A Case Study of Two Small-Scale Stormwater Treatment Areas in South Florida

Executive Summary

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The goal of this project is to discuss stormwater treatment area (STA) function and management followed by a case study of two small-scale stormwater treatment areas in south Florida. STAs are a critical component in managing nonpoint source pollution, primarily phosphorus, entering natural water bodies. STA performance is a function of design, hydrology, vegetation, and other compounding factors. Because of these interdisciplinary factors, designing, implementing, and managing STAs should be a collaborative effort between engineers and environmental specialists. The analysis of TP concentrations at the inflow and outflow monitoring stations for Ten Mile Creek and Taylor Creek highlights the variability of nutrient removal performance in STAs.

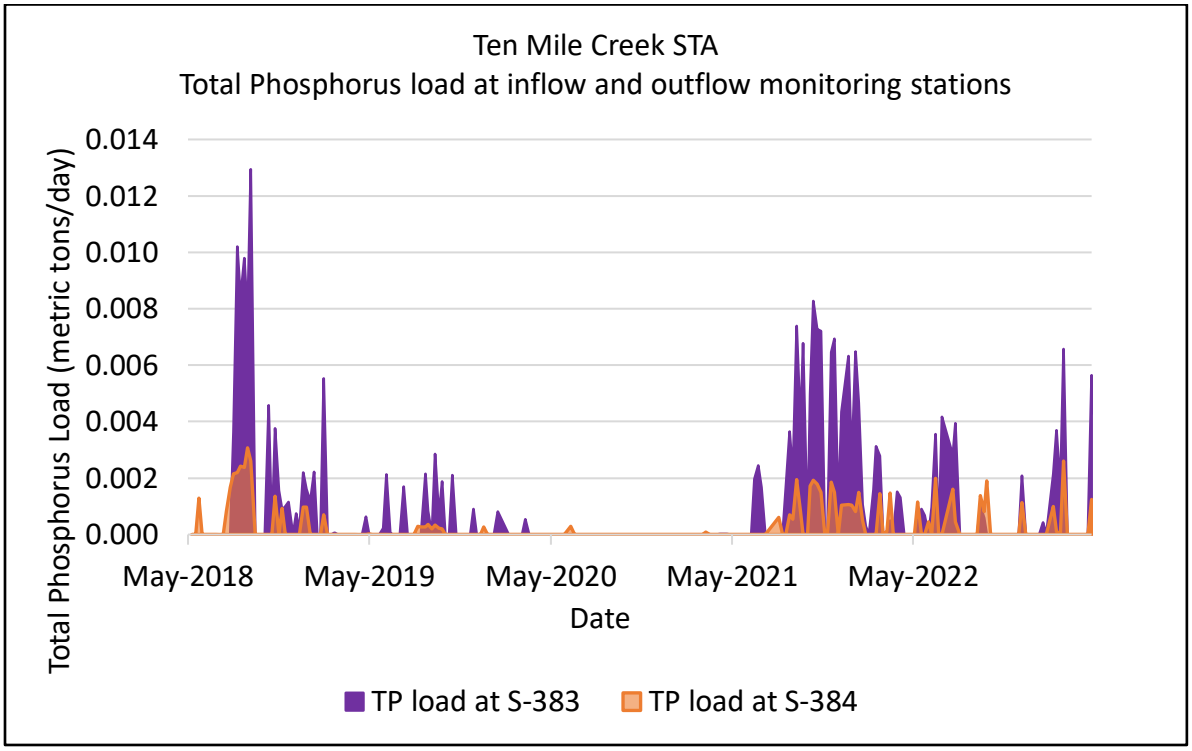
Ten Mile Creek Water Preserve Area (TMC PA) was constructed by the U.S. Army Corps of Engineers (USACE) to hold and treat water from the Ten Mile Creek basin before it enters the north fork of the St. Lucie River (Laham-Pass, 2023). The TMC PA is comprised of a ~550 acre shallow reservoir and a ~140 acre polishing cell/STA. SFWMD monitors water quality at the reservoir inflow, the STA inflow, and the polishing cell outflow (SFWMD 2023). Nutrient targets are published in the St. Lucie River and Estuary Basin Management Action Plan (SLRE BMAP) (SFWMD 2023). Total Maximum Daily Load (TMDL) of 0.081 mg/L of TP (SFWMD 2023).

The Ten Mile Creek outflowing TP concentration was below the 0.081 mg/L TMDL established for the St. Lucie River and Estuary for all data points included in the analyses for this paper (FDEP, 2023). TP concentration at the outflow monitoring station ranged from 0.013 mg/L to 0.052 mg/L from WY 2019-

2023. The performance of Ten Mile Creek STA is consistent and meets the target TP goals set for the area.

Figure 1

Ten Mile Creek STA total phosphorus load at inflow and outflow monitoring stations



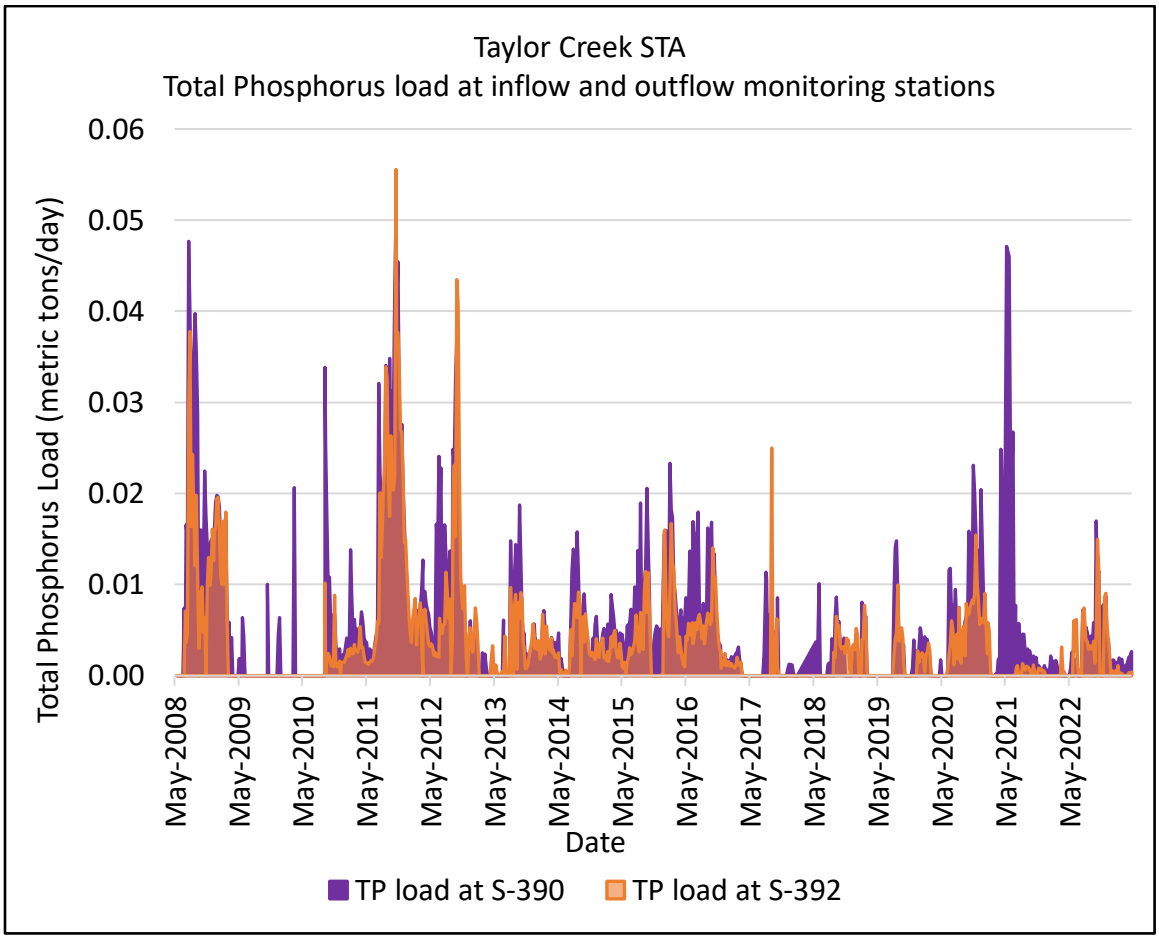
Note. Total phosphorus load at inflow (purple) and outflow (orange) monitoring stations for Ten Mile Creek STA for WY 2019-2023.

Taylor Creek Stormwater Treatment area was built by USACE in 2006 and sponsored by SFWMD as part of the Lake Okeechobee Water Retention/Phosphorus Removal Project to reduce the TP load of water entering Lake Okeechobee (USACE 2006). The USACE transferred the management of TC STA to SFWMD in 2011 (Hill and Iricanin, 2023). The STA is ~140 acres in size and consists of two long and narrow cells that are oriented parallel to Taylor Creek. In the design phase, the STA was expected to reduce the average TP concentration in Taylor Creek by 75%, but the size of the final design was smaller than initially

planned (FDEP, 2020). The entire basin this STA has the second lowest attenuation rate out of the sub-basins in the Okeechobee watershed (FDEP, 2020). Nutrient targets are published in the Lake Okeechobee Basin Management Action Plan the TMDL is 0.113 mg/L of TP (FDEP, 2020).

Figure 2

Taylor Creek STA total phosphorus load at inflow and outflow monitoring stations



Note. Total phosphorus load at inflow (purple) and outflow (orange) monitoring stations for Taylor Creek STA for WY 2009-2023.

The Taylor Creek outflowing TP concentrations ranged from 0.025 mg/L to 1.192 mg/L, and the mean outflowing TP concentration for WY2009-2023 (0.295 mg/L) is more than double the 0.113 mg/L TMDL

established for Taylor Creek/Nubbin Slough (FDEP, 2020). The design efficacy of the Taylor Creek STA is 38%, and the average TP reduction for the STA over the same time period is 35% (Hill & Iricanin, 2023). The STA met or exceeded the 38% reduction goal in five of the thirteen years analyzed. The exceptionally high TP reduction in 2022 may be due to the increased retention time, which was an active management choice made to improve water quality of the STA outflow.

The poor water quality entering Taylor Creek STA when compared to Ten Mile Creek STA is likely the result of increased agricultural inputs via dairy farming upstream of Taylor Creek STA, the added nutrient removal benefits provided by the reservoir at Ten Mile Creek, and the large size of the Taylor Creek Watershed. The average inflowing TP concentration at Ten Mile Creek was 0.074 mg/L and the average inflowing TP at Taylor Creek was 0.374 mg/L. Land use in both Ten Mile Creek and Taylor Creek Watersheds is predominantly agricultural. Secondary and tertiary land use includes urban areas and wetlands (FDEP, 2017). The top five agricultural land uses differ between the watersheds, most notably Taylor Creek has 16,310 acres of dairy farms while Taylor Creek does not have any dairy farm acreage. Flows between the STAs also differ with Ten Mile Creek receiving nearly twice the volume of water than Ten Mile Creek over four years (Penkowski & Iricanin, 2024) (Penkowski, 2024). From WY 2019-2023, Ten Mile Creek received 30,452 acre-feet of water, and Taylor Creek received 16,247 acre-feet (Penkowski & Iricanin, 2024) (Penkowski, 2024). Taylor Creek watershed covers three times the area of Ten Mile Creek and Ten Mile Creek has a shallow reservoir upstream of the STA that provides additional nutrient removal and benefits. Inflowing phosphorus concentrations at Taylor Creek were five times higher, on average than Ten Mile Creek, likely due to the presence of dairy farms upstream of Taylor Creek, the increased size of the Taylor Creek Watershed, and the lack of reservoir upstream of the STA when compared with Ten Mile Creek

Management of Taylor Creek and Ten Mile Creek STAs during the time period analyzed included conveyance structure repairs, water level alterations to adjust the HRT and to accommodate nesting

birds, vegetation maintenance, minor earth and damn repairs, among other needs. On more than one occasion, water levels were drawn down in the systems prior to tropical storms. This storm response may compromise the nutrient removal efficacy of the system but fulfills another key role of the STAs water storage and management. Both STAs require routine monitoring, maintenance, and management by SFWMD and will continue to need these resources as the STAs age.

In addition to nutrient reductions as discussed in this paper, wetland plants can remove PFAS, perfluorinated alkyl substances, from water (Greger & Landberg, 2024). PFAS are manmade chemicals that do not readily break down in the environment and are present in everyday products used around the globe. Their pervasive nature has put PFAS at the forefront of current media and toxicology. STA's may provide benefits in PFAS removal under their current conditions, or with the addition of higher densities of vegetation. STA's have been a tool for water quality improvement for decades, but we are still learning how to maximize their efficacy and how to apply this existing technology to solve new problems.

Many of the STAs in South Florida are aging and are unable to meet or inconsistently meet the BMAP targets established for their area. Additionally, Florida is one of the fastest-growing states and has been for decades (Perry et al., 2022). This consistent inflow of people has led to and will continue to lead to increased urbanization and land use changes in South Florida. Trends in available funds, requests for proposals, and scientific interest, such as the Frontiers in Marine Science research topic "Science supporting the management of eutrophication: Lessons learned from a barrier island lagoon," which features 17 articles focused on the Indian River Lagoon, all point towards a growing need for water quality monitoring and related environmental services in our area (Frontiers in Marine Science, 2020-2024).

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