are several outcomes expected from implementation of the plan. The plan outputs represent the project types included to **Reduce** external loads to the lagoon, **Remove** internal sources from the lagoon, **Restore** the natural filtration systems, and **Respond** to the changing conditions and opportunities. The outcomes from these outputs are the results, impacts, and accomplishments that will occur due to plan implementation (**Figure 2-2**). The timeframes for reaching various outcomes may be impacted by many factors outside Brevard County control, including federal and state legislation and weather; however, division of outcomes into short-term, mid-term, and long-term categories is meant to illustrate the sequence and approximate schedule of anticipated natural recovery.

2.3. Additional Project Benefits

Although the eligible Save Our Indian River Lagoon Trust Fund contribution to new projects is determined based on the amount of total nitrogen removed, the benefits of implementing these projects include reductions in other pollutant sources, as well. These projects will reduce a multitude of different contaminates to meet water quality targets and improve the health, productivity, aesthetic appeal, and economic value of the lagoon. These additional benefits vary according to project design and site-specific conditions but often include significant reduction of pathogenic bacteria, viruses, human and animal wastes, chemicals, metals, plastics, and sediments (see **Table 2-2**Error! Reference source not found.).

Table 2-2: Pollutants Removed by Different Project Types

Stormwater	Septic-to-Sewer	Septic System Upgrade	Muck Removal
Nitrogen Phosphorus Sediments Escherichia coli Viruses Fecal coliform Pesticides Metals Oil Litter	Nitrogen Phosphorus Escherichia coli Viruses Fecal coliform Pharmaceuticals Biochemical oxygen demand	Nitrogen Phosphorus Escherichia coli Viruses Fecal coliform Biochemical oxygen demand	Nitrogen Phosphorus Clay sediments Hydrogen sulfide Biochemical oxygen demand

This Save Our Indian River Lagoon Project Plan is an adaptable document informed by science and under supervision of the community. As monitoring updates our understanding of Indian River Lagoon pollutants, the plan projects will target funds to the most successful and cost-effective projects.

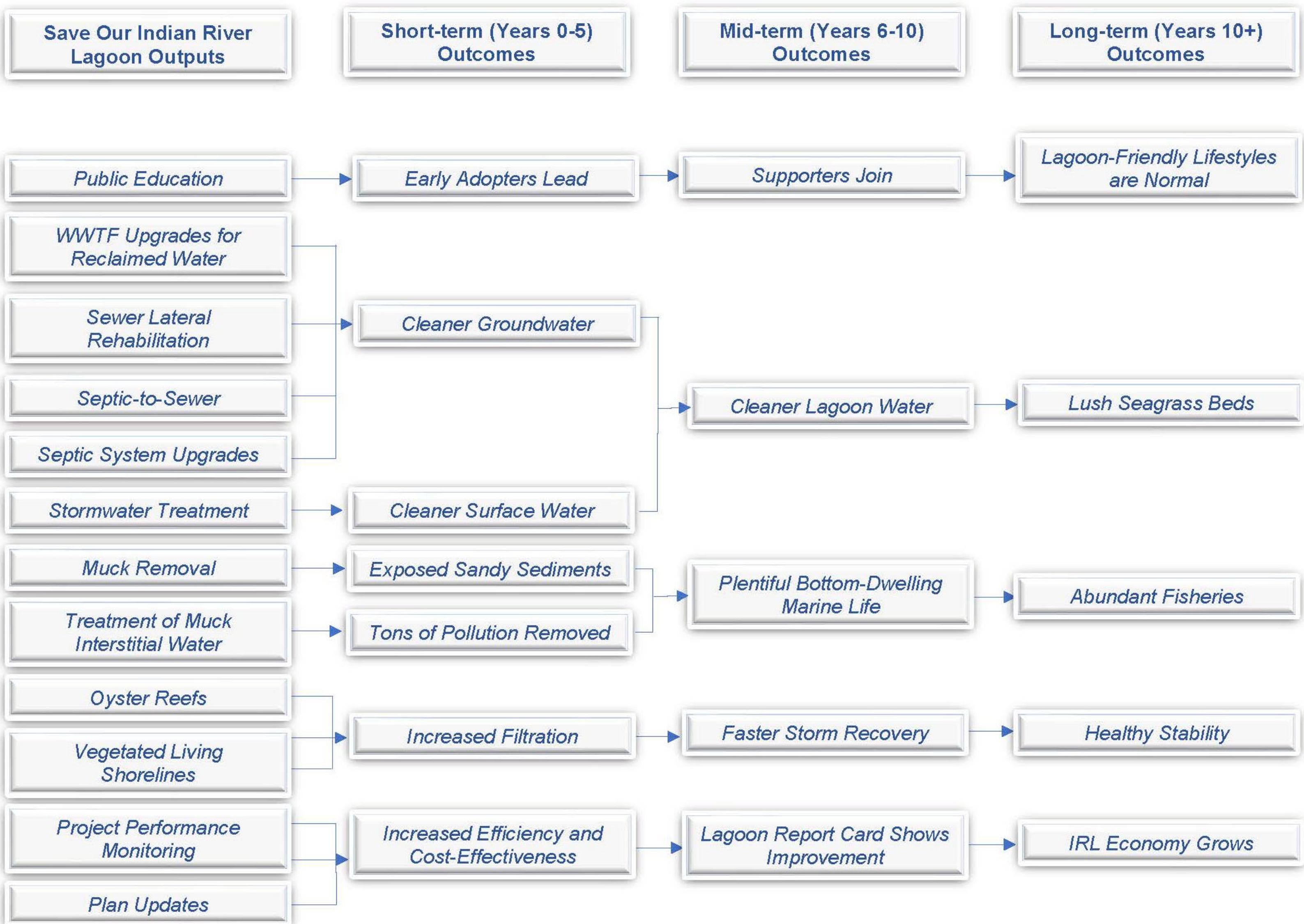


Figure 2-2. Summary of the Save Our Indian River Lagoon Outputs and Outcomes

Figure 2-2 Long Description

Section 3. Pollutant Sources in the IRL Watershed

Pollutant loads in the Indian River Lagoon (IRL) watershed are generated from multiple external sources that discharge to the lagoon. Excess loads also accumulate in nutrient sinks within the lagoon, which release nutrients to the water column during certain conditions.

External sources fall into the following major categories:

- Stormwater runoff that occurs when rainfall hits the land and cannot soak into the ground:
  - Urban stormwater runoff is generated by rainfall and excess irrigation on impervious areas associated with urban development. Urban runoff picks up and transports nutrient loading from fertilizers, grass clippings, and pet waste, as well as other pollutants including sediments, pesticides, oil, and grease. Stormwater ponds and baffle boxes reduce the nutrient loading in stormwater; however, proper maintenance of these systems is necessary to maintain their performance.
  - Agricultural stormwater runoff occurs on agricultural land and this runoff also carries nutrients from fertilizers, as well as livestock waste, pesticides, and herbicides. This source of stormwater runoff is not addressed in this plan as the County does not have jurisdiction over agricultural use. The Florida Department of Agriculture and Consumer Services has an agricultural best management practice program, and they work with agricultural producers to control the loading from this source.
  - Natural stormwater runoff comes from the natural lands in the basin. This source is not addressed by this plan as natural loading does not need be controlled.
- Baseflow is the groundwater flow that contributes loading to the IRL. Due to the sandy soils in the basin and excess irrigation, nutrients can soak quickly into the groundwater with little removal. This groundwater can recharge surface water in ditches, canals, tributaries, or the IRL.
  - Excess fertilizer that soaks into the ground past the root zones.
  - Septic systems, both functioning and failing, contribute nutrient loading to the groundwater.
  - Leaking sewer pipes located above the water table can contribute nutrient loading to the groundwater.
- Atmospheric deposition that falls on both the land and the lagoon itself:
  - Nutrients in the atmosphere fall into the basin largely during rainfall events. The sources of these nutrients are from power plants, cars, and other sources that burn fossil fuels. However, because of atmospheric conditions and weather patterns, not all the nutrients from atmospheric deposition are generated within the watershed. Atmospheric loading is not directly addressed by this plan as air quality and air emission standards are regulated by the federal Clean Air Act and are not within the County's control. However, the stormwater projects and in-lagoon projects will treat some of the nutrient loading from atmospheric deposition that falls on the land and lagoon surface.
- Point sources that treat collected sewage and discharge treated effluent:
  - The direct wastewater treatment facility discharges to the lagoon have been largely removed, and most of the facilities in the basin use the treated effluent for reclaimed water irrigation. However, depending on the level of treatment at the wastewater treatment facility, the reclaimed water can have an excessive concentration of nutrients that may contribute loading to the baseflow.

- There have been issues with inflow and infiltration into the sanitary sewer collection system. Large rain events can result in large amounts of water entering the sewer collection system, and this additional water can cause sewer overflows that contribute nutrients and bacteria to local waterbodies.

In addition to these external sources of loading to the lagoon, nutrients from muck (muck flux) are an internal source of loading within the lagoon itself. Muck is made up of organic materials from soil erosion on the land and from decay of organic matter (leaves, grass clippings, algae, and aquatic vegetation) in the lagoon. As these organic materials decay, they constantly flux nutrients into the water column above, where they add to the surplus of nutrients coming from external sources.

Table 3-1 summarizes the estimated total nitrogen (TN) and total phosphorus (TP) loading from these sources in the Banana River Lagoon (including canals), North IRL, and Zone A of the Central IRL. The stormwater runoff and baseflow/septic systems loading estimates are from the Spatial Watershed Iterative Loading model, the point source loading estimates were based on the facility monthly operating reports and discharge monitoring reports, and the atmospheric deposition loads are from measured data at nearby stations. The muck flux load estimates are calculated based on the muck area in each portion of the lagoon and flux estimates from studies in the lagoon (refer to **Section 4.2.1** for more details). The loading from these sources is also shown graphically in **Figure 3-1, Figure 3-2**, and **Figure 3-3**.

Table 3-1: Loading from Different Sources in Each Sub-lagoon

Source	Banana River Lagoon Total Nitrogen (pounds per year)	Banana River Lagoon Total Phosphorus (pounds per year)	North IRL Total Nitrogen (pounds per year)	North IRL Total Phosphorus (pounds per year)	Central IRL Zone A Total Nitrogen (pounds per year)	Central IRL Zone A Total Phosphorus (pounds per year)
Stormwater Runoff	119,923	15,064	328,047	45,423	279,351	43,193
Baseflow/Septic, Leaking Sewer, Reclaimed Water	164,225	22,613	344,111	47,383	370,129	50,966
Atmospheric Deposition	175,388	3,222	301,977	5,505	49,456	892
Point Sources	17,484	3,370	14,711	1,029	0	0
Muck Flux	393,948	43,216	247,078	17,583	16,927	2,277

Figure 3-1: Banana River Lagoon TN (left) and TP (right) Annual Average Loads by Source

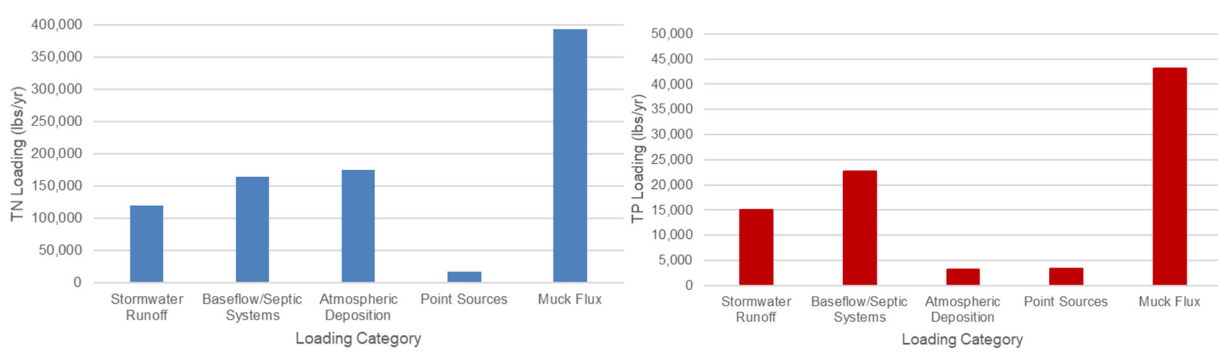


Figure 3-2: North IRL TN (left) and TP (right) Annual Average Loads by Source

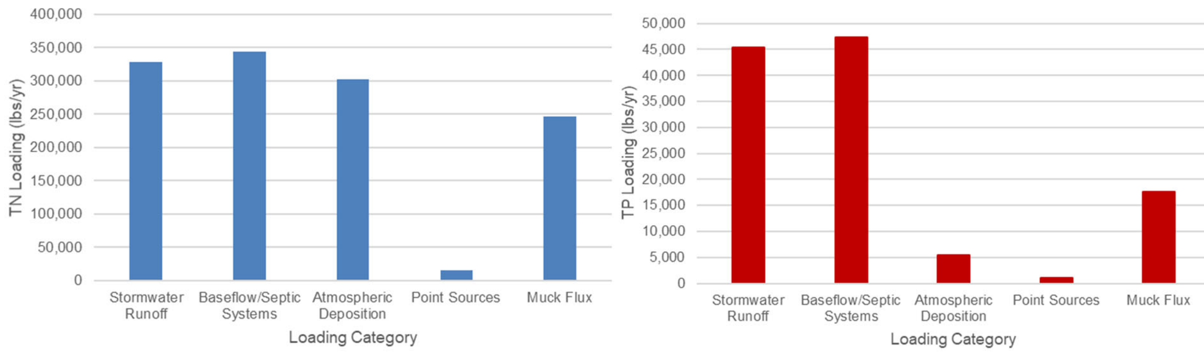
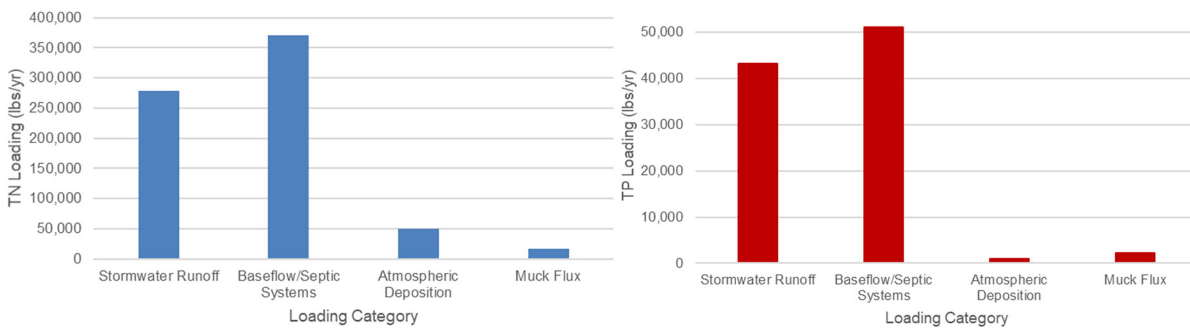


Figure 3-3: Central IRL TN (left) and TP (right) Annual Average Loads by Source



Section 4. Project Options

To restore the lagoon's balance, Brevard County has been implementing a multi-pronged approach to **Reduce** pollutant and nutrient inputs to the lagoon, **Remove** the accumulation of muck from the lagoon bottom, and **Restore** water-filtering oysters and related lagoon ecosystem services. This plan also recommends funding for project monitoring, needed for accountability and to **Respond** to changing conditions and opportunities. Respond funds will be used to track progress, measure cost effectiveness, and report on performance. Each year, the Citizen Oversight Committee (additional details are included in **Section 4.4.1**) will review monitoring reports and make recommendations to the Brevard County Board of County Commissioners to redirect remaining plan funds to those efforts that will be most successful and cost-effective. Although research is important to better understand factors that significantly impact the health, productivity, and natural resilience of the Indian River Lagoon, funding for research is not included in this project plan.

Several goals were set to help select the projects for this plan. The goal for the **Reduce** projects is to achieve the proposed total maximum daily load for each sub-lagoon (refer to **Section 6** for additional details on the total maximum daily loads). The goal for the **Remove** projects is to achieve about a 25% reduction in estimated recycling of internal loads. The goals for the **Restore** projects are to filter the entire volume of the lagoon annually and to reduce shoreline erosion. The most cost-effective projects in each category were selected to maximize nutrient reductions, minimize lag time in lagoon response, reduce risk, and optimize the return on investment.

Section 4.1 through **Section 4.5** provide information on the proposed projects, estimated nutrient reduction benefits, and costs, as well as the ongoing studies needed to measure and assess the project efficiencies and benefits to the lagoon system.

4.1. Projects to Reduce Pollutants

An important step in restoring the lagoon system is reducing the pollutants that enter the Indian River Lagoon (IRL) through stormwater runoff and groundwater. Reduction efforts include source control (such as fertilizer reductions) to reduce the pollutants generated, as well as treatment to reduce pollutants that have already been discharged before they are washed off in stormwater runoff or enter the groundwater system and ultimately discharge to the IRL. Monitoring of these projects will be performed to verify the estimated effectiveness of each project type implemented (refer to **Section 4.4**).

The benefits from fertilizer management and public education, wastewater treatment facility upgrades for reclaimed water, and stormwater treatment are seen fairly quickly in the lagoon system. Public education about fertilizer and other sources of pollution addresses nutrients at their source and prevents these nutrients from entering the system. Wastewater treatment facility upgrades result in reduced nutrients in the treated effluent, which is then used throughout the basin for reclaimed water irrigation. The stormwater projects will capture and treat runoff, which is currently untreated or inadequately treated, before it reaches the lagoon.

While greatly beneficial, septic-to-sewer or upgrade projects may take longer to result in a nutrient reduction to the lagoon. The septic systems in key areas must be removed or upgraded to see the full benefits. In addition, septic systems contribute nutrient loading to the lagoon through groundwater, and the travel time of the nutrient plumes through the groundwater to a waterbody vary throughout the basin depending on watershed conditions.

The following subsections summarize (1) public education and outreach efforts; (2) infrastructure improvements for wastewater treatment facilities; (3) sprayfield and rapid infiltration basin upgrades; (4) package plant connections; (5) sewer laterals rehabilitation; (6) septic-to-sewer and septic system upgrades; (7) stormwater treatment projects; and (8) vegetation harvesting projects.

4.1.1 Public Outreach and Education

The education and outreach campaigns are summarized in the sections below.

Approximately 81,700 pounds per year of TN and 4,200 pounds per year of TP enter the lagoon watershed from excess fertilizer application.

Fertilizer Management

It is a common practice to apply fertilizer on urban and agricultural land uses. However, excessive and inappropriately applied fertilizer pollutes surrounding waters and stormwater. To help address fertilizer as a source of nutrient loading, local governments located within the watershed of a waterbody or water segment that is listed as impaired by nutrients are required to adopt, at a minimum, the Florida Department of Environmental Protection's Model Ordinance for Florida-Friendly Fertilizer Use on Urban Landscapes (Section 403.067, Florida Statutes). Brevard County and its municipalities adopted fertilizer ordinances that included the required items from the Model Ordinance in December 2012, as well as additional provisions in 2013 and 2014. Local fertilizer ordinances are posted online at the Brevard County Extension website. These ordinances require zero phosphorus year-round, nitrogen to be at least 50% slow release, no nitrogen use during the rainy season, and variable surface water protection buffers.

Florida Department of Agriculture and Consumer Services compiled information on the fertilizer sales by county, as well as the estimated nutrients from those fertilizers. It is important to note that all fertilizer sold in a county may not be applied within that county because a portion of that fertilizer may be transported to another county. However, details on the amount of fertilizer transported between counties is not tracked. Therefore, the information in the Florida Department of Agriculture and Consumer Services reports is simply the best estimate of the amount of fertilizer used, and the associated nutrient content, in a county.

Based on the Florida Department of Agriculture and Consumer Services information, the lawn fertilizer sold in Brevard County in fiscal year 2014–2015 contained 408,220 pounds of nitrogen and 32,520 pounds of phosphorus. The fertilizer applied is attenuated through several naturally occurring physical, chemical, and biological processes including uptake by grass. The environmental attenuation/uptake for urban fertilizer is 80% for nitrogen (Florida Department of Environmental Protection, 2017) and 90% for phosphorus. The estimated total nitrogen (TN) and total phosphorus (TP) that is applied but is not naturally attenuated is shown in **Table 4-1**. It is important to note that not all the un-attenuated nutrients will migrate to the lagoon, either through runoff or baseflow (groundwater that enters ditches, canals, and tributaries), but these numbers provide an idea of the excess nutrients that could be reduced as a result of public education and changes in fertilizer use.

Table 4-1: Estimated TN and TP Not Attenuated in Fiscal Year 2014–2015

Parameter	Pounds Sold Fiscal Year 2014-15 (Lawn Only)	Environmental Attenuation (%)	Fiscal Year 2014-15 Pounds (Lawn Only) after Attenuation
Total Nitrogen	408,220	80%	81,644
Total Phosphorus	32,520	90%	3,252

When recent sales data are compared to the fertilizer sold in fiscal year 2013–2014, which is before adoption of the more protective amendments to the ordinance, significant reductions are observed. These reductions from the implementation of the ordinance are shown in **Table 4-2**.

Table 4-2: Reductions from Fertilizer Ordinance Compliance as of Fiscal Year 2014–2015

Parameter	Fiscal Year 2013-14 Pounds (Lawn Only) after Attenuation: Pre-Ordinance (pounds per year)	Fiscal Year 2014-15 Pounds (Lawn Only) after Attenuation: Post-Ordinance (pounds per year)	Reductions from Ordinance to Date (pounds per year)
Total Nitrogen	127,540	81,644	45,896
Total Phosphorus	12,640	3,252	9,388

Based on studies by the University of Florida, approximately 0.03% of applied nitrogen ends up in runoff during establishment of sodded Bermudagrass on a 10% slope. Nitrogen leaching ranged from 8% to 12% of the amount applied (Trenholm and Sartain, 2010). Therefore, nitrogen leaching from fertilizer into the groundwater is 300 to 400 times as much as the nitrogen running off in stormwater. To help address the leaching issue, the Brevard County fertilizer ordinance encourages the use of slow release nitrogen fertilizer. Slow release fertilizer decreases nitrogen leaching by about 30% (University of Florida-Institute of Food and Agricultural Sciences, 2012). In addition, the ordinance requires that fertilizer with zero phosphorus is used.

The public education and outreach campaign was expanded to include focus on slow release and zero phosphorus fertilizers. An important component of this is to reach out to stores within Brevard County to ensure they are making slow release and zero phosphorus fertilizers more visible and to add signage to let buyers know which fertilizers are compliant with all local ordinances. This would cost approximately $125,000 per year for a period of five years. If an additional 25% of fertilizer users switch to 50% slow release nitrogen and zero phosphorus formulations, compliant with the ordinance, this would result in a reduction of 6,123 pounds per year of TN and 813 pounds per year of TP.

In 2018, the Citizen Oversight Committee recommended extending the fertilizer education and outreach beyond the original plan recommendation of five years to all ten years of the plan. As part of this 2023 Update, the Citizen Oversight Committee recommended expanding the fertilizer outreach efforts with an additional $50,000 per year for the remaining five years of the plan, which adds $250,000 to the expanded fertilizer education outreach program. The $881,000 for this project was redistributed as follows: (1) $125,000 in Year 1 to create the education campaign and begin implementation, (2) $50,000 per year to continue implementation in Years 2–5, (3) $100,000 per year in Years 6–10, (4) an additional $50,000 in Year 6 (for a total of $150,000 in this year) to evaluate program success and update the outreach materials, as needed, and (5) $1,200 in Years 6–10 for digital messaging with action items for further reach and evaluation of that reach after Year 6.

In 2019, the University of Florida Institute of Food and Agricultural Sciences and MTN Marketing conducted a survey that was concentrated on fertilizer awareness questions. The results from the 2019 survey were compared to similar questions from the 2015 Blue Life survey to evaluate changes in fertilizer use. Based on the survey results, 33.33% of respondents in 2019 stated that they use slow release nitrogen fertilizer compared to only 6.30% in 2015, which is a 27% increase in the usage of slow release fertilizer. Therefore, as part of the 2021 Update, the estimated nitrogen reductions from the expanded fertilizer education was updated to 27%, which results in an estimated reduction of 6,613 pounds per year of TN. The TP reductions were kept at 25% compliance because, the way the survey was setup, participants were only able to select one option for the type of fertilizer used. Therefore, an update on the use of zero phosphorus formulas could not be obtained.

The updated plan costs and estimated reductions from this outreach are shown in **Table 4-3**.

Table 4-3: Project for Additional Fertilizer Ordinance Compliance

Year Added	Project Number	Project Name	Responsible Entity	Sub-lagoon	Total Nitrogen Reduction (pounds per year)	Total Nitrogen Cost per Pound per Year	Total Phosphorus Reduction (pounds per year)	Total Phosphorus Cost per Pound per Year	Plan Funding
Original	58a	Expanded Fertilizer Education*	Brevard County	All	6,613	$133	813	$1,084	$881,000

Note: The projects highlighted in green and marked with an asterisk were identified in the original plan.

Grass Clippings

Grass clippings contain nutrients and those nutrients are released in stormwater or the lagoon as they decompose (Brevard County Natural Resources Management Department, 2017). St. Augustine grass contains 2.5% nitrogen and 0.2–0.5% (average of 0.5%) phosphorus and Bahia grass contains 2% nitrogen (University of Florida-Institute of Food and Agricultural Sciences, 2015). According to Okaloosa County Extension (2017), a 7,500-square foot lawn produces about 3,000 pounds of clippings per year. Unfortunately, the percentage of those total clippings that end up in stormwater is not known.

To estimate the potential nutrient reduction impact of a grass clippings campaign, it was assumed that the average home lot size is 10,000 square feet with a 100-foot by 100-foot boundary, with 2,500 square feet of built space and 7,500 square feet of lawn (**Figure 4-1**). The University of Florida-Institute of Food and Agricultural Sciences estimated that 3,000 pounds of grass clippings are produced annually from a healthy lawn of this size. It was assumed that most of the grass clippings in Brevard County are from St. Augustine grass, which means that 3,000 pounds of clippings contains approximately 75 pounds of TN and 10.5 pounds of TP.

It was also assumed that the standard mower size is two feet wide. From one roadside pass along 100 feet of the average lawn with a two-foot wide mower, 200 square feet or 2.6% of the total lawn clippings could be cast into the road. This equals 0.02 pounds of TN and 0.0027 pounds of TP per foot per year left in the road. With about 3,800 miles of roads in the Indian River Lagoon (IRL) Basin within Brevard County, of which approximately 1,250 miles are paved with curb and gutter and are most likely to allow the ready transport of grass clippings to the lagoon in stormwater, the potential nutrient release from those grass clippings could be up to 260,000 pounds per year of TN and 35,640 pounds per year of TP from mowing along both sides of the road.

If Brevard County expects a similar rate of awareness of 24% as Alachua County (2012), then a potential 200,000 pounds per year of TN and 27,000 pounds per year of TP may be entering the stormwater. If a successful grass clippings campaign in Brevard County can capture an increase of awareness similar to Alachua County (from 24% to 69%), then there is a potential reduction of 88,920 pounds per year of TN and 12,189 pounds per year of TP. In addition, assuming the environmental attenuation/uptake for grass clippings is similar to the urban fertilizer uptake of 80% for nitrogen and 90% for phosphorus, the estimated reductions would be 17,800 pounds per year of TN and 1,200 pounds per year of TP.

This estimate assumes a simplified worst-case scenario in which everyone leaves a portion of their clippings in the road; however, it does not take into account the number of driveways, sidewalks, medians, and other impervious surfaces that grass clippings could be falling or the grass clippings being directly cast into the IRL, canals, and other waterways. Using the available information, this provides an order of magnitude estimate of the potential benefits of a grass clippings campaign for the IRL.

Figure 4-1: Grass Clippings Example for a Typical Lot

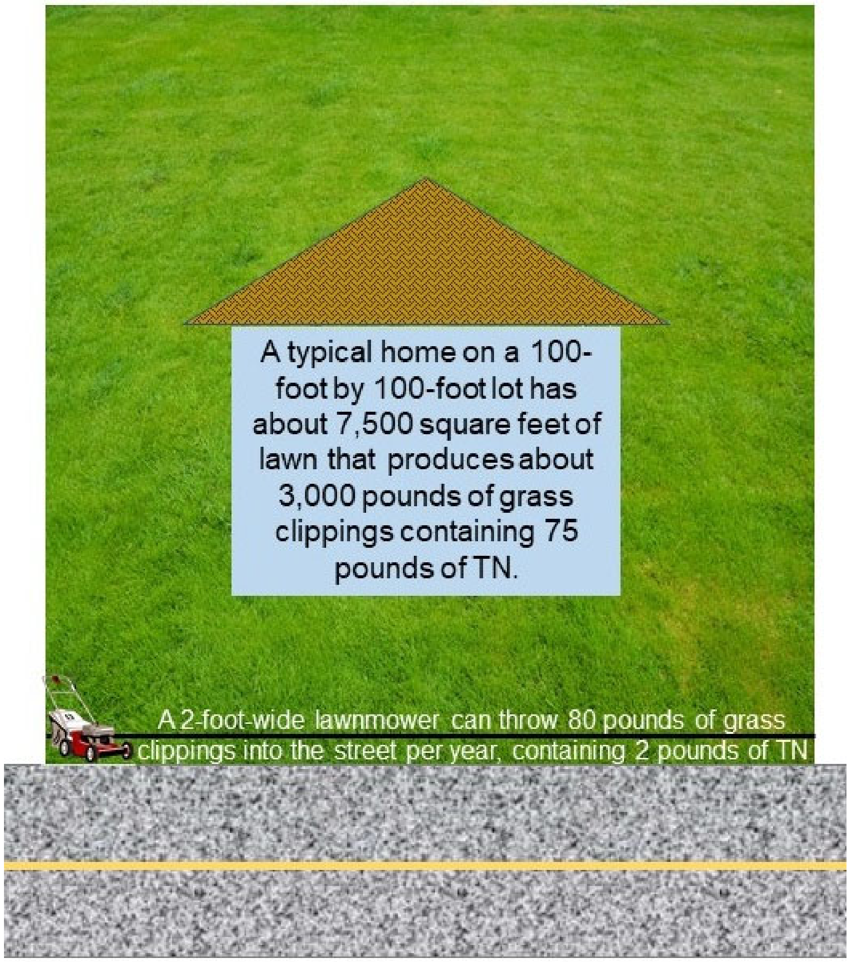


Figure 4-1 Long Description

The Marine Resources Council proposed a partnership between the IRL Basin counties to pursue a grass clippings campaign similar to the Alachua County campaign. The Citizen Oversight Committee recommended contributing $20,000 in Year 1 of the plan towards the research and marketing to develop the campaign. This was followed by an annual investment of $20,000 per year for Years 2 through 10 for media and promotional materials targeting Brevard County. As part of this 2023 Update, the Citizen Oversight Committee recommended expanding the grass clippings campaign with an additional $20,000 per year for the remaining five years of the plan, which adds $100,000 to the campaign. In addition, they recommended adding $1,200 per year in Years 6–10 for digital messaging with action items for further reach and evaluation of that reach after Year 6. Therefore, the total project cost is $306,000.

Table 4-4 summarizes the costs and benefits of implementing the grass clippings campaign.

Table 4-4: Project for Grass Clippings Campaign

Year Added	Project Number	Project Name	Responsible Entity	Sub-lagoon	Total Nitrogen Reduction (pounds per year)	Total Nitrogen Cost per Pound per Year	Total Phosphorus Reduction (pounds per year)	Total Phosphorus Cost per Pound per Year	Plan Funding
2018	58b	Grass Clippings Campaign+	Brevard County	All	17,800	$17	1,200	$255	$306,000

Note: The projects highlighted in tan and marked with a plus sign were added to the plan as part of an annual update.

Market research needed to guide development of a grass clipping campaign was contracted through the Marine Resources Council to a community-based social marketing firm, Uppercase Inc. Survey results from 2018 and 2022 are reported in **Section 4.4.3**.

Excess Irrigation

Fertilizer nutrients are more susceptible to leaching if turfgrass is overwatered, carrying nutrients beyond the reach of the turf roots. During excess watering, soluble nutrients, such as highly mobile nitrate, wash through the soil from the root zone too quickly. Excess irrigation is easy to accomplish in Florida's sandy soils as these soils typically hold no more than 0.75 inches of water per foot of soil depth (Hochmuth et al., 2016). This excess irrigation is part of the baseflow contributing nutrient loading to the IRL.

From June 2015 to May 2016, 470,737 pounds of TN in fertilizer were sold within Brevard County. Florida Department of Agriculture and Consumer Services Urban Turf Fertilizer Rule (RE-1.003[2], Florida Administrative Code) does not specify a percentage of slow-released nitrogen in fertilizer or separately track slow-release nitrogen from all nitrogen sources. However, if it is assumed that 50% of fertilizer was soluble nitrogen (compliant with local fertilizer ordinances), then the total soluble nitrogen sold in Brevard County could be as high as 235,368 pounds per year. If 13% of soluble nitrogen were leached, up to 30,597 pounds per year of TN could potentially enter the groundwater. If, like South Florida survey respondents, 50% of irrigation users in Brevard County are not over-irrigating and if an outreach campaign can impact half of those who do over-irrigate, fertilizer leaching could be reduced by 7,649 pounds per year of TN. As noted above, the environmental attenuation/uptake for urban fertilizer is 80% for nitrogen (Florida Department of Environmental Protection, 2017). Therefore, the total amount of TN that could be reduced by reducing excess irrigation is 1,530 pounds per year.

Conducting an outreach campaign with an initial $50,000 social marketing research and development investment and $25,000 in annual implementation, the total 10-year budget would be $300,000. This results in an average of $196 per pound of TN reduced per year.

This education campaign was originally proposed in 2018 but was not funded at that time. However, as part of this 2023 Update, the Citizen Oversight Committee recommended funding the campaign with $50,000 per year for the remaining five years of the plan, with an additional $50,000 in the first year to create the education campaign and begin implementation (a total of $100,000 in the first year). In addition, they recommended adding $1,200 per year in Years 6–10 for digital messaging with action items for further reach and evaluation of that reach after Year 6. The five-year total budget would be $306,000. **Table 4-5** summarizes the costs and estimated reductions for this campaign.

Table 4-5: Project for Reducing Excess Irrigation Campaign

Year Added	Project Number	Project Name	Responsible Entity	Sub-lagoon	Total Nitrogen Reductions (pounds per year)	Total Nitrogen Cost per Pound per Year	Total Phosphorus Reduction (pounds per year)	Total Phosphorus Cost per Pound per Year	Plan Funding
2023	245	Irrigation Education Campaign+	Brevard County	All	1,530	$200	Not applicable	Not applicable	$306,000

Note: The projects highlighted in tan and marked with a plus sign were added to the plan as part of an annual update.

Stormwater Pond Maintenance

Wet detention ponds, also known as stormwater ponds, are one method used to remove nutrients from stormwater as mandated by Florida Statutes 403.0891. Retention/detention time of water in the pond accommodates the removal of accumulated nutrients by allowing material to settle and be absorbed. By itself, an optimally sized and properly maintained stormwater pond typically provides a 35–40% removal of nitrogen and 65% removal of phosphorus through settling (Florida Department of Environmental Protection and Water Management Districts, 2010). Additional behaviors and technologies can be combined with ponds to increase removal rates. On the other hand, poor pond maintenance practices can decrease nutrient removal rates or worse yet, release nutrients to downstream waterbodies.

A stormwater pond maintenance program would initially focus on vegetative buffers and their appropriate maintenance to reduce stormwater pollution. Brevard County contains 4,175 stormwater ponds covering 13,276 acres with 6,976,338 linear feet of shoreline. The average size of a pond is 3.2 acres with 1,671 linear feet of shoreline. These numbers include ponds affiliated with both residential and commercial areas. The average load to stormwater ponds is 11.4 pounds of TN per acre of land surrounding the pond annually according to the Florida Department of Environmental Protection's Spreadsheet Tool for Estimating Pollutant Loads. Assuming that a 50-foot perimeter directly impacts the pond, there are 8,008 acres contributing 91,288 pounds of TN annually to the ponds. Of this, up to 40% of the TN is removed through retention in the pond leaving a potential 54,773 pounds per year of TN to enter the lagoon. For TP, approximately 18,836 pounds per year is entering the stormwater pond. Of this, up to 65% of the TP is removed through retention in the pond leaving a potential of 6,593 pounds per year TP to enter the lagoon.

Creating a 10-foot-wide low-maintenance buffer zone of un-mowed ornamental grasses has the potential to remove about 25% of the TN and TP entering the pond (United States Environmental Protection Agency, 2005). This amount increases with the width of the buffer and the addition of woody vegetation. For the plan calculations, the assumption was made that convincing homeowners to not mow a 10-foot buffer is the easiest practice to achieve. The pond will remove up to 40% of the remaining TN. Assuming that the education campaign can reach at least half of the 48% of people unaware of what stormwater is, the reduction could be 3,286 pounds per year of TN and 396 pounds per year of TP.

Conducting an outreach campaign with an initial $50,000 social marketing research and development investment plus $25,000 in annual implementation, would require a 10-year total budget of $300,000. This would result in reductions at $91 per pound of TN and $750 per pound of TP. Additionally, during focus group research in the first year, it may be possible to identify other best management practices that homeowners' associations are willing to adopt that would further improve the performance of their stormwater pond. This would improve the cost effectiveness of this campaign.

This education campaign was originally proposed in 2018 but was not funded at that time. However, as part of this 2023 Update, the Citizen Oversight Committee recommended funding the campaign with $50,000 per year for the remaining five years of the plan, with an additional $50,000 in the first year to create the education campaign and begin implementation (a total of $100,000 in the first year). In addition, they recommended adding $1,200 per year in Years 6–10 for digital messaging with action items for further reach and evaluation of that reach after Year 6. The five-year total budget would be $306,000. **Table 4-6** summarizes the costs and estimated reductions for this campaign.

Table 4-6: Project for Stormwater Best Management Practice Maintenance Campaign

Year Added	Project Number	Project Name	Responsible Entity	Sub-lagoon	Total Nitrogen Reductions (pounds per year)	Total Nitrogen Cost per Pound Per Year	Total Phosphorus Reductions (pounds per year)	Total Phosphorus Cost per Pound per Year	Plan Funding
2023	246	Stormwater Best Management Practice Maintenance Education+	Brevard County	All	3,300	$93	400	$765	$306,000

Note: The projects highlighted in tan and marked with a plus sign were added to the plan as part of an annual update.

Septic Systems and Sewer Laterals Maintenance

Nationwide, 10–20% of septic systems are failing from overuse, improper maintenance, unsuitable drainfield conditions, and high-water tables. When septic systems are older and failing or are installed over poor soils close to the groundwater table or open water, they can be a major contributor of nutrients and bacterial and viral pathogens to the system (De and Toor, 2017; United States Environmental Protection Agency, 2002).

A properly functioning septic tank and drainfield system reduces TN by 30–40%. However, the reduction has been measured at 0–20% in adverse conditions. The best available studies estimate a 10% reduction in nitrogen within a properly maintained tank versus an improperly maintained tank. The remaining 20–30% of nitrogen removal occurs in a properly functioning drainfield (Anderson 2006). If 15% of systems are failing and failing systems attenuate 30% less of the nitrogen load, these systems may pose far greater impacts to the groundwater, tributaries, and lagoon than the average impact reported for properly functioning systems. Without the 30% reduction, the potential load to the IRL and its tributaries is estimated to be 27.2 pounds per year of TN for properties within 55 yards (instead of 19 pounds per year of TN for functioning systems), 5.2 pounds per year of TN for properties between 55 and 219 yards away (instead of 3.6 pounds per year of TN for functioning systems), and 1.1 pounds per year of TN for properties more than 219 yards away (instead of 0.8 pounds per year of TN for functioning systems).

There are an estimated 53,204 septic systems in Brevard County within the IRL Basin. As noted in **Section 4.1.6**, the total loading of septic systems within 55 yards of the IRL and its tributaries is calculated at 299,590 pounds per year of TN, the total loading of systems between 55 and 219 yards is 86,575 pounds per year of TN, and the total loading of septic systems further than 219 yards is 10,805 pounds per year of TN. If the failure rate in Brevard County is about 15%, and if failing systems receive 30% less attenuation, then failing systems within 55 yards of open water are contributing 13,481 pounds per year of TN, failing systems between 55 and 219 yards of open water are contributing 3,896 pounds per year of TN, and failing tanks further than 219 yards are contributing 486 pounds per year of TN. By factoring in this failure rate, the total additional loading to the IRL from failing septic systems is approximately 17,863 pounds per year of TN.

A 10-year outreach campaign budget of $300,000, which includes $50,000 for research and campaign development and $25,000 per year for implementation to improve septic system maintenance, reduce excess use, and prevent harmful additives, would strive to reduce the number of failing systems countywide by 25%, thereby reducing the excess loading from failing systems by 4,466 pounds per year of TN. As part of this 2023 Update, the Citizen Oversight Committee recommended expanding the septic system maintenance campaign with an additional $25,000 per year for the remaining five years of the plan, which adds $125,000 to the campaign. In addition, they recommended adding $1,200 per year in Years 6–10 for digital messaging with action items for further reach and evaluation of that reach after Year 6. The updated total budget is $431,000. **Table 4-7** summarizes the costs and benefits of implementing this campaign.

Table 4-7: Project for Septic System Maintenance Program

Year Added	Project Number	Project Name	Responsible Entity	Sub-lagoon	Total Nitrogen Reduction (pounds per year)	Total Nitrogen Cost per Pound per Year	Total Phosphorus Reduction (pounds per year)	Total Phosphorus Cost per Pound per Year	Plan Funding
2018	58c	Septic System Maintenance Education+	Brevard County	All	4,466	$97	Not applicable	Not applicable	$431,000

Note: The projects highlighted in tan and marked with a plus sign were added to the plan as part of an annual update.

Market research needed to guide development of a septic maintenance campaign was contracted with state grant funding through the Marine Resources Council to the University of Central Florida. Survey results from 2018 are reported in **Section 4.4.3**. In reaching out to citizens to participate in the survey, it was found that many people are unsure of whether they are on central sewer or a septic system. When developing the septic system maintenance education program, Brevard County will identify opportunities to educate people who are on central sewer about proper maintenance of their sewer laterals. Adding this education component to the septic system maintenance education campaign is not anticipated to require additional funding.

Lagoon Loyal Program

Using funding from the fertilizer education and septic system maintenance education programs, the marketing company MTN Advertising was contracted to create an outreach campaign to engage Brevard citizens in IRL restoration efforts. The Lagoon Loyal campaign uses an incentive program to motivate positive actions that benefit the IRL (website). Citizens can create an online Lagoon Loyal profile that keeps track of participation in suggested activities that benefit the lagoon and then provides rewards. Completing each activity earns points, which can accumulate and be redeemed for discounts to local area businesses.

Lagoon Loyal businesses providing discounts are given display materials that indicate their support for the lagoon and their participation in the program. These display materials also advertise the program to their customers. Citizens who complete Lagoon Loyal actions receive coupons that encourage them to patronize Lagoon Loyal businesses, providing a positive feedback loop for local citizens and businesses. Combined with social media marketing and traditional media advertising, the program uses the slogan "Let's Be Clear…" to share easy actions that citizens can take to reduce their contribution to lagoon pollution. Message selection is guided by focus groups and survey responses from citizens who either care for a yard or maintain a septic system.

The Lagoon Loyal program has also developed and distributed outreach materials targeted for greatest impact with the public. Fertilizer ordinance signs, educating the public on proper use of fertilizer, were distributed to all fertilizer retail locations in Brevard County. These signs must remain posted anywhere fertilizer is sold. A pilot program was conducted with stickers marking ordinance compliant fertilizer bags to help direct the public in making the right choice when purchasing fertilizer. Three fertilizer best management practices videos were developed and will be distributed through various media outlets starting in 2023.

For the septic system outreach program, a best management practices magnet was created and provided to septic contractors to distribute to clients when making service calls. An educational flyer on septic system best management practices, which also encourages septic system inspections during home purchases, was created to be distributed by realtors, title agencies, and home inspectors to buyers of homes with septic systems. The Lagoon Loyal Program website also maintains landing pages to help interested homeowners find links to the applications for septic system upgrade and septic-to-sewer grants available to eligible locations.

Oyster Gardening Program

Much of the IRL system in Brevard County no longer has a sufficient oyster population to allow for natural recruitment of oysters to suitable substrate (Futch, 1967). Therefore, to create the oyster bars where recruitment is limited, the oysters must be grown and then carefully placed on appropriate substrate in the selected locations. To help grow the oyster population, in fiscal year 2013–2014, the Board of County Commissioners approved $150,000 to launch the Oyster Gardening Program. This program is a citizen-based oyster propagation program where juvenile oysters are raised under lagoon-front homeowners' docks for about six months before being used to populate constructed oyster bar sites. Oyster Gardening participants receive spat-on-shell oysters plus all supplies needed to care for their oysters. The Oyster Gardening Program is executed in partnership with the Brevard Zoo. The project continued during fiscal year 2014–2015 with funding from the state and has continued since with annual County funding.

In 2020, the Citizen Oversight Committee approved $300,000 from the Save Our Indian River Lagoon Tax to fund two years of the Oyster Gardening Program through September 2021 (**Table 4-8**).

Table 4-8: Project for Oyster Gardening Program

Year Added	Project Number	Project Name	Responsible Entity	Sub-lagoon	Total Nitrogen Reduction (pounds per year)	Total Nitrogen Cost per Pound per Year	Total Phosphorus Reduction (pounds per year)	Total Phosphorus Cost per Pound per Year	Plan Funding
2020	193	Oyster Gardening Program+	Brevard County	All	Not applicable	Not applicable	Not applicable	Not applicable	$300,000
2022	227	Restore Our Shores: Community Collaborative+	Brevard County and Brevard Zoo	All	Not applicable	Not applicable	Not applicable	Not applicable	$1,000,000

Note: The projects highlighted in tan and marked with a plus sign were added to the plan as part of an annual update.

As the IRL restoration needs continue to grow, the Oyster Gardening Program is poised to help meet the need for additional resources. Through independent grants, Brevard Zoo Restore Our

Shores has begun participating in seagrass and clam restoration efforts. The Oyster Gardening Program has diversified to connect waterfront homeowners with other community members to tend oyster habitats and grow *Mercenaria mercenaria* clams to repopulate the lagoon. Clams are important filter feeders that can live within seagrass meadows directly benefiting the habitat through local water quality improvements (Wall et al., 2008). Brevard Zoo also plans to pilot "community gardens" where residents can participate in restoration activities on public property, such as tending clam cover nets during the first year of growth.

There has been increasing need for seagrass restoration and, as water quality conditions in the lagoon become suitable, it will be necessary to raise seagrass to plant in the lagoon. The establishment of seagrass nurseries can provide opportunities for the public to engage in seagrass grow-out. Through IRL National Estuary Program funding, Brevard Zoo is working to build a seagrass nursery, which is in the final stages of design. The existing network of community participants in the Oyster Gardening Program will be invaluable to support these additional restoration efforts.

4.1.2 Wastewater Treatment Facility Upgrades

88% of reclaimed water in the County is used in public access areas and for landscape irrigation.

The direct wastewater treatment facility discharges to the Indian River Lagoon (IRL) have been largely removed, and the majority of facilities in the basin use the treated effluent for reclaimed water irrigation. While the use of reclaimed water for irrigation is an excellent approach to conserving potable water, if the reclaimed water is high in nutrient concentrations, the application of the reclaimed water for irrigation can result in nutrients leaching into the groundwater. It is important to note that there are no regulations on the concentration of nutrients in reclaimed water that is used for irrigation. However, University of Florida-Institute of Food and Agricultural Sciences studies indicate that a nitrogen concentration of 5 to 9 milligrams per liter is optimal for turfgrass growth, and each year a maximum amount of 1 pound of nitrogen can be applied per 1,000 square feet of turf (University of Florida-Institute of Food and Agricultural Sciences, 2013a and 2013b). Nitrogen leaching increases significantly when irrigation is greater than 2 centimeters per week (0.75 inches per week), even if the nitrogen concentrations are half of the maximum Institute of Food and Agricultural Sciences recommendation of 9 milligrams per liter.

In Brevard County (County), 88% of the reclaimed water is used in public access areas and for landscape irrigation. The total reclaimed water used countywide is approximately 18.5 million gallons per day, which is applied over 7,340 acres. The unincorporated County and city wastewater treatment facilities with the reclaimed water flows, total nitrogen (TN) concentrations based on permit data and loads in pounds per year are shown in **Table 4-9**. This table also summarizes the excess TN in the reclaimed water after environmental attenuation/uptake (75% for TN [Florida Department of Environmental Protection, 2017]), for both the current TN effluent concentration and if the facility were upgraded to achieve a TN effluent concentration of 6 milligrams per liter (the City of Palm Bay Water Reclamation Facility update will achieve a TN effluent concentration of 7.5 milligrams per liter and the City of Melbourne Grant Street Wastewater Treatment Facility will achieve a TN effluent concentration of 5 milligrams per liter).

Table 4-9: TN Concentrations in Wastewater Treatment Facility Reclaimed Water in 2016

Facility	Permitted Capacity (million gallons per day)	Reclaimed Water Flow (million gallons per day)	Total Nitrogen Concentration (milligrams per liter)	Total Nitrogen After Attenuation (pounds per year)	Total Nitrogen After Attenuation and Upgrade (pounds per year)
City of Palm Bay Water Reclamation Facility	4.0	1.20	29.4	27,305	6,966
City of Melbourne Grant Street	5.5	2.08	21.0	33,806	8,049
City of Titusville Osprey	2.75	1.67	12.7	16,415	7,755
Brevard County Port St. John	0.5	0.35	12.6	3,413	1,625
Cape Canaveral Air Force Station	0.8	0.80	11.9	7,368	3,714
City of West Melbourne Ray Bullard Water Reclamation Facility	2.5	0.85	11.1	7,302	3,947
Brevard County Barefoot Bay Water Reclamation Facility	0.9	0.48	10.3	3,826	2,229
Brevard County South Beaches	8.0	1.12	9.3	8,061	5,201
Brevard County North Regional	0.9	0.26	8.9	1,791	1,207
Rockledge Wastewater Treatment Facility	4.5	1.40	7.0	7,584	6,501
Brevard County South Central Regional	5.5	3.79	6.7	19,653	17,600
City of Titusville Blue Heron	4.0	0.84	4.8	4,993	Not applicable
City of Cape Canaveral Water Reclamation Facility	1.8	0.88	3.8	4,141	Not applicable
City of Cocoa Jerry Sellers Water Reclamation Facility	4.5	1.44	3.5	6,241	Not applicable
Brevard County Sykes Creek	6.0	1.48	3.4	3,895	Not applicable
City of Cocoa Beach Water Reclamation Facility	6.0	3.66	2.5	11,331	Not applicable

Based on a 2007 study by United States Environmental Protection Agency, the cost to upgrade wastewater treatment facilities to meet advanced wastewater treatment standards is approximately $4,200,000 per plant. This cost is in 2006 dollars, which, when inflated to 2016 dollars and costs are included for design and permitting, is approximately $6,000,000 per facility. Where cost estimates were available for facility upgrades, these costs were used instead of the inflated estimated costs. Due to the high cost per pound of TN and total phosphorus (TP) removed to upgrade some of these facilities compared to other projects in this plan, only those facilities in **Table 4-10** are recommended for upgrades as part of this plan. This table also includes the wastewater treatment facility upgrade projects submitted as part of an annual update to the plan. As part of the public education and outreach efforts, customers who use reclaimed water for irrigation should be informed of the nutrient content in the reuse water because they can and should eliminate or reduce the amount of fertilizer added to their lawn and landscaping. This information can be provided to the customers through their utility bill.

Table 4-10: Projects for Wastewater Treatment Facility Upgrades to Improve Reclaimed Water

Year Added	Project Number	Project Name	Responsible Entity	Sub-lagoon	Total Nitrogen Reduction (pounds per year)	Cost per Pound per Year of Total Nitrogen Removed	Total Phosphorus Reduction (pounds per year)	Cost per Pound per Year of Total Phosphorus Removed	Plan Funding
Original	2016-17	City of Palm Bay Water Reclamation Facility*	City of Palm Bay	Central IRL	20,240	$180	102	$35,636	$3,634,900
Original	2016-02a	City of Titusville Osprey Wastewater Treatment Facility*	City of Titusville	North IRL	8,660	$1,016	Not applicable	Not applicable	$8,800,000
2018	59	Grant Street Water Reclamation Facility Nutrient Removal Improvements+	City of Melbourne	Central IRL	18,052	$375	9,671	$700	$6,769,500
2019	99	Cocoa Beach Water Reclamation Facility Upgrade+	City of Cocoa Beach	Banana	2,520	$375	685	$1,380	$945,000
2020	2016-2b	City of Titusville Osprey Nutrient Removal Upgrade Phase 2+	City of Titusville	North IRL	3,626	$83	Not applicable	Not applicable	$300,000
2020	138	Ray Bullard Water Reclamation Facility Biological Nutrient Removal Upgrade+	City of West Melbourne	Central IRL	11,360	$375	3,302	$1,290	$4,260,000
2022	216	City of Rockledge Flow Equalization Basin Project+	City of Rockledge	North IRL	5,365	$383	Not applicable	Not applicable	$2,054,795
2023	234	South Brevard Water Reclamation Facility+	Brevard County Utilities	Central IRL	4,316	$383	863	$1,915	$1,653,028
-	**-**	***Total***	**-**	**-**	***74,139***	***$383 (average)***	***14,623***	***$1,943 (average)***	***$28,417,223***

Note: The projects highlighted in green and marked with an asterisk were identified in the original plan. The projects highlighted in tan and marked with a plus sign were added to the plan as part of an annual update.

4.1.3 Sprayfield and Rapid Infiltration Basin Upgrades

Another opportunity to reduce the nutrient loading from the wastewater treatment facilities is to upgrade the disposal locations, either sprayfields or rapid infiltration basins, for the treated effluent. The sprayfields and rapid infiltration basins could be modified to include biosorption activated media to provide additional nutrient removal. Examples of biosorption activated media include mixes of soil, sawdust, zeolites, tire crumb, vegetation, sulfur, and spodosols (Wanielista et al., 2011). Based on a pilot project in the City of DeLand, the potential removal of adding biosorption activated media to a sprayfield or rapid infiltration basin is 83% for total nitrogen (TN) and 66% for total phosphorus (TP) (City of DeLand and University of Central Florida, 2018). The loads for the facilities in Brevard County that dispose of reclaimed water to a sprayfield or rapid infiltration basin were estimated based on permit and discharge monitoring report information (where available). Attenuation rates used were based on Florida Department of Environmental Protection (2017) estimates of 60% for sprayfields and 25% for rapid infiltration basins. Then the biosorption activated media efficiency rate was applied to determine the TN that could be removed. Costs were estimated for each upgrade and the upgrades that could be made for the least cost per pound of TN are recommended for pilot project funding as part of this plan (see **Table 4-11** and **Table 4-12**). Information on nutrient concentrations or the size of the sprayfield/rapid infiltration basin were missing from several facilities. As this information is gathered, additional upgrades may be found to be cost-effective.

Table 4-11: Projects for Sprayfield or Rapid Infiltration Basin Upgrades for Public Facilities

Year Added	Project Number	Project Name	Responsible Entity	Sub-lagoon	Total Nitrogen Reduction (pounds per year)	Total Nitrogen Cost per Pound per Year	Total Phosphorus Reduction (pounds per year)	Total Phosphorus Cost per Pound per Year	Plan Funding
2017	6	Long Point Park Upgrade+	Brevard County Parks Department	Central IRL	163	$625	Not applicable	Not applicable	$101,854
-	**-**	***Total***	**-**	**-**	***163***	***$625***	***Not applicable***	***Not applicable***	***$101,854***

Note: The projects highlighted in tan and marked with a plus sign were added to the plan as part of an annual update.

Table 4-12: Projects for Sprayfield or Rapid Infiltration Basin Upgrades for Private Facilities

Year Added	Project Number	Project Name	Responsible Entity	Sub-lagoon	Total Nitrogen Reduction (pounds per year)	Total Nitrogen Cost per Pound per Year	Total Phosphorus Reduction (pounds per year)	Total Phosphorus Cost per Pound per Year	Plan Funding
2022	196	Sterling House Condominium Sprayfield+^	Property Owner	Central IRL	154	$390	To be determined	To be determined	$60,000
-	**-**	***Total***	**-**	**-**	***154***	***$390***	***To be determined***	***To be determined***	***$60,000***

Note: The projects highlighted in tan and marked with a plus sign were added to the plan as part of an annual update.
^ This is the most cost-effective location that is not likely to become eligible to connect to sewer in the near future.

4.1.4 Package Plant Connections

Package plants are miniature wastewater treatment facilities that serve small communities producing more than 2,000 gallons of effluent per day. The most common package plant treatment methods are extended aeration, sequencing batch reactors, and oxidation ditches; the same biological treatment methods used in larger wastewater treatment plants. The smallest package plants often use the same technology as advanced septic systems. Following this treatment, the effluent is disposed of in rapid infiltration basins (ponds), sprayfields, or drainfields (United States Environmental Protection Agency, 2000).

Most package plants were removed in the 1990s following the Indian River Lagoon System and Basin Act of 1990. However, opportunities still exist to address some of the worst remaining package plants by upgrading the existing plant, adding nutrient scrubbing technology, or preferably connecting them to central sewer where the wastewater will receive further treatment and disposal far from the lagoon. A few of these package plants are located along the Indian River Lagoon (IRL) and, therefore, pose a substantial nutrient risk due to their effluent concentration and disposal methods. **Table 4-13** lists the estimated total nitrogen (TN) reductions and costs to connect the package plants to the sewer system. The estimated TN load from each package plant accounts for attenuation rates that were based on Florida Department of Environmental Protection (2017) estimates of 60% for sprayfields and 25% for rapid infiltration basins.

Table 4-13: Projects for Package Plant Connection

Year Added	Project Number	Project Name	Responsible Entity	Sub-lagoon	Total Nitrogen Reduction (pounds per year)	Total Nitrogen Cost per Pound per Year	Total Phosphorus Reduction (pounds per year)	Total Phosphorus Cost per Pound per Year	Plan Funding
2021	192	Oak Point Wastewater Treatment Facility Improvements+	Oak Point Mobile Home Park	North IRL	186	$1,500	0	Not applicable	$279,000
2022	249	Indian River Shores Trailer Park+	Property Owner	Central IRL	450	$1,175	To be determined	To be determined	$528,627
2023	237	Willow Lakes Recreational Vehicle Park+	Willow Lakes Homeowners Association	North IRL	725	$1,500	To be determined	To be determined	$1,087,500
2023	239	The Cove at South Beaches Package Plant Connection+	The Cove Homeowners Association	Central IRL	81	$1,500	To be determined	To be determined	$121,500
-	**-**	***Total***	**-**	**-**	***1,442***	***$1,398 (average)***	***To be determined***	***To be determined***	***$2,016,627***

Note: The projects highlighted in tan and marked with a plus sign were added to the plan as part of an annual update.

4.1.5 Sewer Laterals Rehabilitation

Sewage overflows following heavy rainfall events are an indicator of illegal connections or inadequate sewer asset conditions. There are three major components of wastewater flow in a sanitary sewer system: (1) base sanitary (or wastewater) flow, (2) groundwater infiltration, and (3) rainfall inflow. Virtually every sewer system has some infiltration and/or inflow. Historically, small amounts of infiltration and/or inflow are expected and tolerated. However, infiltration and/or inflow becomes excessive when it causes overflows, health, and/or environmental risks. There have been recurring overflows from the South Beaches Wastewater Treatment Facility sewer system, including significant overflows following Hurricane Matthew in 2016 and Hurricane Irma in 2017. Less frequent overflows and line breaks have occurred in other sewer service areas.

In 2012, in recognition of aging infrastructure and increasingly frequent issues, the Brevard County (County) Utility Services Department engaged seven professional engineering firms to perform independent field evaluations of the condition of the sewage infrastructure assets located in each of the County's seven independent sewer service areas. The output of this investigation was the identification of $134 million in specific capital improvement needs required over a ten-year period to bring County-owned sewer system assets up to a fully functional, reliable, affordable, efficient, and maintainable condition (Brevard County Utility Services, 2013). The field evaluation results and corresponding 10-year Capital Improvement Program Plan were presented to the Brevard County Commission in 2013. In response, the Commission approved financing the entire Capital Improvement Program Plan and increased the County's sewer service rates to repay the debt. Plan implementation began in 2014 and projects are progressing quickly.

Because there was already a capital improvement plan and funding mechanism for updating the County's aging sewer system infrastructure, the original Save Our Indian River Lagoon Project Plan did not include analysis or funding for sewer system repairs. Unfortunately, even in areas where capital improvements have been made, infiltration and/or inflow continue to be a problem that contributes to overflows that discharge untreated wastewater into the Indian River Lagoon (IRL). This indicates the probability of problems outside the County-owned assets and could include illegal connections and/or leaks in the privately owned lateral connections of homes and businesses to the County sewer system.

Identifying problems on the customer side of the connection required smoke testing each building or private residence to determine if leaks or illegal connections are present. The extent of infiltration and/or inflow on the customer side of the connections is unknown and, therefore, the nutrient loading associated with these issues are also unknown. As a first step to determine the extent of infiltration and/or inflow problems with the sewer laterals, the County partnered with the City of Satellite Beach on a pilot project to perform smoke testing of more than 12,000 buildings and residences within the area of concern in March through July of 2018. Smoke testing results are included in **Section 4.4.3**.

Repair of privately-owned portions of the sewer system is not funded in the County's adopted Capital Improvement Program Plan for the Wastewater Utility; therefore, use of the Save Our Indian River Lagoon Tax funding was considered. The Brevard County Utility Services Department estimates that infiltration and/or inflow due to rainfall and flooding associated with Hurricane Irma, caused 1,835 pounds per year of total nitrogen (TN) and 350 pounds per year of total phosphorus (TP) to enter the lagoon from sewer overflowing from the South Beaches Regional Wastewater Treatment Facility sewer system. Staff reviewed 13 years of storm-related release data (2004–2017) to estimate the average annual nutrient load to the lagoon from emergency sewage overflows. If repairing private connections could prevent similar overflows in the future, then the average annual nitrogen reduction benefit of such repairs would be approximately 988 pounds per year of TN. The average cost effectiveness of sewer expansion projects funded in the 2017 Plan Supplement was $852 per pound of nitrogen removed, thus the cost to reduce 988 pounds per year of TN loading by implementing septic-to-sewer projects would be $841,842. Therefore, the 2018 Update allocated $840,000 to assist property owners with the cost to repair leaky sewer connections expected to be found through smoke testing.

After smoke testing was complete in the pilot area, the cost to repair the leaks that were detected was estimated at $646,200. These results supported expansion of this program from the Satellite Beach pilot area to other city and county sewer service areas. A second pilot area for smoke testing was added in 2019 and three more areas were added in 2020; however, funds were not added to assist owners with making repairs in these areas. Instead, the Citizen Oversight Committee and Brevard County Board of County Commissioners decided in 2020 to make the $840,000 of funding available to offer grants county-wide for the repair of leaky laterals within the watershed of the IRL. Based on the costs reported so far for the replacement of missing caps and repair of broken pipes, current funding levels may be sufficient to fund the repair of all leaks detected in the currently approved smoke testing areas. **Table 4-14** summarizes the sewer laterals rehabilitation projects. It should be noted that smoke testing alone does not result in nutrient load reductions; identified issues must be repaired to achieve a nutrient load reduction benefit. Therefore, the funding for this type of project is focused on repairs to achieve reductions.

The Save Our Indian River Lagoon Trust Fund will also be used to conduct performance monitoring to measure the nutrient reduction benefits of repairing privately-owned leaky lateral connections. In addition to documenting less groundwater leaking into pipes and overwhelming the sewer infrastructure, monitoring will also seek to document improvement in groundwater quality that may occur when the leaks are repaired.

Table 4-14: Projects for Sewer Laterals Rehabilitation

Year Added	Project Number	Project Name	Responsible Entity	Sub-lagoon	Total Nitrogen Reduction (pounds per year)	Cost per Pound per year of Total Nitrogen Removed	Total Phosphorus Reduction (pounds per year)	Cost per Pound per Year of Total Phosphorus Removed	Plan Funding
2018, 2021	63ab	Satellite Beach Lateral Smoke Testing and Countywide Repair/Replacement+	Brevard County	Banana	988	$850	188	$4,468	$840,000
2019	100	Osprey Basin Lateral Smoke Testing+	City of Titusville	North IRL	640	Not applicable	Not applicable	Not applicable	$200,000
2020	114	Barefoot Bay Lateral Smoke Testing+	Brevard County Utility Services Department	Central IRL	864	Not applicable	Not applicable	Not applicable	$90,000
2020	115	South Beaches Lateral Smoke Testing+	Brevard County Utility Services Department	Central IRL	1,662	Not applicable	Not applicable	Not applicable	$200,000
2020	116	Merritt Island Lateral Smoke Testing+	Brevard County Utility Services Department	North IRL	2,042	Not applicable	Not applicable	Not applicable	$250,000
-	***-***	***Total***	***-***	***-***	***6,196***	***$1,230 (average)***	***188***	***$8,404 (average)***	***$1,580,000***

Note: The projects highlighted in tan and marked with a plus sign were added to the plan as part of an annual update.

4.1.6 Septic-to-Sewer and Septic System Upgrades

Septic systems are commonly used where central sewer does not exist. When properly sited, designed, constructed, maintained, and operated, septic systems are often a safe means of disposing of domestic waste but still add nutrients to the system. However, when septic systems are older and failing or are installed over poor soils close to the groundwater table or open water, they can be a major contributor of nutrients and bacterial and viral pathogens to the Indian River Lagoon (IRL) system. To address this source, options for both septic-to-sewer and septic system upgrades were evaluated. It is important to note that although Brevard County (County) is taking the lead on these projects, the Florida Department of Health is responsible for the regulation and permitting of septic systems. The County will coordinate with Florida Department of Health on the septic system projects recommended in this plan.

Septic-to-Sewer by Extension

In 2018, Brevard County conducted a more detailed evaluation of septic system impacts to surface waters through both groundwater monitoring and modeling using the Florida Department of Environmental Protection-approved ArcGIS-Based Nitrate Load Estimation Toolkit (Rios et al., 2013). This evaluation found that groundwater conductance and soil types were more important for nitrogen transport from septic systems than was previously accounted for in the approach used for ranking in the original Save Our Indian River Lagoon Plan. Therefore, for the 2019 Update, the approach to prioritize areas for septic system connection to the sewer system was modified. The updated approach and recommended projects are summarized below.

The updated approach to rank areas for septic system impacts used information on the potential nutrient contribution from the ArcGIS-Based Nitrate Load Estimation Toolkit (Rios et al., 2013). Potential nutrient contributions were determined based on numerous factors, but after testing model sensitivity to these factors, a simplified approach was developed for Brevard County that was based primarily on the spatial location of the septic system (i.e., Barrier Island, Merritt Island, Mainland, or Melbourne Tillman Water Control District), soil type (soil hydraulic conductance), and the minimum distance to waterbodies (Applied Ecology, 2018).

A direct comparison between the previous model that adapted studies from Martin and St. Lucie counties (**Table 4-15**) and the new model tailored to Brevard County's soil and water (**Table 4-16**) is difficult. For loading in pounds per year, the previous study estimated total nitrogen (TN), which is the sum of nitrate, nitrite, ammonia, and organic nitrogen, whereas the new approach using the ArcGIS-Based Nitrate Load Estimation Toolkit estimated only nitrate and ammonia. Through the detailed ArcGIS-Based Nitrate Load Estimation Toolkit analysis it was also determined that there are 6,260 fewer septic systems in the IRL Basin than estimated in the original plan.

Table 4-15: Original Estimate of TN Loading and Cost to Connect for Septic Systems

Septic System Distance from Surface Water (yards)	Number of Septic Systems	Total Nitrogen Load Per System (pounds per year)	Total Nitrogen Load (pounds per year)	Cost per System to Connect	Total Cost	Cost per Pound per Year of Total Nitrogen
0–55	15,090	27.095	408,863	$20,000	$301,800,000	$738
55–219	25,987	6.865	178,395	$20,000	$519,740,000	$2,913
Greater than 219	18,361	0.001	10	$20,000	$367,220,000	$37,624,010
Total	***59,438***	***9.880 (average)***	***587,268***	***$20,000***	***$1,188,760,000***	***$2,024 (average)***

Table 4-16: Updated Estimate of TN Loading based on ArcGIS-Based Nitrate Load Estimation Toolkit and Updated Cost to Connect for Septic Systems

Septic System Distance from IRL (yards)	Number of Septic Systems	Total Nitrogen Load per System (pounds per year)	Total Nitrogen Load (pounds per year)	2022 Cost per System to Connect	Total Cost	Cost per Pound per Year of Total Nitrogen
0–55	15,737	19.037	299,590	$60,618	$953,945,466	$3,184
55–219	23,969	3.612	86,575	$60,618	$1,452,952,842	$16,782
Greater than 219	13,472	0.802	10,805	$60,618	$816,645,696	$75,584
Total	***53,178***	***Not applicable***	***396,970***	***$60,618***	***$3,223,544,004***	***$8,120 (average)***

Those septic systems within 55 yards of surface waters were further analyzed by soil hydraulic conductivity since it was found to be a highly influential variable in nutrient loading from septic systems. Hydraulic conductance is the ability of water to move through pore space in the soil with sandy soils having a higher conductance compared to loamy and clay soils. As shown in **Table 4-17**, nitrogen loading is much higher in the very high and high conductivity soils compared to the average for all soils within 55 yards. Although only half of the septic systems are in very high and high conductance soils, these account for 76% of the nitrogen loading.

Table 4-17: Septic Systems by Soil Hydraulic Conductance Class within 55 Yards of IRL

Hydraulic Conductivity of Septic Systems Within 55 Yards of IRL	Number of Septic Systems	Total Nitrogen Load per System (pounds per year)	Total Nitrogen Load (pounds per year)	Cost per System to Connect	Total Cost	Cost per Pound per Year of Total Nitrogen
Very High	1,899	34.926	66,324	$60,618	$115,113,582	$1,736
High	6,304	26.021	164,039	$60,618	$382,135,872	$2,330
Medium	3,230	12.198	39,401	$60,618	$195,796,140	$4,970
Low	3,396	5.930	20,141	$60,618	$205,858,728	$10,222
Very Low	908	10.664	9,683	$60,618	$55,041,144	$5,684
Total	***15,737***	***Not applicable***	***299,588***	***$60,618***	***$953,945,466***	***$3,184 (average)***

Table 4-18 shows those properties with septic systems in very high and high hydraulic conductance soils distributed by distance to surface waterbodies. Waterfront properties served by septic systems, including those properties adjacent to the lagoon, tributary rivers and creeks, or on canals or drainage ditches that discharge to the lagoon contribute 48% of all septic system loading in the IRL watershed in Brevard County. Changes in the 2019 Update shifted septic-to-sewer and septic upgrade projects as much as feasible to areas of high conductivity soils located adjacent to waterways that contribute the greatest loading to the IRL.

Table 4-18: Septic Systems in Very High and High Hydraulic Conductance Soils Distributed by Distance to Surface Waters

Septic System Distance from Surface Water (yards)	Number of Septic Systems	Total Nitrogen Load per System (pounds per year)	Total Nitrogen Load (pounds per year)	Cost per System to Connect	Total Cost	Cost per Pound per Year of Total Nitrogen
0–11	5,584	33.838	188,956	$60,618	$338,490,912	$1,791
11–22	1,207	16.404	19,799	$60,618	$73,165,926	$3,695
22–33	465	17.466	8,121	$60,618	$28,187,370	$3,471
33–44	384	12.458	4,784	$60,618	$23,277,312	$4,866
44–55	563	15.456	8,702	$60,618	$34,127,934	$3,922
Total	***8,203***	***28.083***	***230,362***	***$60,618***	***$497,249,454***	***$2,159 (average)***

For the funded opportunities that were identified using the new ranking method, the number of lots that could be connected, associated cost of the connection, and estimated TN reductions are shown in **Table 4-19**. **Figure 4-10** through **Figure 4-14** show the location of each of these areas. These funded opportunities, including the quick connection projects described below, represent the connection of approximately 9% of the septic systems in Brevard County within the IRL Basin but reduce 30% of the nutrient load contribution attributed to existing septic systems in Brevard.

Another opportunity for removing septic systems is to use a hybrid septic tank effluent pumping system. In this system, effluent from the septic tank is connected to sewer pressure lines. Small-diameter pipes, which can be installed relatively quickly, are used instead of the gravity sewer system. A high pressure ½ horsepower pump (115 volt) pumps the effluent from the septic system to a force main or gravity sewer system. The City of Vero Beach is installing these systems and they are leaving the drainfields in place, which saves money and allows for a backup in the event that a power outage affects the septic tank effluent pumping system. If the drainfield is not left in place, a 500-gallon pump chamber is installed to allow enough reserve capacity to address power outages. Each septic tank effluent pumping system also has an emergency generator receptacle to address long-term power outages associated with hurricanes. The estimated cost per connection is $6,000 to $10,000, which includes the cost of the pipes. The City of Vero Beach maintains the septic tank effluent pumping system and pumps out the septic tank when needed. The customer pays the electrical costs to operate the pump for this system.

For highly ranked properties located within the vicinity of a pressure line or gravity sewer system, the septic tank effluent pumping system may be a good option instead of the septic system upgrades described below. If septic tank effluent pumping systems are selected as a preferred option anywhere in Brevard County, specific locations for septic tank effluent pumping system installation can be submitted for funding consideration through the annual project funding request and plan update process.

Table 4-19: Projects for Septic-to-Sewer

Year Added	Project Number	Project Name	Responsible Entity	Sub-lagoon	Total Nitrogen Reduction (pounds per year)	Total Nitrogen Cost per Pound per Year	Total Phosphorus Reduction (pounds per year)	Total Phosphorus Cost per Pound per Year	Plan Funding
Original	2016-47	Sykes Creek - Zone N*	Brevard County	Banana	2,784	$1,500	Not applicable	Not applicable	$4,176,000
Original	2016-48	Sykes Creek - Zone M*	Brevard County	Banana	1,798	$1,500	Not applicable	Not applicable	$2,697,000
Original	2016-49	Sykes Creek - Zone T*	Brevard County	Banana	3,360	$1,500	Not applicable	Not applicable	$5,040,000
Original	2016-30	City of Rockledge*	City of Rockledge	North IRL	712	$703	Not applicable	Not applicable	$500,580
Original	2016-31/32	City of Cocoa – Zones J and K*	City of Cocoa	North IRL	3,748	$1,646	Not applicable	Not applicable	$6,167,373
Original	2016-33	City of Melbourne*	City of Melbourne	North IRL	878	$988	Not applicable	Not applicable	$867,672
Original	2016-35	South Beaches - Zone A*	Brevard County	North IRL	1,306	$1,500	Not applicable	Not applicable	$1,959,000
Original	2016-39	City of Palm Bay – Zone A*	City of Palm Bay	Central IRL	2,136	$1,203	Not applicable	Not applicable	$2,569,644
Original	2016-46	City of Palm Bay – Zone B*	City of Palm Bay	Central IRL	6,809	$1,220	Not applicable	Not applicable	$8,309,628
Original	109	City of Titusville - Zones A-G*	City of Titusville	North IRL	1,563	$769	Not applicable	Not applicable	$1,201,392
Original	203	South Central - Zone A*	Brevard County	North IRL	3,655	$1,500	Not applicable	Not applicable	$5,482,500
2017	1	Breeze Swept Septic-to-Sewer Connection+	City of Rockledge	North IRL	2,002	$440	Not applicable	Not applicable	$880,530
2017	2a	Merritt Island Septic Phase Out Project+	Merritt Island Redevelopment Agency	North IRL	2,501	$128	Not applicable	Not applicable	$320,268
2017	4	Hoag Sewer Conversion+	City of Melbourne	Central IRL	101	$852	Not applicable	Not applicable	$86,031
2017	5	Pennwood Sewer Conversion	City of Melbourne	Central IRL	103	$786	Not applicable	Not applicable	$81,000
2018	60	Sylvan Estates Septic-to-Sewer Conversion+	City of West Melbourne	Central IRL	1,073	$1,455	Not applicable	Not applicable	$1,561,215
2018	61	Riverside Drive Septic-to-Sewer Conversion+	City of Melbourne	North IRL	305	$872	Not applicable	Not applicable	$265,960

Year Added	Project Number	Project Name	Responsible Entity	Sub-lagoon	Total Nitrogen Reduction (pounds per year)	Total Nitrogen Cost per Pound per Year	Total Phosphorus Reduction (pounds per year)	Total Phosphorus Cost per Pound per Year	Plan Funding
2018	62	Roxy Avenue Septic-to-Sewer Conversion+	City of Melbourne	North IRL	102	$872	Not applicable	Not applicable	$88,944
2019	2019-27	Sharpes - Zone A+	Brevard County	North IRL	5,248	$1,500	Not applicable	Not applicable	$7,872,000
2019	2019-29	South Banana - Zone B+	Brevard County	Banana	915	$1,500	Not applicable	Not applicable	$1,372,500
2019	2020-34	South Central - Zone F+	City of Melbourne	North IRL	1,688	$1,008	Not applicable	Not applicable	$1,701,972
2019	2019-36	South Beaches - Zone O+	Brevard County	North IRL	136	$979	Not applicable	Not applicable	$133,488
2019	2019-37	South Beaches - Zone P+	Brevard County	North IRL	242	$1,241	Not applicable	Not applicable	$300,348
2019	2019-38	City of Titusville - Zone H+	City of Titusville	North IRL	910	$1,284	Not applicable	Not applicable	$1,168,020
2019	2019-40	Rockledge - Zone B+	City of Rockledge	North IRL	4,037	$1,323	Not applicable	Not applicable	$5,339,520
2020	2020-28	South Central – Zone D (Melbourne)+	City of Melbourne	North IRL	177	$1,500	Not applicable	Not applicable	$265,500
2020	145	Merritt Island - Zone F+	Brevard County Utility Services Department	Banana	1,292	$851	Not applicable	Not applicable	$1,100,000
2020	50b	South Central - Zone C+	Brevard County Utility Services Department	North IRL	5,146	$1,283	Not applicable	Not applicable	$6,600,000
2020	136	Micco - Zone B+	Brevard County Utility Services Department	Central IRL	8,687	$1,036	Not applicable	Not applicable	$9,000,000
2020	146	Merritt Island - Zone C+	Brevard County Utility Services Department	Banana	1,419	$1,113	Not applicable	Not applicable	$1,580,000
2020	147	Sykes Creek - Zone R+	Brevard County Utility Services Department	Banana	2,925	$1,500	Not applicable	Not applicable	$4,387,500
2020	150	South Central - Zone D+	Brevard County Utility Services Department	North IRL	3,387	$1,410	Not applicable	Not applicable	$4,774,500

Year Added	Project Number	Project Name	Responsible Entity	Sub-lagoon	Total Nitrogen Reduction (pounds per year)	Total Nitrogen Cost per Pound per Year	Total Phosphorus Reduction (pounds per year)	Total Phosphorus Cost per Pound per Year	Plan Funding
2020	148	North Merritt Island - Zone E+	Brevard County Utility Services Department	Banana	2,541	$1,500	Not applicable	Not applicable	$3,811,500
2020	151	Merritt Island - Zone G+	Brevard County Utility Services Department	Banana	11,078	$1,500	Not applicable	Not applicable	$16,617,000
2020	152	Sharpes - Zone B+	Brevard County Utility Services Department	North IRL	2,692	$1,500	Not applicable	Not applicable	$4,038,000
2020	153	Cocoa - Zone C+^	Brevard County Utility Services Department	North IRL	3,499	$1,500	Not applicable	Not applicable	$800,000
2021	3	Micco Sewer Line Extension (Phase I and II)+	Brevard County	Central IRL	1,493	$1,500	Not applicable	Not applicable	$2,239,500
2021	189	Avendia del Rio Septic-to-Sewer+	City of Melbourne	Central IRL	71	$986	Not applicable	Not applicable	$70,000
2021	190	Bowers Septic-to-Sewer+	City of Melbourne	North IRL	120	$1,225	Not applicable	Not applicable	$147,000
2021	191	Kent and Villa Espana Septic-to-Sewer Conversion+	City of Melbourne	North IRL	542	$1,310	Not applicable	Not applicable	$710,000
2022	222	Hedgecock/ Grabowsky and Desoto Fields+	City of Satellite Beach	Banana	81	$1,500	Not applicable	Not applicable	$121,500
2022	224	Lake Ashley Circle+	City of West Melbourne	Central IRL	1,136	$1,500	Not applicable	Not applicable	$1,704,000
2022	225	Dundee Circle and Manor Place+	City of West Melbourne	Central IRL	1,499	$1,500	Not applicable	Not applicable	$2,248,500
2023	238	Kelly Park+	Brevard County Parks and Recreation	Banana	90	$1,500	Not applicable	Not applicable	$135,000
2023	240	Rotary Park+	Brevard County Parks and Recreation	Banana	104	$1,500	Not applicable	Not applicable	$156,000

Year Added	Project Number	Project Name	Responsible Entity	Sub-lagoon	Total Nitrogen Reduction (pounds per year)	Total Nitrogen Cost per Pound per Year	Total Phosphorus Reduction (pounds per year)	Total Phosphorus Cost per Pound per Year	Plan Funding
2023	241	Manatee Cove+	Brevard County Parks and Recreation	North IRL	24	$1,500	Not applicable	Not applicable	$36,000
2023	242	Riverwalk+	Brevard County Parks and Recreation	North IRL	4	$1,500	Not applicable	Not applicable	$6,000
-	**-**	***Total***	**-**	**-**	***96,119***	***$1,256 (average)***	***Not applicable***	***Not applicable***	***$120,686,169***

Note: The projects highlighted in green and marked with an asterisk were identified in the original plan. The projects highlighted in tan and marked with a plus sign were added to the plan as part of an annual update.
^ The Cocoa – Zone C project is not fully funded at this time. The $800,000 allocated to this project is for design and permitting to prepare the project for construction and make it more competitive for grant funding.

Figure 4-2: Septic-to-Sewer Projects in Banana River Lagoon

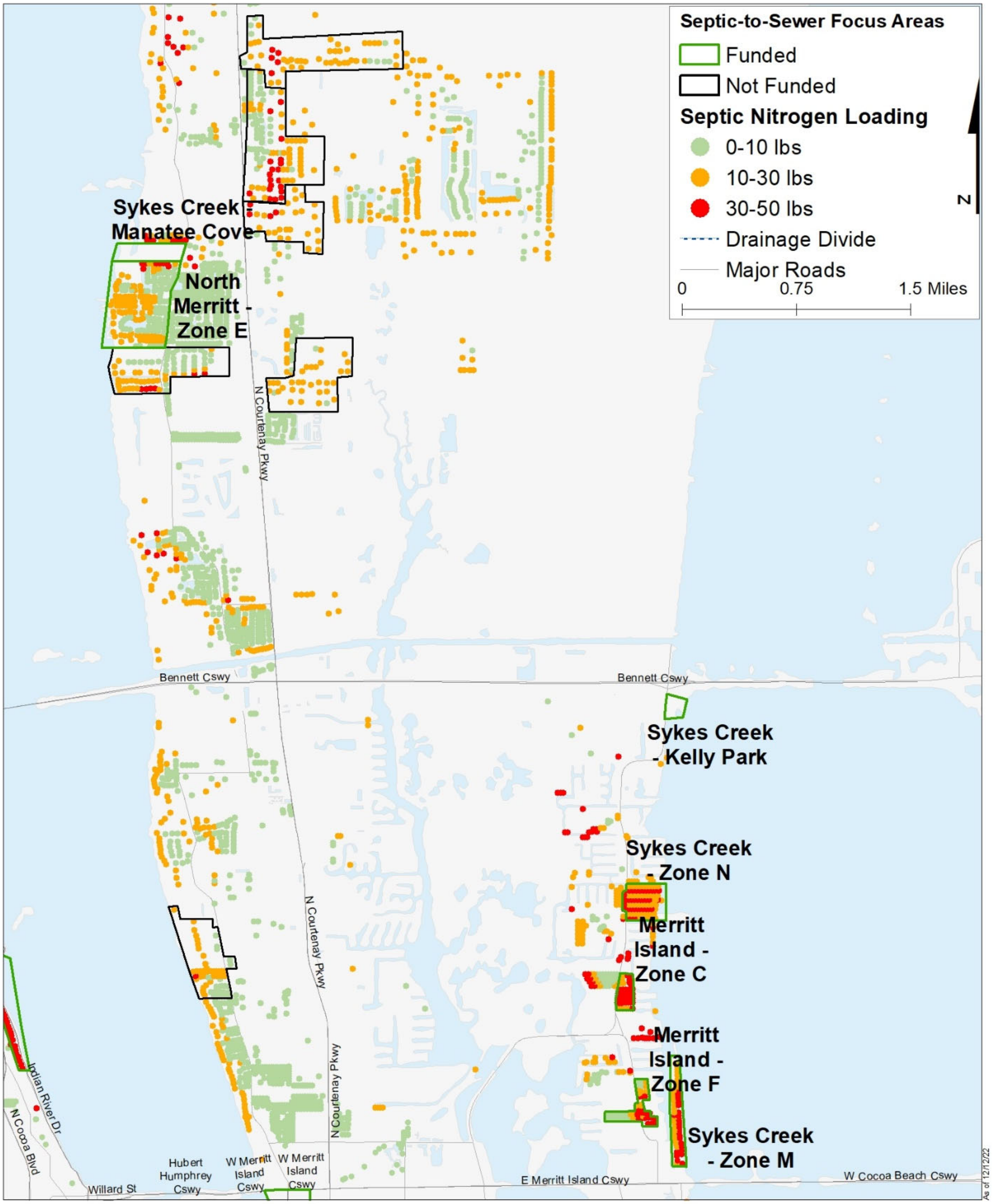


Figure 4-2 [Long Description]

Figure 4-3: Septic-to-Sewer Projects in Banana River Lagoon, continued

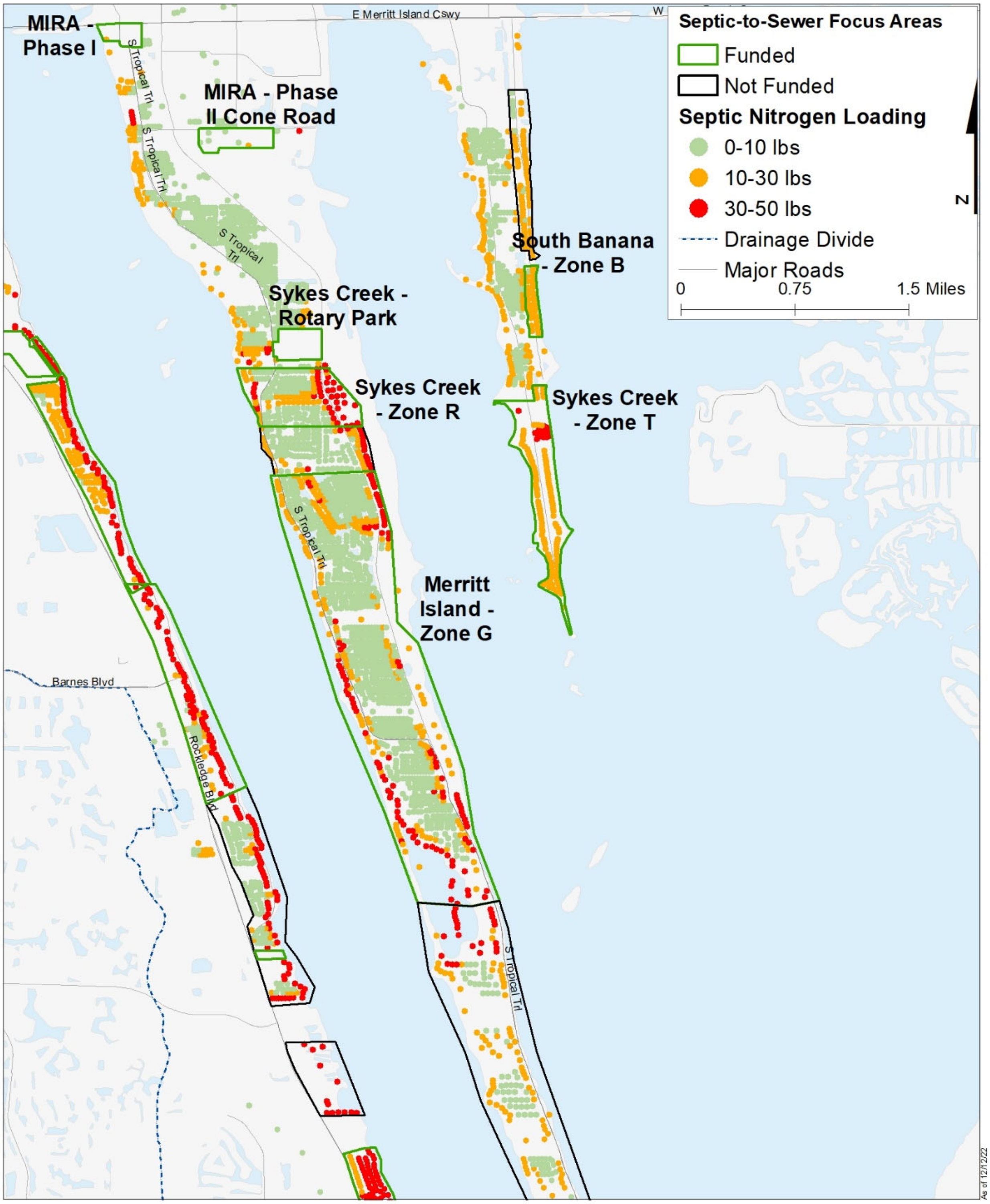


Figure 4-3 Long Description

Figure 4-4: Septic-to-Sewer Projects in Banana River Lagoon, continued

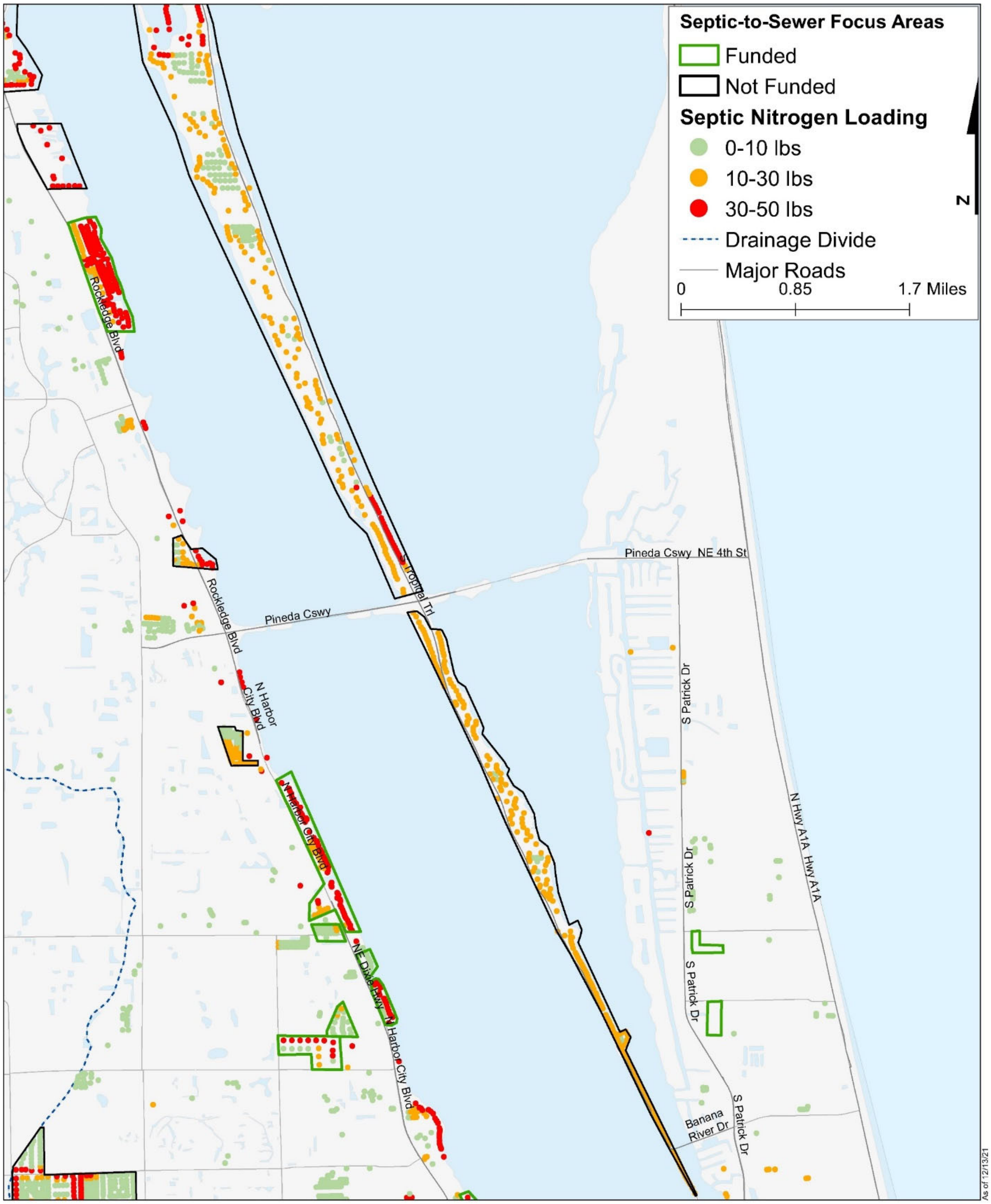


Figure 4-4 Long Description

Figure 4-5: Septic-to-Sewer Projects in North IRL

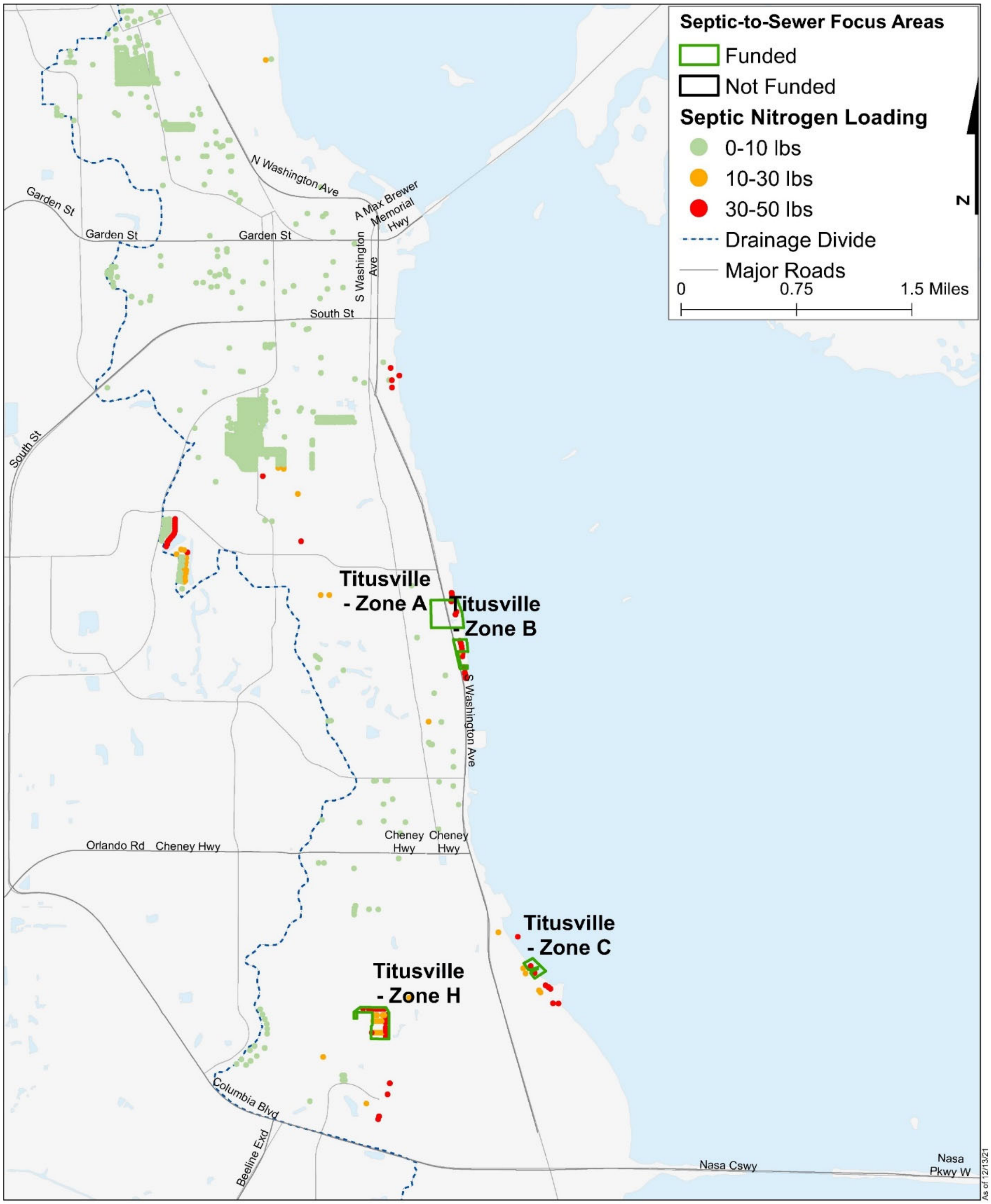


Figure 4-5 Long Description

Figure 4-6: Septic-to-Sewer Projects in North IRL, continued

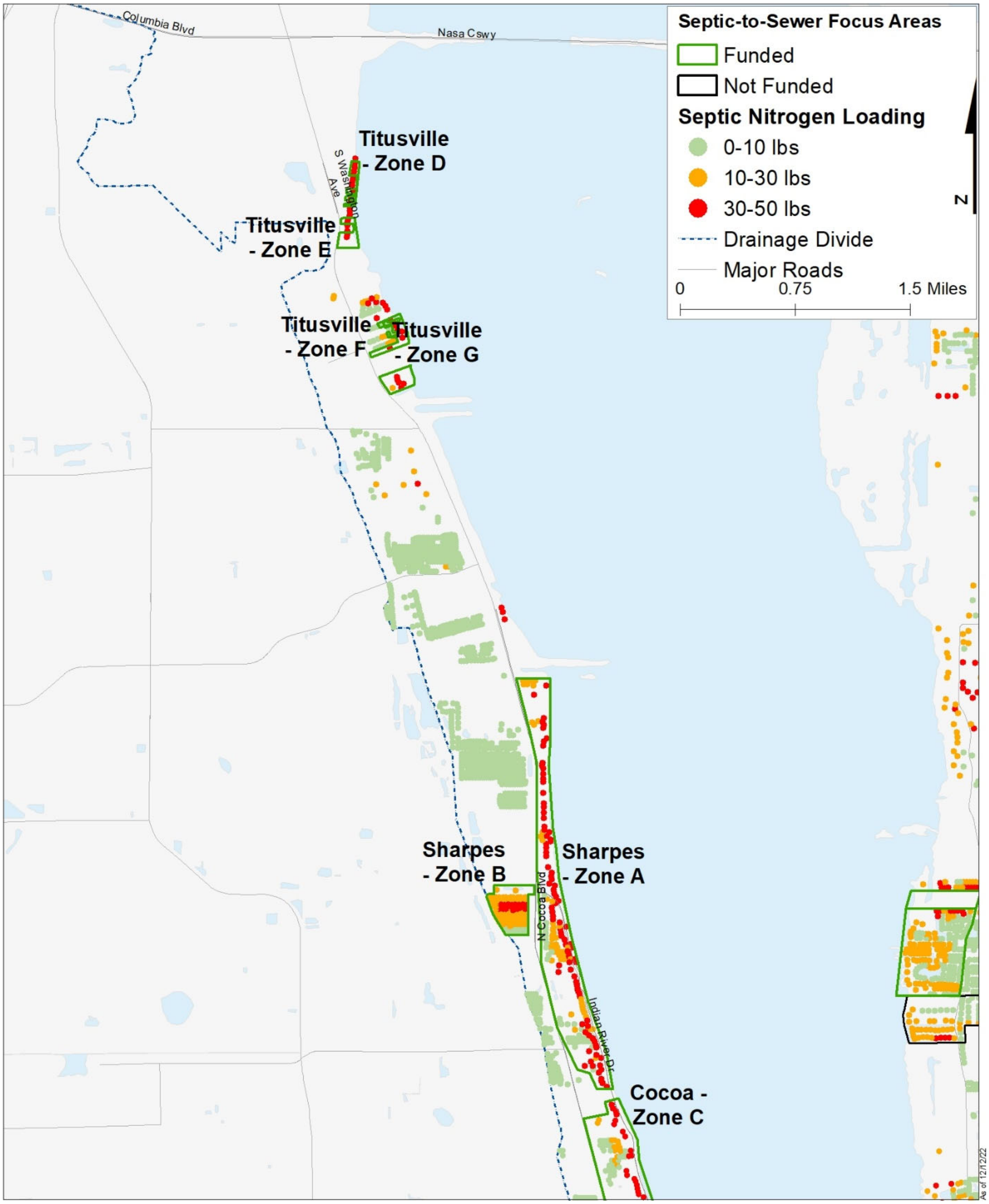


Figure 4-6 Long Description

Figure 4-7: Septic-to-Sewer Projects in North IRL, continued

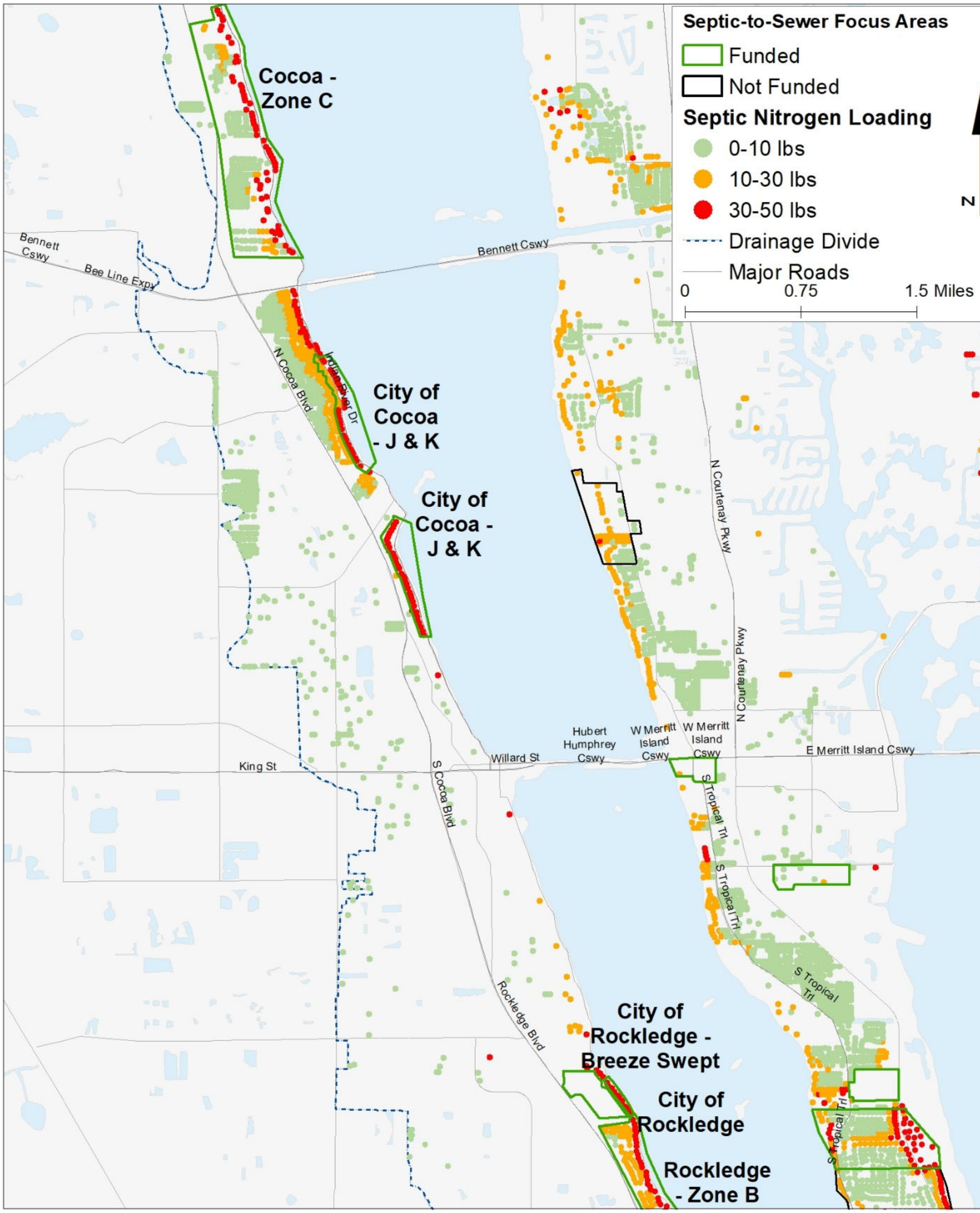


Figure 4-7 [Long Description]

Figure 4-8: Septic-to-Sewer Projects in North IRL, continued

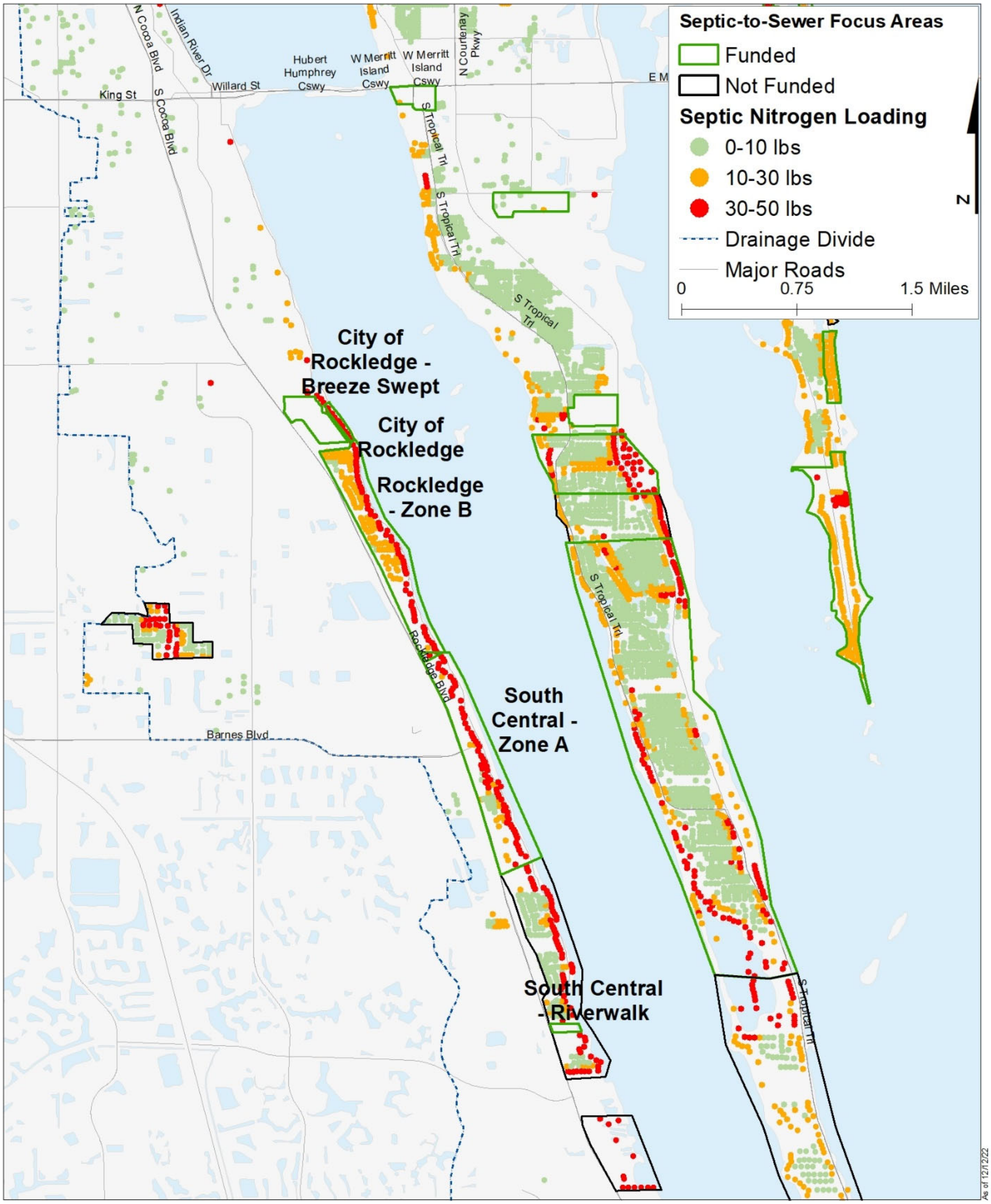


Figure 4-8 Long Description

Figure 4-9: Septic-to-Sewer Projects in North IRL, continued

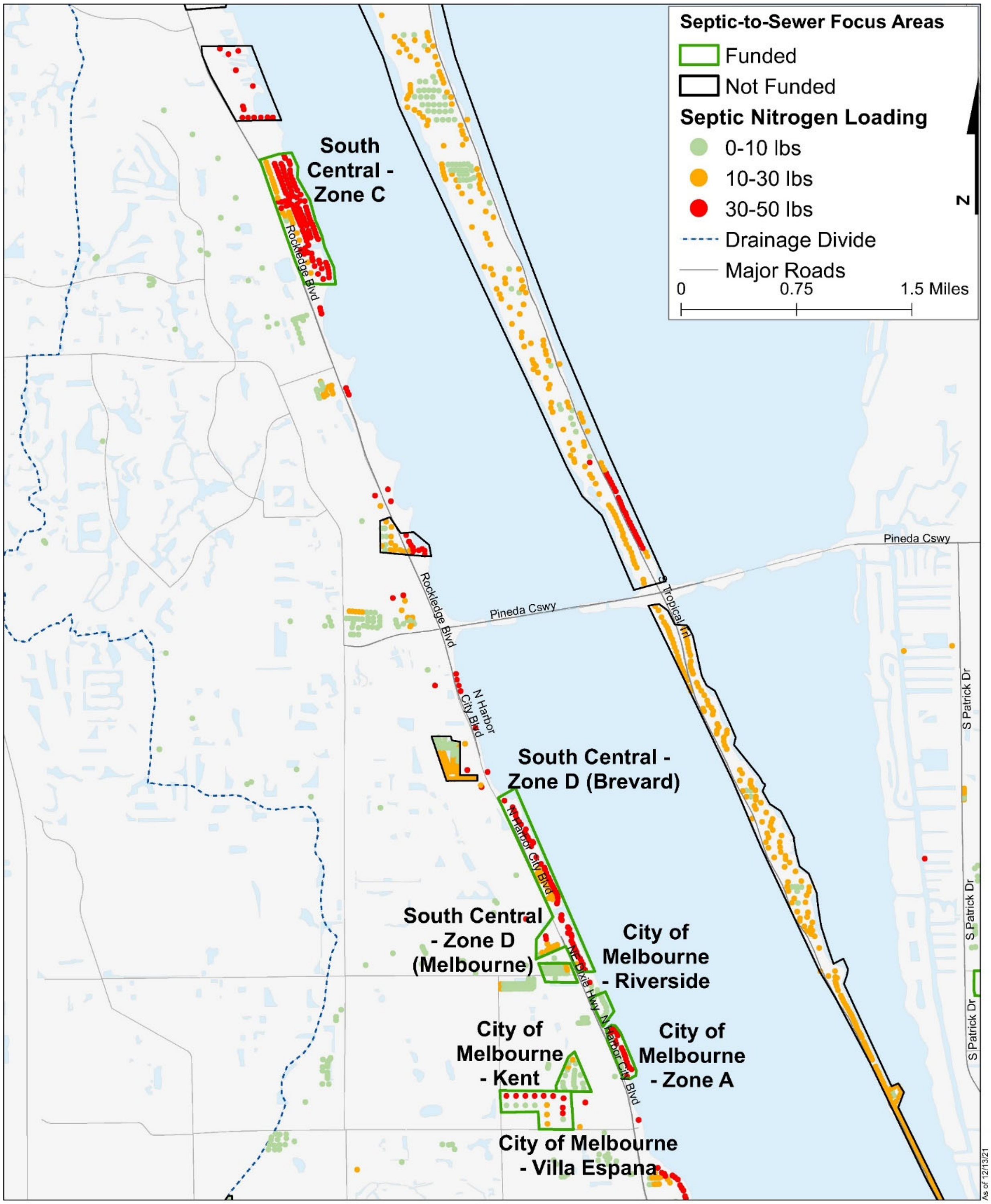


Figure 4-9 Long Description

Figure 4-10: Septic-to-Sewer Projects in North IRL, continued

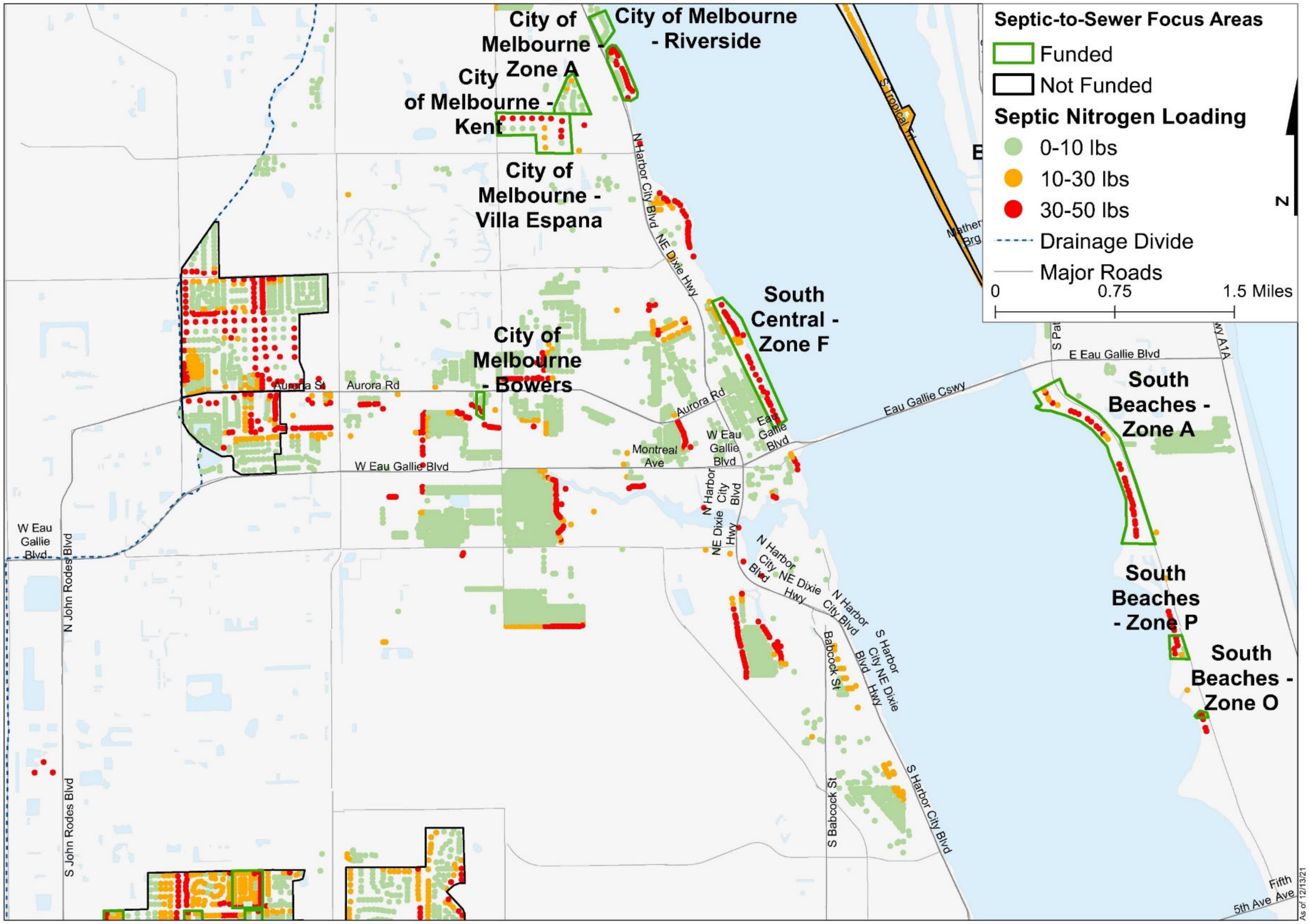


Figure 4-10 [Long Description]

Figure 4-11: Septic-to-Sewer Projects in Central IRL

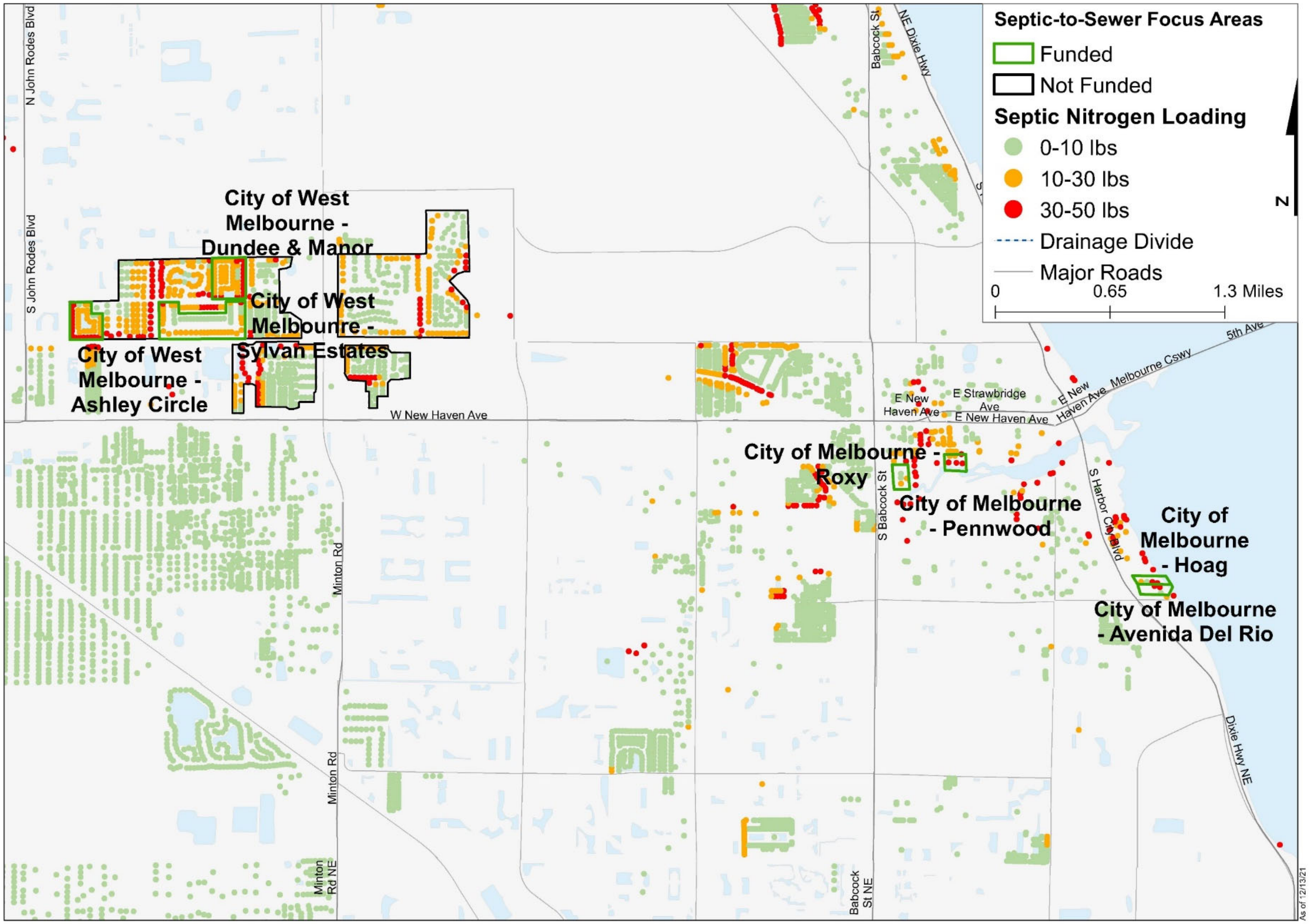


Figure 4-11 Long Description

Figure 4-12: Septic-to-Sewer Projects in Central IRL, continued

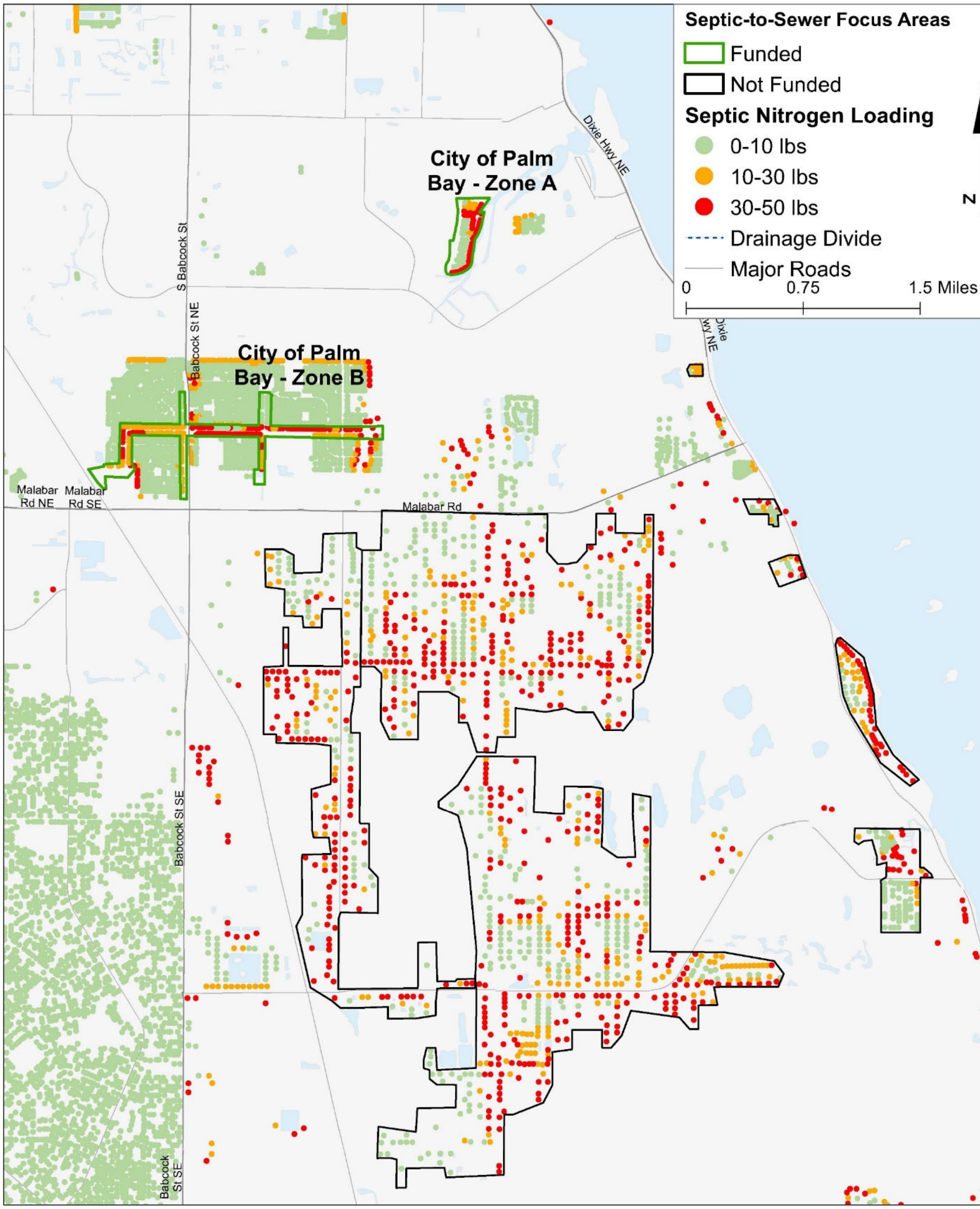


Figure 4-12 Long Description

Figure 4-13: Septic-to-Sewer Projects in Central IRL, continued

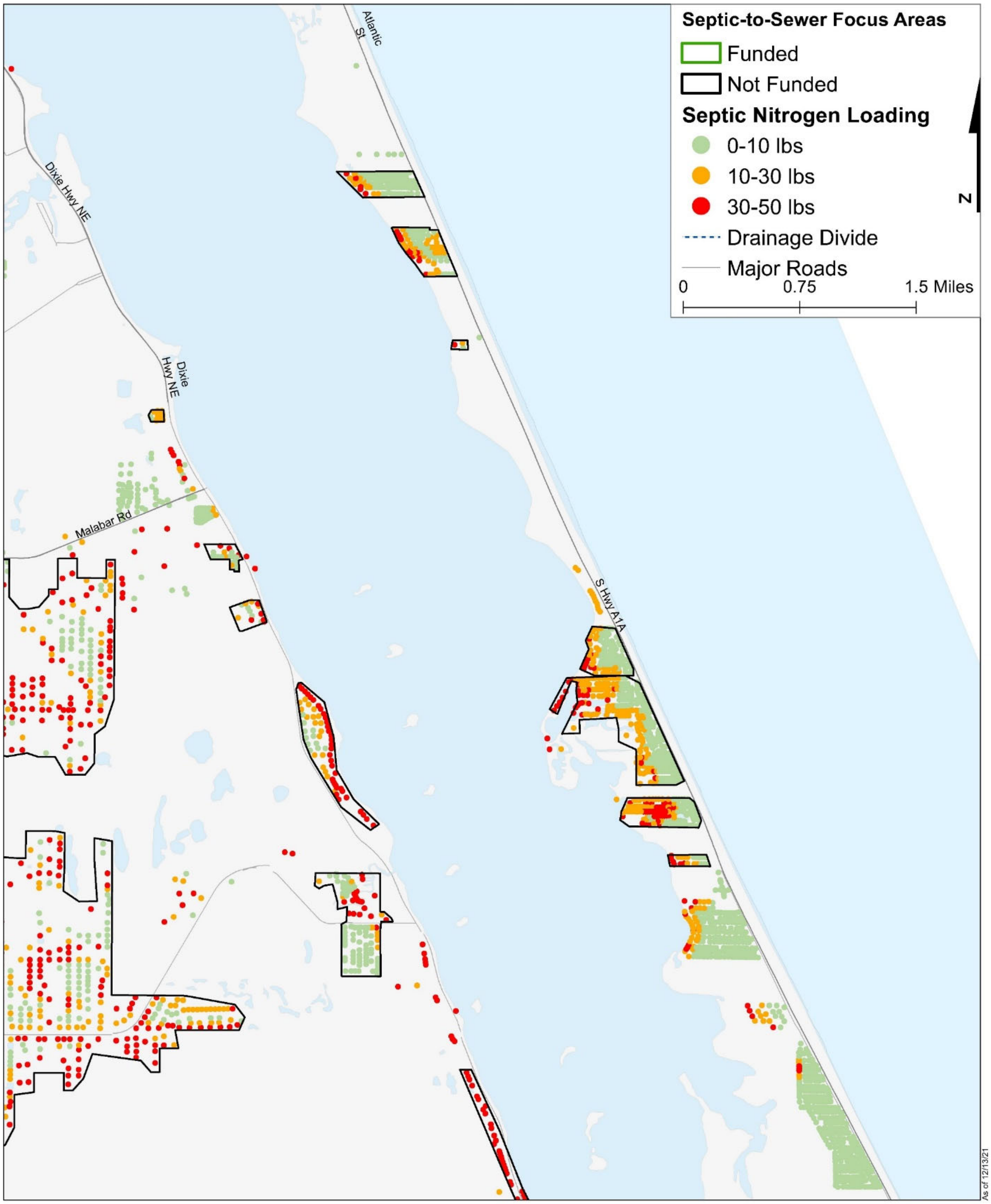


Figure 4-13 [Long Description](#)

Figure 4-14: Septic-to-Sewer Projects in Central IRL, continued

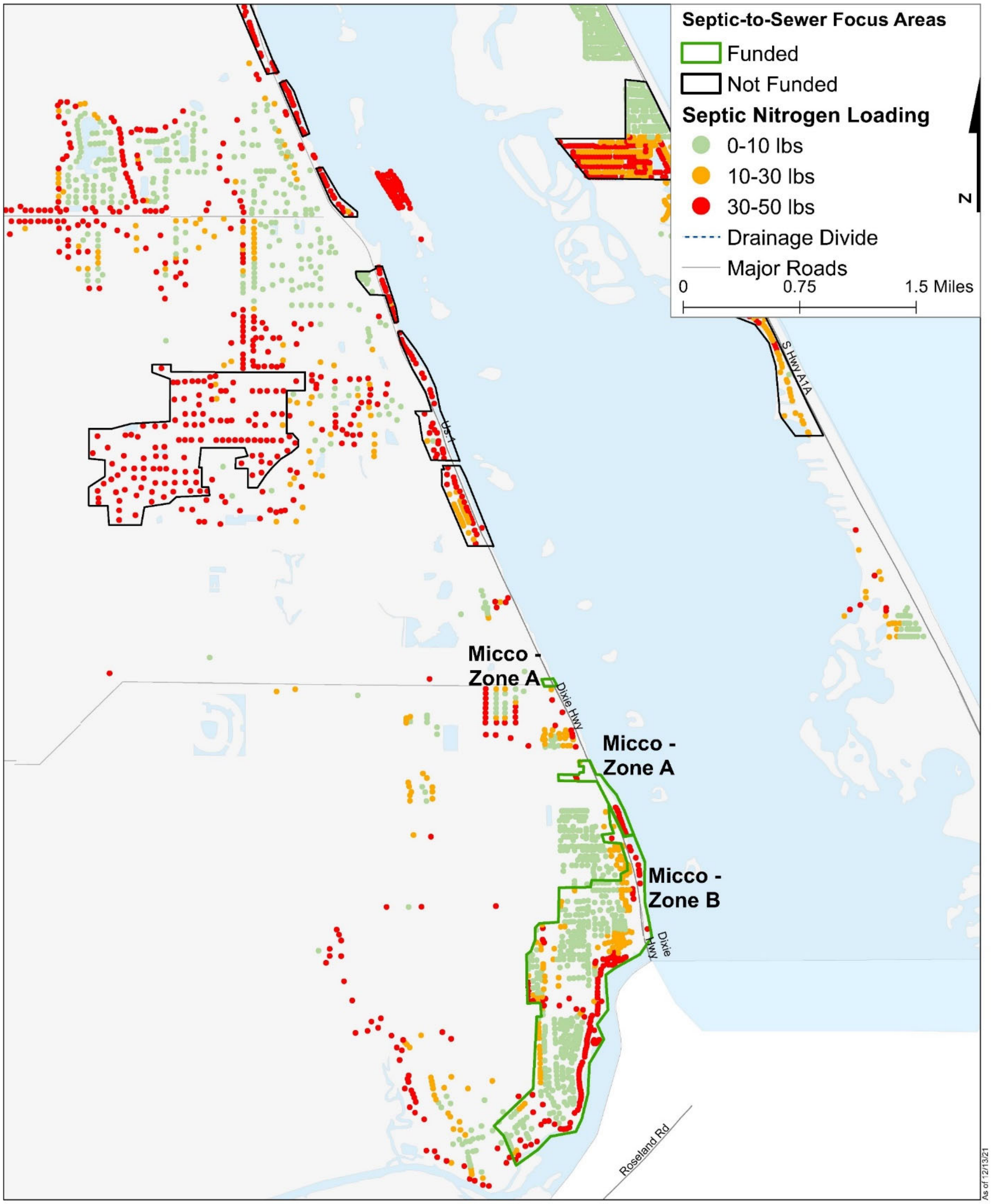


Figure 4-14 Long Description

Septic-to-Sewer by Connection

The detailed septic analysis also identified 4,496 properties located within 30 feet of existing sewer infrastructure. The highest loading "Quick Connect" opportunities are included in **Table 4-20** based on their ability to connect to gravity or force main sewer and are shown in **Figure 4-15** through **Figure 4-17**.

Quick Connects to sewer will be funded on a prorated basis of $1,200 per pound of nitrogen loading to the lagoon reduced, up to a maximum of $18,000 for connection to force main sewer and a maximum of $12,000 for connection to gravity sewer. Funding allocation for this grant program is based on the number of highest priority connection opportunities within each sub-lagoon as reported in **Table 4-20**.

However, recently secured funding from state cost-share grants will allow the County to offer these grants to all property owners within the IRL watershed on a first-come, first-served basis, for a maximum of $18,000 per property for connection to force main sewer and a maximum of $12,000 per property for connection to gravity sewer. This is possible because the average nitrogen loading per septic system within the lagoon watershed is 7.5 pounds. At the pro-rated basis of $1,200 per pound, the average cost-share for preventing 7.5 pounds of nitrogen loading would be $9,000 from program funds. While grant funds last, these program funds will be matched with $9,000 of state grant funding to cost share up to $18,000 per connection.

Table 4-20: Projects for Septic-to-Sewer by Connection

Year Added	Project Number	Project Name	Responsible Entity	Sub-lagoon	Total Nitrogen Reduction (pounds per year)	Total Nitrogen Cost per Pound per Year	Total Phosphorus Reduction (pounds per year)	Total Phosphorus Cost per Pound per Year	Plan Funding
2019	2016-16	Banana Quick Connects – 144 lots+	Brevard County	Banana	3,224	Average of $592 Maximum of $1,200	Not applicable	Not applicable	$1,908,000
2019	2016-18	North IRL Quick Connects – 463 lots+	Brevard County	North IRL	11,339	Average of $531 Maximum of $1,200	Not applicable	Not applicable	$6,018,000
2019	2016-19	Central IRL Quick Connects – 269 lots+	Brevard County	Central IRL	6,883	Average of $487 Maximum of $1,200	Not applicable	Not applicable	$3,354,000
-	**-**	***Total***	**-**	**-**	***21,446***	***$526 (average)***	***Not applicable***	***Not applicable***	***$11,280,000***

Note: The projects highlighted in tan and marked with a plus sign were added to the plan as part of an annual update.

Figure 4-15: Quick Connection Septic-to-Sewer Locations in North Brevard County

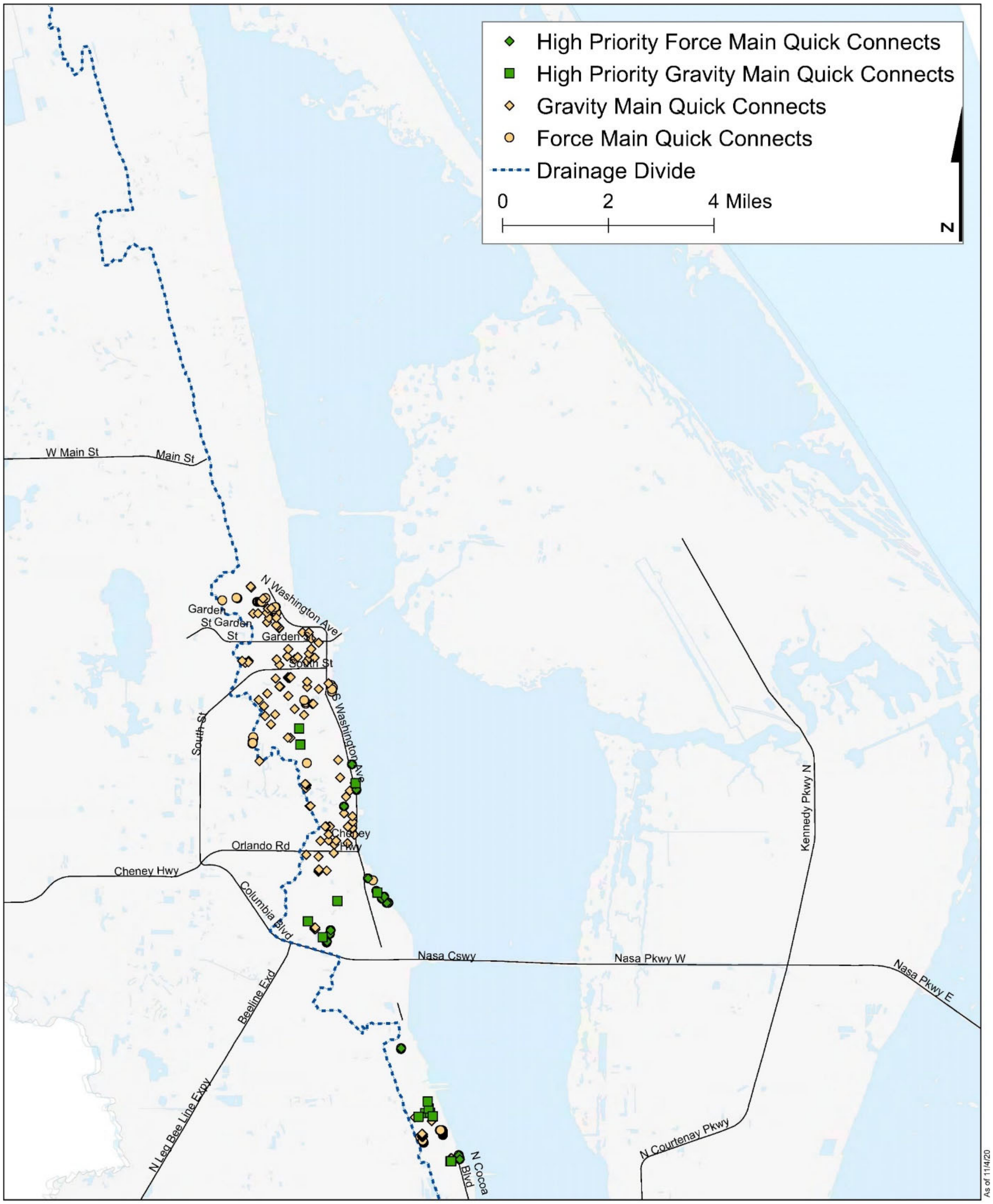


Figure 4-15 [Long Description](#)

Figure 4-16: Quick Connection Septic-to-Sewer Locations in Central Brevard County

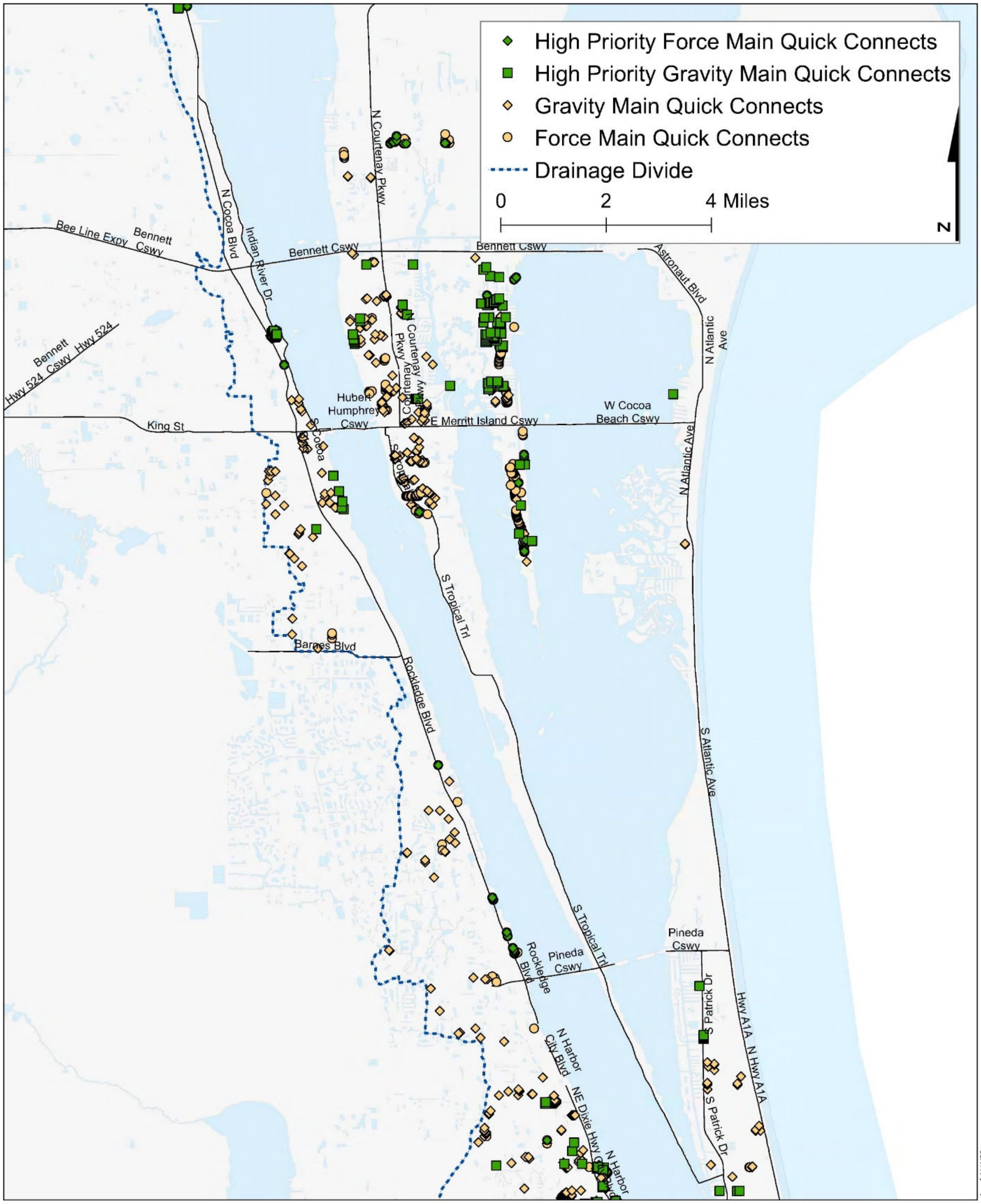


Figure 4-16 Long Description

Figure 4-17: Quick Connection Septic-to-Sewer Locations in South Brevard County

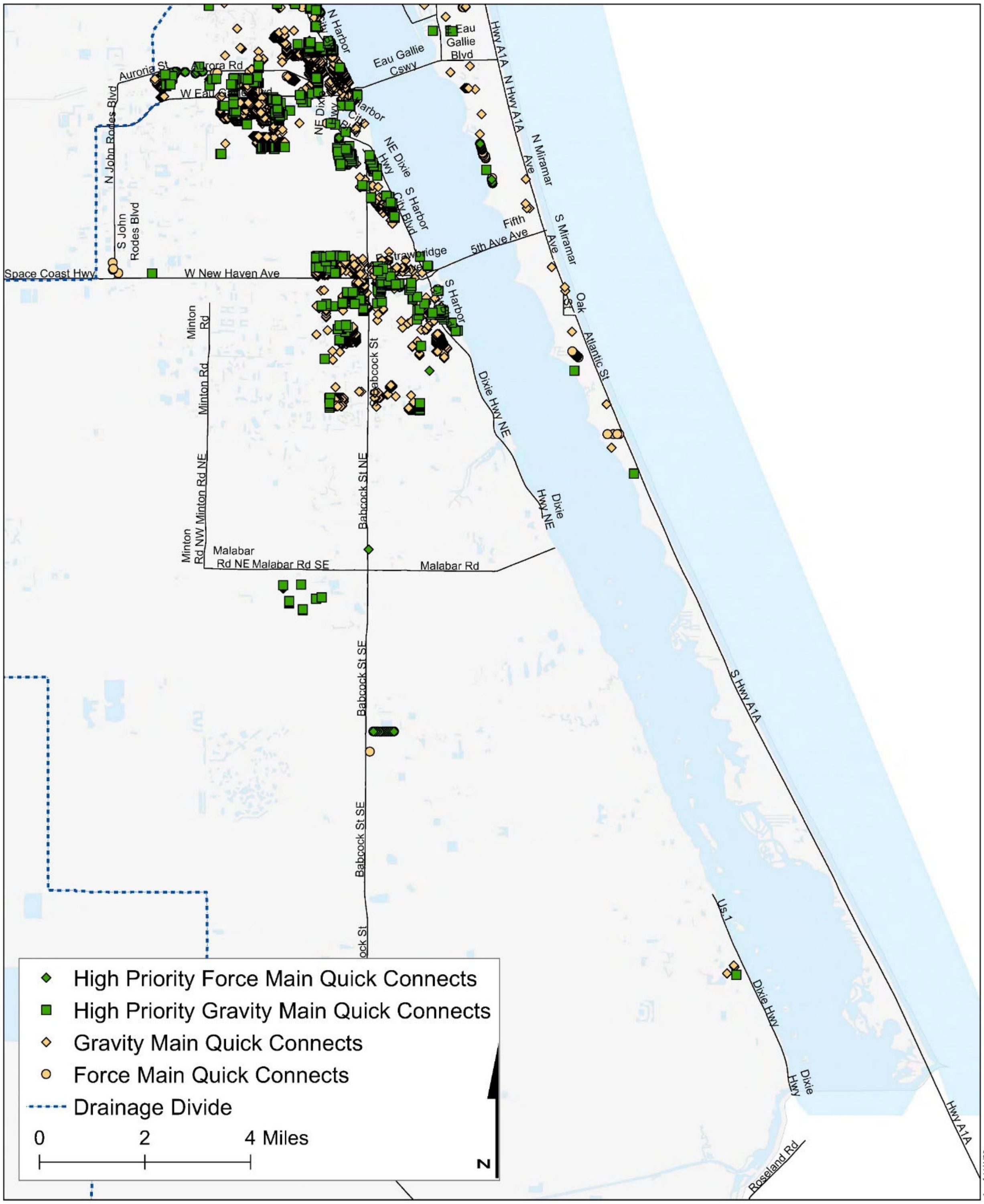


Figure 4-17 [Long Description]

Septic System Upgrades

In locations where providing sewer service is not feasible due to distance from sewer infrastructure, facility capacity, or insufficient density of high-risk systems, there are options to upgrade the highest risk septic systems to increase the nutrient and pathogen removal efficiency. In recent years, research has been conducted on passive treatment systems, which provide significant treatment efficiencies without monthly sewer fees or highly complex maintenance needs for mechanical features.

In July 2018, the Florida Department of Health adopted new rules that allow for In-Ground Nitrogen-Reducing Biofilters under the drainfield of septic systems (**Figure 4-18**). This passive nitrogen-reducing technology is a result of the Florida Onsite Sewage Nitrogen Reduction Strategies project and the Springs and Aquifer Protection Act. Pilot projects to install this new system are currently in progress throughout the state and Brevard County is a participating partner in these initial installations. This passive In-Ground Nitrogen-Reducing Biofilter system is expected to remove 65% of nitrogen from the effluent and cost an extra $4,000 above the typical costs of a conventional septic system. This system requires 51” of soil above the groundwater and, therefore, may not be appropriate in areas with shallow groundwater.

Figure 4-18: Example In-Ground Nitrogen-Reducing Biofilter Septic System

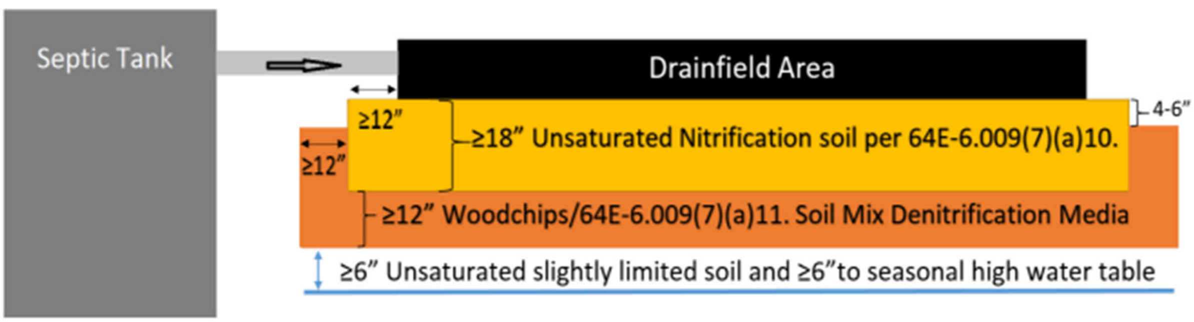


Figure 4-18 Long Description

The current ruling by Florida Department of Health only allows woodchips within the denitrification layer of this system; however, other biosorption activated media can also enhance nutrient and bacterial removal before the effluent reaches the drainfield or groundwater, potentially removing more than 65% of nitrogen from effluent, and lasting longer than woodchips. A test of the biosorption activated media removal capacity was conducted at Florida’s Showcase Green Envirohome in Indialantic, Florida. This test location is a residential site built with stormwater, graywater, and wastewater treatment in a compact footprint onsite (Wanielista et al., 2011). The media used in this study was Bold & Gold®, which is a patented blend of mineral materials, sand, and clay. In this study, the effluent from the septic tank was evenly divided between an innovative biosorption filter media bed and a conventional drainfield. The study found that the TN and TP removal efficiencies were 76.9% and 73.6%, respectively, for the Bold & Gold® media drainfield system, which was significantly higher than the 45.5% TN removal and 32.1% TP removal from the conventional drainfield.

In 2019, Brevard County entered into agreement with the Florida Department of Health to test In-Ground Nitrogen Reducing Biofilter septic systems with known nitrogen-reducing media. The first six septic systems under this agreement were installed in summer of 2020 using Bold & Gold® wastewater filtration media. To measure effectiveness of the alternative media, nutrient concentration of septic tank effluent is being measured before and after passage through a layer of filtration media. Five of the study sites were monitored quarterly from July 2021 to June 2022. The testing of the five sites has concluded and analysis of the sampling data is being performed. A final report showing the nitrogen removal efficiency of the system will be completed and presented to the Florida Department of Environmental Protection in 2023. The agreement allows for testing of other nitrogen-reducing media as they become available.

In areas where septic systems are in close proximity to a surface waterbody but are not in a location where connection to the sewer system is feasible, adding biosorption activated media to the drainfield or upgrading to the passive nitrogen removing systems could be used to retrofit the existing septic systems. The estimated cost for these retrofits was increased from $16,000 per septic system in the original plan to $18,000 each in the 2019 Update. In 2022, the average cost to install an advanced treatment septic system was $20,845. Any operations and maintenance costs associated with these upgrades, once installed, will be the responsibility of the owner. To be conservative and to match the Florida Department of Health rule, the estimates of the TN reductions that could be achieved are based on an efficiency of 65% removal, which is the average efficiency from the two state studies described above that tested biosorption activated media in the drainfield.

In areas where the In-Ground Nitrogen-Reducing Biofilters system or biosorption activated media retrofits are not appropriate, National Sanitation Foundation 245 certified aerobic treatment units are another alternative. National Sanitation Foundation 245 certification verifies that these advanced septic systems remove at least 50% of nitrogen within the septic tank, although some systems have been shown to remove up to 80% of nitrogen. The drainfield is credited with removing another 15% of nitrogen, which brings the total nitrogen removed by the advanced septic system to 65%. Due to the electrical plumbing requirements of aerobic treatment units, the owner is required to have a maintenance agreement with a septic company and an operating permit from the Florida Department of Health. Individually engineered performance-based septic systems, some of which use the septic system effluent for drip irrigation, provide another septic system option for meeting 65% nitrogen load reduction onsite.

There are also options for distributed onsite sewage treatment systems that are approved by the Florida Department of Environmental Protection as miniature sewage treatment plants sized for residential and commercial use. These systems provide additional opportunities to improve nutrient removal from sites where connection to central sewer is not feasible and are eligible options for septic system upgrades as part of this plan. Both the Save Our Indian River Lagoon Project Plan and Springs and Aquifer Protection Act have highlighted the need for other wastewater options that have less impact on surface water and groundwater. Brevard County will continue to vet these options as they become available in Florida.

To prioritize the septic systems for upgrade, the scoring matrix used in the original Save Our Indian River Lagoon Project Plan was replaced in the 2019 Update using ArcGIS-Based Nitrate Load Estimation Toolkit modeling performed during determination of the Nitrogen Reduction Overlay area adopted in the Countywide Septic Ordinance, as noted above.

The septic systems with the highest loading in each sub-lagoon are recommended for retrofit upgrades to reduce the impacts of these septic systems on the waterbodies. The costs and nutrient reductions by sub-lagoon are shown in **Table 4-21**. The locations of the highest priority sites for septic system upgrades are shown in **Figure 4-19**, **Figure 4-20**, and **Figure 4-21**. This upgrade opportunity alone addresses at least 3% of the septic systems in the IRL drainage basin and nearly 10% of the nitrogen load contributed by existing septic systems.

Septic retrofit upgrades will be funded on a prorated basis of $1,200 per pound of reduced nitrogen loading to the lagoon, up to a maximum of $18,000 per septic parcel. Funding allocation for this grant program is based on the number of highest priority upgrade opportunities within each sub-lagoon as reported in **Table 4-21**. However, recently secured funding from state cost-share grants allows the County to offer these grants to more locations than the priority lots identified for Save Our Indian River Lagoon Trust funds listed in **Table 4-21**. Combined state and local funding is currently offered to all property owners within the IRL watershed (excluding those within a funded septic-to-sewer project area) on a first-come, first-served basis, prorated based on a property's estimated nitrogen loading.

In some circumstances, properties qualified for septic system upgrade funding may be near a sewer line. These septic upgrade funds can be used to connect the qualified property to sewer as this option results in a greater reduction in nitrogen loading to the lagoon.

Table 4-21: Projects for Septic System Upgrades

Year Added	Project Number	Project Name	Responsible Entity	Sub-lagoon	Total Nitrogen Reduction (pounds per year)	Cost per Pound per Year of Total Nitrogen	Total Phosphorus Reduction (pounds per year)	Cost per Pound per Year of Total Phosphorus	Plan Funding
Original	51	Banana River Lagoon – at least 100 lots*	Brevard County	Banana	1,934	Average of $931 Maximum of $1,200	Not applicable	Not applicable	$1,800,000
Original	52	North IRL – 586 lots*	Brevard County	North IRL	13,857	Average of $761 Maximum of $1,200	Not applicable	Not applicable	$10,548,000
Original	53	Central IRL – 939 lots*	Brevard County	Central IRL	22,190	Average of $762 Maximum of $1,200	Not applicable	Not applicable	$16,902,000
-	*-*	***Total***	*-*	*-*	***37,981***	***$770 (average)***	***Not applicable***	***Not applicable***	***$29,250,000***

Note: The projects highlighted in green and marked with an asterisk were identified in the original plan. The projects highlighted in tan and marked with a plus sign were added to the plan as part of an annual update.

Figure 4-19: Septic System Upgrades in North Brevard County

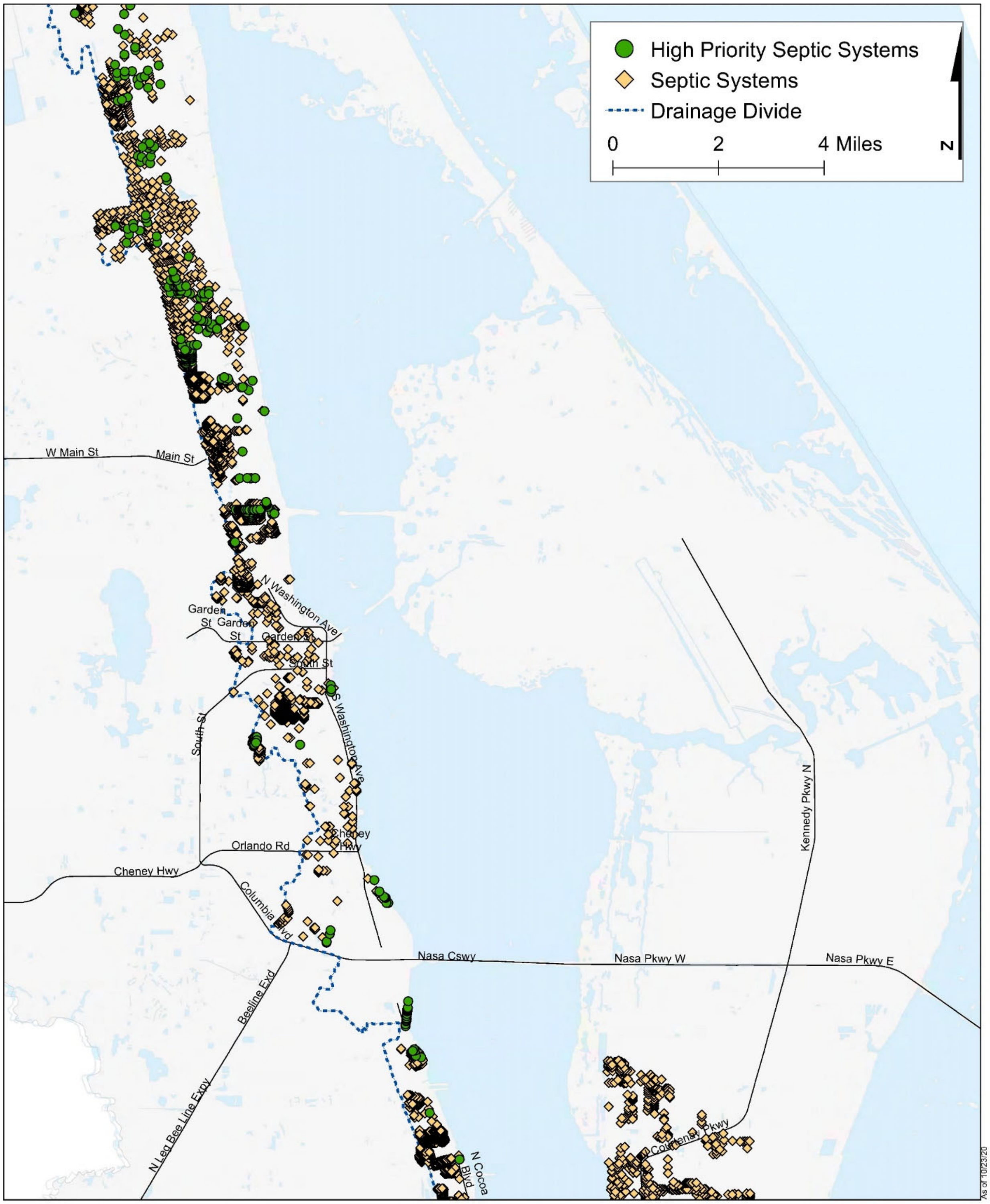


Figure 4-19 Long Description

Figure 4-20: Septic System Upgrades in Central Brevard County

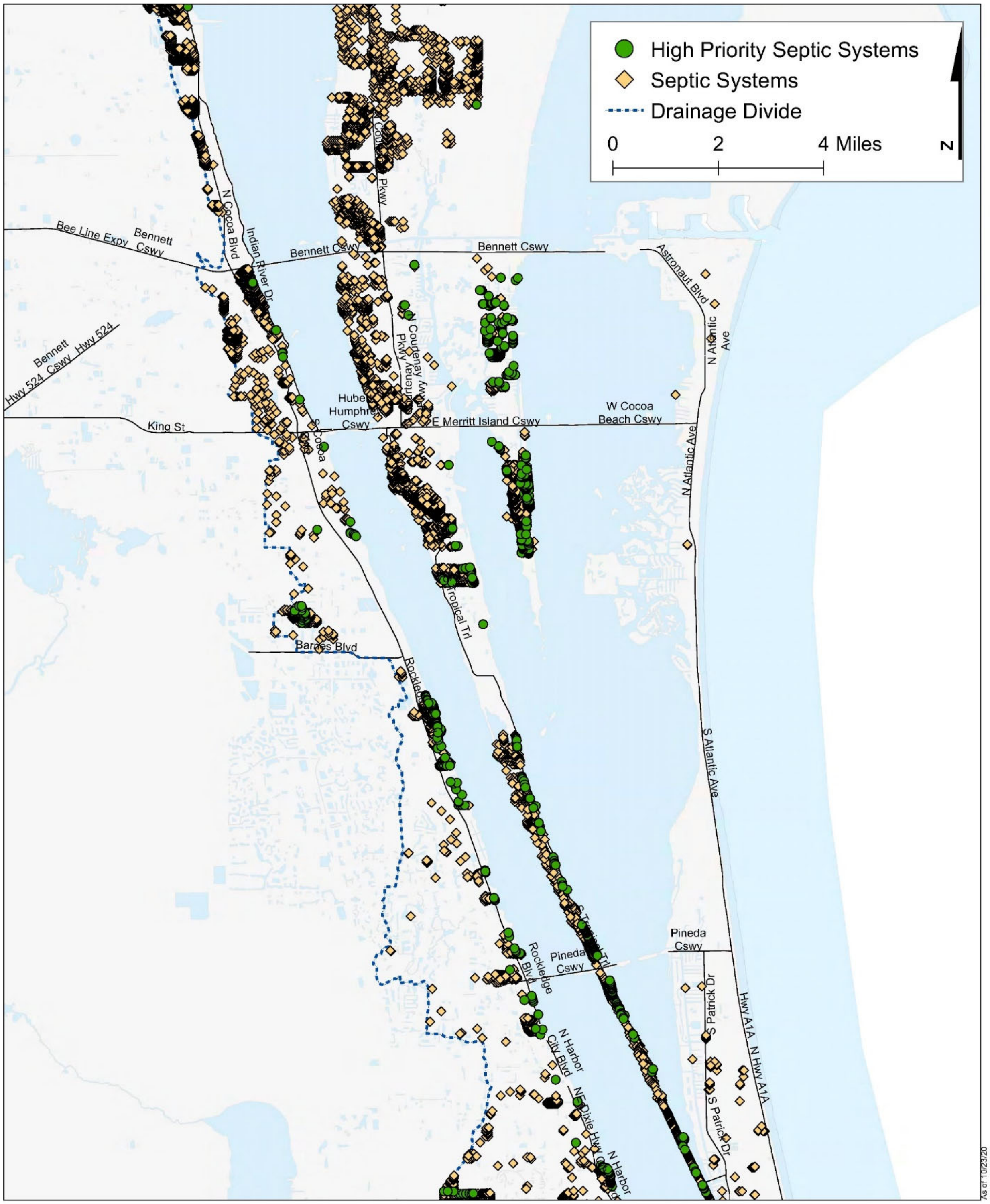


Figure 4-20 Long Description

Figure 4-21: Septic System Upgrades in South Brevard County

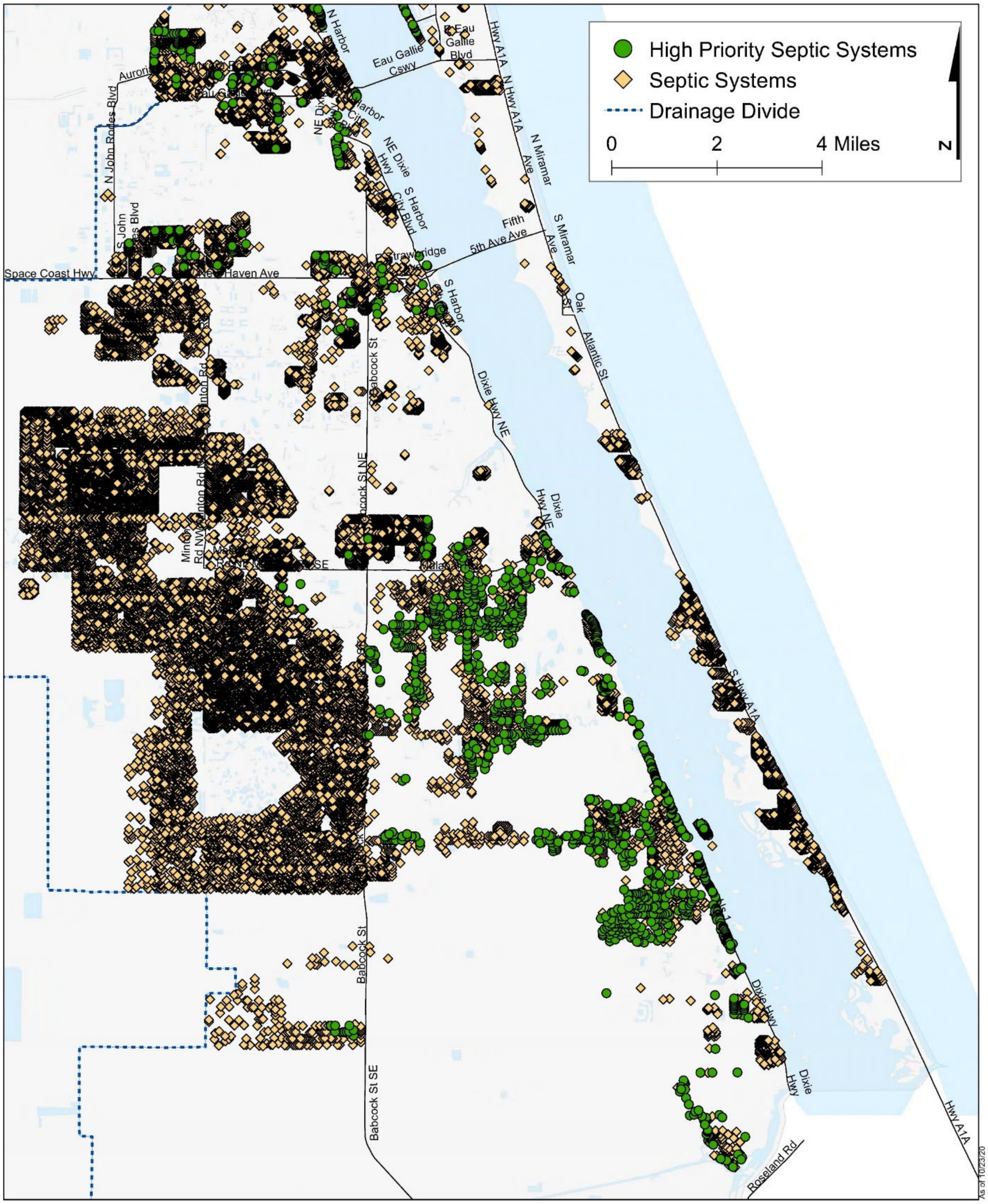


Figure 4-21 Long Description

Reimbursement Incentives for Best Available Nitrogen-Reducing Systems

Starting in 2023, as an incentive for homeowners to consider best available technology, reimbursements will be scaled according to the percentage of total nitrogen (TN) reduction reported for the installed technology rather than the minimum standard of 65% achieved by all National Sanitation Foundation 245 certified systems. The National Sanitation Foundation 245 minimum standard is based on a requirement of at least 50% TN reduction in the tank combined with an assumption of 15% more TN removal (30% of the remaining 50%) in the drainfield. Currently, TN removal rates for National Sanitation Foundation 245 certified systems range from a low of 53% to a high of 79% in the tank and 67% to 85% TN reduction when including the drainfield (**Table 4-22**). Furthermore, new technologies with higher removal rates may be added to the list of National Sanitation Foundation 245 systems approved for use in Florida. The list of Florida National Sanitation Foundation 245 Certified Aerobic Treatment Units and their average TN removal efficiencies is available at the following website.

Table 4-22: Total Nitrogen Removal for Different Types of Septic Systems

System Type	Total Nitrogen Removal in Tank*	Total Nitrogen Removal in Drainfield	Total Nitrogen Removal of Total System
Conventional	10%	20%	30%
Basic National Sanitation Foundation 245, 50% Reduction	50%	15%	65%
National Sanitation Foundation 245, 60% Reduction	60%	12%	72%
National Sanitation Foundation 245, 70% Reduction	70%	9%	79%
National Sanitation Foundation 245, 75% Reduction	75%	7.5%	83%
National Sanitation Foundation 245, 80% Reduction	80%	6%	86%

* Total nitrogen removal in the tank is from the average TN reduction published in the National Sanitation Foundation 245 Completion Report for use in Florida.

Table 4-23 is a sample table of scaled eligible reimbursement amounts for systems with different TN reduction capabilities. Each row assumes the home currently has a conventional system that is loading 30 pounds of TN per year to the IRL. This table illustrates how the eligible reimbursement increases for higher performing systems and provides an incentive for homeowners to consider best available technology instead of the least expensive, lowest performing National Sanitation Foundation 245 certified system.

Table 4-23: Example Eligible Reimbursement for Different Septic System Upgrades

System Type	Load for a 30 Pounds Per Year Home	Increased Reduction Over Conventional (pounds)	Cost-share Rate per Pound of Reduction	Eligible Reimbursement
Conventional	21.0	0.0	$1,200	$0
Basic National Sanitation Foundation 245, 50% Reduction	10.5	10.5	$1,200	$12,600
National Sanitation Foundation 245, 60% Reduction	8.4	12.6	$1,200	$15,120
National Sanitation Foundation 245, 70% Reduction	6.3	14.7	$1,200	$17,640
National Sanitation Foundation 245, 75% Reduction	5.3	15.8	$1,200	$18,900
National Sanitation Foundation 245, 80% Reduction	4.2	16.8	$1,200	$20,160

Due to basic National Sanitation Foundation 245 systems achieving 50% load reduction in the tank, scaling the load reduction and eligible reimbursement amount up from the basic eligible reimbursement is a simple calculation. The Scaled Reimbursement Eligibility is calculated by doubling the percent TN removal in the tank for the chosen system multiplied by the Eligible Reimbursement Amount of the Basic National Sanitation Foundation 245 system. The Eligible Reimbursement Amount of a Basic National Sanitation Foundation 245 system is posted online for each home in the Septic Upgrade Story Map. For example, to calculate the Scaled Reimbursement Eligibility of a system that reduces TN by 70% in the tank, the eligible amount for a basic National Sanitation Foundation 245 system is multiplied by 140%.

In 2022, retroactive reimbursement payments were approved for Brevard County property owners who upgraded existing conventional septic systems to advanced treatment septic systems before applying for grant funds. These retroactive reimbursements are capped at $6,000 and the upgrade must meet the following conditions:

1. Upgrade must have been voluntary, not required by local or state code.
2. Upgrade must have followed all Save Our Indian River Lagoon Program guidelines other than grant approval prior to construction.
3. Upgrade must have been properly permitted and certified by the Florida Department of Health/Florida Department of Environmental Protection.
4. Operation and maintenance permits must be current, with no gaps in the owner's compliance.
5. Retroactive payment amount shall not exceed the sum of costs documented with proof of payment.
6. Work must have been completed after program inception.
7. Work had to be completed before June 1, 2022 (when the last notifications were mailed to owners of priority sites).
8. Eligible funding is pro-rated at $1200 per pound of TN based on septic loading estimated in the 2018 county-wide septic system loading model for conventional septic systems at the site.
9. Retroactive payment amount shall be up to $6,000, representing the typical difference in cost between conventional ($12,000) and advanced systems ($18,000) and equal to the typical cost-share of $1,200 per pound times 5 pounds of TN load reduction.
10. The sum of retroactive payments to be processed by staff shall not exceed $100,000 without specific authorization by the County Commission.

4.1.7 Stormwater Treatment

Stormwater runoff contributes 33.6% of the external TN loading and 43.4% of the external TP loading to the lagoon annually.

Stormwater runoff from urban areas carries pollutants that affect surface waters and groundwater. These pollutants include nutrients, pesticides, oil and grease, debris and litter, and sediments. In Brevard County, there are more than 1,500 stormwater outfalls to the Indian River Lagoon (IRL).

There are a variety of best management practices that can be used to capture and treat stormwater to remove or reduce these pollutants before the stormwater runoff reaches a waterbody or infiltrates to the groundwater. Potential stormwater best management practices that could help restore the IRL system include:

- Traditional best management practices – These are the typical practices used to treat stormwater runoff and include wet detention ponds, retention, swales, dry detention, baffle boxes, stormwater reuse, alum injection, street sweeping, catch basin inserts/inlet filters, floating islands/managed aquatic plant systems. Descriptions of these traditional best management practices and expected total nitrogen (TN) and total phosphorus (TP) efficiencies are shown in **Table 4-24**.
- Low impact development/green infrastructure – These practices use natural stormwater management techniques to minimize runoff and help prevent pollutants from getting into stormwater runoff. These best management practices address the pollutants at the source so implementing them can help decrease the size of traditional retention and detention basins and can be less costly than traditional best management practices (University of Florida Institute of Food and Agricultural Sciences, 2016). Descriptions of low impact development and green infrastructure best management practices and estimated efficiencies are shown in **Table 4-25**.
- Denitrification best management practices – These practices use a soil media, known as biosorption activated media to increase the amount of denitrification that occurs, which increases the amount of TN and TP removed. Biosorption activated media includes mixes of soil, sawdust, zeolites, tire crumb, vegetation, sulfur, and spodosols. Additional details about denitrification best management practices are included below.
- Best management practices to reduce baseflow intrusion – These practices are modifications to existing best management practices help reduce intrusion of captured groundwater baseflow into stormwater drainage systems. These best management practices include backfilling canals so that they do not cut through the baseflow, modifying canal cross-sections to maintain the same storage capacity while limiting the depth, installing weirs to control the water levels in the best management practice, or adding a cutoff wall to prevent movement into the baseflow.
- Re-diversion to the St. Johns River – There are portions of the current IRL Basin that historically flowed towards the St. Johns River. By re-diverting these flows back to the St. Johns River, the excess stormwater runoff, as well as the additional freshwater inputs, to the IRL would be removed. The re-diversion projects would include a treatment component so that the runoff is treated before being discharged to the St. Johns River. The St. Johns River Water Management District has taken the lead on large-scale projects while the County has re-diverted more than 400 acres in the Crane Creek basin and partnered with the St. Johns River Water Management District to increase re-diversion from the Melbourne-Tillman Water Control District canal system.

Table 4-24: Traditional Stormwater Best Management Practices with TN and TP Removal Efficiencies

Best Management Practice	Definition	Total Nitrogen Removal Efficiency	Total Phosphorus Removal Efficiency	Source
Wet detention ponds	Permanently wet ponds that are designed to slowly release a portion of the collected stormwater runoff through an outlet structure. Recommended for sites with moderate to high water table conditions. Provide removal of both dissolved and suspended pollutants through physical, chemical, and biological processes.	8%-44%	45%-75%	Florida Department of Environmental Protection et al., 2010
Off-line retention	Recessed area that is designed to store and retain a defined quantity of runoff, allowing it to percolate through permeable soils into the groundwater aquifer. Runoff in excess of the specified volume of stormwater does not flow into the retention system storing the initial volume of stormwater.	40%-84%	40%-84%	Harper et al., 2007
On-line retention and swales	Recessed area that is designed to store and retain a defined quantity of runoff, allowing it to percolate through permeable soils into the groundwater aquifer. Runoff in excess of the specified volume of stormwater does flow through the retention system that stores the initial volume of stormwater.	30%-74%	30%-74%	Harper et al., 2007
Dry detention	Designed to store a defined quantity of runoff and slowly release it through an outlet structure to adjacent surface waters. After drawdown of the stored runoff is completed, the storage basin does not hold any water. Used in areas where the soil infiltration properties or seasonal high-water table elevation will not allow the use of a retention basin.	10%	10%	Harper et al., 2007
2nd generation baffle box	Box chambers with partitions connected to a storm drain. Water flows into the first section of the box where most pollutants settle out. Overflows into the next section to allow further settling. Water ultimately overflows to the stormwater pipe. Floating trays capture leaves, grass clippings, and litter to prevent them from dissolving in the stormwater.	19.05%	15.5%	GPI, 2010
Stormwater reuse	Reuse of stormwater from wet ponds for irrigation. Compare volume going to reuse to total volume of annual runoff to pond.	Amount of water not discharged annually	Amount of water not discharged annually	Not applicable
Alum injection	Chemical treatment systems that inject aluminum sulfate into stormwater systems to cause coagulation of pollutants.	50%	90%	Harper et al., 2007
Street sweeping	Cleaning of pavement surfaces to remove sediments, debris, and trash deposited by vehicle traffic. Prevents these materials from being introduced into the stormwater system.	Total nitrogen content in dry weight of material collected annually	Total phosphorus content in dry weight of material collected annually	University of Florida, 2011
Catch basin inserts/inlet filters	Devices installed in storm drain inlets to provide water quality treatment through filtration of organic debris and litter, settling of sediment, and adsorption of hydrocarbon by replaceable filters.	Total nitrogen content in dry weight of material collected annually	Total phosphorus content in dry weight of material collected annually	University of Florida, 2011

Best Management Practice	Definition	Total Nitrogen Removal Efficiency	Total Phosphorus Removal Efficiency	Source
Managed Aquatic Plant System	Aquatic plant-based best management practices that remove nutrients through a variety of processes related to nutrient uptake, transformation, and microbial activities.	10% with 5% pond coverage	10% with 5% pond coverage	Florida Department of Environmental Protection, 2018

Table 4-25: Low Impact Development and Green Infrastructure Best Management Practices and TN and TP Removal Efficiencies

Best Management Practice	Definition	Total Nitrogen Removal Efficiency	Total Phosphorus Removal Efficiency	Source
Permeable pavement	Hard, yet penetrable, surfaces reduce runoff by allowing water to move through them into groundwater below (University of Florida Institute of Food and Agricultural Sciences, 2016).	30%-74%	30%-74%	Harper et al., 2007
Bioswales	An alternative to curb and gutter systems, bioswales convey water, slow runoff, and promote infiltration. Swales may be installed along residential streets, highways, or parking lot medians (University of Florida Institute of Food and Agricultural Sciences, 2016). Must be designed for conveyance, greater in length than width, have shallow slopes, and include proper landscaping.	38%-89%	9%-80%	Florida Department of Environmental Protection, 2014
Green roofs	These systems can significantly reduce the rate and quantity of runoff from a roof and provide buildings with thermal insulation and improved aesthetics (University of Florida Institute of Food and Agricultural Sciences, 2016). Retention best management practice covered with growing media and vegetation that enables rainfall infiltration and evapotranspiration of stored water. Including a cistern capture, retain, and reuse water adds to effectiveness.	45% (without cistern) 60%-85% (with cistern)	Not applicable	Florida Department of Environmental Protection, 2014
Bioretention basins/rain gardens	Small, vegetated depressions in the landscape collect and filter stormwater into the soil (University of Florida Institute of Food and Agricultural Sciences, 2016). Constructed adjacent to roof runoff and impervious areas.	30%-50%	30%-90%	Florida Department of Environmental Protection, 2014
Tree boxes	Bioretention systems with vertical concrete walls designed to collect/retain specified volume of stormwater runoff from sidewalks, parking lots and/or streets. Consists of a container filled with a soil mixture, a mulch layer, under-drain system, and shrub or tree (Florida Department of Environmental Protection, 2014).	38%-65%	50%-80%	Florida Department of Environmental Protection, 2014

Due to the importance of treating dry season baseflow to the lagoon, Brevard County has found that ditch denitrification is the most cost-effective best management practice. Biosorption activated media can be added in existing or new best management practices to improve the nutrient removal efficiency. The removal efficiencies of using biosorption activated media in various stormwater treatment projects (Wanielista, 2015) are summarized in **Table 4-26**. While the efficiencies in **Table 4-26** are only for Bold & Gold®, other types of biosorption activated media may be used in a project, if there is Florida-specific information available on the removal efficiencies for that media.

Table 4-26: TN and TP Removal Efficiencies for Biosorption Activated Media

Location in Best Management Practice Treatment Train	Material	Total Nitrogen Removal Efficiency	Total Phosphorus Removal Efficiency
Bold & Gold® as a first practice, example up-flow filter in baffle box and a constructed wetland	Expanded clay, tire chips	55%	65%
Bold & Gold® in up-flow filter at wet pond and dry basin outflow	Organics, tire chips, expanded clay	45%	45%
Bold & Gold® in inter-event flow using up-flow filter at wet pond and down-flow filter at dry basin	expanded clay, tire chips	25%	25%
Bold & Gold® down-flow filters 12-inch depth at wet pond or dry basin pervious pavement, tree well, rain garden, swale, and strips	Clay, tire crumb, sand and topsoil	60%	90%

Note: From Wanielista, 2015

The County's proposed total maximum daily loads include two components: (1) a total maximum daily load for the five-month period (January–May) that is critical for seagrass growth, and (2) a total maximum daily load for the remaining seven months of the year to avoid algal blooms and protect healthy dissolved oxygen levels. In 2019, Brevard County updated the estimates for nutrient loading entering the lagoon through each stormwater ditch and outfall. The update incorporated more recent land use data, more recent rainfall and evapotranspiration data, and improved stormwater infrastructure mapping and topography. There are more than 2,000 hydrologically distinct catchment basin areas within the lagoon watershed countywide. These connect to the lagoon through more than 1,500 stormwater ditches and outfall structures. For the purpose of maximizing seagrass response to stormwater treatment, these new loading estimates for catchment basins were prioritized based on the amount of nutrients migrating into the stormwater system as groundwater baseflow during a five-month season found to be most critical to annual seagrass expansion or loss.

The stormwater project benefits were estimated, as follows, to ensure both components of the total maximum daily load are adequately addressed. The five-month total maximum daily load covers the dry season in this area when there is minimal rainfall and stormwater runoff; therefore, the benefits of stormwater biosorption activated media projects during this period were based only on January–May baseflow loading estimates from the Spatial Watershed Iterative Loading model. The estimated project treatment efficiencies used for January to May baseflow only are 55% for TN and 65% for TP. To estimate annual load reduction benefits, the annual baseflow and stormwater loading estimates from the Spatial Watershed Iterative Loading model were used with a project efficiency of 45% for TN and 45% for TP. The estimated TN and TP reductions in pounds per year accomplished by using biosorption activated media upstream of these priority outfalls are summarized in **Table 4-24**. The locations of the basins to be treated are shown in **Figure 4-22**, **Figure 4-23**, and **Figure 4-24**. Projects approved as part of an annual update to the plan are also included in **Table 4-27**.

Table 4-27: Projects for Stormwater Treatment

Year Added	Project Number	Project Name	Responsible Entity	Sub-Lagoon	Total Nitrogen Reduction (pounds per year)	Cost per Pound of Total Nitrogen Removed	Total Phosphorus Reduction (pounds per year)	Cost per Pound of Total Phosphorus Removed	Plan Funding
Original	-	Basin 1329*	Brevard County	Banana	205	$851	28	$6,228	$174,374
Original	-	Basin 611*	Brevard County	Banana	1,354	$190	115	$2,232	$256,647
Original	-	Basin 828*	Brevard County	Banana	1,397	$226	127	$2,486	$315,752
Original	-	Basin 951*	Brevard County	Banana	1,562	$241	154	$2,446	$376,697
Original	-	Basin 691*	Brevard County	Banana	1,749	$250	183	$2,387	$436,739
Original	-	Basin 984*	Brevard County	Banana	1,412	$261	143	$2,572	$367,856
Original	-	Basin CCB-E*	Brevard County	Banana	1,335	$269	210	$1,709	$358,815
Original	-	Basin 873*	Brevard County	Banana	775	$274	69	$3,076	$212,263
Original	-	Basin CCB-F*	Brevard County	Banana	1,043	$289	158	$1,911	$301,904
Original	-	Basin 497*	Brevard County	Banana	952	$291	95	$2,919	$277,315
Original	-	Basin 925*	Brevard County	Banana	895	$292	90	$2,899	$260,900
Original	-	Basin 602*	Brevard County	Banana	903	$305	126	$2,185	$275,367
Original	-	Basin 1002*	Brevard County	Banana	1,162	$308	173	$2,072	$358,417
Original	-	Basin CCAFS-4A*	Brevard County	Banana	817	$312	82	$3,110	$255,027
Original	-	Basin 979A*	Brevard County	Banana	956	$314	147	$2,041	$300,044
Original	-	Basin 781*	Brevard County	Banana	935	$315	98	$3,005	$294,448
Original	-	Basin CCB-G*	Brevard County	Banana	3,907	$300	545	$2,147	$1,170,193
Original	-	Basin 539*	Brevard County	Banana	708	$319	97	$2,330	$225,983
Original	-	Basin CCAFS-6B*	Brevard County	Banana	895	$292	90	$2,899	$260,900
Original	-	Basin 1037*	Brevard County	Banana	1,135	$299	122	$2,779	$338,996
Original	-	Basin CCAFS-3A*	Brevard County	Banana	2,896	$316	450	$2,031	$914,034
Original	-	Basin CCAFS-5A*	Brevard County	Banana	1,967	$326	281	$2,284	$641,772
Original	-	Basin CCB-B*	Brevard County	Banana	760	$340	110	$2,351	$258,615
Original	-	Basin CC-B2A*	Brevard County	Banana	774	$343	125	$2,125	$265,590
Original	-	Basin CCAFS-1A*	Brevard County	Banana	2,531	$329	390	$2,133	$831,706
Original	-	Basin 674*	Brevard County	Banana	1,206	$340	145	$2,824	$409,459
Original	-	Basin 650*	Brevard County	Banana	1,251	$341	160	$2,668	$426,918
Original	-	Basin 1222*	Brevard County	Banana	931	$350	135	$2,412	$325,634
Original	-	Basin CCAFS-6D*	Brevard County	Banana	905	$351	107	$2,966	$317,334
Original	-	Basin 1024*	Brevard County	Banana	668	$358	104	$2,302	$239,360
Original	-	Basin CCAFS-6A*	Brevard County	Banana	734	$364	81	$3,301	$267,363
Original	-	Basin CCAFS-2A*	Brevard County	Banana	1,778	$356	309	$2,046	$632,338
Original	-	Basin 1304*^	Brevard County	Banana	181	$467	To be determined	To be determined	$84,534
Original	-	Basin CCB-C*	Brevard County	Banana	525	$380	83	$2,406	$199,669
Original	-	Basin 1172*	Brevard County	Banana	919	$370	133	$2,555	$339,784
Original	-	Basin CCB-D*	Brevard County	Banana	628	$378	103	$2,302	$237,072

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Original	-	Basin 1067*	Brevard County	Banana	811	$374	114	$2,657	$302,940
Original	-	Basin 484*	Brevard County	Banana	445	$386	40	$4,294	$171,765
Original	-	Basin CCB-I*	Brevard County	Banana	1,337	$372	187	$2,662	$497,711
Original	-	Basin 730*	Brevard County	Banana	576	$385	61	$3,638	$221,908
Original	-	Basin 483*	Brevard County	Banana	708	$391	84	$3,294	$276,681
Original	-	Basin CCB-H*	Brevard County	Banana	629	$394	102	$2,428	$247,633
Original	-	Basin 601*	Brevard County	Banana	506	$398	52	$3,870	$201,219
Original	-	Basin 1309*	Brevard County	Banana	593	$398	89	$2,649	$235,737
Original	-	Basin 1280B*^	Brevard County	Banana	390	$382	50	$2,981	$149,036
Original	-	Basin 350*	Brevard County	Banana	695	$398	85	$3,256	$276,776
Original	-	Basin 997*	Brevard County	Banana	545	$405	83	$2,657	$220,513
Original	-	Basin 476*	Brevard County	Banana	680	$400	78	$3,487	$271,990
Original	-	Basin 479*	Brevard County	Banana	445	$411	42	$4,359	$183,087
Original	-	Basin 520*	Brevard County	Banana	400	$415	35	$4,747	$166,140
Original	-	Basin 1037A*	Brevard County	Banana	540	$410	79	$2,805	$221,616
Original	-	Basin 537*	Brevard County	Banana	591	$411	68	$3,573	$242,931
Original	-	Basin 543*	Brevard County	Banana	511	$414	54	$3,921	$211,734
Original	-	Basin 1187*	Brevard County	Banana	645	$414	85	$3,141	$266,956
Original	-	Basin CCAFS-9A*	Brevard County	Banana	614	$418	129	$1,987	$256,367
Original	-	Basin 585*	Brevard County	Banana	399	$430	37	$4,634	$171,474
Original	-	Basin 591*	Brevard County	Banana	546	$426	59	$3,942	$232,568
Original	-	Basin 508*	Brevard County	Banana	595	$426	70	$3,621	$253,457
Original	-	Basin 673*	Brevard County	Banana	801	$430	115	$2,998	$344,722
Original	-	Basin CCAFS-4C*	Brevard County	Banana	445	$448	47	$4,238	$199,191
Original	-	Basin 638*	Brevard County	Banana	523	$444	75	$3,097	$232,248
Original	-	Basin 940B*	Brevard County	Banana	1,157	$159	84	$2,191	$184,039
Original	-	Basin 716*	Brevard County	North IRL	1,508	$227	139	$2,467	$342,882
Original	-	Basin 622*	Brevard County	North IRL	784	$233	56	$3,263	$182,723
Original	-	Basin 608*	Brevard County	North IRL	986	$239	84	$2,802	$235,379
Original	-	Basin 286*	Brevard County	North IRL	2,588	$234	351	$1,722	$604,442
Original	-	Basin 668*	Brevard County	North IRL	540	$410	79	$2,805	$221,616
Original	-	Basin 659*	Brevard County	North IRL	591	$411	68	$3,573	$242,931
Original	-	Basin 384*	Brevard County	North IRL	511	$414	54	$3,921	$211,734
Original	-	TV-St. Johns Basin*	Brevard County	North IRL	645	$414	85	$3,141	$266,956
Original	-	Basin 253*	Brevard County	North IRL	1,242	$244	132	$2,298	$303,306
Original	-	Basin 911*	Brevard County	North IRL	1,004	$249	90	$2,774	$249,681
Original	-	Basin 560*	Brevard County	North IRL	572	$260	41	$3,634	$148,977
Original	-	TV-ST Teresa Basin*	Brevard County	North IRL	2,872	$245	426	$1,654	$704,644

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Original	-	Basin 16*	Brevard County	North IRL	1,095	$258	176	$1,603	$282,132
Original	-	Basin 338*	Brevard County	North IRL	1,938	$255	210	$2,351	$493,710
Original	-	Basin 1419*	Brevard County	North IRL	1,735	$264	249	$1,841	$458,458
Original	-	TV-Addison Canal Basin*	Brevard County	North IRL	7,070	$251	914	$1,944	$1,776,359
Original	-	Basin 199*	Brevard County	North IRL	1,125	$268	108	$2,788	$301,101
Original	-	Basin 973*	Brevard County	North IRL	2,134	$264	307	$1,836	$563,514
Original	-	TV-Chain of Lakes Basin*	Brevard County	North IRL	4,707	$255	683	$1,760	$1,202,096
Original	-	Basin 498*	Brevard County	North IRL	1,243	$269	118	$2,835	$334,533
Original	-	Basin 662*	Brevard County	North IRL	977	$273	101	$2,641	$266,724
Original	-	Basin 1399*	Brevard County	North IRL	1,498	$271	232	$1,751	$406,207
Original	-	Basin CO-2K*	Brevard County	North IRL	1,448	$273	204	$1,936	$395,000
Original	-	Basin 1430*	Brevard County	North IRL	2,361	$269	347	$1,831	$635,330
Original	-	TV-La Paloma Basin*	Brevard County	North IRL	2,146	$270	314	$1,847	$580,034
Original	-	Basin CO-2QA*	Brevard County	North IRL	1,354	$275	199	$1,872	$372,458
Original	-	Basin 895*	Brevard County	North IRL	1,130	$278	135	$2,330	$314,596
Original	-	TV-South Marine Basin*	Brevard County	North IRL	1,252	$279	176	$1,984	$349,141
Original	-	Basin 176*	Brevard County	North IRL	797	$286	74	$3,082	$228,031
Original	-	Basin 1396*	Brevard County	North IRL	1,011	$285	147	$1,961	$288,282
Original	-	Basin RL-2A*	Brevard County	North IRL	1,715	$280	246	$1,949	$479,417
Original	-	Basin 62*	Brevard County	North IRL	721	$292	118	$1,784	$210,453
Original	-	Basin 141*^	Brevard County	North IRL	482	$482	77	$3,014	$232,093
Original	-	Basin 19*	Brevard County	North IRL	818	$291	128	$1,860	$238,037
Original	-	TV-Main Street Basin*	Brevard County	North IRL	1,298	$284	189	$1,950	$368,643
Original	-	Basin 94*	Brevard County	North IRL	1,141	$288	178	$1,844	$328,190
Original	-	Basin 115*^	Brevard County	North IRL	707	$468	98	$3,373	$330,570
Original	-	Basin 478*	Brevard County	North IRL	896	$289	80	$3,241	$259,270
Original	-	Basin RL-3B*	Brevard County	North IRL	2,158	$283	307	$1,992	$611,433
Original	-	Basin 992*	Brevard County	North IRL	1,241	$290	186	$1,938	$360,409
Original	-	Basin 865*	Brevard County	North IRL	879	$296	109	$2,384	$259,812
Original	-	Basin 388*	Brevard County	North IRL	1,203	$292	130	$2,705	$351,642
Original	-	Basin 193*^	Brevard County	North IRL	343	$866	49	$6,063	$297,091
Original	-	Basin 1377*	Brevard County	North IRL	1,324	$293	200	$1,940	$388,003
Original	-	TV-Parrish Basin*	Brevard County	North IRL	1,070	$296	163	$1,940	$316,191
Original	-	Basin 26*^	Brevard County	North IRL	295	$662	46	$4,247	$195,366
Original	-	Basin RL-3I*	Brevard County	North IRL	3,009	$283	423	$2,015	$852,434

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Original	-	Basin 1392*	Brevard County	North IRL	1,050	$298	159	$1,965	$312,440
Original	-	Basin 204*	Brevard County	North IRL	622	$304	55	$3,441	$189,265
Original	-	Basin 451*	Brevard County	North IRL	1,075	$297	123	$2,595	$319,144
Original	-	Basin 72*	Brevard County	North IRL	1,038	$300	150	$2,073	$310,968
Original	-	TV-Sycamore Basin*	Brevard County	North IRL	1,246	$298	184	$2,020	$371,746
Original	-	Basin 1387*	Brevard County	North IRL	890	$303	125	$2,155	$269,319
Original	-	Basin 474*	Brevard County	North IRL	801	$304	76	$3,209	$243,883
Original	-	Basin 157*	Brevard County	North IRL	898	$304	90	$3,037	$273,345
Original	-	Basin 816*	Brevard County	North IRL	678	$310	130	$1,614	$209,884
Original	-	TV-Marina Basin*	Brevard County	North IRL	1,169	$341	170	$2,345	$398,654
Original	-	Basin 410*	Brevard County	North IRL	1,322	$268	158	$2,240	$353,997
Original	-	Basin 1456*	Brevard County	North IRL	952	$306	138	$2,109	$291,040
Original	-	Basin 824*	Brevard County	North IRL	721	$311	103	$2,179	$224,416
Original	-	Basin 833*	Brevard County	North IRL	1,083	$307	183	$1,819	$332,889
Original	-	Basin 254*	Brevard County	North IRL	581	$313	45	$4,039	$181,759
Original	-	Basin 575*	Brevard County	North IRL	662	$313	54	$3,831	$206,891
Original	-	Basin 218*	Brevard County	North IRL	491	$318	39	$4,003	$156,102
Original	-	Basin CO-2I*	Brevard County	North IRL	979	$311	146	$2,082	$303,988
Original	-	Basin 155*	Brevard County	North IRL	913	$312	94	$3,027	$284,524
Original	-	Basin 1464*	Brevard County	North IRL	968	$312	134	$2,251	$301,677
Original	-	Basin 1368*	Brevard County	North IRL	1,125	$312	162	$2,166	$350,856
Original	-	Basin 738*	Brevard County	North IRL	497	$324	51	$3,162	$161,251
Original	-	Basin 832*^	Brevard County	North IRL	506	$514	90	$2,888	$259,955
Original	-	Basin 314*	Brevard County	North IRL	827	$316	86	$3,034	$260,926
Original	-	Basin 1458*	Brevard County	North IRL	947	$315	128	$2,330	$298,235
Original	-	Basin 901*	Brevard County	North IRL	1,895	$308	232	$2,516	$583,778
Original	-	Basin 1256*	Brevard County	North IRL	1,580	$310	236	$2,079	$490,539
Original	-	TV-South Street Basin*	Brevard County	North IRL	900	$321	131	$2,202	$288,472
Original	-	Basin 829*	Brevard County	North IRL	812	$323	161	$1,627	$262,007
Original	-	Basin 6*	Brevard County	North IRL	716	$326	84	$2,775	$233,058
Original	-	Basin 22*^	Brevard County	North IRL	293	$561	19	$8,645	$164,250
Original	-	Basin 439*	Brevard County	North IRL	585	$330	53	$3,644	$193,133
Original	-	Basin 10*^	Brevard County	North IRL	356	$662	To be determined	To be determined	$235,599
Original	-	Basin 413*	Brevard County	North IRL	915	$324	103	$2,876	$296,198
Original	-	Basin 1263*	Brevard County	North IRL	914	$324	132	$2,247	$296,545
Original	-	Basin 758*	Brevard County	North IRL	533	$334	49	$3,628	$177,788

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Original	-	Basin 835*	Brevard County	North IRL	1,134	$325	159	$2,318	$368,604
Original	-	Basin 1078*	Brevard County	North IRL	1,017	$328	150	$2,226	$333,896
Original	-	Basin 831*	Brevard County	North IRL	733	$332	105	$2,320	$243,650
Original	-	TV-Royal Palm Basin*	Brevard County	North IRL	878	$332	127	$2,298	$291,899
Original	-	Basin 499*	Brevard County	North IRL	761	$335	78	$3,264	$254,570
Original	-	Basin 1381*	Brevard County	North IRL	968	$332	146	$2,204	$321,738
Original	-	Basin 1342*	Brevard County	North IRL	1,034	$332	157	$2,188	$343,533
Original	-	Basin 1298*^	Brevard County	North IRL	750	$613	113	$4,069	$459,774
Original	-	Basin 112*	Brevard County	North IRL	734	$341	107	$2,336	$249,931
Original	-	Basin RL-3A*	Brevard County	North IRL	796	$338	113	$2,384	$269,351
Original	-	Basin 2159*	Brevard County	Central IRL	2,754	$214	350	$1,683	$589,003
Original	-	Basin 2185*	Brevard County	Central IRL	1,208	$238	94	$3,057	$287,331
Original	-	Basin 2163*	Brevard County	Central IRL	1,264	$237	89	$3,369	$299,840
Original	-	Basin 1736*	Brevard County	Central IRL	4,263	$234	551	$1,812	$998,442
Original	-	Basin 1604*	Brevard County	Central IRL	2,916	$239	425	$1,641	$697,286
Original	-	Basin 2239*	Brevard County	Central IRL	1,643	$248	261	$1,564	$408,107
Original	-	Basin 1762*	Brevard County	Central IRL	4,250	$238	621	$1,626	$1,009,602
Original	-	Basin 2222*	Brevard County	Central IRL	1,534	$248	226	$1,687	$381,189
2017	13	Central Boulevard Baffle Box+	City of Cape Canaveral	Banana	481	$72	14	$2,479	$34,700
2017	14	Church Street Type II Baffle Box+	City of Cocoa	North IRL	937	$94	135	$652	$88,045
2017	15	Bayfront Stormwater Project+	City of Palm Bay	Central IRL	348	$88	83	$369	$30,624
2017	16	Gleason Park Reuse+	City of Indian Harbour Beach	Banana	48	$88	9	$469	$4,224
2017	18	Denitrification Retrofit of Johns Road Pond+	Brevard County	North IRL	1,199	$88	Not applicable	Not applicable	$105,512
2017	19	St. Teresa Basin Treatment+	City of Titusville	North IRL	3,100	$88	459	$594	$272,800
2017	20	South Street Basin Treatment+	City of Titusville	North IRL	987	$88	156	$557	$86,856
2017	21	La Paloma Basin Treatment+	City of Titusville	North IRL	2,367	$88	346	$602	$208,296
2017	22	Kingsmill-Aurora Phase Two+	Brevard County	North IRL	4,176	$88	814	$451	$367,488
2017	23	Denitrification Retrofit of Huntington Pond+	Brevard County	North IRL	1,190	$88	Not applicable	Not applicable	$104,720

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2017	24	Denitrification Retrofit of Flounder Creek Pond+	Brevard County	North IRL	856	$88	Not applicable	Not applicable	$75,328
2017	34	Cliff Creek Baffle Box+	City of Melbourne	North IRL	3,952	$88	797	$436	$347,781
2017	35	Thrush Drive Baffle Box+	City of Melbourne	North IRL	3,661	$88	773	$417	$322,200
2018	64	Stormwater Low Impact Development Convair Cove 1 – Blakey Boulevard+	City of Cocoa Beach	Banana	30	$155	3	$1,550	$4,650
2018	65	Stormwater Low Impact Development Convair Cove 2 – Dempsey Drive+	City of Cocoa Beach	Banana	29	$155	3	$1,498	$4,495
2018	66	Big Muddy at Cynthia Baffle Box+	City of Indian Harbour Beach	Banana	269	$155	48	$869	$41,695
2018	67	Grant Place Baffle Box+	City of Melbourne	Central IRL	937	$88	193	$427	$82,481
2018	68	Crane Creek/M-1 Canal Flow Restoration+	St. Johns River Water Management District	Central IRL	23,113	$88	2,719	$748	$2,033,944
2018	69	Apollo/GA Baffle Box+	City of Melbourne	North IRL	3,381	$88	479	$621	$297,522
2019	66b	Big Muddy at Cynthia Baffle Box Expansion+	City of Indian Harbour Beach	Banana	167	$155	10	$2,584	$25,837
2019	85	Basin 1304 Bioreactor+	Brevard County	Banana	958	$94	127	$709	$90,000
2019	87	Fleming Grant Biosorption Activated Media+	Brevard County	Central IRL	602	$94	91	$622	$56,588
2019	88	Espanola Baffle Box+	City of Melbourne	Central IRL	1,119	$94	148	$711	$105,186
2019	89	Basin 1298 Bioreactor+	Brevard County	North IRL	917	$94	116	$743	$86,198
2019	90	Johns Road Pond Biosorption Activated Media+	Brevard County	North IRL	245	$94	37	$622	$23,030

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2019	91	Burkholm Road Biosorption Activated Media+	Brevard County	North IRL	685	$94	104	$619	$64,390
2019	92	Basin 115 Carter Road Biosorption Activated Media+	Brevard County	North IRL	665	$94	101	$619	$62,510
2019	93	Basin 193 Wiley Avenue Biosorption Activated Media+	Brevard County	North IRL	954	$87	144	$575	$82,735
2019	94	Basin 832 Broadway Pond Biosorption Activated Media+	Brevard County	North IRL	456	$94	69	$621	$42,864
2019	95	Cherry Street Baffle Box+	City of Melbourne	North IRL	980	$313	174	$1,763	$306,740
2019	96	Spring Creek Baffle Box+	City of Melbourne	North IRL	1,057	$313	232	$1,426	$330,841
2019	97	Titusville High School Baffle Box+	City of Titusville	North IRL	1,190	$94	166	$674	$111,813
2019	98	Coleman Pond Managed Aquatic Plant System+	City of Titusville	North IRL	1,240	$28	198	$177	$35,000
2020	110	Osprey Plant Pond Managed Aquatic Plant Systems+	City of Titusville	North IRL	606	$99	88	$682	$60,000
2020	117	Basin 10 County Line Road Woodchip Bioreactor+	Brevard County Stormwater	North IRL	597	$122	90	$809	$72,773
2020	118	Basin 26 Sunset Avenue Serenity Park Woodchip Bioreactor+	Brevard County Stormwater	North IRL	605	$122	92	$802	$73,810
2020	119	Basin 141 Irwin Avenue Woodchip Bioreactor+	Brevard County Stormwater	North IRL	567	$122	86	$804	$69,174
2020	120	Draa Field Pond Managed Aquatic Plant Systems+	City of Titusville	North IRL	256	$122	38	$823	$31,281
2020	121	Basin 2258 Babcock Road Woodchip Bioreactor+	Brevard County Stormwater	Central IRL	412	$122	62	$810	$50,203

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2020	122	Basin 22 Hunting Road Serenity Park Woodchip Bioreactor+	Brevard County Stormwater	North IRL	329	$122	50	$802	$40,077
2020	124	Floating Wetlands to Existing Stormwater Ponds+	City of Cocoa	North IRL	12	$125	3	$499	$1,497
2020	125	Diamond Square Stormwater Pond+	City of Cocoa	North IRL	85	$122	23	$451	$10,383
2020	127	Basin 5 Dry Retention+	Town of Indialantic	North IRL	113	$148	18	$927	$16,680
2020	128	Jackson Court Stormwater Treatment Facility+	City of Satellite Beach	Banana	56	$148	8	$1,033	$8,266
2020	129	Forrest Avenue 72-inch Outfall Baseflow Capture/Treatment+	City of Cocoa	North IRL	94	$148	12	$1,163	$13,956
2021	169	Basin 1335 Sherwood Park Stormwater Quality+	City of Melbourne	North IRL	3,214	$122	879	$446	$392,108
2021	174	St. Johns 2 Baffle Box+	City of Titusville	North IRL	1,992	$122	611	$398	$243,070
2021	123	Ray Bullard Water Reclamation Facility Stormwater Management Area+	City of West Melbourne	Central IRL	1,317	$122	400	$402	$160,674
2021	175	High School Baffle Box+	City of Melbourne	North IRL	1,183	$122	319	$452	$144,326
2021	176	Funeral Home Baffle Box+	City of Melbourne	North IRL	481	$122	129	$455	$58,682
2021	177	North and South Lakemont Ponds Floating Wetlands+	City of Cocoa	North IRL	107	$122	25	$522	$13,054
2021	178	Marina B Managed Aquatic Plant Systems+	City of Titusville	North IRL	55	$122	7	$953	$6,670
2021	179	Lori Laine Basin Pipe Improvement Project+	City of Satellite Beach	Banana	117	$150	21	$835	$17,525

Year Added	Project Number	Project Name	Responsible Entity	Sub-Lagoon	Total Nitrogen Reduction (pounds per year)	Cost per Pound of Total Nitrogen Removed	Total Phosphorus Reduction (pounds per year)	Cost per Pound of Total Phosphorus Removed	Plan Funding
2022	213	Johnson Junior High Denitrification Media Chamber Modification+	Brevard County Natural Resources	Central IRL	206	$313	Not applicable	Not applicable	$64,478
2022	214	Sand Point Park Baffle Box+	City of Titusville	North IRL	438	$313	71	$1,931	$137,135
2022	215	Basin 960 Pioneer Road Denitrification+	Brevard County Natural Resources	Banana	105	$370	3	$12,950	$38,850
2022	219	McNabb Outfall Bioretention+	City of Cocoa Beach	Banana	44	$441	7	$2,775	$19,423
2022	220	Basin 1398 Sand Dollar Canal Bioreactor+	Brevard County Natural Resources	North IRL	444	$446	70	$2,829	$198,024
2023	205	Basin 998 Hampton Homes+	Brevard County Natural Resources	Banana	312	$204	47	$1,354	$63,618
2023	206	Basin 1066 Angel Avenue+	Brevard County Natural Resources	Banana	1,150	$202	173	$1,342	$232,200
2023	207	Basin 1124 Elliot Drive+	Brevard County Natural Resources	Banana	533	$278	78	$1,899	$148,100
2023	235	Woodland Business Center Stormwater Retention+	Woodland Business Center	Banana	11	$446	2	$2,453	$4,906
2023	247	Basin 998 Richland Avenue Canal+	Brevard County Natural Resources	Banana	641	$204	97	$1,348	$130,782
2023	250	Basin 1280B Flamingo Road+	Brevard County Natural Resources	Banana	161	$445	31	$2,311	$71,645
2023	251	Basin 1304 West Arlington Road+	Brevard County Natural Resources	Banana	216	$446	To be determined	To be determined	$96,425
2023	231	North Fiske Stormwater Pond Floating Wetlands+	City of Cocoa	North IRL	200	$250	32	$1,563	$50,000

Year Added	Project Number	Project Name	Responsible Entity	Sub-Lagoon	Total Nitrogen Reduction (pounds per year)	Cost per Pound of Total Nitrogen Removed	Total Phosphorus Reduction (pounds per year)	Cost per Pound of Total Phosphorus Removed	Plan Funding
2023	232	Riverfront Center Nutrient Removing Filtrations Boxes+	City of Titusville	North IRL	679	$313	160	$1,327	$212,257
2023	233	Commons and City Hall Tree Boxes+	City of Titusville	North IRL	80	$313	15	$1,669	$25,040
2023	248	Basin 116 Lionel Road+	Brevard County Natural Resources	North IRL	936	$198	142	$1,308	$185,700
2023	252	Basin 89 Scottsmoor I Aurantia+	Brevard County Natural Resources	North IRL	1,706	$144	292	$839	$245,100
-	*-*	***Total***	*-*	*-*	***270,261***	***$242 (average)***	***37,449***	***$1,750 (average)***	***$65,529,120***

Note: The projects highlighted in green and marked with an asterisk were identified in the original plan. The projects highlighted in tan and marked with a plus sign were added to the plan as part of an annual update.
^ The costs and nutrient reductions for these original projects were modified to exclude portions of these priority basins that were funded as separate projects.

Figure 4-22: Stormwater Projects in North Brevard County

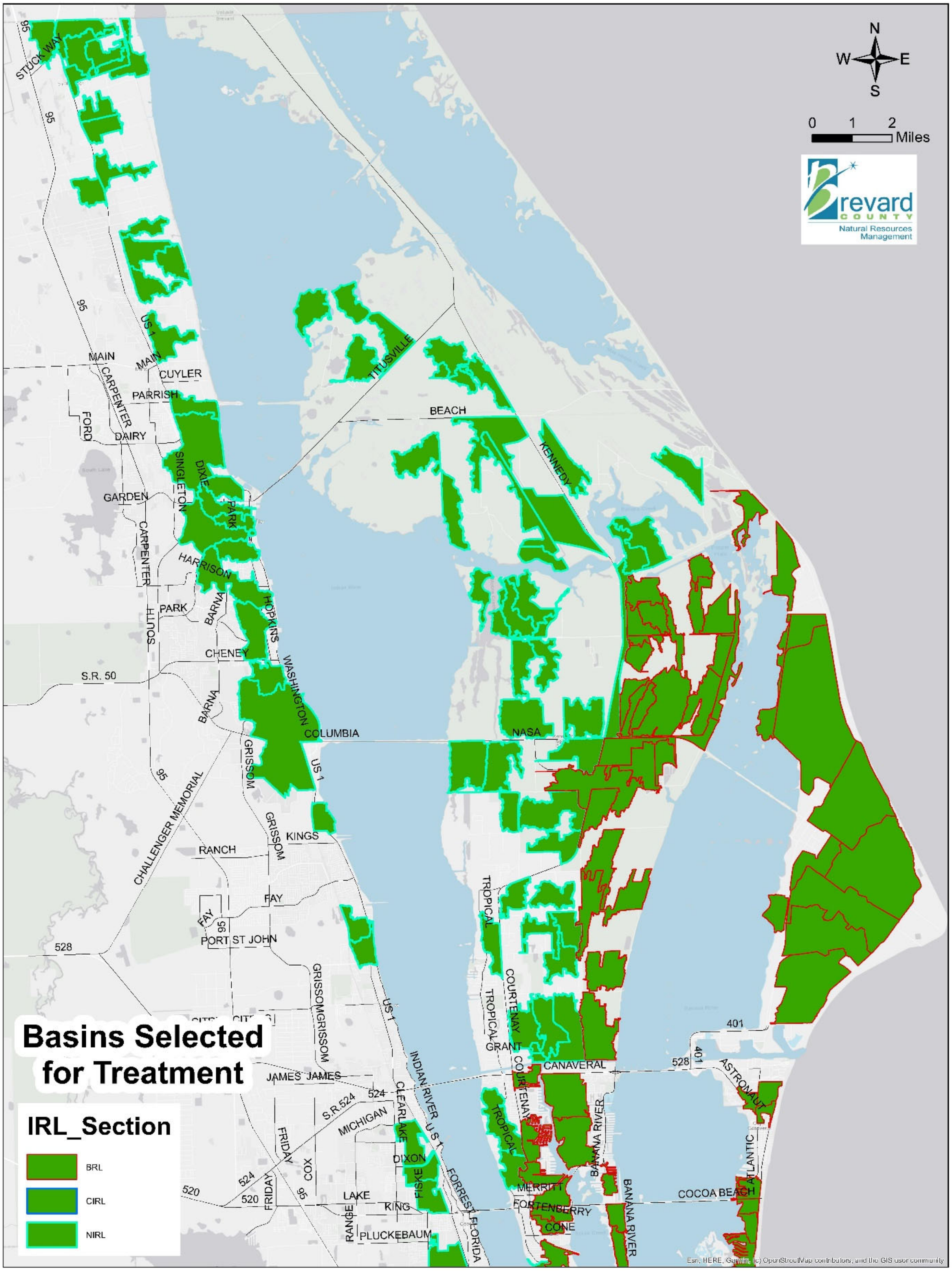


Figure 4-22 [Long Description]

Figure 4-23: Stormwater Projects in Central Brevard County

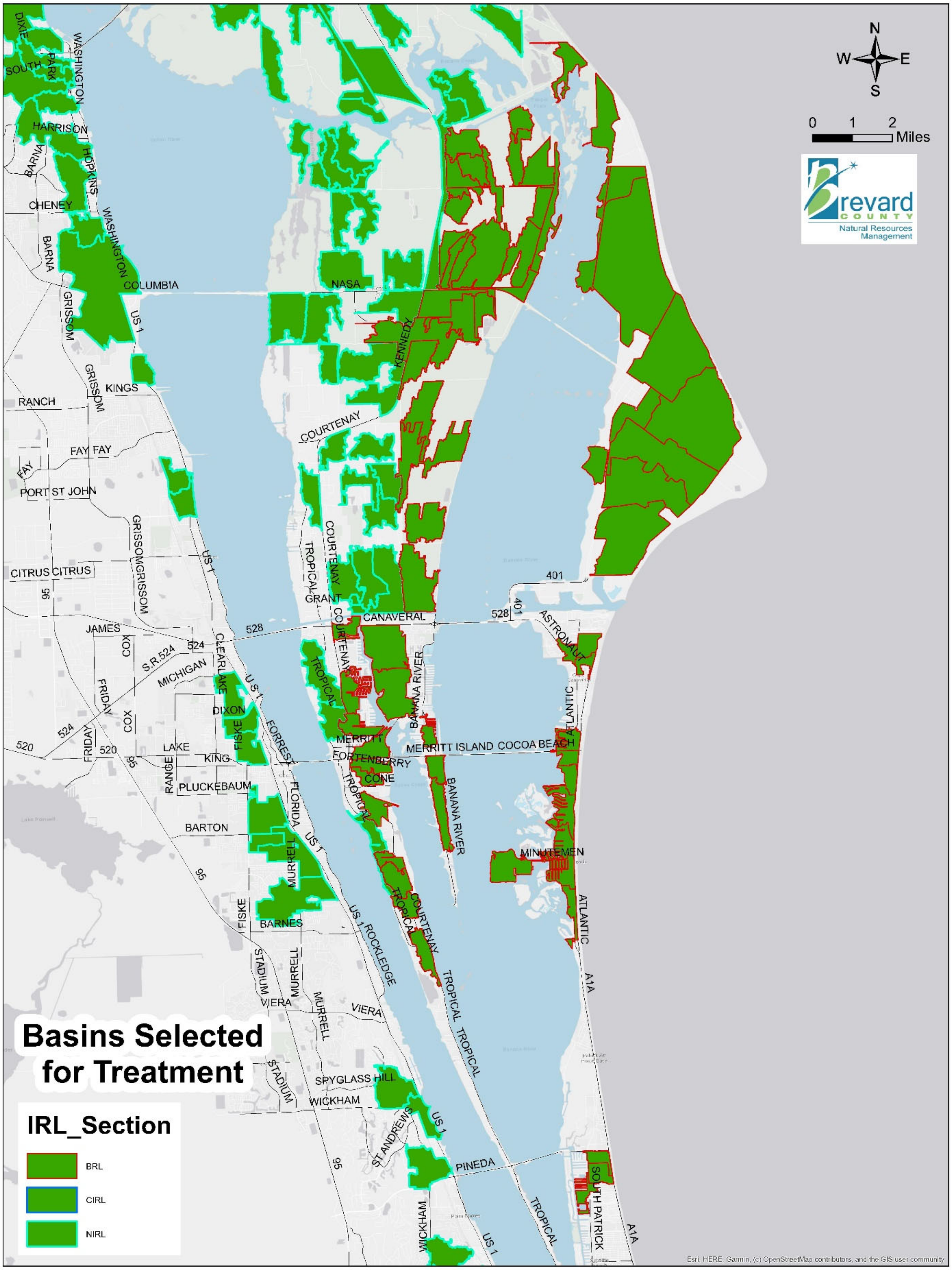


Figure 4-23 Long Description

Figure 4-24: Stormwater Projects in South Brevard County

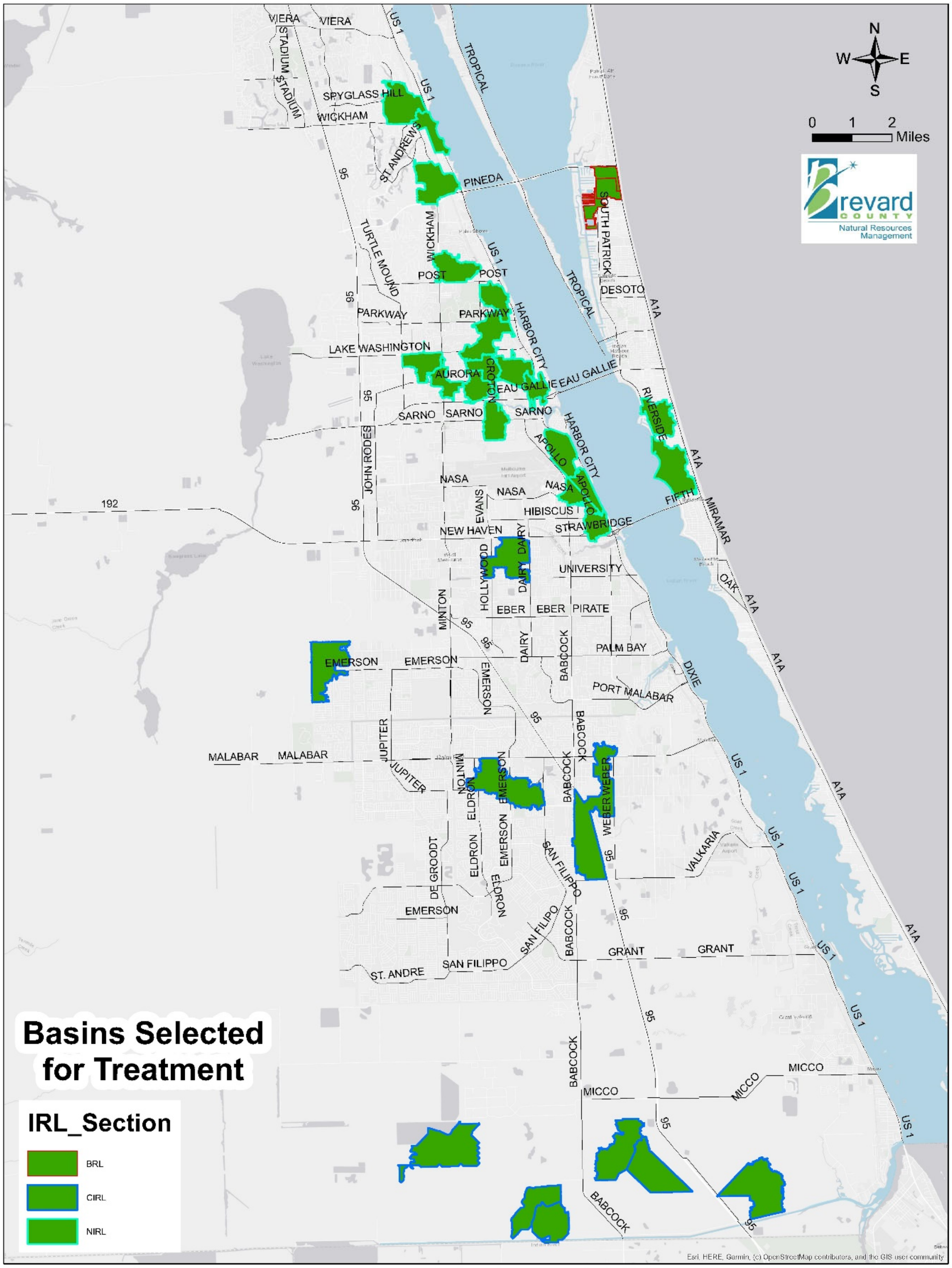


Figure 4-24 Long Description

4.1.8 Vegetation Harvesting

Mechanical removal or harvest of aquatic vegetation rather than treatment with herbicides or other control mechanisms may be one method of reducing nutrient loads to the Indian River Lagoon (IRL) and its tributaries. The use of aquatic plants for nutrient management has been considered since at least the 1960s (Boyd, 1969). The harvest of aquatic vegetation removes nutrients from the waterbody rather than recycling them through decomposition and settlement of the plant material into the sediment. Most freshwater plants do not tolerate the salinity of the IRL and, upon release (such as floating plants washed out of canals) to the lagoon, will die and decompose adding a nutrient load directly to the IRL.

Aquatic vegetation can occur either in mixed stands or as large monocultures. It is not uncommon for invasive plants to form largely monotypic stands. The plant material can form dense floating mats that prevent light diffusion into the water column, thus shading the bottom and limiting benthic habitat. The dense layer of vegetation also limits exchange of gases across the water surface and can cause depletion of dissolved oxygen under the mat. At greater densities, vegetation may also form floating islands or tussocks and incorporate woody plants.

Common invasive plants present in waterways that connect to the IRL are hydrilla, water lettuce, duck weed, and water hyacinth, and these plants present the greatest opportunity for harvest and removal of nutrients through plant biomass. However, native vegetation can be intermixed with exotics. Examples of common native aquatic vegetation that may also be removed includes cattails, fanwort, coontail, bladderwort, and water lilies.

The removal of aquatic vegetation may be accomplished in several ways. For canals or waterbodies with small surface area, booms laid across the water surface can divert flow to screening and sorting facilities for removal of floating vegetation. Also, in canals, drag lines or back hoes can be used for removal of submerged vegetation or modified front end loaders with baskets can collect floating plant material. There are also specifically designed harvesters and shredders that move through the water and cut and remove vegetation (Florida Department of Environmental Protection, 2012).

The cost-share for vegetation harvesting was based on actual annualized costs and laboratory analyses of the total nitrogen (TN) and total phosphorus (TP) content of plant material removed from floating vegetative islands in eight Brevard County stormwater ponds (see **Table 4-28**). Cost-share reimbursement of approved projects will be based on laboratory analysis of plant material to determine true nutrient removal. Eligible cost-share will be adjusted as additional cost and nutrient removal benefit data are collected.

Table 4-28: Estimated Costs and Nutrient Reductions for Vegetation Harvesting

Project	Annualized Cost	Annualized Total Nitrogen Reductions (pounds per year)	Cost per Pound per Year of Total Nitrogen Reduction	Annualized Total Phosphorus Reductions (pounds per year)	Cost per Pound per Year of Total Phosphorus Reduction
Vegetation Harvesting	$198,868	1,812	$110	191	$1,041

Table 4-29 summarizes the approved projects for vegetation harvesting.

Table 4-29: Projects for Vegetation Harvesting

Year Added	Project Number	Project Name	Responsible Entity	Sub-lagoon	Total Nitrogen Reduction (pounds per year)	Cost per Pound per Year of Total Nitrogen Reduction	Total Phosphorus Reduction (pounds per year)	Cost per Pound per Year of Total Phosphorus Reduction	Plan Funding
2020	111	Draa Field Vegetation Harvesting+	City of Titusville	North IRL	786	$110	99	$873	$86,413
2020	112	County Wide Stormwater Pond Harvesting+^	Brevard County Stormwater	North IRL	931	$15	327	$43	$14,000
2021	171	Mechanical Aquatic Vegetation Harvesting+	Melbourne-Tillman Water Control District	Central IRL	16,636	$61	1,664	$608	$1,011,976
2021	172	Horseshoe Pond Vegetative Harvesting+^	Brevard County Stormwater	North IRL	4,536	$2	242	$34	$8,140
2021	173	North and South Lakemont Ponds Vegetation Harvesting+	City of Cocoa	North IRL	18	$110	4	$495	$1,980
2022	208	Maritime Hammock Preserve Stormwater Pond Aquatic Vegetation Harvesting+^	City of Cocoa Beach	Banana	143	$101	5	$2,896	$14,480
2022	209	Basin 1398 Sand Dollar Canal Harvesting+	Brevard County Natural Resources	North IRL	222	$110	21	$1,163	$24,420
2022	210	Basin 958 Pioneer Road Vegetation Harvesting+	Brevard County Natural Resources	Banana	363	$110	47	$850	$39,930
2022	211	Cocoa Beach Golf Course Stormwater Ponds Aquatic Vegetation Harvesting+	City of Cocoa Beach	Banana	5,385	$110	542	$1,093	$592,350
2023	228	Unincorporated Countywide Vegetation Harvesting+	Brevard County Natural Resources	All	4,091	$110	993	$453	$450,000
-	***-***	***Total***	***-***	***-***	***33,111***	***$68 (average)***	***3,944***	***$569 (average)***	***$2,243,689***

Note: The projects highlighted in tan and marked with a plus sign were added to the plan as part of an annual update.
^ Total nitrogen and total phosphorus reductions adjusted after project completion and certified laboratory analysis.

4.2. Projects to Remove Pollutants

The purpose of the projects in this section is to remove pollutants that have accumulated in the lagoon. Brevard County (County) has already begun to remove deep accumulations of muck from the lagoon bottom. Dredging to remove muck in other locations of the lagoon will continue, as well as treatment of the interstitial water when feasible. These muck removal projects have more immediate benefits on the lagoon water quality than external reduction projects because the nutrient flux is reduced as soon as muck is dredged from the system whereas it takes time for the external load reduction benefits to reach the lagoon. The County is also evaluating opportunities to use new treatment technologies to provide surface water remediation. In addition, the St. Johns River Water Management District, Indian River Lagoon National Estuary Program, and Florida Institute of Technology are evaluating opportunities for enhanced circulation projects, which will allow additional water to flow into the lagoon system to help remove the built-up sediments and muck. The following sections describe the proposed muck removal projects, scrubbing of muck interstitial water, and spoil management areas as well as potential surface water remediation and potential circulation enhancement projects.

4.2.1 Muck Removal

Muck flux contributes 45% of the TN and 49% of TP load to the Banana River Lagoon each year.

The muck in the Indian River Lagoon (IRL) increases turbidity, inhibits seagrass growth, promotes oxygen depletion in sediments and the water above, stores and releases nutrients, covers the natural bottom, and destroys healthy communities of benthic organisms (Trefry, 2013). When muck is suspended within the water column due to wind or human activities such as boating, these suspended solids limit light availability and suppress seagrass growth. Even for deeper water areas without seagrass growth, muck remains a nutrient source that potentially affects a broader area of the lagoon through nutrient flux and resuspension of fine sediments and their subsequent transport. As shown in **Table 3-1,** the annual release of nutrients from decaying muck is almost as much as the annual external loading delivered by stormwater and groundwater baseflow combined. The muck deposits cover an estimated 6,700 acres of the lagoon system bottom in Brevard County (Trefry, 2018).

The muck deposits in the lagoon flux nutrients that enter the water column and contribute to algal blooms and growth of macroalgae. Muck flux rates for nitrogen and phosphorus have been estimated through studies in the IRL system. For this plan, the average flux rates used are 150 pounds of total nitrogen (TN) per acre per year and 20 pounds of total phosphorus (TP) per acre per year (Trefry, 2018) except where specific measurements indicate otherwise.

The focus of the muck removal projects for this plan is on large deposits of muck in big, open water sites within the lagoon itself. Several of the canal systems that directly connect to the lagoon are also included for muck removal. The goal of the muck removal is to reduce TN and TP muck flux loads by 25%, which should result in a significant improvement in water quality and seagrass extent, as well as a reduced risk of massive algal blooms and fish kills. A 70% efficiency for muck removal projects was applied. This efficiency accounts for two factors: (1) each target dredge area has less than 100% muck cover, and (2) some pockets of muck within dredged areas will inevitably be left behind regardless of the dredge technology used. In 2018 and 2019, the Florida Institute of Technology conducted evaluations of the muck deposits throughout the lagoon system for Brevard County (Fox and Trefry, 2018; Fox and Trefry, 2019; Shenker, 2018; Souto, 2018; Trefry et al., 2019a and 2019b; Zarillo and Listopad, 2019; Fox, 2022). The updated muck acreage estimates are shown in **Table 4-30**.

Table 4-30: Muck Acreages in the IRL System

Muck Reduction Targets	Open Banana	Banana Canals	North IRL	North IRL Canals	Central IRL	Central IRL Canals	Mosquito Lagoon
Muck area (acres)	1,276	752	3,035	51	59	37	398
Muck flux (pounds of total nitrogen per year)	305,890	112,800	243,379	7,650	76,324	5,550	7,164
Funded dredging sites (acres)	223	0	251	0	10	24	0
Flux from funded dredging sites (pounds of total nitrogen per year)	143,635	0	70,223	0	6,140	0	0
Flux reduction from funded sites (pounds of total nitrogen per year)	106,845	49,949	51,687	0	4,728	10,030	0
Percent of total flux reduced by dredging the funded sites	35%	44%	21%	0%	6%	2%	0%

Using the information from the Florida Institute of Technology, Brevard County reevaluated the priority muck locations for dredging. The estimated area and nutrient flux using average flux rates for Brevard County or site-specific data collected by the Florida Institute of Technology are shown in **Table 4-31** for the recommended projects. **Table 4-32** provides a summary of the recommended projects and the projects submitted as part of an annual plan. The locations of these projects are shown in **Figure 4-25** through **Figure 4-28**.

As dredging proceeds, upland input of muck components must be reduced to prevent new muck accumulation. Therefore, land-based source control measures for nutrients, organic waste, and erosion are needed. Without source controls, muck removal will need to be frequently repeated, which is neither cost-effective nor beneficial to the lagoon's health. Public awareness and commitment are needed to control future muck accumulation. Activities that contribute organic debris and sediment to stormwater and open water must be curtailed. Additional scientific assessment should be carried out to evaluate and optimize the dredging process.

Table 4-31: Estimated Costs and Nutrient Reductions for Muck Removal Project Areas

Location	Sub-Lagoon	Cubic Yards	Acres	Total Nitrogen Flux* (pounds per acre per year)	Total Phosphorus Flux (pounds per acre per year)
Canaveral South	Banana	420,000	55	917	50
Pineda Banana River Lagoon	Banana	195,000	28	765	35
Patrick Space Force Base	Banana	205,000	26	650	21
Cocoa Beach Golf	Banana	975,000	140	392	21
Titusville Railroad West	North IRL	90,000	70	285	12
National Aeronautics and Space Administration Causeway East	North IRL	285,000	34	917	44
Rockledge A	North IRL	125,000	38	142	31
Titusville Railroad East	North IRL	115,000	36	294	9
Eau Gallie Northeast	North IRL	250,000	73	89	29

*Flux rates from Fox, 2022.

Table 4-32: Projects for Muck Removal

Year Added	Project Number	Project Name	Responsible Entity	Sub-Lagoon	Total Nitrogen Reduction (pounds per year)	Cost per Pound per Year of Total Nitrogen Removed	Total Phosphorus Reduction (pounds per year)	Cost per Pound per Year of Total Phosphorus Removed	Plan Funding
Original	2016-10a	Canaveral South*>	Brevard County	Banana	35,305	$416	1,925	$7,636	$14,700,000
Original	2016-5a	Pineda Banana River Lagoon*>	Brevard County	Banana	14,994	$455	686	$9,949	$6,825,000
Original	2016-11a	Patrick Space Force Base*>	Brevard County	Banana	11,830	$607	382	$18,783	$7,175,000
Original	168a	Cocoa Beach Golf*^>	Brevard County	Banana	38,416	$556	2,058	$10,374	$21,350,000
Original	2016-06a	Titusville Railroad West*>	Brevard County	North IRL	13,965	$226	588	$5,357	$3,150,000
Original	2016-07a	National Aeronautics and Space Administration Causeway East*>	Brevard County	North IRL	21,825	$457	1,047	$9,527	$9,975,000
Original	2016-04a	Rockledge A*>	Brevard County	North IRL	3,777	$1,158	825	$5,303	$4,375,000
Original	2016-08a	Titusville Railroad East*>	Brevard County	North IRL	7,409	$543	227	$17,731	$4,025,000
Original	54a	Eau Gallie Northeast*>	Brevard County	North IRL	4,548	$1,924	1,482	$5,904	$8,750,000
2017	41a	Grand Canal Muck Dredging+#	Brevard County	Banana	10,469	$251	1,396	$1,882	$2,626,600
2017	42a	Sykes Creek Muck Dredging+	Brevard County	Banana	19,635	$240	2,618	$1,797	$4,705,428
2018	70a	Cocoa Beach Muck Dredging – Phase III+	City of Cocoa Beach	Banana	4,095	$336	780	$1,764	$1,376,305
2018	71	Merritt Island Muck Removal – Phase 1+	Brevard County	Banana	8,085	$957	1,540	$5,022	$7,733,517
2018	72a	Muck Removal of Indian Harbour Beach Canals+	City of Indian Harbour Beach	Banana	3,780	$961	720	$5,044	$3,631,815
2018	2016-3a	Muck Re-dredging in Turkey Creek+>	Brevard County	Central IRL	4,728	$45	221	$973	$215,000
2019	101	Cocoa Beach Muck Dredging Phase II-B+	City of Cocoa Beach	Banana	6,300	$939	840	$7,045	$5,917,650
2020	144	Satellite Beach Muck Dredging+	City of Satellite Beach	Banana	3,885	$485	518	$3,638	$1,884,225
2022	223	Spring Creek Dredging+	City of Melbourne	North IRL	154	$520	21	$3,813	$80,080
2023	236	Sunnyland Canals Muck Removal+	Sunnyland Beach Property Owners Association	Central IRL	10,030	$520	336	$15,523	$5,215,600
-	-	***Total***	-	-	***223,230***	***$509 (average)***	***18,210***	***$6,244 (average)***	***$113,711,220***

Note: The projects highlighted in green and marked with an asterisk were identified in the original plan. The projects highlighted in tan and marked with a plus sign were added to the plan as part of an annual update.

^ The Cocoa Beach Golf project is not fully funded at this time. A total of $21,350,000 is available and Brevard County is looking for options to fund the remaining $12,775,000 for dredging plus associated interstitial water treatment.

In 2021, contingency funding was approved to add Berkeley Canal to the Grand Canal project.

> Flux Rate from Fox, 2022.

Figure 4-25: Location of Muck Removal Projects in the Northern Banana River Lagoon

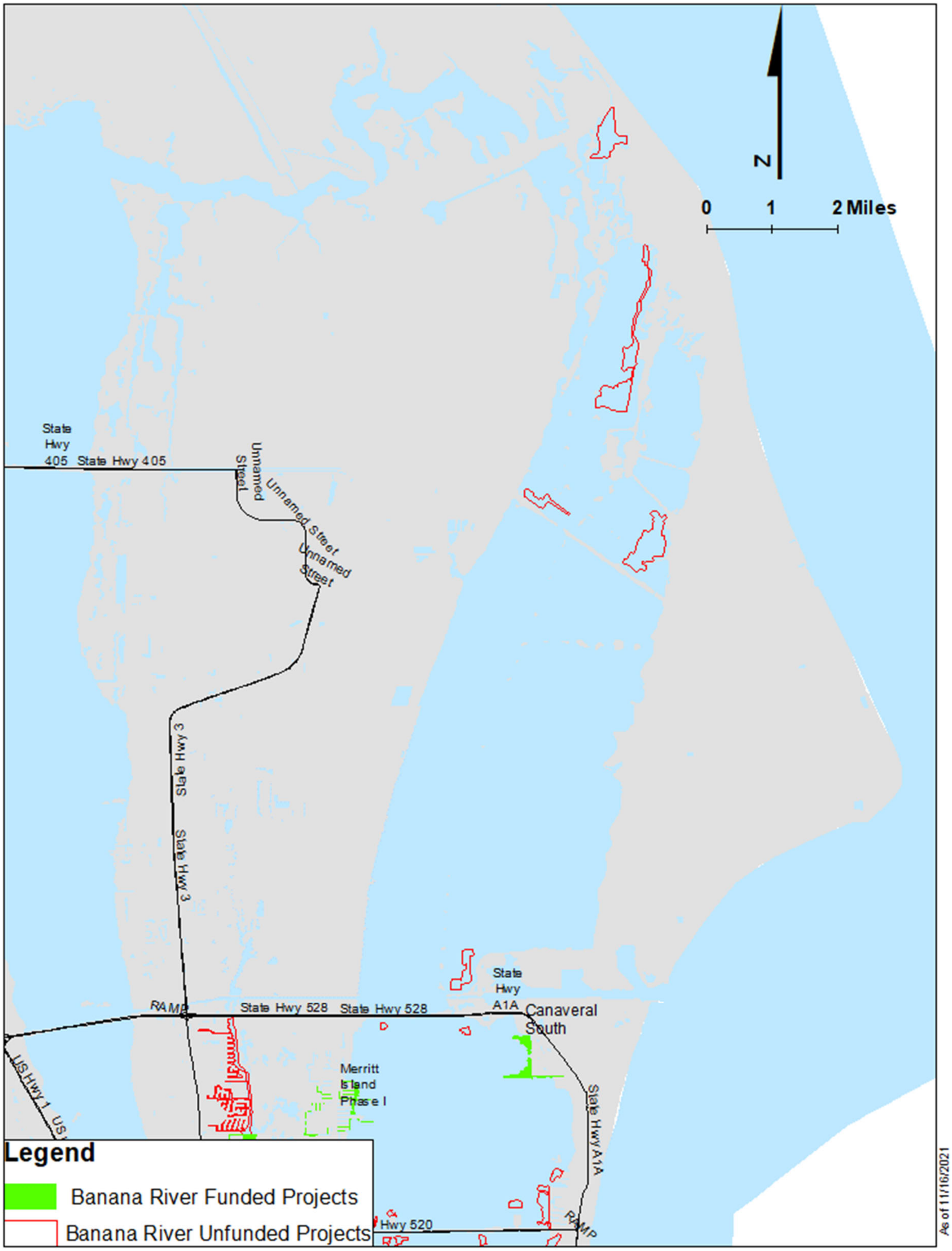


Figure 4-25 [Long Description]

Figure 4-26: Location of Muck Removal Projects in the Southern Banana River Lagoon

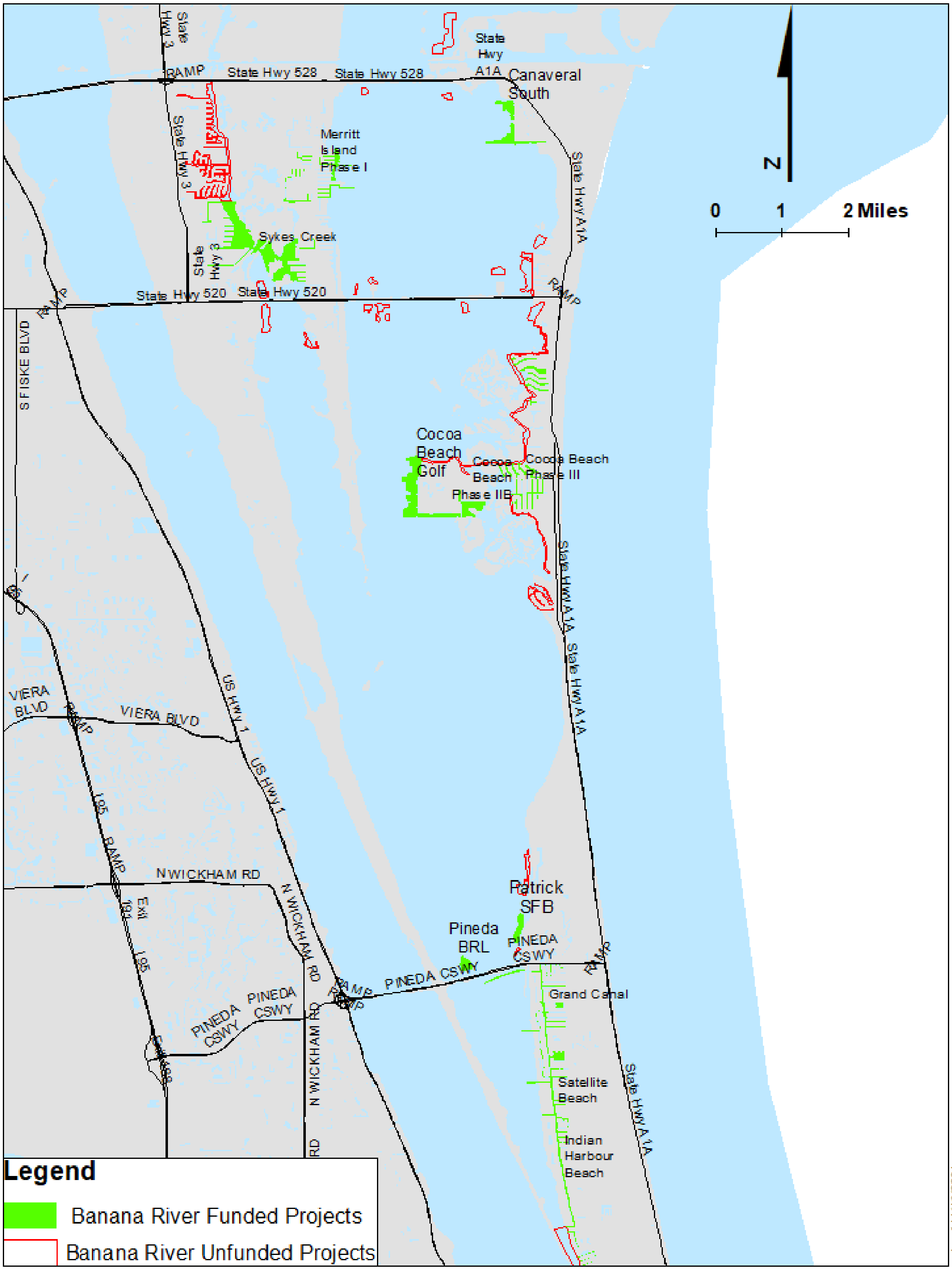


Figure 4-26 [Long Description]

Figure 4-27: Location of Muck Removal Projects in North IRL

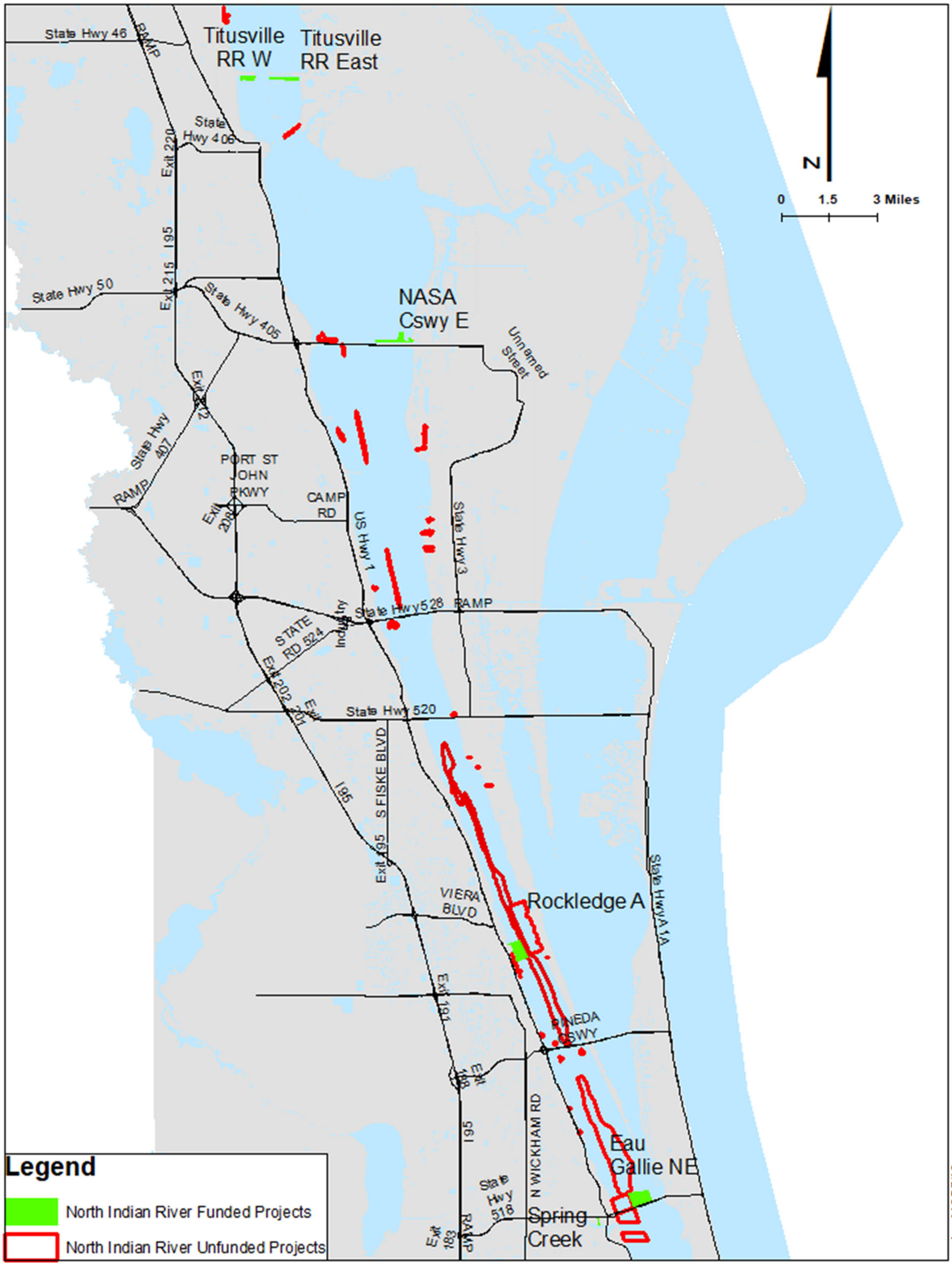


Figure 4-27 Long Description

Figure 4-28: Location of Muck Removal Projects in Central IRL

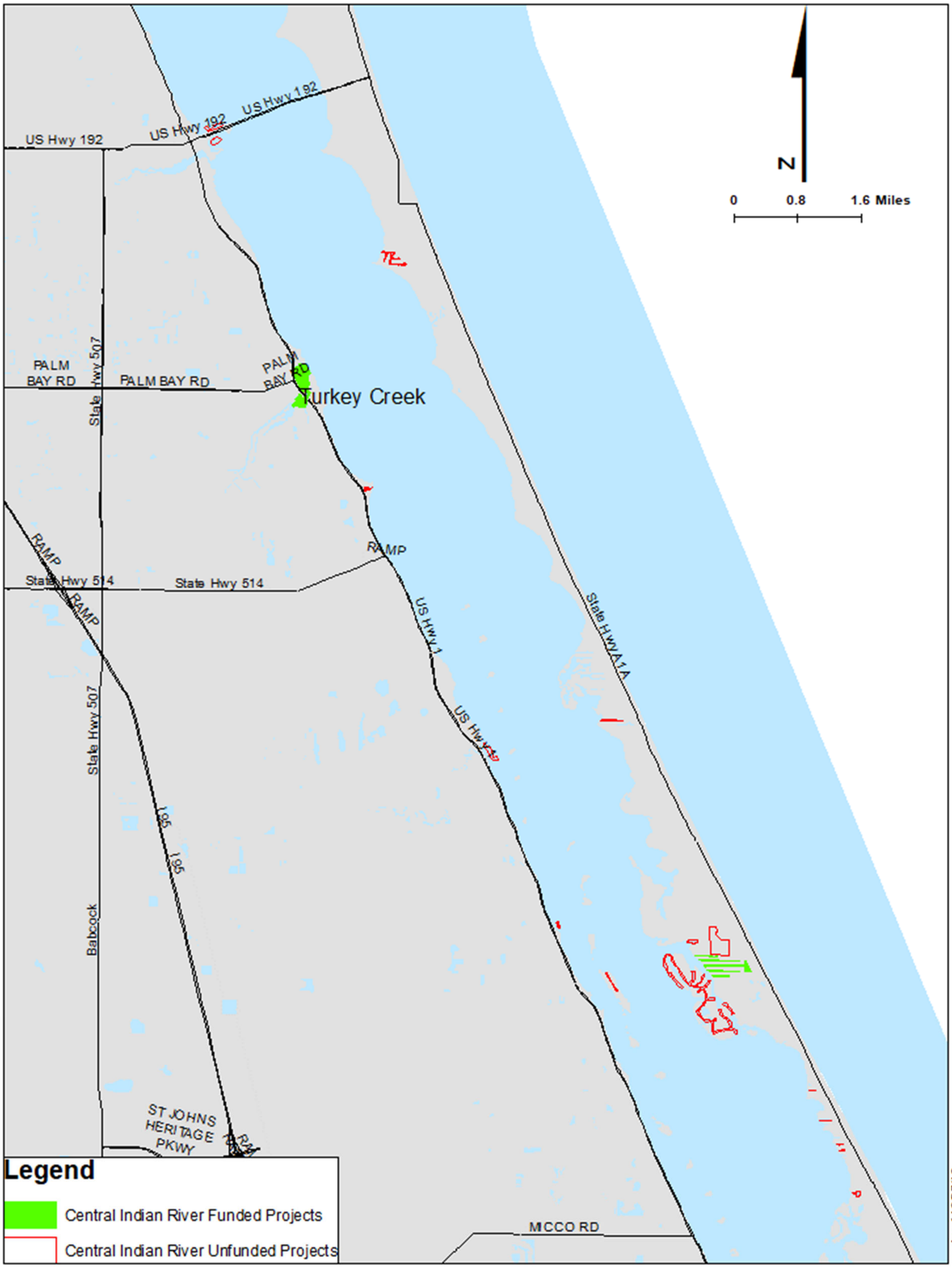


Figure 4-28 Long Description

4.2.2 Treatment of Muck Interstitial Water

Interstitial water refers to the water content that is present within the muck material. Sampling and testing conducted by Florida Institute of Technology researchers has shown that the majority of nutrients are bound to solid particles in the muck; however, the interstitial water also contains a significant amount of dissolved nutrients. When the muck material is dredged, interstitial water nutrients are pumped with the muck and lagoon water in a slurry to the dredged material management area. At the dredged material management area, the muck slurry is processed in a settling pond where sediments settle out and overflow water is returned to the Indian River Lagoon (IRL). Treatment of this overflow water represents a significant opportunity to prevent return of these nutrients to the IRL.

Working with the dredging industry, sewage treatment industry, stormwater treatment entrepreneurs, and industrial waste treatment engineers, feasible and reasonably cost-effective concentration targets for return water to the IRL were initially identified as 2,000–3,000 parts per billion for total nitrogen (TN) and 75–100 parts per billion for total phosphorus (TP). Treatment options for TP were demonstrated during the state-funded initial dredging of Turkey Creek, with Florida Institute of Technology researchers providing independent third-party verification of performance levels. These targets can be achieved through a variety of technologies including, but not limited to, coagulants, polymers, biosorption activated media, or a combination of these technologies. Costs vary by technology, target nutrient reduction levels, and interstitial nutrient concentrations. Open market costs were initially collected through three bid solicitations: (1) Mims Boat Ramp muck removal project, (2) Sykes Creek muck removal project, and (3) Grand Canal muck removal project. More recent dredging experience indicates that concentration targets for TN may need to be adjustable and procured as bid options or alternates to allow market conditions to identify what targets are most cost-effective.

To encourage partnering entities and applicants for Save Our Indian River Lagoon Trust Fund dollars to take advantage of this opportunity to enhance the performance of muck removal projects by removing interstitial water nutrients from the dredge slurry during muck dredging operations whenever project configuration allows, a separate cost-share was developed to account for this added cost and associated nutrient reduction benefit. Using available cost information from Turkey Creek, Mims, and Sykes Creek, County staff considered how to incentivize the addition of this processing step as soon as possible into permitted muck removal projects, as well as future projects. When the substitute project request form was distributed to the public in 2018, staff estimated that a cost-share of $200 per pound of TN removed would be sufficient to entice most partners to agree to stipulate a specific condition in their bids and dredging contracts that return water not exceed 3,000 parts per billion of TN nor 100 parts per billion of TP. However, based on recent bids for nutrient mitigation alternatives for sediment dewatering for Sykes Creek (Tetra Tech, 2015), Grand Canal, and Mims, the cost-share used for Brevard County projects in the 2019 Update was reduced to $50 per pound of TN removed. This cost will remain volatile until a contractor meets the concentration targets long enough to determine cost more accurately.

The recommended locations for interstitial water treatment and load reductions are shown in **Table 4-33**.

Table 4-33: Projects for Treatment of Interstitial Water

Year Added	Project Number	Project Name	Responsible Entity	Sub-lagoon	Total Nitrogen Reduction (pounds per year)	Cost per Pound per Year of Total Nitrogen Removed	Total Phosphorus Reduced (pounds per year)	Cost per Pound per Year of Total Phosphorus Removed	Plan Funding
2017	40	Mims Muck Removal: Outflow Water Nutrient Removal+*	Brevard County	North IRL	2,803	$143	244	$1,639	$400,000
2018	2016-10b	Canaveral South+	Brevard County	Banana	42,688	$50	3,887	$549	$2,134,419
2018	2016-5b	Pineda Banana River Lagoon+	Brevard County	Banana	19,820	$50	1,804	$549	$990,980
2018	2016-11b	Patrick Space Force Base+	Brevard County	Banana	20,836	$50	1,897	$549	$1,041,800
2018	168b	Cocoa Beach Golf+^	Brevard County	Banana	99,098	$30	9,022	$334	$3,013,100
2018	41b	Grand Canal+#	Brevard County	Banana	89,495	$174	To be determined	To be determined	$15,610,821
2018	42b	Sykes Creek+	Brevard County	Banana	64,278	$175	To be determined	To be determined	$11,248,704
2018	2016-06b	Titusville Railroad West+	Brevard County	North IRL	9,148	$50	833	$549	$457,375
2018	2016-07b	National Aeronautics and Space Administration Causeway East+	Brevard County	North IRL	28,967	$50	2,637	$549	$1,448,355
2018	2016-04b	Rockledge A+	Brevard County	North IRL	12,705	$50	1,157	$549	$635,244
2018	2016-08b	Titusville Railroad East+	Brevard County	North IRL	11,688	$50	1,064	$549	$584,424
2018	54b	Eau Gallie Northeast+	Brevard County	North IRL	25,410	$50	2,313	$549	$1,270,487
2018	2016-3b	Muck Interstitial Water Treatment for Turkey Creek+	Brevard County	Central IRL	Not applicable	Not applicable	688	Not applicable	Part of dredging cost
2018	72b	Muck Interstitial Water Treatment for Indian Harbour Beach Canals+	City of Indian Harbour Beach	Banana	27,418	$200	To be determined	To be determined	$5,483,600
2020	113	Satellite Beach Interstitial Water Treatment+	City of Satellite Beach	Banana	29,978	$102	3,059	$1,000	$3,057,756
-	**-**	***Total***	**-**	**-**	***484,332***	***$98 (average)***	***28,605***	***$1,656 (average)***	***$47,377,065***

Note: The projects highlighted in tan and marked with a plus sign were added to the plan as part of an annual update.
* Outflow Water Nutrient Removal for the Mims Muck Removal project was funded, bid, and awarded to the lowest successful bidder; however, the contractor was unsuccessful at reducing outflow water nutrient concentrations as much as required by the contract. Therefore, only partial reductions were achieved and the Save Our Indian River Lagoon 0.5 cent sales tax funding was not used.
^ The Cocoa Beach Golf project is not fully funded at this time. A total of $3,013,100 is available and Brevard County is looking for options to fund the remaining $1,941,800.
# In 2021, contingency funding was approved to add Berkeley Canal to the Grand Canal project.

4.2.3 Spoil Management Areas

As Brevard County (County) seeks to execute muck dredging projects, the availability of upland processing areas for the treatment of dredge spoils has become a growing concern. These working sites, referred to as temporary spoil management areas or in the industry as dredged material management areas, are upland parcels of land that can be used as needed for the temporary processing of dredge spoils until such time as the materials can be moved offsite to a permanent beneficial use or disposal location.

To move muck dredging projects forward in a timely manner, initial project locations were selected to make use of existing dredged material management areas through the County's long-standing partnership with the Florida Inland Navigation District. The Florida Inland Navigation District manages Florida's Intracoastal Waterway for which it has acquired eight dredged material management area sites distributed from north to south along the 72 miles of the Indian River Lagoon (IRL), not the Banana River, in Brevard County. Only three of these Florida Inland Navigation District dredged material management areas are presently developed; however, the County is working on partnership agreements with the Florida Inland Navigation District to construct dredged material management area facilities at their remaining sites.

The eight Florida Inland Navigation District sites are insufficient to meet the volume and timing of muck dredging projects included in this plan. As the distance between dredging sites and dredged material management areas increase, more booster pumps are required. Booster pumps can complicate project operations and increase cost, particularly as multiple boosters become necessary. Booster pumps are required as project pump distances approach one-mile and are required at one-mile intervals thereafter. Each booster pump adds approximately $1 per cubic yard of material dredged. Pump distances for the Eau Gallie and Sykes Creek projects have five- to seven-mile pump distances to the Florida Inland Navigation District sites and project amounts in excess of 400,000 cubic yards each.

As a supplement to the Florida Inland Navigation District sites, Brevard County staff investigated lease and purchase options for the development of additional multi-use spoil management areas. Lease options for parcels of interest resulted in unfavorable cost-benefit ratios on these short-term investments due to the up-front costs of site development including design, permitting, mitigation, and construction. Similar cost effectiveness issues arise from depending on private sector contractors to provide a temporary dredged material management area as part of construction costs. The contractor passes along most or all the costs of providing a dredged material management area, but the County does not have the benefit of using the site multiple times over the 10-year timespan of this plan or thereafter.

Fee simple purchase and development of spoil management areas, designed with multi-use options for the implementation of regional surface water or stormwater treatment projects, emerges as the most cost-effective long-term option. Through fee simple site acquisition and a prescribed site use and management plan, investments in acquisition and development costs, including required mitigation, can be recovered. For example, the acquisition of a spoil management site four miles closer than the nearest Florida Inland Navigation District site could reduce booster pump costs by $1.6 million on a single 400,000 cubic yard muck removal project. This savings can offset site acquisition and development costs associated with the parcel.

Publicly owned dredged material management area sites could be used for stormwater or surface water treatment, when not being used for dredging. These additional uses can be factored into site selection and design to provide supplementary lagoon benefits. Therefore, land acquisition shall be considered an eligible muck management project cost, particularly when the site can be designed to provide multi-use regional surface water or stormwater treatment alongside or intermittently between usages for muck management. A preliminary project design and construction layout with cost evaluation (comparison to an existing, more distant dredged material management area) shall be part of the site selection and land acquisition decision process.

Another factor to consider when evaluating long-term operations and the feasibility of muck dredging projects is the strategy for final disposal and the development of permanent beneficial use or disposal locations. Often left to the contractor as part of their construction and implementation plan, a final disposition strategy is in many cases not part of the dredging project plan. The dependency on private sector contractors to provide a final disposition strategy and permanent material disposal site can have consequences that a managed permanent disposal site can avoid. These consequences can increase the contractor's risk and drive up project costs.

A managed disposal site would consider the fiscal, environmental, and social implications of the site. A final disposition strategy evaluates the appropriateness of the disposal site in terms of the local community and future development, the environmental proximity to surface waters and runoff potential, groundwater protection, hauling costs, and minimizing risk by providing a defined disposal site. A defined material disposal site, laid-out in the project design, provides a level of security at the time of project bidding that reduces risk to the contractor and potentially lowers the project cost. Staff investigation into the purchase, use and reclamation of existing borrow pits are an example of final disposal areas that are being considered. Similar to what is seen with the development of temporary spoil management areas, the most cost-effective long-term option for the disposal of muck material should include the evaluation of fee simple purchase options and the development of spoil disposal areas.

4.2.4 Surface Water Remediation System

In 2016, AquaFiber Technologies Corporation had a technology that could treat up to 25 cubic feet per second (16 million gallons per day) of water from Turkey Creek, which is a major tributary to the Central Indian River Lagoon (IRL). This project would reduce total suspended solids by more than 90%, remove algal blooms and cyanobacteria to improve the lagoon's color and clarity, improve the dissolved oxygen concentration by returning water with near 100% oxygen saturation, and produce a biomass that can be processed into fertilizer pellets or used as a feedstock for waste-to-energy utilities to produce electricity.

This project would remove an estimated 35,633 pounds per year of total nitrogen (TN) and 2,132 pounds per year of total phosphorus (TP) from the watershed. The facility would cost $19,720,760 for design, permitting, construction, and use of a technology to destroy the biomass onsite. The cost to operate and maintain the remediation facility is estimated to be $6,271,200 per year. **Table 4-34** summarizes the benefits and costs of nutrient removal for this project for a 10-year period. On an annual basis, the yearly costs would be $8,243,276, which would result in an annual cost per pound per year of TN removed of $231 and cost per pound per year of TP removed of $3,867.

Brevard County also received information from Phosphorus Free Water Solutions, which has a pay for performance treatment technology to reduce phosphorus, nitrogen, color, and turbidity in surface waters. Phosphorus Free evaluated a project to treat 50 cubic feet per second of water from Turkey Creek. Based on the measured concentrations in Turkey Creek, Phosphorus Free Water Solutions provided two options for treating nitrogen. The measured phosphorus concentration in Turkey Creek is very low and it would not be cost-effective to remove additional phosphorus from the system through this technology. The first option would use the basic nitrogen removal process, which would remove a portion of the dissolved organic nitrogen. This option would reduce TN by 53% or 50,353 pounds per year at a cost of $6,797,000 or $135 per pound of TN removed. The second option would include an additional treatment step to increase the removal of dissolved organic nitrogen. This option would reduce TN by 86% or 81,469 pounds per year at a cost of $13,035,000 or $160 per pound of TN removed (**Table 4-34**). The costs for each scenario do not include the capital costs to construct the treatment facility, only the annual pay for performance cost estimates for a ten-year contract for treatment.

Table 4-34: Summary of Annual Benefits and Ten-Year Costs of a Surface Water Remediation System

Project	Ten-Year Project Cost	Total Nitrogen Reduction (pounds per year)	Cost per pound per Year of Total Nitrogen Removed	Total Phosphorus Reduction (pounds per year)	Cost per Pound per Year of Total Phosphorus Removed
AquaFiber	$82,432,760	35,633	$2,313	2,132	$38,665
Phosphorus Free Option 1	$67,970,000	50,353	$1,350	To be determined	To be determined
Phosphorus Free Option 2	$130,350,000	81,469	$1,600	To be determined	To be determined

These technologies have not yet been tested in estuarine systems; therefore, these remediation systems are not recommended at this time. However, these types of treatment technologies offer additional benefits that should be more thoroughly explored to better assess the total value to restoring and maintaining lagoon health. In 2020, Brevard County received a grant to collaborate with AquaFiber Technologies Corporation to pilot test their surface water remediation technologies. Unfortunately, AquaFiber had to cancel the project due to COVID-19 related economic hardships. Brevard County continues to investigate potential surface water remediation technologies and a portion of the Respond funding may be used to incentivize pilot testing. As feasible technologies are proven, projects may be added to future plan updates.

4.2.5 Enhanced Circulation

The 2011 superbloom occurred in the Banana River Lagoon, North Indian River Lagoon (IRL), and southern Mosquito Lagoon. These areas have long residence times, which means that water in these areas stagnates and nutrients can build up leading to additional algal blooms. Options to address this condition are to increase circulation by replacing causeways with bridges, installing culverts under causeways, or increasing ocean exchange by adding culverts, pump stations, or inlets to provide new connections to the ocean. Addressing manmade causeways that interfere with natural circulation should be beneficial without unintended consequences and modeling can help prioritize actions, but implementation is costly and requires participation by the Florida Department of Transportation.

New artificial ocean exchange projects introduce a lot of unknowns. While the residence time of water in the IRL system would decrease, the input ocean water with its complement of marine life has the potential to alter the lagoon ecosystem. Whether the amount of ocean exchange needed to have a beneficial impact on the system can be achieved without causing unintended harm to the lagoon is unknown. Artificial ocean exchange projects are costly with significant social implications and permitting hurdles to overcome. For these reasons, causeway replacements are encouraged while ocean exchange projects are not a recommended component of this plan. Other entities are taking the lead on evaluating options. The results of evaluations by the St. Johns River Water Management District and the IRL National Estuary Program are summarized below.

The St. Johns River Water Management District contracted with CDM Smith and Taylor Engineering to identify potential locations where enhanced circulation projects would be beneficial. The first phase of the project (CDM Smith et al., 2014) involved a literature review and geographic information system desktop analysis. All the locations considered in Phase I, including the top ranked locations, are shown in **Figure 4-29**. From this first phase, ten locations were identified for future evaluation as shown in **Table 4-35**. The external projects are those that could potentially connect the IRL system with the Atlantic Ocean whereas internal projects are connections within the IRL (CDM Smith et al., 2015).

Table 4-35: Phase I Top Ranked Potential Enhanced Circulation Project Locations

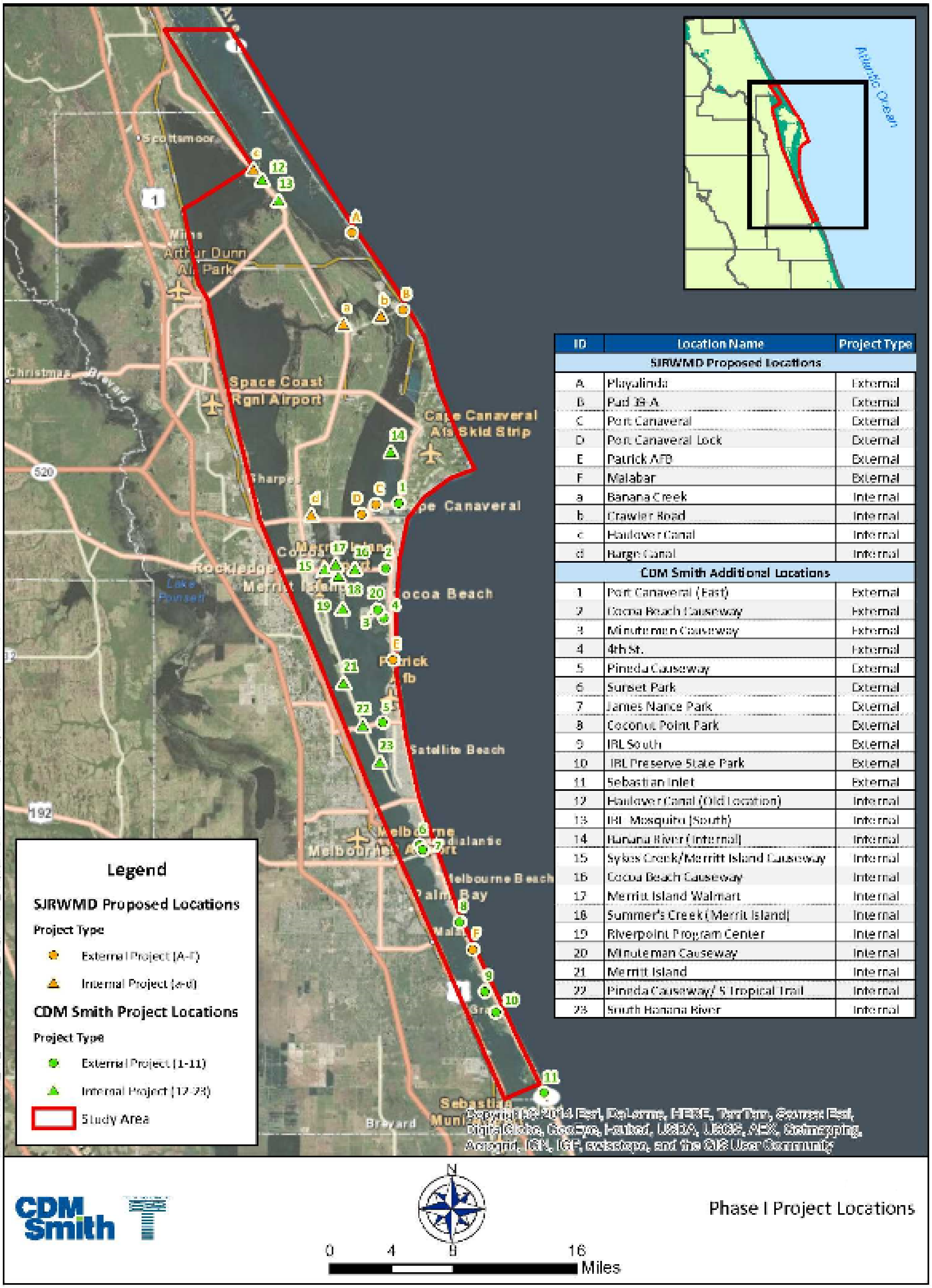
Project Site	Project Description	Zone	Project Type	Rank
D	Canaveral Lock*	Banana River Lagoon	External	1
C	Port Canaveral*	Banana River Lagoon	External	2
15	Sykes Creek/Merritt Island Causeway*	Banana River Lagoon	Internal	3
B	Pad 39-A*	Banana River Lagoon	External	4
16	Cocoa Beach Causeway	Banana River Lagoon	Internal	5
23	South Banana River	Banana River Lagoon	Internal	6
E	Patrick Air (Space) Force Base *	Banana River Lagoon	External	7
20	Minuteman Causeway	Banana River Lagoon	Internal	8
1	Port Canaveral (East)	Banana River Lagoon	External	9
8	Coconut Point Park*	Central and Southern Portion of IRL Study Area	External	10

Source: CDM Smith et al., 2015.
* Sites evaluated in Phase 2 of the CDM Smith and Taylor Engineering project for the St. Johns River Water Management District.

As part of the second phase of the project, six of the top ranked sites were further evaluated to assess the water volumes. These sites are noted in **Table 4-35**. Based on the initial evaluation of the sites, CDM Smith and Taylor Engineering determined that a project at the Sykes Creek/Merritt Island Causeway was not feasible. This location had a relatively new bridge crossing with built-up abutment protection that precludes construction of culverts and the increase of bridge openings. In addition, this connection would only provide an internal connection in the IRL and would not increase the tidal exchange. The five remaining sites were evaluated for the following types of connections (additional information in **Table 4-36**):

- Port Canaveral (Project Site C) – Culvert connection
- Pad 39-A (Project Site B) – Culvert connection
- Patrick Air (Space) Force Base (Project Site E) – Culvert connection
- Canaveral Lock (Project Site D) – Open channel flow by keeping the Canaveral Lock open over extended periods. Additional maintenance dredging may be needed to remove sediment deposition near the gates.
- Coconut Point Park (Project Site 8) – Culvert connection
- Coconut Point Park (Project Site 8) – Inlet connection with an inlet that is at least 1,350-feet long, with an average depth of about 25 feet below mean sea level.

Figure 4-29: Phase I Potential Enhanced Circulation Project Locations



ID	Location Name	Project Type
SJRWMD Proposed Locations		
A	Playalinda	External
B	Pad 39-A	External
C	Port Canaveral	External
D	Port Canaveral Lock	External
E	Patrick AFB	External
F	Malabar	External
a	Banana Creek	Internal
b	Crawler Road	Internal
c	Haulover Canal	Internal
d	Barge Canal	Internal
CDM Smith Additional Locations		
1	Port Canaveral (East)	External
2	Cocoa Beach Causeway	External
3	Minuteman Causeway	External
4	4th St.	External
5	Pineda Causeway	External
6	Sunset Park	External
7	James Nance Park	External
8	Coconut Point Park	External
9	IRL South	External
10	IRL Preserve State Park	External
11	Sebastian Inlet	External
12	Haulover Canal (Old Location)	Internal
13	IRL Mosquito (South)	Internal
14	Banana River (Internal)	Internal
15	Sykes Creek/Merritt Island Causeway	Internal
16	Cocoa Beach Causeway	Internal
17	Merritt Island Walmart	Internal
18	Summer's Creek (Merrit Island)	Internal
19	Riverpoint Program Center	Internal
20	Minuteman Causeway	Internal
21	Merritt Island	Internal
22	Pineda Causeway/ S Tropical Trail	Internal
23	South Banana River	Internal

Source: CDM Smith et al., 2015.

Figure 4-29 Long Description

Table 4-36: Computed Hydraulics for Connections at Select Locations

Site/Potential Project	Flood Prism (million cubic feet)	Ebb Prism (million cubic feet)	Maximum Flow (cubic feet per second)	Estimated Impacted Area for 0.27 Foot Tide Range (acres)
Port Canaveral Culvert (Project Site C)	1.51	-1.08	89	92 to 128
Pad 39-A Culvert (Project Site B) (estimated)	1.38 to 1.51	-1.08 to -1.59	Not applicable	92 to 135
Patrick Air (Space) Force Base Culvert (Project Site E) (estimated)	1.38 to 1.51	-1.08 to -1.59	Not applicable	92 to 135
Canaveral Lock Open Channel Flow (Project Site D)	68.67	-83.03	-4,670	5,839 to 7,060
Coconut Point Park Culvert (Project Site 8)	1.38	-1.59	-94	117 to 135
Coconut Point Park Inlet (Project Site 8)	1,890	Not applicable	111,000	160,698

Source: CDM Smith et al., 2015.
Note: Positive flow is towards the IRL.

A screening matrix was used to evaluate the costs and benefits of the project based on the criteria for the tidal prism, area affected, land acquisition, relative costs, ease of construction, seagrass loss, and benefit to cost ratio. The top ranked project from this evaluation is the Port Canaveral culvert (CDM et al., 2015). It is important to note that a culvert will likely not provide the amount of exchange needed to provide a significant benefit to the lagoon. The size of the lagoon in Brevard County is more than 150,000 acres. The second ranked project is the Canaveral Lock open channel. This option may have challenges moving forward based on past experience with sediment blocking submarines from using the port after the lock was held open for an extended period of time. In addition, there are limited data for estimating the water quality benefits and unintended ecological consequences that could result from keeping the lock open.

In 2019, the Florida Institute of Technology received $800,000 in funding from the Florida Legislature, which was administered by the Florida Department of Education, to plan and perform studies at sites within the lagoon and along the coast to restore lagoon inflow. The first phase of the study gathered baseline data and performed modeling on existing water quality, biological parameters, and hydrologic conditions at potential locations for future temporary permitted inflow test structures. The Phase 1 modeling and engineering project research was conducted in parallel with the biological and water quality monitoring to gather data for an enhanced circulation pilot project. The first phase of the project was completed in September 2020. Phase 1 provided baseline biological and geochemical data near the three proposed inflow locations: Port Canaveral and south Cocoa Beach in Brevard County and Bethel Creek in Indian River County. Modeling results were provided for different flow rates in each location based on preliminary engineering concepts for three structure options: pipe with no pump, pump and pipe, and weir (Florida Institute of Technology, 2020).

In 2020, the Florida Institute of Technology received another $752,000 in funding from the Florida Legislature, which was also administered by the Florida Department of Education, for Phase 2 of the study. Phase 2 identified the most feasible and cost-effective location for a temporary inflow pilot system in the Banana River Lagoon within a cove that would receive inflow from the ocean side of the Port Canaveral lock system. Engineering design for a 0.5 cubic meter per second pumping system was completed, and pre-application meetings were held with the permitting agencies. This phase also included additional water quality, geochemical, and biological monitoring to build a baseline conditions database, and updated models to predict changes due to the pilot inflow. Phase 2 was completed in September 2021 (Florida Institute of Technology, 2021). In 2022, the Florida Institute of Technology received another $921,500 in funding from the Florida Legislature, which is also administered by the Florida Department of Education, for Phase 3 of the study. Phase 3 is focused on the design and permitting of a temporary inflow pilot system and additional research and modeling. This phase will be completed in July 2023.

Temporary Inlet: Another potential option for ocean exchange is when a large storm creates an opening. Instead of immediately filling in the new opening, an evaluation should be completed using available models to determine the potential benefits of temporarily stabilizing the opening long enough to provide significant ocean exchange for short-term water quality benefits, but not long enough to excessively alter beach erosion and sand transport into the lagoon.

Causeway Modification: In 2018, the IRL National Estuary Program, in partnership with the Canaveral Port Authority, worked with the Florida Institute of Technology to assess the potential for modifications of the State Road 528 and State Road 520 causeways and bridge structures to enhance circulation in the northern portion of the Banana River Lagoon and adjacent North IRL. The Florida Institute of Technology used the United States Army Corps of Engineers Coastal Modeling System for this evaluation (Zarillo, 2018).

The model was set up to reproduce the physical conditions of 2015 to ensure the model was well calibrated. Measured data, including water levels, freshwater inflows, wind velocity, and topography, were used to drive the model. Nine model tests were performed to represent current conditions and scenarios with hypothetical bridge spans over the Banana River Lagoon and North IRL. Three of the model tests included flow relief structures embedded in the State Road 528 and State Road 520 causeways. The tests were run using numerical tracer dye concentration throughout the model domain to track the dye concentration reduction throughout the model simulation. Circulation in the model occurred through ocean exchanges though the Sebastian Inlet, freshwater inflows, and wind (Zarillo, 2018).

The model results indicated that modifying the bridge and causeway structures would have a detectible influence on exchange rates within the Banana River Lagoon and North IRL. Longer bridge spans over the Banana River Lagoon along State Road 528 combined with longer bridge spans over State Road 520 resulted in a 10% net reduction in the dye concentration in the Banana River Lagoon between State Road 528 and State Road 520 at the end of the 340-day model run. The net improvement in exchange in the Banana River Lagoon immediately to the north of State Road 528 was predicted to be 5% if bridge spans are present on both state roads. The study concluded that a significant improvement in exchange in the Banana River Lagoon study area and adjacent North IRL would require bridge spans on both State Road 520 and State Road 528 (Zarillo, 2018).

In 2019, Dr. Zarillo expanded his circulation model to include Mosquito Lagoon and the ocean inlet at New Smyrna instead of a closed boundary at Haulover Canal. This expanded model was run again to estimate the impact of causeways on residence time in various compartments of the IRL. In this study, longer bridge spans over the Banana River Lagoon along State Road 528 and State Road 520 resulted in a 17% net reduction in the dye concentration in the Banana River Lagoon between State Road 528 and State Road 520 at the end of the 340-day model run. The net improvement in exchange in the Banana River Lagoon immediately to the north of State Road 528 was predicted to be 8% and exchange within Sykes Creek improved by 20% (Zarillo, 2019).

In response to the 2019 model results, the St. Johns River Water Management District offered to use their state-of-the-art ecological modeling tools to quantify water quality improvements and algal bloom reductions anticipated from the proposed causeway modifications. At the request of Brevard County, Port Canaveral, and IRL National Estuary Program, the Florida Department of Transportation agreed to pause their causeway widening project for six months until the ecological impacts could be estimated and evaluated. The modeling results confirmed the improvement in residence time identified in Dr. Zarillo's modeling but found little corresponding change in chlorophyll-*a* concentrations (St. Johns River Water Management District, 2020).

As part of the State Road 528 widening project from Industry Road to State Road 401/Port Canaveral, the Florida Department of Transportation will be replacing all bridges except the newest bridge over the IRL. Due to input from various stakeholders and environmental agencies, the Florida Department of Transportation committed to bridging and elevating the causeway over the Banana River Lagoon to improve transportation resiliency. This design option will allow other stakeholders to analyze a future causeway removal for better water flow in the Banana River Lagoon in an effort to improve water quality. The Florida Department of Transportation will be pursuing a design/build option to update the current design and move directly into construction. It is unknown when funding will become available.

4.3. Projects to Restore the Lagoon

Another component of this plan is to implement projects that will restore important, filtering ecosystem services within and adjacent to the lagoon to improve water quality and resilience. Oyster reefs provide ecosystem services including improved water quality, shoreline stabilization, carbon burial, and habitat (Grabowski et al., 2012). Creating oyster bars and planting shorelines with natural vegetation will help to filter excess nutrients and suspended solids from the lagoon (Grizzle et al., 2008; Reidenbach et al., 2013), which will improve water quality, allowing for seagrass growth (Newell and Koch, 2004) and may reduce the number and severity of algal blooms in the lagoon system. Oyster bars and planted shorelines also create habitat for more than 300 different lagoon species. These types of projects take years before the full benefits are seen in the lagoon as it takes some time for the oysters and vegetation to grow and become established.

The sections below summarize the oyster restoration, planted shoreline, and clam restoration and aquaculture projects that are proposed, as well as considerations for seagrass planting.

4.3.1 Oyster Restoration

> *The primary mechanism by which oyster bars remove nitrogen is by increasing local denitrification rates.*

In addition to the fisheries value of oysters, they provide a variety of nonmarket ecosystem services, with a combined estimated economic value between $5,500 and $99,000 per hectare per year (Grabowski et al., 2012). Restored oyster bars have been shown to result in a positive net effect on the removal and sequestration of nitrogen compared to unrestored sites. As nitrogen is a major contributor to algal blooms and resulting increased turbidity, removal of nitrogen from the system often yields water quality benefits. The nitrogen is removed through three pathways: (1) assimilation of the nitrogen in the shell and tissues of the oysters, (2) enhanced burial of nitrogen into the sediments surrounding oyster bars, and (3) conversion to gaseous form with return to the atmosphere through microbe-related denitrification (zu Ermgassen, 2016).

The primary mechanism by which oysters remove nitrogen from the system is by increasing local denitrification rates (Grabowski et al., 2012). While the impacts of oyster bars may be localized, they also influence the larger ecosystem. For example, a study by Sharma et al. (2016) found that even with limited bio-filtration and nonsignificant reef effects on water velocity, there was a “shadow” effect on seagrass beds between the reef and shoreline, which resulted in higher localized seagrass area five years after deployment relative to other nearby areas. Further, in a study by Kroeger (2012), it was noted that the eastern section of Mobile Bay had experienced harmful algal blooms that caused fish kills. These conditions occur in the summer months when denitrification by restored oysters would be highest. Therefore, the nitrogen removal associated with the oyster bar project in the bay may make a noticeable contribution to the local water quality by avoiding peak nitrogen concentrations that may trigger algal blooms. In a study by Kellogg et al. (2013), the denitrification rates associated with oyster bars from various studies were documented. Based on these studies, the average denitrification rate is 159.3 pounds of total nitrogen (TN) per acre per year (291 micromoles of TN per square meter per hour, which equates to 0.04 pounds of TN per square meter per year). A 2017 study was also conducted in the Mosquito Lagoon to determine the local benefits from oyster bed restoration. This study found that the average denitrification rate is 401.5 pounds of TN per acre per year (450 kilograms of TN per hectare per year) and measured nitrogen sequestration in oyster tissues and shells is 0.04 pounds of TN per square foot, which equates to 1,742.4 pounds of TN per acre per year (Schmidt and Gallagher, 2017).

The focus for oyster restoration in the Indian River Lagoon (IRL) system is to provide filtration, sequestration, denitrification, and scour protection along the shoreline (see **Section 4.3.2** for details on scour protection). The goal is not to restore historical oysters in the system because limited information is available on where oysters were historically located. In addition, seagrasses are a more critical component of the system, so restoration efforts aim to use the beneficial aspects of oysters in protecting seagrass from waves and increasing light availability (Newell and Koch, 2004) while minimizing the competition for space. Therefore, sites are evaluated for relative seagrass and oyster habitat requirements such as salinity, depth, and bottom type. In October 2021, Brevard County adopted an Oyster Habitat Suitability and Rehabilitation Success Plan, which details environmental and biological targets to guide site selection for oyster bar projects, outlines adaptive management strategies, and defines related success criteria. Oyster bars may be constructed in submerged areas deeper than seagrass, in areas without an historic persistence of seagrass presence, or as narrow bars along the shoreline to act as a living wave break to reduce erosion.

The oysters from the Oyster Gardening Program have been used to develop several pilot bars and demonstration sites in the IRL. In fiscal year 2014–2015, Brevard County received a $410,000 appropriation from the Florida Legislature for the Indian River Lagoon Oyster Restoration Project. This pilot study was completed in fall 2016. The design of oyster wave breaks funded by the Save Our Indian River Lagoon tax is based on monitoring results from the pilot bars and wave tank studies at Florida Institute of Technology that tested the oyster bar stability and wave attenuation of different designs. From these studies the importance of reef location and seasonal water depth (Anderson, 2016) as well as the ability of the reef to act as a wave break (Weaver et al., 2017) were highlighted.

To create enough oyster bar area to filter the volume of lagoon water annually, approximately 20 miles (105,600 feet) of oyster bars are needed at a width of six feet. These bars will be placed throughout the IRL system, at sites that meet Habitat Suitability selection criteria, along mosquito impoundments, parks, and private properties where owners want to participate. Based on the pilot project costs and knowing that larger bars will be constructed more efficiently (using information from the pilot projects), it was estimated that the 20 miles of oyster bars could be constructed at a cost of $10 million.

With the recent study on oyster bars in the IRL system (Schmidt and Gallagher, 2017), the benefits associated with oyster bars versus planted shorelines could be delineated. For the proposed oyster bar along 20 miles (105,600 feet) of shoreline with a width of six feet (total of 633,600 square feet), the estimated reductions are 25,344 pounds per year of TN and 906 pounds per year of total phosphorus (TP). These estimates are based on the estimated TN reduction rate of 0.04 pounds of TN per square foot of oyster bar from Schmidt and Gallagher 2017 and the estimated TP reduction rate of 0.001 pounds of TP per square foot of oyster bar from Kellogg et al. (2013). The projects for oyster bar restoration are summarized in **Table 4-37**.

Table 4-37: Projects for Oyster Restoration

Year Added	Project Number	Project Name	Responsible Entity	Sub-lagoon	Total Nitrogen Reduction (pounds per year)	Cost per Pound per Year of Total Nitrogen Reduction	Total Phosphorus Reduction (pounds per year)	Cost per Pound per Year of Total Phosphorus Reduction	Plan Funding
Original	2016-55	Banana River Lagoon Oyster Bars*	Brevard County	Banana	7,864	$395	197	$15,750	$3,102,755
Original	2016-56	North IRL Oyster Bars*	Brevard County	North IRL	7,314	$395	183	$15,770	$2,885,834
2018	75	Marina Isles Oyster Bar+	Brevard Zoo	Banana	60	$445	20	$1,335	$26,700
2018	76	Bettinger Oyster Bar+	Brevard Zoo	Banana	24	$445	8	$1,335	$10,680
2018	78a	McNabb Park Oyster Bar+	City of Cocoa Beach	Banana	72	$473	24	$1,419	$34,056
2018	79	Gitlin Oyster Bar+	Brevard Zoo	Banana	36	$445	12	$1,335	$16,020
2018	80	Coconut Point/Environmentally Endangered Lands Oyster Bar+	Brevard Zoo	Central IRL	96	$470	2	$22,560	$45,120
2018	81	Wexford Oyster Bar+	Brevard Zoo	Central IRL	70	$445	24	$1,298	$31,150
2018	82a	Riverview Park Oyster Bar+	City of Melbourne	Central IRL	230	$473	78	$1,395	$108,790
2018	83	Bomalaski Oyster Bar+	Brevard Zoo	North IRL	20	$445	7	$1,271	$8,900
2018	73	Riverview Senior Resort Oyster Bar+	Brevard County	Central IRL	77	$394	2	$15,152	$30,304
2019	104	Brevard Zoo Banana River Oyster Project+	Brevard Zoo	Banana	1,476	$395	37	$15,757	$583,020
2019	105	Brevard Zoo Central IRL Oyster Project+	Brevard Zoo	Central IRL	408	$395	10	$16,116	$161,160
2019	106	Brevard Zoo North IRL Oyster Project+	Brevard Zoo	North IRL	864	$395	22	$15,513	$341,280
2020	139	Brevard Zoo North IRL Oyster Project 2+	Brevard Zoo	North IRL	841	$400	21	$16,019	$336,400
2020	140	Brevard Zoo Central IRL Oyster Project 2+	Brevard Zoo	Central IRL	677	$400	17	$15,929	$270,800
2020	141	Brevard Zoo Banana River Oyster Project 2+	Brevard Zoo	Banana	662	$400	17	$15,576	$264,800
2020	142	Brevard Zoo Oyster Reef Adjustments North IRL+	Brevard Zoo	North IRL	68	$400	2	$13,600	$27,200
2020	143	Brevard Zoo Oyster Reef Adjustments Banana River+	Brevard Zoo	Banana	32	$400	1	$12,800	$12,800

Year Added	Project Number	Project Name	Responsible Entity	Sub-lagoon	Total Nitrogen Reduction (pounds per year)	Cost per Pound per Year of Total Nitrogen Reduction	Total Phosphorus Reduction (pounds per year)	Cost per Pound per Year of Total Phosphorus Reduction	Plan Funding
2021	184	Brevard Zoo North Indian River Lagoon Oyster Project 3+	Brevard Zoo	North IRL	1,056	$397	26	$16,124	$419,232
2021	185	Brevard Zoo Central Indian River Lagoon Tributary Pilot Oyster Project+	Brevard Zoo	Central IRL	581	$397	15	$15,377	$230,657
2021	186	Brevard Zoo North Indian River Lagoon Individual Oyster Project+	Brevard Zoo	North IRL	436	$397	11	$15,736	$173,092
2021	187	Brevard Zoo Central Indian River Lagoon Oyster Project 3+	Brevard Zoo	Central IRL	218	$397	5	$17,309	$86,546
2021	188	Brevard Zoo Banana River Oyster Project 3+	Brevard Zoo	Banana	143	$397	4	$14,193	$56,771
2022	217	Central IRL Oyster Project 4+	Brevard Zoo	Central IRL	348	$397	9	$15,351	$138,156
2022	218	Central Oyster Project Offshore Reefs+	Brevard Zoo	Central IRL	900	$397	23	$15,535	$357,300
2022	226	Hog Point Offshore Oyster Bar+	Brevard County	Central IRL	126	$397	3	$16,674	$50,022
-	**-**	***Total***	**-**	**-**	***24,699***	***$397 (average)***	***780***	***$12,576 (average)***	***$9,809,545***

Note: The projects highlighted in green and marked with an asterisk were identified in the original plan. The projects highlighted in tan and marked with a plus sign were added to the plan as part of an annual update. As specific project locations are added each year, the amount of funding for the original projects is reduced accordingly to keep the total funding allocation constant for projects that restore natural filtration processes (including oyster, clam, and planted shoreline projects).

4.3.2 Planted Shorelines

Typically, efforts to protect shorelines have involved hardened structures, such as seawalls, rock revetments, or bulkheads, to dampen or reflect wave energy. Although these types of structures may mitigate shoreline retreat, they accelerate scour and the ecological damages that result can be great (Scyphers et al., 2011). The planted shoreline approach incorporates natural habitats into a shoreline stabilization design; maintains the connectivity between aquatic, intertidal, and terrestrial habitats; and minimizes the adverse impacts of shoreline stabilization on the estuarine system. These efforts range from maintaining or transplanting natural shoreline vegetation without additional structural components to incorporating shoreline vegetation with hardened features, such as rock sills or oyster bars, in settings with higher wave energy (Currin et al., 2010). Selection of the most appropriate management system begins with a site analysis to evaluate the type of shoreline, amount of energy that a shoreline experiences, sediment transport forces, type and location of ecological resources, and adjacent land uses (Restore America's Estuaries, 2015).

Oyster bars can function as natural breakwaters, in addition to providing nutrient removal benefits through denitrification, as noted in **Section 4.3.1**. The rate of vertical oyster bar growth on unharvested bars (2–6.7 centimeters per year) is greater than predicted sea-level rise rate (2–6 millimeters per year); therefore, bars could serve as natural protection against shoreline erosion, shoreline habitat loss, and property damage and loss along many estuarine shorelines (Ridge et al., 2017). Oyster bars reduce erosion of other estuarine habitats such as salt marshes and submerged aquatic vegetation by serving as a living breakwater that attenuates wave energy and stabilizes sediments (Grabowski et al., 2012).

As part of a study for the Chesapeake Bay, Forand et al. (2014) evaluated the pollutant load reductions from planted shoreline projects in the area. The results of this evaluation are shown in **Table 4-38**, and were used to update the United States Environmental Protection Agency Chesapeake Bay Program Office estimate of the total nitrogen (TN) and total phosphorus (TP) reductions per foot of planted shoreline. The estimated nutrient reductions from planted shorelines can be calculated using Chesapeake Bay Program Office recommended rates of 0.2 pounds of TN per linear foot and 0.068 pounds of TP per linear foot (Forand et al., 2014.), which is for an average planting width of 24 feet. These values were adjusted for the proposed average planting width of eight feet, which results in a reduction of 0.067 pounds of TN per linear foot and 0.023 pounds of TP per linear foot.

Table 4-38: Pollutant Load Reductions for Shoreline Management Practices

Source	Total Nitrogen (pounds per foot per year)	Total Phosphorus (pounds per foot per year)	Study Location
Ibison, 1990	1.65	1.27	Virginia
Ibison, 1992	0.81	0.66	Virginia
Proctor, 2012	Not applicable	0.38 or 0.29	Virginia
Maryland Department of the Environment, 2011	0.16	0.11	Maryland
Baltimore County mean (Forand, 2013)	0.27	0.18	Maryland
Chesapeake Bay Program Office Scenario Builder, 2012	0.02	0.0025	Chesapeake Bay Program policy threshold from one restoration site
New Interim Chesapeake Bay Program Office Rate (Expert Panel, 2013)	***0.20***	***0.068***	***Chesapeake Bay Program Office policy thresholds that come from six stream restoration sites***

Note: Table is from Forand et al., 2014.

To promote success, mangroves incorporated into planted shorelines will be at least three years old with fully woody trunks, which have been found to increase successful establishment by 1,087% compared to seedlings based on studies conducted in Mosquito Lagoon (Fillya, 2021).

A capstone project with students at the United States Naval Academy aimed to further investigate methods to increase the successful establishment of planted shorelines. The students chose the Fisherman's Landing shoreline to collect initial data on water level and waves and tested potential natural solutions in a wave tank at the United States Naval Academy. The final design considered mangroves planted shoreward of cordgrass within 10 feet of mean high water level. The mangroves would be planted at a density of 1 per 5.4 square feet for a total of 30 mangroves within a 50 by 3.25 foot area. Cordgrass would be planted at 48 stems per square foot with 5,400 plugs per 50 by 3 foot area. Most waves on site had a period of about 2 seconds. In the wave tank, an incoming 2-inch wave with wave periods of 0.75, 1.57, and 2.38 seconds were tested. Wave energy attenuation for cordgrass or mangroves alone was about 30% to 40%. However, the configuration with both mangroves and cordgrass together yielded a 46% wave height attenuation and a 60% wave energy attenuation (Freitas et al., 2022).

At this time, the plan does not recommend a total length of planted shoreline. Planted shoreline projects will be considered for funding annually as partners submit projects for the plan. A cost-share of $16 per linear foot of shoreline, planted in eight-foot wide swaths, was established by using typical nursery installation costs and standard canopy dimensions for native shoreline species found in Brevard County. This equates to $240 per pound of nitrogen reduced by shoreline plantings.

Brevard County conducted a survey of the shorelines, in conjunction with the University of Central Florida, to determine if the shoreline included a bulkhead/seawall, hardened slope/riprap, or no structure to help identify potential locations for future oyster bars and planted shorelines (Donnelly et al., 2018) (**Figure 4-30**).

Table 4-39 summarizes the approved projects for planted shorelines and the estimated load reductions.

Figure 4-30: Shoreline Survey to Identify Locations Appropriate for Oyster Bars and Planted Shorelines

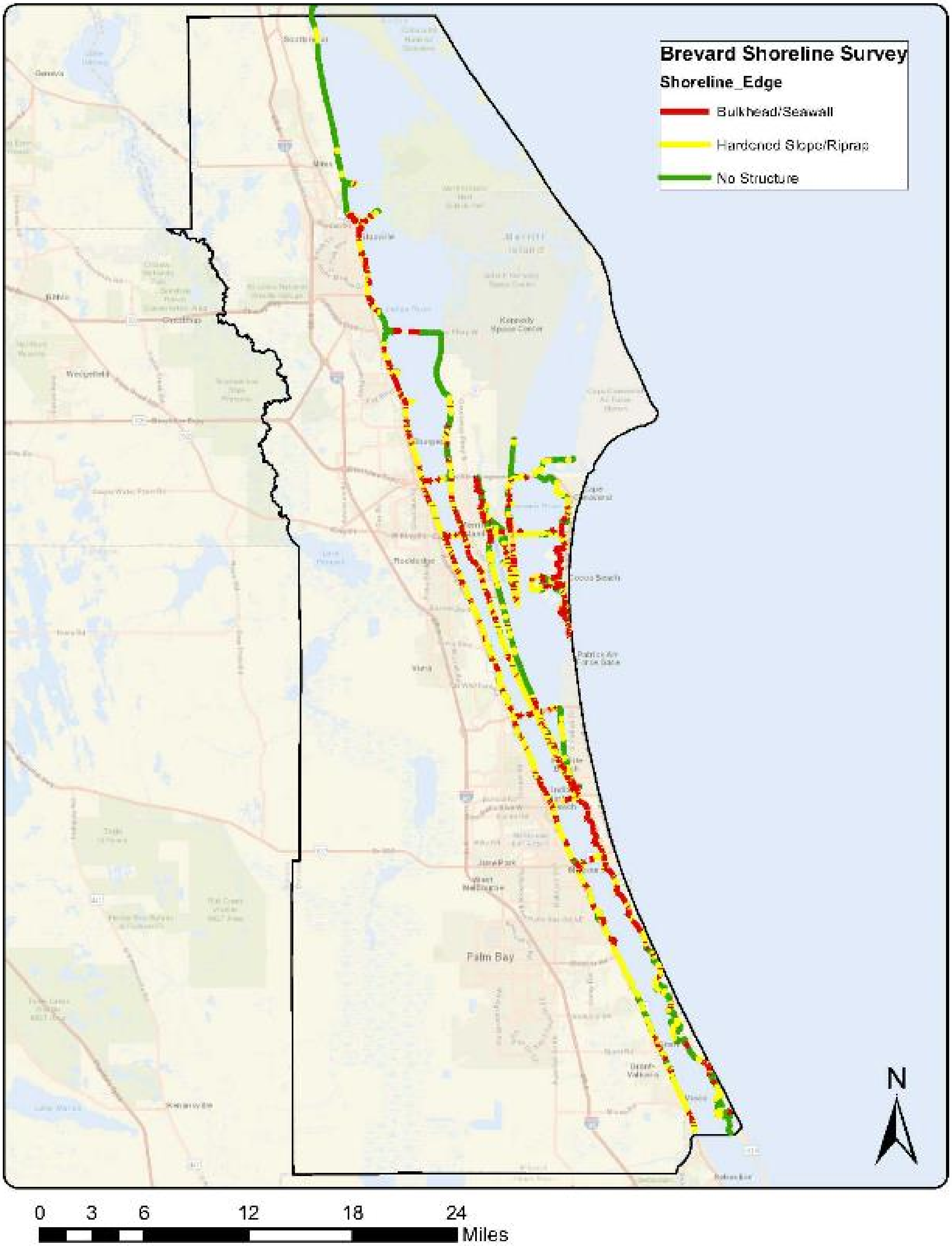


Figure 4-30 Long Description

Table 4-39: Projects for Planted Shorelines

Year Added	Project Number	Project Name	Responsible Entity	Sub-lagoon	Total Nitrogen Reduction (pounds per year)	Cost per Pound per Year of Total Nitrogen Reduction	Total Phosphorus Reduction (pounds per year)	Cost per Pound per Year of Total Phosphorus Reduction	Plan Funding
2018	77a	Cocoa Beach Country Club Planted Shoreline+	Marine Resources Council	Banana	67	$240	23	$699	$16,080
2018	77b	Lagoon House Shoreline Restoration Planting+	Marine Resources Council	Central IRL	100	$240	34	$706	$24,000
2018	78b	McNabb Park Planted Shoreline+	City of Cocoa Beach	Banana	24	$240	8	$720	$5,760
2018	82b	Riverview Park Planted Shoreline+	City of Melbourne	Central IRL	77	$240	26	$711	$18,480
2019	103	Brevard Zoo North IRL Plant Project+	Brevard Zoo	North IRL	3	$240	1	$720	$720
2020	130	Brevard Zoo North IRL Plant Project 2+	Brevard Zoo	North IRL	41	$240	14	$703	$9,840
2020	133	Fisherman's Landing+	Marine Resources Council	Central IRL	20	$240	7	$686	$4,800
2020	135	Rotary Park+	Marine Resources Council	Central IRL	20	$240	7	$686	$4,800
2021	180	Scottsmoor Impoundment+	Marine Resources Council	North IRL	44	$240	15	$704	$10,560
2021	181	Riveredge+	Marine Resources Council	North IRL	17	$240	6	$680	$4,080
2022	212	Titusville Causeway Multi-Trophic Restoration and Living Shoreline Resiliency Action Project+	Brevard County Natural Resources	North IRL	131	$240	45	$699	$31,440
-	***-***	***Total***	***-***	***-***	***544***	***$240 (average)***	***186***	***$702 (average)***	***$130,560***

Note: The projects highlighted in tan and marked with a plus sign were added to the plan as part of an annual update.

4.3.3 Clam Restoration and Aquaculture

Another potential tool for nutrient extraction, scour prevention, and water filtration in the Indian River Lagoon (IRL) is through clam aquaculture and restoration. Like oysters, clams can remove nitrogen from a system by burying it in sediments and enhancing the denitrification process through increased microbial activity in biodeposits (Clements and Comeau, 2019). The harvesting of clam shells and tissues can also extract nitrogen, as bivalves directly incorporate nitrogen (i.e., from consumption of phytoplankton and detritus; not dissolved nitrogen in the water) into their tissues and shells (Clements and Comeau, 2019).

Studies suggest that bivalve aquaculture has the potential to stimulate rates of denitrification equal to that of wild oyster beds and that the impacts of biodeposition from aquaculture are minimal (Clements and Comeau, 2019). The culture gear (bags, cover netting) used by growers creates a favorable environment for a myriad of plants and animals, such as juvenile fish and crabs, by providing habitat, substrate, and protection. This is especially significant since shellfish aquaculture leases can only be located in areas of the lagoon that undergo a resource survey to ensure the site is devoid of seagrasses and other marine life.

The exploration of clam aquaculture in Brevard County as a mitigation tool to extract excess nutrients from the IRL is warranted. According to the University of Florida Clam Farm Benefits Calculator, a single littleneck clam can filter 4.5 gallons of seawater per day and remove 0.09 grams of nitrogen when harvested. Therefore, in 2020, the Citizen Oversight Committee approved allocating $60,000 in funds to stimulate bivalve aquaculture in Brevard County. This funding would be used to sponsor 10 farms with up to $6,000 per farmer to plant up to 500,000 clams each. The funding would help to offset licensure, lease, and/or material costs. It is estimated that the clams from this stimulus project would remove 1,000 pounds per year of total nitrogen (TN) at a cost of $60 per pound of TN (**Table 4-40**). This program will also help promote education directed toward awareness of local aquaculture industries and their dependence on water quality to create mindfulness of the effects of eutrophication in a visceral, practical way. IRL clam restoration may lead to opportunities for successful partnerships with local clam farmers. Public sentiment toward clam restoration has been positive and the nutrient-removal aspects of shellfish aquaculture align with the Plan’s goals.

In addition, a statewide partnership aims to restore clams in the IRL using genetic stock able to withstand the unfavorable condition of an algae bloom-ridden lagoon. The IRL Clam Restoration project is a cooperative venture between the Coastal Conservation Association, Florida Fish and Wildlife Conservation Commission, University of Florida Whitney Lab, Brevard Zoo, and Florida Oceanographic Society. They collected broodstock living in the IRL, spawned them, and have begun outplanting these “super clams” in bags or under cover-netting to strategic locations in the IRL (based upon historical sites and current water quality trends) including existing partner habitat restoration and commercial lease areas. Next steps include tracking survivorship and growth. One final goal is to establish brood stock that will serve as the optimized variety (phenotype) lines for further stock enhancement.

In 2020, grant funding was requested to outplant super clam progeny at 100 sites throughout the lagoon. Funding was secured and a combination of private properties and public locations were chosen so that volunteers could assist with restoration. These locations were spread throughout the lagoon to help obtain information on survival rates in different areas to improve restoration efforts. All clams were deployed and monitoring for one-year post-deployed has been completed. The final report will be completed in December 2022; however, preliminary results indicate that site selection is incredibly important for successful clam restoration, particularly in relationship to salinity.

Table 4-40: Projects for Clam Restoration

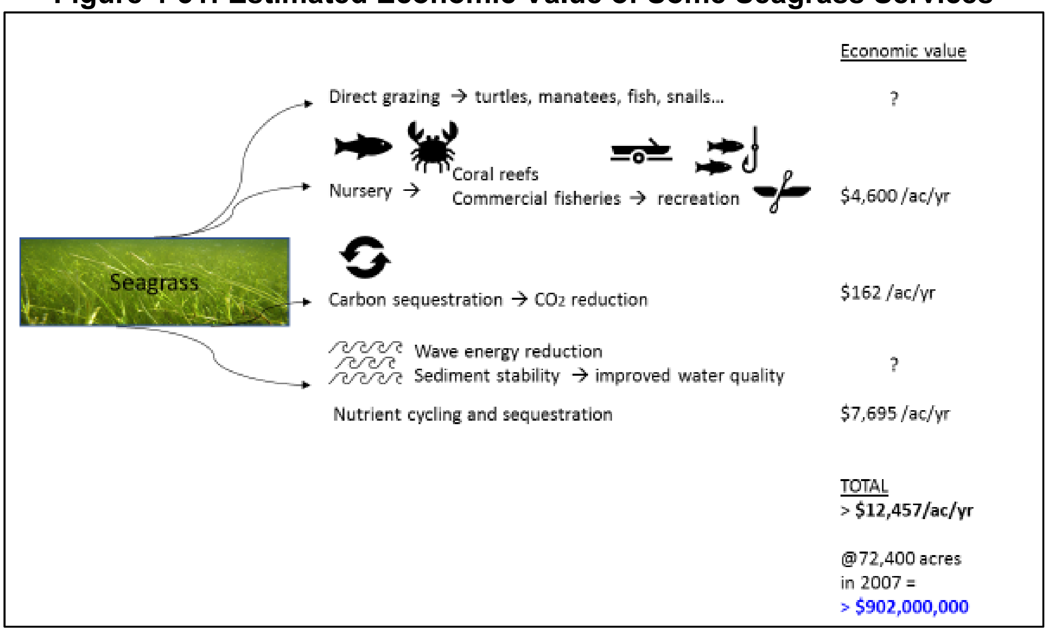
Year Added	Project Number	Project Name	Responsible Entity	Sub-lagoon	Total Nitrogen Reduction (pounds per year)	Cost per Pound per Year of Total Nitrogen Reduction	Total Phosphorus Reduction (pounds per year)	Cost per Pound per Year of Total Phosphorus Reduction	Plan Funding
2021	194	Aquaculture Stimulus Project+	Brevard County	All	1,000	$60	Not applicable	Not applicable	$60,000
-	**-**	***Total***	**-**	**-**	***1,000***	***$60***	***Not applicable***	***Not applicable***	***$60,000***

Note: The projects highlighted in tan and marked with a plus sign were added to the plan as part of an annual update.

4.3.4 Seagrass Planting

The original Indian River Lagoon (IRL) Surface Water Improvement and Management Plan of 1989, as well as subsequent management plans up to and including the current basin management action plans, target a healthy, estuarine ecosystem populated by seagrasses. Seagrasses provide crucial benefits to Florida's estuaries by providing food and shelter to a variety of animals, improving water quality, and preventing erosion of sediment (Orth et al., 2006). In total, the lagoon's 72,000 acres of seagrass could provide an economic benefit of more than $900 million per year (**Figure 4-31**; Dewsbury et al., 2016).

Figure 4-31: Estimated Economic Value of Some Seagrass Services



Note: Adapted from Dewsbury et al., 2016

Figure 4-31 Long Description

One key ecological role for seagrasses is to absorb and cycle nitrogen and phosphorus (Romero et al., 2006). Seagrasses do not remove these nutrients permanently, but they compete for them against phytoplankton and macroalgae and hold them longer (Banta et al., 2004). By stabilizing the cycling of nutrients, seagrasses can increase a system's ability to absorb nutrient loads without the initiation of detrimental blooms of phytoplankton or macroalgae (Schmidt et al., 2012). Seagrasses can filter nitrogen inputs via photosynthesis and nutrient uptake, acting as a sink seasonally (McGlathery, 2008). However, when systems become eutrophic, this function can be lost (McGlathery, 2008). The contribution of seagrasses can be evaluated by examining the quantity of nutrients bound in its aboveground and belowground structures (its mass of biological material or biomass), with this approach treating uptake and release of nutrients as offsetting components of the nutrient cycle (**Table 4-41**).

Table 4-41: Average Nutrients in Seagrass from 1996–2009

Sub-lagoon	Acres	Seagrass (pounds per 100 acres)	Nitrogen (pounds per 100 acres)	Phosphorus (pounds per 100 acres)
Southern Mosquito Lagoon	14,000	45,000	1,000	100
Banana River Lagoon	21,000	45,000	1,000	100
North IRL	19,000	37,000	900	90
Central IRL	7,000	36,000	900	90

Seagrass restoration may be necessary because more than 30,000 acres of seagrasses were lost due to shading during the superbloom in 2011, recovery has been limited, and the brown tide in 2016 exacerbated the situation. In fact, the Banana River Lagoon in Brevard County experienced the largest initial losses of seagrass (**Appendix C**). Throughout the northern lagoon, decreases in the extent and cover of seagrass between 2009 and 2019 meant that approximately 216,053 pounds (98 metric tons) of nitrogen and 22,046 pounds (10 metric tons) of phosphorus were no longer stored in seagrass. These quantities represent 11% and 40% of the mean concentrations of dissolved nitrogen and phosphorus in the northern lagoon, respectively (Morris et al., 2022). After the loss of seagrass, nitrogen and phosphorus became available to phytoplankton, drift algae, and other primary producers (**Table 4-42)**. Furthermore, the absence of seagrasses has made the sediments less stable, which will hamper future colonization and spread of new seagrass.

Overall, seagrasses may need some help to recover in the short-term, with more rapid recovery helping to sequester nutrients and reduce the amounts available to phytoplankton. Measures that could help seagrasses recover include protecting existing seagrass to promote expansion or protecting areas from waves to reduce the movement of sediment and allow seagrasses to colonize. Planting has also been discussed, and *Halodule wrightii* would be the initial focus because it has been the most widespread species in the lagoon (Dawes et al., 1995; Morris et al., 2021), and can act as a pioneer due to its rapid growth and wide tolerance thresholds.

Table 4-42: Average Seagrass Lost and Nutrients Made Available to Other Primary Producers in 2015

Sub-lagoon	Reduction in Acres	Seagrass Reduction* (pounds per 100 acres)	Nitrogen Reduction (pounds per 100 acres)	Phosphorus Reduction (pounds per 100 acres)
Southern Mosquito Lagoon	0	15,000	300	30
Banana River Lagoon	12,000	37,000	900	90
North IRL	1,000	8,000	200	20
Central IRL	4,000	20,000	500	50

* Changes in seagrass cover yield changes in biomass of seagrass within the same number of acres.

Planting seagrass is not a trivial undertaking; it requires considerable planning, resources, and time. For example, having suitable conditions is critical as shown in Tampa Bay where stakeholders invested more than $500 million in projects to reduce nutrient pollution before they saw any return from planting seagrass (Lewis et al., 1999). Costs documented during a workshop on seagrass restoration started at $1.4 million per acre for larger scale projects (Treat and Lewis, 2006). Seagrass meadows influence nutrient dynamics through storage, cycling, and promoting denitrification. Scaled nitrogen storage and removal rates vary from 6 to 78 pounds per acre per year based on studies of various seagrass species conducted in Australia, Virginia, North Carolina, and IRL (Piehler and Smyth, 2011; Russel and Greening, 2015; Smyth et al., 2015; Aoki et al., 2019; Morris et al., 2022). With project costs ranging from approximately $2 to $7 per square foot of seagrass, this equates to $1,085 to $48,306 per pound of nitrogen sequestration. Some of the lessons learned from past projects include selecting sites that will support seagrass growth, employing optimal methods for planting (e.g., type of planting units, use of chemicals to enhance growth, and density of initial planting), and protecting newly planted seagrass from disturbance (e.g., grazing, waves, exposure, and low salinity) until it is established. It may be best to tailor approaches to a specific location; therefore, one or more pilot studies prior to attempting full-scale restoration should prove valuable.

The Brevard County Natural Resources Management Department has been awarded a grant for state resiliency funds to support a pilot project in the IRL. If funded, Brevard County will partner with private and non-profit entities to plant 1.5 acres of seagrass. The project would be designed to test different planting methods (e.g., type of unit to be planted and density of units) to better understand how to approach, most effectively and economically, future, larger-scale restoration. The area would be monitored for two years post-restoration to document growth and survival, with potential measures being density, percent cover, and canopy height, as well as water depth, dissolved oxygen concentration, light availability, and other environmental conditions.

Similar or more complex pilot studies could be designed to investigate other key components of restoration. Overall, successfully incorporating planting into the restoration of tens of thousands of acres of seagrass will benefit from strategic investment in optimizing techniques. For example, site selection and project scale may be critical to surviving chronic natural disturbance and increasing the potential for natural recolonization (Fonseca presentation to the Citizen's Oversight Committee on August 20, 2021). Brevard County is investing in a decision tree that will help all interested groups with these issues. This tool is based on decades of research by St. Johns River Water Management District regarding abiotic factors and thresholds found to limit seagrasses in the IRL. Variables known to influence seagrass growth and persistence were weighed using an ArcGIS-based suitability model to help identify the relative risk of planting in the Brevard County portion of the IRL. In this way, it does not predict outcomes, rather aims to identify current conditions that pose differing risk levels to seagrass survival. It also aims to provide a framework for a methodical approach to planting design, execution, and monitoring so that important questions can be addressed and lessons learned can inform future restoration efforts. By its design, as results from future pilot projects are gathered, the model can be updated to reflect changes in lagoon conditions and incorporate new data and lessons learned. The ArcGIS tool can be found at this link. **Appendix C** includes additional details about seagrass.

4.4. Projects to Respond to New Information

The funding raised from the Save Our Indian River Lagoon sales tax will go towards the projects listed in the sections above that will reduce or remove pollutants and restore the lagoon. In addition, $10 million of the funding, over a period of 10 years, will go towards monitoring efforts to measure the success, nutrient removal efficiency, and cost effectiveness of projects included in this plan and in future updates of this plan. Measuring effectiveness is important for reporting progress toward total load reduction targets and for refining project designs to be more effective with each iteration. The monitoring data will be used to determine which projects are providing the most benefit in the most cost-effective manner so that the plan can be updated, as needed. The data will also be used to ensure the lagoon is responding as anticipated to the reductions made so that changes to the plan can be implemented if the lagoon is not responding as expected.

4.4.1 Adaptive Management to Report, Reassess, and Respond

The Indian River Lagoon (IRL) is located along the Space Coast, which is also known as a global center for exploration, innovation, and development of cutting edge technology. With a dedicated funding source and a brilliant community dedicated to meeting the challenges of today and tomorrow, it is wise to have a process that allows this plan to be updated and revised as new opportunities and better solutions are developed. The intent of the proposed adaptive management strategy is to provide a process that not only allows but also fosters the development and implementation of better tools and techniques and allows the tax rate to be reduced accordingly or retired ahead of schedule.

Although this plan was developed with the best information available in 2016, identifying the sources of water quality pollution and pairing those problems with the most timely and cost-effective solutions is a rapidly changing field of knowledge. To respond to change and take advantage of future opportunities, monitoring is necessary. Even without change in the industry, monitoring will provide data to support and refine the application of existing technology. An adaptive management approach is used to provide a mechanism to make adjustments to the plan based on new information. As projects from this plan are implemented, the actual costs and nutrient reduction benefits will be tracked, and the plan will be modified, as needed, as project performance in the lagoon basin is better understood.

This plan will be updated approximately annually with information from implemented projects and adjustments to the remaining projects. A volunteer committee of diversely skilled citizens has been assembled to assist Brevard County with the annual plan updates. The Citizen Oversight Committee consists of seven representatives and seven alternates that represent the following fields of expertise: science, technology, economics/finance, real estate, education/outreach, tourism, and lagoon advocacy. The League of Cities nominated representatives for three fields of expertise and nominated alternates for the remaining four fields of expertise. The Brevard County Board of County Commissioners nominated representatives for the other four fields of expertise and alternates for the remaining three fields of expertise. All Citizen Oversight Committee representatives and alternates were appointed by the Brevard County Board of County Commissioners. Appointees serve for two-year terms, after which time they may be considered for reappointment or replacement. The first term ended in February 2019 and the second term ended in February 2021. The Committee's recommendations for plan updates will be presented at least annually to the Board of County Commissioners, and changes to the plan will be approved by the Board of County Commissioners.

Brevard County staff provides project monitoring reports to the Citizen Oversight Committee and works with them to recommend adjusting the planned projects, as needed. The adaptive management process allows for alternative projects to be submitted by the county, municipalities, and other community partners to be reviewed by the Citizen Oversight Committee for inclusion in the next annual update to this plan. Projects that deliver comparable nutrient removal benefits may be approved for inclusion in the plan. If a new approved project costs more than the average cost per pound of total nitrogen for that project type listed in this plan at the time of project submittal, the requesting partner must provide the balance of the costs. The requesting partner will be allowed reasonable overhead cost to manage the project from design and permitting through construction completion.

As projects are implemented, progress toward meeting the County's proposed revisions to the total maximum daily loads are being tracked. Adjustments to the types and locations of projects implemented will be made to ensure that total maximum daily loads can be achieved in all Brevard County portions of the lagoon.

4.4.2 Cost-share for Substitute Projects

For the 2023 Update, local municipalities and partners were once again invited to submit new projects for inclusion in the Save Our Indian River Lagoon Project Plan. The projects submitted were required to deliver comparable nutrient removal benefits as those projects listed in the original plan and plan updates for each sub-lagoon.

The requesting partners each submitted a “Save Our Indian River Lagoon Project Plan Project Submittal Request” to Brevard County for review of the proposed projects. The project requests were provided to the Citizen Oversight Committee to evaluate the potential for inclusion in the plan. The projects recommended by the Citizen Oversight Committee were included in the draft plan update presented to the Brevard County Board of County Commissioners for approval.

To determine the amount of funding that a project would be eligible to receive from the Save Our Indian River Lagoon Trust Fund, the estimated total nitrogen (TN) reductions from the project were multiplied by the allowable cost per pound per year of TN shown below in **Table 4-43** for that project type. The costs shown in **Table 4-43** were included in the application instructions provided to the partners in July 2022 and were an average of the actual or engineer’s estimate of cost per pound of TN removed from the projects previously listed in the Save Our Indian River Lagoon Project Plan, as amended, or comparable projects recently planned or completed elsewhere in the Indian River Lagoon (IRL) watershed.

Table 4-43: Cost-share Offered for Project Requests Submitted for the 2023 Update

Project Type	Cost-share Offered per Pound per Year of Total Nitrogen
Wastewater Treatment Facility Upgrades for Reclaimed Water	$383
Package Plant Connections	$1,500
Sewer Lateral Rehabilitation	$255
Septic-to-Sewer by Extension	$1,500
Septic System Upgrades	$1,200
Stormwater Projects	-
Mainland	$313
Merritt Island	$370
Beaches	$446
Vegetation Harvesting	$110
Muck Removal	$520
Treatment of Muck Interstitial Water	$97
Oyster Bar	$397
Planted Shorelines	$240

4.4.3 Responding to Implemented Projects

During the first years of plan implementation, over 70 projects have been completed throughout the Indian River Lagoon (IRL) system as shown in **Figure 4-32** through **Figure 4-35**. The implementation of these projects provided new cost information and actual pollution reduction measurements used to update the project cost-effectiveness for the 2023 Update. The project costs and Save Our Indian River Lagoon Tax Fund money expended on completed projects are shown in **Table 4-44**. **Table 4-45** summarizes the Save Our Indian River Lagoon Tax Fund money that has been contracted and/or expended on projects that are currently underway.

Table 4-44: Save Our Indian River Lagoon Tax Funds Expended on Completed Construction Projects (as of October 31, 2022)

Project Number	Project	Project Type	Estimated Total Cost	Final Total Cost	Change in Total Cost	Eligible Save Our Indian River Lagoon Cost	Final Save Our Indian River Lagoon Cost	Change in Save Our Indian River Lagoon Cost
193	Oyster Gardening	Public Education	$300,000	$300,000	$0	$300,000	$300,000	$0
99	Cocoa Beach Water Reclamation Facility Upgrades	Wastewater Treatment Facility Upgrades	$5,920,320	$6,554,233	$633,913	$945,000	$945,000	$0
2016-17	City of Palm Bay Water Reclamation Facility Upgrades	Wastewater Treatment Facility Upgrades	$3,634,900	$3,634,900	$0	$3,634,900	$3,634,900	$0
6	Long Point Park Denitrification	Package Plant Rapid Infiltration Basin Upgrade	$101,854	$22,207	-$79,647	$101,854	$22,207	-$79,647
114	Barefoot Bay Lateral Smoke Testing	Sewer Laterals	$100,000	$83,564	-$16,436	$90,000	$83,564	-$6,436
115	South Beaches Lateral Smoke Testing	Sewer Laterals	$200,000	$192,297	-$7,703	$200,000	$84,304	-$115,696
116	Merritt Island Lateral Smoke Testing	Sewer Laterals	$250,000	$246,630	-$3,370	$250,000	$246,630	-$3,370
1	Breeze Swept Septic-to-Sewer	Septic-to-Sewer	$3,400,000	$3,400,000	$0	$880,530	$880,530	$0
2	Merritt Island Redevelopment Agency Phase 1 and 2 Septic-to-Sewer	Septic-to-Sewer	$3,138,098	To be determined	To be determined	$320,000 (plus $268 of contingency)	$320,268	$268
60	Sylvan Estates Septic-to-Sewer	Septic-to-Sewer	$1,720,430	$2,431,490	$711,060	$1,561,215	$1,561,215	$0
51	Banana River Lagoon 9 of 100 Septic System Upgrades	Septic System Upgrades	$126,768	$150,069	$23,301	$126,768	$125,968	-$800

Project Number	Project	Project Type	Estimated Total Cost	Final Total Cost	Change in Total Cost	Eligible Save Our Indian River Lagoon Cost	Final Save Our Indian River Lagoon Cost	Change in Save Our Indian River Lagoon Cost
52	North IRL 35 of 586 Septic System Upgrades	Septic System Upgrades	$609,899	$709,849	$99,950	$609,899	$605,999	-$3,900
53	Central IRL 55 of 939 Septic System Upgrades	Septic System Upgrades	$948,360	$1,034,099	$85,739	$948,360	$946,650	-$1,710
2016-16	Banana Septic System 3 of 144 Quick Connections	Quick Connections	$31,960	$29,749	-$2,211	$31,960	$29,689	-$2,271
2016-18	North IRL Septic System 43 of 463 Quick Connections	Quick Connections	$708,300	$888,504	$180,204	$708,300	$630,950	-$77,350
2016-19	Central IRL Septic System 3 of 269 Quick Connections	Quick Connections	$30,000	$217,094	$187,094	$30,000	$30,000	$0
13	Central Boulevard Baffle Box	Stormwater	$41,700	$43,700	$2,000	$34,700	$34,700	$0
14	Church Street Baffle Box	Stormwater	$233,455	$233,455	$0	$88,045	$88,045	$0
15	Bayfront Stormwater Ponds	Stormwater	$630,956	$635,702	$4,746	$30,624	$30,624	$0
16	Gleason Park Reuse Expansion	Stormwater	$11,000	$7,193	-$3,807	$4,224	$4,224	$0
18	Basin 62 Denitrification Retrofit of Johns Road Pond	Stormwater	$116,905	$274,564	$157,659	$105,512	$105,512	$0
19	St. Teresa Basin Treatment	Stormwater	$375,250	$474,292	$99,042	$272,800	$272,800	$0
20	South Street Basin Treatment	Stormwater	$475,125	$683,969	$208,844	$86,856	$86,856	$0
21	La Paloma Basin Treatment	Stormwater	$375,250	$462,347	$87,097	$208,296	$208,296	$0
34	Cliff Creek Baffle Box	Stormwater	$350,000	$737,612	$387,612	$347,781	$347,781	$0
35	Thrush Drive Baffle Box	Stormwater	$350,000	$609,394	$259,394	$322,200	$322,200	$0

Project Number	Project	Project Type	Estimated Total Cost	Final Total Cost	Change in Total Cost	Eligible Save Our Indian River Lagoon Cost	Final Save Our Indian River Lagoon Cost	Change in Save Our Indian River Lagoon Cost
64	Stormwater Low Impact Development Convair Cove 1 – Blakey Boulevard	Stormwater	$218,263	$216,995	-$1,268	$4,650	$4,650	$0
65	Stormwater Low Impact Development Convair Cove 2 – Dempsey Drive	Stormwater	$218,263	$216,995	-$1,268	$4,495	$4,495	$0
66	Big Muddy at Cynthia Baffle Box	Stormwater	$288,640	$288,640	$0	$67,532	$59,631	-$7,901
67	Grant Place Baffle Box	Stormwater	$498,831	$498,831	$0	$82,841	$82,841	$0
85	Basin 1304 Bioreactor	Stormwater	$125,000	$141,988	$16,988	$90,000	$83,029	-$6,971
87	Basin 2134 Fleming Grant Biosorption Activated Media	Stormwater	$172,300	$169,300	-$3,000	$56,588	$56,588	$0
89	Basin 1298 Bioreactor	Stormwater	$125,000	$136,100	$11,100	$86,198	$85,829	-$369
90	Basin 51 Johns Road Biosorption Activated Media	Stormwater	$116,905	$154,000	$37,095	$23,030	$23,030	$0
91	Basin 100 Burkholm Road Biosorption Activated Media	Stormwater	$117,735	$141,457	$23,722	$64,390	$64,390	$0
92	Basin 115 Carter Road Biosorption Activated Media	Stormwater	$156,079	$146,950	-$9,129	$62,510	$62,510	$0
93	Basin 193 Wiley Ave Biosorption Activated Media	Stormwater	$117,735	$162,216	$44,481	$82,735	$82,735	$0
94	Basin 832 Broadway Pond Biosorption Activated Media	Stormwater	$269,751	$269,750	-$1	$42,864	$42,864	$0
97	Titusville High School Baffle Box	Stormwater	$485,250	$332,800	-$152,450	$111,813	$111,813	$0
98	Coleman Pond Managed Aquatic Plant System	Stormwater	$35,000	$11,438	-$23,563	$35,000	$11,438	-$23,563

Project Number	Project	Project Type	Estimated Total Cost	Final Total Cost	Change in Total Cost	Eligible Save Our Indian River Lagoon Cost	Final Save Our Indian River Lagoon Cost	Change in Save Our Indian River Lagoon Cost
110	Osprey Pond Managed Aquatic Plant System	Stormwater	$60,000	$37,500	-$22,500	$60,000	$37,500	-$22,500
117	Basin 10 County Line Road Woodchip Bioreactor	Stormwater	$180,116	$166,174	-$13,942	$72,773	$72,773	$0
118	Basin 26 Sunset Road Serenity Park Woodchip Bioreactor	Stormwater	$130,062	$242,532	$112,470	$73,810	$73,810	$0
119	Basin 141 Irwin Avenue Woodchip Bioreactor*	Stormwater	$124,626	$146,926	$22,300	$69,174	$69,174	$0
120	Draa Field Pond Managed Aquatic Plant Systems	Stormwater	$60,000	$48,750	-$11,250	$31,281	$31,281	$0
122	Basin 22 Huntington Road Serenity Park Woodchip Bioreactor*	Stormwater	$103,852	$99,334	-$4,518	$40,077	$40,077	$0
123	Ray Bullard Water Reclamation Facility Stormwater Management Area	Stormwater	$1,604,860	$1,604,860	$0	$160,674	$111,847	-$48,827
124	Floating Wetlands to Existing Stormwater Ponds	Stormwater	$50,000	$14,336	-$35,664	$1,497	$1,497	$0
127	Indialantic Basin 5 Dry Retention Pond	Stormwater	$74,700	$62,718	-$11,982	$16,680	$16,680	$0
128	Jackson Court Stormwater Treatment Facility	Stormwater	$391,633	$391,633	$0	$8,266	$8,266	$0
169	Sherwood Park Stormwater Quality Project	Stormwater	$1,696,489	$1,696,489	$0	$292,400 (plus $99,708 of contingency)	$392,108	$0
177	North and South Lakemont Ponds Floating Wetlands	Stormwater	$43,250	$38,250	-$5,000	$13,054	$13,054	$0

Project Number	Project	Project Type	Estimated Total Cost	Final Total Cost	Change in Total Cost	Eligible Save Our Indian River Lagoon Cost	Final Save Our Indian River Lagoon Cost	Change in Save Our Indian River Lagoon Cost
178	Marina B Managed Aquatic Plant System	Stormwater	$14,531	$17,424	$2,893	$6,670	$6,670	$0
111	Draa Field Vegetation Harvesting	Vegetation Harvesting	$60,000	$115,261	$55,261	$57,360 (plus $29,053 of contingency)	$86,413	$0
112	County Stormwater Pond Harvesting	Vegetation Harvesting	$14,000	$14,777	$777	$14,000	$14,000	$0
172	Horseshoe Pond Vegetative Harvesting	Vegetation Harvesting	$14,000	$13,090	$910	$8,140	$8,140	$0
208	Maritime Hammock Preserve Stormwater Pond Vegetation Harvesting	Vegetation Harvesting	$14,500	$14,480	-$21	$7,700 (plus $6,780 of contingency)	$14,480	$0
2016-03	Turkey Creek Hurricane Dredge and Interstitial Treatment	Muck Removal & Interstitial Treatment	$1,545,522	$1,098,631	-$446,891	$215,000	$137,329	-$77,671
40	Mims Muck Dredging Interstitial Treatment*	Interstitial Treatment	$2,162,286	$1,546,187	-$616,099	$400,000	$0	-$400,000
70	Cocoa Beach Muck Dredging Phase III	Muck Removal	$3,109,818	$2,903,356	-$206,462	$1,376,305	$1,376,305	$0
101	Cocoa Beach Muck Dredging Phase II-B	Muck Removal	$7,417,650	$7,417,650	$0	$5,917,650	$5,911,150	-$6,500
73	Riverview Senior Oyster Bar	Oyster	$30,304	$30,304	$0	$30,304	$30,304	$0
75	Marina Isles Oyster Restoration	Oyster	$26,700	$26,700	$0	$26,700	$26,700	$0
76	Bettinger Oyster Bar	Oyster	$10,680	$10,680	$0	$10,680	$10,680	$0
79	Gitlin Oyster Bar	Oyster	$16,020	$16,020	$0	$16,020	$16,020	$0
80	Brevard Zoo Coconut Point/Environmentally Endangered Lands Oyster Restoration	Oyster	$45,120	$45,120	$0	$45,120	$45,120	$0
81	Wexford Oyster Bar	Oyster	$31,150	$31,150	$0	$31,150	$31,150	$0
83	Bomalaksi Oyster Bar	Oyster	$8,900	$8,900	$0	$8,900	$8,900	$0

Project Number	Project	Project Type	Estimated Total Cost	Final Total Cost	Change in Total Cost	Eligible Save Our Indian River Lagoon Cost	Final Save Our Indian River Lagoon Cost	Change in Save Our Indian River Lagoon Cost
105	Brevard Zoo Central IRL Oyster Project	Oyster	$161,160	$161,160	$0	$161,160	$161,160	$0
77a	Cocoa Beach Country Club Living Shoreline	Living Shoreline	$16,080	$16,080	$0	$16,080	$16,080	$0
77b	Lagoon House Living Shoreline	Living Shoreline	$24,000	$24,000	$0	$24,000	$24,000	$0
103	Brevard Zoo North Plant Project	Living Shoreline	$720	$720	$0	$720	$720	$0
130	Brevard Zoo Plant Project 2	Living Shoreline	$9,840	$9,840	$0	$9,840	$9,840	$0
133	Fisherman's Landing Living Shoreline	Living Shoreline	$4,800	$4,800	$0	$4,800	$4,800	$0
135	Rotary Park Living Shoreline	Living Shoreline	$4,800	$4,800	$0	$4,800	$4,800	$0
181	Riveredge	Living Shoreline	$4,080	$4,080	$0	$4,080	$4,080	$0
-	***Total***	**-**	***$46,391,530***	***$45,029,084***	***$1,775,652***	***$22,427,144***	***$21,541,663***	***-$885,481***

* Not paid due to the contractor not meeting nutrient scrubbing contract requirements.

Table 4-45: Save Our Indian River Lagoon Tax Funds Contracted or Expended on Projects Underway (as of October 31, 2022)

Project Number	Project	Project Type	Save Our Indian River Lagoon Plan Funding	Save Our Indian River Lagoon Funds Contracted	Save Our Indian River Lagoon Expenditures for Projects Underway
58	Expanded Fertilizer Education	Public Education	$625,000	$312,500	$252,833
58	Grass Clippings Campaign	Public Education	$200,000	$100,000	$35,000
58	Septic System Maintenance Education	Public Education	$300,000	$150,000	$131,831
227	Restore Our Shores: Community Collaborative	Public Education	$1,000,000	$1,000,000	$100,000
2016-02	City of Titusville Osprey Wastewater Treatment Facility	Wastewater Treatment Facility Upgrade	$8,300,000	$8,300,000 (plus $800,000 of contingency)	$6,877,270
59	City of Melbourne Grant Street Water Reclamation Facility	Wastewater Treatment Facility Upgrade	$6,769,500	$6,769,500	$0
138	Ray Bullard Water Reclamation Facility	Wastewater Treatment Facility Upgrade	$4,260,000	$4,260,000	$205,047
216	City of Rockledge Flow Equalization Basin Project	Wastewater Treatment Facility Upgrade	$2,054,795	$2,054,795	$133,747
63ab	Satellite Beach Pilot & County-wide Repair/Replacement	Sewer Laterals	$840,000	$840,000	$212,642
192	Oak Point Wastewater Treatment Facility Improvements	Package Plant Connection	$279,000	$279,000	$126,802
2019-27	Sharpes – Zone A	Septic-to-Sewer	$6,207,192	$562,031	$151,472
2019-29	South Banana - Zone B	Septic-to-Sewer	$1,368,252	$735,750	$45,214
2020-34	South Central - Zone F	Septic-to-Sewer	$1,701,972	$1,701,972	$120,141
2016-35	South Beaches - Zone A	Septic-to-Sewer	$1,234,764	$18,000	$75,863
2019-36	South Beaches - Zone O	Septic-to-Sewer	$133,488	$133,488	$18,243
2019-37	South Beaches - Zone P	Septic-to-Sewer	$500,580	$500,580	$95,485
2016-47	Sykes Creek - Zone N	Septic-to-Sewer	$2,603,016	$2,603,016	$220,423
2016-48	Sykes Creek - Zone M	Septic-to-Sewer	$1,868,832	$1,868,832	$518,859
2016-49	Sykes Creek - Zone T	Septic-to-Sewer	$4,939,056	$4,939,056	$197,740
2016-50	South Central - Zone C	Septic-to-Sewer	$6,600,000	$6,600,000	$4,535,536
3	Micco Sewer Line Extension	Septic-to-Sewer	$2,038,500	$2,038,500	$255,748
4	Hoag Sewer Conversion	Septic-to-Sewer	$86,031	$86,031	$26,095
5	Pennwood Sewer Conversion	Septic-to-Sewer	$40,632	$40,632 (plus $40,368 of contingency)	$17,074

Project Number	Project	Project Type	Save Our Indian River Lagoon Plan Funding	Save Our Indian River Lagoon Funds Contracted	Save Our Indian River Lagoon Expenditures for Projects Underway
61	Riverside Drive Septic-to-Sewer Conversion	Septic-to-Sewer	$265,960	$262,044	$0
62	Roxy Avenue Septic-to-Sewer Conversion	Septic-to-Sewer	$88,944	$88,944	$39,495
109	City of Titusville - Zones A-G	Septic-to-Sewer	$1,201,392	$943,110	$144,037
136	Micco - Zone B	Septic-to-Sewer	$9,000,000	$2,248,125	$701,489
145	Merritt Island - Zone F	Septic-to-Sewer	$1,100,000	$735,750	$57,533
146	Merritt Island - Zone C	Septic-to-Sewer	$1,580,000	$735,750	$58,112
147	Sykes Creek - Zone R	Septic-to-Sewer	$3,500,000	$735,750	$123,352
148	North Merritt Island - Zone E	Septic-to-Sewer	$3,635,000	$562,031	$194,429
150	South Central - Zone D (Brevard County	Septic-to-Sewer	$4,774,500	$654,403	$105,591
151	Merritt Island - Zone G	Septic-to-Sewer	$16,617,000	$735,750	$458,819
152	Sharpes - Zone B	Septic-to-Sewer	$4,038,000	$562,031	$40,245
153	Cocoa - Zone C	Septic-to-Sewer	$5,248,500	$562,031	$83,346
191	Kent & Villa Espana	Septic-to-Sewer	$710,000	$710,000	$0
203	South Central - Zone A	Septic-to-Sewer	$5,482,500	$707,437	$30,715
224	Lake Ashley Circle	Septic-to-Sewer	$1,704,000	$1,704,000	$0
225	Dundee Circle & Manor Place	Septic-to-Sewer	$2,248,500	$2,248,500	$0
22	Basin 1387 Kingsmill-Aurora Phase Two	Stormwater	$367,488	$367,488	$0
23	Basin 41 Denitrification Retrofit of Huntington Pond	Stormwater	$104,720	$104,720	$9,074
24	Basin 71 Denitrification Retrofit of Flounder Creek Pond	Stormwater	$75,328	$75,328	$19,923
68	Crane Creek/M-1 Canal Flow Restoration	Stormwater	$2,033,944	$2,033,944	$100,000
121	Basin 2258 Babcock Street Woodchip Bioreactor	Stormwater	$50,203	$50,203	$0
174	St. Johns 2 Baffle Box	Stormwater	$243,070	$243,070	$0
205	Basin 998 Hampton Homes	Stormwater	$194,400	$63,618	$0
206	Basin 1066 Angel Avenue	Stormwater	$232,200	$29,487	$0
207	Basin 1124 Elliot Drive	Stormwater	$148,100	To be determined	$0
213	Johnson Junior High Denitrification Media Chamber Modification	Stormwater	$64,478	$64,478	$0
214	Sand Point Park Baffle Box	Stormwater	$137,135	$137,135	$0
215	Basin 960 Pioneer Road Denitrification	Stormwater	$38,850	$38,850	$0
220	Basin 1398 Sand Dollar Canal Bioreactor	Stormwater	$198,024	$198,024	$0
250	Basin 1280B Flamingo Road Denitrification	Stormwater	$71,645	$71,645	$0

Project Number	Project	Project Type	Save Our Indian River Lagoon Plan Funding	Save Our Indian River Lagoon Funds Contracted	Save Our Indian River Lagoon Expenditures for Projects Underway
251	Basin 1304B West Arlington Road Denitrification	Stormwater	$96,425	$96,425	$0
252	Basin 89 Scottsmoor I Aurantia Road Denitrification	Stormwater	$245,100	$245,100	$0
171	Mechanical Aquatic Vegetation Harvesting	Vegetation Harvesting	$1,011,976	$1,011,976	$132,683
209	Basin 1398 Sand Dollar Canal Harvesting	Vegetation Harvesting	$24,420	$24,420	$0
210	Basin 958 Pioneer Road Vegetation Harvesting	Vegetation Harvesting	$39,930	$39,930	$0
2016-04	Rockledge A Muck & Interstitial Treatment	Muck and Interstitial	$5,010,244	$175,340	$143,331
2016-05	Pineda Banana River Lagoon & Interstitial Treatment	Muck and Interstitial	$7,815,980	$0	$0
2016-06	Titusville Railroad West & Interstitial Treatment	Muck and Interstitial	$3,607,375	$146,361	$143,107
2016-07	National Aeronautics and Space Administration Causeway East & Interstitial Treatment	Muck and Interstitial	$11,423,355	$209,255	$182,059
2016-08	Titusville Railroad East & Interstitial Treatment	Muck and Interstitial	$4,609,424	$204,017	$268,499
2016-10	Canaveral South & Interstitial Treatment	Muck and Interstitial	$16,834,419	To be determined	$69,384
2016-11	Patrick Space Force Base & Interstitial Treatment	Muck and Interstitial	$8,216,800	To be determined	$0
41	Grand Canal Muck & Interstitial Treatment	Muck and Interstitial	$18,020,368	$18,020,368	$6,015,858
42	Sykes Creek Muck & Interstitial Treatment	Muck and Interstitial	$15,954,132	$7,472,651	$1,131,067
54	Eau Gallie Northeast Muck & Interstitial Treatment	Muck and Interstitial	$10,020,487	$188,789	$122,706
71	Merritt Island Muck Removal – Phase 1	Muck and Interstitial	$7,733,517	To be determined	$0
72	Muck Removal of Indian Harbour Beach Canals & Interstitial Treatment	Muck and Interstitial	$9,115,415	$9,115,415	$0
168	Cocoa Beach Golf Muck & Interstitial Treatment	Muck and Interstitial	$24,363,100	$24,363,100	$898,121
78a	McNabb Park Oyster Project	Oyster Bars	$34,056	$34,056	$9,096
104	Brevard Zoo Banana River Oyster Project	Oyster Bars	$583,020	$583,020	$40,812
106	Brevard Zoo North IRL Oyster Project	Oyster Bars	$341,280	$341,280	$176,134
139	Brevard Zoo North IRL Oyster Project 2	Oyster Bars	$336,400	$336,400	$47,539
140	Brevard Zoo Central IRL Oyster Project 2	Oyster Bars	$270,800	$270,800	$87,364

Project Number	Project	Project Type	Save Our Indian River Lagoon Plan Funding	Save Our Indian River Lagoon Funds Contracted	Save Our Indian River Lagoon Expenditures for Projects Underway
184	Brevard Zoo North Indian River Lagoon Oyster Project 3	Oyster Bars	$419,232	$419,232	$56,730
78b	McNabb Park Planted Shoreline	Planted Shoreline	$5,670	$5,670	$0
181	Riveredge	Planted Shoreline	$4,080	$4,080	$0
182	Newfound Harbor Drive	Planted Shoreline	$1,680	$1,680	$0
194	Aquaculture Stimulus Program	Clam Restoration	$60,000	$18,000	$6,000
-	Respond and Monitoring	Respond	$10,000,000	-	$2,725,143
-	***Total***	***-***	***$275,303,176***	***$118,554,062***	***$28,774,858***

Figure 4-32: Completed Projects in North Brevard County

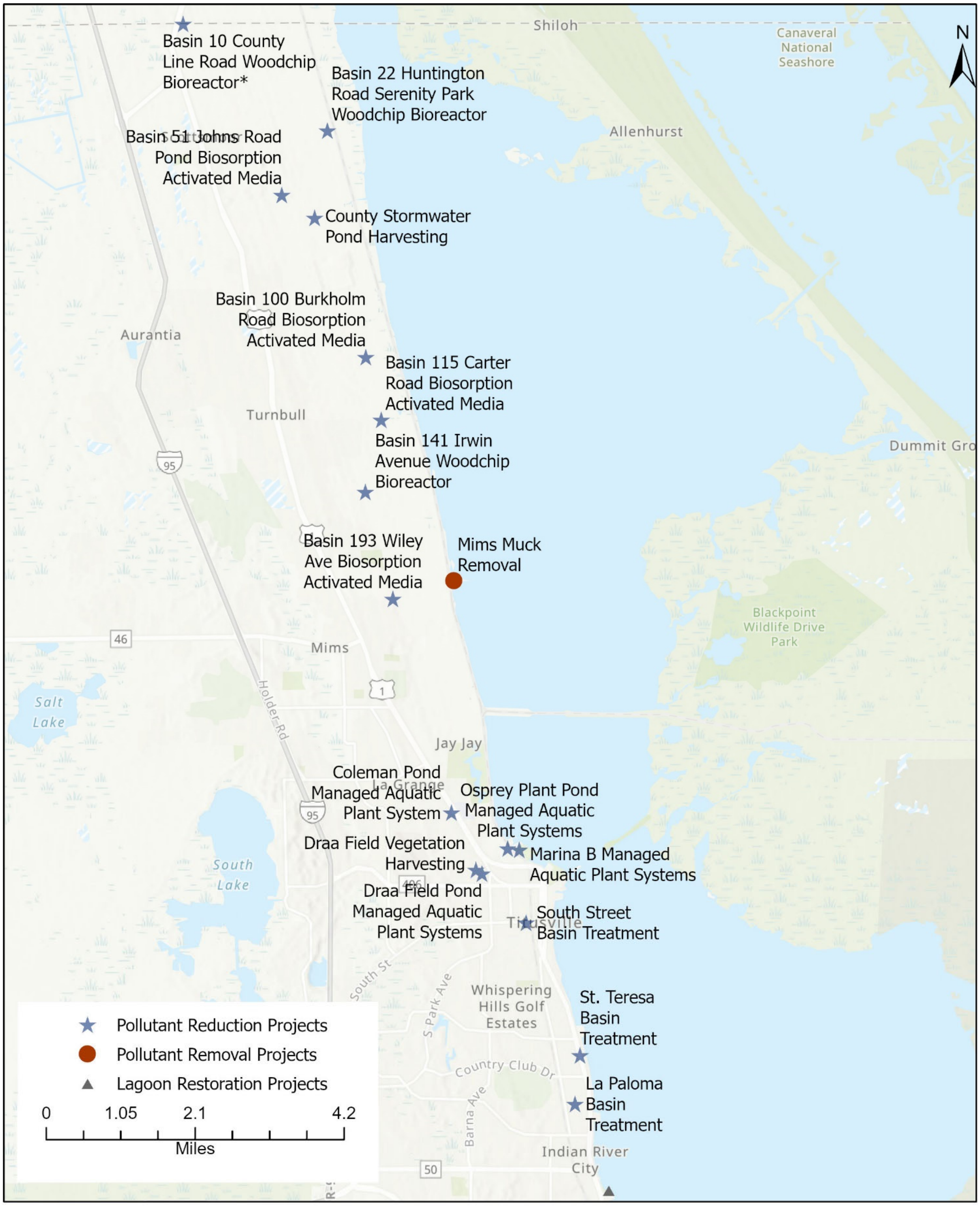


Figure 4-32 Long Description

Figure 4-33: Completed Projects in North Central Brevard County

Figure 4-33 [Long Description]

Figure 4-34: Completed Projects in Central Brevard County

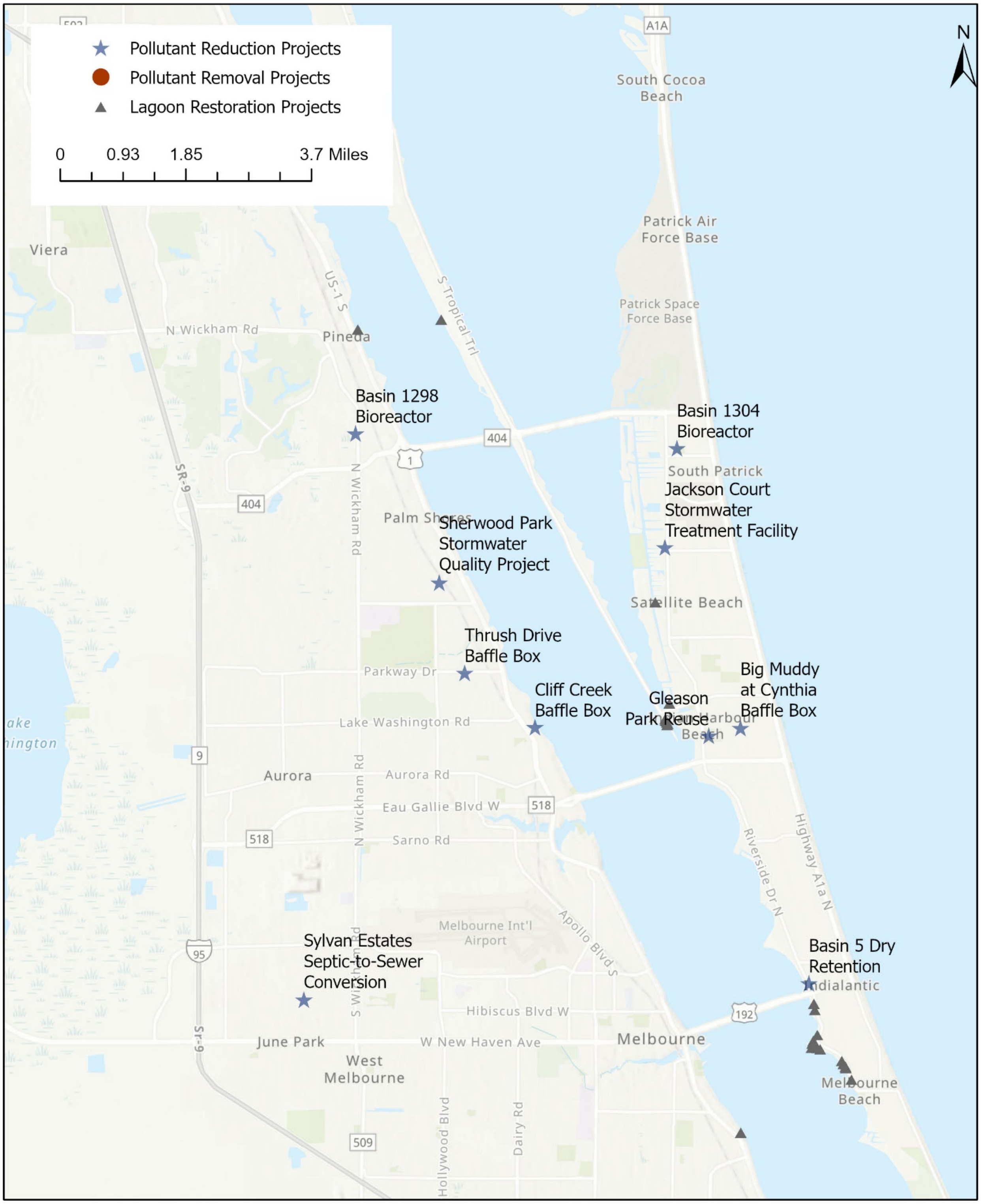


Figure 4-34 Long Description

Figure 4-35: Completed Projects in South Brevard County

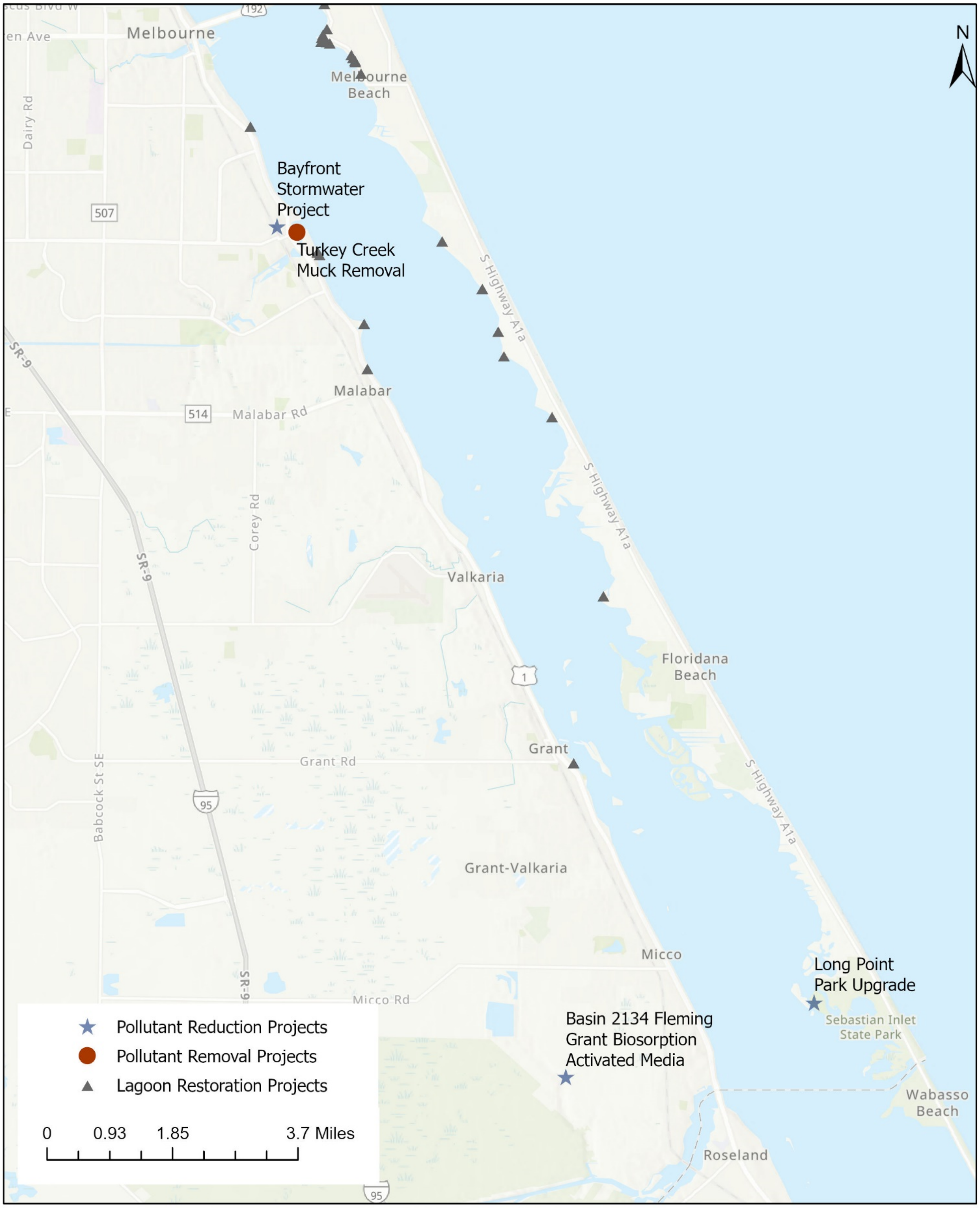


Figure 4-35 Long Description

Fertilizer Management Outreach

As noted in Section 4.1.1, in 2019, the University of Florida Institute of Food and Agricultural Sciences and MTN Marketing conducted a survey that was concentrated on fertilizer awareness questions. The results from the 2019 survey were compared to similar questions from the 2015 Blue Life survey to evaluate changes in fertilizer use. Based on the survey results, 33.33% of respondents in 2019 stated that they use slow release nitrogen fertilizer compared to only 6.30% in 2015, which is a 27% increase in the usage of slow release fertilizer. This resulted in better than anticipated cost effectiveness. The cost per pound of total nitrogen (TN) removed improved from an initial estimate of $102 to a revised estimate of $95. The total phosphorus (TP) reductions were kept at the original plan estimate of an additional 25% compliance because, the way the survey was setup, participants were only able to select one option for the type of fertilizer used. Therefore, an update on the use of zero phosphorus formulas could not be obtained.

Also in 2019, Brevard County amended the fertilizer ordinance to require all fertilizer retail stores to display signage at the point of sale informing the public on the ordinance and best practices for fertilizer management. Focus groups were conducted to enhance the design of the sign. A total of 132 signs were distributed to 53 retails stores across Brevard County. In summer 2020, the stores were surveyed for compliance with the ordinance. Only eight stores were out of compliance with no signage posted. Request for compliance letters were issued to the eight stores and additional signs were delivered to stores that could not locate the original signs. The stores were receptive of the letters and willing to come into compliance. In 2021, the stores were surveyed again and nearly half of the stores were out of compliance with missing signs. The signs were redesigned to add a sticker on the back noting that signs are legally required to be posted and provided contact information to request new signs if they were damaged. This information was already included with the letters provided to the managers when the signs were first delivered but the stickers on the signs will ensure this information is not lost with turnover in staff.

In 2021, five stores allowed stickers to be applied to fertilizer bags to indicate they met the fertilizer ordinance restrictions to test if marked bags would influence consumer choices when buying fertilizer. Issues with relabeling new stock and two of the stores not providing their post study sales data made for inconclusive results. The study will be reevaluated to see if it can be repeated in the future.

Grass Clipping Outreach

Uppercase, Inc. conducted a survey between September 9, 2018, and November 11, 2018, reaching out to citizens of Brevard, Martin, and Volusia counties through advertisements on social media sites, in popular mobile apps, on Google advertisements, in instant messenger, and other online and app platforms, as well as on the counties' social media pages. The survey received 733 responses from the three counties. When asked which items in the list provided are pollutants, 61% of respondents said grass clippings were a pollutant and 50% said leaves were a pollutant. Landscape professionals were more likely to say grass clippings were a pollutant (65%). About 48% of respondents maintained their own yards and 36% used a lawn care company. When asking those respondents who maintain their own yards what they do with grass clippings, 68% say they "seldom" or "never" leave the clippings where they land. 70% of respondents say they "always" or "usually" blow clippings back into their yard, 94% said they “never” or “seldom” blow clippings into the middle of the road, 97% said they “seldom” or “never” blow clippings toward a storm drain, and 97% say they “never” or “seldom” blow grass clippings toward a waterbody. The survey also tested taglines and images to encourage keeping grass clippings out of the street and waterbodies, and the best communication channels to provide this information (Uppercase, 2018). The results from this survey will be used to guide the grass clipping campaign.

In 2021 and 2022, the Marine Resources Council conducted focus groups to test messaging campaigns and find the best method of delivering the message to both homeowner and lawncare professionals. Recommendations on messaging were to focus on the barriers to correct management of grass clippings, as well as promote the existing University of Florida-Institute of Food and Agricultural Sciences Green Industries certification program. Messaging was found to have the best reach to both groups through social media and billboards. Social media ranked highest with homeowners and billboards ranked highest with lawncare professionals. The next highest-ranking methods for both groups was through television and radio advertisements with homeowners ranking both media relatively equal and lawn care professionals showing a slightly higher preference to television advertisement.

Septic System and Sewer Lateral Maintenance Outreach

The University of Central Florida conducted a survey of Brevard County residents to gather information on septic system-related topics. The survey was conducted between May 2018 and September 2018 through phone calls and door-to-door visits, resulting in a total of 404 completed surveys. Most respondents (70%) said that they have had their septic system pumped out, of which most (39.1%) had their system pumped out in the last 2–4 years or within the last 12 months (38%). Most respondents (51%) answered that they have had their current septic system inspected although many (42%) answered that they have not had their septic system inspected. Of those who responded that their septic systems had been inspected, most were inspected within the past 12 months (41.8%) followed by within the past 2–4 years (37.2%). Most residents (53%) did not receive any information regarding the home's septic system when they moved into the home. Of the total respondents, 55.8% strongly agreed with the statement "I restrict what I flush in toilets to prevent damage." The participants strongly agree (44.8%) and agree (42.8%) with the statement "I avoid pouring chemicals and solvents down the sink" (Olive et al., 2018). The results from this survey will be used to help guide implementation of the septic system maintenance education program.

Information based on the United States Environmental Protection Agency's best management practices to maintain a healthy septic system was dispersed through social media and online advertisements. Additionally, a refrigerator magnet with this information was developed and distributed to septic system companies to provide to homeowners during septic system service. A flyer and letter were developed and distributed to realtors, title companies, and home inspectors to give to potential home buyers considering homes with septic tanks. The letter encourages homebuyers to have a septic tank inspected during the purchase process and the flyer informs them how to maintain a septic system if they have not owned a home with one previously.

Lagoon Loyal Program

The full launch of the Lagoon Loyal website and incentive program was on July 1, 2020. To date, there are 1,919 citizens and 94 businesses participating in the Lagoon Loyal Program. They have reported a total of 3,193 actions taken to help the lagoon. There have also been 91,282 educational sessions on the Lagoon Loyal websites.

Measuring Performance

Groundwater monitoring wells have been installed to measure pre- and post-project pollution levels in multiple project areas. This includes two areas where upgrades are underway for the reduction of nutrients in the reclaimed water supplied by two wastewater treatment plants, in four septic areas where permitting is underway to provide sewer service, in one sewer area to estimate pollution from leaky infrastructure, and at five septic upgrade pilot projects.

This countywide groundwater monitoring effort has been ongoing for more than four years. Differences have been observed in the forms and concentrations of nitrogen and phosphorus present in communities with different types of wastewater treatment. The monitoring demonstrates that septic systems and reclaimed water communities have significantly higher TN concentrations in comparison to sewer service areas and natural areas across all regions of the county. The areas with septic systems and reclaimed water had the highest average TN concentrations at 5.88 milligrams per liter and 6.41 milligrams per liter, respectively. Communities on septic systems had significantly higher TP concentrations compared to the other communities across all regions of the county. The average septic system TP concentration was 1.01 milligrams per liter compared to 0.16, 0.19, and 0.27 milligrams per for natural communities, sewer communities, and reclaimed water communities, respectively. Further, most of the TP in septic system communities (0.83 milligrams per liter) was in the highly bioavailable form of phosphate. Groundwater with only elevated nitrate plus nitrite concentrations is likely a good indicator of the use of reclaimed water for irrigation. Groundwater with elevated ammonia and phosphorus is likely a good indicator of the presence of septic systems (**Figure 4-36**) (Applied Ecology and Marine Resources Council, 2022).

Figure 4-36: Countywide Groundwater Nutrient Concentrations for TN (top) and TP (bottom)

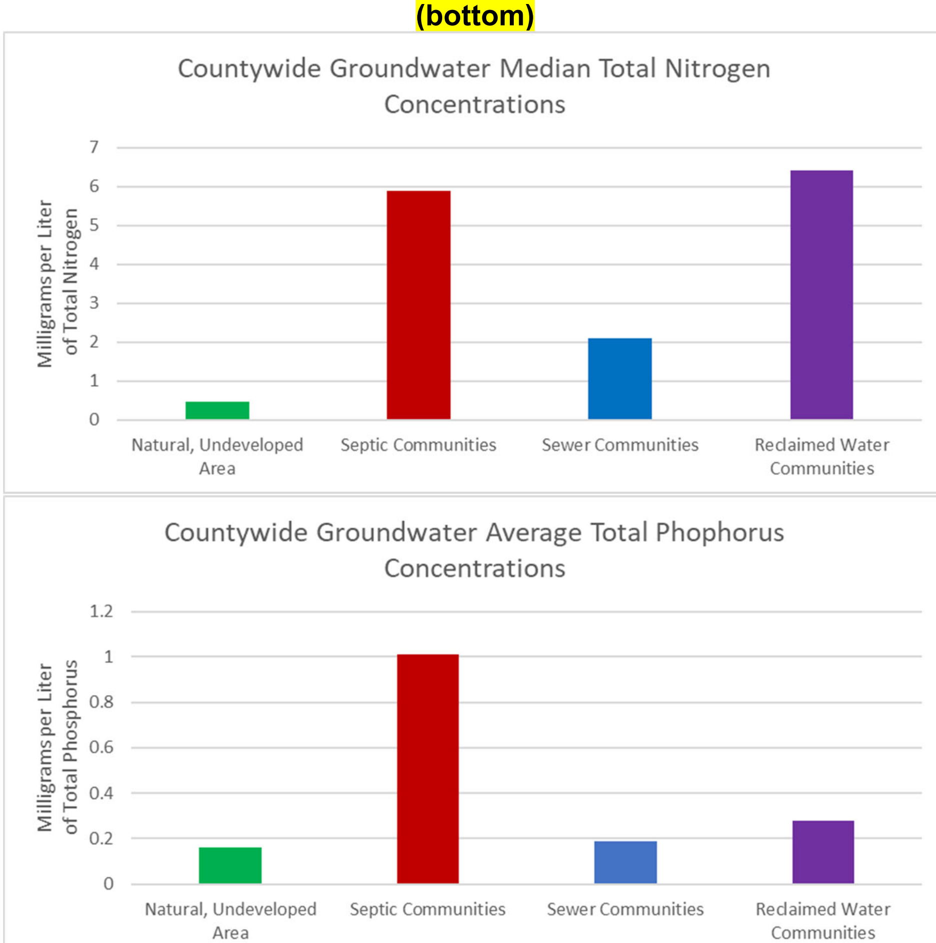


Figure 4-36 Long Description

Package Plant Rapid Infiltration Basin Upgrade

A denitrification wall was built surrounding a rapid infiltration basin approximately 120 feet from the IRL at Long Point Park in Melbourne Beach. Six monthly measurements of nitrogen and phosphorus from within the rapid infiltration basin were compared to nutrient measurements in the IRL versus in the groundwater at three locations between the basin and the lagoon. Average percent removals have been high when comparing concentrations in the rapid infiltration basin to the groundwater location closest to the lagoon. Ammonia decreased by 62%, nitrite by 99%, nitrate by 82%, TN by 60%, total Kjeldahl nitrogen by 59%, orthophosphate by 72%, and TP by 66%. When comparing the basin concentrations to the groundwater inside the denitrification wall, the ammonia was reduced by 59%, nitrite by 98%, TN by 53%, total Kjeldahl nitrogen by 57%, orthophosphate by 78%, and TP by 61%; however, nitrate increased by 834%. Once the water passes through the denitrification wall, nitrate levels drop substantially (97% immediately). Overall, this project has been successful and no further monitoring is planned. Based on actual costs and current data on nitrogen removal, the cost effectiveness is $136 instead of $802 per pound of TN reduced.

Sewer Lateral Rehabilitation

In 2018, Brevard County Utilities conducted a sanitary sewer system smoke testing pilot study within the South Beaches Service Area between Pineda Causeway and Eau Gallie Boulevard. The study used smoke testing to identify major contributors of stormwater into the sanitary sewer system and identify the necessary repairs. A smoke-blowing machine that produces a non-toxic artificial “smoke” is used to pump smoke into the sewer system through an open manhole. As the smoke travels through the sanitary sewer system, it rises to the surface through any deficiencies in the lateral lines, such as cracks, leaks, and breaks. The South Beaches service area was selected because it had been experiencing elevated sanitary flow rates during storm events due to stormwater flow into the sanitary sewer through broken or missing infrastructure. Smoke testing was performed for the Phase 1 area in April and May 2018 for 5,165 properties. The testing identified 99 deficiencies of which there were 87 broken/missing cleanout caps, 9 broken lateral pipes, 2 damaged gravity sewer pipes, and 1 damaged manhole. Smoke testing was performed for the Phase 2 area in May and July 2018 for 7,592 properties. The testing identified 190 deficiencies of which there were 163 broken or missing cleanout caps, 21 broken lateral pipes, 1 storm connection, and 5 damaged manholes/gravity mains. The County purchased cleanout caps and replaced the damaged or missing caps that were identified, accessible, and had no damage to the cleanout port (Kimley Horn, 2018a and 2018b).

Based on the data collected during the pilot study, the Save Our Indian River Lagoon Trust Fund allocated funds to cover costs to repair up to 250 broken cleanout ports or missing caps and 30 broken private lateral lines. The estimated cost for these repairs is $646,200, which is well below the $840,000 budgeted for this project. Phase 1 of the pilot smoke testing was completed in April and May of 2018 for 5,165 properties. The testing identified 99 deficiencies of which there were 87 broken/missing cleanout caps, nine broken lateral pipes, two damaged gravity sewer pipes, and one damaged manhole. Phase 2 of the pilot smoke testing was completed in May and July of 2018 for 7,592 properties. The testing identified 190 deficiencies of which there were 163 broken or missing cleanout caps, 21 broken lateral pipes, one storm connection, and five damaged manholes/gravity mains. Brevard County purchased cleanout caps and replaced the damaged or missing caps that were identified, accessible, and had no damage to the cleanout port (Kimley Horn, 2018a and 2018b).

This pilot study showed that smoke testing is an imperfect, but quick and affordable way to identify many sewer deficiencies over a large area. Brevard County also learned that the unknown costs of fixing private sewer laterals have disincentivized cash-limited homeowners from making repairs promptly. In response, Brevard County has seven qualified plumbers that can be paid directly by the County to fix these repairs and Brevard County is using code enforcement to require property owners fix known deficiencies according to County Code.

In 2022, Brevard County conducted additional smoke testing at over 40,000 homes in the Sykes Creek (Merritt Island), South Beaches, and Barefoot Bay Service Areas. The 2022 smoke tests resulted in 229 cleanout caps being replaced during the testing phase and 431 code enforcement letters being mailed out for sewer lateral deficiencies. Additional smoke testing is funded for Titusville.

The preliminary results from performance data for this area noted that the groundwater sampled at seven of the eight lateral sites had evidence of sewage leaking out of the lateral when the groundwater table was low. Multiple sites had high nitrogen concentration values at or near the break locations, likely directly caused by a sewer leak. Most of the elevated phosphorus was in the readily bioavailable form of ortho-phosphorus (Applied Ecology, 2019). Additional sampling will be conducted after repairs are complete to verify improvements.

Septic-to-Sewer

The Breeze Swept septic-to-sewer project in the City of Rockledge removed 143 septic systems installed between 1958 and 1967. This was the first septic-to-sewer conversion project to be undertaken as a strategic measure to reduce the nutrient loading to the IRL. During construction, the contractor noticed that many septic systems were already failing, which posed an increased health and environmental risk. The City of Rockledge authorized Applied Ecology to install five shallow groundwater monitoring wells in June 2017, three within the Breeze Swept community and two additional reference (i.e., control) wells in an adjacent septic community. Post-construction monitoring continued through summer 2019. There were 18 sampling events with a total of 90 samples collected. All samples were sent to a certified lab and analyzed for ammonia, nitrate-nitrite, total Kjeldahl nitrogen, and fecal coliform. The median ammonia, nitrate-nitrite, total Kjeldahl nitrogen, and mean TN concentrations from the post-construction samples taken from wells within the Breeze Swept community decreased with a statistically significant difference while the control wells showed no significant differences in median concentrations of nitrate-nitrite, total Kjeldahl nitrogen, and TN concentrations during the sampling period. These data provide a better understanding of the impact of septic systems on local water quality and help inform future septic-to-sewer conversion projects.

Construction costs for septic-to-sewer projects increased significantly since the original plan was developed in 2016. At that time, the estimated cost per lot for connection to gravity sewer was $20,000. This estimate included construction of the public and private side of the sewer, abandonment of the septic tank, connection fee, and restoration of the site. Based on 2018 actual and budgeted costs from within Brevard County and surrounding counties, the estimated cost per lot was previously increased to $33,372. Cost estimates have continued to increase due to construction inflation and supply-chain issues. Challenges associated with constructing sewer within old, narrow rights-of-way filled with existing utilities also drive up costs. The current estimate for this 2023 Update is $60,618 per lot.

The project in the Breeze Swept community in the City of Rockledge, completed in 2017, cost $23,800 per lot. The West Melbourne Sylvan Estates project increased from an engineer's estimate of $28,800 to an actual project cost of $41,212 per lot. Indian River County experienced a similar increase in costs for a sewer project in West Wabasso. Phase 1 of West Wabasso was approved in 2011 with an estimated cost of $20,348 per lot. Actual costs for construction in 2014 were $22,942 per lot. Cost estimates for phase 2 of West Wabasso are $46,269 per lot. The South Central C sewer project was recently contracted at $73,748 per lot.

There are many opportunities to remove septic systems in areas with existing sewer lines. The plan currently allocates $12,000 to these connection opportunities. Costs to connect to gravity lines were found to be consistent with this estimate; however, costs to connect to force main lines were more. In the 2019 Update, connection costs to force main sewer were increased to $18,000 to cover the cost of a grinder pump, the pump's electrical connection, directional drilling of the lateral line, abandonment of the septic tank, connection fee, and restoration of the site.

Septic System Upgrades

The average cost of an upgraded septic system was increased from $16,000 to $18,000 in the 2019 Plan Update to reflect the more accurate cost to safely decommission the old tank and install the new tank and drainfield, electrical costs, and restoration of the site. Many of the oldest septic systems that are contributing the most loading to the lagoon do not comply with modern setbacks established by the Florida Department of Health. Bringing these septic systems to current standards in small lots is contributing to the higher average upgrade costs. The estimate of $16,000 is more accurate for new construction. For the 103 upgrades completed so far, the average cost was $19,480 (previously noted as $18,353 for the first 48 and $17,811 for the first eight completed upgrades).

Stormwater Treatment

Brevard County was awarded a grant to help upgrade multiple baffle boxes to second generation technology. Eight baffle boxes in Cocoa, Cape Canaveral, Melbourne, and Titusville were retrofitted with screens to collect larger items such as litter, leaves, and twigs from the stormwater entering the baffle box. Three of the baffle box projects were sampled twice each to estimate the pollutant removal effectiveness of the added screens. The baffle box projects chosen for sampling were Central Boulevard (City of Cape Canaveral), Church Street (City of Cocoa), and South Street (City of Titusville). By applying state-approved dry bulk density ratios to the volumes of material captured in the screens, nutrient removal was estimated to be 7.12 pounds of TN per year and 0.57 pounds of TP per year.

AECOM Algae Harvesting Pilot Project

In 2022, Brevard County Natural Resources secured an innovative technology grant from the Florida Department of Environmental Protection for $999,000 titled Mobile Algae Harvesting to Mitigate Harmful Algal Blooms in Brackish Waterways. The project will pilot test emerging Hydronucleation Flotation Technology as a potential innovative solution for mitigating algae blooms and reducing nutrient concentrations in the IRL. Hydronucleation Flotation Technology is an advanced dissolved air flotation, liquid-solid separation process that efficiently removes algae cells and other suspended particles along with associated nutrients and algal metabolites from water. The technology has been tested extensively in freshwater systems in Florida and New York. The project in Brevard County will test the feasibility of using Hydronucleation Flotation Technology in brackish waters of the IRL.

Brevard County has partnered with AECOM Technical Services, Inc. to implement this project. AECOM has a compact, mobile, and modular Hydronucleation Flotation Technology design that can be operated from land or on water, providing versatility and scalability to tackle nutrient enrichment and algal blooms in a variety of aquatic settings. If proven successful, Hydronucleation Flotation Technology could be used in brackish waters throughout Florida to treat algal blooms in-situ and help reduce nutrient loads to inhibit future occurrences of harmful algal blooms.

AECOM will deploy a barge-mounted Hydronucleation Flotation Technology algal harvester in the IRL for (1) emergency response actions in targeted "hot spots" to mitigate harmful algal blooms as they occur within the IRL, and (2) reducing the nutrient loading into the IRL by positioning the harvester at key tributaries that discharge nutrients into the IRL. The harvester will be repositioned for testing multiple locations in the IRL over a five-month period. The system will treat a sufficient volume of water at each location to evaluate system performance and cost-effectiveness tracked by a comprehensive monitoring program.

Muck Removal

Pre-project muck flux data have been collected by researchers at Florida Institute of Technology for more than 20 potential muck dredging sites. These data were considered with other available data to reprioritize muck dredging areas in the 2019 Update.

The goal of the muck removal program is to improve water quality and ecosystem health within the IRL. Muck removal benefits include reducing nitrogen, phosphorus, hydrogen sulfide, turbidity, pathogens, and contaminants; improving dissolved oxygen and pH; as well as uncovering clean, sandy sediments for recolonization by seagrass, shellfish, and a diversity of benthic marine life to support an abundant and productive food web. The St. Johns River Water Management District maintains several long-term water quality monitoring stations in the IRL, including one northeast of Brevard County's Turkey Creek muck removal project and one east of the St. Johns River Water Management District's Eau Gallie River and Elbow Creek restoration dredging project. Median turbidity values, measured monthly for 17.5 years at the St. Johns River Water Management District monitoring station near Turkey Creek, were 2.79 nephelometric turbidity units before dredging, 1.71 nephelometric turbidity units during dredging, and 2.26 nephelometric turbidity units for the three years of monthly data available after dredging. Median turbidity values, measured monthly for 25 years at the St. Johns River Water Management District monitoring station near Eau Gallie River and Elbow Creek, were 3.07 nephelometric turbidity units before dredging, 2.83 nephelometric turbidity units during dredging, and 1.61 nephelometric turbidity units for the two years of monthly data available after dredging. Although the median turbidity values are lower after dredging compared with before dredging, there is too much monthly variability in the data to determine if the water quality improvements are statistically significant. However, the data indicate no significant increase in turbidity during dredging.

In 2020, Tetra Tech prepared a document with lessons learned for the muck dredging projects implemented between 2014 and 2019. One lesson learned is that the thickness and extent of muck deposits is generally difficult to determine. Therefore, a combination of sediment probes to plan an optimum density and pattern of sediment cores can improve the accuracy of muck sediment isopach mapping. Another lesson learned was related to the use of polymers and flocculants. The contractor methods used at the Mims Boat Ramp did not work for performance-based specifications for nutrient removal. For future projects, more than just bench testing of the chemicals is needed and enhanced contract standards, developed by Brevard County, should be included in future project specifications. Muck sediments with high clay contents can be difficult to dewater. Design efforts should include bench testing of polymer additives to improve flocculation of the suspended sediments and the geotechnical testing of the dredged material slurry to help optimize the dewatering of the dredged material. Significant benefits to TP removal can be realized through the appropriate use of polymers (Tetra Tech, 2020).

Predicting the response of the IRL system to muck removal could be useful for scaling the level of effort and investment that should be directed to dredging. Of the 16 funded muck removal project locations, three have been completed and two are in progress. While the results from completed projects are encouraging, they can also inform modeling that can predict the overall lagoon response to the current level of proposed dredging. Dr. Gary Zarillo of the Florida Institute of Technology has simulated the impacts of muck dredging on the IRL by conducting three-dimensional modeling using observed and predicted hydrodynamic and water quality data. Results are presented in his July 2022 report entitled *Impacts of Environmental Muck Dredging*. Model results indicate that muck dredging benefits IRL water quality and has the potential to substantially reduce nitrogen and phosphorus concentrations in the water well beyond the immediate site of dredging operations.

Model inputs included observed data from the completed Turkey Creek muck removal project and sampling stations located throughout the IRL operated by several agencies and institutions. The model was calibrated using observed data and used to predict water quality response if another 14 muck sites in Brevard County were dredged as planned. Model results found that the relative level of improvement in water quality constituents, such as reductions in TN and TP and increases in dissolved oxygen, ranged from about 15% to 50% near areas of muck removal projects. Furthermore, when looking at water quality constituents throughout the entire Brevard County portion of the IRL, even areas most distant from dredging indicated measurable improvements of 2% to 4%.

General Performance of Interstitial Water Treatment

Data collected by researchers at the Florida Institute of Technology indicated the interstitial water, or the water that is "squeezed" out of the dredged muck material, contains relatively high concentrations of dissolved nitrogen and phosphorus. Treatment of this interstitial water can help to prevent a significant amount of nutrients from being returned to the lagoon; although there are numerous challenges to overcome and adapt to when treating brackish water with variable characteristics. The various ions present in brackish lagoon water (a mix of saltwater and freshwater) interact with other ions used in more traditional methods for treatment of stormwater and wastewater (freshwater). When collaborating with the dredging industry, stormwater treatment engineers, and wastewater treatment engineers to treat the interstitial water, different approaches were tested first in jars, then on a larger laboratory scale, followed by a pilot scale, and finally improved upon at full scale where the challenges of variable field conditions were experienced.

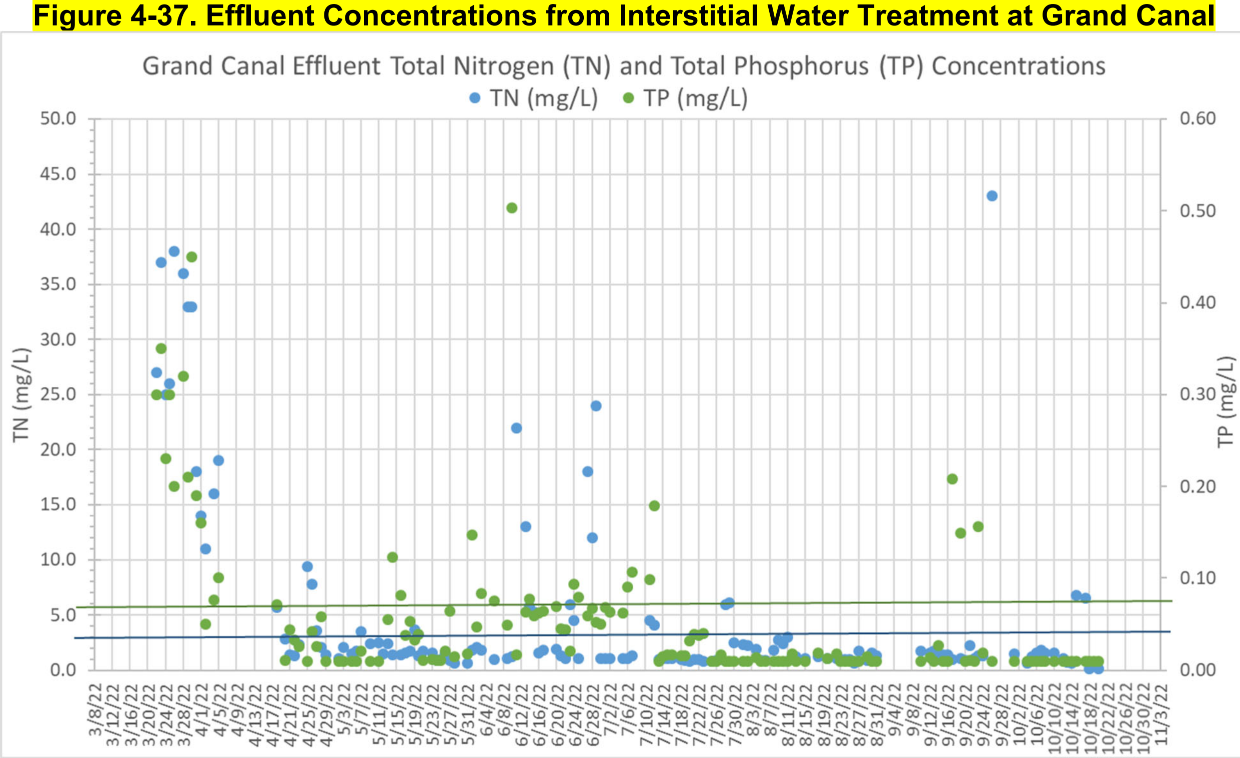
Treatment of the interstitial water first began with the Turkey Creek dredging project where contractors began removing phosphorus through sorption methods and found that large amounts of nitrogen could be removed as well. Therefore, to further reduce the amount of nutrients entering the lagoon, when bid requests were advertised for the Mims dredging project, interstitial treatment was included as pay-for-performance bid options in addition to muck removal. For Mims, bid options were requested for several effluent concentration targets ranging from 1,000–3,000 parts per billion (1–3 milligrams per liter) for nitrogen and 75–100 parts per billion (0.075–0.1 milligrams per liter) for phosphorus. These concentrations are the equivalent of advanced wastewater treatment for sewage. Both dredging and interstitial treatment were contracted, and the contractor was able to reduce interstitial nutrient concentrations but was unable to meet the contracted targets measured by seven-calendar day rolling averages; therefore, they were only paid for dredging and not paid for interstitial treatment.

Learning how complex it was to treat brackish water of highly variable quality and character, but still wanting to incentivize meeting the effluent concentration targets, Brevard County strengthened the contract terms in the bid for the Grand Canal dredging and interstitial water treatment project. A start-up grace period of 21 days was granted to the contractor to ramp up to meeting the established effluent discharge targets of 3,000 parts per billion (3 milligrams per liter) for nitrogen and 75 parts per billion (0.075 milligrams per liter) for phosphorus. If the contractor was not able to meet the targets after the grace period, the new contract language allowed Brevard County to stop work and require a new treatment proposal from the contractor.

Challenges for interstitial treatment include variable organic decomposition rates as the sun heats the geotubes used to separate muck solids from the interstitial water, differences in sediment characteristics as the dredge moves, rainfall, etc. These can result in fluctuating influent nutrient concentrations that may lead to instances where the discharge targets are not met. One bad day could devastate the seven-day rolling average; therefore, the Grand Canal dredging contract was revised to use daily data for performance pay calculations. Two interstitial treatment subcontractors were only able to meet the targets some of the time; therefore, the prime contractor brought in replacements. The current subcontractor is meeting nitrogen and phosphorus targets greater than 75% of the time, including the initial 21-day grace period for starting up the treatment process (**Figure 4-37**).

With the contractor consistently meeting nutrient effluent discharge targets at Grand Canal, the same treatment process was applied to the Sykes Creek dredging and interstitial water treatment project. Payment to the contractor for Phase I is based on the seven-day running average; however, because one bad day could impact the seven-day average, Phase II of the project will be bid with payment to be based on daily ability to meet the effluent discharge targets. Perfection is not expected due to confounding factors that influence treatment although, the efficacy of the treatment methods continues to improve with practice. At Sykes Creek, treatment of interstitial water has been successful with targets being met greater than 80% of the time for nitrogen and 100% of the time for phosphorus (**Figure 4-38**).

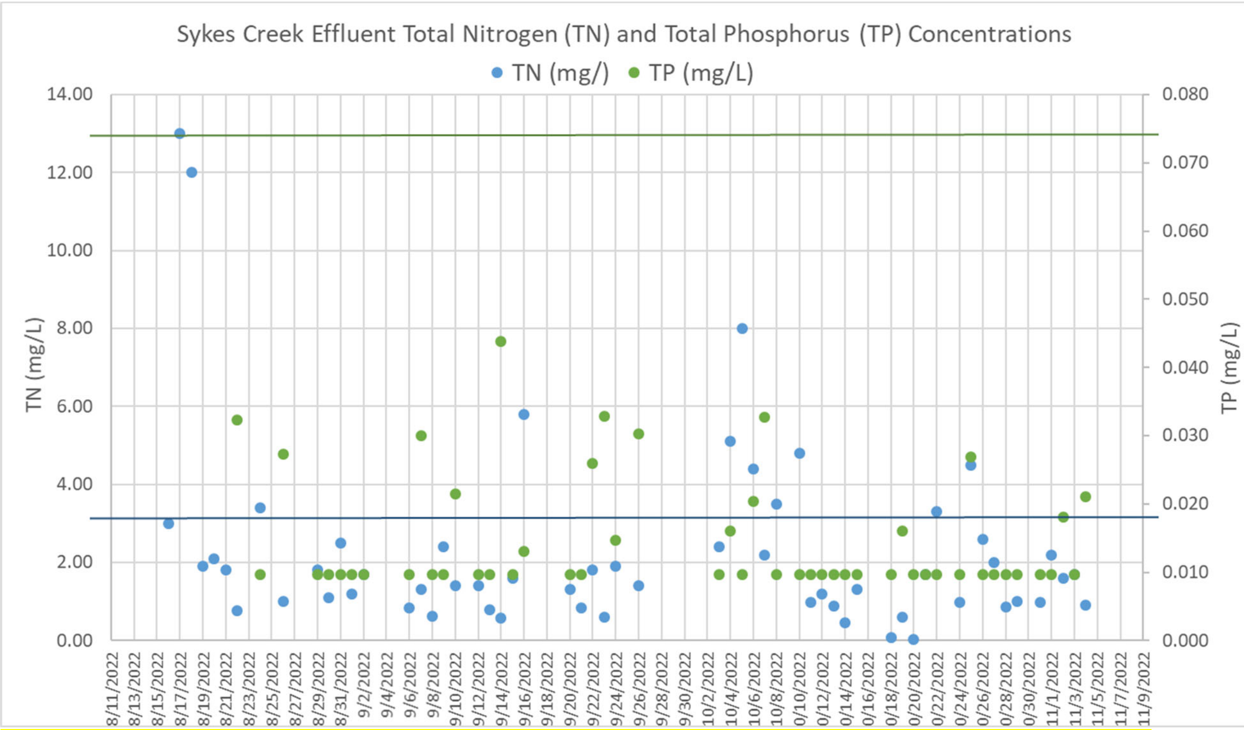
Figure 4-37. Effluent Concentrations from Interstitial Water Treatment at Grand Canal



Note: The blue horizontal line indicates the nitrogen effluent target (3 milligrams per liter) while the green line indicates the phosphorus effluent target (0.075 milligrams per liter).

Figure 4-37 Long Description

Figure 4-38: Effluent Concentrations from Interstitial Water Treatment at Sykes Creek



Note: The blue horizontal line indicates the nitrogen effluent target (3 milligrams per liter) while the green line indicates the phosphorus effluent target (0.075 milligrams per liter).

Figure 4-38 Long Description

Decreasing nutrient concentrations through treatment of the interstitial water prevents relatively high concentrations of dissolved nutrients from re-entering the lagoon in the return water. Contract payment terms are used to incentivize private industry to meet targeted nutrient reductions. As both the treatment process and payment terms evolve, the timing and method for collecting performance metric data also change. Based on several months of performance data available for assessing the current process at the Grand Canal, the cost-effectiveness of interstitial treatment is on the order of $120 per pound of total nitrogen. Updated costs that will be available when Sykes Creek Phase II is bid and future nutrient concentration data to be collected upstream and downstream of interstitial treatment will be used to measure and report the actual cost-effectiveness of interstitial treatment.

In-lagoon Aeration Study

Dr. Austin Fox and Dr. John Trefry from the Florida Institute of Technology conducted two separate aeration studies in the northern IRL. The first studied microbubble aeration in two canals that were similar in bottom type and hydrology before aeration: (1) Anderson Canal (south of Anderson Court, Satellite Beach, Florida) was used as the control canal, and (2) Redwood Canal (south of Redwood Court, Satellite Beach, Florida) was used as the aeration canal. In the first study, from July 2017 to July 2018, microporous diffusers were installed at 50-meter intervals along the bottom of the aerated canal. An additional three diffusers were placed at the mouth the aerated canal, forming a bubble curtain to prevent any suspended material from being blown out of the canal. Water quality sampling was collected monthly for one year at the aeration and control sites. Microbubble aeration creates overturning vertical circulation of the water column, facilitating gas exchange at the water's surface and from the bubbles themselves. In a separate second study using a similar experiment setup, aeration using nanobubbles (highly concentrated dissolved oxygen) was studied from February 2019 to March 2020 in the canal off Turkey Creek along the Florida Institute of Technology Rivers Edge property. During the second study, highly concentrated dissolved oxygen was injected directly into bottom water using six injection nozzles located at the bottom of the Rivers Edge Canal, with a control area adjacent to the aerated canal.

Results from the first study showed that aeration using microporous diffusers created a uniform concentration of dissolved oxygen vertically throughout the water column, whereas sites in the control (non-aerated) canal had high dissolved oxygen saturation at the surface and low to no dissolved oxygen saturation near the bottom. Nanobubble aeration used in the second study resulted in oversaturation of oxygen in bottom water without causing vertical mixing. Benthic fluxes of nitrogen and phosphorous showed similar seasonal variations between the aerated and control canals, except when the average nitrogen flux between February to April 2018 was 35% lower in the microbubble-aerated canal than in its control. It was also noted that the microbubble-aerated canal experienced recruitment of benthic infauna during winter months when oxygen was able to enter the sediment, but in the summer months when bacterial metabolism and oxygen demand was high, mortality of the recruits occurred. Muck thickness, volume, and dissolved nutrients did not significantly decrease and water clarity did not significantly improve using either the microbubble or nanobubble aeration techniques. Despite this, these two studies illustrated how aeration using microporous diffusers or highly concentrated dissolved oxygen can decrease benthic fluxes during cool months and how both types of aeration can increase bottom water dissolved oxygen in localized areas surrounding the aerators.

Brevard County conducted a separate aeration experiment in Sykes Creek (2576 Sykes Creek Drive, Merritt Island, Florida) from December 4–7, 2018. A commercial, floating, surface-pond aerator with no fountain was deployed in a fixed location. Dissolved oxygen levels were measured in 10-foot increments at a depth of two feet extending out from the aerator in both a northeast and southeast direction for 200 feet, before the aerator was turned on and after it was run continuously for three days (but before it was turned off and removed). The results showed dissolved oxygen concentrations near 100% saturation at 7.9–9.0 milligrams per liter before aeration began, and significantly higher ($p<0.001$), above 100% saturation, at 10.3–11.1 milligrams per liter at the end of the three-day experiment. Aeration using atmospheric air is only capable of bringing dissolved oxygen to 100% saturation. Therefore, although dissolved oxygen increased during aeration, the rise above 100% dissolved oxygen saturation suggests that aeration was not directly responsible for the significant increase in dissolved oxygen — it was likely due to increased photosynthetic activity in the area on the sunny December 7, relative to the overcast December 4. Wind direction in the area from December 4–7 (Time and Date, 2021) was consistently from the north, north-northwest, or northwest with similar low speeds (about 10 miles per hour), indicating similar physical parameters across the study days and that differences in weather conditions were mainly influenced by cloud cover before and during aeration.

Thus, both the Florida Institute of Technology studies and Brevard County experiment illustrated how aeration — whether from microbubbles, nanobubbles, or surface aeration — can help create small areas of refugia for benthic organisms against hypoxic events, although benefits are limited to localized areas surrounding the aerators.

Oyster Restoration and Planted Shorelines

Brevard County oyster bars have predominately been built using mesh bags filled with oyster shell, known as cultch. They are typically two layers tall and, in some areas, are seeded with approximately 100 young adult oysters per square yard of the top layer. A University of Central Florida research team conducts independent monitoring of a subset of oyster bar projects, visually inspecting for oysters growing through the bags and cementing or “bridging” of adjacent oysters, and documenting the presence of predators, algal cover, and sedimentation. Additionally, a subsample of building units is emptied to quantify oyster survival, growth, recruitment, and the abundance as well as the diversity of fish and invertebrates living within the modules.

Monitoring results inform future decisions about oyster bar site selection, design, material type, and the need for seeding. Recruitment is necessary for oyster bars to sustain themselves without additional seeding. Adopted success metrics for the oyster bar projects are the presence of two distinct size classes and at least 46 oysters and 46 grams total dry weight per square yard (50 oysters and 50 grams total dry weight per square meter) (Brevard County Oyster Habitat Suitability and Rehabilitation Success Plan, 2021). Analysis of data collected on 10 oyster bar projects over a four-year period suggests there was greater recruitment at sites in the southern portion of Brevard County than those to the north with greater numbers in the summer to late fall than late winter through spring (University of Central Florida, 2022b). Continued recruitment of new oysters has been observed at 17 of the 19 oyster monitoring areas graphed in **Figure 4-39**. **Figure 4-39** shows the average number of measured oysters in each size class per monitored unit at locations funded by the Save Our Indian River Lagoon Program. Project names represent the location of projects within the lagoon and are presented in order by deployment date. Each name includes the date (in parentheses) and age of the project at the most recent monitoring event. These numbers reflect the average of the first 50 randomly encountered oysters per sample, not the density of oysters at each location. Also, the material type and shell volume monitored varies by locations.

The first two years of monitoring at 11 of the 19 areas are reported in the University of Central Florida monitoring reports. Brevard Zoo also monitors a subset of oyster bar sites and continues monitoring the sites that have concluded the first two years of monitoring by the University of Central Florida for permit reporting. Taken together, approximately 79% of the oyster bar projects meet the density criteria, 67% meet the biomass criteria, and 63% meet all success criteria as of the most recent reported monitoring events.

Figure 4-39: Distribution of Oyster Sizes, Age, and Average Number of Measured Oysters Per Unit

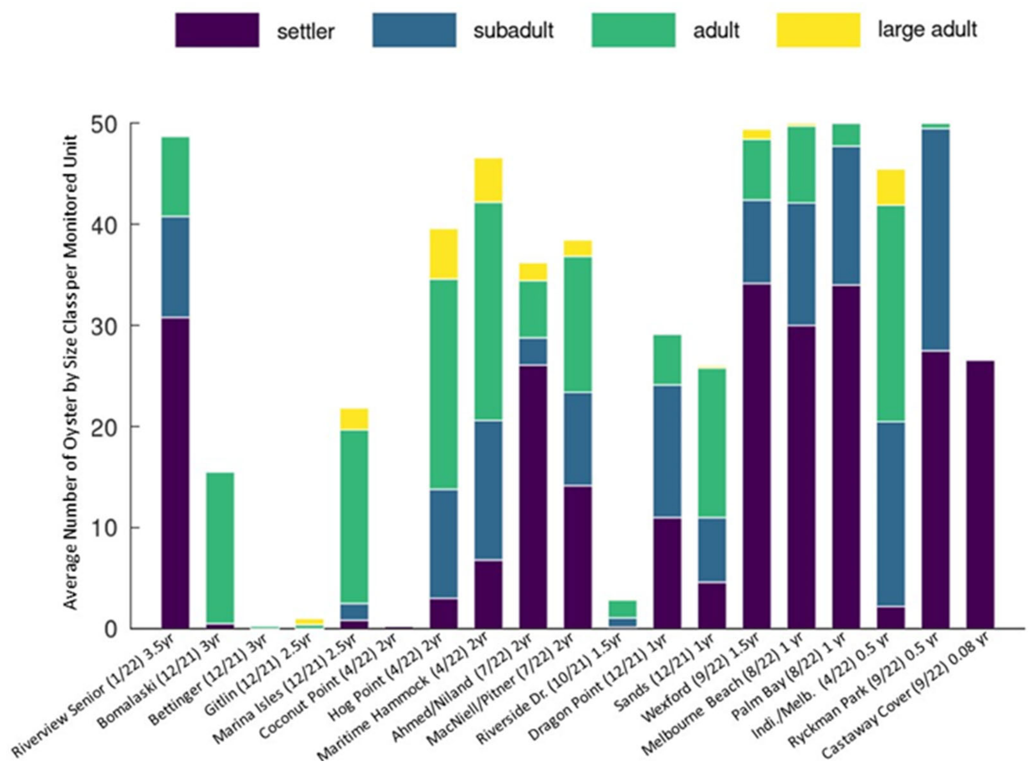


Figure 4-39 Long Description

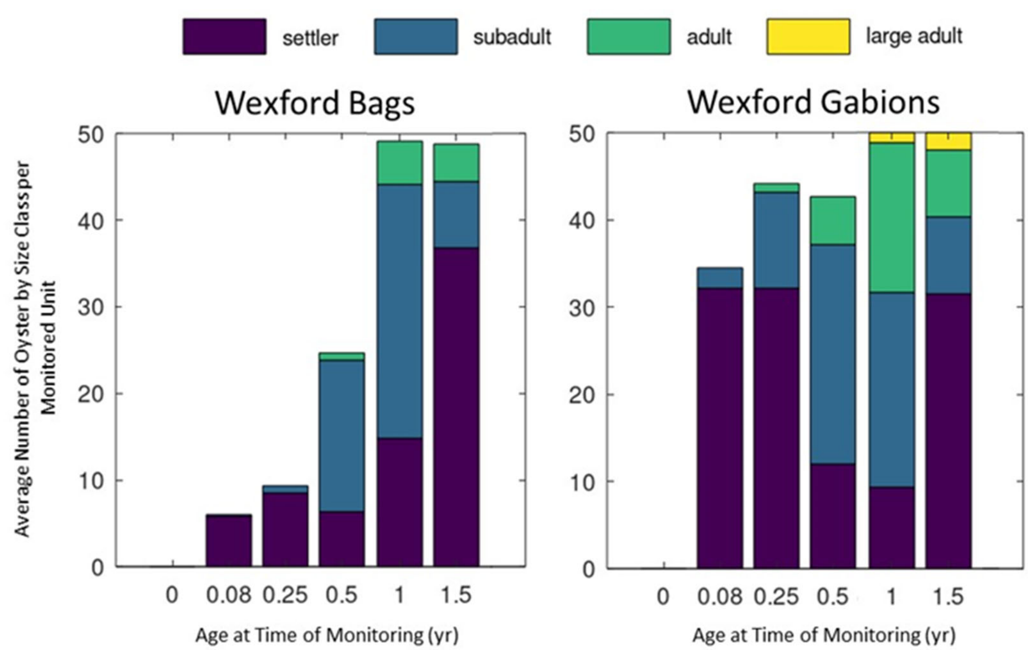
The formation of bridges between bags has been noted at Bomalaski, Marina Isles, Maritime Hammock, and MacNiell-Pitner. Comparison of data from multiple sites indicates that oyster bars located in narrow canals are exposed to more variable salinities and less recruitment and, although surviving oysters do grow, the numbers of live oysters decline over time (University of Central Florida, 2020a). In contrast, bars constructed in open waters of the lagoon experience fluctuations in density but many have sufficient recruitment to maintain populations over time (University of Central Florida, 2022b).

Beginning in July 2020, two projects located within 500 feet of one another were deployed and monitored to compare the influence of initial seeding in the Central IRL (Ahmed/Niland and MacNeill/Pitner locations in **Figure 4-39**). At one year of age, recruitment and oyster density were similar at both sites, 10 and 12 settlers and 28 and 26 oysters per bag at the two sites, respectively. After two years the populations remained similar, with an average 45 ± 5 oysters and 14 settlers per bag at the unseeded location and 63 ± 12 oysters and 26 settlers per bag at the seeded location.

In response to concerns related to the breakdown of plastics in the environment, six alternatives to using ultraviolet stabilized plastic mesh bags for securing loose oyster shell were tested at three locations in the IRL. With funding from the IRL National Estuary Program and collaborators from the University of Florida, Brevard County and the Brevard Zoo Restore Our Shores team built test structures that were monitored throughout an 18-month study. Modules were hung from docks and consisted of controls (ultraviolet stabilized plastic Naltex™ mesh bags); two gauges of galvanized steel gabions; and multiple configurations of cement, oyster shell, and several natural materials including Community Oyster Reef Enhancement modules, jute-reinforced calcium sulfoaluminate Plastic-free Restoration of Oyster Shorelines units, and oyster balls. Monitoring of degradation, fouling, and oyster recruitment and growth occurred quarterly. Results of this study suggest that oyster gabions tended to maintain higher oyster densities and species richness without compromised structural integrity compared to the other materials' performance (Brevard County Natural Resources Management Department, 2022). Changes in trends over time and by location indicate that different materials may be best suited to different environments.

In 2020, alternative materials also began being tested on select oyster bar projects. Community Oyster Reef Enhancement modules were tested along-side ultraviolet stabilized plastic mesh bags at the Hog Point oyster bar. At two-years post-deployment, the average oyster density on Community Oyster Reef Enhancement modules was approximately 7.5% of that in the mesh bags when normalized by reef area (extrapolated from University of Central Florida, 2022a). In the alternative material test, these modules also tended to support much lower densities than mesh bags or gabions. Oyster gabions have also been tested along-side plastic mesh bags at the Wexford oyster bar. In the alternative material test, gabions tended to persist longer, support an equal or greater number of oysters, and oysters formed bridges earlier and more frequently (Brevard County Natural Resources Management Department, 2022). At Wexford, oyster densities have been consistently higher and oysters tended to grow more quickly and to larger size classes in the gabions than plastic mesh bags (**Figure 4-40**).

Figure 4-40: Average Number of Measured Oysters in Each Size Class for Ultraviolet Stabilized Plastic Mesh Bags (left) and Galvanized After Welding Steel Gabions (right)



Note: Each bar represents the age of the project for each monitoring event.

Figure 4-37 Long Description

The University of Central Florida has also monitored planted shorelines projects. Earlier projects (2018–2019) had higher success rates; 46–64% for red mangroves and 36–38% for sand cordgrass. In more recent projects, survival was initially similar to previous projects at equivalent ages. However, significant erosion was noted at two locations after fall 2020. Competition with terrestrial vegetation and erosion via waves and boat wakes are common causes of loss. In an effort to improve success and incorporate vegetation in hardened shorelines, variations of concrete-coated jute fiber mangrove planters are being tested. A pilot led by the Marine Resources Council had a mangrove survival rate of 57% after three months. At this location, *Spartina* spp. and muhly grasses were also planted in an upland area above a rip-rap shoreline, which had approximately 75% survival after three-months.

Data on oyster reef denitrification rates are very limited in Florida; therefore, a scientist with the University of Florida's Institute of Food and Agricultural Sciences was contracted to sample sediment from three oyster bar projects, one each from the North IRL, Central IRL, and Banana River Lagoon. This work builds on a previous study conducted for Brevard County on intertidal oyster reefs of different ages within the Mosquito Lagoon (Schmidt and Gallagher, 2017). Improved analysis techniques were employed on the subtidal oyster bars present in Brevard County to obtain sediment denitrification, percent organic matter, oxygen demand, and nitrate, ammonium, and phosphate flux rates across the sediment-water interface. In this study, oysters were also included in some of the incubations for each site, which tended to alter most of the response variables tested, highlighting the importance of live organisms for filtration, biodeposition, and contributions to the microbiome. The net denitrification varied across seasons and locations and were within range of those in the northeast and mid-Atlantic regions of the United States. Although oyster reef sediments were not significantly different than reference sediments, denitrification rates increased when oysters were present in the samples. It is likely that the young age of the oyster bars and high energy of these sites may have limited the accumulation of biodeposits, affecting net denitrification rates. However, denitrification efficiencies were greater than 50% for most sites and seasons suggesting efficient nitrogen removal (Smyth, 2022).

Remote Sensing of Harmful Algal Blooms in IRL and Connected Waterways in Brevard County

The identification of algae bloom triggers and behaviors is vital to local efforts to manage the watershed. In 2021, Brevard County was awarded $290,972 from a Florida Department of Environmental Protection Water Protection Grant for development of innovative technologies to address harmful algal blooms. Brevard County will use remote sensing technologies as a cost-effective and encompassing approach to provide rapid identification of harmful algal bloom formation, determine the harmful algal bloom lifecycle, and identify hotspots of harmful algal bloom occurrences.

The scope of work includes the development, implementation, and analysis of satellite and unmanned aerial vehicle remote sensing of harmful algal blooms in the lagoon. The European Space Agency Sentinel-2 and Sentinel-3 satellites will be the primary sources of remote sensing data to provide Brevard County with weekly harmful algal bloom updates. Applied Ecology, Inc. will perform spatiotemporal statistical analysis of these harmful algal blooms and corresponding water quality parameters. Applied Ecology, Inc. will also fly an unmanned aerial vehicle equipped with a hyperspectral camera, which will provide high resolution imagery of the lagoon tributaries and canals as well as on-the-ground data to improve the analysis of the satellite imagery. The 2022 year of weekly mapping and data collected and analyzed for this project will be made available to interested agencies and researchers through an ArcGIS Online webapp.

The scope of work for this grant also includes the development of a rapid harmful algal bloom identification and characterization process. This effort included a brief literature review of the recent research on IRL algae, summary of recent chlorophyll-*a* monitoring in the lagoon, assessment of satellite remote sensing for its suitability in estimating chlorophyll-*a* concentrations, and statistical analysis of how harmful algal blooms have varied within the lagoon over space and time (2015–2021) as determined by satellite remote sensing.

As requested by Brevard County, a rapid assessment of the 2020 Titusville Sand Point Park sewage spill was performed. On December 19, 2020, the City of Titusville reported to the Florida Department of Environmental Protection that there was a large release of over 7.2 million gallons of raw sewage into a stormwater pond at Sand Point Park along the IRL. The 2020 bloom event had reached its highest concentrations in the North IRL by September 2020, with concentrations of more than 150 micrograms per liter estimated chlorophyll-*a* throughout the North IRL. From September to December 2020, the estimated chlorophyll-*a* concentrations steadily decreased from a range of 90–154 micrograms per liter to 19–40 micrograms per liter. From January to February 2021, the variation in estimated chlorophyll-*a* peaked on February 3, 2021, at 56.1 micrograms per liter. The 2020 bloom in the North IRL was in decline prior to the sewage leak. There does not appear to be a corresponding increase in chlorophyll-*a* concentrations after the leak and the bloom concentrations in the Sand Point Park area of the lagoon were not significantly different from other areas further from the leak.

4.4.4 Research Needs

Although the Save Our Indian River Lagoon Project Plan does not fund research, it should be recognized that many important research questions need attention. Universities, state agencies, and non-profit organizations are currently leading lagoon research efforts. This plan acknowledges the research needs identified in the Florida Department of Environmental Protection basin management action plans, St. Johns River Water Management District 2011 Superbloom Report, and Indian River Lagoon (IRL) National Estuary Program Comprehensive Conservation and Management Plan, which are summarized below.

- Research needs identified in the basin management action plans (Florida Department of Environmental Protection 2021a, 2021b, and 2021c):
    - Collect data to update the bathymetry for the IRL Basin, which would be used in evaluations of seagrass depth limits.
    - Continue coordinated monitoring of phytoplankton, periphyton, drift algae, and macroalgae in the basin to gain insights into the cycling of nutrients as well as toxin production and release.
    - Analyze storm event monitoring data at the major outfalls.
    - Refine load estimates delivered by baseflows and modeling the contributions of baseflows.
    - Synthesize data on nutrient flux/internal recycling of legacy nutrient loads held within IRL sediments and exchanged with the water column.
    - Complete the development, calibration, and validation of a water quality model that can be used to design, site, and prioritize projects that reduce nutrient loads (e.g., Hydrologic Simulation Program FORTRAN or Spatial Watershed Iterative Loading model coupled with the Environmental Fluid Dynamics Code model, or another model that generates predictions of conditions that may be favorable for seagrass growth).

- Research needs identified in the Comprehensive Conservation and Management Plan revision (IRL National Estuary Program 2019):
    - Undertake further studies to quantify the impacts of septic systems on the IRL with a focus on identifying high priority “problem” and “potential problem” areas.

- Develop, improve, and implement best management practices and education programs for stormwater management and freshwater discharges.
- Determine the impacts of atmospheric deposition of nutrients and other pollutants on the nutrient budget, water quality, and resources of the IRL.
- Support implementation, review, and update of IRL total maximum daily loads as needed and as best available science evolves.
- Work to continue, expand, update, and improve the IRL species inventory.
- Research and develop new and improved wetland best management practices with a focus on understanding wetland responses to sea level rise and climate change.
- Continue to support and expand research initiatives and coordinated finfish and shellfish management strategies specific to the IRL.
- Prepare a Risk-Based Vulnerability Assessment and Adaptation Plan for the IRL.
- Develop a comprehensive IRL monitoring plan.
- Advance the ten research priorities in the 2018 Looking Ahead – Science 2030 Report.
- Update the IRL economic analysis produced by the Treasure Coast and East Central Florida Regional Planning Councils every five years.
- Support advancements in hydrological model development, verification, and application.
- Continue evaluation of options to enhance water flow through engineering solutions that have well defined water quality and ecological outcomes.
- Complete muck mapping of the entire IRL, prioritize muck dredging projects and site selection for seagrass and filter feeder restoration projects, and reduce source contributions of sediment and biomass that result in muck formation.
- Track emerging technologies, innovative approaches or alternatives to dredging, muck capping, upstream controls of muck transport, more efficient approaches to dewatering, enhanced pollutant removal in post-dredge water, and enhanced muck management to improve process efficiency and identify beneficial uses of muck.
- Monitor and research to better understand contaminants of emerging concern within the IRL system.
- Research spatially explicit data on the extent and condition of existing filter feeder habitat.
- Research and report on science-based siting, planning, design, and construction criteria for living shorelines.
- Support research and assessment to identify and map suitable habitats and spawning habitats for forage fishes and track population size and health.

- Research needs identified in 2011 Superbloom Report (St. Johns River Water Management District 2016b):
  - Garner an improved understanding of the ideal biological and physiological conditions and tolerances of picocyanobacteria (small cyanobacteria) and Pedinophyceae (green microflagellate), including their ability to use organic forms of nutrients, their ability to fix nitrogen, their nutrient uptake rates, their reproductive rates, and their defenses against grazers.
  - Maintain or expand water quality sampling to ensure spatiotemporal variations are captured adequately, which could include continuous monitoring of various parameters to fill gaps between monthly samples.
  - Develop an improved understanding of the physiological tolerances of drift algae and seagrasses, especially manmade conditions that could be mitigated to improve health or natural resilience.

- Maintain or expand surveys of drift algae and seagrasses to improve the capacity to evaluate their role in nutrient cycles.
- Improve the ability to model bottom-up influences from external and internal nutrient loads, including atmospheric deposition, surface water runoff, groundwater inputs, diffusive flux from muck, decomposition of drift algae, and cycling and transformation of nitrogen and phosphorus.
- Enhance surveys of bacterioplankton to improve the understanding of nutrient cycling.
- Improve surveys of potential zooplanktonic, infaunal, epifaunal, and fish grazers to enhance the understanding of spatiotemporal variation in top-down control of phytoplankton blooms.
- Evaluate grazing pressure exerted by common species to enhance the understanding of top-down control of phytoplankton blooms.

4.5. Unfunded Projects

Throughout initial development and annual updates of this plan, there have been projects considered that are not funded due to being less cost-effective than similar projects that were selected for funding. If some of the recommended projects in the plan receive funding from outside sources, such as grants or legislative appropriations, additional projects could be implemented using the Save Our Lagoon Trust Fund. If funding becomes available, the projects listed in **Table 4-46** through **Table 4-50** include numerous unfunded opportunities sorted by the next most cost-effective projects (based on total nitrogen [TN] and total phosphorus [TP] load reductions in pounds per year available for each major type of pollution reduction strategy.

Table 4-46: Unfunded Wastewater Treatment Facility Reclaimed Water Upgrade Projects

Facility	Cost to Upgrade	Total Nitrogen Removed after Attenuation (pounds per year)	Cost per Pound per Year of Total Nitrogen Removed	Total Phosphorus Removed after Attenuation (pounds per year)	Cost per Pound per Year of Total Phosphorus Removed
Cape Canaveral Air Force Station	$6,000,000	3,653	$1,642	To be determined	To be determined
Brevard County South Beaches	$6,000,000	2,860	$2,098	To be determined	To be determined
Brevard County South Central Regional	$6,000,000	2,053	$2,923	To be determined	To be determined
Brevard County Port St. John	$6,000,000	1,788	$3,356	To be determined	To be determined
Rockledge Wastewater Treatment Facility	$6,000,000	1,084	$3,460	To be determined	To be determined
Brevard Count Barefoot Bay Water Reclamation Facility	$6,000,000	1,597	$5,535	To be determined	To be determined
Total	***$36,000,000***	***13,035***	***$2,762 (average)***	***To be determined***	***To be determined***

Table 4-47: Unfunded Package Plant Connection Projects

Facility Name	Number of Units	Cost to Connect to Sewer	Total Nitrogen Load Reduction (pounds per year)	Cost per Pound Per Year of Total Nitrogen Removed
Merritt Island Utility Company*	198	$1,349,445	1,367	$987
South Shores Utility	134	$1,301,154	928	$1,402
Pelican Bay Mobile Home (also known as Riverview)	200	$1,028,802	541	$1,901
Housing Authority of Brevard County	26	$451,375	207	$2,179
River Grove I & II Mobile Home Park	200	$1,761,167	697	$2,528
Sterling House Condominium	45	$660,445	186	$3,556
Riverview Mobile Home and Recreational Vehicle Park	110	$763,933	207	$3,690
Lighthouse Cove	80	$1,182,706	196	$6,034
Palm Harbor Mobile Home Park	130	$728,858	118	$6,177
Tropical Trail Village	74	$648,025	51	$12,718
Treetop Villas	28	$1,157,797	69	$16,005
Canebreaker Condo	24	To be determined	No data	To be determined
Enchanted Lakes Estates	190	To be determined	No data	To be determined
Camelot Recreational Vehicle Park Inc.	178	To be determined	No data	To be determined
Southern Comfort Mobile Home Park	40	To be determined	No data	To be determined
Summit Cove Condominium	84	To be determined	No data	To be determined
Total	***1,623***	***$10,435,269***	***3,281***	***$3,181 (average)***

* As of 2022, the private entity that owns this package plant was not interested in connecting to central sewer.

Table 4-48: Unfunded Sprayfield or Rapid Infiltration Basin Upgrade Projects

Facility	Type	Estimated Cost to Upgrade	Total Nitrogen Removed from Upgrade (pounds per year)	Cost per Pound per Year of Total Nitrogen Removed
Aquarina Beach Community	Sprayfield	$75,010	704	$107
Indian River Shores Trailer Park	Rapid Infiltration Basin	$38,145	193	$198
Housing Authority of Brevard County	Rapid Infiltration Basin	$52,272	172	$304
River Grove Mobile Home Village	Rapid Infiltration Basin	$182,299	578	$315
South Shores Utility	Sprayfield	$300,564	771	$390
Merritt Island Utility Company	Rapid Infiltration Basin	$495,277	1,073	$462
Pelican Bay Mobile Home	Rapid Infiltration Basin	$222,156	449	$495
Lighthouse Cove	Sprayfield	$120,000	163	$736
River Forest Mobile Home Park	Sprayfield	$78,405	101	$776
Tropical Trail Village	Rapid Infiltration Basin	$90,169	79	$1,141
Treetop Villas	Sprayfield	$105,000	58	$1,810
Riverview Mobile Home and Recreational Vehicle Park	Sprayfield	$333,234	172	$1,937
Palm Harbor Mobile Home Park	Sprayfield	$300,564	98	$3,067
Harris Malabar Facility	Rapid Infiltration Basin	$2,085,000	495	$4,212
Enchanted Lakes Estates	Sprayfield	$36,000	To be determined	To be determined
Camelot Recreational Vehicle Park Inc	Sprayfield	Unknown size	To be determined	To be determined
Southern Comfort Mobile Home Park	Rapid Infiltration Basin	To be determined	To be determined	To be determined
Space X Launch Complex 39A	Sprayfield	To be determined	To be determined	To be determined
Total	**-**	***$4,565,575***	***5,180***	***$881 (average)***

Table 4-49: Unfunded Septic-to Sewer-Projects

Service Area	Number of Lots	Cost	Total Nitrogen Reduction (pounds per year)	Total Nitrogen Cost per Pound Per Year
Grant-Valkaria – Zone G	30	$1,001,160	1,418	$706
Grant-Valkaria – Zone E	128	$4,271,616	5,862	$729
Grant-Valkaria – Zone B	34	$1,134,648	1,501	$756
Grant-Valkaria – Zone F	17	$567,324	688	$824
Grant-Valkaria – Zone D	18	$600,696	690	$871
Grant-Valkaria – Zone A	42	$1,401,624	1,296	$1,082
Malabar – Zone B	64	$2,135,808	1,929	$1,107
Grant-Valkaria – Zone C	30	$1,001,160	853	$1,173
Malabar – Zone A	430	$14,349,960	11,456	$1,253
Valkaria – Zone I	223	$7,441,956	5,380	$1,383
South Beaches – Zone F	3	$100,116	70	$1,435
Valkaria – Zone J	503	$16,786,116	11,507	$1,459
Malabar – Zone C	14	$467,208	289	$1,617
South Central – Zone B	180	$6,006,960	3,700	$1,623
Sharpes – Zone B	136	$4,538,592	2,692	$1,686
South Beaches – Zone E	387	$12,914,964	7,491	$1,724
Rockledge – Zone C	91	$3,036,852	1,736	$1,749
South Beaches – Zone K	21	$700,812	397	$1,765
North Merritt Island – Zone F	34	$1,550,000	830	$1,867
North Merritt Island – Zone D	29	$1,293,000	685	$1,888
City of West Melbourne	60	$2,002,320	1,041	$1,923
Pineda	27	$1,257,000	644	$1,952
Sykes Creek – Zone IJ	77	$1,900,000	62	$1,974
South Beaches – Zone L	178	$5,940,216	2,973	$1,998
Sykes Creek – Zone J	63	$2,102,436	1,028	$2,045
South Banana – Zone A	88	$3,025,000	1,444	$2,095
South Central – Zone BC	13	$1,222,000	582	$2,100
South Beaches – Zone G	112	$3,737,664	1,764	$2,119
City of West Melbourne – Zone B	60	$2,002,320	894	$2,240
Malabar – Zone D	24	$800,928	352	$2,278
North Merritt Island – Zone A	107	$4,245,000	1,821	$2,331
South Beaches – Zone D	89	$2,970,108	1,273	$2,333
South Central – Zone E	411	$13,715,892	5,761	$2,381
South Beaches – Zone M	334	$11,146,248	4,293	$2,596
Grant-Valkaria – Zone H	100	$3,337,200	1,272	$2,624
Malabar – Zone F	14	$467,208	174	$2,683
Melbourne Village – Zone B	224	$7,475,328	2,705	$2,763
Sykes Creek – Zone H	74	$2,469,528	887	$2,783
South Central – Zone I	72	$2,170,000	772	$2,811
Sykes Creek – Zone G	52	$1,735,344	602	$2,881
South Beaches – Zone N	103	$3,437,316	1,193	$2,882
Sykes Creek – Zone C	81	$2,703,132	929	$2,909
Melbourne Village – Zone A	85	$2,836,620	918	$3,091
South Central – Zone H	165	$5,506,380	1,779	$3,096
South Central – Zone G	196	$6,540,912	2,090	$3,129
North Merritt Island – Zone C	71	$2,369,412	737	$3,217
Merritt Island – Zone H	285	$22,500,000	5,464	$4,118
Sykes Creek – Zone S	164	$6,600,000	1,584	$4,167
North Merritt Island – Zone B	56	$4,690,000	1,066	$4,399
Merritt Island – Zone A	249	$16,700,000	3,440	$4,855
South Beaches – Zone C	118	$3,937,896	683	$5,763
Total	***6,166***	***$232,843,980***	***111,598***	***$2,086 (average)***

Table 4-50: Unfunded Muck Dredging and Interstitial Treatment Projects

Sub-Lagoon	Indian River Lagoon Muck Sites	Dredging Cost Estimate	Interstitial Water Treatment Cost	Total Cost	Total Nitrogen Reduction (pounds per year)	Cost per Pound of Total Nitrogen Removed	Total Phosphorus Reduction (pounds per year)	Cost per Pound of Total Phosphorus Removed
Banana	Cocoa Beach Golf (unfunded portion)*	$12,775,000	$1,941,800	$14,716,800	Not applicable	Not applicable	Not applicable	Not applicable
Central IRL	Goat Creek	$350,000	$50,819	$400,819	735	$545	98	$4,090
North IRL	Pineda to Eau Gallie	$30,625,000	$4,446,705	$35,071,705	34,965	$1,003	1,554	$22,569
North IRL	520 to Pineda	$31,500,000	$4,573,754	$36,073,754	35,280	$1,022	1,568	$23,006
Central IRL	Mullet Creek Islands Area	$4,550,000	$660,653	$5,210,653	4,305	$1,210	574	$9,078
North IRL	National Aeronautics and Space Administration Causeway West	$4,375,000	$635,244	$5,010,244	3,903	$1,284	193	$25,960
North IRL	Pineda	$5,250,000	$762,292	$6,012,292	4,610	$1,304	492	$12,220
Banana	Kent Drive	$1,750,000	$254,097	$2,004,097	1,365	$1,468	182	$11,012
Banana	National Aeronautics and Space Administration Area	$98,000,000	$14,229,457	$112,229,457	68,985	$1,627	9,198	$12,202
Banana	528 East	$1,225,000	$177,868	$1,402,868	840	$1,670	112	$12,526
North IRL	North IRL Venetian Canals/Channels	$13,475,000	$1,956,551	$15,431,551	9,160	$1,685	1,243	$12,415
Banana	Newfound Harbor East	$1,575,000	$228,688	$1,803,688	1,050	$1,718	140	$12,883
Banana	Banana Venetian Collector Canals/Channels	$119,000,000	$17,278,627	$136,278,627	78,960	$1,726	10,927	$12,472
Banana	Patrick Space Force Base Borrow Pit-2	$4,725,000	$686,063	$5,411,063	3,045	$1,777	406	$13,328
Banana	Newfound Harbor South	$4,725,000	$686,063	$5,411,063	3,045	$1,777	406	$13,328
Banana	Mathers Bridge Area	$12,250,000	$1,778,682	$14,028,682	7,875	$1,781	1,050	$13,361
North IRL	Max Brewer Causeway	$2,800,000	$406,556	$3,206,556	1,785	$1,796	238	$13,473
Banana	Newfound Harbor North	$3,150,000	$457,375	$3,607,375	1,995	$1,808	266	$13,562
Banana	Cocoa Beach High School	$6,825,000	$990,980	$7,815,980	4,305	$1,816	574	$13,617
Central IRL	Central IRL Venetian Collector Canals/Channels	$6,300,000	$914,750	$7,214,750	3,904	$1,848	537	$13,435
Banana	Brightwaters	$8,225,000	$1,194,258	$9,419,258	5,040	$1,869	672	$14,017
Banana	Patrick Space Force Base Borrow Pit-4	$525,000	$76,229	$601,229	315	$1,909	42	$14,315
Banana	Sunset Café	$3,850,000	$559,014	$4,409,014	2,310	$1,909	308	$14,315
Banana	520 Borrow Pit-1	$1,400,000	$203,278	$1,603,278	840	$1,909	112	$14,315
Banana	Cape Canaveral Hospital	$2,100,000	$304,917	$2,404,917	1,260	$1,909	168	$14,315
Banana	520 Borrow Pit-2	$700,000	$101,639	$801,639	420	$1,909	56	$14,315
Banana	520 Borrow Pit-3	$525,000	$76,229	$601,229	315	$1,909	42	$14,315
Banana	520 Borrow Pit-4	$1,400,000	$203,278	$1,603,278	840	$1,909	112	$14,315

Sub-Lagoon	Indian River Lagoon Muck Sites	Dredging Cost Estimate	Interstitial Water Treatment Cost	Total Cost	Total Nitrogen Reduction (pounds per year)	Cost per Pound of Total Nitrogen Removed	Total Phosphorus Reduction (pounds per year)	Cost per Pound of Total Phosphorus Removed
Banana	520 Borrow Pit-5	$1,050,000	$152,458	$1,202,458	630	$1,909	84	$14,315
Banana	520 Borrow Pit-6	$525,000	$76,229	$601,229	315	$1,909	42	$14,315
Banana	520 Borrow Pit-7	$700,000	$101,639	$801,639	420	$1,909	56	$14,315
Central IRL	Trout Creek	$175,000	$25,410	$200,410	105	$1,909	14	$14,315
Central IRL	Melbourne Causeway North	$875,000	$127,049	$1,002,049	525	$1,909	70	$14,315
Central IRL	Front St Park	$875,000	$127,049	$1,002,049	525	$1,909	70	$14,315
North IRL	Warwick Dr	$700,000	$101,639	$801,639	420	$1,909	56	$14,315
North IRL	Crab Shack	$700,000	$101,639	$801,639	420	$1,909	56	$14,315
Banana	Port Canaveral	$9,275,000	$1,346,716	$10,621,716	4,988	$2,129	245	$43,354
North IRL	Cocoa South	$5,250,000	$762,292	$6,012,292	1,947	$3,088	182	$33,035
Central IRL	Turkey Creek	$4,900,000	$711,473	$5,611,473	1,750	$3,207	231	$24,292
North IRL	National Aeronautics and Space Administration Causeway to 528	$16,625,000	$2,413,926	$19,038,926	4,694	$4,056	313	$60,827
North IRL	Rockledge A	$29,575,000	$4,294,247	$33,869,247	8,093	$4,185	1,184	$28,606
North IRL	Eau Gallie Northwest	$19,145,000	$2,779,826	$21,924,826	3,207	$6,837	244	$89,856
North IRL	Cocoa 520-528	$3,850,000	$559,014	$4,409,014	599	$7,361	40	$110,225
North IRL	Eau Gallie South	$40,250,000	$5,844,241	$46,094,241	4,144	$11,123	777	$59,323
-	***Total***	***$518,420,000***	***$75,360,713***	***$593,780,713***	***314,234***	***$1,890 (average)***	***35,032***	***$16,961 (average)***

*Note: The funding for the Cocoa Beach Golf project is the balance of funding needed to fully implement this project. Brevard County is looking for sources of funding for this balance.

Section 5. Project Funding

5.1. Project Funding, Schedule, and Scope Adjustments

5.1.1 Contingency Fund Reserve

The 2018 Update established a Contingency Fund Reserve (Reserve) that will be included with the development and adoption of the County's budget each fiscal year. The Reserve will amount to inflation plus 5% of the total Trust Fund dollars that are budgeted for all approved projects scheduled to occur or move ahead in that fiscal year. This includes projects in the Save Our Indian River Lagoon Project Plan (Plan), including additions captured in annual updates or supplements. The purpose of the Reserve is to fund emergency response to harmful algal blooms and major fish kills; cover reasonable funding shortfalls that may occur during project implementation and would delay implementation or completion of that project unless a ready source of funds is on hand; provide funding for projects (whether during the term of the project or upon project completion) that remove additional nutrients beyond the amount originally planned or anticipated in the project cost-share agreement; or move projects forward ahead of schedule if ready to proceed.

The Reserve includes an additional amount of funding to account for the impact of inflation on project delivery costs. Inflation is estimated by applying the Consumer Price Index to project costs, compounded for the number of years between the year the project cost was estimated and the year that the project is expected to be constructed. For the 2023 Plan Update, inflation is applied and compounded annually for the years between when a project was added to the plan and when its construction is now anticipated. Construction costs have increased more than the Consumer Price Index. For projects that are not yet completed, an inflation factor of 2.6% is applied for Years 0–3, 7.8% for Year 4, 12.1% for Year 5, and 3.8% for Years 6–10.

If a cost increase for an individual project is less than 10% of the amount identified in the project's cost-share agreement or the estimated cost or eligible amount of Trust Fund cost-share stated in the Save Our Indian River Lagoon Project Plan, as updated, then additional funding from the Reserve may be allocated to the project, as needed, in accordance with Brevard County approvals, policies, and administrative orders. For projects that are contracted with government entities and other partners that encounter cost overruns, the cost-share agreement may be increased up to 10% over the eligible cost-share amount stated in Attachment E of the respective cost-share agreement. Such an amendment will be executed by the authorized County representative and the appropriate representative or authorized agent of the government entity or partnering organization.

For project cost increases that are more than 10% above the amount identified in the project's cost-share agreement or the estimated cost or eligible amount of Trust Fund cost-share stated in the Save Our Indian River Lagoon Project Plan, as updated, County staff will evaluate the project circumstances and present findings to the Citizen Oversight Committee for review. The Committee will recommend rejection, modification, or approval of the funding request and provide such recommendation to the County representative authorized to sign the amendment. Staff will provide the Committee's recommendation to the County representative authorized to sign the request based on the authority granted by the County Commission.

The Reserve may also be used to increase funding for approved projects (whether during the term of the project or upon project completion) that provide greater nutrient reduction benefits than planned or anticipated if funding could be made available before the next Plan update. If a project can be or was expanded or altered to provide greater nutrient reduction benefits than planned, contingency funds can be allocated at the rate for that project type established in the most recently adopted Plan update in the table titled "Cost-share Offered for Project Requests Submitted for the 2023 Update" (**Table 4-43**). In no case shall the governmental entity or partnering organization request Reserve funds that result in the total cost-share award exceeding the actual project costs incurred by the recipient, minus other grants or donations for that project.

Amendments to the project cost-share agreements shall follow one of the two approval processes identified below:

1. If a cost increase for an individual project is less than 10% of the cost identified in the project's cost-share agreement, then the authorized County representative is eligible to review and, if acceptable, approve an amendment to the project cost-share agreement.
2. If a cost increase for an individual project is more than 10% of the cost identified in the project's cost-share agreement, then County staff will bring the item before the Citizen Oversight Committee for a recommendation to reject, modify, or approve the funding request. This recommendation will then be brought to the authorized County representative for review and, if acceptable, approval of an amendment to the project cost-share agreement.

5.1.2 Schedule Acceleration

If a project has already been approved by the County Commission and is: (1) ready to move forward earlier than scheduled in the Plan; (2) consistent with temporal sequencing goals in the Plan; and (3) recommended by the Citizen Oversight Committee, and if there are sufficient Trust Fund dollars available for the project, then the County Manager (for budget changes less than $100,000) or County Commission (in any circumstance) are authorized to adjust the project schedule to ensure that approved projects funded in the Plan move forward as soon as feasible. This authority allows projects to move forward as soon as they are ready and funding is available.

5.1.3 Scope Reduction

If a project is not able to be fully completed as initially approved in the Plan due to extenuating circumstances including, but not limited to, permitting restrictions, loss of additional funding, or other situations beyond the entity's control, then the project may be downsized, within the framework of the already-approved project, and upon recommendation by the Citizen Oversight Committee. This recommendation will then be brought to the authorized County representative for review and, if acceptable, approval of an amendment to the costs and scope of the project's cost-share agreement. The revised funding amount will be based on the pounds of nitrogen removal estimated for the reduced project multiplied by the eligible cost-share per pound of total nitrogen removed that is adopted for that project type in the most recent Save Our Indian River Lagoon Project Plan. If a project is downsized between Plan updates, the revised Plan costs and nutrient load reductions will be reflected in the next annual Plan update.

5.2. Revenue Projection Update

Brevard County calculated a new estimate for Save Our Indian River Lagoon Sales Tax revenues. This estimate is based on the actual revenues for 2017, 2018, 2019, 2020, 2021, and the first nine months of 2022. The October, November, and December 2021 revenues were used to estimate the revenue for the remaining four months of 2022 by using a rate of growth of 9%. The new estimate for the total tax revenue is $586,515,580, or an average of $58.6 million per year. This current estimate is $24.6 million per year more than the $34 million per year estimate in the original Save Our Indian River Lagoon Plan, which was based on 2016 dollars, and $4.4 million per year more than the projection in the 2022 Plan Update.

5.3. Project Funding Allocations

Figure 5-1 summarizes the funding allocated by category (Reduce, Remove, Restore, and Respond) in this 2023 Plan Update. **Figure 5-1** shows the funding allocations by project type from the original plan through the 2023 Plan Update.

Figure 5-1: Funding for Reduce, Remove, Restore, and Respond Projects

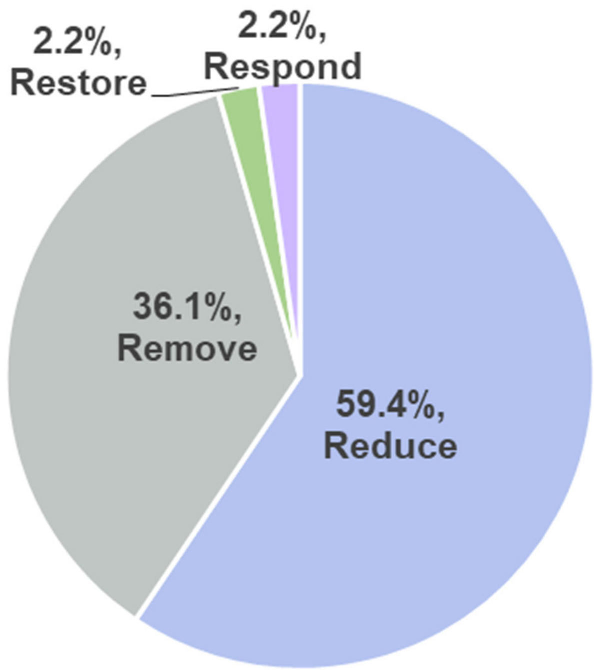


Figure 5-2: Evolution of Project Funding Allocations

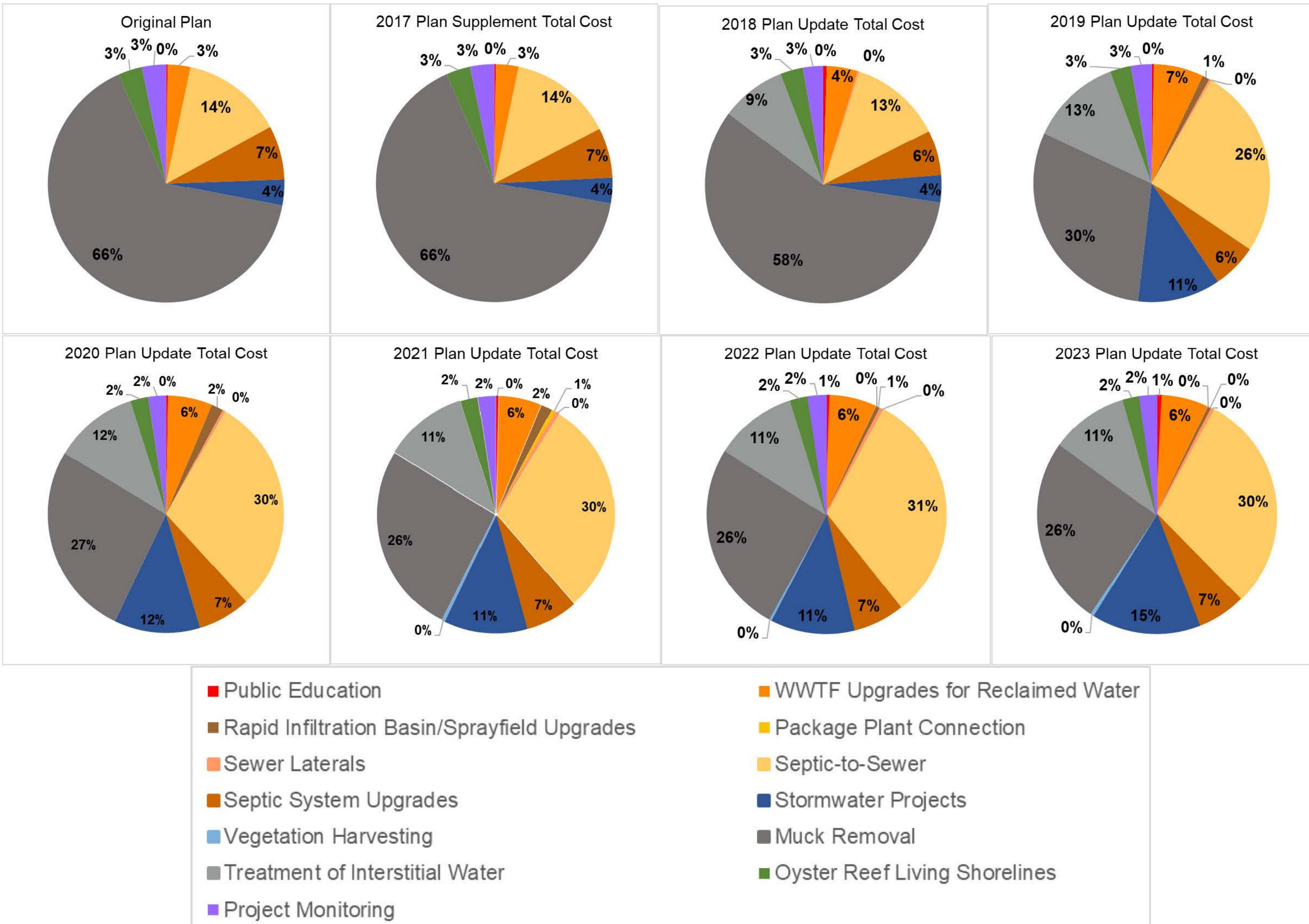


Figure 5-2 Long Description

Section 6. Summary of the Plan through the 2023 Update

6.1. Progress Toward the Local Targets for Maximum Total Loads

The County has been working with its municipalities, Florida Department of Transportation District 5, and Patrick Space Force Base to update total loading estimates to the lagoon and revise the total maximum daily loads for nitrogen and phosphorus using the best available data and more detailed modeling than previously available. Based on this process, five-month total maximum daily loads, which target the load reductions needed during the seagrass growing period (January – May), were proposed in addition to annual total maximum daily loads that protect water quality year-round. These load reductions specifically target water quality conditions needed for restoring lagoon seagrass beds to provide crucial habitat for fish and other marine life. Therefore, as this Save Our Indian River Lagoon Project Plan was developed, the total nitrogen (TN) and total phosphorus (TP) reductions from the project types that **Reduce** incoming load were compared to the proposed five-month total maximum daily loads for each sub-lagoon. After satisfying the five-month total maximum daily loads, annual load reductions for each project were compared to the 12-month total maximum daily loads. In all cases, the projects identified to meet the five-month total maximum daily loads were sufficient to meet the proposed 12-month total maximum daily loads. As projects are implemented, progress toward meeting the five-month and full-year total maximum daily loads is being tracked.

Only the projects that reduce external loading to the lagoon, not muck removal or living shorelines, were used to meet the total maximum daily loads. Even though decades of treatment projects to reduce nutrient loads have been completed to date, only the reductions associated with basin management action plan projects that were completed between January 1, 2010 (the last year of the Spatial Watershed Iterative Loading model period) and February 29, 2016 (the end of the last basin management action plan reporting period when the Save Our Indian River Lagoon Project Plan was developed) were included in the load reduction calculations as these projects also provide nutrient load reductions that have occurred after the period of record used to develop the proposed total maximum daily load updates. In Zone A of the Central Indian River Lagoon (IRL), the reductions from the St. Johns River Water Management District's C-1 re-diversion project, which was implemented with cost-share funding from the Florida Department of Environmental Protection and Brevard County, were also included as this project results in significant load reductions that were not included in the February 29, 2016, basin management action plan annual progress report. As shown in **Table 6-1**, **Table 6-3**, and **Table 6-5**, the projects proposed in this plan plus the recently completed basin management action plan projects and C-1 re-diversion project exceed the five-month reductions called for by the proposed total maximum daily load updates.

The total project reductions were also compared to the full year estimated loading to the lagoon from the Spatial Watershed Iterative Loading model. As shown in **Table 6-2**, **Table 6-4**, and **Table 6-6**, the proposed projects in this plan, as well as the recently completed basin management action plan projects and C-1 re-diversion project, achieve significant reductions of the overall loading to the lagoon and exceed the full year reductions called for by the proposed local total maximum daily loads.

Table 6-1: Banana River Lagoon Project Reductions to Meet Five-Month Total Maximum Daily Load

Project	Total Nitrogen Reductions (pounds per year)	Total Phosphorus Reductions (pounds per year)
Fertilizer Ordinance Implementation	2,945	603
Future Education	2,163	129
Wastewater Treatment Facility Upgrade for Reclaimed Water	1,050	285
Sewer Laterals	412	78
Septic-to-Sewer	13,171	0
Septic System Upgrade	806	0
Stormwater Projects	15,365	2,238
Vegetation Harvesting	2,455	78
Basin Management Action Plan Projects (2010-February 2016)	5,303	1,440
Total	***43,670***	***4,851***
Proposed Total Maximum Daily Load Reductions (five-month)	***30,337***	***2,737***
Percent of Proposed Total Maximum Daily Load Reductions Achieved	***143.9%***	***177.2%***

Table 6-2: Banana River Lagoon Project Reductions Compared to Full Year Loading

Project	Total Nitrogen Reductions (pounds per year)	Total Phosphorus Reductions (pounds per year)
Fertilizer Ordinance Implementation	7,068	1,446
Future Education	5,191	310
Wastewater Treatment Facility Upgrade for Reclaimed Water	2,520	685
Sewer Laterals	988	188
Septic-to-Sewer	31,611	0
Septic System Upgrade	1,934	0
Stormwater Projects	64,719	8,564
Vegetation Harvesting	5,891	187
Basin Management Action Plan Projects (2010-February 2016)	12,726	3,456
Total	***132,648***	***14,836***
Starting Load (full year)	***477,020***	***44,269***
Percent of Starting Load Reduced	***27.8%***	***33.5%***
Proposed Full-Year Total Maximum Daily Load Percent Reductions	***9.0%***	***9.6%***

Table 6-3: North IRL Project Reductions to Meet Five-Month Total Maximum Daily Load

Project	Total Nitrogen Reductions (pounds per year)	Total Phosphorus Reductions (pounds per year)
Fertilizer Ordinance Implementation	8,070	1,651
Future Education	59,273	354
Wastewater Treatment Facility Upgrade for Reclaimed Water	7,355	To be determined
Sewer Laterals	1,118	To be determined
Package Plant Connection	380	To be determined
Septic-to-Sewer	23,318	0
Septic System Upgrade	5,774	0
Stormwater Projects	40,916	6,525
Vegetation Harvesting	2,705	66
Basin Management Action Plan Projects (2010-February 2016)	16,983	3,180
Total	***165,892***	***11,776***
Proposed Total Maximum Daily Load Reductions (five-month)	***61,447***	***7,410***
Percent of Proposed Total Maximum Daily Load Reductions Achieved	***270.0%***	***158.9%***

Table 6-4: North IRL Project Reductions Compared to Full Year Loading

Project	Total Nitrogen Reductions (pounds per year)	Total Phosphorus Reductions (pounds per year)
Fertilizer Ordinance Implementation	19,368	3,962
Future Education	142,256	849
Wastewater Treatment Facility Upgrade for Reclaimed Water	17,651	To be determined
Sewer Laterals	2,682	To be determined
Package Plant Connection	911	To be determined
Septic-to-Sewer	55,963	0
Septic System Upgrade	13,857	0
Stormwater Projects	159,108	22,573
Vegetation Harvesting	6,493	159
Basin Management Action Plan Projects (2010-February 2016)	40,758	7,632
Total	***459,047***	***35,175***
Starting Load (full year)	***988,847***	***99,340***
Percent of Starting Load Reduced	***46.4%***	***35.4%***
Proposed Full-Year Total Maximum Daily Load Percent Reductions	***11.4%***	***11.4%***

Table 6-5: Central IRL Project Reductions to Meet Five-Month Total Maximum Daily Load

Project	Total Nitrogen Reductions (pounds per year)	Total Phosphorus Reductions (pounds per year)
Fertilizer Ordinance Implementation	8,108	1,659
Future Education	5,955	356
Wastewater Treatment Facility Upgrade for Reclaimed Water	22,487	5,808
Sewer Laterals	1,053	To be determined
Rapid Infiltration Basin/Sprayfield	132	To be determined
Package Plant Connection	221	To be determined
Septic-to-Sewer	12,496	0
Septic System Upgrade	9,246	0
Stormwater Projects	15,158	2,104
Vegetation Harvesting	6,932	693
C-1 Re-Diversion	53,892	6,295
Basin Management Action Plan Projects (2010-February 2016)	378	243
Total	***136,058***	***17,158***
Proposed Total Maximum Daily Load Reductions (five-month) *	***67,547***	***8,151***
Percent of Proposed Total Maximum Daily Load Reductions Achieved	***201.4%***	***210.5%***

* The total maximum daily load reductions are for Zone A only; however, some of the septic system projects are in Zone SEB. There are sufficient projects to achieve the Zone A reductions without the Zone SEB projects (refer to **Section 2.1**).

Table 6-6: Central IRL Project Reductions Compared to Full Year Loading

Project	Total Nitrogen Reductions (pounds per year)	Total Phosphorus Reductions (pounds per year)
Fertilizer Ordinance Implementation	19,460	3,981
Future Education	14,293	854
Wastewater Treatment Facility Upgrade for Reclaimed Water	53,968	13,938
Sewer Laterals	2,526	To be determined
Rapid Infiltration Basin/Sprayfield	317	To be determined
Package Plant Connection	531	To be determined
Septic-to-Sewer	29,991	0
Septic System Upgrade	22,190	0
Stormwater Projects	47,886	6,313
Vegetation Harvesting	16,636	1,664
C-1 Re-Diversion	129,341	15,108
Basin Management Action Plan Projects (2010-February 2016)	908	582
Total	***338,047***	***42,440***
Starting Load (full year) *	***698,937***	***95,051***
Percent of Starting Load Reduced	***48.4%***	***44.6%***
Proposed Full-Year Total Maximum Daily Load Percent Reductions	***17.8%***	***16.3%***

* The total maximum daily load reductions are for Zone A only; however, some of the septic system are in Zone SEB. There are sufficient projects to achieve the Zone A reductions without the Zone SEB projects (refer to **Section 2.1**).

In addition to the projects that address the external nutrient loading summarized above, the plan includes muck flux, interstitial water treatment, oyster bars, and planted shoreline projects that will significantly reduce internal nutrient loading within the lagoon itself. The annual reductions from these projects are summarized in **Table 6-7**, along with the percentage of nutrients from 2018 estimates of muck flux that would be reduced by these projects.

Table 6-7: Annual Muck Flux, Muck Interstitial Water, Oyster Bar, and Planted Shoreline Project Benefits Compared to Annual Nutrient Loadings from Muck Flux

Project Type	Banana River Lagoon Total Nitrogen (pounds per year)	Banana River Lagoon Total Phosphorus (pounds per year)	North IRL Total Nitrogen (pounds per year)	North IRL Total Phosphorus (pounds per year)	Central A Total Nitrogen (pounds per year)	Central A Total Phosphorus (pounds per year)
Muck Flux Reduction	156,794	13,463	51,678	4,190	14,758	557
Average Annual Removal of Nutrients from Interstitial Water	39,361	1,967	9,072	825	69	0
Oyster Bars	10,369	320	10,599	272	3,731	188
Clams	423	0	432	0	145	0
Planted Shorelines	91	31	236	81	217	74
Total Project Reductions	***207,038***	***15,781***	***72,017***	***5,368***	***18,920***	***819***
Estimated Muck Flux Loading	***418,690***	***43,216***	***251,029***	***17,583***	***81,874***	***2,277***
Percent of Muck Flux Reduced	***49.4%***	***36.5%***	***28.7%***	***30.5%***	***23.1%***	***36.0%***

6.2. Plan Summary

Table 6-8 summarizes all the project types, as well as their estimated costs, total nitrogen (TN) and total phosphorus (TP) reductions, and costs per pound of TN and TP removed. The information from this table on the project reductions and cost effectiveness was used to determine the schedule for implementing the projects (see **Table 6-9**). Projects that could achieve large reductions quickly, such as fertilizer reductions and wastewater treatment facility upgrades, as well as the most cost-effective septic-to-sewer, and stormwater projects were prioritized for earliest implementation. This prioritization allows for the reductions to occur as quickly as possible while best using available funding sources. Project scheduling also considered the timing of upstream reductions with downstream removals, where feasible.

The timeline in **Table 6-9** is shown in years after funding from the Save Our Indian River Lagoon sales tax became available. Each year corresponds to the County's fiscal year, which is October 1st through September 30th. Year 1 started on October 1, 2017, which was just before revenues would have begun to accrue if the funding source had been a property tax, as initially considered. When the referendum approved by the voters was a sales tax, collections began in January 2017 and the first revenue check was received by the County in March 2017. Therefore, a plan update was adopted in March 2017 to begin plan implementation in Year 0. **Table 6-9** includes the cost estimates developed as part of the original plan or provided in the year new or substitute projects were added to the plan.

As noted in **Section 4.4.1**, an adaptive management approach is being used in the implementation of this plan. As projects are completed and information on the actual construction costs, timeline, and reductions are obtained, the plan will continue to be adjusted, as needed, to ensure that the most cost-effective projects are being used to meet the Indian River Lagoon (IRL) restoration goals.

Table 6-8: Summary of Projects, Estimated TN and TP Reductions, and Costs

Project Number	Project	Save Our Lagoon Project Cost	Total Nitrogen Reductions (pounds per year)	Cost per Pound per Year of Total Nitrogen	Total Phosphorus Reductions (pounds per year)	Cost per Pound per Year of Total Phosphorus
-	**Public Education**	-	-	-	-	-
58a	Expanded Fertilizer Education	$881,000	6,613	$133	813	$1,084
58b	Grass Clippings Campaign	$306,000	17,800	$17	1,200	$255
58c	Septic System Maintenance Education	$431,000	4,466	$97	To be determined	To be determined
245	Irrigation Education Campaign	$306,000	1,530	$200	Not applicable	Not applicable
246	Stormwater Best Management Practice Maintenance Education	$306,000	3,300	$93	400	$765
193	Oyster Gardening Program	$300,000	Not applicable	Not applicable	Not applicable	Not applicable
227	Restore Our Shores: Community Collaborative	$1,000,000	Not applicable	Not applicable	Not applicable	Not applicable
-	**Wastewater Treatment Facility Upgrades for Reclaimed Water**	-	-	-	-	-
99	Cocoa Beach Water Reclamation Facility Upgrade	$945,000	2,520	$375	685	$1,380
2016-02a	City of Titusville Osprey Wastewater Treatment Facility	$8,800,000	8,660	$1,016	Not applicable	Not applicable
2016-17	City of Palm Bay Water Reclamation Facility	$3,634,900	20,240	$180	102	$35,636
59	City of Melbourne Grant Street Water Reclamation Facility	$6,769,500	18,052	$375	9,671	$700
2016-2b	City of Titusville Osprey Nutrient Removal Upgrade Phase 2	$300,000	3,626	$83	Not applicable	Not applicable
138	Ray Bullard Water Reclamation Facility Biological Nutrient Removal Upgrades	$4,260,000	11,360	$375	3,302	$1,290
216	City of Rockledge Flow Equalization Basin Project	$2,054,795	5,365	$383	Not applicable	Not applicable
234	South Brevard Water Reclamation Facility	$1,653,028	4,316	$383	863	$1,915
-	**Rapid Infiltration Basin/Sprayfield Upgrades**	-	-	-	-	-
6	Long Point Park Upgrade	$22,207	163	$136	To be determined	To be determined
196	Sterling House Condominium Sprayfield	$60,000	154	$390	To be determined	To be determined
-	**Package Plant Connection**	-	-	-	-	-
192	Oak Point Wastewater Treatment Facility Improvements	$279,000	186	$1,500	0	Not applicable
249	Indian River Shores Trailer Park Wastewater Treatment Facility	$528,627	450	$1,175	To be determined	To be determined
237	Willow Lakes Recreational Vehicle Park	$1,087,500	725	$1,500	To be determined	To be determined
239	The Cove at South Beaches Package Plant Connection	$121,500	81	$1,500	To be determined	To be determined
-	**Sewer Laterals**	-	-	-	-	-
63ab	Satellite Beach Lateral Smoke Testing and Countywide Repair/Replacement	$840,000	988	$850	188	$4,468
100	Osprey Basin Lateral Smoke Testing	$200,000	640	Not applicable	Not applicable	Not applicable
114	Barefoot Bay Lateral Smoke Testing	$83,564	864	Not applicable	Not applicable	Not applicable
115	South Beaches Lateral Smoke Testing	$84,304	1,662	Not applicable	Not applicable	Not applicable

Project Number	Project	Save Our Lagoon Project Cost	Total Nitrogen Reductions (pounds per year)	Cost per Pound per Year of Total Nitrogen	Total Phosphorus Reductions (pounds per year)	Cost per Pound per Year of Total Phosphorus
116	Merritt Island Lateral Smoke Testing	$246,630	2,042	Not applicable	Not applicable	Not applicable
-	**Septic-to-Sewer by Extension**	-	-	-	-	-
47	Sykes Creek - Zone N	$4,176,000	2,784	$1,500	To be determined	To be determined
48	Sykes Creek - Zone M	$2,697,000	1,798	$1,500	To be determined	To be determined
146	Merritt Island - Zone C	$1,580,000	1,419	$1,113	To be determined	To be determined
49	Sykes Creek - Zone T	$5,040,000	3,360	$1,500	To be determined	To be determined
2019-29	South Banana - Zone B	$1,372,500	915	$1,500	To be determined	To be determined
145	Merritt Island - Zone F	$1,100,000	1,292	$851	To be determined	To be determined
147	Sykes Creek - Zone R	$4,387,500	2,925	$1,500	To be determined	To be determined
148	North Merritt Island - Zone E	$3,811,500	2,541	$1,500	To be determined	To be determined
151	Merritt Island - Zone G	$16,617,000	11,078	$1,500	To be determined	To be determined
2016-30	City of Rockledge	$500,580	712	$703	To be determined	To be determined
2016-31/32	City of Cocoa - Zones J and K	$6,167,373	3,748	$1,646	To be determined	To be determined
109	City of Titusville - Zones A-G	$1,201,392	1,563	$769	To be determined	To be determined
150	South Central - Zone D (Brevard County)	$4,774,500	3,387	$1,410	To be determined	To be determined
2020-28	South Central - Zone D (Melbourne)	$265,500	177	$1,500	To be determined	To be determined
50b	South Central - Zone C	$6,600,000	5,146	$1,283	To be determined	To be determined
203	South Central - Zone A	$5,482,500	3,655	$1,500	To be determined	To be determined
2016-33	City of Melbourne	$867,672	878	$988	To be determined	To be determined
2020-34	South Central - Zone F	$1,701,972	1,688	$1,008	To be determined	To be determined
2019-27	Sharpes - Zone A	$7,872,000	5,248	$1,500	To be determined	To be determined
2016-35	South Beaches - Zone A	$1,959,000	1,306	$1,500	To be determined	To be determined
2019-36	South Beaches - Zone O	$133,488	136	$982	To be determined	To be determined
2019-37	South Beaches - Zone P	$300,348	242	$1,241	To be determined	To be determined
2019-38	City of Titusville - Zone H	$1,168,020	910	$1,284	To be determined	To be determined
2019-40	Rockledge - Zone B	$5,339,520	4,037	$1,323	To be determined	To be determined
1	Breeze Swept Septic-to-Sewer Connection	$880,530	2,002	$440	To be determined	To be determined
2	Merritt Island Septic Phase Out Project	$320,268	2,501	$128	To be determined	To be determined
61	Riverside Drive Septic-to-Sewer Conversion	$262,044	305	$859	To be determined	To be determined
62	Roxy Avenue Septic-to-Sewer Conversion	$88,944	102	$872	To be determined	To be determined
152	Sharpes - Zone B	$4,038,000	2,692	$1,500	To be determined	To be determined
153	Cocoa - Zone C	$800,000	3,499	$1,500	To be determined	To be determined

Project Number	Project	Save Our Lagoon Project Cost	Total Nitrogen Reductions (pounds per year)	Cost per Pound per Year of Total Nitrogen	Total Phosphorus Reductions (pounds per year)	Cost per Pound per Year of Total Phosphorus
190	Bowers Septic-to-Sewer	$147,000	120	$1,225	To be determined	To be determined
191	Kent and Villa Espana Septic-to-Sewer Conversion	$710,000	542	$1,310	To be determined	To be determined
2016-39	City of Palm Bay – Zone A	$2,569,644	2,136	$1,203	To be determined	To be determined
2016-46	City of Palm Bay – Zone B	$8,309,628	6,809	$1,220	To be determined	To be determined
4	Hoag Sewer Conversion	$86,031	101	$852	To be determined	To be determined
5	Pennwood Sewer Conversion	$81,000	103	$786	To be determined	To be determined
60	Sylvan Estates Septic-to-Sewer Conversion	$1,561,215	1,073	$1,455	To be determined	To be determined
136	Micco - Zone B	$9,000,000	8,687	$1,036	To be determined	To be determined
3	Micco Sewer Line Extension (Phase I and II)	$2,239,500	1,493	$1,500	To be determined	To be determined
189	Avendia del Rio Septic-to-Sewer	$70,000	71	$986	To be determined	To be determined
222	Hedgecock/Grabowsky and Desoto Fields	$121,500	81	$1,500	To be determined	To be determined
224	Lake Ashley Circle	$1,704,000	1,136	$1,500	To be determined	To be determined
225	Dundee Circle and Manor Place	$2,248,500	1,499	$1,500	To be determined	To be determined
238	Kelly Park	$135,000	90	$1,500	To be determined	To be determined
240	Rotary Park	$156,000	104	$1,500	To be determined	To be determined
241	Manatee Cove	$36,000	24	$1,500	To be determined	To be determined
242	Riverwalk	$6,000	4	$1,500	To be determined	To be determined
-	**Septic-to-Sewer by Connection**	-	-	-	-	-
2016-16	Banana Septic System 144 Quick Connections	$1,905,729	3,224	$591	To be determined	To be determined
2016-18	North IRL Septic System 463 Quick Connections	$5,940,650	11,339	$524	To be determined	To be determined
2016-19	Central IRL Septic System 269 Quick Connections	$3,354,000	6,883	$487	To be determined	To be determined
-	**Septic System Upgrades**	-	-	-	-	-
51	Banana River Lagoon 100 Septic System Upgrades	$1,799,200	1,934	$930	To be determined	To be determined
52	North IRL 586 Septic System Upgrades	$10,544,100	13,857	$761	To be determined	To be determined
53	Central IRL 939 Septic System Upgrades	$16,900,290	22,190	$762	To be determined	To be determined
-	**Stormwater Projects**	-	-	-	-	-
-	Banana River Lagoon 62 Basin Projects	$19,836,658	59,391	$334	7,742	$2,562
13	Central Boulevard Baffle Box	$34,700	481	$72	14	$2,479
16	Gleason Park Reuse	$4,224	48	$88	9	$469
64	Stormwater Low Impact Development Convair Cove 1 – Blakey Boulevard	$4,650	30	$155	3	$1,550
65	Stormwater Low Impact Development Convair Cove 2-Dempsey Drive	$4,495	29	$155	3	$1,498

Project Number	Project	Save Our Lagoon Project Cost	Total Nitrogen Reductions (pounds per year)	Cost per Pound per Year of Total Nitrogen	Total Phosphorus Reductions (pounds per year)	Cost per Pound per Year of Total Phosphorus
66	Big Muddy at Cynthia Baffle Box	$41,695	269	$155	48	$869
66b	Big Muddy at Cynthia Baffle Box Expansion	$17,936	167	$107	10	$1,794
85	Basin 1304 Bioreactor	$83,029	958	$87	127	$654
128	Jackson Court Stormwater Treatment Facility	$8,266	56	$148	8	$1,033
179	Lori Laine Basin Pipe Improvement Project	$17,525	117	$150	21	$835
215	Basin 960 Pioneer Road Denitrification	$38,850	105	$370	3	$12,950
219	McNabb Outfall Bioretention	$19,423	44	$441	7	$2,775
205	Basin 998 Hampton Homes	$63,618	312	$204	47	$1,354
206	Basin 1066 Angel Avenue	$232,200	1,150	$202	173	$1,342
207	Basin 1124 Elliot Drive	$148,100	533	$278	78	$1,899
235	Woodland Business Center Stormwater Retention	$4,906	11	$446	2	$2,453
247	Basin 998 Richland Avenue Canal	$130,782	641	$204	97	$1,348
250	Basin 1280B Flamingo Road	$71,645	161	$445	31	$2,311
251	Basin 1304 West Arlington Road	$96,425	216	$446	To be determined	To be determined
-	North IRL 93 Basin Projects	$32,079,207	110,134	$291	14,370	$2,232
14	Church Street Type II Baffle Box	$88,045	937	$94	135	$652
18	Denitrification Retrofit of Johns Road Pond	$105,512	1,199	$88	To be determined	To be determined
19	St. Teresa Basin Treatment	$272,800	3,100	$88	459	$594
20	South Street Basin Treatment	$86,856	987	$88	156	$557
21	La Paloma Basin Treatment	$208,296	2,367	$88	346	$602
22	Kingsmill-Aurora Phase Two	$367,488	4,176	$88	814	$451
23	Denitrification Retrofit of Huntington Pond	$104,720	1,190	$88	To be determined	To be determined
24	Denitrification Retrofit of Flounder Creek Pond	$75,328	856	$88	To be determined	To be determined
34	Cliff Creek Baffle Box	$347,781	3,952	$88	797	$436
35	Thrush Drive Baffle Box	$322,200	3,661	$88	773	$417
69	Apollo/GA Baffle Box	$297,522	3,381	$88	479	$621
89	Basin 1298 Bioreactor	$85,829	917	$94	116	$740
90	Johns Road Pond Biosorption Activated Media	$23,030	245	$94	37	$622
91	Burkholm Road Biosorption Activated Media	$64,390	685	$94	104	$619
92	Carter Road Biosorption Activated Media	$62,510	665	$94	101	$619
93	Wiley Avenue Biosorption Activated Media	$82,735	954	$87	144	$575
94	Broadway Pond Biosorption Activated Media	$42,864	456	$94	69	$621
95	Cherry Street Baffle Box	$306,740	980	$313	174	$1,763

Project Number	Project	Save Our Lagoon Project Cost	Total Nitrogen Reductions (pounds per year)	Cost per Pound per Year of Total Nitrogen	Total Phosphorus Reductions (pounds per year)	Cost per Pound per Year of Total Phosphorus
96	Spring Creek Baffle Box	$330,841	1,057	$313	232	$1,426
97	Titusville High School Baffle Box	$111,813	1,190	$94	166	$674
98	Coleman Pond Managed Aquatic Plant System	$11,438	1,240	$9	198	$58
110	Osprey Plant Pond Managed Aquatic Plant Systems	$37,500	606	$62	88	$426
117	Basin 10 County Line Road Woodchip Bioreactor	$72,773	597	$122	90	$809
118	Basin 26 Sunset Avenue Serenity Park Woodchip Bioreactor	$73,810	605	$122	92	$802
119	Basin 141 Irwin Avenue Woodchip Bioreactor	$69,174	567	$122	86	$804
120	Draa Field Pond Managed Aquatic Plant Systems	$31,281	256	$122	38	$823
122	Basin 22 Hunting Road Serenity Park Woodchip Bioreactor	$40,077	329	$122	50	$802
124	Floating Wetlands to Existing Stormwater Ponds	$1,497	12	$125	3	$499
125	Diamond Square Stormwater Pond	$10,383	85	$122	23	$451
127	Basin 5 Dry Retention	$16,680	113	$148	18	$927
129	Forrest Avenue 72-inch Outfall Baseflow Capture/Treatment	$13,956	94	$148	12	$1,163
169	Basin 1335 (Sherwood Park) Stormwater Quality Project	$392,108	3,214	$122	879	$446
174	St. Johns 2 Baffle Box	$243,070	1,992	$122	611	$398
175	High School Baffle Box	$144,326	1,183	$122	319	$452
176	Funeral Home Baffle Box	$58,682	481	$122	129	$455
177	North and South Lakemont Ponds Floating Wetlands	$13,054	107	$122	25	$522
178	Marina B Managed Aquatic Plant Systems	$6,670	55	$121	7	$953
231	North Fiske Stormwater Pond Floating Wetlands	$50,000	200	$250	32	$1,563
232	Riverfront Center Nutrient Removing Filtrations Boxes	$212,257	679	$313	160	$1,327
233	Commons and City Hall Tree Boxes	$25,040	80	$313	15	$1,669
248	Basin 116 Lionel Road	$185,700	936	$198	142	$1,308
252	Basin 89 Scottsmoor I Aurantia	$245,100	1,706	$144	292	$839
-	Central IRL 8 Basin Projects	$4,670,800	19,832	$236	2,617	$1,785
15	Bayfront Stormwater Project	$30,624	348	$88	83	$369
67	Grant Place Baffle Box	$82,481	937	$88	193	$427
68	Crane Creek/M-1 Canal Flow Restoration	$2,033,944	23,113	$88	2,719	$748
87	Fleming Grant Biosorption Activated Media	$56,588	602	$94	91	$622
88	Espanola Baffle Box	$105,186	1,119	$94	148	$711
121	Basin 2258 Babcock Road Woodchip Bioreactor	$50,203	412	$122	62	$810
123	Ray Bullard Water Reclamation Facility Stormwater Management Area	$111,847	1,317	$85	400	$280
213	Johnson Junior High Denitrification Media Chamber Modification	$64,478	206	$313	Not applicable	Not applicable

Project Number	Project	Save Our Lagoon Project Cost	Total Nitrogen Reductions (pounds per year)	Cost per Pound per Year of Total Nitrogen	Total Phosphorus Reductions (pounds per year)	Cost per Pound per Year of Total Phosphorus
214	Sand Point Park Baffle Box	$137,135	438	$313	71	$1,931
220	Basin 1398 Sand Dollar Canal Bioreactor	$198,024	444	$446	70	$2,829
-	**Vegetation Harvesting**	-	-	-	-	-
111	Draa Field Vegetation Harvesting	$86,413	786	$110	99	$873
112	County Wide Stormwater Pond Harvesting	$14,000	931	$15	327	$43
171	Mechanical Aquatic Vegetation Harvesting	$1,011,976	16,636	$61	1,664	$608
172	Horseshoe Pond Vegetative Harvesting	$8,140	4,536	$2	242	$34
173	North and South Lakemont Ponds Vegetation Harvesting	$1,980	18	$110	4	$495
208	Maritime Hammock Preserve Stormwater Pond Harvesting	$14,480	143	$101	5	$2,896
209	Basin 1398 Sand Dollar Canal Harvesting	$24,420	222	$110	21	$1,163
210	Basin 958 Pioneer Road Vegetation Harvesting	$39,930	363	$110	47	$850
211	Cocoa Beach Golf Course Stormwater Ponds Harvesting	$592,350	5,385	$110	542	$1,093
228	Unincorporated Countywide Vegetation Harvesting	$450,000	4,091	$110	993	$453
-	**Muck Removal**	-	-	-	-	-
2016-10a	Canaveral South	$14,700,000	35,305	$416	1,925	$7,636
2016-5a	Pineda Banana River Lagoon	$6,825,000	14,994	$455	686	$9,949
2016-11a	Patrick Space Force Base	$7,175,000	11,830	$607	382	$18,783
168a	Cocoa Beach Golf	$21,350,000	38,416	$556	2,058	$10,374
41a	Grand Canal Muck	$2,626,600	10,469	$251	1,396	$1,882
42a	Sykes Creek Muck	$4,705,428	19,635	$240	2,618	$1,797
70a	Cocoa Beach Muck Dredging – Phase III	$1,376,305	4,095	$336	780	$1,764
71	Merritt Island Muck Removal – Phase 1	$7,733,517	8,085	$957	1,540	$5,022
72a	Muck Removal of Indian Harbour Beach Canals	$3,631,815	3,780	$961	720	$5,044
101	Cocoa Beach Muck Dredging Phase II-B	$5,911,150	6,300	$938	840	$7,037
144	Satellite Beach Muck Dredging	$1,884,225	3,885	$485	518	$3,638
2016-06a	Titusville Railroad West	$3,150,000	13,965	$226	588	$5,357
2016-07a	National Aeronautics and Space Administration Causeway East	$9,975,000	21,825	$457	1,047	$9,527
2016-04a	Rockledge A	$4,375,000	3,777	$1,158	825	$5,303
2016-08a	Titusville Railroad East	$4,025,000	7,409	$543	227	$17,731
54a	Eau Gallie Northeast	$8,750,000	4,548	$1,924	1,482	$5,904
2016-3a	Muck Re-dredging in Turkey Creek	$137,329	4,728	$29	221	$621
223	Spring Creek Dredging	$80,080	154	$520	21	$3,813
236	Sunnyland Canals Muck Removal	$5,215,600	10,030	$520	336	$15,523
-	**Treatment of Interstitial Water**	-	-	-	-	-

Project Number	Project	Save Our Lagoon Project Cost	Total Nitrogen Reductions (pounds per year)	Cost per Pound per Year of Total Nitrogen	Total Phosphorus Reductions (pounds per year)	Cost per Pound per Year of Total Phosphorus
40	Mims Muck Removal: Outflow Water Nutrient Removal	$0	2,803	Not applicable	244	Not applicable
2016-10b	Canaveral South	$2,134,419	42,688	$50	3,887	$549
2016-5b	Pineda Banana River Lagoon	$990,980	19,820	$50	1,804	$549
2016-11b	Patrick Space Force Base	$1,041,800	20,836	$50	1,897	$549
168b	Cocoa Beach Golf	$3,013,100	99,098	$30	9,022	$334
41b	Grand Canal Interstitial	$15,610,821	89,495	$174	To be determined	To be determined
42b	Sykes Creek Interstitial	$11,248,704	64,278	$175	To be determined	To be determined
72b	Muck Interstitial Water Treatment for Indian Harbour Beach Canals	$5,483,600	27,418	$200	To be determined	To be determined
113	Satellite Beach Interstitial Water Treatment	$3,057,756	29,978	$102	3,059	$1,000
2016-06b	Titusville Railroad West	$457,375	9,148	$50	833	$549
2016-07c	National Aeronautics and Space Administration Causeway East	$1,448,355	28,967	$50	2,637	$549
2016-04b	Rockledge A	$635,244	12,705	$50	1,157	$549
2016-08b	Titusville Railroad East	$584,424	11,688	$50	1,064	$549
54b	Eau Gallie Northeast	$1,270,487	25,410	$50	2,313	$549
2016-3b	Muck Interstitial Water Treatment for Turkey Creek	Included in muck project	Not applicable	Not applicable	688	Not applicable
-	**Oyster Bars**	-	-	-	-	-
2016-55	Banana River Lagoon County Oyster Bars	$3,102,755	7,864	$395	197	$15,750
75	Marina Isles Oyster Bar	$26,700	60	$445	20	$1,335
76	Bettinger Oyster Bar	$10,680	24	$445	8	$1,335
78a	McNabb Park Oyster Bar	$34,056	72	$473	24	$1,419
79	Gitlin Oyster Bar	$16,020	36	$445	12	$1,335
104	Brevard Zoo Banana River Oyster Project	$583,020	1,476	$395	37	$15,757
141	Brevard Zoo Banana River Oyster Project 2	$264,800	662	$400	17	$15,576
143	Brevard Zoo Oyster Reef Adjustments Banana River	$12,800	32	$400	1	$12,800
188	Brevard Zoo Banana River Oyster Project 3	$56,771	143	$397	4	$14,193
2016-56	North IRL County Oyster Bars	$2,885,834	7,314	$395	183	$15,770
83	Bomalaski Oyster Bar	$8,900	20	$445	7	$1,271
106	Brevard Zoo North IRL Oyster Project	$341,280	864	$395	22	$15,513
139	Brevard Zoo North IRL Oyster Project 2	$336,400	841	$400	21	$16,019
142	Brevard Zoo Oyster Reef Adjustments North IRL	$27,200	68	$400	2	$13,600
184	Brevard Zoo North Indian River Lagoon Oyster Project 3	$419,232	1,056	$397	26	$16,124
186	Brevard Zoo North Indian River Lagoon Individual Oyster Project	$173,092	436	$397	11	$15,736

Project Number	Project	Save Our Lagoon Project Cost	Total Nitrogen Reductions (pounds per year)	Cost per Pound per Year of Total Nitrogen	Total Phosphorus Reductions (pounds per year)	Cost per Pound per Year of Total Phosphorus
80	Coconut Point/Environmentally Endangered Lands Oyster Bar	$45,120	96	$470	2	$22,560
81	Wexford Oyster Bar	$31,150	70	$445	24	$1,298
82a	Riverview Park Oyster Bar	$108,790	230	$473	78	$1,395
73	Riverview Senior Resort Oyster Bar	$30,304	77	$394	2	$15,152
105	Brevard Zoo Central IRL Oyster Project	$161,160	408	$395	10	$16,116
140	Brevard Zoo Central IRL Oyster Project 2	$270,800	677	$400	17	$15,929
185	Brevard Zoo Central Indian River Lagoon Tributary Pilot Oyster Project	$230,657	581	$397	15	$15,377
187	Brevard Zoo Central Indian River Lagoon Oyster Project 3	$86,546	218	$397	5	$17,309
217	Central IRL Oyster Project 4	$138,156	348	$397	9	$15,351
218	Central Oyster Project Offshore Reefs	$357,300	900	$397	23	$15,535
226	Hog Point Offshore Oyster Bar	$50,022	126	$397	3	$16,674
-	**Planted Shorelines**	-	-	-	-	-
77a	Cocoa Beach Country Club Planted Shoreline	$16,080	67	$240	23	$699
78b	McNabb Park Planted Shoreline	$5,760	24	$240	8	$720
103	Brevard Zoo North IRL Plant Project	$720	3	$240	1	$720
130	Brevard Zoo North IRL Plant Project 2	$9,840	41	$240	14	$703
180	Scottsmoor Impoundment	$10,560	44	$240	15	$704
181	Riveredge	$4,080	17	$240	6	$680
212	Titusville Causeway Multi-Trophic Restoration and Living Shoreline	$31,440	131	$240	45	$699
77b	Lagoon House Shoreline Restoration Planting	$24,000	100	$240	34	$706
82b	Riverview Park Planted Shoreline	$18,480	77	$240	26	$711
133	Fisherman's Landing	$4,800	20	$240	7	$686
135	Rotary Park	$4,800	20	$240	7	$686
-	**Clam Restoration**	-	-	-	-	-
194	Aquaculture Stimulus Program	$60,000	1,000	$60	To be determined	To be determined
-	**Projects Monitoring**	**$10,000,000**	-	-	-	-
-	**Contingency**	**$20,559,808**	-	-	-	-
-	**Inflation**	**$120,655,652**	-	-	-	-
-	***Total***	***$586,515,581***	***1,309,977***	***$448 (average)***	***106,607***	***$5,502 (average)***

Table 6-9: Timeline for Funding Needs (Table 46 in the Original Save Our Indian River Lagoon Project Plan)

Project Name/Total Project Cost	Year 0 (Fiscal Year 2016-2017)	Year 1 (Fiscal Year 2017-2018)	Year 2 (Fiscal Year 2018-2019)	Year 3 (Fiscal Year 2019-2020)	Year 4 (Fiscal Year 2020-2021)	Year 5 (Fiscal Year 2021-2022)	Year 6 (Fiscal Year 2022-2023)	Year 7 (Fiscal Year 2023-2024)	Year 8 (Fiscal Year 2024-2025)	Year 9 (Fiscal Year 2025-2026)	Year 10 (Fiscal Year 2026-2027)
Public Education	-	-	-	-	-	-	-	-	-	-	-
Fertilizer Management	-	Year 1 of Program*	Year 2 of Program*	Year 3 of Program*	Year 4 of Program*	Year 5 of Program*	Year 6 of Program	Year 7 of Program	Year 8 of Program	Year 9 of Program	Year 10 of Program
$881,000	-	$0	$120,951	$49,477	$46,571	$35,834	$156,354	$117,954	$117,953	$117,953	$117,953
Grass Clippings	-	Year 1 of Program*	Year 2 of Program*	Year 3 of Program*	Year 4 of Program*	Year 5 of Program*	Year 6 of Program	Year 7 of Program	Year 8 of Program	Year 9 of Program	Year 10 of Program
$306,000	-	$0	$20,000	$0	$6,638	$8,362	$57,401	$57,400	$57,400	$49,400	$49,399
Septic System Maintenance	-	Year 1 of Program*	Year 2 of Program*	Year 3 of Program*	Year 4 of Program*	Year 5 of Program*	Year 6 of Program	Year 7 of Program	Year 8 of Program	Year 9 of Program	Year 10 of Program
$431,000	-	$0	$48,380	$49,245	$22,709	$11,497	$59,835	$59,835	$59,835	$59,832	$59,832
Irrigation	-	-	-	-	-	-	Year 1 of Program	Year 2 of Program	Year 3 of Program	Year 4 of Program	Year 5 of Program
$306,000	-	-	-	-	-	-	$101,200	$51,200	$51,200	$51,200	$51,200
Stormwater Best Management Practice	-	-	-	-	-	-	Year 1 of Program	Year 2 of Program	Year 3 of Program	Year 4 of Program	Year 5 of Program
$306,000	-	-	-	-	-	-	$101,200	$51,200	$51,200	$51,200	$51,200
Oyster Gardening	-	-	-	Year 1 of Program*	Year 2 of Program*	-	-	-	-	-	-
$300,000	-	-	-	$150,000	$150,000	-	-	-	-	-	-
Restore Our Shores	-	-	-	-	-	Year 1 of Program*	Year 2 of Program	Year 3 of Program	Year 4 of Program	Year 5 of Program	Year 6 of Program
$1,000,000	-	-	-	-	-	$100,000	$200,000	$200,000	$200,000	$200,000	$100,000
Wastewater Treatment Facility Upgrades	-	-	-	-	-	-	-	-	-	-	-
Banana River Lagoon	-	-	Cocoa Beach*	-	-	-	-	-	-	-	-
$945,000	-	-	$945,000	-	-	-	-	-	-	-	-
North IRL	-	-	-	Titusville Osprey Design and Permitting	Titusville Osprey Design and Start Construction	Titusville Osprey Construction	-	-	-	-	-
$8,000,000	-	-	-	$1,000,000	$3,000,000	$4,000,000	-	-	-	-	-
North IRL	-	-	-	-	Osprey Nutrient Upgrade Phase 2	-	-	-	-	-	-
$300,000	-	-	-	-	$300,000	-	-	-	-	-	-
North IRL	-	-	-	-	-	Rockledge Flow Equalization Basin	-	-	-	-	-
$2,054,795	-	-	-	-	-	$2,054,795	-	-	-	-	-
Central IRL	-	Palm Bay Permit and Engineering*	Palm Bay Construction*	Palm Bay Construction*	-	-	-	-	-	-	-
$3,634,900	-	$200,000	$1,200,000	$2,234,900	-	-	-	-	-	-	-
Central IRL	-	-	-	Melbourne Grant Street	-	-	-	-	-	-	-
$6,769,500	-	-	-	$6,769,500	-	-	-	-	-	-	-
Central IRL	-	-	-	Ray Bullard Biological Nutrient Removal	-	-	-	-	-	-	-
$4,260,000	-	-	-	$4,260,000	-	-	-	-	-	-	-
Central IRL	-	-	-	-	-	-	South Brevard Water Reclamation Facility	-	-	-	-
$1,653,028	-	-	-	-	-	-	$1,653,028	-	-	-	-
Rapid Infiltration Basin/ Sprayfield Upgrades	-	-	-	-	-	-	-	-	-	-	-
North IRL	-	-	-	-	-	Sterling House Condominium	-	-	-	-	-
$60,000	-	-	-	-	-	$60,000	-	-	-	-	-
Central IRL	Long Point*	-	-	-	-	-	-	-	-	-	-
$22,207	$22,207	-	-	-	-	-	-	-	-	-	-
Package Plant Connections	-	-	-	-	-	-	-	-	-	-	-
North IRL	-	-	-	-	Oak Point	-	Willow Lakes Recreational Vehicle Park	-	-	-	-
$1,366,500	-	-	-	-	$279,000	-	$1,087,500	-	-	-	-
Central IRL	-	-	-	-	-	-	The Cove at South Beaches	-	-	-	-
$121,500	-	-	-	-	-	-	$121,500	-	-	-	-

Project Name/Total Project Cost	Year 0 (Fiscal Year 2016-2017)	Year 1 (Fiscal Year 2017-2018)	Year 2 (Fiscal Year 2018-2019)	Year 3 (Fiscal Year 2019-2020)	Year 4 (Fiscal Year 2020-2021)	Year 5 (Fiscal Year 2021-2022)	Year 6 (Fiscal Year 2022-2023)	Year 7 (Fiscal Year 2023-2024)	Year 8 (Fiscal Year 2024-2025)	Year 9 (Fiscal Year 2025-2026)	Year 10 (Fiscal Year 2026-2027)
Central IRL	-	-	-	-	-	Indian River Shores Trailer Park	-	-	-	-	-
$528,627	-	-	-	-	-	$528,627	-	-	-	-	-
Sewer Laterals	-	-	-	-	-	-	-	-	-	-	-
Banana River Lagoon	-	-	-	-	Satellite Beach Smoke Testing and Countywide Repairs	-	-	-	-	-	-
$840,000	-	-	-	-	$840,000	-	-	-	-	-	-
North IRL	-	-	Titusville Osprey Basin	-	-	-	-	-	-	-	-
$200,000	-	-	$200,000	-	-	-	-	-	-	-	-
North IRL	-	-	-	Merritt Island Lateral Smoke Testing*	-	-	-	-	-	-	-
$246,630	-	-	-	$246,630	-	-	-	-	-	-	-
Central IRL	-	-	-	Barefoot Bay Lateral Smoke Testing*	-	-	-	-	-	-	-
$83,564	-	-	-	$83,564	-	-	-	-	-	-	-
Central IRL	-	-	-	South Beaches Lateral Smoke Testing*	-	-	-	-	-	-	-
$84,304	-	-	-	$84,304	-	-	-	-	-	-	-
Septic Removal	-	-	-	-	-	-	-	-	-	-	-
Banana River Lagoon	Sykes M Engineering	-	Sykes Creek M	-	-	-	Kelly Park	-	-	-	-
$2,832,000	$250,000	-	$2,447,000	-	-	-	$135,000	-	-	-	-
Banana River Lagoon	-	Sykes Creek N	-	-	-	-	Rotary Park	-	-	-	-
$4,332,000	-	$4,176,000	-	-	-	-	$156,000	-	-	-	-
Banana River Lagoon	Sykes T Engineering	-	-	Sykes Creek T	-	-	-	-	-	-	-
$5,040,000	$250,000	-	-	$4,790,000	-	-	-	-	-	-	-
Banana River Lagoon	-	-	-	-	South Banana B Engineering	South Banana B	-	-	-	-	-
$1,372,500	-	-	-	-	$275,000	$1,097,500	-	-	-	-	-
Banana River Lagoon	-	-	-	-	Quick Connects*	Quick Connects*	Quick Connects	Quick Connects	Quick Connects	-	-
$1,905,729	-	-	-	-	$21,729	$7,960	$700,000	$694,311	$481,729	-	-
Banana River Lagoon	-	-	-	-	Merritt Island C Engineering	Merritt Island C	Merritt Island C	-	-	-	-
$1,580,000	-	-	-	-	$145,000	$717,500	$717,500	-	-	-	-
Banana River Lagoon	-	-	-	-	Merritt Island F Engineering	-	Merritt Island F	-	-	-	-
$1,100,000	-	-	-	-	$100,000	-	$1,000,000	-	-	-	-
Banana River Lagoon	-	-	-	-	Sykes Creek R Engineering	-	-	Sykes Creek R	Sykes Creek R	-	-
$4,387,500	-	-	-	-	$320,000	-	-	$376,247	$3,691,253	-	-
Banana River Lagoon	-	-	-	-	Merritt Island G Engineering	-	Merritt Island G	Merritt Island G	Merritt Island G	-	-
$16,617,000	-	-	-	-	$1,650,000	-	$2,646,636	$2,000,000	$10,320,364	-	-
Banana River Lagoon	-	-	-	-	North Merritt Island E Engineering	-	North Merritt Island E	-	-	-	-
$3,811,500	-	-	-	-	$727,000	-	$3,084,500	-	-	-	-
Banana - Satellite Beach	-	-	-	-	-	Hedgecock/Grabowsky and Desoto Fields	-	-	-	-	-
$121,500	-	-	-	-	-	$121,500	-	-	-	-	-
North IRL	South Central C Engineering	South Central C	-	-	South Central C	-	Manatee Cove	-	-	-	-
$6,636,000	$450,000	$4,222,080	-	-	$1,927,920	-	$36,000	-	-	-	-
North IRL	Breeze Swept*	-	-	-	-	-	Riverwalk	-	-	-	-
$886,530	$880,530	-	-	-	-	-	$6,000	-	-	-	-
North IRL	Merritt Island Redevelopment Agency*	-	-	-	-	-	-	-	-	-	-
$320,000	$320,000	-	-	-	-	-	-	-	-	-	-
North IRL	-	-	Riverside Drive	-	-	-	-	-	-	-	-
$262,044	-	-	$262,044	-	-	-	-	-	-	-	-

Project Name/Total Project Cost	Year 0 (Fiscal Year 2016-2017)	Year 1 (Fiscal Year 2017-2018)	Year 2 (Fiscal Year 2018-2019)	Year 3 (Fiscal Year 2019-2020)	Year 4 (Fiscal Year 2020-2021)	Year 5 (Fiscal Year 2021-2022)	Year 6 (Fiscal Year 2022-2023)	Year 7 (Fiscal Year 2023-2024)	Year 8 (Fiscal Year 2024-2025)	Year 9 (Fiscal Year 2025-2026)	Year 10 (Fiscal Year 2026-2027)
North IRL	-	-	Roxy Avenue	-	-	-	-	-	-	-	-
$88,944	-	-	$88,944	-	-	-	-	-	-	-	-
North IRL	-	-	-	Cocoa J and K	-	-	-	-	-	-	-
$5,622,000	-	-	-	$5,622,000	-	-	-	-	-	-	-
North IRL	-	-	-	-	-	-	-	-	Rockledge	-	-
$500,580	-	-	-	-	-	-	-	-	$500,580	-	-
North IRL	-	-	-	Titusville A-G	-	-	-	-	-	-	-
$1,201,392	-	-	-	$1,201,392	-	-	-	-	-	-	-
North IRL	-	-	-	-	-	-	-	Titusville H	-	-	-
$1,168,020	-	-	-	-	-	-	-	$1,168,020	-	-	-
North IRL	-	-	-	-	Quick Connects*	Quick Connects*	Quick Connects	Quick Connects	Quick Connects	Quick Connects	-
$5,940,650	-	-	-	-	$570,000	$60,950	$1,465,425	$1,465,425	$1,465,425	$913,425	-
North IRL	-	-	-	-	South Central D (Brevard) Engineering	South Central D (Brevard)	-	-	-	-	-
$4,774,500	-	-	-	-	$955,000	$3,819,500	-	-	-	-	-
North IRL	-	-	-	-	-	-	South Central D (Melbourne)	-	-	-	-
$265,500	-	-	-	-	-	-	$265,500	-	-	-	-
North IRL	-	-	-	-	South Central A Engineering	South Central A	-	-	-	-	-
$5,482,500	-	-	-	-	$675,000	$4,807,500	-	-	-	-	-
North IRL	-	-	-	-	-	South Beaches A	South Beaches A	-	-	-	-
$1,959,000	-	-	-	-	-	$400,000	$1,559,000	-	-	-	-
North IRL	-	-	-	-	-	-	South Central F	-	-	-	-
$1,701,972	-	-	-	-	-	-	$1,701,972	-	-	-	-
North IRL	-	-	-	South Beaches O	-	-	-	-	-	-	-
$133,488	-	-	-	$133,488	-	-	-	-	-	-	-
North IRL	-	-	-	South Beaches P	-	-	-	-	-	-	-
$300,348	-	-	-	$300,348	-	-	-	-	-	-	-
North IRL	-	-	-	-	-	-	-	Melbourne	-	-	-
$867,672	-	-	-	-	-	-	-	$867,672	-	-	-
North IRL	-	-	-	-	Sharpes A Engineering	-	-	-	Sharpes A	-	-
$7,872,000	-	-	-	-	$1,245,000	-	-	-	$6,627,000	-	-
North IRL	-	-	-	-	-	-	-	-	-	Rockledge Zone B	-
$5,339,520	-	-	-	-	-	-	-	-	-	$5,339,520	-
North IRL	-	-	-	-	Sharpes B Engineering	-	-	-	Sharpes B	-	-
$4,038,000	-	-	-	-	$810,000	-	-	-	$3,228,000	-	-
North IRL	-	-	-	-	Cocoa C Engineering	-	-	-	-	-	-
$800,000	-	-	-	-	$800,000	-	-	-	-	-	-
North IRL	-	-	-	-	Bowers	-	-	-	-	-	-
$147,000	-	-	-	-	$147,000	-	-	-	-	-	-
North IRL	-	-	-	-	Kent and Villa Espana	-	-	-	-	-	-
$710,000	-	-	-	-	$710,000	-	-	-	-	-	-
Central IRL	-	-	-	-	Micco Phases I & II	-	-	-	-	-	-
$2,239,500	-	-	-	-	$2,239,500	-	-	-	-	-	-
Central IRL	Hoag	-	-	-	-	-	-	-	-	-	-
$86,031	$86,031	-	-	-	-	-	-	-	-	-	-
Central IRL	Pennwood	-	-	-	-	-	-	-	-	-	-
$40,632	$40,632	-	-	-	-	-	-	-	-	-	-
Central IRL	-	-	-	-	Palm Bay B	-	-	-	-	-	-
$8,309,628	-	-	-	-	$8,309,628	-	-	-	-	-	-
Central IRL	-	-	-	-	-	Quick Connects*	Quick Connects	Quick Connects	Quick Connects	Quick Connects	Quick Connects
$3,354,000	-	-	-	-	-	$30,000	$697,500	$697,500	$697,500	$667,500	$564,000
Central IRL	-	Sylvan Estates*	-	-	-	-	-	-	-	-	-
$1,561,215	-	$1,561,215	-	-	-	-	-	-	-	-	-
Central IRL	-	-	-	-	Palm Bay A	-	-	-	-	-	-
$2,569,644	-	-	-	-	$2,569,644	-	-	-	-	-	-
Central IRL	-	-	-	-	Micco B Engineering	-	Micco B	Micco B	-	-	-
$9,000,000	-	-	-	-	$2,248,125	-	$5,000,000	$1,751,875	-	-	-

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Central IRL	-	-	-	-	Avendia del Rio	-	-	-	-	-	-
$70,000	-	-	-	-	$70,000	-	-	-	-	-	-
Central - West Melbourne	-	-	-	-	-	Lake Ashley Circle	-	-	-	-	-
$1,704,000	-	-	-	-	-	$1,704,000	-	-	-	-	-
Central - West Melbourne	-	-	-	-	-	Dundee Circle and Manor Place	-	-	-	-	-
$2,248,500	-	-	-	-	-	$2,248,500	-	-	-	-	-
Septic Upgrades	-	-	-	-	-	-	-	-	-	-	-
Banana River Lagoon	-	-	-	-	-	9 Upgrades*	23 Upgrades	23 Upgrades	23 Upgrades	22 Upgrades	-
$1,799,200	-	-	-	-	-	$125,968	$423,609	$423,609	$423,609	$402,405	-
North IRL	-	-	-	-	15 Upgrades*	20 Upgrades*	116 Upgrades	116 Upgrades	116 Upgrades	102 Upgrades	101 Upgrades
$10,544,100	-	-	-	-	$270,000	$335,999	$2,092,020	$2,092,020	$2,092,020	$1,840,020	$1,822,021
Central IRL	-	-	-	2 Upgrades*	26 Upgrades*	27 Upgrades*	180 Upgrades	180 Upgrades	180 Upgrades	180 Upgrades	164 Upgrades
$16,900,290	-	-	-	$34,485	$452,621	$459,544	$3,248,133	$3,248,133	$3,248,133	$3,248,133	$2,961,108
Banana - Cape Canaveral	Central Boulevard Baffle Box*	-	-	-	-	-	-	-	-	-	-
$34,700	$34,700	-	-	-	-	-	-	-	-	-	-
Banana - Indian Harbour Beach	Gleason Park Reuse*	Big Muddy at Cynthia Baffle Box*	Big Muddy Expansion*	-	-	-	-	-	-	-	-
$63,855	$4,224	$41,695	$17,936	-	-	-	-	-	-	-	-
Banana - Cocoa Beach	-	-	-	-	Convair Cove 1 – Blakey Blvd*	McNabb Outfall Bioretention	-	-	-	-	-
$24,073	-	-	-	-	$4,650	$19,423	-	-	-	-	-
Banana - Cocoa Beach	-	-	-	-	Convair Cove 2- Dempsey Drive *	-	-	-	-	-	-
$4,495	-	-	-	-	$4,495	-	-	-	-	-	-
Banana - Satellite Beach	-	-	-	Jackson Court*	Lori Laine	-	-	-	-	-	-
$25,791	-	-	-	$8,266	$17,525	-	-	-	-	-	-
Banana - Woodland	-	-	-	-	-	-	Woodland Business Center	-	-	-	-
$4,906	-	-	-	-	-	-	$4,906	-	-	-	-
Banana - Brevard	-	-	Basin 1304 Bioreactor*	-	-	Basin 960 Pioneer Road	Basin 998 Hampton Homes	-	-	-	-
$185,497	-	-	$83,029	-	-	$38,850	$63,618	-	-	-	-
Banana - Brevard	-	-	-	-	-	-	Basin 1066 Angel Avenue	-	-	-	-
$232,200	-	-	-	-	-	-	$232,200	-	-	-	-
Banana - Brevard	-	-	-	-	-	-	Basin 1124 Elliot Drive	-	-	-	-
$148,100	-	-	-	-	-	-	$148,100	-	-	-	-
Banana - Brevard	-	-	-	-	-	-	Basin 998 Richland Avenue Canal	-	-	-	-
$130,782	-	-	-	-	-	-	$130,782	-	-	-	-
Banana - Brevard	-	-	-	-	-	-	Basin 1280B Flamingo Road	-	-	-	-
$71,645	-	-	-	-	-	-	$71,645	-	-	-	-
Banana - Brevard	-	-	-	-	-	-	Basin 1304 West Arlington Road	-	-	-	-
$96,425	-	-	-	-	-	-	$96,425	-	-	-	-
Banana - Brevard	-	-	-	-	-	-	13 Projects	13 Projects	12 Projects	12 Projects	12 Projects
$19,836,658	-	-	-	-	-	-	$3,953,625	$6,555,197	$3,544,711	$2,948,431	$2,834,694
North IRL - Cocoa	Church Street Type II Baffle Box*	-	-	Floating Wetlands*	North and South Lakemont*	-	North Fiske Floating Wetlands	-	-	-	-
$152,596	$88,045	-	-	$1,497	$13,054	-	$50,000	-	-	-	-
North IRL - Cocoa	-	-	-	Diamond Square Pond	-	-	-	-	-	-	-
$10,383	-	-	-	$10,383	-	-	-	-	-	-	-
North IRL - Cocoa	-	-	-	Forrest Avenue Outfall	-	-	-	-	-	-	-
$13,956	-	-	-	$13,956	-	-	-	-	-	-	-
North IRL - Titusville	-	St. Teresa Basin Treatment*	Titusville High School Baffle Box*	-	St. Johns 2 Baffle Box	Sand Point Park Baffle Box	Riverfront Center Nutrient Removing Boxes	-	-	-	-
$977,075	-	$272,800	$111,813	-	$243,070	$137,135	$212,257	-	-	-	-

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North IRL - Titusville	-	South Street Basin Treatment*	Coleman Pond Managed Aquatic Plant System*	Osprey Plant Managed Aquatic Plant Systems*	Marina B Managed Aquatic Plants*	-	Commons and City Hall Tree Boxes	-	-	-	-
$167,504	-	$86,856	$11,438	$37,500	$6,670	-	$25,040	-	-	-	-
North IRL - Titusville	-	La Paloma Basin Treatment*	-	Draa Pond Managed Aquatic Plant Systems*	-	-	-	-	-	-	-
$239,577	-	$208,296	-	$31,281	-	-	-	-	-	-	-
North IRL - Melbourne	-	Cliff Creek Baffle Box*	Apollo/GA Baffle Box	-	High School Baffle Box	-	-	-	-	-	-
$789,629	-	$347,781	$297,522	-	$144,326	-	-	-	-	-	-
North IRL - Melbourne	-	Thrush Drive Baffle Box*	Cherry Street Baffle Box	-	Funeral Home Baffle Box	-	-	-	-	-	-
$687,622	-	$322,200	$306,740	-	$58,682	-	-	-	-	-	-
North IRL - Melbourne	-	-	Spring Creek Baffle Box	-	-	-	-	-	-	-	-
$330,841	-	-	$330,841	-	-	-	-	-	-	-	-
North IRL - Indialantic	-	-	-	Basin 5 Dry Retention*	-	-	-	-	-	-	-
$16,680	-	-	-	$16,680	-	-	-	-	-	-	-
North IRL - Brevard	-	Kingsmill-Aurora Phase Two	Basin 1298 Bioreactor*	-	-	Basin 1398 Sand Dollar Canal Bioreactor	-	-	-	-	-
$651,341	-	$367,488	$85,829	-	-	$198,024	-	-	-	-	-
North IRL - Brevard	-	Denitrification Retrofit of Huntington Pond	Johns Road Pond*	Basin 10 County Line Road Bioreactor*	-	Basin 116 Lionel Road	-	-	-	-	-
$386,223	-	$104,720	$23,030	$72,773	-	$185,700	-	-	-	-	-
North IRL - Brevard	-	Denitrification Retrofit of Flounder Creek Pond	Burkholm Road*	Basin 26 Sunset Avenue Serenity Park Bioreactor*	-	Basin 89 Scottsmoor I Aurantia	-	-	-	-	-
$458,628	-	$75,328	$64,390	$73,810	-	$245,100	-	-	-	-	-
North IRL - Brevard	-	Denitrification Retrofit of Johns Road Pond*	Carter Road*	Basin 141 Irwin Avenue Woodchip Bioreactor*	-	-	-	-	-	-	-
$237,196	-	$105,512	$62,510	$69,174	-	-	-	-	-	-	-
North IRL - Brevard	-	-	Wiley Avenue*	Basin 22 Hunting Road Serenity Park Bioreactor*	-	-	-	-	-	-	-
$122,812	-	-	$82,735	$40,077	-	-	-	-	-	-	-
North IRL - Brevard	-	-	Broadway Pond*	-	-	-	-	-	-	-	-
$42,864	-	-	$42,864	-	-	-	-	-	-	-	-
North IRL - Brevard	-	-	-	-	Basin 1335 (Sherwood Park)*	-	-	-	-	-	-
$292,400	-	-	-	-	$292,400	-	-	-	-	-	-
North IRL - Brevard	-	-	-	-	-	-	19 Projects	19 Projects	19 Projects	18 Projects	18 Projects
$32,079,207	-	-	-	-	-	-	$8,604,350	$6,617,009	$6,531,029	$5,331,295	$4,995,524
Central IRL - Palm Bay	Bayfront Stormwater Project*	-	-	-	-	-	-	-	-	-	-
$30,624	$30,624	-	-	-	-	-	-	-	-	-	-
Central IRL - Melbourne	-	-	Grant Place Baffle Box*	-	Ray Bullard Stormwater Management Area*	-	-	-	-	-	-
$194,328	-	-	$82,481	-	$111,847	-	-	-	-	-	-
Central IRL - Melbourne	-	-	Espanola Baffle Box	-	-	-	-	-	-	-	-
$105,186	-	-	$105,186	-	-	-	-	-	-	-	-
Central - St. Johns River Water Management District	-	-	Crane Creek/M-1 Canal Flow Restoration	-	-	-	-	-	-	-	-
$2,033,944	-	-	$2,033,944	-	-	-	-	-	-	-	-
Central IRL - Brevard		-	Fleming Grant*	Basin 2258 Babcock Road Bioreactor	-	Johnson Junior High Denitrification	-	-	-	-	-
$171,269		-	$56,588	$50,203	-	$64,478	-	-	-	-	-
Central IRL - Brevard	-	-	-	-	-	-	3 Projects	3 Projects	2 Projects	-	-
$4,670,800	-	-	-	-	-	-	$1,176,174	$2,103,835	$1,390,791	-	-

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Vegetation Harvesting	-	-	-	-	-	-	-	-	-	-	-
Banana - Brevard	-	-	-	-	-	Basin 958 Pioneer Road	-	-	-	-	-
$39,930	-	-	-	-	-	$39,930	-	-	-	-	-
Banana - Cocoa Beach	-	-	-	-	-	Maritime Hammock*	-	-	-	-	-
$7,700	-	-	-	-	-	$7,700	-	-	-	-	-
Banana - Cocoa Beach	-	-	-	-	-	Cocoa Beach Golf Course	Cocoa Beach Golf Course	-	-	-	-
$592,350	-	-	-	-	-	$216,150	$376,200	-	-	-	-
North IRL - Brevard	-	-	-	County Wide Pond Harvesting*	Horseshoe Pond*	Basin 1398 Sand Dollar	-	-	-	-	-
$46,560	-	-	-	$14,000	$8,140	$24,420	-	-	-	-	-
North IRL - Titusville	-	-	-	Draa Field Vegetation Harvesting*	-	-	-	-	-	-	-
$57,360	-	-	-	$57,360	-	-	-	-	-	-	-
North IRL - Cocoa	-	-	-	-	North and South Lakemont Harvesting	-	-	-	-	-	-
$1,980	-	-	-	-	$1,980	-	-	-	-	-	-
Central IRL - Melbourne-Tillman	-	-	-	-	Mechanical Harvesting	-	-	-	-	-	-
$1,011,976	-	-	-	-	$1,011,976	-	-	-	-	-	-
Countywide	-	-	-	-	-	-	Unincorporated Countywide				
$450,000	-	-	-	-	-	-	$450,000				
Muck Removal & Interstitial Treatment	-	-	-	-	-	-	-	-	-	-	-
Banana River Lagoon	-	-	Cocoa Beach Phase III*	Cocoa Beach Ph II-B*	-	-	-	-	-	-	-
$7,287,455	-	-	$1,376,305	$5,911,150	-	-	-	-	-	-	-
Banana River Lagoon	-	-	Merritt Island	-	-	-	-	-	-	-	-
$7,733,517	-	-	$7,733,517	-	-	-	-	-	-	-	-
Banana River Lagoon	-	-	-	Indian Harbour Beach	Indian Harbour Beach	-	-	-	-	-	-
$9,115,415	-	-	-	$500,000	$8,615,415	-	-	-	-	-	-
Banana River Lagoon	-	-	29% Sykes Creek	-	71% Sykes Creek	-	-	-	-	-	-
$15,954,132	-	-	$5,954,132	-	$10,000,000	-	-	-	-	-	-
Banana River Lagoon	-	-	20% Grand Canal	25% Grand Canal	55% Grand Canal	-	-	-	-	-	-
$18,020,368	-	-	$3,020,368	$5,000,000	$10,000,000	-	-	-	-	-	-
Banana River Lagoon	-	-	-	2% Cocoa Beach Golf	2% Cocoa Beach Golf	8% Cocoa Beach Golf	8% Cocoa Beach Golf	20% Cocoa Beach Golf	20% Cocoa Beach Golf	20% Cocoa Beach Golf	20% Cocoa Beach Golf
$24,363,100	-	-	-	$500,000	$500,000	$1,750,000	$1,750,000	$4,965,775	$4,965,775	$4,965,775	$4,965,775
Banana River Lagoon	-	-	-	-	-	2% Canaveral South	25% Canaveral South	30% Canaveral South	35% Canaveral South	8% Canaveral South	-
$16,834,419	-	-	-	-	-	$400,000	$4,208,605	$5,050,326	$5,892,047	$1,283,441	-
Banana River Lagoon	-	-	-	-	-	3% Pineda	47% Pineda	50% Pineda	-	-	-
$7,815,980	-	-	-	-	-	$200,000	$3,707,990	$3,907,990	-	-	-
Banana River Lagoon	-	-	-	-	-	Patrick Space Force Base	-	-	-	-	-
$8,216,800	-	-	-	-	-	$8,216,800	-	-	-	-	-
Banana River Lagoon	-	-	-	Satellite Beach	Satellite Beach	-	-	-	-	-	-
$4,941,981	-	-	-	$500,000	$4,441,981	-	-	-	-	-	-
North IRL	-	-	2% Eau Gallie Northeast	49% Eau Gallie Northeast	49% Eau Gallie Northeast	-	-	-	-	-	-
$10,020,487	-	-	$200,409	$4,910,039	$4,910,039	-	-	-	-	-	-
North IRL	-	1% Titusville East	4% Titusville East	4% Titusville East	11% Titusville East	20% Titusville East	20% Titusville East	20% Titusville East	20% Titusville East	-	-
$4,609,424	-	$46,094	$184,377	$184,377	$507,037	$921,885	$921,885	$921,885	$921,884	-	-
North IRL	-	1% Titusville West	4% Titusville West	4% Titusville West	21% Titusville West	30% Titusville West	40% Titusville West	-	-	-	-
$3,607,375	-	$36,074	$144,295	$144,295	$757,549	$1,082,212	$1,442,950	-	-	-	-
North IRL	-	1% National Aeronautics and Space Administration East	4% National Aeronautics and Space Administration East	-	10% National Aeronautics and Space Administration East	10% National Aeronautics and Space Administration East	15% National Aeronautics and Space Administration East	18% National Aeronautics and Space Administration East	22% National Aeronautics and Space Administration East	20% National Aeronautics and Space Administration East	-
$11,423,355	-	$114,234	$456,934	-	$1,142,336	$1,142,336	$1,713,503	$2,089,217	$2,480,125	$2,284,670	

Project Name/Total Project Cost	Year 0 (Fiscal Year 2016-2017)	Year 1 (Fiscal Year 2017-2018)	Year 2 (Fiscal Year 2018-2019)	Year 3 (Fiscal Year 2019-2020)	Year 4 (Fiscal Year 2020-2021)	Year 5 (Fiscal Year 2021-2022)	Year 6 (Fiscal Year 2022-2023)	Year 7 (Fiscal Year 2023-2024)	Year 8 (Fiscal Year 2024-2025)	Year 9 (Fiscal Year 2025-2026)	Year 10 (Fiscal Year 2026-2027)
North IRL	-	-	-	4% Rockledge A	48% Rockledge A	48% Rockledge A	-	-	-	-	-
$5,010,244	-	-	-	$200,000	$2,405,122	$2,405,122	-	-	-	-	-
North IRL - Melbourne	-	-	-	-	-	Spring Creek	-	-	-	-	-
$80,080	-	-	-	-	-	$80,080	-	-	-	-	-
Central IRL	-	Turkey Creek*	-	-	-	-	-	-	-	-	-
$137,329	-	$137,329	-	-	-	-	-	-	-	-	-
Central IRL	-	-	-	-	-	-	Sunnyland Canals	-	-	-	-
$5,215,600	-	-	-	-	-	-	$5,215,600	-	-	-	-
Oyster Bars	-	-	-	-	-	-	-	-	-	-	-
Banana - Brevard Zoo	-	Marina Isles*	Brevard Zoo Banana River	Brevard Zoo Banana River Oyster Project 2	Brevard Zoo Banana River Oyster Project 3	-	-	-	-	-	-
$931,291	-	$26,700	$583,020	$264,800	$56,771	-	-	-	-	-	-
Banana - Brevard Zoo	-	Bettinger*	-	Brevard Zoo Oyster Reef Adjustments	-	-	-	-	-	-	-
$23,480	-	$10,680	-	$12,800	-	-	-	-	-	-	-
Banana - Cocoa Beach	-	-	-	-	McNabb	-	-	-	-	-	-
$34,056	-	-	-	-	$34,056	-	-	-	-	-	-
Banana - Brevard Zoo	-	Gitlin*	-	-	-	-	-	-	-	-	-
$16,020	-	$16,020	-	-	-	-	-	-	-	-	-
Banana - Brevard	-	-	-	-	-	-	39,318.1 square feet Oysters	39,318.1 square feet Oysters	39,318.1 square feet Oysters	39,318.1 square feet Oysters	39,318.1 square feet Oysters
$3,102,755	-	-	-	-	-	-	$620,551	$620,551	$620,551	$620,551	$620,551
North IRL - Brevard Zoo	-	Bomalaski*	Brevard Zoo North IRL	Brevard Zoo North IRL Oyster Project 2	Brevard Zoo North Indian River Lagoon Oyster Project 3	-	-	-	-	-	-
$1,105,812	-	$8,900	$341,280	$336,400	$419,232	-	-	-	-	-	-
North IRL - Brevard	-	-	-	-	-	-	36,569.3 square feet Oysters	36,569.3 square feet Oysters	36,569.3 square feet Oysters	36,569.3 square feet Oysters	36,569.3 square feet Oysters
$2,885,834	-	-	-	-	-	-	$577,167	$577,167	$577,167	$577,167	$577,166
North IRL - Brevard Zoo	-	-	-	Brevard Zoo Oyster Reef Adjustments	Brevard Zoo North Indian River Lagoon Individual Oyster Project	-	-	-	-	-	-
$200,292	-	-	-	$27,200	$173,092	-	-	-	-	-	-
Central IRL - Brevard Zoo	-	Coconut Point*	Brevard Zoo Central IRL*	Brevard Zoo Central IRL Oyster Project 2	Brevard Zoo Central Indian River Lagoon Oyster Project 3	-	-	-	-	-	-
$563,626	-	$45,120	$161,160	$270,800	$86,546	-	-	-	-	-	-
Central IRL - Melbourne	-	Riverview Park	-	-	-	-	-	-	-	-	-
$108,790	-	$108,790	-	-	-	-	-	-	-	-	-
Central IRL - Brevard Zoo	-	Wexford*	-	-	Brevard Zoo Central Indian River Lagoon Tributary Pilot Oyster Project	Central IRL Oyster Project 4	-	-	-	-	-
$399,963	-	$31,150	-	-	$230,657	$138,156	-	-	-	-	-
Central IRL - Brevard Zoo	-	-	-	-	-	Central Oyster Project Offshore Reefs	-	-	-	-	-
$357,300	-	-	-	-	-	$357,300	-	-	-	-	-
Central IRL - Brevard	-	-	-	-	-	Hog Point	-	-	-	-	-
$50,022	-	-	-	-	-	$50,022	-	-	-	-	-
Central IRL - Brevard	-	Riverview Senior Resort*	-	-	-	-	-	-	-	-	-
$30,304	-	$30,304	-	-	-	-	-	-	-	-	-
Planted Shorelines	-	-	-	-	-	-	-	-	-	-	-
Banana - Marine Resources Council	-	Cocoa Beach*	-	-	-	-	-	-	-	-	-
$16,014	-	$16,014	-	-	-	-	-	-	-	-	-
Banana - Cocoa Beach	-	-	-	-	McNabb	-	-	-	-	-	-
$5,760	-	-	-	-	$5,760	-	-	-	-	-	-
North IRL - Brevard Zoo	-	-	Brevard Zoo North IRL*	Brevard Zoo North IRL Plant Project 2*	-	-	-	-	-	-	-

Project Name/Total Project Cost	Year 0 (Fiscal Year 2016-2017)	Year 1 (Fiscal Year 2017-2018)	Year 2 (Fiscal Year 2018-2019)	Year 3 (Fiscal Year 2019-2020)	Year 4 (Fiscal Year 2020-2021)	Year 5 (Fiscal Year 2021-2022)	Year 6 (Fiscal Year 2022-2023)	Year 7 (Fiscal Year 2023-2024)	Year 8 (Fiscal Year 2024-2025)	Year 9 (Fiscal Year 2025-2026)	Year 10 (Fiscal Year 2026-2027)
$10,560	-	-	$720	$9,840	-	-	-	-	-	-	-
North IRL - Marine Resources Council	-	-	-	-	Scottsmoor	-	-	-	-	-	-
$10,560	-	-	-	-	$10,560	-	-	-	-	-	-
North IRL - Marine Resources Council	-	-	-	-	Riveredge*	-	-	-	-	-	-
$4,080	-	-	-	-	$4,080	-	-	-	-	-	-
North IRL - Brevard	-	-	-	-	-	Titusville Causeway	-	-	-	-	-
$31,440	-	-	-	-	-	$31,440	-	-	-	-	-
Central IRL - Marine Resources Council	-	Lagoon House*	-	Fisherman's Landing*	-	-	-	-	-	-	-
$28,761	-	$23,961	-	$4,800	-	-	-	-	-	-	-
Central IRL - Melbourne	-	Riverview Park	-	-	-	-	-	-	-	-	-
$18,480	-	$18,480	-	-	-	-	-	-	-	-	-
Central IRL - Marine Resources Council	-	-	-	Rotary Park*	-	-	-	-	-	-	-
$4,800	-	-	-	$4,800	-	-	-	-	-	-	-
Clam Restoration	-	-	-	-	-	-	-	-	-	-	-
All	-	-	-	-	Aquaculture Stimulus	-	-	-	-	-	-
$60,000	-	-	-	-	$60,000	-	-	-	-	-	-
Project Monitoring	Year 0 Monitoring*	Year 1 Monitoring*	Year 2 Monitoring*	Year 3 Monitoring*	Year 4 Monitoring*	Year 5 Monitoring*	Year 6 Monitoring	Year 7 Monitoring	Year 8 Monitoring	Year 9 Monitoring	Year 10 Monitoring
$10,000,000	$17,105	$165,036	$363,802	$734,338	$617,033	$887,374	$1,443,063	$1,443,063	$1,443,062	$1,443,062	$1,443,062
Contingency	-	-	-	-	-	-	-	-	-	-	-
Banana - Brevard	-	-	-	-	Grand Canal (Berkeley)	-	-	-	-	-	-
$217,053	-	-	-	-	$217,053	-	-	-	-	-	-
Banana - Cocoa Beach	-	Cocoa Beach Planted*	-	-	-	-	Maritime Hammock*	-	-	-	-
$6,846	-	$66	-	-	-	-	$6,780	-	-	-	-
Central IRL	-	Lagoon House Planted*	-	-	-	-	-	-	-	-	-
$39	-	$39	-	-	-	-	-	-	-	-	-
North IRL	Merritt Island Redevelopment Agency*	-	-	-	-	-	-	-	-	-	-
$268	$268	-	-	-	-	-	-	-	-	-	-
North IRL - Cocoa	-	-	-	-	-	-	Cocoa J and K	-	-	-	-
$545,373	-	-	-	-	-	-	$545,373	-	-	-	-
North IRL - Titusville	-	-	-	Titusville Osprey WWTF	Draa Field Vegetation Harvesting*	-	-	-	-	-	-
$829,053	-	-	-	$800,000	$29,053	-	-	-	-	-	-
North IRL - Melbourne	-	-	-	-	Basin 1335 (Sherwood Park)*	-	-	-	-	-	-
$99,708	-	-	-	-	$99,708	-	-	-	-	-	-
Central IRL - Melbourne	-	-	-	-	Pennwood	-	-	-	-	-	-
$40,368	-	-	-	-	$40,368	-	-	-	-	-	-
All	Year 0 Contingency	Year 1 Contingency	Year 2 Contingency	Year 3 Contingency	Year 4 Contingency	Year 5 Contingency	Year 6 Contingency	Year 7 Contingency	Year 8 Contingency	Year 9 Contingency	Year 10 Contingency
$20,559,808	$53,833	$463,464	$1,234,528	$1,850,099	$3,808,357	$1,953,659	$3,211,319	$2,436,568	$3,011,864	$1,547,596	$988,521
Inflation	Year 0 Inflation	Year 1 Inflation	Year 2 Inflation	Year 3 Inflation	Year 4 Inflation	Year 5 Inflation	Year 6 Inflation	Year 7 Inflation	Year 8 Inflation	Year 9 Inflation	Year 10 Inflation
$120,655,652	$300,558	$2,550,673	$7,161,561	$11,074,400	$21,077,522	$9,700,395	$12,368,903	$14,417,710	$20,491,294	$12,591,056	$8,921,580
$586,515,581	***$2,828,75***	***$15,941,099***	***$38,047,603***	***$60,746,431***	***$104,051,227***	***$53,229,227***	***$81,801,824***	***$67,028,694***	***$85,183,501***	***$46,533,632***	***$31,123,586***

* Completed project with actual Save Our Indian River Lagoon Tax Fund cost.

Appendix A: Funding Needs and Leveraging Opportunities

Brevard County explored a variety of possible mechanisms to fund the Indian River Lagoon (IRL) projects in this plan, including:

- Special Taxing District approved by referendum to allow an ad valorem tax levy and bonds
- Special Act by the legislature allowing ad valorem tax levy by referendum to issue bonds
- Local government surtax (0.5 cent sales tax)
- Altering legislation to allow for Tourist Development Council funding to be used for lagoon restoration
- Municipal Service Taxing Unit/Special District
- Increased stormwater utility assessment

The County placed a referendum on the November 8, 2016, ballot for the 0.5 cent sales tax, and this referendum passed by more than 60% of the vote. The Save Our Indian River Lagoon 0.5 cent sales tax will generate approximately $58.6 million per year. The proposed 1 mill increase would have generated approximately $32 million per year, whereas the proposed increase of 0.5 mill would have only generated $16 million per year. To implement the projects in a timely manner according to the schedule in **Table 6-9**, and to accelerate the projects where possible, the County will seek to use funds generated from the sales tax to leverage matching funding from grants and appropriations and/or pay debt service on bonds. If additional funding is provided through matching funds from other sources, additional projects may be implemented, which would increase the overall plan cost, and/or project timelines may be moved up to allow the benefits of those projects to occur earlier than planned.

Examples of other funding programs (many from Florida Department of Environmental Protection, 2019) are:

- Section 319 grant program – The Florida Department of Environmental Protection administers funds received from United States Environmental Protection Agency to implement projects or programs that reduce nonpoint sources of pollution. Projects or programs must benefit Florida's impaired waters, and local sponsors must provide at least a 40% match or in-kind contribution. Eligible activities include demonstration and evaluation of urban and agricultural stormwater best management practices, stormwater retrofits, and public education.
- State water quality assistance grants – Funding may be available through periodic legislative appropriations to the Florida Department of Environmental Protection. When funds are available, the program prioritizes stormwater construction projects to benefit impaired waters, similar to the Section 319 grant program.
- Water management district funding – Florida's five regional water management districts offer financial assistance for a variety of water-related projects, for water supply development, water resource development, and surface water restoration. Assistance may be provided from ad valorem tax revenues or from periodic legislative appropriations for alternative water supply development, springs restoration, and Surface Water Improvement and Management projects. The amount of funding available, matching requirements, and types of assistance may vary from year to year.
- Budget Appropriation – The Florida Legislature may solicit applications directly for projects, including water projects, in anticipation of upcoming legislative sessions. This

process is an opportunity to secure legislative sponsorship of project funding through the state budget.

- IRL National Estuary Program – The IRL Council funds projects each year through their work plan process.
- Tourism + Lagoon Grant Program – The Brevard County Tourism Development Council has approved funding for the development of projects that demonstrate a benefit to the health of the IRL and a positive impact to Brevard County for litter control along shorelines and causeways/entryways, restoration and protection of living shorelines, habitat restoration to support fish and wildlife viewing, and waterway destinations and access for improved and sustainable recreational waterway access. Due to revenue shortfalls in 2020, this program has been placed on an indefinite hold.
- Clean Water State Revolving Fund loan program – This program provides low-interest loans to local governments to plan, design, and build or upgrade wastewater, stormwater, and nonpoint source pollution prevention projects. Discounted assistance for small communities is available. Interest rates on loans are below market rates and vary based on the economic wherewithal of the community. The Clean Water State Revolving Fund is Florida's largest financial assistance program for water infrastructure.
- Florida Resilient Coastlines Program – The Florida Department of Environmental Protection offers technical assistance and funding to coastal communities dealing with increasingly complex flooding, erosion, and habitat shifts.
- Resilient Florida Grants – The Resilient Florida Program was created in 2021 and is made up of several components including grants that are available to counties, municipalities, water management districts, flood control districts and regional resilience entities. The purpose of these grants is to help address the impacts of flooding and sea level rise by providing funding assistance to analyze and plan for vulnerabilities and implement projects for adaptation and mitigation.
- Florida Rural Water Association Loan Program – This program provides low-interest bond or bank financing for community utility projects in coordination with the Florida Department of Environmental Protection's State Revolving Fund program. Other financial assistance may also be available.
- Rural Development Rural Utilities Service Guaranteed and Direct Loans and Grants – The United States Department of Agriculture's program provides a combination of loans and grants for water, wastewater, and solid waste projects to rural communities and small incorporated municipalities.
- Small Cities Community Development Block Grant Program – The Florida Department of Economic Opportunity makes funds available annually for water and sewer projects that benefit low- and moderate-income persons.
- State Housing Initiatives Partnership Program – Florida Housing administers the program, which provides funds to local governments as an incentive to create partnerships that produce and preserve affordable homeownership and multifamily housing. The program is designed to provide very low, low, and moderate income families with assistance. Funding may be used for emergency repairs, new construction, rehabilitation, down payment and closing cost assistance, impact fees, construction and gap financing, mortgage buy-downs, acquisition of property for affordable housing, matching dollars for federal housing grants and programs, and homeownership counseling.
- Rural Development Funding – The United States Department of Agriculture provides funds that will cover the repair and maintenance of private septic systems. The amount of funds available, as well as the specific purposes for which grants are intended, changes from year to year.

- American Rescue Plan Act – The American Rescue Plan Act went into place in 2021 to help address the economic impacts from COVID-19. Funding from this act can be used by the state and local governments for a variety of projects including improvements to wastewater and stormwater infrastructure.

Appendix B: References

Alachua County. 2012. Keeping Grass off the Streets Campaign Social Marketing Public Outreach Campaign Final Report. Alachua County Environmental Protection Department.

Anderson, D. L. 2006. A Review of Nitrogen Loading and Treatment Performance Recommendation for Onsite Wastewater Treatment Systems in the Wekiva Study Area. Hazen and Sawyer, P.C.

Anderson, D. L. 2016. A Review of Nitrogen Loading and Treatment Performance Recommendations for Onsite Wastewater Treatment Systems (OWTS) in the Wekiva Study Area. Wekiva Issue Paper R:\40391-001.

Aoki, L.R., McGlathery, K.J., and Oreska, M.P.J. 2019. Seagrass restoration reestablishes the coastal nitrogen filter through enhanced burial. Limnology and Oceanography 65(1): 1-12.

Applied Ecology. 2018. Parcel-, Modified Focus Area, and Community-Based OSTDS Prioritization Analysis in Support of an Updated SOIRL Septic System Conversion and/or Replacement Projects. Prepared for Brevard County Natural Resources Management Department.

Applied Ecology. 2019. Save Our Indian River Lagoon Groundwater Monitoring of Sewer Lateral Retrofit Projects: Reporting Period May through August 2019. Prepared for Brevard County Natural Resources Management Department.

Applied Ecology and Marine Resources Council. 2022. Brevard County Groundwater Monitoring Report: Annual Report for the Save Our Indian River Lagoon Project Plan Groundwater Quality Monitoring. Prepared for Brevard County Natural Resources Management Department.

Arnade, L. J. 1999. Seasonal correlation of well contamination and septic tank distance. Ground Water 37: 920-923.

Ayres Associates. 1993. An Investigation of the Surface Water Contamination Potential From On-Site Sewage Disposal Systems (OSDS) in the Turkey Creek Sub-Basin of the Indian River Lagoon Basin. St. Johns River Water Management District SWIM Project IR-1-110.1-D. Report to the Florida Department of Health and Rehabilitative Services under Contract No. LP114 and LP596.

Banta, G. T., Pedersen, M. F., and Nielsen, S. L. 2004. Decomposition of marine primary producers: Consequences for nutrient recycling and retention in coastal ecosystems, p. 187–216. In Estuarine nutrient cycling: the influence of primary producers. Kluwer Academic Publishers.

Barile, P. 2018. Widespread sewage pollution of the Indian River Lagoon system, Florida (USA) resolved by spatial analyses of macroalgal biogeochemistry. Marine Pollution Bulletin 128:557–574.

Bilskie, M. V., Bacopoulos, P., and Hagen, S. C. 1990. Astronomic tides and nonlinear tidal dispersion for a tropical coastal estuary with engineered features (causeways): Indian River Lagoon system. Estuarine, Coastal and Shelf Science 216:54-70.

Blue Life Program. Website.

Bostater, C. and Rotkiske, T. 2016. Movement Measurements of Muck and Fluidized Mud at Dredge Sites. Impacts of Environmental Muck Dredging at Florida Institute of Technology Annual Report.

Bostater, C. and Rotkiske, T. 2018. Moving Muck & Fluidized Mud & Tributary Bedload Measurements at Dredge Sites. Impacts of Environmental Muck Dredging at Florida Institute of Technology Annual Report.

Boyd, C. 1969. The nutritive value of three species of water weeds. Economic Botany 23(2): 123-127.

Brehm, J. M., Pasko, D. K., and Eisenhauer, B.W. 2013. Identifying key factors in homeowner's adoption of water quality best management practices. Environmental Management. 52, 113–122.

Brevard County Natural Resources Management Department. 2017. Today's Leaves and Grass Clippings, Tomorrow's Indian River Lagoon Muck.

Brevard County Natural Resources Management Department. 2021. Oyster Habitat Suitability and Rehabilitation Success Plan.

Brevard County Natural Resources Management Department. 2022. Indian River Lagoon National Estuary Program: Testing Steel Gabions and Concrete Core Modules for Use in Oyster Bars in the I.R.L. Final Report: 5/31/2022.

Brevard County Utility Services. 2013. Infrastructure Asset Evaluation.

Carsey, T. P., Ferry, R., Goodwin, K. D., Ortner, P. B., Proni, J., Swart, P. K., and Zhang, J. Z. 2005. Brevard County Near Shore Ocean Nutrification Analysis. National Oceanic and Atmospheric Administration/Brevard County Near Shore Nutrification Analysis Project Final Report.

Caschetto, M., Robertson, W., Petitta, M., and Aravena, R. 2018. Partial nitrification enhances natural attenuation of nitrogen in a septic system plume. Science of the Total Environment 625: 801–808.

CDM Smith and Taylor Engineering. 2014. Preliminary Concept Design for Artificial Flushing Projects in the Indian River Lagoon. Phase I – Literature Review/Preliminary Site Selection. Prepared for the St. Johns River Water Management District.

CDM Smith and Taylor Engineering. 2015. Preliminary Concept Design for Artificial Flushing Projects in the Indian River Lagoon. Phase II – Conceptual Design/Project Refinement. Prepared for the St. Johns River Water Management District.

Chang, N., Wanielista, M., Daranpob, A., Xuan, Z., and Hossain, F. 2010. New Performance-Based Passive Septic Tank Underground Drainfield for Nutrient and Pathogen Removal Using Sorption Media. Environmental Engineering Science, Volume: 27 Issue: 6, p. 469-482. doi: 10.1089/ees.2009.0387.

City of DeLand and University of Central Florida. 2018. Final Report Bio-sorption Activated Media for Nitrogen Removal in a Rapid Infiltration Basin – Monitoring Project. Prepared for Florida Department of Environmental Protection: Project Agreement No. NS 003.

Clark, L. B., Gobler, C. J., and Sañudo-Wilhelm, S. A. 2006. Spatial and Temporal Dynamics of Dissolved Trace Metals, Organic Carbon, Mineral Nutrients, and Phytoplankton in a Coastal Lagoon: Great South Bay, New York. Estuaries and Coasts 29:841–854.

Clements, J. C. and Comeau, L. A. 2019. Nitrogen removal potential of shellfish aquaculture harvests in eastern Canada: A comparison of culture methods. Aquaculture Reports. Volume 13, March 2019, 100183.

CloseWaters LLC. 2016. Expected Monetary Value Evaluation for the Save Our Indian River Lagoon Project Plan.

Cogger, C. G., Hajjar, L. M., Moe, C. L., and Sobsey, M. D. 1988. Septic System Performance on a Coastal Barrier Island. Journal of Environmental Quality 17:401-408.

Cowan, J. L. and Boynton, W. R. 1996. Sediment-water oxygen and nutrient exchanges along the longitudinal axis of Chesapeake Bay: Seasonal Patterns, controlling factors and ecological significance. Estuaries 19:562-580.

Currin, C. A., Chappell, W. S., and Deaton, A. 2010. Developing alternative shoreline armoring strategies: The living shoreline approach in North Carolina, in Shipman, H., Dethier, M.N., Gelfenbaum, G., Fresh, K.L., and Dinicola, R.S., eds., 2010, Puget Sound Shorelines and the Impacts of Armoring—Proceedings of a State of the Science Workshop, May 2009: United States Geological Survey Scientific Investigations Report 2010-5254, p. 91-102.

Dawes, C. J., Hanisak, D., and Kenworthy, J. W. 1995. Seagrass biodiversity in the Indian River Lagoon. Bulletin of Marine Science 57: 59–66.

De, M. and Toor, G. S. 2017. Nitrogen transformations in the mounded drainfields of drip dispersal and gravel trench septic systems. Ecological Engineering. 102. 352-360.

Dewsbury, B. M., Bhat, M. and Fourqurean, J. W. 2016. A review of seagrass economic valuations: gaps and progress in valuation approaches. Ecosystem Services 18: 68–77.

Dietz, M. E., Clausen, J. C., and Filchak, K. K. 2004. Education and changes in residential nonpoint source pollution. Environmental Management 34(5), 684–690.

Donnelly, M., Shaffer, M., Connor, S., and Walters, L. 2018. Shoreline Characterization in the northern Indian River Lagoon. Coastal and Estuarine Ecology Lab Research Data 2.

Fillya, R. 2021. Strategies for successful mangrove living shoreline stabilizations in shallow water subtropical estuaries. Electronic Theses and Dissertations, 2020-.501.

Fisher, T. R., Carlson, P. R., and Barber, R. T. 1982. Sediment nutrient regeneration in three North Carolina estuaries. Estuarine, Coastal and Shelf Science 14:101-116.

Fisher, T. R., Gilbert, P. M., Hagy, J.D., Harding, L. W., Houde, E. D., Kimmel, D. G., Miller, W. D., Newell, R. I. E., Roman M. R., Smith, E. M., and Stevenson, J. C. 2005. Eutrophication of Chesapeake Bay: historical trends and ecological interactions. Marine Ecology Progress Series 303:1-29.

Florida Department of Agriculture and Consumer Services. Detail Fertilizer Summary by County. From July 2011 to June 2012.

Florida Department of Agriculture and Consumer Services. Total Fertilizer and Nutrients by County. From July 2011 to June 2012.

Florida Department of Agriculture and Consumer Services. Total Fertilizer and Nutrients for Brevard County for Fiscal Year 2012-2013, Fiscal Year 2013-2014, Fiscal Year 2014-2015, and Fiscal Year 2015-2016. Personal communication on May 17, 2016.

Florida Department of Environmental Protection. 2010. Florida Friendly Best Management Practices for Protection of Water Resources by the Green Industries.

Florida Department of Environmental Protection. 2012. Removal of Aquatic Vegetation for Nutrient Credits in the Indian River Lagoon (IRL) Basin.

Florida Department of Environmental Protection. 2013a. Basin Management Action Plan for the Implementation of Total Maximum Daily Loads for Nutrients Adopted by the Florida Department of Environmental Protection in the Indian River Lagoon Basin, Central Indian River Lagoon.

Florida Department of Environmental Protection. 2013b. Basin Management Action Plan for the Implementation of Total Maximum Daily Loads for Nutrients Adopted by the Florida Department of Environmental Protection in the Indian River Lagoon Basin, Banana River Lagoon.

Florida Department of Environmental Protection. 2013c. Basin Management Action Plan for the Implementation of Total Maximum Daily Loads for Nutrients Adopted by the Florida Department of Environmental Protection in the Indian River Lagoon Basin, North Indian River Lagoon.

Florida Department of Environmental Protection. 2021a. Indian River Lagoon Basin, Banana River Lagoon Basin Management Action Plan. Division of Environmental Assessment and Restoration, Water Quality Restoration Program.

Florida Department of Environmental Protection. 2021b. Indian River Lagoon Basin, Central Indian River Lagoon Basin Management Action Plan. Division of Environmental Assessment and Restoration, Water Quality Restoration Program.

Florida Department of Environmental Protection. 2021c. Indian River Lagoon Basin, North Indian River Lagoon Basin Management Action Plan. Division of Environmental Assessment and Restoration, Water Quality Restoration Program.

Florida Department of Environmental Protection. 2014. Presentation: Indian River Lagoon Basin Management Action Plan New Project Idea Feedback.

Florida Department of Environmental Protection. 2016. Reuse Statutory Authority.

Florida Department of Environmental Protection. 2017. Nitrogen Source Inventory and Loading Estimates for the Contributing Areas of Homosassa Springs Group and Chassahowitzka Springs Group. Division of Environmental Assessment and Restoration, Water Quality Evaluation and Total Maximum Daily Loads Program, Ground Water Management Section.

Florida Department of Environmental Protection. 2018. Statewide Best Management Practice (BMP) Efficiencies for Nonpoint Source Management of Surface Waters. Draft – January 2018.

Florida Department of Environmental Protection. 2019. Water Resources Funding in Florida. Prepared by the Division of Water Restoration Assistance.

Florida Department of Environmental Protection and Water Management Districts. 2010. Draft Environmental Resource Permit Stormwater Quality Applicant's Handbook: Design Requirements for Stormwater Treatment Systems in Florida.

Florida Department of Health. 2015. Florida Onsite Sewage Nitrogen Reduction Strategies Study, Final Report.

Florida Institute of Technology. 2020. Restore Lagoon Inflow Research (Phase 1) Project Summary. Prepared for the Florida Department of Education.

Florida Institute of Technology. 2021. Restore Lagoon Inflow Research (Phase 2) Project Summary. Prepared for the Florida Department of Education.

Forand, N., DuBois, K., Halka, J., Hardaway, S., Janek, G., Karrh, L., Koch, E., Linker, L., Mason, P., Morgereth, E., Proctor, D., Smith, K., Stack, B., Stewart, S., and Wolinski, B. 2014. Recommendations of the Expert Panel to Define Removal Rates for Shoreline Management Projects. Submitted to: Urban Stormwater Work Group Chesapeake Bay Partnership.

Fox, A. 2022. Temporal & Spatial Trends for Benthic Fluxes of Nitrogen & Phosphorus within the IRL System, February 2022.

Fox, A. L. and Trefry, J. H. 2018. Environmental Dredging to Remove Fine-Grained, Organic-Rich Sediments and Reduce Inputs of Nitrogen and Phosphorus to a Subtropical Estuary. Marine Technology Society Journal 52:42-57.

Fox, A. L. and Trefry J. H. 2019. Lagoon-Wide Application of the Quick-Flux Technique to Determine Sediment Nitrogen and Phosphorus Fluxes (Subtask 4). Impacts of Environmental Muck Dredging 2017-2018. Florida Institute of Technology.

Freitas, J., Julian, J., Kmitta, J., Prickett C., and Rogerson, M. 2022. Department of Naval Architecture and Ocean Engineering: Ocean Engineering Capstone Design – Living

Shoreline in Brevard County, FL. Report Submitted to A. Metzger, T. Johnson, and P. Magoulick (Project Advisors) 5/4/2022.

Futch, C. R. 1967. A Survey of the Oyster Resources of Brevard County, Florida. Florida Board of Conservation, Marine Laboratory.

Gao, Y., Cornwell, J. C., Stocker, D. K., and Owens, M. S. 2012. Effects of cyanobacterial-driven pH increases on sediment nutrient fluxes and coupled nitrification denitrification in a shallow fresh water estuary. Biogeosciences 9:2697-2710.

Gehl, R. J., Schmidt, J. P., Stone, L. R., Schlegel, A. J., and Clark, G. A. 2005. In Situ Measurements of Nitrate Leaching Implicate Poor Nitrogen and Irrigation Management on Sandy Soils. Journal of Environmental Quality 34:2243–2254.

Geza, M., Lowe K. S., and McCray, J. E. 2014. STUMOD—a Tool for Predicting Fate and Transport of Nitrogen in Soil Treatment Units. Environ Model Assess 19:243–256.

Giblin, A. E. and Gaines, A. G. 1990. Nitrogen inputs to a marine embayment: the importance of groundwater. Biogeochemistry 10:309-328.

Gilliom, R. J. and Patmont, C. R. 1983. Lake Phosphorus Loading from Septic Systems by Seasonally Perched Groundwater. Water Pollution Control Federation 55:1297-1305.

GPI Southeast. 2010. Final Report Baffle Box Effectiveness Monitoring Project. DEP Contract No. S0236. Prepared for Florida Department of Environmental Protection and Sarasota County Board of County Commissioners.

Grabowski, J. H., Brumbaugh, R. D., Conrad, R. F., Keeler, A. G., Opaluch, J. J., Peterson, C. H., Piehler, M. F., Powers, S. P., and Smyth, A. R. 2012. Economic Valuation of Ecosystem Services Provided by Oyster Reefs. BioScience, Volume 62 No. 10, p. 900-909. doi:10.1525/bio.2012.62.10.10.

Griffin, D. W., Gibson, C. J., Lipp, E. K., and Riley, K. 1999. Detection of Viral Pathogens by Reverse Transcriptase PCR and of Microbial Indicators by Standard Methods in the Canals of the Florida Keys. Applied and Environmental Microbiology 65:4118-4125.

Grizzle, R. E., Greene, J. K., and Coen, L. D. 2008. Seston removal by natural and constructed intertidal eastern oyster (Crassostrea virginica) reefs: A comparison with previous laboratory studies, and the value of in situ methods. Estuaries and Coasts 31:1208-1220.

Harden, H. H., Roeder, E., Hooks, M., and Chanton, J. P. 2008. Evaluation of onsite sewage treatment and disposal systems in shallow karst terrain. Water Research 42: 2585 – 2597.

Harden, H. H., Chanton, J. P., Hicks, R., and Wade, E. 2010. Wakulla County Septic Tank Study Phase II Report on Performance Based Treatment Systems. The Florida State University Department of Earth, Ocean and Atmospheric Science. FDEP Agreement No: WM926.

Harper, H. H. and Baker, D. M. 2007. Evaluation of Current Stormwater Design Criteria within the State of Florida. Prepared for Florida Department of Environmental Protection, Contract No. S0108.

Harris, P. J. 1995. Water quality impacts from on-site waste disposal systems to coastal areas through groundwater discharge. Environmental Geology 26:262-268.

Harrison, M., Stanwyck, E., Beckingham, B., Starry, O., Hanlon, B., and Newcomer, J. 2012. Smart growth and the septic tank: Wastewater treatment and growth management in the Baltimore region. Land Use Policy 29:483– 492.

Hazen and Sawyer. 2015. Evaluation of Full Scale Prototype Passive Nitrogen Reduction Systems (PNRS) and Recommendations for Future Implementation. Report to the Florida Department of Health. Report. Appendices.

Hochmuth, G., Trenholm, L., Rainey, D., Momol, E., Lewis, C., and Niemann, B. 2016. Managing Landscape Irrigation to Avoid Soil and Nutrient Losses. EDIS Publication: SL384.

Indian River Lagoon (IRL) Clam Restoration Project. 2019. Coastal Conservation Association, University of Florida Whitney Lab, Florida Fish and Wildlife Conservation Commission. Website.

Indian River Lagoon (IRL) National Estuary Program. 2019. Looking Ahead to 2030: A 10-Year Comprehensive Conservation and Management Plan for the Indian River Lagoon, Florida.

Johnson, K. 2017. Biological Responses to Muck Dredging in the Indian River Lagoon, Part I. Seagrass Monitoring and Infaunal Surveys. Impacts of Environmental Muck Dredging at Florida Institute of Technology Annual Report.

Johnson, K. and Shenker, S. 2016. Biological Responses to Muck Removal. Impacts of Environmental Muck Dredging at Florida Institute of Technology Annual Report.

Katz, B. G., Griffi, D. W., McMahon, P. B., Harden, H. S., Wade, E., Hicks, R. W., and Chanton, J. P. 2010. Fate of Effluent-Borne Contaminants beneath Septic Tank Drainfields Overlying a Karst Aquifer. Journal of Environmental Quality 39:1181–1195.

Kellogg, M. L., Luckenbach, M. W., Brown, B. L., Carmichael, R. H., Cornwell, J. C., Piehler, M. F., and Owens, M. S. 2013. Quantifying Nitrogen Removal by Oysters Workshop Report. Submitted to National Oceanic and Atmospheric Administration Chesapeake Bay Office.

Kelly, J. R. and Nixon, S. W. 1984. Experimental studies of the effect of organic deposition on the metabolism of a coastal marine bottom community. Marine Ecology Progress Series 17:157-169.

Kemp, W. M. and Boynton, W. R. 1984. Spatial and temporal coupling of nutrient inputs to estuarine primary production. The role of particulate transport and decomposition. Bulletin of Marine Science 35:242-247.

Kemp, W. M., Boynton, W. R., Adolf, J. E., Boesch, D. F., Boicourt, W. C., Brush, G., Cornwell, J. C., Fisher, T. R., Gilbert, P. M., Hagy, J.D., Harding, L. W., Houde, E. D., Kimmel, D. G., Miller, W. D., Newell, R. I. E., Roman M. R., Smith, E. M., and Stevenson, J. C. 2005. Eutrophication of Chesapeake Bay: historical trends and ecological interactions. Marine Ecology Progress Series 303:1-29.

Kendal, C. and McDonnel, J. J. 1998. Isotope Tracers in Catchment Hydrology. Elsevier Science B.V., Amsterdam, 839 p.

Kimley Horn. 2018a. South Beaches Phase 1 Smoke Testing Report. Prepared for Brevard County Utility Services Department.

Kimley Horn. 2018b. South Beaches Phase 2 Smoke Testing Report. Prepared for Brevard County Utility Services Department.

Kroeger, Timm. 2012. Dollars and Sense: Economic Benefits and Impacts from two Oyster Reef Restoration Projects in the Northern Gulf of Mexico. The Nature Conservancy.

Koop, K., Boynton, W. R., Wulff, F., and Carman, R. 1990. Sediment-water oxygen and nutrient exchanges along a depth gradient in the Baltic Sea. Marine Ecology Progress Series 63:65-77.

Lagoon Loyal. Website.

Lambert, M. R., Giller, J. S. J., Skelly, D. K., and Bribiescas, R. G. 2016. Septic systems, but not sanitary sewer lines, are associated with elevated estradiol in male frog metamorphs from suburban ponds. General and Comparative Endocrinology 232:109–114.

Lancellotti, B. V., Loomis, J. W., Hoyt, K. P., Avizinis, E., and Amador, J. A. 2017. Evaluation of Nitrogen Concentration in Final Effluent of Advanced Nitrogen-Removal Onsite Wastewater Treatment Systems (OWTS). Water Air Soil Pollution 228: 383.

Lapointe, B. E., Brewton, R. A., and Wilking, L. E. 2018. Microbial Source Tracking of Bacterial Pollution in the North Fork of the St. Lucie River. Harbor Branch Oceanographic Institute Report.

Lapointe, B. E., Herren, L. W., Debortoli, D. D., and Vogel, M. A. 2015. Evidence of sewage-driven eutrophication and harmful algal blooms in Florida's Indian River Lagoon. Harmful Algae 43:82–102.

Lapointe, B. E., Herren, L. W., and Paule, A. L., Septic systems contribute to nutrient pollution and harmful algal blooms in the St. Lucie Estuary, Southeast Florida, USA. Harmful Algae 70:1–22.

Lazarus, S. 2017. Wind and microclimate analysis improved site characterization in support of environmental flow modeling. Impacts of Environmental Muck Dredging at Florida Institute of Technology Annual Report.

Lefebvre, L. W., Provancha, J. A., Slone, D. H., and Kenworthy, W. J. 2017. Manatee grazing impacts on a mixed species seagrass bed. Marine Ecology Progress Series 564:29-45.

Lewis, R. R. III, Clark, P. A., Fehring, W. K., Greening, H. S., Johansson, R. O., and Paul, R. T. 1999. The rehabilitation of the Tampa Bay Estuary, Florida, USA, as an example of successful integrated coastal management. Marine Pollution Bulletin 37: 468–473.

Li, L., Spoelstra, J., Robertson, W. D., Schiff, S. L., and Elgood, R. J. 2014. Nitrous Oxide as an Indicator of Nitrogen Transformation in a Septic System Plume. Journal of Hydrology 519:1882-1894.

Lusk, M., Toor, G. S., and Obreza, T. 2011. Onsite Sewage Treatment and Disposal Systems: Phosphorus. University of Florida-Institute of Food and Agricultural Sciences Publication SL349.

Mallin, M. A. 2013. Septic Systems in the Coastal Environment: Multiple Water Quality Problems in Many Areas. Monitoring Water Quality, http://dx.doi.org/10.1016/B978-0-444-59395-5.00004-2.

Mallin, M. A. and McIver, M. R. 2012. Pollutant impacts to Cape Hatteras National Seashore from urban runoff and septic leachate. Marine Pollution Bulletin 64: 1356–1366.

Marine Resources Council and Applied Ecology. 2020. Brevard County Groundwater Monitoring and Modeling Report: Final Report for the Groundwater Pollution, Engaging the Community in Solutions (Florida Department of Environmental Protection Contract #LP05112) and Save Our Indian River Lagoon Project Plan Groundwater Quality Monitoring (Task Order #271010-14-003). Prepared for Brevard County Natural Resources Management Department.

McGlathery, K.J. 2008. Seagrass habitats. In: Capone, D.G., Bronk, D.A., Mulholland, M.R., Carpenter, E.J. (eds) Nitrogen in the marine environment, 2nd edition. Elsevier, New York, NY, p 1037−1071.

Meeroff, D. E., Bloetscher, F., Bocca, T., and Morin, F. 2008. Evaluation of Water Quality Impacts of On-site Treatment and Disposal Systems on Urban Coastal Waters. Water Air Soil Pollution 192:11–24.

Meile, C., Porubsky, W. P., Walker, R. L., and Payne, K. 2010. Natural attenuation of nitrogen loading from septic effluents: Spatial and environmental controls. Water Research 44:1399-1408.

Morris, L.J., Hall, L.M., Jacoby, C.A., Chamberlain, R.H., Hanisak, M.D., Miller, J.D., and Virnstein, R.W. 2022. Seagrass in a changing estuary, the Indian River Lagoon, Florida, USA. Submitted to Journal: Frontiers in Marine Science.

Morton, T. G., Gold, A. J., and Sullivan, W. M. 1988. Influence of Overwatering and Fertilization on Nitrogen Losses from Home Lawns. Journal of Environmental Quality. volume 17 pages 124-130. doi:10.2134/jeq1988.00472425001700010019x.

Newell, R.I.E. and Koch, E.W. 2004. Modeling seagrass density and distribution in response to changes in turbidity stemming from bivalve filtration and seagrass sediment stabilization. Estuaries 27(5): 793-806.

Odera, E., Martin, E., and Lamm, A. J. 2015. Southern Florida High Water Users' Public Opinions of Water in Florida. PIE2013/14-11. Gainesville, FL: University of Florida/Institute of Food and Agricultural Sciences Center for Public Issues Education.

Okaloosa County Extension. Accessed: October 5, 2017.

Olive, M., Daniel, L., and Donley, A. 2018. Septic Tank Survey: 2018. University of Central Florida Institute for Social and Behavioral Sciences. Presented to the Marine Resources Council.

Orth, R. J., Carruthers, T. J. B., Dennison, W. C., Duarte, C. M., Fourqurean, J. W., Heck Jr., K. L., Hughes, R., Kendrick, G. A., Kenworthy, J., Olyarnik, S., Short, F. T., Waycott, M., and Williams, S. L. 2006. A global crisis for seagrass ecosystems. BioScience 56:987-996.

Otis, R., Kreissl, J., Frederick, R., Goo, R., Casey, P., and Tonning, B. 2002. Onsite Wastewater Treatment Systems Manual. EPA/625/R-00/008.

Ott, E., Monaghan, P., and Wells, O. 2015. Strategies to Encourage Adoption of Stormwater Pond Best Management Practices by Homeowners. University of Florida-Institute of Food and Agricultural Sciences.

Ouyang, Y. and Zhang, J. 2012. Quantification of Shallow Groundwater Nutrient Dynamics in Septic Areas. Water, Air, & Soil Pollution 223:3181-3193.

Paperno, R., Dutka-Gianelli, J., and Tremain, D. Seasonal Variation in Nekton Assemblages in Tidal and Nontidal Tributaries in a Barrier Island Lagoon System. Estuaries and Coasts 41:1821–1833.

Paterson, R. G., Burby, R. J., and Nelson, A. C. 1991. Sewering the Coast: Bane or Blessing to Marine Water Quality. Coastal Management 19:239-252.

Phillips, P. J., Schubert, C., Argue, D., Fisher, I., Furlong, E. T., Foreman, W., Gray, J., and Chalmers, A. 2015. Concentrations of Hormones, Pharmaceuticals and Other Micropollutants in Groundwater Affected by Septic Systems in New England and New York. Science of the Total Environment 512:43-54.

Piehler, M.F. and Smyth, A.R. 2011. Habitat-specific distinctions in estuarine denitrification affect both ecosystem function and services. Ecosphere 2(1): Article 12.

Praecipio Economics Finance Statistics. 2016. The Blue Life Campaign and its Impact on Stormwater-Related Knowledge, Familiarity, Information and Behavior: Evidence from a Survey-Based Analysis of Brevard County Residents (2012 and 2015). Prepared for the Brevard County Board of County Commissioners.

Reidenbach, M. A., Berg, P., Hume, A., Hansen, J. C. R., and Whitman, E. R. 2013. Hydrodynamics of intertidal oyster reefs: The influence of boundary layer flow processes on sediment and oxygen exchange. Fluids and Environments 3: 225-239.

Restore America's Estuaries. 2015. Living Shorelines: From Barriers to Opportunities. Arlington, VA.

Richards, S., Paterson, E., Withers, P. J., and Stutter, M. 2016. Septic Tank Discharges as Multi-Pollutant Hotspots in Catchments. Science of the Total Environment 542:854-863.

Ridge, J. T., Rodriguez, A. B., and Fodrie, F. J. 2017. Evidence of exceptional oyster-reef resilience to fluctuations in sea level. Ecology and Evolution 7: 10409-10420.

Rios, J. F., Ye, M., Wang, L., Lee, P. Z., Davis, H., and Hicks, R. 2013. ArcNLET: A GIS-based Software to Simulate Groundwater Nitrate Load from Septic Systems to Surface Water Bodies. Computers & Geosciences 52:108-116.

Robertson, W. D. 1995. Development of steady-state phosphate concentrations in septic system plumes. Journal of Contaminant Hydrology 19:289-305.

Robertson, W. D. 2008. Irreversible Phosphorus Sorption in Septic System Plumes? Ground Water 46:51-60.

Robertson, W. D., Cherry, J. A., and Sudicky, E. A. 1991. Ground-water Contamination from Two Small Septic Systems on Sand Aquifers. Groundwater 29:82-92.

Robertson, W. D., Schiff, S. L., and Ptacek, C. J. 1998. Review of Phosphate Mobility and Persistence in 10 Septic System Plumes. Round Water 36:1000-1010.

Roeder, E. 2008. Revised Estimates of Nitrogen Inputs and Nitrogen Loads in the Wekiva Study Area. Bureau of Onsite Sewage Programs Florida Department of Health.

Romero, J., Lee, K., Perez, M., Mateo, M. A., and Alcoverro, T. 2006. Nutrient dynamics in seagrass ecosystems. P. 227-254. In A. W. D. Larkum, R. J. Orth, and C. M. Duarte [eds.], Seagrasses: Biology, ecology and conservation. Springer.

Rosen, J., Gibson., M., and Bartrand, T. 2010. Assessment of the Extra-Enteric Behavior of Fecal Indicator Organisms in Ambient Waters. United States Environmental Protection Agency Office of Water (4305T).

Russel, M. and Greening, H. 2015. Estimating Benefits in a Recovering Estuary: Tampa Bay, Florida. Estuaries and Coasts 38 (suppl 1): S9-S18.

Salup, N. Personal communication. December 31, 2019.

Sayemuzzaman, M. and Ye, M. August 2015. Estimation of Nitrogen Loading from Converted Septic Systems (2013-14 and 2014-15) to Surface Waterbodies in Port St. Lucie, FL. Department of Scientific Computing, Florida State University. Prepared for the Florida Department of Environmental Protection. Tallahassee, Florida.

Schmidt, A. L, Wysmyk, J. K. C., Craig, S. E., and Lotze, H. K. 2012. Regional-scale effects of eutrophication on ecosystem structure and services of seagrass beds. Limnology and Oceanography 57(5): 1389-1402.

Schmidt, C. and Gallagher, S. 2017. The denitrification potential and ecosystem services from ten years of oyster bed restoration in the Indian River Lagoon.

Scyphers, S. B., Powers, S. P., Heck, K. L. Jr., and Byron, D. 2011. Oyster Reefs as Natural Breakwaters Mitigate Shoreline Loss and Facilitate Fisheries. PLoS ONE 6(8):e22396. doi:10.1371/journal.pone.0022396.

Seevers, B., Graham, D., Gamon, J., and Conklin, N. 1997. Education through cooperative extension. Albany, NY: Delmar Publishers.

Sharma, S., Goff, J., Moody, R. M., Byron, D. Heck Jr., K. L., Powers, S. P., Ferraro, C., and Cebrian, J. 2016. Do restored oyster reefs benefit seagrass? An experimental study in the Northern Gulf of Mexico. Restoration Ecology doi: 10.1111/rec.12329.

Shenker, J. 2018. Biological Responses to Muck Dredging in the Indian River Lagoon, Part II: Fish Populations and Sea Grass Transplanting Experiment. Impacts of Environmental Muck Dredging at Florida Institute of Technology Annual Report.

Smyth, A. 2022. Brevard County Oyster reef Denitrification Assessment. Final Project Report: 15 June 2022.

Smyth, A.R., Piehler, M.F., and Grabowski, J.H. 2015. Habitat context influences nitrogen removal by restored oyster reefs. Journal of Applied Ecology 52: 716-725.

Souto, L. 2018. Source to Slime Study in Indian River Lagoon. Impacts of Environmental Muck Dredging at Florida Institute of Technology Annual Report.

St. Johns River Water Management District. 2016a. Indian River Lagoon: background and history.

St. Johns River Water Management District. 2016b. 2011 Superbloom Report; Evaluating Effects and Possible Causes with Available Data. Prepared by Indian River Lagoon 2011 Consortium.

St. Johns River Water Management District. 2020. Results of SJRWMD Model Runs. Presentation by Mike Register, Director Water Supply Planning & Assessment.

Swann, C. P. 2000. A survey of nutrient behavior among residents in the Chesapeake Bay watershed. In: National conference on tools for urban water resource management and protection., (pp 230-237). Chicago, IL, United States Environmental Protection Agency.

Swain, E. D. and Prinos, S. T. 2018. Using Heat as a Tracer to Determine Groundwater Seepage in the Indian River Lagoon, Florida, April–November 2017. United States Geological Survey Open-File Report 2018–1151.

Tetra Tech. 2015. Letter Report: Nutrient Mitigation Alternatives for Sediment Dewatering. Prepared for Brevard County Natural Resources Management Department.

Tetra Tech. 2020. Brevard County Muck Dredging Projects (2014-2019) Summary Report. Florida Department of Environmental Protection Grant Agreement No. S0714.

Time and Date. 2021. December 2018 Weather in Merritt Island — Graph.

Tran, K. C., Euan, J., and Isla, M. L. 2002. Public Perception of Development Issues: Impact of Water Pollution on a Small Coastal Community. Ocean & Coastal Management 45:405-420.

Treat, S. F. and Lewis III, R. R. (eds). 2006. Seagrass restoration: success, failure, and the cost of both. Lewis Environmental Services, Inc. 175 pp.

Trenholm, L. E. and Sartain, J. B. 2010. Turf Nutrient Leaching and Best Management Practices in Florida. HortTechnology, volume 20, number 1, 107-110. Prepared by the University of Florida.

Trefry, J. H. 2013. Presentation on Sediment Accumulation and Removal in the Indian River Lagoon. Presentation to the Environmental Preservation and Conservation Senate Committee. Marine and Environmental Systems, Florida Institute of Technology.

Trefry, J. H. 2018. Personal communication.

Trefry, J. H., Fox, A. L., Trocine, R. P., Fox, S. L., and Beckett, K. M. 2019a. Trends for Inputs of Muck Components from Rivers, Creeks and Outfalls to the Indian River Lagoon (Subtask 3). Impacts of Environmental Muck Dredging 2017–2018. Florida Institute of Technology.

Trefry, J. H., Johnson, K. B., Fox, A. L., and Ma, X. 2019b. Optimizing Selection of Sites for Environmental Dredging in the Indian River Lagoon System (Subtask 5). Impacts of Environmental Muck Dredging 2017-2018. Florida Institute of Technology.

Trefry, J. H., Trocine, R. P., Fox, A. L., Fox, S. L., Voelker, J. E., and Beckett, K. M. 2016. The Efficiency of Muck Removal from the Indian River Lagoon and Water Quality after Muck Removal. Impacts of Environmental Muck Dredging at Florida Institute of Technology Annual Report.

Trefry, J. H., Trocine, R. P., Fox, A. L., Fox, S. L., Voelker, J. E., and Beckett, K. M. 2016. Determining the Effectiveness of Muck Removal on Sediment and Water Quality in the Indian River Lagoon, Florida. Impacts of Environmental Muck Dredging at Florida Institute of Technology Annual Report.

Trefry, J. H., Trocine, R. P., Fox, A. L., Fox, S. L., Voelker, J. E., and Beckett, K. M. 2017. Inputs of Nitrogen and Phosphorus from Major Tributaries to the Indian River Lagoon. Impacts of Environmental Muck Dredging at Florida Institute of Technology Annual Report.

University of Central Florida. 2020a. January Brevard County Save Our Indian River Lagoon Oyster Monitoring Report.

University of Central Florida. 2020b. November Brevard County Save Our Indian River Lagoon Oyster Monitoring Report.

University of Central Florida. 2022a. Brevard County Save Our Indian River Lagoon (SOIRL) Living Shoreline Monitoring – Monthly Report for April 2022

University of Central Florida. 2022b. Brevard County Save Our Indian River Lagoon (SOIRL) Living Shoreline Monitoring – Monthly Report for May 2022.

University of Florida College of Engineering. 2011. Quantifying Nutrient Loads Associated with Urban Particulate Matter, and Biogenic/Litter Recovery through Current Municipal Separate Storm Sewer System Source Control and Maintenance Practices. Prepared for Florida Stormwater Association Educational Foundation.

University of Florida-Institute of Food and Agricultural Sciences. 2012. Warm-Season Turfgrass N Rates and Irrigation Best Management Practice Verification. Prepared for the Florida Department of Environmental Protection.

University of Florida-Institute of Food and Agricultural Sciences. 2013a. Using Reclaimed Water to Irrigate Turfgrass – Lessons Learned from Research with Nitrogen. Document SL389.

University of Florida-Institute of Food and Agricultural Sciences. 2013b. Urban Turf Fertilizer Rule for Home Lawn Fertilization. Document ENH1089.

University of Florida-Institute of Food and Agricultural Sciences. 2016. Florida Friendly Landscaping, Low Impact Development.

University of Florida-Institute of Food and Agricultural Sciences. 2017. EDIS SL181-B. Tissue Testing and Interpretation for Florida Turfgrasses.

University of Florida-Institute of Food and Agricultural Sciences. Online Resource Guide for Florida Shellfish Aquaculture. c2014-2015. Accessed December 2019.

United States Census Bureau. 2015. Persons per household, 2010-2014.

United States Environmental Protection Agency. 2000. Wastewater Technology Fact Sheet: Package Plants. EPA 832-F-00-016.

United States Environmental Protection Agency. 2002. Onsite Wastewater Treatment Manual. EPA 625/R-00/008. National Risk Management Research Laboratory, Office of Water, United States Environmental Protection Agency. Washington, DC.

United States Environmental Protection Agency. 2005. Riparian Buffer Width, Vegetative Cover, and Nitrogen Removal Effectiveness.

United States Environmental Protection Agency. 2007. Biological Nutrient Removal Processes and Costs. Fact Sheet EPA823-R-07-002. Office of Water.

Uppercase, Inc. 2018. Martin, Brevard & Volusia Grass Clippings Campaign Survey Research 2018 Draft Report.

Valiela, I. and Costa, J. E. 1988. Eutrophication of Buttermilk Bay, a Cape Cod Coastal Embayment: Concentrations of Nutrients and Watershed Nutrient Budgets. Environmental Management 12:539-553.

Valiela, I., Collins, G., Kremer, J., Lajtha, K., Geist, M., Seely, B., Brawley, J., and Sham, C. H. 1997. Nitrogen Loading from Coastal Watersheds to Receiving Estuaries: New Method and Application. Ecological Applications 7:358-380.

Valiela, I., Geist, M., McClelland, J., and Tomasky, G. 2000. Nitrogen Loading from Watersheds to Estuaries: Verification of the Waquoit Bay Nitrogen Loading Model. Biogeochemistry 49:277-293.

Waite, H. 2017. Investigating the Quantity and Types of Microplastics in the Organic Tissue of Oysters and Crabs in the Indian River Lagoon. Honors in the Major Theses. 157.

Wall, C.C., Peterson, B.J., and Gobler, C.J. 2008. Facilitation of seagrass Zostera marina productivity by suspension-feeding bivalves. Marine Ecology Progress Series 357: 165-174.

Wang, L., Ye, M., Rios, J. F., Fernandes, R., Lee, P. Z., and Hicks, R. W. 2013. Estimation of Nitrate Load from Septic Systems to Surface Water Bodies Using an ArcGIS-based Software. Environmental earth sciences 70:1911-1926.

Wanielista, M., Goolsby, M., Chopra, M., Chang, N., and Hardin, M. 2011. Green Residential Stormwater Management Demonstration: An Integrated Stormwater Management and Graywater System to Reduce the Quantity and Improve the Quality of Residential Water Discharges. University of Central Florida Stormwater Management Academy. Prepared for the Florida Department of Environmental Protection.

Wanielista, M. 2015. A Biosorption Activated Media Called Bold & Gold to Reduce Nutrients in Stormwater. Presentation. University of Central Florida.

Weaver, R. J. and Waite, T. D. 2018. Feasibility of muck removal at fixed locations in the IRL watershed and subsequent ferrate treatment to remove nutrients and contaminants. Impacts of Environmental Muck Dredging at Florida Institute of Technology Annual Report.

Windsor, J. G., Bostater, C., Johnson, K. B., Shenker, J., Trefry, J. H., and Zarillo. G. A., Impacts of Environmental Muck Dredging 2014–2015 Final Project Report to Brevard County Natural Resources Management Department, Funding provided by the Florida legislature as part of DEP Grant Agreement No. S0714 – Brevard County Muck Dredging, Indian River Lagoon Research Institute, Florida Institute of Technology, Melbourne, Florida.

Withers, P. J. A., Jarvie, H. P., and Stoate, C. 2011. Quantifying the Impact of Septic Tank Systems on Eutrophication Risk in Rural Headwaters. Environment International 37:644-653.

Withers, P. J. A., May, L., Jarvie, H. P., Jordan, P., Doody, D., Foy, R. H., Bechmann, M., Cooksley, S., Dils, R., and Deal, N. 2012. Nutrient Emissions to Water from Septic Tank Systems in Rural Catchments: Uncertainties and Implications for Policy. Environmental Science & Policy 24:71-82.

Withers, P. J., Jordan, P., May, L., Jarvie, H. P., and Deal, N. E. 2014. Do Septic Tank Systems Pose a Hidden Threat to Water Quality? Frontiers in Ecology and the Environment 12:123-130.

Xiao, H., Wang, D., Hagen, S. C., Medeiros, S. C., and Hall, C. R. 2016. Assessing the Impacts of Sea-level Rise and Precipitation Change on the Surficial Aquifer in the Low-lying Coastal Alluvial Plains and Barrier Islands, East-central Florida (USA). Hydrogeology Journal 24:1791-1806.

Zanini, L., Robertson, W. D., Ptacek, C. J., Schiff, S. L., and Mayer, T. 1998. Phosphorus characterization in sediments impacted by septic effluent at four sites in central Canada. Journal of Contaminant Hydrology 33:405–429.

Zarillo, G. 2018. Numerical Flushing Experiments Final Report. Submitted to the Indian River Lagoon National Estuary Program and Canaveral Port Authority. Florida Institute of Technology, Melbourne, FL.

Zarillo, G. 2019. Numerical Model Flushing Experiments Addendum Report. Submitted to the Indian River Lagoon National Estuary Program and Canaveral Port Authority. Florida Institute of Technology, Melbourne, FL.

Zarillo, G. and Listopad, C. 2016. Hydrologic and Water Quality Model for Management and Forecasting within Brevard County Waters. Impacts of Environmental Muck Dredging at Florida Institute of Technology Annual Report.

Zarillo, G. and Listopad, C. 2017. Hydrologic and Water Quality Model for Management and Forecasting within Brevard County Waters. Impacts of Environmental Muck Dredging at Florida Institute of Technology Annual Report.

Zarillo, G. A. and Listopad, C. 2019. Sediment & Water Quality Modeling for Nutrients, Muck and Water Clarity Scenario Assessments. Impacts of Environmental Muck Dredging at Florida Institute of Technology Annual Report.

Zarillo, G. A. and Listopad, C. 2022. Sediment & Water Quality Modeling for Nutrients, Muck and Water Clarity Scenario Assessments. Impacts of Environmental Muck Dredging at Florida Institute of Technology Annual Report.

Zhang, X., Liu, X., Zhang, M., Dahlgren, R. A., and Eitzel, M. 2010. A Review of Vegetated Buffers and a Meta-analysis of Their Mitigation Efficacy in Reducing Nonpoint Source Pollution. Journal of Environmental Quality 39:76-84.

Zhu, Y., Ye, M., Roeder, E., Hicks, R. W., Shi, L., and Yang, J. 2016. Estimating Ammonium and Nitrate Load from Septic Systems to Surface Water Bodies within ArcGIS Environments. Journal of Hydrology 532:177-192.

zu Ermgassen, P., Hancock, B., DeAngelis, B., Greene, J., Schuster, E., Spalding, M., and Brumbaugh, R. 2016. Setting objectives for oyster habitat restoration using ecosystem services: A manager's guide. The Nature Conservancy, Arlington VA. 76pp.

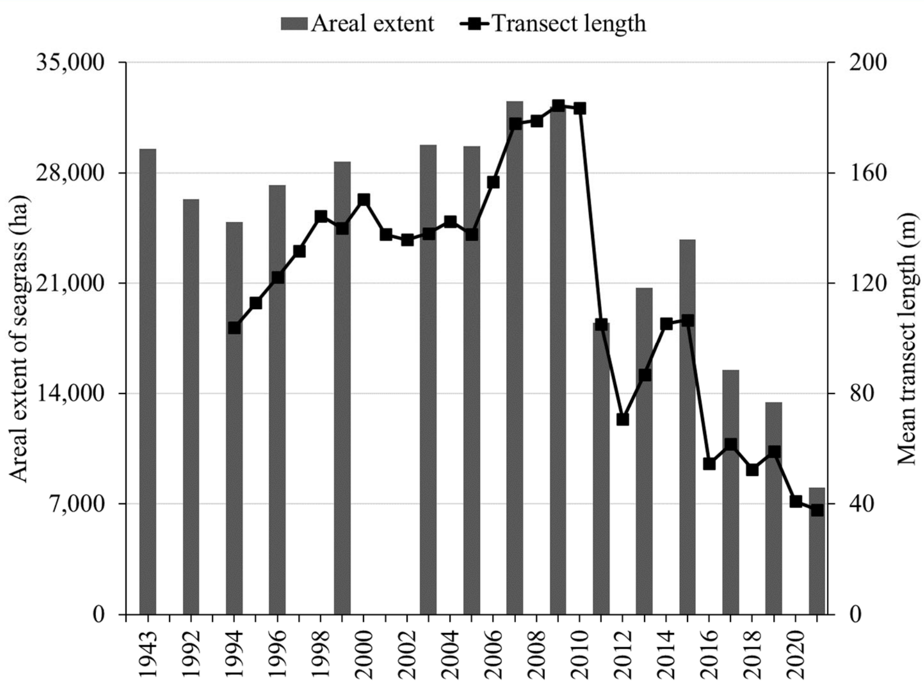
Appendix C: Seagrasses

Loss of Seagrass

In partnership, the St. Johns River Water Management District, South Florida Water Management District, and Florida Department of Environmental Protection mapped seagrass from aerial imagery taken in 1943 and every two to three years since 1986 (**Figure C-1**). Through 2009, the areal footprint of seagrass generally expanded, with some areas nearing their targets, which are benchmarks to evaluate the success of reducing nutrient loads to the Indian River Lagoon (IRL) system. Unfortunately, the areal extent of seagrass in the IRL began to decline in 2011 when mapping documented a loss of almost 43% of the acreage present in 2009. Most of this loss occurred in the reaches adjacent to Brevard County, with extensive losses in Banana River Lagoon (an 88% reduction from 24,000 to 3,000 acres) and in the IRL north of Sebastian Inlet (a 60% reduction from 50,000 to 20,000 acres). The losses resulted from several intense phytoplankton blooms (primarily single-celled algae) that reached unprecedented concentrations for a record duration as indicated by concentrations of chlorophyll-*a* (**Figure C-2**). Beyond the shallowest water, the bloom effectively reduced the amount of light reaching seagrasses below what they required for survival. As a result, the remaining canopies moved shoreward and to shallower depths, with decreased cover, and a disruption to the species distribution (Morris et al., 2021).

After the 2011 losses, the meadows showed some recovery in 2013 and 2015. However, a brown tide (*Aureoumbra lagunensis*) bloom in 2016 reversed recovery such that, in 2019, the areal extent of seagrasses decreased further to only 58% of that present in 2009. The prognosis is not good because, even where seagrass survives, the cover of seagrass is often less than 5%, which is a record drop from the prior 30–50% (Morris et al., 2021).

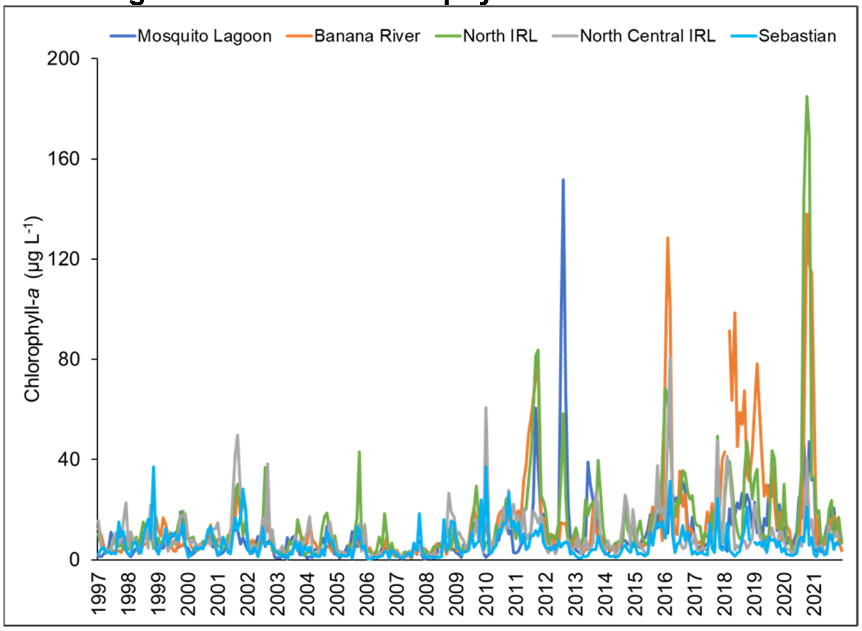
Figure C-1: Mean Areal Extent of Seagrass and Mean Length of Transects



Note: From Morris et al., 2021.

Figure C-1 Long Description

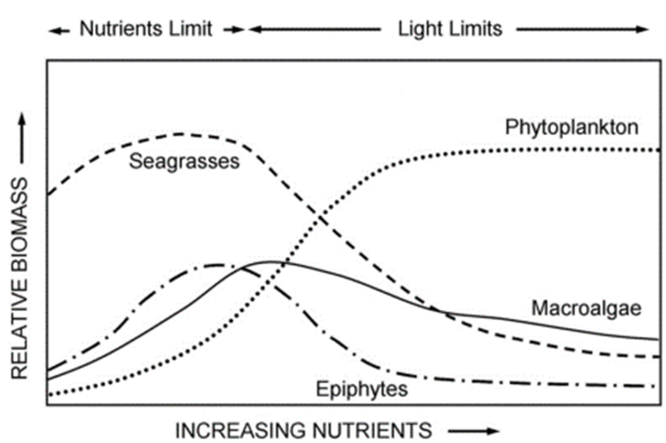
Figure C-2: Mean Chlorophyll-*a* Concentrations



[Figure C-2 Long Description](#)

Unfortunately, the IRL appears to be following a pattern described for systems that receive increased loads of nutrients (Duarte, 1995; Burkholder et al., 2007). The pattern involves a shift in the composition of the primary producer assemblage, with higher nutrient loads differentially promoting faster growing macroalgae and ultimately phytoplankton (**Figure C-3**). The macroalgae and phytoplankton can exacerbate loss of seagrasses, primarily through shading. Loss of seagrass and macroalgae makes more nutrients available to phytoplankton through decreased competition (Schmidt et al. 2012), and loss of seagrass means that the sediments may be more prone to resuspension, which also reduces light penetration. Overall, the change in the system becomes self-perpetuating. Reducing nutrient loads represents a critical first step in efforts to reverse the shift in primary producers. However, a return to the previous areal coverage of seagrass may take some time, especially if too few recruits are available and sediments are too destabilized for colonization.

Figure C-3: Conceptual Model Illustrating a Shift in Biomass Among Major Primary Producers with Increasing Nutrient Enrichment



Note: Adapted from Burkholder et al. 2007

Nutrient Content of Seagrass

Halodule wrightii stores nutrients in its aboveground and belowground biological material, or biomass. The biomass of this and other seagrasses changes seasonally, with peak growth of aboveground shoots occurring in April and May and the greatest aboveground biomass recorded during summer. These seasonal changes introduce uncertainty into estimates of nutrient storage, but mean values will suffice for estimating return on investment in the long-term (**Table C-1**). For example, a single shoot of *Halodule wrightii* may contain up to five or more leaves in the summer, whereas in the winter this same shoot may contain only one leaf (Dunton 1996). For this estimate of nutrient content, we will assume that spring-summer growth and fall-winter senescence are equal. Thus, we will focus on our recent estimates of an average amount of aboveground and belowground biomass or standing stock of *Halodule wrightii* (**Table C-1** and **Table C-2**).

Table C-1: Estimates of Biomass for *Halodule* Species

Location	Total Biomass (grams dry weight per square meter)	Reference
Texas (Laguna Madre)	10–400	Zieman and Zieman, 1989
North Carolina (multiple locations)	22–208	Zieman and Zieman, 1989
South Florida and Tampa Bay	10–300	Zieman and Zieman, 1989
IRL (Fort Pierce Inlet)	124–198	Hefferman and Gibson, 1983
IRL (Grand Harbor/Vero)	45	Hefferman and Gibson, 1983
IRL (Link Port)	20–140	Virnstein unpublished
IRL (Brevard County)	53*	Morris, Chamberlain, and Jacoby unpublished
Texas (Laguna Madre)	10–400	Zieman and Zieman, 1989

* Mean aboveground biomass = 23 grams dry weight meters^{-2} = [(mean percent cover × 30.533) × 0.019]; mean belowground biomass = 30 grams dry weight meters^{-2} = 1.3 × aboveground biomass

Table C-2: Total Biomass in Seagrasses Along Brevard County

Sub-lagoon	Description	Total Biomass (grams dry weight per square meter)
Mosquito Lagoon	Brevard County line to southern end of sub-lagoon	74
Banana River Lagoon	National Aeronautics and Space Administration restricted area	64
Banana River Lagoon	Remainder of Banana River Lagoon	44
IRL	North of State Road 405	51
IRL	State Road 405 to Pineda Causeway	35
IRL	Pineda Causeway to Hog Point	28
IRL	Hog Point to Brevard County line	51
Mean	***Not applicable***	***50***

Duarte (1990) compared nutrient contents of 27 species of seagrass, including *Halodule wrightii*. He determined that nitrogen and phosphorus represent about 2.2% and 0.2% of the dry weight of aboveground and belowground tissue of *Halodule wrightii*, respectively. These values are similar to those calculated during a recent study in the IRL (**Table C-3**). The values can be combined with estimates of biomass to calculate how much nitrogen and phosphorus are sequestered by 100 acres of *Halodule wrightii* on average (**Table C-4**).

Table C-3: Estimates of Nutrient Content for *Halodule wrightii* (percentage of dry weight)

Location	Carbon Above Ground	Nitrogen Above Ground	Phosphorus Above Ground	Carbon Below Ground	Nitrogen Below Ground	Phosphorus Below Ground
BRL-1	29.60	2.02	0.17	30.60	1.24	0.14
BRL-2	30.60	2.36	0.24	29.08	1.47	0.27
BRL-3	29.60	2.66	0.26	28.09	1.48	0.25
IRL-1	31.74	2.39	0.18	31.69	1.42	0.15
IRL-2	30.08	2.56	0.26	30.48	1.74	0.27
IRL-3	28.26	2.08	0.25	23.86	1.36	0.20
Mean	***29.98***	***2.35***	***0.23***	***28.97***	***1.45***	***0.21***

BRL = Banana River Lagoon, IRL = Indian River Lagoon

Table C-4: Average Amount of Nutrients Contained in Seagrass from 1996–2009

Sub-lagoon	Acres	Seagrass (pounds per 100 acres)	Nitrogen (pounds per 100 acres)	Phosphorus (pounds per 100 acres)
Southern Mosquito Lagoon	14,000	45,000	1,000	100
Banana River Lagoon	21,000	45,000	1,000	100
North IRL	19,000	37,000	900	90
Central IRL	7,000	36,000	900	90

Draft Evaluation Criteria for Planting Seagrass

Part of the wisdom accumulated from past seagrass restoration projects is the importance of selecting sites that will support seagrass growth. Key information has been synthesized into an initial guide, with higher scores and more certainty indicating better sites for planting seagrass (**Table C-5**). Please note that the presence of seagrass leads to a lower score based on the premise that natural recruitment represents the most cost-effective option for restoring seagrass. In addition, a high level of uncertainty can suggest targets for further study. This guide can be refined following pilot studies to determine optimal methods for planting seagrass (e.g., type of planting units, use of chemicals to enhance growth, and density of initial planting) and protecting it from disturbance (e.g., grazing, waves, exposure, and low salinity) until it is established.

References

Burkholder, J.M., Tomasko, D.A., and Touchette, B.W. 2007. Seagrasses and eutrophication. Journal of Experimental Marine Biology and Ecology 350: 46–72.

Duarte, C.M. 1990. Seagrass nutrient content. Marine Ecology Progress Series 6: 201–207.

Duarte, C.M. 1995. Submerged aquatic vegetation in relation to different nutrient regimes. Ophelia 41: 87–112.

Dunton, K.H. 1990. Production ecology of Ruppia maritima and Halodule wrightii Aschers in two subtropical estuaries. Journal of Experimental Marine Biology and Ecology 143: 147–164.

Hefferman J.J. and Gibson, R.A. 1983. A comparison of primary production rates in Indian River, Florida seagrass systems. Florida Scientist 46: 295–306.

Morris, L.J, Hall, L.M., Miller, J.D., Lasi, M.A., Chamberlain, R.H., Virnstein, R.W., and Jacoby, C.A. 2021. Diversity and distribution of seagrasses as related to salinity, temperature, and availability of light in the Indian River Lagoon, Florida. Proceedings of Indian River Lagoon Symposium 2020.

Schmidt, A.L., Wysmyk, J.K.C., Craig, S.E., and Lotze, H.K. 2012. Regional-scale effects of eutrophication on ecosystem structure and services of seagrass beds. Limnology and Oceanography 57(5): 1389-1402.

Zieman, J.C. and Zieman, R.T. 1989. The ecology of seagrass meadows of the west coast of Florida: a community profile. United States Fish and Wildlife Service, Biological Report 85(7.25), September 1989.

Table C-5: Guide for Ranking Potential Seagrass Restoration Sites

Category	Metric	Timeframe	Attributes for Score = 0	Attributes for Score = 2	Attributes for Score = 4	Attributes for Score = 6	Score	Uncertainty (1 = low, 3 = high)
Critical Depth Zone 0.5-0.8 meters below mean sea level	**Width of Critical Depth Zone** (distance perpendicular to shore)	**Recent**	**Very narrow:** < 25 meters wide (< 82 feet)	**Narrow:** 25-50 meters (82-164 feet)	**Moderately wide:** 50-100 meters (164-328 feet)	**Broad:** > 100 meters (> 328 feet)		
Critical Depth Zone 0.5-0.8 meters below mean sea level	**Distance to seagrass** (identified via the most recent map or targeted reconnaissance)	**Recent**	**Continuous seagrass at site and within 1 kilometer (land use code = 9116):** seagrass is a dominant feature (restoration not needed)	**Isolated:** no seagrass within 1 kilometers (0.6 miles) so conditions may be unfavorable	**Discontinuous seagrass at site and within 1 kilometers (land use code = 9113):** seagrass is patchy, so restoration may connect patches	**Seagrass nearby:** seagrass within 0.5-1.0 kilometers (0.3-0.6 miles)		
Critical Depth Zone 0.5-0.8 meters below mean sea level	**Percent cover in Critical Depth Zone** (derived from the closest transect, paired considerations)	**Past** (2000-2009)	**High:** > 30%	**Low:** 10-20%	**Moderate:** 20-30%	**High:** > 30%		
Critical Depth Zone 0.5-0.8 meters below mean sea level	**Percent cover in Critical Depth Zone** (derived from the closest transect, paired considerations)	**Last 3 Years**	**High:** > 10% (restoration not needed)	**Low:** < 10% (restoration may not help)	**Low:** < 10% (restoration may help but ultimate gain is likely limited)	**Low:** < 10% (potentially optimum site for restoration)		
Potential stressors	**Water quality** (salinity and light availability derived from the closest station)	**Last 3 Years**	**Bad:** salinity < 10 ppt anytime and < 18 ppt for > 3 consecutive months, or annual mean salinity -1 standard deviation < 17 ppt. Secchi depth < 0.5 m (1.6ft) anytime and < 0.65 m (2.1ft) for > 3 consecutive months, or annual mean Secchi depth -1 standard deviation < 0.65 m.	**Poor:** salinity < 18 ppt for 3 consecutive months but never < 12 ppt, or annual mean salinity -1 standard deviation < 17 ppt. Secchi depth < 0.65 m for < 3 consecutive months but never < 0.5 m, or annual mean Secchi depth -1 standard deviation < 0.65 m.	**Supportive:** salinity always > 18 Secchi depth always > 0.65 meters and may be 0.65-1.0 meters (2.1-3.3 feet) for 3 consecutive months	**Good:** salinity consistently > 23 Secchi depth consistently > 1.0 meters		
Potential stressors	**Sediment** (assessed via visits to the site or other current information)	**Present**	**Not supportive:** anoxic and sulfidic near the surface or easily resuspended or moved	**Minimally supportive:** hard bottom (e.g., compact sand or shells), not conducive for growth of rhizomes and roots, porewater may lack nutrients	**Generally supportive:** unconsolidated sediment that holds plants with relatively little resuspension and movement observed, porewater nutrients not limiting	**Fully supportive:** loosely consolidated sediment with firmly anchored plants if present, anoxic and sulfidic layers located below the zone occupied by roots and rhizomes, porewater rich in nutrients		
Potential stressors	**Water movement** (assessed via visits to the site or other current information)	**Present**	**High currents - possible scouring:** frequent and strong currents or waves that may cause ripples in the sediment and uproot new plants	**Moderate to high currents:** currents and waves bend plants, sweep fragments of seagrass away before they can gain a foothold, and cause some resuspension of sediment	**Moderate currents:** plants often stand upright, fragments of seagrass may be trapped, sediment typically not resuspended	**Low currents:** mild currents or waves, sediment not disturbed, no apparent negative effects on any seagrass that is present		
Potential stressors	**Shoreline characteristics** (assessed via visits the site or other current information)	**Present**	**Unnatural shoreline:** Critical Depth Zone in close proximity to urban development, including canals, and a hardened shoreline (e.g., riprap or bulkhead)	**Semi-natural shoreline:** Critical Depth Zone near moderate development and some shoreline is vegetated	**Mostly natural shoreline:** Critical Depth Zone near low to moderate development, most of the shoreline is vegetated shoreline or the site is associated with living shoreline project	**All natural shoreline:** vegetated shoreline with very limited development		
Potential stressors	**Public use** (assessed via visits to the site visits or other current information, including recent aerial photographs)	**Present**	**High use:** Critical Depth Zone adjacent to or within an area with frequent boating, swimming or fishing (e.g., aerial photographs show prop scars)	**Near high use:** Critical Depth Zone within 0.5 kilometers (0.3 miles) of a highly used area	**Not near high use:** Critical Depth Zone more than 0.5 kilometers from a highly used area	**Low use:** no public facilities nearby and limited signs of use		
Potential stressors	**Biota** (assessed via visits to the site or other current information on grazing or physical disturbance)	**Present**	**Heavy use:** site adjacent to deep water or manatee zone, power plant within 10 kilometers (6.2 miles), freshwater nearby, manatees and rays observed frequently, disturbance or grazing evident in > 50% of the area on a weekly-monthly basis	**Moderate use:** power plant > 10 kilometers away, deep water and manatee zones > 0.5 kilometers away, no freshwater nearby, disturbance or grazing evident in < 50% of the area on a monthly basis	**Intermittent use:** disturbance or grazing evident in < 25% of the area on a quarterly basis	**Rare use:** disturbance or grazing hardly evident		
Logistics	**Enhancement or protection** (assessed via visits to the site)	**Present**	**Extensive need:** dense planting required due to absence of seagrass, fencing or caging required due to grazing, other enhancement or protection required, including living shorelines, sediment barriers, wave baffles	**Substantial need:** moderately dense planting required because only 1-2% cover present, fencing or caging required, few additional enhancements or protections required	**Moderate need:** low density planting sufficient because at least 2% cover present, fencing or caging required for a limited time, other enhancements or protections beneficial but not critical	**Limited need:** minimal density planting or no planting required because > 2% cover present and protection from grazing may result in spread of seagrass, no other enhancements or protections required		
Logistics	**Maintenance** (assessed via visits to the site)	**Anticipated**	**High maintenance:** weekly cleaning	**Moderate maintenance:** monthly cleaning	**Low maintenance:** quarterly cleaning	**Minimum maintenance:** maintain as needed		
Logistics	**Staging and accessibility** (assessed via visits to the site)	**Present**	**Very difficult:** substantial impediments that may include boat ramps **>** 10 kilometer away, soft sediment that is easily disturbed, permitting and access issues	**Moderately difficult:** boat ramp within 10 kilometers, somewhat firm sediment, tractable permitting and access issues	**Relatively simple:** boat ramp nearby and few other issues	**No issues**		
Logistics	**Monitoring** (relevant past, current and future information on water quality and seagrasses available)	**Present**	**No external support:** no sampling of seagrass within 5 kilometers (3.1 miles), nearest water quality station not representative of conditions at the site	**Minimal external support:** seagrass surveyed within 3-5 kilometers (1.9-3.1 miles); water quality station is representative of conditions at the site	**Moderate external support:** seagrass and water quality sampled within 3 kilometers, so both are representative of conditions at the site	**Considerable external support:** seagrasses and water quality sampled at or adjacent to the site		
Total								

Notes:
Optimize potential for success by planting: a) within the Critical Depth Zone (e.g., at 0.6-0.8 meters below mean sea level) with due recognition of tides and annual changes in water levels; or b) during the spring (e.g., late March to May) when water clarity is best, water temperatures are warming, and grazing by fish is relatively low
Scoring: if conditions do not match the attributes provided, then assign a score between the two that are most applicable

Appendix D: Withdrawn Projects

Some of the projects submitted and approved as part of a plan update were determined to be less cost-effective and/or infeasible to implement after further investigation. Stormwater basin delineations were updated in 2019 with some basins merged or renamed in the 2020 Plan Update. Therefore, these projects were removed from the Save Our Indian River Lagoon Project Plan so that the funding could be used for other projects. **Table D-1** lists the projects that have been removed from the plan at the request of the responsible entity.

Table D-1: Summary of Project Withdrawals from the Plan

Year Removed	Project Name	Responsible Entity	Sub-Lagoon	Total Nitrogen Reduction (pounds per year)	Total Phosphorus Reduction (pounds per year)	Plan Funding
2018	Holman Road Baffle Box	City of Cape Canaveral	Banana	71	2	$6,248
2018	Center Street Baffle Box	City of Cape Canaveral	Banana	297	9	$26,136
2018	International Drive Baffle Box	City of Cape Canaveral	Banana	443	4	$34,700
2018	Angel Isles Baffle Box	City of Cape Canaveral	Banana	131	3	$11,528
2018	Cherie Down Park Swale	City of Cape Canaveral	Banana	27	9	$2,376
2018	Norwood Baffle Box Retrofit	City of Palm Bay	Central IRL	1,631	254	$143,528
2018	Victoria Pond	City of Palm Bay	Central IRL	267	42	$23,486
2018	Goode Park	City of Palm Bay	Central IRL	794	121	$69,872
2018	Florin Pond	City of Palm Bay	Central IRL	75	11	$6,600
2018	Airport Boulevard Dry Retrofit	City of Melbourne	North IRL	99	23	$8,718
2018	National Aeronautics and Space Administration Boulevard Pond Retrofit	City of Melbourne	Central IRL	1,097	157	$96,532
2018	General Aviation Drive Retrofit	City of Melbourne	Central IRL	158	10	$13,937
2018	L-1 Canal Bank Stabilization	Brevard County	North IRL	995	383	$87,560
2018	Stormwater project in Basin 979	Brevard County	Banana	3,275	448	$225,000
2018	Stormwater project in Basin 1280	Brevard County	Banana	1,735	236	$175,000
2018	Stormwater project in Basin 1063	Brevard County	Banana	1,235	192	$100,000
2018	Stormwater project in Basin 970	Brevard County	Banana	1,092	185	$100,000
2018	Stormwater project in Basin 995	Brevard County	Banana	1,048	169	$100,000
2018	Stormwater project in Basin 754	Brevard County	Banana	734	95	$100,000
2018	Stormwater project in Basin 327	Brevard County	North IRL	1,999	283	$125,000
2018	Stormwater project in Basin 1582	Brevard County	Central IRL	2,402	443	$200,000

Year Removed	Project Name	Responsible Entity	Sub-Lagoon	Total Nitrogen Reduction (pounds per year)	Total Phosphorus Reduction (pounds per year)	Plan Funding
2019	Cocoa Beach Muck Dredging – Phase III Interstitial	City of Cocoa Beach	Banana	2,942	To be determined	$514,809
2019	Indian River Drive Oyster Bar (reduction from 1,900 to 140 feet)	Brevard County	North IRL	422	10	$166,672
2019	Indian River Drive Planted Shoreline (reduction from 1,900 to 140 feet)	Brevard County	North IRL	118	41	$20,620
2019	Stormwater project in Basin 905	Brevard County	Banana	1,143	178	$150,000
2019	Stormwater project in Basin 492	Brevard County	Banana	1,020	117	$100,000
2019	Stormwater project in Basin 522	Brevard County	Banana	795	110	$125,000
2019	Stormwater project in Basin 705	Brevard County	Banana	650	95	$100,000
2019	Stormwater project in Basin 821	Brevard County	Banana	627	123	$100,000
2019	Stormwater project in Basin 820	Brevard County	Banana	597	112	$100,000
2019	Stormwater project in Basin 47	Brevard County	North IRL	1,348	139	$125,000
2019	Stormwater project in Basin 219	Brevard County	North IRL	956	113	$125,000
2020	Cape Canaveral Air Force Station Upgrade	Cape Canaveral Air Force Station	Banana	25,627	To be determined	$6,000,000
2020	Malabar - Zone B	Brevard County	Central IRL	1,929	Not applicable	$2,135,808
2020	Malabar - Zone A	Brevard County	Central IRL	11,456	Not applicable	$14,349,960
2020	South Beaches - Zone F	Brevard County	Central IRL	70	Not applicable	$100,116
2020	Carver Cove Swale	City of Cape Canaveral	Banana	32	9	$2,816
2020	Cocoa Palms Low Impact Development	City of Cape Canaveral	Banana	13	10	$1,144
2020	M1 Canal Biosorption Activated Media	Brevard County	Central IRL	1,433	191	$66,300
2020	Oliver Oyster Bar	Brevard Zoo	North IRL	116	39	$51,620
2020	Coconut Point/Environmentally Endangered Lands Oyster Bar (reduction from 27,125 square feet to 2,400 square feet)	Brevard Zoo	Central IRL	989	367	$464,830
2020	Turkey Creek Shoreline Restoration – Oysters	City of Palm Bay	Central IRL	309	8	$122,055
2020	Eden Isles Lane Oyster Bar	Brevard Zoo	Banana	49	17	$21,805
2020	Turkey Creek Shoreline Restoration – Planted	City of Palm Bay	Central IRL	104	36	$24,960
2020	Stormwater project in Basin 388	Brevard County	Banana	1,390	138	$100,000
2020	Stormwater project in Basin 451	Brevard County	Banana	1,168	121	$100,000
2020	Stormwater project in Basin 815	Brevard County	Banana	698	113	$100,000

Year Removed	Project Name	Responsible Entity	Sub-Lagoon	Total Nitrogen Reduction (pounds per year)	Total Phosphorus Reduction (pounds per year)	Plan Funding
2020	Stormwater project in Basin 829	Brevard County	Banana	630	145	$100,000
2020	Stormwater project in Basin 865	Brevard County	Banana	454	151	$100,000
2020	Stormwater project in Basin 889	Brevard County	Banana	539	85	$100,000
2020	Stormwater project in Basin 901	Brevard County	Banana	1,658	196	$150,000
2020	Stormwater project in Basin 912	Brevard County	Banana	1,025	34	$100,000
2020	Stormwater project in Basin 929	Brevard County	Banana	304	41	$100,000
2020	Stormwater project in Basin 933	Brevard County	Banana	302	38	$100,000
2020	Stormwater project in Basin 934	Brevard County	Banana	365	42	$100,000
2020	Stormwater project in Basin 938	Brevard County	Banana	424	160	$100,000
2020	Stormwater project in Basin 940	Brevard County	Banana	816	106	$100,000
2020	Stormwater project in Basin 943	Brevard County	Banana	708	90	$100,000
2020	Stormwater project in Basin 944	Brevard County	Banana	614	83	$100,000
2020	Stormwater project in Basin 955	Brevard County	Banana	522	60	$100,000
2020	Stormwater project in Basin 957	Brevard County	Banana	586	53	$100,000
2020	Stormwater project in Basin 958	Brevard County	Banana	164	26	$100,000
2020	Stormwater project in Basin 960	Brevard County	Banana	537	80	$100,000
2020	Stormwater project in Basin 961	Brevard County	Banana	431	57	$100,000
2020	Stormwater project in Basin 963	Brevard County	Banana	2,092	396	$150,000
2020	Stormwater project in Basin 969	Brevard County	Banana	528	78	$100,000
2020	Stormwater project in Basin 973	Brevard County	Banana	2,048	311	$175,000
2020	Stormwater project in Basin 975	Brevard County	Banana	521	75	$100,000
2020	Stormwater project in Basin 977	Brevard County	Banana	558	59	$100,000
2020	Stormwater project in Basin 980	Brevard County	Banana	836	127	$100,000
2020	Stormwater project in Basin 981	Brevard County	Banana	993	179	$100,000
2020	Stormwater project in Basin 982	Brevard County	Banana	642	68	$100,000
2020	Stormwater project in Basin 988	Brevard County	Banana	621	108	$100,000
2020	Stormwater project in Basin 989	Brevard County	Banana	1,030	110	$100,000
2020	Stormwater project in Basin 990	Brevard County	Banana	634	102	$100,000
2020	Stormwater project in Basin 992	Brevard County	Banana	1,244	195	$100,000

Year Removed	Project Name	Responsible Entity	Sub-Lagoon	Total Nitrogen Reduction (pounds per year)	Total Phosphorus Reduction (pounds per year)	Plan Funding
2020	Stormwater project in Basin 1000	Brevard County	Banana	277	40	$100,000
2020	Stormwater project in Basin 1001	Brevard County	Banana	401	54	$100,000
2020	Stormwater project in Basin 1010	Brevard County	Banana	374	55	$100,000
2020	Stormwater project in Basin 1014	Brevard County	Banana	333	50	$100,000
2020	Stormwater project in Basin 1016	Brevard County	Banana	920	136	$100,000
2020	Stormwater project in Basin 1018	Brevard County	Banana	389	54	$100,000
2020	Stormwater project in Basin 1026	Brevard County	Banana	1,073	180	$100,000
2020	Stormwater project in Basin 1033	Brevard County	Banana	1,113	152	$100,000
2020	Stormwater project in Basin 1038	Brevard County	Banana	157	25	$100,000
2020	Stormwater project in Basin 1039	Brevard County	Banana	708	104	$100,000
2020	Stormwater project in Basin 1041	Brevard County	Banana	273	47	$100,000
2020	Stormwater project in Basin 1048	Brevard County	Banana	107	20	$100,000
2020	Stormwater project in Basin 1070	Brevard County	Banana	113	12	$100,000
2020	Stormwater project in Basin 1071	Brevard County	Banana	1,082	144	$100,000
2020	Stormwater project in Basin 1082	Brevard County	Banana	264	39	$100,000
2020	Stormwater project in Basin 1098	Brevard County	Banana	341	53	$100,000
2020	Stormwater project in Basin 1104	Brevard County	Banana	701	106	$100,000
2020	Stormwater project in Basin 1117	Brevard County	Banana	282	43	$100,000
2020	Stormwater project in Basin 1120	Brevard County	Banana	313	50	$100,000
2020	Stormwater project in Basin 1121	Brevard County	Banana	186	27	$100,000
2020	Stormwater project in Basin 1125	Brevard County	Banana	307	51	$100,000
2020	Stormwater project in Basin 1133	Brevard County	Banana	562	90	$100,000
2020	Stormwater project in Basin 1142	Brevard County	Banana	534	73	$100,000
2020	Stormwater project in Basin 1152	Brevard County	Banana	245	30	$100,000
2020	Stormwater project in Basin 1159	Brevard County	Banana	134	20	$100,000
2020	Stormwater project in Basin 1167	Brevard County	Banana	180	28	$100,000
2020	Stormwater project in Basin 1175	Brevard County	Banana	394	42	$100,000
2020	Stormwater project in Basin 1183	Brevard County	Banana	272	39	$100,000
2020	Stormwater project in Basin 1188	Brevard County	Banana	166	29	$100,000

Year Removed	Project Name	Responsible Entity	Sub-Lagoon	Total Nitrogen Reduction (pounds per year)	Total Phosphorus Reduction (pounds per year)	Plan Funding
2020	Stormwater project in Basin 1198	Brevard County	Banana	365	62	$100,000
2020	Stormwater project in Basin 1220	Brevard County	Banana	396	61	$100,000
2020	Stormwater project in Basin 1223	Brevard County	Banana	561	86	$100,000
2020	Stormwater project in Basin 1225	Brevard County	Banana	122	19	$100,000
2020	Stormwater project in Basin 1231	Brevard County	Banana	300	58	$100,000
2020	Stormwater project in Basin 1248	Brevard County	Banana	306	46	$100,000
2020	Stormwater project in Basin 1250	Brevard County	Banana	188	26	$100,000
2020	Stormwater project in Basin 1251	Brevard County	Banana	448	66	$100,000
2020	Stormwater project in Basin 1262	Brevard County	Banana	443	80	$100,000
2020	Stormwater project in Basin 1265	Brevard County	Banana	743	98	$100,000
2020	Stormwater project in Basin 1270	Brevard County	Banana	187	28	$100,000
2020	Stormwater project in Basin 1296	Brevard County	Banana	241	48	$100,000
2020	Stormwater project in Basin 1302	Brevard County	Banana	172	25	$100,000
2020	Stormwater project in Basin 1303	Brevard County	Banana	166	24	$100,000
2020	Stormwater project in Basin 1305	Brevard County	Banana	119	25	$100,000
2020	Stormwater project in Basin 1310	Brevard County	Banana	583	106	$100,000
2020	Stormwater project in Basin 1311	Brevard County	Banana	104	15	$100,000
2020	Stormwater project in Basin 1314	Brevard County	Banana	170	26	$100,000
2020	Stormwater project in Basin 1317	Brevard County	Banana	1,679	143	$125,000
2020	Stormwater project in Basin 1319	Brevard County	Banana	117	16	$100,000
2020	Stormwater project in Basin 1327	Brevard County	Banana	352	52	$100,000
2020	Stormwater project in Basin 1328	Brevard County	Banana	617	89	$100,000
2020	Stormwater project in Basin 1332	Brevard County	Banana	303	47	$100,000
2020	Stormwater project in Basin 1334	Brevard County	Banana	795	130	$100,000
2020	Stormwater project in Basin 1336	Brevard County	Banana	470	68	$100,000
2020	Stormwater project in Basin 1337	Brevard County	Banana	1,121	186	$100,000
2020	Stormwater project in Basin 1338	Brevard County	Banana	256	37	$100,000
2020	Stormwater project in Basin 1343	Brevard County	Banana	1,388	142	$100,000
2020	Stormwater project in Basin 1346	Brevard County	Banana	189	28	$100,000

Year Removed	Project Name	Responsible Entity	Sub-Lagoon	Total Nitrogen Reduction (pounds per year)	Total Phosphorus Reduction (pounds per year)	Plan Funding
2020	Stormwater project in Basin 1350	Brevard County	Banana	1,049	165	$100,000
2020	Stormwater project in Basin 1351	Brevard County	Banana	129	19	$100,000
2020	Stormwater project in Basin 1357	Brevard County	Banana	338	56	$100,000
2020	Stormwater project in Basin 1362	Brevard County	Banana	476	71	$100,000
2020	Stormwater project in Basin 1366	Brevard County	Banana	1,483	242	$100,000
2020	Stormwater project in Basin 1371	Brevard County	Banana	273	39	$100,000
2020	Stormwater project in Basin 1372	Brevard County	Banana	720	113	$100,000
2020	Stormwater project in Basin 1378	Brevard County	Banana	744	104	$100,000
2020	Stormwater project in Basin 2421	Brevard County	Banana	343	49	$100,000
2020	Stormwater project in Basin 83	Brevard County	North IRL	452	61	$100,000
2020	Stormwater project in Basin 100	Brevard County	North IRL	888	115	$100,000
2020	Stormwater project in Basin 105	Brevard County	North IRL	549	72	$100,000
2020	Stormwater project in Basin 212	Brevard County	North IRL	693	89	$100,000
2020	Stormwater project in Basin 228	Brevard County	North IRL	684	131	$100,000
2020	Stormwater project in Basin 262	Brevard County	North IRL	794	126	$100,000
2020	Stormwater project in Basin 263	Brevard County	North IRL	469	65	$100,000
2020	Stormwater project in Basin 288	Brevard County	North IRL	732	78	$100,000
2020	Stormwater project in Basin 289	Brevard County	North IRL	1,112	223	$100,000
2020	Stormwater project in Basin 290	Brevard County	North IRL	1,116	193	$100,000
2020	Stormwater project in Basin 291	Brevard County	North IRL	485	82	$100,000
2020	Stormwater project in Basin 294	Brevard County	North IRL	551	84	$100,000
2020	Stormwater project in Basin 335	Brevard County	North IRL	1,187	206	$100,000
2020	Stormwater project in Basin 353	Brevard County	North IRL	497	86	$100,000
2020	Stormwater project in Basin 354	Brevard County	North IRL	555	115	$100,000
2020	Stormwater project in Basin 392	Brevard County	North IRL	840	155	$100,000
2020	Stormwater project in Basin 408	Brevard County	North IRL	1,179	170	$125,000
2020	Stormwater project in Basin 454	Brevard County	North IRL	1,996	302	$150,000
2020	Stormwater project in Basin 510	Brevard County	North IRL	586	92	$100,000
2020	Stormwater project in Basin 512	Brevard County	North IRL	364	53	$100,000

Year Removed	Project Name	Responsible Entity	Sub-Lagoon	Total Nitrogen Reduction (pounds per year)	Total Phosphorus Reduction (pounds per year)	Plan Funding
2020	Stormwater project in Basin 513	Brevard County	North IRL	1,137	183	$100,000
2020	Stormwater project in Basin 544	Brevard County	North IRL	624	98	$100,000
2020	Stormwater project in Basin 568	Brevard County	North IRL	534	85	$100,000
2020	Stormwater project in Basin 578	Brevard County	North IRL	430	68	$100,000
2020	Stormwater project in Basin 594	Brevard County	North IRL	833	135	$100,000
2020	Stormwater project in Basin 597	Brevard County	North IRL	800	142	$100,000
2020	Stormwater project in Basin 624	Brevard County	North IRL	860	134	$100,000
2020	Stormwater project in Basin 626	Brevard County	North IRL	1,602	193	$150,000
2020	Stormwater project in Basin 644	Brevard County	North IRL	686	94	$100,000
2020	Stormwater project in Basin 660	Brevard County	North IRL	844	212	$100,000
2020	Stormwater project in Basin 677	Brevard County	North IRL	709	136	$100,000
2020	Stormwater project in Basin 751	Brevard County	North IRL	532	121	$100,000
2020	Stormwater project in Basin 759	Brevard County	North IRL	614	98	$100,000
2020	Stormwater project in Basin 796	Brevard County	North IRL	639	98	$100,000
2020	Stormwater project in Basin 805	Brevard County	North IRL	645	94	$100,000
2020	Stormwater project in Basin 806	Brevard County	North IRL	622	100	$100,000
2020	Stormwater project in Basin 827	Brevard County	North IRL	639	96	$100,000
2020	Stormwater project in Basin 838	Brevard County	North IRL	658	135	$100,000
2020	Stormwater project in Basin 840	Brevard County	North IRL	619	84	$100,000
2020	Stormwater project in Basin 862	Brevard County	North IRL	416	72	$100,000
2020	Stormwater project in Basin 871	Brevard County	North IRL	366	53	$100,000
2020	Stormwater project in Basin 884	Brevard County	North IRL	437	68	$100,000
2020	Stormwater project in Basin 889	Brevard County	North IRL	539	85	$100,000
2020	Stormwater project in Basin 890	Brevard County	North IRL	533	110	$100,000
2020	Stormwater project in Basin 894	Brevard County	North IRL	794	116	$100,000
2020	Stormwater project in Basin 896	Brevard County	North IRL	581	123	$100,000
2020	Stormwater project in Basin 902	Brevard County	North IRL	276	35	$100,000
2020	Stormwater project in Basin 903	Brevard County	North IRL	631	88	$100,000
2020	Stormwater project in Basin 920	Brevard County	North IRL	511	87	$100,000

Year Removed	Project Name	Responsible Entity	Sub-Lagoon	Total Nitrogen Reduction (pounds per year)	Total Phosphorus Reduction (pounds per year)	Plan Funding
2020	Stormwater project in Basin 921	Brevard County	North IRL	743	96	$100,000
2020	Stormwater project in Basin 922	Brevard County	North IRL	601	107	$100,000
2020	Stormwater project in Basin 938	Brevard County	North IRL	424	160	$100,000
2020	Stormwater project in Basin 939	Brevard County	North IRL	502	71	$100,000
2020	Stormwater project in Basin 940	Brevard County	North IRL	816	106	$100,000
2020	Stormwater project in Basin 952	Brevard County	North IRL	1,251	212	$100,000
2020	Stormwater project in Basin 960	Brevard County	North IRL	537	80	$100,000
2020	Stormwater project in Basin 962	Brevard County	North IRL	527	75	$100,000
2020	Stormwater project in Basin 980	Brevard County	North IRL	836	127	$100,000
2020	Stormwater project in Basin 985	Brevard County	North IRL	687	99	$100,000
2020	Stormwater project in Basin 987	Brevard County	North IRL	1,099	172	$100,000
2020	Stormwater project in Basin 993	Brevard County	North IRL	611	93	$100,000
2020	Stormwater project in Basin 1002	Brevard County	North IRL	1,181	159	$100,000
2020	Stormwater project in Basin 1016	Brevard County	North IRL	920	136	$100,000
2020	Stormwater project in Basin 1027	Brevard County	North IRL	560	84	$100,000
2020	Stormwater project in Basin 1029	Brevard County	North IRL	685	93	$100,000
2020	Stormwater project in Basin 1032	Brevard County	North IRL	719	115	$100,000
2020	Stormwater project in Basin 1033	Brevard County	North IRL	1,113	152	$100,000
2020	Stormwater project in Basin 1034	Brevard County	North IRL	902	132	$100,000
2020	Stormwater project in Basin 1037	Brevard County	North IRL	533	105	$100,000
2020	Stormwater project in Basin 1039	Brevard County	North IRL	708	104	$100,000
2020	Stormwater project in Basin 1067	Brevard County	North IRL	463	67	$100,000
2020	Stormwater project in Basin 1071	Brevard County	North IRL	1,082	144	$100,000
2020	Stormwater project in Basin 1073	Brevard County	North IRL	428	61	$100,000
2020	Stormwater project in Basin 1076	Brevard County	North IRL	595	91	$100,000
2020	Stormwater project in Basin 1077	Brevard County	North IRL	1,687	289	$150,000
2020	Stormwater project in Basin 1080	Brevard County	North IRL	861	134	$100,000
2020	Stormwater project in Basin 1081	Brevard County	North IRL	1,281	210	$100,000
2020	Stormwater project in Basin 1112	Brevard County	North IRL	1,032	166	$100,000

Year Removed	Project Name	Responsible Entity	Sub-Lagoon	Total Nitrogen Reduction (pounds per year)	Total Phosphorus Reduction (pounds per year)	Plan Funding
2020	Stormwater project in Basin 1113	Brevard County	North IRL	416	93	$100,000
2020	Stormwater project in Basin 1124	Brevard County	North IRL	681	99	$100,000
2020	Stormwater project in Basin 1128	Brevard County	North IRL	279	77	$100,000
2020	Stormwater project in Basin 1150	Brevard County	North IRL	476	57	$100,000
2020	Stormwater project in Basin 1151	Brevard County	North IRL	1,057	141	$125,000
2020	Stormwater project in Basin 1172	Brevard County	North IRL	852	123	$100,000
2020	Stormwater project in Basin 1197	Brevard County	North IRL	609	82	$100,000
2020	Stormwater project in Basin 1213	Brevard County	North IRL	904	131	$100,000
2020	Stormwater project in Basin 1214	Brevard County	North IRL	727	84	$100,000
2020	Stormwater project in Basin 1215	Brevard County	North IRL	382	52	$100,000
2020	Stormwater project in Basin 1219	Brevard County	North IRL	512	60	$100,000
2020	Stormwater project in Basin 1220	Brevard County	North IRL	396	61	$100,000
2020	Stormwater project in Basin 1221	Brevard County	North IRL	545	85	$100,000
2020	Stormwater project in Basin 1222	Brevard County	North IRL	888	171	$100,000
2020	Stormwater project in Basin 1224	Brevard County	North IRL	401	111	$100,000
2020	Stormwater project in Basin 1228	Brevard County	North IRL	501	83	$100,000
2020	Stormwater project in Basin 1231	Brevard County	North IRL	300	58	$100,000
2020	Stormwater project in Basin 1233	Brevard County	North IRL	605	101	$100,000
2020	Stormwater project in Basin 1240	Brevard County	North IRL	638	100	$100,000
2020	Stormwater project in Basin 1241	Brevard County	North IRL	584	83	$100,000
2020	Stormwater project in Basin 1244	Brevard County	North IRL	576	78	$100,000
2020	Stormwater project in Basin 1245	Brevard County	North IRL	356	49	$100,000
2020	Stormwater project in Basin 1251	Brevard County	North IRL	448	66	$100,000
2020	Stormwater project in Basin 1253	Brevard County	North IRL	379	54	$100,000
2020	Stormwater project in Basin 1259	Brevard County	North IRL	450	106	$100,000
2020	Stormwater project in Basin 1262	Brevard County	North IRL	443	80	$100,000
2020	Stormwater project in Basin 1273	Brevard County	North IRL	1,964	288	$175,000
2020	Stormwater project in Basin 1291	Brevard County	North IRL	518	79	$100,000
2020	Stormwater project in Basin 1292	Brevard County	North IRL	386	60	$100,000

Year Removed	Project Name	Responsible Entity	Sub-Lagoon	Total Nitrogen Reduction (pounds per year)	Total Phosphorus Reduction (pounds per year)	Plan Funding
2020	Stormwater project in Basin 1293	Brevard County	North IRL	461	67	$100,000
2020	Stormwater project in Basin 1294	Brevard County	North IRL	628	94	$100,000
2020	Stormwater project in Basin 1295	Brevard County	North IRL	800	121	$100,000
2020	Stormwater project in Basin 1301	Brevard County	North IRL	1,025	154	$125,000
2020	Stormwater project in Basin 1307	Brevard County	North IRL	431	47	$100,000
2020	Stormwater project in Basin 1312	Brevard County	North IRL	549	120	$100,000
2020	Stormwater project in Basin 1313	Brevard County	North IRL	619	92	$100,000
2020	Stormwater project in Basin 1316	Brevard County	North IRL	557	68	$100,000
2020	Stormwater project in Basin 1318	Brevard County	North IRL	1,124	148	$100,000
2020	Stormwater project in Basin 1324	Brevard County	North IRL	1,422	176	$150,000
2020	Stormwater project in Basin 1330	Brevard County	North IRL	639	89	$100,000
2020	Stormwater project in Basin 1331	Brevard County	North IRL	1,000	159	$100,000
2020	Stormwater project in Basin 1339	Brevard County	North IRL	857	103	$100,000
2020	Stormwater project in Basin 1344	Brevard County	North IRL	459	61	$100,000
2020	Stormwater project in Basin 1348	Brevard County	North IRL	723	102	$100,000
2020	Stormwater project in Basin 1354	Brevard County	North IRL	597	86	$100,000
2020	Stormwater project in Basin 1359	Brevard County	North IRL	887	142	$100,000
2020	Stormwater project in Basin 1361	Brevard County	North IRL	524	79	$100,000
2020	Stormwater project in Basin 1363	Brevard County	North IRL	715	123	$100,000
2020	Stormwater project in Basin 1367	Brevard County	North IRL	1,042	146	$100,000
2020	Stormwater project in Basin 1372	Brevard County	North IRL	720	113	$100,000
2020	Stormwater project in Basin 1378	Brevard County	North IRL	744	104	$100,000
2020	Stormwater project in Basin 1380	Brevard County	North IRL	929	134	$100,000
2020	Stormwater project in Basin 1382	Brevard County	North IRL	622	88	$100,000
2020	Stormwater project in Basin 1384	Brevard County	North IRL	923	142	$100,000
2020	Stormwater project in Basin 1389	Brevard County	North IRL	822	134	$100,000
2020	Stormwater project in Basin 1390	Brevard County	North IRL	612	92	$100,000
2020	Stormwater project in Basin 1391	Brevard County	North IRL	887	142	$100,000
2020	Stormwater project in Basin 1395	Brevard County	North IRL	768	114	$100,000

Year Removed	Project Name	Responsible Entity	Sub-Lagoon	Total Nitrogen Reduction (pounds per year)	Total Phosphorus Reduction (pounds per year)	Plan Funding
2020	Stormwater project in Basin 1398	Brevard County	North IRL	449	74	$100,000
2020	Stormwater project in Basin 1401	Brevard County	North IRL	953	147	$100,000
2020	Stormwater project in Basin 1403	Brevard County	North IRL	558	88	$100,000
2020	Stormwater project in Basin 1413	Brevard County	North IRL	528	78	$100,000
2020	Stormwater project in Basin 1416	Brevard County	North IRL	1,799	229	$150,000
2020	Stormwater project in Basin 1417	Brevard County	North IRL	771	117	$100,000
2020	Stormwater project in Basin 1418	Brevard County	North IRL	832	111	$100,000
2020	Stormwater project in Basin 1423	Brevard County	North IRL	487	73	$100,000
2020	Stormwater project in Basin 1425	Brevard County	North IRL	690	113	$100,000
2020	Stormwater project in Basin 1426	Brevard County	North IRL	720	116	$100,000
2020	Stormwater project in Basin 1428	Brevard County	North IRL	440	65	$100,000
2020	Stormwater project in Basin 1429	Brevard County	North IRL	477	55	$100,000
2020	Stormwater project in Basin 1434	Brevard County	North IRL	932	112	$125,000
2020	Stormwater project in Basin 1435	Brevard County	North IRL	328	43	$100,000
2020	Stormwater project in Basin 1441	Brevard County	North IRL	1,034	149	$100,000
2020	Stormwater project in Basin 1459	Brevard County	North IRL	895	132	$100,000
2020	Stormwater project in Basin 1463	Brevard County	North IRL	1,321	195	$100,000
2020	Stormwater project in Basin 1491	Brevard County	North IRL	641	93	$100,000
2020	Stormwater project in Basin 1498	Brevard County	North IRL	483	74	$100,000
2020	Stormwater project in Basin 2419	Brevard County	North IRL	381	43	$100,000
2020	Stormwater project in Basin 2420	Brevard County	North IRL	450	121	$100,000
2020	Stormwater project in Basin 2421	Brevard County	North IRL	343	49	$100,000
2020	Stormwater project in Basin 1439	Brevard County	Central IRL	1,413	183	$200,000
2020	Stormwater project in Basin 1445	Brevard County	Central IRL	1,493	198	$200,000
2020	Stormwater project in Basin 1470	Brevard County	Central IRL	2,813	452	$200,000
2020	Stormwater project in Basin 1508	Brevard County	Central IRL	2,459	356	$200,000
2020	Stormwater project in Basin 1562	Brevard County	Central IRL	3,314	449	$275,000
2020	Stormwater project in Basin 1615	Brevard County	Central IRL	2,815	390	$200,000
2020	Stormwater project in Basin 1803	Brevard County	Central IRL	2,227	318	$200,000

Year Removed	Project Name	Responsible Entity	Sub-Lagoon	Total Nitrogen Reduction (pounds per year)	Total Phosphorus Reduction (pounds per year)	Plan Funding
2020	Stormwater project in Basin 1825	Brevard County	Central IRL	1,896	394	$200,000
2021	Cape Shores Swales	City of Cape Canaveral	Banana	31	15	$2,746
2021	Justamere Road Swale	City of Cape Canaveral	Banana	6	3	$528
2021	Hitching Post Berms	City of Cape Canaveral	Banana	29	22	$2,552
2021	Oyster Bar	Brevard County	Banana	120	3	$47,350
2021	Stewart Road Dry Retrofit	City of Melbourne	North IRL	208	47	$18,344
2021	Stormwater project in Basin 1349	Brevard County	North IRL	1,747	268	$354,400
2021	Stormwater project in Basin 1409	Brevard County	North IRL	1,375	209	$293,800
2021	Indian River Drive Oyster Bar	Brevard County	North IRL	34	1	$13,258
2021	Indian River Drive Planted Shoreline	Brevard County	North IRL	9	3	$2,240
2021	Stormwater project in Basin 2191	Brevard County	Central IRL	1,925	185	$326,500
2021	Stormwater project in Basin 1511	Brevard County	Central IRL	2,409	378	$410,300
2022	Cape Canaveral Air Force Station Regional – Rapid Infiltration Basin	Brevard County	Banana	4,625	1,226	$5,227,200
2022	Brevard Zoo Banana River Plant Project	Brevard Zoo	Banana	13	4	$3,120
2022	Brevard Zoo Banana River Plant Project 2	Brevard Zoo	Banana	2	1	$480
2022	Newfound Harbor Drive	Marine Resources Council	Banana	7	2	$1,680
2022	Port St. John Wastewater Treatment Plant – Rapid Infiltration Basin	Brevard County	North IRL	4,116	915	$980,100
2022	Brevard Zoo North Indian River Lagoon Plant Project 3	Brevard Zoo	North IRL	4	1	$960
2022	Brevard Zoo Central IRL Plant Project	Brevard Zoo	Central IRL	8	3	$1,920
2022	Canebreaker Condo – Sprayfield	Brevard County	North IRL	61	To be determined	$36,000
2023	Burris Way Alley West Stormwater Low Impact Development Improvement	City of Cocoa Beach	Banana	3	0	$1,249
2023	Stormwater project in Basin CC-B2C	Brevard County	Banana	430	63	$128,000
2023	Stormwater project in Basin CC-B4B	Brevard County	Banana	411	66	$125,100
2023	Stormwater project in Basin 592	Brevard County	Banana	359	34	$109,500

Appendix E: Long Descriptions of Figures

Figure 1-1: Decline of Commercial Fishing in Brevard County

The graph shows the declining value of the commercial fishery in Brevard County using Florida Fish and Wildlife Conservation Commission data from 1995 through 2019. The commercial fishery values drop over time while fish kill counts increase with the largest peaks in 2007 and 2016. The following table is a summary of the values represented in the graph.

Reporting Year	Value of Commercial Fishery
1995	$21,808,095
1996	$24,052,219
1997	$15,027,821
1998	$11,264,215
1999	$14,765,165
2000	$15,879,487
2001	$13,096,088
2002	$6,253,406
2003	$7,155,669
2004	$8,219,153
2005	$6,314,361
2006	$6,216,198
2007	$5,127,527
2008	$8,207,268
2009	$6,166,197
2010	$6,499,390
2011	$8,354,718
2012	$7,932,126
2013	$7,278,107
2014	$6,588,523
2015	$7,960,368
2016	$6,647,791
2017	$8,444,720
2018	$6,747,679
2019	$7,925,947

Return to **Figure 1-1**.

Figure 2-2. Summary of the Save Our Indian River Lagoon Outputs and Outcomes

Graphic showing output of Public Education will result in years 0–5 early adopters lead, years 6–10 supporters join, and years 10+ lagoon friendly lifestyles are normal. Output of Reclaimed Water Upgrades, Sewer Later Rehabilitation, Septic-to-Sewer and Septic System Upgrades, and Stormwater Treatment will result in years 0–5 cleaner ground and surface water, years 6–10 cleaner lagoon water, and years 10+ lush seagrass beds. Outputs of Muck Removal and Treatment of Muck Interstitial Water will result in years 0–5 exposed sandy sediments and tons of pollution removed, years 5–10 plentiful bottom dwelling marine life, and years 10+ abundant fishes. Output of Oyster Reefs and Living Shorelines will result in years 0–5 increased filtration, years 5–10 faster storm recovery, and years 10+ healthy stability. Outputs of Project Performance Monitoring and Plan Updates will result in years 0–5 increased efficiency and cost effectiveness, years 5–10 lagoon report card shows improvement, and years 10+ the Indian River Lagoon economy grows.

Return to **Figure 2-2**.

Figure 4-1: Grass Clippings Example for a Typical Lot

Example graphic showing the potential for grass clippings to get onto and be left on a road. For a 100 foot by 100 foot lot with a 2,500 square foot home and driveway, it will produce an estimated 3,000 pounds of grass clippings per year containing 75 pounds of total nitrogen and 10.4 pounds of total phosphorus. Grass clippings can be blown into the road from an approximately 2-foot-wide strip of lawn.

Return to **Figure 4-1**.

Figure 4-2: Septic-to-Sewer Projects in Banana River Lagoon

Map showing the locations of the highest priority and high priority sewer locations within the northern portion of the Banana River Lagoon. The seven areas with the highest loading, which include Sykes Creek – Manatee Cove, North Merritt Island Zone E, Sykes Creek – Kelly Park, Sykes Creek Zone N, Merritt Island Zone C, Merritt Island Zone F, and Sykes Creek Zone M, are funded for septic removal. The map also shows the locations of all individual septic systems with loading estimates of 0–10 pounds, 10–30 pounds, and 30–50 pounds. Most are concentrated along the water in the west and southeast portions of Merritt Island with the areas closest to water being either 10–30 pounds or 30–50 pounds. The areas further from the water are 0–10 pounds. There are areas scattered across the north-central portion of Merritt Island. There is a line running north to south in the west that shows the drainage divide. The Bennett Causeway runs east to west through the middle of the map and North Courtenay Parkway runs north to south.

Return to **Figure 4-2**.

Figure 4-3: Septic-to-Sewer Projects in Banana River Lagoon, continued

Map showing the locations of the highest priority and high priority sewer locations within the southern portion of the Banana River Lagoon. The seven areas with the highest loading, which include Merritt Island Redevelopment Agency Phase 1, Merritt Island Redevelopment Agency Phase 2 Cone Road, Sykes Creek – Rotary Park, Sykes Creek Zone R, Sykes Creek Zone G, South Banana Zone B, and Sykes Creek Zone T, are funded. The map also shows the locations of all septic systems with loading estimates of 0–10 pounds, 10–30 pounds, and 30–50 pounds. These cover most of the areas near the water with the areas closest to the water being either 10–30 pounds or 30–50 pounds. The areas further from the water, including the center of Merritt Island, are 0–10 pounds. There is a line running north to south in the west that shows the drainage divide. South Tropical Trail runs north to south through most of the septic areas on this map.

Return to **Figure 4-3**.

Figure 4-4: Septic-to-Sewer Projects in Banana River Lagoon, continued

Map showing the locations of the highest priority and high priority sewer locations within the central portion of the Banana River Lagoon. None of the areas on the map are funded. The map also shows the locations of all septic systems with loading estimates of 0–10 pounds, 10–30 pounds, and 30–50 pounds. Most of Merritt Island is 10–30 pounds with a scattering of 30–50 pounds in the north portion. There are also a few areas of 0–10 pounds in the center north part of the island. There is a line running north to south in the west that shows the drainage divide. Pineda Causeway runs east to west and Rockledge Boulevard runs north to south in this area.

Return to **Figure 4-4**.

Figure 4-5: Septic-to-Sewer Projects in North IRL

Map showing the locations of the highest priority and high priority sewer locations within the northern portion of the North Indian River Lagoon. The four areas with the highest loading, which include Titusville Zone A, Titusville Zone B, Titusville Zone C, and Titusville Zone H, are funded. The map also shows the locations of all septic systems with loading estimates of 0–10 pounds, 10–30 pounds, and 30–50 pounds. The zones previously mentioned have loading in the 10–30 pounds and 30–50 pounds range. There is a sparse scatter of 0–10 pound zones over the rest of the map with two dense concentrations in the northern half of the map. There is a line running north to south in the west that shows the drainage divide. Garden Street runs east to west in the northern portion of the map and Cheney Highway/Orlando Road runs east to west in the southern part of the map. South Street loops through the map area.

Return to **Figure 4-5**.

Figure 4-6: Septic-to-Sewer Projects in North IRL, continued

Map showing the locations of the highest priority and high priority sewer locations within the north-central portion of the North Indian River Lagoon. The seven areas with the highest loading, which include Titusville Zone D, Titusville Zone E, Titusville Zone F, Titusville Zone G, Sharpes Zone A, Sharpes Zone B, and Cocoa Zone C, are funded. The map also shows the locations of all septic systems with loading estimates of 0–10 pounds, 10–30 pounds, and 30–50 pounds. These cover most of the areas near the water with the areas closest to the water being either 10–30 pounds or 30–50 pounds. The areas further from the water are 0–10 pounds. There is a line running north to south in the west that shows the drainage divide. National Aeronautics and Space Administration Causeway is at the top of the map and Indian River Drive/North Cocoa Boulevard runs north to south.

Return to **Figure 4-6**.

Figure 4-7: Septic-to-Sewer Projects in North IRL, continued

Map showing the locations of the highest priority and high priority sewer locations within the central portion of the central North Indian River Lagoon. The five areas with the highest loading, which include Cocoa Zone C, Cocoa Zones J and K, City of Rockledge Breeze Swept, City of Rockledge, and Rockledge Zone B. All are funded. The map also shows the locations of all septic systems with loading estimates of 0–10 pounds, 10–30 pounds, and 30–50 pounds. These cover most of the areas near the water with the areas closest to the water being either 10–30 pounds or 30–50 pounds. The areas further from the water are 0–10 pounds. There is a line running north to south in the west that shows the drainage divide. Bennett Causeway runs east to west in the northern portion of the map and King Street/Hubert Humphrey Causeway/Merritt Island Causeway runs east to west in the southern portion of the map. Cocoa Boulevard runs north to south in the western portion of the map and North Courtenay Parkway runs north to south in the eastern portion of the map.

Return to **Figure 4-7**.

Figure 4-8: Septic-to-Sewer Projects in North IRL, continued

Map showing the locations of the highest priority and high priority sewer locations within the south-central portion of the North Indian River Lagoon. The areas of City of Rockledge Breeze Swept, City of Rockledge, Rockledge Zone B, South Central Zone A, and South Central – Riverwalk are funded. The map also shows the locations of all septic systems with loading estimates of 0-10 pounds, 10–30 pounds, and 30–50 pounds. These cover most of the areas near the water with the areas closest to the water being either 10–30 pounds or 30–50 pounds. The areas further from the water are 0–10 pounds. Rockledge Zone C is not along the water and has areas near the center that are 10–30 pounds or 30–50 pounds and the areas near the east and west sides are 0–10 pounds. There is a line running north to south in the west that shows the drainage divide. The Merritt Island Causeway runs east to west at the top of the map. Cocoa Boulevard/Rockledge Boulevard runs north to south in the western portion of the map and South Tropical Trail runs north to south in the eastern portion of the map.

Return to **Figure 4-8**.

Figure 4-9: Septic-to-Sewer Projects in North IRL, continued

Map showing the locations of the highest priority and high priority sewer locations within the southern portion of the North Indian River Lagoon. The areas of South Central Zone C, South Central Zone D (Brevard), South Central Zone D (Melbourne), City of Melbourne Riverside, City of Melbourne Zone A, City of Melbourne Kent, and City of Melbourne Villa Espana are funded. The map also shows the locations of all septic systems with loading estimates of 0–10 pounds, 10–30 pounds, and 30–50 pounds. These cover most of the areas near the water with the areas closest to the water being either 10–30 pounds or 30–50 pounds. The areas further from the water are 0–10 pounds. There is a line running north to south in the west that shows the drainage divide. Pineda Causeway runs east to west in the middle of the map. Rockledge Drive runs north to south in the western portion of the map and South Tropical Trail runs north to south in the eastern portion.

Return to **Figure 4-9**.

Figure 4-10: Septic-to-Sewer Projects in North IRL, continued

Map showing the locations of the highest priority and high priority sewer locations within the southern portion of the North Indian River Lagoon. The areas of City of Melbourne Riverside, City of Melbourne Zone A, City of Melbourne Kent, City of Melbourne Villa Espana, City of Melbourne Bowers, South Central Zone F, South Beaches Zone A, South Beaches Zone P, and South Beaches Zone O are funded. The map also shows the locations of all septic systems with loading estimates of 0–10 pounds, 10–30 pounds, and 30–50 pounds. These cover most of the areas near the water with the areas closest to the water being either 10–30 pounds or 30–50 pounds. The areas further from the water are 0–10 pounds. There are clusters of all three types of loading in the west-central and southwest part of the map. There is a line running north to south in the west that shows the drainage divide. Eau Gallie Boulevard runs east to west in the middle of the map. Dixie Highway runs north to south in the western portion of the map and Patrick Drive runs north to south in the eastern portion.

Return to **Figure 4-10**.

Figure 4-11: Septic-to-Sewer Projects in Central IRL

Map showing the locations of the highest priority and high priority sewer locations within the northern portion of the Central Indian River Lagoon. The funded areas include City of West Melbourne Dundee Place and Manor Place, City of West Melbourne Lake Ashley Circle, City of West Melbourne Sylvan Estates, City of Melbourne Roxy, City of Melbourne Pennwood, City of Melbourne Hoag, and City of Melbourne Avenida del Rio are funded. The map also shows the locations of all septic systems with loading estimates of 0–10 pounds, 10–30 pounds, and 30–50 pounds. These cover some of the areas near the water with the areas closest to the water being 30–50 pounds. The areas further from the water are 0–10 pounds and 10–30 pounds mostly clustered in the center of the map just west of the Melbourne Causeway along U.S. 192 and approximately 4 miles west of U.S. 192 in West Melbourne. New Haven Avenue/Melbourne Causeway runs east to west through the middle of the map. Babcock Street runs north to south in the middle of the map and Dixie Highway runs north to south closer to the eastern portion of the map.

Return to **Figure 4-11**.

Figure 4-12: Septic-to-Sewer Projects in Central IRL, continued

Map showing the locations of the highest priority and high priority sewer locations within the southern portion of the Central Indian River Lagoon. The funded areas include City of Palm Bay Zones A and B. The map also shows the locations of all septic systems with loading estimates of 0–10 pounds, 10–30 pounds, and 30–50 pounds. These cover about 30% of the map with a few areas closest to the water being either 10–30 pounds or 30–50 pounds. The areas further from the water are 0–10 pounds and tightly clustered in the western part of the map west of Babcock Street in the Malabar area. There are clusters of all three types of loading away from the water in the central and south central part of the map. Babcock Street runs north to south in the western portion of the map and Dixie Highway runs north to south in the western portion.

Return to **Figure 4-12**.

Figure 4-13: Septic-to-Sewer Projects in Central IRL, continued

Map showing the locations of the highest priority and high priority sewer locations within the south central portion of the Central Indian River Lagoon. None of the areas on this map are funded. The map also shows the locations of all septic systems with loading estimates of 0–10 pounds, 10–30 pounds, and 30–50 pounds. These cover half of the areas near the water on the Barrier Island on the eastern portion of the map. There are isolated clusters of high loading areas along the waterfront on the mainland or western side of the map. There are clusters of all three types of loading away from the water in the west-central and southwest part of the map. Highway A1A runs north to south in the middle of the map.

Return to **Figure 4-13**.

Figure 4-14: Septic-to-Sewer Projects in Central IRL, continued

Map showing the locations of the highest priority and high priority sewer locations within the southern portion of the Central Indian River Lagoon. The funded areas include Micco Zones A and B. The map also shows the locations of all septic systems with loading estimates of 0–10 pounds, 10–30 pounds, and 30–50 pounds. These cover most of the areas near the water and along the Saint Sebastian River with the areas closest to the water being either 10–30 pounds or 30–50 pounds. The areas further from the water in the northwestern portion of the map are 30–50 pounds. There are clusters of all three types of loading in the northwestern and southern part of the map. Dixie Highway runs north to south in the middle of the map and Highway A1A runs north to south in the western portion of the map.

Return to **Figure 4-14**.

Figure 4-15: Quick Connection Septic-to-Sewer Locations in North Brevard County

Map showing the locations of properties eligible to receive reimbursement to connect to a sewer system in the northern portion of the north Indian River Lagoon. Dots scattered along the map indicate whether the owner can connect to a force main or gravity type sewer and whether the parcel is a high priority. On this map, the dots are mostly near the water. Approximately half are for force main connections and half are for gravity sewer connections. There is a line running north to south in the west that shows the drainage divide. These sites are located north and south of the National Aeronautics and Space Administration Causeway on the western side of the lagoon.

Return to **Figure 4-15**.

Figure 4-16: Quick Connection Septic-to-Sewer Locations in Central Brevard County

Map showing the locations of properties eligible to receive reimbursement to connect to a sewer system in the central Indian River Lagoon. Dots scattered along the map indicate whether the owner can connect to a force main or gravity type sewer and whether the parcel is a high priority. On this map, the dots are mostly near the water and tightly clustered in the northern portion of the map on Merritt Island. There are a few scattered near the water in the southern portion of the map south of the Pineda Causeway. Approximately half are for force main connections and half are for gravity sewer connections. There is a line running north to south in the west that shows the drainage divide. The sites are located near the Merritt Island Causeway to the northern portion of the map and Pineda Causeway to the southern portion of the map.

Return to **Figure 4-16**.

Figure 4-17: Quick Connection Septic-to-Sewer Locations in South Brevard County

Map showing the locations of properties eligible to receive reimbursement to connect to a sewer system in the southern portion of the Indian River Lagoon in Brevard County. Dots scattered along the map indicate whether the owner can connect to a force main or gravity type sewer and whether the parcel is a high priority. On this map, the dots are mostly near the water and tightly clustered in the northern portion of the map near Melbourne and Eau Gallie. There are a few scattered near the water in the central portion of the map near Malabar. Approximately 20% are for force main connections and approximately 80% are for gravity sewer connections. There is a line running north to south in the west that shows the drainage divide.

Return to **Figure 4-17**.

Figure 4-18: Example In-Ground Nitrogen-Reducing Biofilter Septic System

This a diagram showing how an in-ground nitrogen reducing biofilter is constructed. It shows a septic tank to the left with a pipe leading out of it with an arrow showing the direction of water flow to the drainfield. The drainfield area is depicted as an 18-inch layer of soil above a 12-inch layer of woodchips or other denitrification media. There is a layer below these that shows an empty space which indicates native soil that should be at least six inches above the seasonal high water table.

Return to **Figure 4-18**.

Figure 4-19: Septic System Upgrades in North Brevard County

Map showing the locations of properties eligible to receive reimbursement to install an upgraded septic system in the northern portion of Brevard County along the Indian River Lagoon. Dots scattered along the map indicate whether the owner is eligible to receive reimbursement. On this map, the dots are mostly near the water and scattered from north to south. There is a line running north to south in the west that shows the drainage divide. The National Aeronautics and Space Administration Causeway runs east to west near the southern part of the map.

Return to **Figure 4-19**.

Figure 4-20: Septic System Upgrades in Central Brevard County

Map showing the locations of properties eligible to receive reimbursement to install an upgraded septic system in the central portion of Brevard County along the Indian River Lagoon. Dots scattered along the map indicate whether the owner is eligible to receive reimbursement. On this map, the dots are mostly near the water and scattered from north to south on Merritt Island. There is a line running north to south in the west that shows the drainage divide. The Bennett Causeway and Merritt Island Causeway run east to west in the northern portion of the map. Rockledge Parkway runs north to south on the western side and Courtenay Parkway runs north to south on the eastern side of the lagoon.

Return to **Figure 4-20**.

Figure 4-21: Septic System Upgrades in South Brevard County

Map showing the locations of properties eligible to receive reimbursement to install an upgraded septic system in the southern portion of Brevard County along the Indian River Lagoon. Dots scattered along the map indicate whether the owner is eligible to receive reimbursement. On this map, the dots are mostly near the water and scattered from north to south on along U.S. 1 and about one to three miles inland. There is a line running north to south in the west that shows the drainage divide. The Eau Gallie Causeway and 5th Avenue run east to west near the top of the map Babcock Street runs north to south in the middle of the map.

Return to **Figure 4-21**.

Figure 4-22: Stormwater Projects in North Brevard County

Map showing the selected basins for stormwater treatment in the northern portion of the Banana River Lagoon and North Indian River Lagoon in Brevard County. Project areas cover roughly 60% of the shoreline on the mainland and are all part of the North Indian River Lagoon. Project areas cover roughly 75% of North Merritt Island and half are part of the North Indian River Lagoon while the other half are part of the Banana River Lagoon. Project areas cover roughly 85% of the Barrier Island and all are part of the Banana River Lagoon.

Return to **Figure 4-22**.

Figure 4-23: Stormwater Projects in Central Brevard County

Map showing the selected basins for stormwater treatment in the southern portion of the Banana River Lagoon and North Indian River Lagoon in Brevard County. Project areas cover roughly 50% of the shoreline on the mainland and are all part of the North Indian River Lagoon. Project areas cover roughly 70% of South Merritt Island and half are part of the North Indian River Lagoon while the other half are part of the Banana River Lagoon. Project areas cover roughly 80% of the Barrier Island and all are part of the Banana River Lagoon.

Return to **Figure 4-23**.

Figure 4-24: Stormwater Projects in South Brevard County

Map showing the selected basins for stormwater treatment in the Central Indian River Lagoon for Brevard County. There is one project area on the Barrier Island on the north end of the map that is part of the Banana River Lagoon. Project areas for the Central Indian River Lagoon cover roughly 30% of the shoreline and are concentrated in the north half of the mainland with two sections also on the Barrier Island. Ten project areas are scattered inland from the shoreline in the southern half of the map.

Return to **Figure 4-24**.

Figure 4-25: Location of Muck Removal Projects in the Northern Banana River Lagoon

Map of the northern Banana River Lagoon in Brevard County showing the locations of the funded and unfunded muck removal projects. There are four unfunded projects in the very northern part of the Banana River Lagoon near the top of the map. Towards the bottom of the map, just south of State Highway 528, there are two funded projects: Canaveral South is along the Barrier Island shoreline and Merritt Island Phase I is along the Merritt Island shoreline. Additional unfunded projects are located at the bottom of the map, as well as the canals on Merritt Island.

Return to **Figure 4-25**.

Figure 4-26: Location of Muck Removal Projects in the Southern Banana River Lagoon

Map of the southern Banana River Lagoon in Brevard County showing the locations of the funded and unfunded muck removal projects. Towards the top of the map, just south of State Highway 528, are three funded projects. Canaveral South is along the Barrier Island shoreline. Merritt Island Phase I is just to the south and west along the Merritt Island shoreline. The Sykes Creek project is a little further south and west from that project. Further south, below State Highway 520, is the Cocoa Beach IIB project along the Barrier Island shoreline. South of that is the Cocoa Beach Phase III project. To the west of that is the Cocoa Beach Golf project. About six miles south along the Barrier Island is the Patrick Space Force Base project. To the west of that is the Pineda Banana River Lagoon project near the Merritt Island shoreline. South of that project, and south of State Highway 404 is the Grand Canal project on the Barrier Island. South of that project is the Satellite Beach project followed by the Indian Harbour Beach project.

Return of **Figure 4-26**.

Figure 4-27: Location of Muck Removal Projects in North IRL

Map of the North Indian River Lagoon in Brevard County showing the locations of the funded and unfunded muck removal projects. There are six funded projects. Titusville Railroad West is at the top of the map along the mainland shoreline. Just east of that on the Merritt Island shoreline is the Titusville Railroad East project. The National Aeronautics and Space Administration Causeway East project is about 10 miles south along the Merritt Island shoreline and just north of State Highway 405. The Rockledge A project is about 15 miles south along the Merritt Island shoreline. The Eau Gallie Northeast project is about 9 miles south near the Merritt Island shoreline. The Spring Creek project is located about two miles south and near the bottom of the map on the mainland.

Return to **Figure 4-27**.

Figure 4-28: Location of Muck Removal Projects in Central IRL

Map of the Central Indian River Lagoon in Brevard County showing the locations of the funded and unfunded muck removal projects. The only funded projects are the Turkey Creek project, which is about three miles south of U.S. Highway 192 along the mainland shoreline, and Sunnyland, which is on the barrier island near the south end of the map.

Return to **Figure 4-28**.

Figure 4-29: Phase I Potential Enhanced Circulation Project Locations

Map of Brevard County showing a 40 square mile area where potential enhanced circulation projects could be located. The St. Johns River Water Management District identified potential projects the following areas: one in the southern part of the Mosquito Lagoon, one in the northern part of the Banana River Lagoon, two in Cape Canaveral, one at Patrick Air (Space) Force Base, and one at Malabar. They identified four internal projects with one at the north end of Merritt Island, two around Haulover Canal, and one in central Merritt Island. CDM Smith identified 23 additional potential project locations both internal and external spread throughout Brevard County with a heavy concentration around central Merritt Island.

Return to **Figure 4-29**.

Figure 4-30: Shoreline Survey to Identify Locations Appropriate for Oyster Bars and Planted Shorelines

Map of Brevard County showing the shoreline survey edge types including bulkhead and seawall, hardened slope and riprap, and no structures. No structures were found mainly in the northern portion of Brevard County on the mainland and also around the central part of Merritt Island near Kennedy Space Center. There were also small concentrations on the southern part of Merritt Island in the Banana River Lagoon and on the southern portion of the Barrier Island. The rest of the shoreline was interspersed with both bulkhead and seawall types and hardened slope and riprap types. A large concentration of bulkhead and seawall was found on the western shore of Merritt Island, along Sykes Creek, in Cocoa Beach, and much of the west coast of the central Barrier Island.

Return to **Figure 4-30**.

Figure 4-31: Estimated Economic Value of Some Seagrass Services

Graphic showing the economic value provided by seagrass adapted from Dewsbury et. al. (2016). Seagrass provide direct grazing by turtles, manatees, fish, and snails, which has an unknown economic value. It is also nursery grounds for fish and crabs and benefit coral reefs, commercial fisheries, and recreation for a $4,600 per acre per year economic value. Additionally, it sequesters carbon, which reduces carbon dioxide for a $162 per acre per year economic value. It also reduces wave energy, which leads to sediment stability and improved water quality for an unknown economic benefit. Finally, it cycles and sequesters nutrients for an economic value of $7,695 per acre per year. Seagrasses provide a total economic benefit of $12,457 per acre per year. In 2007, there were 72,400 acres providing a total benefit of more than $902,000,000.

Return to **Figure 4-31**.

Figure 4-32: Completed Projects in North Brevard County

Map of North Brevard County showing locations of 17 completed projects. Near the top of the map, the Basin 10 County Line Road woodchip bioreactor is located at the north end on the west shore of the Indian River Lagoon. About two and a half miles southeast of that is the Basin 22 Huntington Road Serenity Park woodchip bioreactor. One mile southwest of that is the Basin 51 Johns Road pond biosorption activated media. About a half mile southeast of that is the County stormwater pond harvesting. Two miles south is Basin 100 Burkholm Road biosorption activated media. A half mile south of that is Basin 115 Carter Road biosorption activated media. One mile south of that is the Basin 141 Irwin Avenue woodchip bioreactor. One mile south of that is the Basin 193 Wiley Avenue biosorption activated media. A half mile south of that is Mims muck removal. About three miles south is Coleman Pond managed aquatic plant system. About a mile southeast is the Osprey Plant pond managed aquatic plant system and Marina B managed aquatic plant system. About a half mile southwest is the Draa Field vegetation harvesting and Draa Field pond managed aquatic plant systems. One mile southeast is the South Street baffle box. Two miles south of that is St. Theresa baffle box. A half mile south of that is the La Paloma baffle box.

Return to **Figure 4-32**.

Figure 4-33: Completed Projects in North Central Brevard County

Map of North Central Brevard County showing locations of 9 completed projects. Near the top of the map is the Basin 832 Broadway Pond biosorption activated media. Six miles south of that is the floating wetlands to existing stormwater ponds. Two miles south of that is the Church Street baffle box. Two miles south of that is the Breeze Swept septic removal. In the southern part of Merritt Island is the Merritt Island Redevelopment Agency Septic Removal Phase 1 and Phase 2 septic removal projects. In the southern part of the Barrier Island is the Central Boulevard baffle box. About five miles south of that is the Cocoa Beach Water Reclamation Facility upgrade and Cocoa Beach muck dredging Phase III.

Return to **Figure 4-33**.

Figure 4-34: Completed Projects in Central Brevard County

Map of Central Brevard County showing locations of 10 completed projects. Near the top of the map is the Basin 1298 bioreactor. Two miles south of that is the Sherwood Park stormwater quality project. One mile south of that is the Thrush Drive baffle box. One mile southeast of that is the Cliff Creek baffle box. About six miles southwest of that is the Sylvan Estates septic-to-sewer conversion project. In the southern part of the Barrier Island is the Basin 1304 bioreactor. Two miles south of that is the Jackson Court stormwater treatment facility. Three miles south of that is the Big Muddy at Cynthia baffle box. About one mile southwest of that is the Gleason Park reuse. About four miles south of that is the Basin 5 dry retention project.

Return to **Figure 4-34**.

Figure 4-35: Completed Projects in South Brevard County

Map of south Brevard County showing locations of 4 completed projects. Near the top of the map is the Bayfront stormwater project and Turkey Creek muck removal. About 12 miles southeast of that is the Basin 2134 Fleming Grant biosorption activated media. Near the bottom of the map on the Barrier Island is the Long Point package plant upgrade.

Return to **Figure 4-35**.

Figure 4-36: Countywide Groundwater Nutrient Concentrations for TN (top) and TP (bottom)

Bar graphs showing the total nitrogen (TN) and total phosphorus (TP) concentrations in groundwater for four areas: natural or undeveloped, septic system communities, sewer communities, and reclaimed water communities. The following table summarizes the values shown in the bar graphs.

Area	Total Nitrogen Concentration (milligrams per liter)	Total Phosphorus Concentration (milligrams per liter)
Natural, Undeveloped Area	0.47	0.16
Septic Communities	5.88	1.01
Sewer Communities	2.10	0.19
Reclaimed Water Communities	6.41	0.28

Return to **Figure 4-36**.

Figure 4-37. Effluent Concentrations from Interstitial Water Treatment at Grand Canal

A scatterplot showing the effluent concentrations from interstitial water treatment at Grand Canal with total nitrogen (TN) on the left axis and total phosphorus (TP) on the right axis. The blue horizontal line indicates the nitrogen effluent target (3 milligrams per liter) while the green line indicates the phosphorus effluent target (0.075 milligrams per liter). The following table summarizes the values shown in the chart.

Sample Date	Total Nitrogen (milligrams per liter)	Total Phosphorus (milligrams per liter)	Sample Date	Total Nitrogen (milligrams per liter)	Total Phosphorus (milligrams per liter)
3/22/2022	27.00	0.30000	7/18/2022	0.95	0.01580
3/23/2022	37.00	0.35000	7/19/2022	0.93	0.01530
3/24/2022	25.00	0.23000	7/20/2022	0.82	0.03160
3/25/2022	26.00	0.30000	7/21/2022	1.00	0.03920
3/26/2022	38.00	0.20000	7/22/2022	0.98	0.03770
3/28/2022	36.00	0.32000	7/23/2022	0.84	0.03950
3/29/2022	33.00	0.21000	7/25/2022	0.85	0.00970
3/30/2022	33.00	0.45000	7/26/2022	0.93	0.00970
3/31/2022	18.00	0.19000	7/27/2022	0.94	0.01640
4/1/2022	14.00	0.16000	7/28/2022	5.90	0.00970
4/2/2022	11.00	0.05000	7/29/2022	6.10	0.00970
4/4/2022	16.00	0.07600	7/30/2022	2.50	0.00970
4/5/2022	19.00	0.10000	8/1/2022	2.30	0.00970
4/18/2022	5.70	0.07100	8/2/2022	2.20	0.00970
4/20/2022	2.80	0.01040	8/4/2022	1.90	0.01410
4/21/2022	1.40	0.04350	8/5/2022	0.86	0.00970
4/22/2022	1.30	0.03320	8/6/2022	0.89	0.00970
4/23/2022	2.30	0.02560	8/8/2022	1.80	0.00970
4/25/2022	9.40	0.00970	8/9/2022	2.70	0.00970
4/26/2022	7.80	0.04240	8/10/2022	2.40	0.00970
4/27/2022	3.60	0.02620	8/11/2022	3.00	0.00970
4/28/2022	2.10	0.05850	8/12/2022	1.30	0.01770
4/29/2022	1.40	0.00970	8/13/2022	1.20	0.00970
5/2/2022	1.10	0.00970	8/15/2022	1.10	0.00970
5/3/2022	2.10	0.00970	8/18/2022	1.20	0.01900
5/5/2022	1.50	0.00970	8/20/2022	1.10	0.01270
5/6/2022	1.70	0.00970	8/22/2022	1.10	0.01790
5/7/2022	3.50	0.02120	8/23/2022	0.97	0.00970
5/9/2022	2.40	0.00970	8/24/2022	1.00	0.00970
5/11/2022	2.50	0.00970	8/25/2022	0.98	0.00970
5/12/2022	1.50		8/26/2022	0.63	0.00970
5/13/2022	2.40	0.05510	8/27/2022	1.70	0.00970
5/14/2022	1.40	0.12300	8/29/2022	0.91	0.01520
5/16/2022	1.40	0.08160	8/30/2022	1.60	0.00970
5/17/2022	1.60	0.03770	8/31/2022	1.30	0.00970
5/18/2022	1.70	0.05290	9/10/2022	1.70	0.00970
5/19/2022	3.70	0.03330	9/12/2022	1.60	0.01370
5/20/2022	1.30	0.03880	9/13/2022	1.70	0.00970
5/21/2022	1.70	0.01110	9/14/2022	1.00	0.02730
5/23/2022	1.60	0.01140	9/15/2022	1.40	0.00970
5/24/2022	0.86	0.01050	9/16/2022	1.40	0.00970
5/25/2022	1.00	0.01120	9/17/2022	1.00	0.20800
5/26/2022	1.60	0.02050	9/19/2022	1.10	0.14900
5/27/2022	0.91	0.06420	9/20/2022	0.93	0.00970
5/28/2022	0.66	0.01470	9/21/2022	2.20	0.01050
5/31/2022	0.66	0.01750	9/22/2022	1.10	0.00970

Sample Date	Total Nitrogen (milligrams per liter)	Total Phosphorus (milligrams per liter)	Sample Date	Total Nitrogen (milligrams per liter)	Total Phosphorus (milligrams per liter)
6/1/2022	1.80	0.14700	9/23/2022	1.30	0.15600
6/2/2022	2.10	0.04650	9/24/2022	1.30	0.01850
6/3/2022	1.80	0.08280	9/26/2022	43.00	0.00970
6/6/2022	0.98	0.07550	10/1/2022	1.50	0.00970
6/9/2022	1.10	0.04900	10/4/2022	0.63	0.00970
6/10/2022	1.20	0.50300	10/5/2022	1.20	0.00970
6/11/2022	22.00	0.01690	10/6/2022	1.60	0.00970
6/13/2022	13.00	0.06290	10/7/2022	1.80	0.00970
6/14/2022	5.80	0.07740	10/8/2022	1.60	0.00970
6/15/2022	5.30	0.05940	10/10/2022	1.60	0.00970
6/16/2022	1.60	0.06210	10/12/2022	1.10	0.00970
6/17/2022	1.80	0.06440	10/13/2022	0.71	0.00970
6/20/2022	1.90	0.06930	10/14/2022	0.63	0.00970
6/21/2022	1.30	0.04480	10/15/2022	6.80	0.00970
6/22/2022	1.10	0.04350	10/17/2022	6.50	0.00973
6/23/2022	5.90	0.02070	10/18/2022	0.12	0.00970
6/24/2022	4.50	0.09310	10/19/2022	0.62	0.00970
6/25/2022	1.10	0.07900	10/20/2022	0.10	0.00970
6/27/2022	18.00	0.05910	10/21/2022	2.70	0.00970
6/28/2022	12.00	0.06740	10/22/2022	1.30	0.00970
6/29/2022	24.00	0.05230	10/24/2022	1.30	0.00970
6/30/2022	1.10	0.04970	10/25/2022	4.50	0.00970
7/1/2022	1.10	0.06850	10/26/2022	2.60	0.00970
7/2/2022	1.10	0.06340	10/27/2022	2.00	0.00970
7/5/2022	1.10	0.06230	10/28/2022	1.30	0.00970
7/6/2022	1.10	0.09030	10/29/2022	2.20	0.00970
7/7/2022	1.30	0.10600	10/31/2022	2.10	0.00970
7/11/2022	4.50	0.09820	11/1/2022	0.84	0.00970
7/12/2022	4.10	0.17900	11/2/2022	1.20	0.00970
7/13/2022	1.00	0.00970	11/4/2022	1.40	0.00970
7/14/2022	1.10	0.01430	11/5/2022	1.10	0.00970
7/15/2022	1.10	0.01670	11/7/2022	0.43	0.00970
7/16/2022	1.10	0.01670	-	-	-

Return to **Figure 4-37**.

Figure 4-38: Effluent Concentrations from Interstitial Water Treatment at Sykes Creek

A scatterplot showing the effluent concentrations from interstitial water treatment at Sykes Creek with total nitrogen (TN) on the left axis and total phosphorus (TP) on the right axis. The blue horizontal line indicates the nitrogen effluent target (3 milligrams per liter) while the green line indicates the phosphorus effluent target (0.075 milligrams per liter). The following table summarizes the values shown in the chart.

Sample Date	Total Nitrogen (milligrams per liter)	Total Phosphorus (milligrams per liter)	Sample Date	Total Nitrogen (milligrams per liter)	Total Phosphorus (milligrams per liter)
8/16/2022	3.000	0.0323	10/6/2022	4.400	0.0097
8/17/2022	13.000	0.0097	10/7/2022	2.200	0.0097
8/18/2022	12.000	0.0273	10/8/2022	3.500	0.0097
8/19/2022	1.900	0.0097	10/10/2022	4.800	0.0097
8/20/2022	2.100	0.0097	10/11/2022	0.990	0.0160
8/21/2022	1.800	0.0097	10/12/2022	1.200	0.0097

Sample Date	Total Nitrogen (milligrams per liter)	Total Phosphorus (milligrams per liter)	Sample Date	Total Nitrogen (milligrams per liter)	Total Phosphorus (milligrams per liter)
8/22/2022	0.770	0.0097	10/13/2022	0.890	0.0097
8/24/2022	3.400	0.0097	10/14/2022	0.460	0.0097
8/26/2022	1.000	0.0097	10/15/2022	1.300	0.0097
8/29/2022	1.800	0.0300	10/18/2022	0.080	0.0269
8/30/2022	1.100	0.0097	10/19/2022	0.590	0.0097
8/31/2022	2.500	0.0097	10/20/2022	0.037	0.0097
9/1/2022	1.200	0.0214	10/21/2022	1.700	0.0097
9/2/2022	1.700	0.0097	10/22/2022	3.300	0.0097
9/6/2022	0.840	0.0097	10/24/2022	0.970	0.0097
9/7/2022	1.300	0.0438	10/25/2022	4.500	0.0097
9/8/2022	0.630	0.0097	10/26/2022	2.600	0.0180
9/9/2022	2.400	0.0131	10/27/2022	2.000	0.0097
9/10/2022	1.400	0.0097	10/28/2022	0.860	0.0210
9/12/2022	1.400	0.0097	10/29/2022	1.000	0.0097
9/13/2022	0.790	0.0259	10/31/2022	0.980	0.0097
9/14/2022	0.570	0.0328	11/1/2022	2.200	0.0097
9/15/2022	1.600	0.0147	11/2/2022	1.600	0.0097
9/16/2022	5.800	0.0303	11/3/2022	1.700	0.0097
9/20/2022	1.300	0.0097	11/4/2022	0.900	0.0097
9/21/2022	0.840	0.0161	11/7/2022	0.370	0.0097
9/22/2022	1.800	0.0097	11/8/2022	1.200	0.0097
9/23/2022	0.610	0.0204	11/11/2022	2.800	0.0097
9/24/2022	1.900	0.0327	11/12/2022	3.800	0.0097
9/26/2022	1.400	0.0097	11/14/2022	1.400	0.0097
10/3/2022	2.400	0.0097	11/17/2022	0.570	0.0097
10/4/2022	5.100	0.0097	11/18/2022	3.500	0.0097
10/5/2022	8.000	0.0097	11/19/2022	1.700	0.0097

Return to **Figure 4-38**.

Figure 4-39: Distribution of Oyster Sizes, Age, and Average Number of Measured Oysters Per Unit

A bar chart showing the distribution of oyster sizes, as of most recent monitoring, for oyster sites located within the Banana River Lagoon, North Indian River Lagoon, and Central Indian River Lagoon. At each site, there are two bars for the number of oysters at the start of the bar creation and the number at the time of sampling. The number of settlers, subadults, adults, and large adults are shown. The following table summarizes the values shown in the bar graph.

Location	Settler	Subadult	Adult	Large Adult
Riverview Senior	30.8	10.0	7.9	0.0
Bomalaski	0.5	0.0	15	0.0
Bettinger	0.0	0.0	0.3	0.0
Gitlin	0.0	0.0	0.4	0.6
Marina Isles	0.8	1.7	17.2	2.2
Coconut Point	0.2	0.1	0.0	0.0
Hog Point	3.0	10.8	20.8	5.0
Maritime Hammock	6.8	13.8	21.6	4.4
Ahmed Niland	26.1	2.7	5.6	1.8
MacNiel Pitner	14.2	9.2	13.5	1.6
Riverside Drive	0.1	0.9	1.8	0.1
Dragon Point	11.0	13.1	5.0	0.0
Sands	4.6	6.4	14.8	0.2

Location	Settler	Subadult	Adult	Large Adult
Wexford	34.2	8.3	6.0	1.0
Melbourne Beach	30.0	12.1	7.6	0.3
Palm Bay	34.0	13.8	2.3	0.0
North1	2.2	18.3	21.4	3.6
Ryckman	27.5	22.0	0.5	0.0
Castaway Cove	26.6	0.0	0.0	0.0

Return to **Figure 4-39**.

Figure 4-40: Average Number of Measured Oysters in Each Size Class for Ultraviolet Stabilized Plastic Mesh Bags (left) and Galvanized After Welding Steel Gabions (right)

A bar chart showing the average number of measured oysters in each size class per monitored unit at the Wexford oyster bar for modules constructed from ultraviolet stabilized plastic mesh bags and galvanized after welding steel gabions. Each bar represents the age of the project for each monitoring event. The number of settlers, subadults, adults, and large adults are shown. The following table summarizes the values shown in the bar graph.

Location	Settler	Subadult	Adult	Large Adult
Wexford Bags 0 year	Not applicable	Not applicable	Not applicable	Not applicable
Wexford Bags 0.08 year	5.8	0.2	0.0	0.0
Wexford Bags 0.25 year	8.5	0.8	0.0	0.0
Wexford Bags 0.5 year	6.3	17.5	0.8	0.0
Wexford Bags 1 year	14.8	29.3	5.0	0.0
Wexford Bags 1.5 years	36.8	7.7	4.3	0.0
Wexford Gabions 0 year	Not applicable	Not applicable	Not applicable	Not applicable
Wexford Gabions 0.08 year	32.2	2.3	0.0	0.0
Wexford Gabions 0.25 year	32.2	11.0	1.0	0.0
Wexford Gabions 0.5 year	12.0	25.2	5.5	0.0
Wexford Gabions 1 year	9.3	22.3	17.2	1.2
Wexford Gabions 1.5 years	31.5	8.8	7.7	2.0

Return to **Figure 4-40**.

Figure 5-2: Evolution of Project Funding Allocations

Series of pie charts showing the percent distribution of funding from the original plan to each of the plan updates in 2017, 2018, 2019, 2020, 2021, 2022, and 2023. Public education makes up about 0% of the total funding in all years except 2022 and 2023 when it is about 1%. Wastewater facility upgrades for reclaimed water were 3% of the costs in the original plan and 2017 Supplement; 4% in the 2018 Update; 7% in the 2019 Update; 6% in the 2020, 2021, and 2022 Updates; and 7% in the 2023 Update. Rapid infiltration basins/sprayfield upgrades were added in the 2019 Update as 1% of the cost, 2% in the 2020 and 2021 Updates, and 0% in the 2022 and 2023 Updates. Package plant connections were added in the 2021 Update and represent 1% of the costs, also in the 2022 Update and 0% of the costs in the 2023 Update. Sewer laterals were added in the 2019 Update and represent about 0% of the cost in all years. Septic-to-sewer was 14% of the cost in the original plan and 2017 Supplement, 13% in the 2018 Update, 26% in the 2019 Update, 30% in the 2020 and 2021 Updates, 31% in the 2022 Update, and 32% in the 2023 Update. Septic system upgrades were 7% of the cost in the original plan and 2017 Supplement, 6% in the 2018 and 2019 Updates, and 7% in the 2020, 2021, 2022, and

2023 Updates. Stormwater projects were 4% of the costs in the original plan and 2017 and 2018 Updates; 11% in the 2019 Update; 12% in the 2020 Update; 11% in the 2021 and 2022 Updates; and 16% in the 2023 Update. Vegetation harvesting was added in the 2021 Update and is about 0% of the cost in the 2021 and 2022 Updates and 1% of the costs in the 2023 Update. Muck removal was 66% of the cost in the original plan and 2017 Supplement, 58% in the 2018 Update, 30% in the 2019 Update, 27% in the 2020 Update, 26% in the 2021 and 2022 Updates, and 27% in the 2023 Update. Treatment of interstitial water was added in the 2019 Update at 13% of the costs, 12% in the 2020 Update, and 11% in the 2021, 2022, and 2023 Updates. Oyster bars and living shorelines were 3% of the costs in the original plan through the 2019 Update, and 2% in the 2020, 2021, 2022, and 2023 Updates. Project monitoring was 3% of the costs in the original plan through the 2019 Update, and 2% in the 2020, 2021, 2022, and 2023 Updates.

Return to **Figure 5-2**.

Figure C-1: Mean Areal Extent of Seagrass and Mean Length of Transects

A line and bar graph comparing seagrass extent in hectares versus the mean transect length in meters. The date range is 1943 and then every other year from 1992 to 2020. In 1943, the seagrass extent was 29,539 hectares. In 1992 the extent was 26,334 hectares. The extent gradually climbed to a peak of around 32,000 hectares in 2006 and 2008. The extent then drastically dropped in 2010 to 18,507 hectares. It slowly increased to 23,797 hectares in 2014 and then dropped to 13,438 hectares in 2018. A further drop to 8,021 hectares occurred in 2020. The mean transect length followed a similar trend in years starting at 104 meters in 1994 with a peak of 184 meters in 2008. It dropped to 87 meters in 2012 and increased to 104 in 2014. It then dropped to 62 in 2016, then dropped to 58 in 2018, and further dropped to 38 in 2020.The following table summarizes the data shown in the graph.

Year	Seagrass extent (hectares)	Mean transect length (meters)
1943	29,539	No data
1992	26,334	No data
1994	24,894	104
1996	27,230	122
1998	28,700	140
2002	29,800	138
2004	29,691	138
2006	32,552	178
2008	32,210	184
2010	18,507	105
2012	20,703	87
2014	23,797	107
2016	15,463	62
2018	13,438	59
2020	8,021	38

Return to **Figure C-1**.

Figure C-2: Mean Chlorophyll-a Concentrations

Line graph of mean chlorophyll-*a* in micrograms per liter showing lines for the Mosquito Lagoon (ML), Banana River Lagoon (BRL), North Indian River Lagoon (NIRL), North Central Indian

River Lagoon (NCIRL), and Sebastian (Seb). The time span is yearly from 1997 to 2021. 1997 had values ranging from 1.14 to 22.74 with the highest in NCIRL. 1998 ranged from 1.25 to 37.14 with the highest in Seb. 1999 ranged from 2.24 to 19.34 with the highest in NIRL. 2000 ranged from 1.06 to 14.00 with the highest in BRL. 2001 ranged from 1.68 to 49.70 with the highest in NCIRL. 2002 ranged from 0.98 to 38.2 with the highest in NCIRL. 2003 ranged from 0.30 to 15.97 with the highest in North IRL. 2004 ranged from 0.80 to 18.72 with the highest in NIRL. 2005 ranged from 0.45 to 42.98 with the highest in NIRL. 2006 ranged from 0.00 to 18.51 with the highest in NIRL. 2007 ranged from 0.34 to 18.55 with the highest in Seb. 2008 ranged from 0.57 to 26.68 with the highest in NCIRL. 2009 ranged from 1.02 to 29.40 with the highest in NIRL. 2010 ranged from 1.08 to 60.70 with the highest in NCIRL. 2011 ranged from 2.63 to 83.73 with the highest in NIRL. 2012 ranged from 2.22 to 151.58 with the highest in ML. 2013 ranged from 0.79 to 39.68 with the highest in NIRL. 2014 ranged from 0.89 to 25.97 with the highest in NIRL. 2015 ranged from 1.49 to 38.20 with the highest in NIRL. 2016 ranged from 2.21 to 128.36 with the highest in BRL. 2017 ranged from 1.86 to 49.28 with the highest in NIRL. 2018 ranged from 1.43 to 98.49 with the highest in BRL. 2019 ranged from 2.95 to 78.16 with the highest in BRL. 2020 ranged from 1.63 to 184.99 with the highest in NIRL. 2021 ranged from 1.32 to 60.36 with the highest in BRL.

Return to **Figure C-2**.