Reclaimed Water and Stormwater: A Perfect Pair to Meet Total Maximum Daily Load Wasteload Allocations?

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The City of Cocoa (City) is located in east central Florida within Brevard County along the Indian River Lagoon, as shown in Figure 1. The lagoon is an estuary of national significance spanning 251 km (156 mi) of Florida's eastern coastline. Historical activities such as development, dredging, and diversion of freshwater have resulted in the loss of salt marshes, degradation of habitat, and the introduction of pollutants. Other anthropogenic inputs, including untreated stormwater runoff and wastewater discharges, have also degraded the lagoon's water quality.

In 2009, Florida issued a total maximum daily load (TMDL) for nutrients and dissolved oxygen (DO) for segments of the lagoon. As a result of the TMDL, the City was required to significantly reduce wet weather discharge pollutant loadings from its Jerry Sellers Water Reclamation Facility (WRF) to the lagoon.

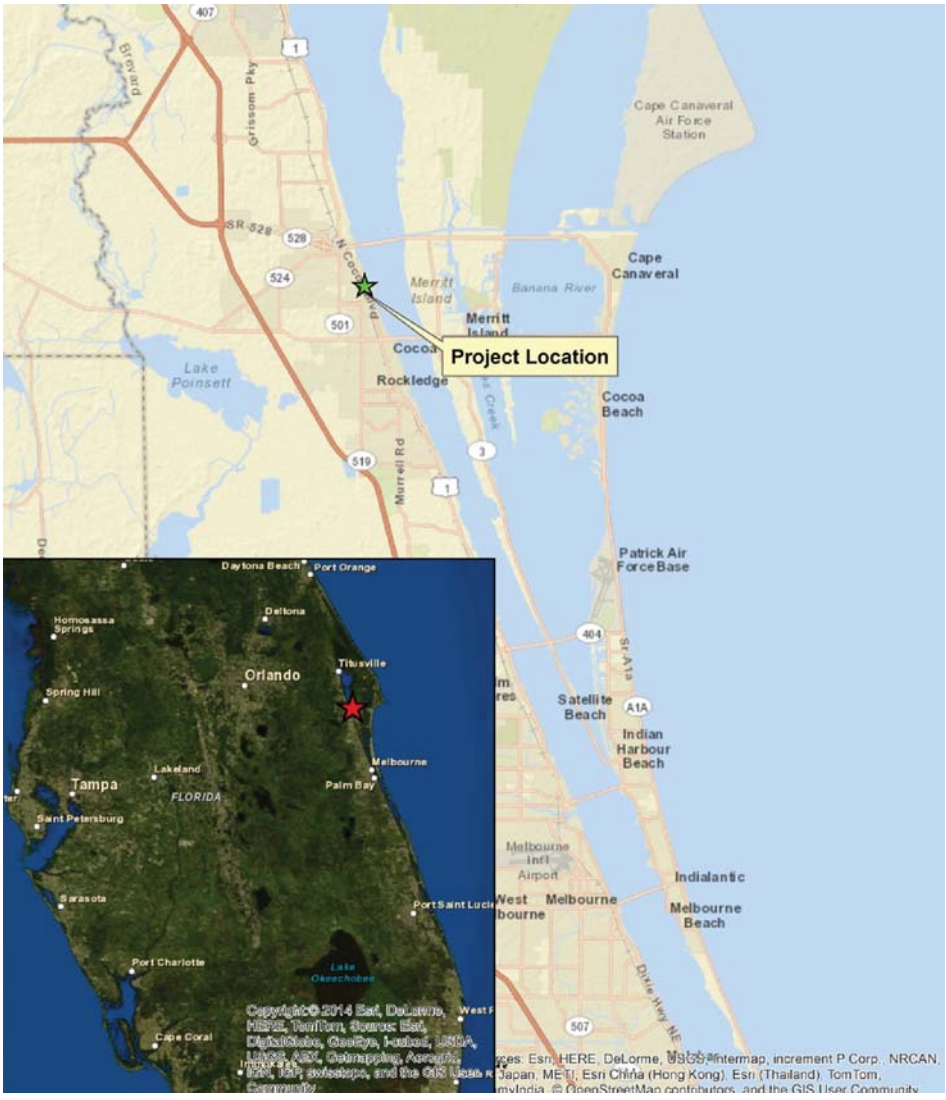

Figure 1. Location Map

Background

Prior to adoption of the Indian River Lagoon TMDL, the City was authorized to discharge up to 41,007 lbs/yr of total nitrogen (TN) and 13,669 lbs/yr of total phosphorus (TP) from the WRF to the lagoon as part of its assigned waste load allocation (WLA). The City's wastewater facility permit allowed surface discharge from the facility for up to 91 days per year. The remainder of the time, per the Florida Department of Environmental Protection (FDEP), the treated wastewater was directed to a 4.5-mil-gal-per-day (mgd) annual average daily flow (AADF) permitted capacity slow-rate public access system, which consisted of on-site irrigation and decorative ponds, irrigation of residential lawns, parks, playgrounds, cemeteries, golf driving ranges, highway medians, and other landscape areas within the City's reuse service area (FDEP, 2009). Once the TMDL was adopted, the City received a new WLA from FDEP, which represented 86.5 and 89.6 percent reductions in TN and TP, respectively, from the previous WLA. Under the new WLA, the City is authorized to discharge 5,556 lbs/yr and 1,423 lbs/yr of TN and TP, respectively, from the WRF to the lagoon during wet weather conditions. Once the TMDL was adopted by FDEP, the City's wastewater facility permit was subsequently modified to reflect these more stringent WLA limits.

Prior to the new WLA, the City had established an aggressive reuse program. When reuse demand exceeded its wastewater effluent, demand was met though supplemental sources, such as stormwater from Bracco Reservoir, or groundwater. Direct discharge to the lagoon,

however, was allowed periodically during wet weather when surplus exceeded demand. The more stringent effluent limits imposed by the TMDL created a challenge of how to further manage the City's resources in order to achieve and maintain feasible operations, as well as permit compliance.

Site Description

The Bracco Reservoir has a 7.3-km2 (1,800-acre) tributary area. It consists of a system of five wet detention ponds that store 130 mil gal (MG) of water. Figure 2 shows the project location, including Bracco Reservoir. In the northern tributary area, stormwater is conveyed to the Bracco Reservoir through a series of wetlands. A 0.0130-km2 (3.3-acre) stormwater treatment facility permitted to the Florida Department of Transportation (FDOT) to treat and attenuate runoff from the widening of highway U.S. 1 is located east of the wetlands. At the time of this evaluation, the facility did not receive stormwater runoff as roadway widening had not yet been completed. Immediately south of the FDOT stormwater treatment facility is North Fiske Pond, a 0.077-km2 (19-acre) stormwater management facility that shares a common outfall with the FDOT stormwater treatment pond. This pond is owned by the City. Its only current surface water inputs are rainfall and runoff from open space surrounding the pond. When the FDOT pond is active, North Fiske Pond could accept overflows based on the current design configuration. Overflow would occur through a common outfall and discharge west to the wetlands.

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Figure 2. Project Area

Figure 3. Bracco Reservoir

Figure 4. North Fiske Pond Proposed System Configuration

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From the wetlands, surface water flows south and enters the northernmost pond in the Bracco Reservoir system. Figure 3 shows the Bracco Reservoir configuration. From this point, surface water flows south through the series of interconnected wet detention ponds that make up the Bracco Reservoir system. Depending on conditions, discharge can occur through a 72-in. reinforced concrete pipe to the lagoon. Bracco Reservoir also accepts stormwater runoff from urbanized areas to the west and south. Stormwater can also be withdrawn from the southernmost pond in Bracco Reservoir for use by the City as an alternative source to supplement its reclaimed water supply at the WRF.

Methodology

Faced with this more stringent WLA, the City realized that more controls would be needed to reduce the frequency (and associated loadings) of wastewater discharges to the lagoon. To meet the WLA, the City identified potential routing of reclaimed water from the WRF to City-owned North Fiske Pond. In addition to receiving limited stormwater runoff inputs, North Fiske Pond also had surplus storage of 79 acre-ft based on its normal water level. Under the current design configuration, North Fiske Pond discharges directly to surface waters (i.e., wetlands) to the west. The City thus needed to identify a feasible and permittable solution that routes reclaimed water to a surface water management pond, potentially intermingling reclaimed and surface waters.

In Florida, wastewater facility discharges are permitted through the FDEP, while surface water management is largely regulated by one of five state water management districts. The City is located within the St. Johns River Water Management District (SJRWMD) and subject to the regulations of that agency. Subsequent to coordinating with each agency about the proposed project, goals and constraints of the project were established to meet the requirements of each respective agency, as well as to minimize the frequency of comingling reclaimed water and off-site surface waters. Constraints and goals established for this project included:

- Reduce point source discharges to the lagoon by applying reclaimed water to North Fiske Pond.
- Provide the ability to apply reclaimed water to North Fiske Pond with as much flexibility, frequency, and capacity as possible to reduce wet weather discharges to the lagoon and maintain compliance with the TMDL and WLA.
- Once reclaimed water is routed to North Fiske Pond, discharge from the pond will not occur except during extreme storm events.
- The proposed system shall not affect the existing stormwater management system or increase design peak stages and flows.

To demonstrate the performance of the surface water management system under proposed conditions, a stormwater model of the existing system was developed. Baseline information about the hydraulics of the current system was compiled through comprehensive review of previous environmental resource permits issued for North Fiske Pond and Bracco Reservoir. The hydrology was formulated using basin delineations from environmental resource permits and subsequently updated using current 1-ft topographic information, current land use, and soils information. The information obtained during field visits was also used to supplement model development. A stormwater model using the interconnected channel and pond routing (ICPR) software developed by Streamline Technologies® was used to simulate stormwater runoff and routing in the project area.

To achieve discharge from North Fiske Pond during only extreme storms, modification of the pond's existing 24-in. outfall pipe was proposed. The modification included adding a control structure to regulate discharge to the downstream wetland from North Fiske Pond. Consistent with the goals of the proposed system, and in conjunction with the modification to the North Fiske outfall pipe, an operations plan was developed to define the conditions under which reclaimed water could be applied to North Fiske Pond. The operations plan is based on the water level within North Fiske Pond; reclaimed water can be applied to the North Fiske Pond whenever the water level is below a designated level. Based on the proposed modification to the North Fiske outfall pipe and modeling results, the operations plan included the following:

- The proposed North Fiske Pond control structure would be set to a control elevation of 27.75 ft National Geodetic Vertical Datum (NGVD).
- Reclaimed water could be applied to North Fiske Pond as long as the pond stage is less than 26.75 ft NGVD.

Under the proposed condition, the FDOT pond would still operate as designed and permitted. The control structure regulating flow from North Fiske Pond was sized to eliminate significant increases in peak stages and flows downstream during design storm events (i.e., 25-year and 100-year/24-hour return periods). Under proposed conditions, an 8-in. line was used to estimate the maximum flow of reclaimed water from the WRF to North Fiske Pond. This was represented as a baseflow component that was introduced to North Fiske Pond in the proposed conditions model. Figures 4 and 5 show the proposed system configuration in layout and cross-section formats. The proposed improvements required preparation of a modification to the City's wastewater facility permit and modification to the existing environmental resource permit issued by SJRWMD for North Fiske Pond.

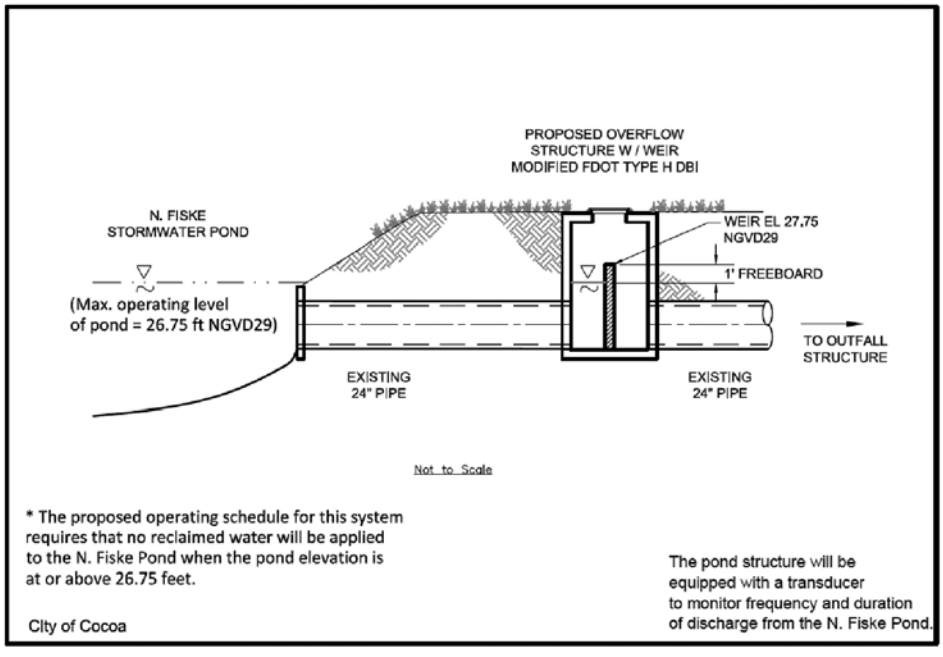

Figure 5. North Fiske Pond Proposed Control Structure: Design Configuration

Results

Tables 1 and 2 show the flow and stage results for the existing and proposed project. Stages and flows do not increase significantly under the proposed condition. North Fiske Pond is anticipated to only discharge during storm events greater than the 25-year/24-hour storm. Under SJRWMD's rules, stormwater management systems must treat and attenuate runoff generated by a 25-year/24-hour design storm.

As a result of routing reclaimed water to North Fiske Pond, it is anticipated that wet weather discharges to the lagoon from the WRF will be reduced. Flows will be routed to the pond via an 8-in. line, which has an estimated flow capacity of 1.25 mgd. The control structure for North Fiske Pond will also be modified so that surface water overflow from the pond will only occur as a result of a storm exceeding the 25-year design event. Discharge monitoring reports for the WRF over 12 years were reviewed to estimate the potential load reduction associated with the proposed improvements. Discharge monitoring reports for 2001 through 2005 were included in the review to determine how the WLA was originally calculated by FDEP. Once values calculated by FDEP were replicated, the same methodology was applied to the entire period of record. Figures 6 and 7 summarize average annual TN and TP loads to the lagoon based on discharge monitoring reports data, as well as with the anticipated improvements in place. The difference in load that could potentially be discharged to the lagoon was calculated for months where discharge exceeded an average flow rate of 1.25 mgd (the estimated capacity of the 8-in. line that will route reclaimed water to North Fiske Pond). For months not exceeding an average flow rate of 1.25 mgd, a credit for 100 percent of the monthly load was applied as a potential reduction. The percent load reduction anticipated for each year of reporting with the improvements in place is also shown in the figures.

Conclusion

Table 1 shows that peak stages do not vary significantly between existing and proposed conditions. The peak stage of North Fiske Pond does not exceed the proposed control elevation for the 25-year storm and therefore will not discharge to the wetland except during larger storms. The results in Table 2 demonstrate that flows to the adjacent wetlands under existing and proposed conditions are also consistent, both from the project area and from all upstream areas. These analyses demonstrate that existing and proposed conditions are consistent and show no significant differences.

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Table 1. Simulated Peak Stage

Location	Critical Elevation (ft-NGVD)	Peak Design Stages (ft NGVD)					
		Existing Conditions			Proposed Conditions		
		Mean Annual	25-Year	100-Year	Mean Annual	25-Year	100-Year
FDOT Pond	30.0	29.0	29.7	30.1	29.0	29.7	30.1
North Fiske Pond	30.0	24.6	26.6	27.6	26.9	27.6	28.7
Wetland	35.0	26.7	28.0	29.2	26.7	28.1	29.3

Table 2. Simulated Peak Discharge

Discharge Source	Peak Discharge to Wetland (cfs)					
	Existing Conditions			Proposed Conditions		
	Mean Annual	25-Year	100-Year	Mean Annual	25-Year	100-Year
Project	0	9	15	1	13	15
Total[1]	281	709	1,160	281	714	1,160

[1] Total flow to the wetland from the project area, as well as outside areas.

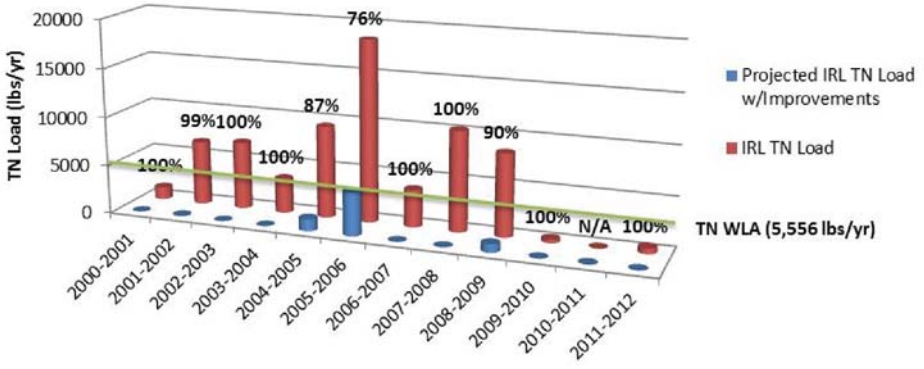

Figure 6. Anticipated Total Nitrogen Load Reductions Based on Discharge Monitoring Report Data

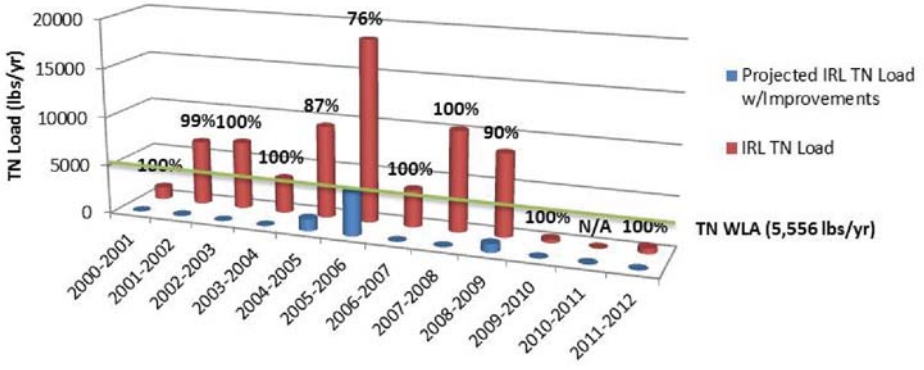

Figure 7. Anticipated Total Phosphorus Load Reductions Based on Discharge Monitoring Report Data

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Figures 6 and 7 demonstrate that the proposed improvements have the potential to meet the WLA for TN (5,556 lbs/yr) and TP (1,423 lbs/yr) on an annual basis as currently required by the City's permit. Except for 2005-2006, resulting discharges to the lagoon due to the proposed improvement would be significantly below the required WLA for the WRF. Actual load reductions provided by the proposed improvements would depend on the actual wasteload flow rates and flow capacities of the reclaimed system and North Fiske Pond. Future load reductions to the lagoon that occur subsequent to implementation of the proposed improvements will depend on the following:

1. Actual wet weather flows from the WRF, as load is dependent on flow from the plant.
2. Available capacity in North Fiske Pond. An operating schedule for the proposed improvements has been proposed so that discharge of reclaimed water to the pond cannot occur when the pond is at or above 26.75 ft NGVD. If the pond has met or exceeded this elevation, flow from the WRF will be discharged to the lagoon as allowed under the current permit.

Based on the estimated cumulative load reduction shown over the 12-year period of record (63,199 lbs/yr of TN and 5,808 lbs/yr of TP), the City may consider coordinating with FDEP to determine if future reductions, as a result of the proposed improvements, can be credited toward the remaining required nonpoint source reductions under the City's National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit to meet the TMDL. Since this evaluation was completed in early 2013, the City recently began implementation of the modifications to the stormwater and reclaimed water infrastructure associated with the North Fiske Pond. Once the improvements are in place, the frequency and duration of discharge from the North Fiske Pond will be measured and reported by the City as a permit condition.

References

Florida Department of Environmental Protection (2009). TMDL Report. Nutrient and Dissolved Oxygen TMDLs for the Indian River Lagoon and Banana River Lagoon.

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