Wet Weather Reuse Management Needs Wetlands

Rafael Vázquez-Burney

Water reuse systems in Florida are challenged to balance wet weather supply with dry weather demand of reclaimed water. It's typical for reuse systems to beneficially reuse only half of their annual production of reclaimed water for irrigation. Wet weather flows are disposed of in either injection wells, to never be seen again, or in surface waters, causing nutrient loads and water quality impairments.

While other approaches, such as sprayfields and rapid infiltration basins, are available to reuse wet weather flows, these contribute nutrient loads to groundwater and springsheds and are often located near the coast, missing opportunities of groundwater supply augmentation.

Wetlands are one of the most important natural resources in Florida. They provide a wide range of ecological and environmental functions. These functions include biological, physical, and chemical processes that take place among water, soil, vegetation, and microbial communities to improve water quality. Capitalizing on these natural biogeochemical processes can result in high-quality treatment of reclaimed water with little energy, which translates into economic benefits for municipalities and environmental benefits to their citizens.

Wetlands in Florida have rainfall-driven natural hydroperiods, with high water levels in the rainy season and low levels in the dry season. This natural seasonality works perfectly in unison with excess wet weather flows that occur in the rainy season when there is little irrigation demand, and higher reclaimed water demand in the dry season when irrigation is highest.

Florida's water resources across the state are riddled with total maximum daily loads (TMDL), noncompliant minimum flows and levels (MFL), water use caution areas (WUCA), and other regulatory pressures that affect the importance of proper management of wet weather reclaimed water flows. Treatment wetlands are an ideal approach to turning this liability into a benefit and in compliance with the regulations.

Two distinct approaches in wetlands technology are used in Florida: application of reclaimed water to natural wetlands and constructed wetlands, each depending on location-specific drivers.

Application of treated wastewater effluent to natural wetlands has been used in Florida since the 1970s. Chapter 62-611, Florida Administrative Code (FAC), Wetlands Application Rule, provides state regulations for the discharge of treated wastewater to natural wetlands. This rule specifically promotes the use of hydrologically altered wetlands by allowing higher hydraulic and nutrient loads to these systems to encourage the restoration of natural wetlands. This approach has been implemented throughout Florida successfully with operating systems, such as Poinciana's Boot Wetlands (1984) and JEA's Blacksford Swamp (1999).

More recently, Pasco County Utilities is implementing this approach for an herbaceous, hydrologically altered wetlands within Crews Lake. This project involves the use of 3.9 mil gal per day (mgd) of excess reclaimed water from the Pasco County reuse system to restore 225 acres of natural wetlands that have suffered for decades from surface water diversions and consumptive uses from wellfield drawdown. The Crews Lake project involves seasonal application of reclaimed water to support the rehydration of the hydrologically altered system and restore native and desirable wetlands communities with minimal construction improvements.

Constructed wetlands are also an alternative for management of wet weather flows. Constructed wetlands can be flow-through surface flow wetlands or groundwater recharge wetlands; the flow-through surface flow wetlands typically discharge to a receiving waterbody. The purpose of these systems is to reduce nutrient loads to the receiving waterbody, typically driven by TMDL regulations. Long-term examples of flow-through surface flow wetlands include the Orlando Easterly Wetlands and City of Lakeland Wetlands, both operational since 1987.

Groundwater recharge wetlands do not have a wetland outflow, and therefore, contribute to aquifer augmentation. These are located where the confining unit between the surficial and Floridan aquifer systems is discontinuous, and where groundwater use has resulted in excessive drawdown and caused adverse effects to lakes and wetlands.

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Many Florida utilities are challenged to manage wet weather reclaimed water flows while dealing with regulatory pressures, such as TMDLs, MFLs, and WUCAs. This article explores options and examples that may help utilities to beneficially reuse wet weather reclaimed water flows and turn a discarded resource into a solution with multiple ecological benefits.

Natural Wetlands for Beneficial Water Reuse

The University of Florida Center for Wetlands, founded in 1973 by H.T. Odum, was created with the goal to assess the use of wetlands to recycle wastewater. Over the next thirty years, Florida became recognized as the pioneer and leader in the field of wetlands creation and management for engineering purposes. The studies of water reuse using wetlands led to the Florida Department of Environmental Protection (FDEP) introducing a set of rules for water reuse using wetlands. Today, it has been fully accepted as a low-energy alternative to advanced wastewater treatment and traditional effluent management approaches.

The rule provides state regulations for the discharge of treated wastewater to natural wetlands and establishes:

- The quality and quantity of wastewater that may be discharged to wetlands.
- The quality of water discharged from wetlands to contiguous surface waters.

It also provides water quality, vegetation, and wildlife standards (providing protection of other wetlands functions and values), and establishes permitting procedures and monitoring requirements for wastewater discharges to wetlands. In addition, the rule classifies wet-

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lands based on the level of treatment provided by the wastewater, background hydrology of the wetlands (hydrologically altered or hydrologically unaltered), and the type of vegetation (herbaceous or woody). The rule specifically promotes the use of hydrologically altered wetlands by allowing higher hydraulic and nutrient loads to these systems to encourage the restoration of natural wetlands. The use of natural wetlands to receive reclaimed water has been successfully implemented throughout Florida, with systems in operation since the early 1980s. Figure 1 presents the wetlands in Florida that have been permitted to receive and reuse reclaimed water.

Drivers and Applications for Using Natural Wetlands for Wet Weather Management

Hydrologically altered natural wetlands have become a common sight throughout the state due to ditching, construction of canals, and other drainage works that have resulted in the substantial encroachment of upland species and significant reduction in water levels. Furthermore, groundwater use for public supply and agriculture in areas where confinement of the Floridan aquifer system is limited has also resulted in the degradation and hydraulic alteration of wetlands in the areas of drawdown. The presence of these degraded wetlands within or near local wastewater utilities can provide an opportunity to manage wet weather flows by applying reclaimed water to these wetlands during times of surplus. These wetlands can provide low-cost and robust treatment of reclaimed water, while supporting the restoration of the ecology.

For utilities that operate surface water discharges to manage wet weather reclaimed water surplus, it's likely that TMDLs and nutrient limitations in the receiving waterbody will limit the amount and quality of reclaimed water that can be discharged. These limitations can lead to expensive upgrades to wastewater facilities. Using natural wetlands can eliminate the regulatory burden associated with the surface water discharge and the need to upgrade wastewater facilities by using natural wetlands treatment processes to produce an outflow that is near background levels for nutrients, while also enhancing wetland ecology.

Utilities that do not operate surface water discharges can also benefit from the use of wetlands to receive reclaimed water. Many Florida utilities can manage reclaimed water by applying it to rapid infiltration basins and sprayfields, which provide limited water quality improvements for nutrients; however, locations that can accommodate land application systems are often in areas with transmissive sandy soils and where the clayey layer that confines the Florida aquifer system is limited or nonexistent to allow for aquifer recharge via infiltration.

It's typical for these areas to be located within nutrient-limited springsheds, which are subject to TMDL regulations. This has led to significant regulatory burden associated with the nutrient loads to these springsheds, forcing the implementation of expensive wastewater facility upgrades to reduce nutrient concentrations. The use of natural wetlands to receive reclaimed water can be a viable low-cost alternative to reduce the nutrient loads to springsheds, while providing hydrologic benefits to local wetlands.

Groundwater use throughout Florida has caused impacts to local wetlands within the areas of drawdown in locations where the Floridan aquifer system confining unit is limited or nonexistent. These wetlands can become ideal candidates for the application of reclaimed water for the restoration of these systems, while potentially providing some natural recharge of the underlying aquifer through wetland infiltration.

Examples of application of reclaimed water to hydrologically altered natural wetlands to support their restoration are now being implemented. The Crews Lake Natural Systems Restoration (Pasco County) and the Bennet Swamp Rehydration Project (City of Daytona Beach) are presented as case studies.

Figure 1. Map of Permitted Wastewater Natural Wetlands in Florida

Recent Case Studies for the Use of Natural Wetlands for Wet Weather Management

Crews Lake Natural Systems Restoration Project: Pasco County

Pasco County has permitted and is planning a project to apply reclaimed water to an herbaceous, hydrologically altered natural wetland within Crews Lake. While all the wetlands permitted in the state of Florida to date have been forested wetlands, the rule allows for the use of herbaceous wetlands if they are hydrologically altered. This project is the first herbaceous wetland permitted to receive wastewater under the Wetlands Application Rule in Florida.

During wet weather conditions, reclaimed water flows in Pasco County can exceed customer demand to the extent that the existing rapid infiltration basin becomes limited in capacity to adequately manage surplus reclaimed water. Furthermore, the existing rapid infiltra-

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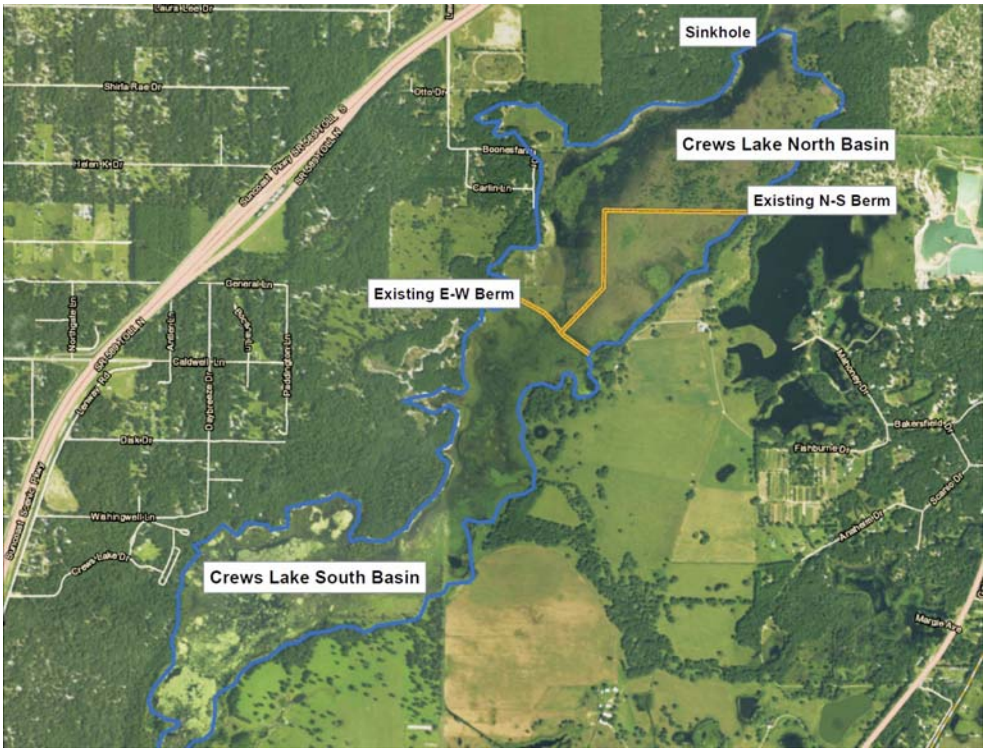

Figure 2. Existing Features at Crews Lake

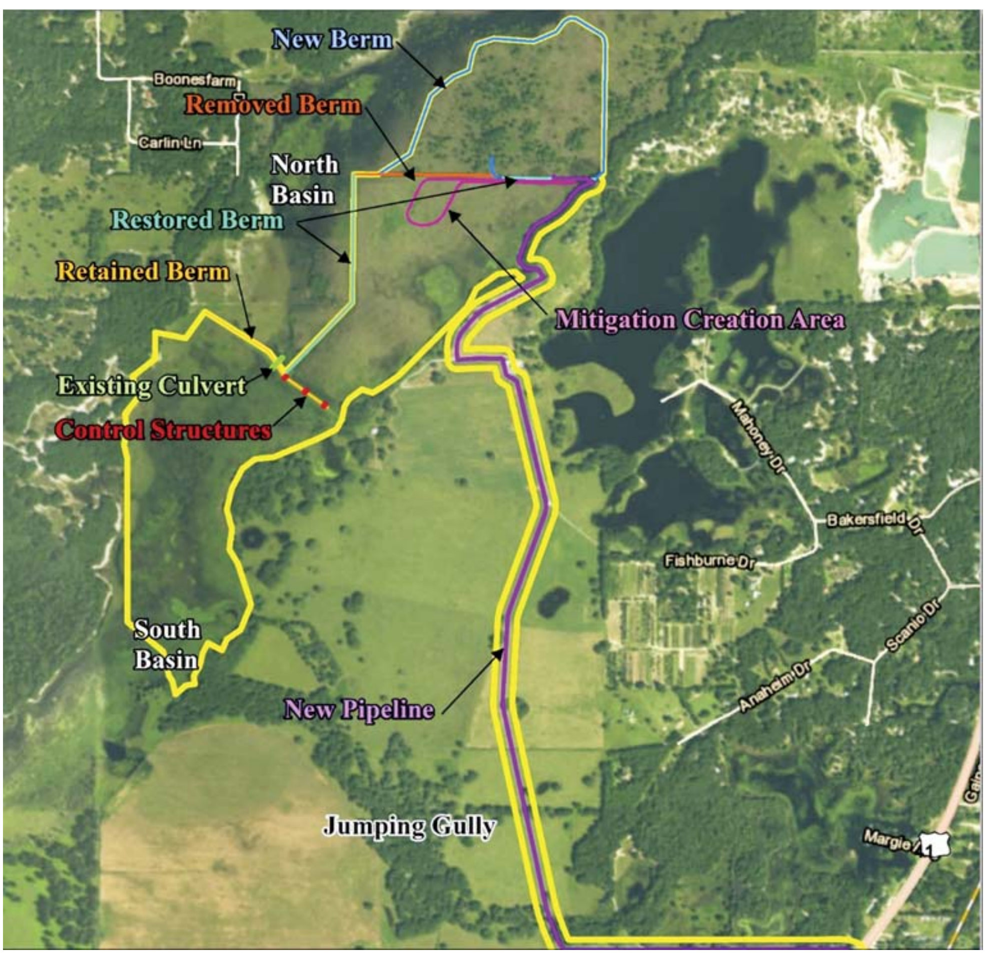

Figure 3. Site Plan of the Proposed Crews Lake Natural Systems Restoration Project

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tion basins are located within the Weeki Wachee Springshed, which is one of the recent Florida springsheds subject to TMDL regulation for nitrogen (N). The county intends to improve its wet weather management and reduce its nutrient loads to the Weeki Wachee Springshed by using surplus reclaimed water to enhance the wetlands within Crews Lake.

Hydrologic conditions within the lake and its watershed have been impacted by many factors in the past, including construction of berms, stormwater management/drainage systems, wellfield drawdown, watershed segmentation, and surface water diversions, resulting in excessively low water levels. A series of earthen berms were constructed in the 1940s to support a cattle operation within the lake bed.

The hydrologically altered condition of the north basin is attributed to the lack of flow from its tributaries and nearby wellfield drawdowns. In addition, a sinkhole located north of the berm controls the duration and extent of inundation in the north basin because the channel flowing to the sinkhole is significantly lower in elevation than the proposed restoration area within the north basin. Portions of the north basin have been invaded by pine trees, evidence of a long-term reduction in water levels and a reduced wetland hydroperiod.

Use of reclaimed water will help restore hydrologically altered wetlands, hydroperiods of the north basin, and impacted biological communities. To allow for proper hydration and restoration, some work to the lake bed needs to take place to avoid all the water applied being lost to the existing sinkhole. The wetlands restoration area layout consists of an application area constructed using existing onsite berms and adding newly constructed berms. The application area will be created by constructing a berm enclosing a total of 135 acres within Crews Lake.

Within the application area, a 4-acre mitigation wetland marsh will be created to offset the wetlands impact related to the construction of the berms. The application area also includes an additional 90 acres of wetlands downstream of the berm, extending southwest from the existing berm to the Pasco County property line, where the water quality compliance point is located. The total footprint of the wetlands application area is 225 acres. Water will be applied through a distribution system and will be conveyed via a pipeline from an existing reclaimed water transmission line. The applied water will accumulate in the

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Table 1. Chapter 62-611, Florida Administrative Code, Versus Crews Lake Design Loading Rates

Parameter	Ch. 62-611, FAC Design Criteria Loading	Crews Lake Design Loading
Hydraulic Loading Rate	6 in./wk	4.5 in./wk
Hydraulic Retention Time	14 days	19 days
Total Nitrogen Loading Rate	75 g/m2/yr	48 g/m2/yr
Total Phosphorus Loading Rate	9 g/m2/yr	8.9 g/m2/yr

Table 2. Estimated Total Nitrogen and Total Phosphorus Mass Removal for Wetland System

	Q (mgd)	TN (mg/L)	TN (kg/d)	TP (mg/L)	TP (kg/d)
Average Wetland System Inflow	3.9	8.13	120	1.48	22.1
Average Wetland System Outflow	3.9	1.1	16	0.18	2.6
Total Nitrogen Reduction			**104**		**19.5**
System Reduction (%)			**87%**		**88%**

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system, evaporate or transpire, infiltrate, or flow to the south basin. Under typical operating conditions, water depths will increase to an elevation governed by control structures during the wet season and decline below ground elevation during the dry season. Figure 3 shows the overall site plan of the proposed Crews Lake Natural Systems Restoration Project.

Based on average reclaimed water concentrations of N at 8.3 mg/L and phosphorus (P) at 1.48 mg/L, and the proposed application area, it was determined that the design annual average daily flow (AADF) the system could receive and meet the rule's aerial nutrient loading requirements is 3.9 mil gal per day (mgd) AADF. This results in a weekly hydraulic loading rate of 4.47 in./wk. The resulting design nutrient loads are 8.9 grams (g) total phosphorus (TP)/m^2/yr and 48 g total nitrogen (TN)/m^2/yr (Table 1).

Water quality performance forecasting of the wetland system was modeled. Table 2 shows TN and TP water quality performance forecasts. It's anticipated that outflow from the Crews Lake wetland treatment system would reach TN and TP concentrations of approximately 1.1 mg/L and 0.18 mg/L, respectively. These are below the rule-required 3 mg/L TN and 0.2 mg/L TP outflow concentration.

The project will use up to 3.9 mgd of wet weather reclaimed water from the Pasco County reuse system to restore the 225 acres of natural wetlands that have experienced decades of depressed water levels. In addition, due to the inherit capability of wetlands to improve water quality, this system is estimated to remove 65,000 lbs-N/yr and 16,000 lbs-P/yr from the TMDL-limited Weeki Wachee Springshed. This novel wetland project has turned important operational challenges in reclaimed water system management into a system with regionally significant environmental benefits.

Bennet Swamp Rehydration Project: City of Daytona Beach

Wetland hydroperiod restoration, nutrient load reduction to the Halifax River, and groundwater recharge were recognized by Saint Johns River Water Management District (SJRWMD) and FDEP, which provided significant funding to implement this project.

The City of Daytona Beach is constructing the Bennett Swamp Rehydration Project to comply with conditions of its consumptive use permit (CUP) to support the rehydration of this hydrologically altered wetland and increase groundwater recharge. The city identified Bennett Swamp as a system that could benefit from the application of reclaimed water.

The application area identified for the swamp is approximately 2,200 acres. The swamp in this area is a bay- and cypress-forested wetland system. Numerous studies have documented that the system has been hydrologically stressed for several decades. The rehydration project provides a potential environmental benefit to restore the swamp by supplementing natural rainfall with highly treated reclaimed wastewater.

This project has been permitted by FDEP under the standard permit criteria of the Wetlands Application Rule. Restoring wetland hydroperiods will significantly benefit wetland ecology and improve wildlife habitat and ecological productivity.

Another significant environmental benefit will be the reduction of nutrients discharged to the Halifax River; currently, the city has a National Pollutant Discharge Elimination System (NPDES) permit to discharge up to 20 mgd. This project will also reduce between 36,000 to 72,000 lbs per year of TN and 12,000 and 24,000 lbs per year of TP to the river.

The region will also realize a third significant environmental benefit because this project is projected to recharge groundwater at a rate equivalent to the daily consumption of 125,000 domestic users.

To determining the appropriate design rate of reclaimed water application, the effect of in-

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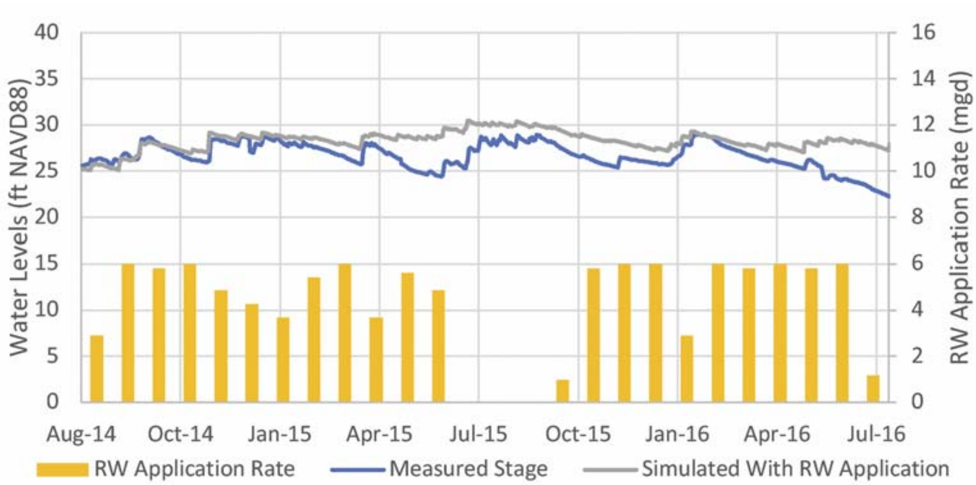

Figure 4. Water Levels With Application of Reclaimed Water to Bennet Swamp

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filtration needed to be assessed. A water balance approach was used to calculate the infiltration rate of this area by considering rainfall, evapotranspiration (ET), and the change in water level. It is estimated that infiltration is approximately 0.5 in. per day, which is considered the rate of groundwater recharge that can be achieved with this project.

Due to TMDL load allocations from Bennett Swamp, any increase in wetland outflow could be considered a new load and not allowed. Due to this constraint, an evaluation was needed to calculate seasonal application rates of reclaimed water that the swamp can assimilate into the wetland subsoils without affecting wetland outflows.

The water balance approach was used by applying water only during times when the stage is below the levels that cause wetland outflows. To do this, it has been assessed that when water levels get to approximately the 90th percentile level, application of reclaimed water would cease. For this evaluation, the application rate was assumed to be 1 in. per week, but only if water levels are below the 90th percentile level.

The results from this evaluation yielded monthly average flow of 0 to 6 mgd, depending on rainfall and water levels; the average flow was estimated to be 4.3 mgd. Annual average flows are expected to range between 3 and 5 mgd, where drier years would result in more reclaimed water able to be assimilated in the wetland. The results from the application of reclaimed water are presented in Figure 4.

This evaluation reveals that the reclaimed water application would improve depth and duration to control terrestrial plant invasion, increase median value to arrest hydric soil oxidation, and maintain deep-water habitat, while allowing natural periodic dry-down and constraining maximum levels to prevent increased wetland outflows.

This project is an excellent example of beneficial reuse of excess reclaimed water. The multiple ecological benefits of the project provided the opportunity for the city to access multiple funding sources and garner wide regional support.

Constructed Wetlands for Beneficial Water Reuse

Constructed wetlands have been implemented in Florida since the 1980s, with the Orlando Easterly Wetlands and the Lakeland Wetlands in operation since 1987. Both were constructed to reduce nutrients and provide a means for managing excess reclaimed water.

Reclaimed water wetlands implemented in Florida are either flow-through surface flow wetlands or groundwater recharge wetlands. Flow-through surface flow wetlands are constructed marshes that promote sheet flow through dense wetland vegetation and provide nutrient reduction via microbial activity present on plant surfaces and wetland detritus. Typically, these discharge to a receiving waterbody. The purpose of these systems is to reduce nutrients to the receiving waterbody, typically driven by TMDLs.

Groundwater recharge wetlands do not have a wetland outflow, rely on infiltration for continuous loading, serve to polish the water quality of the applied flows, and recharge the local aquifer with clean water. Water quality improvements occur, much like in flow-through surface flow wetlands, via microbial activity present on the plant surfaces and the wetland detritus; however, these also include a treatment horizon in the wetland subsoils that is rich in carbon and is anaerobic. This horizon is ideal for the reduction of nitrate-nitrogen, a common parameter of concern in Florida, as the water passed through it.

The first groundwater recharge wetland constructed in Florida is the Wakodahatchee Wetlands in Palm Beach County, operational since 1996. The largest groundwater recharge wetland in the world was constructed in 2017 in Pasco County. This system is a 176-acre wetland, which receives 5 mgd of reclaimed water to recharge the Upper Floridan aquifer within the area of drawdown caused by nearby regional wellfields.

Drivers and Applications for Using Constructed Wetlands for Wet Weather Management

Many utilities in Florida rely on surface water discharges to manage wet weather flows. These discharges contribute to nutrient loads to the receiving waterbodies, and it's typical for them to become a regulatory concern with numeric nutrient criteria as they are subject to TMDL regulations. Over the past decades, regulatory pressure has led to expensive wastewater treatment facility (WWTF) upgrades to employ advanced treatment for nutrients; however, even effluents from advanced WWTFs contain N and P levels that still contribute to nutrient loads to the receiving waterbodies. Treatment wetlands can achieve lower levels of nutrient concentrations than WWTFs, often reaching natural background levels of N and P.

Constructed wetlands can be used to polish treated wastewaters before the water is discharged to the receiving waterbody, thus reducing nutrient loads. Furthermore, these wetlands can be sized to receive and treat secondary effluents with little or partial nutrient control from the WWTF, avoiding expensive upgrades to them to implement nutrient reduction.

Due to the long retention times and ability to operate at varying water levels, constructed wetlands become a robust option for managing wet weather reclaimed water flows. Short-term increases of flow from the WWTF associated with wet weather conditions (when reclaimed water flows are larger and user demands are lower) can be dampened by constructed wetlands without sacrificing treatment capacity. In fact, wetlands in Florida are adapted to have higher water levels in the wet summer months and lower levels in the dry winter months. Annual reclaimed water flow patterns work in uni-

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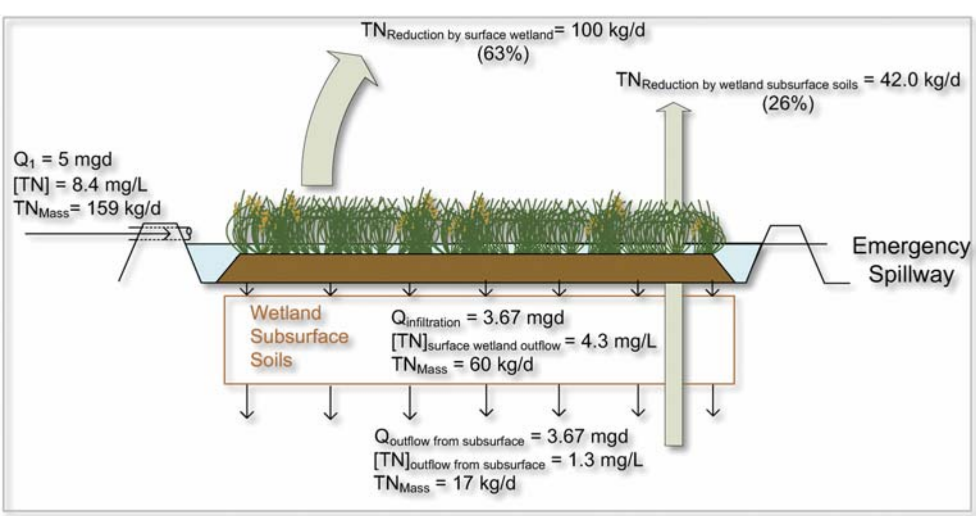

Figure 5. 4G Ranch Wetlands Water Quality Performance Forecasting

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son with Florida wetlands by mimicking natural rainfall patterns.

Not only surface waters are subject to nutrient limitations in Florida. Recently, a great deal of consideration has been given to springs and springsheds. Nitrate loads to springsheds are affecting spring water quality and ecology, which has led to limitations in the ability of utilities to reuse reclaimed water through land application within these sensitive springsheds. This is leading utilities to consider groundwater recharge wetlands to replace rapid infiltration basins and sprayfields to provide a greater level of nutrient load removal to the springshed. Wetlands, particularly infiltration wetlands, provide a great deal of nitrate reduction as water passes through the organic-rich and anaerobic wetland subsoils that are ideal for denitrification. These systems can help manage the costs of expensive upgrades to WWTFs by providing passive nutrient removal.

Recent Case Studies for the Use of Constructed Wetlands for Wet Weather Management

4G Ranch Wetlands: Pasco County

The Pasco County master reuse system is the sole method of wastewater effluent management for the county. This strategy has allowed the utility to avoid expensive upgrades of its treatment facilities to advanced wastewater treatment standards, while sustaining economic growth through implementation of an innovative reuse system. The reuse system receives advanced secondary treated effluent from six water reclamation facilities and serves 12,000 reclaimed water customers. Over 23 mgd is reused through irrigation, rapid infiltration basins, and industrial reuse. As the county grew, without proportionally increasing the number of irrigation customers, additional reuse capacity was needed.

In 2010, the feasibility of using wetlands to manage reclaimed water was investigated by the county and the Southwest Florida Water Management District. In 2013, a detailed public-private partnership was created to use privately owned land for the project. In 2014, hydrogeologic investigations, including aquifer performance and infiltration testing, were conducted for planning, design, and permitting. In 2015, a design that includes 15 wetland cells, with a total area of 176 acres, was completed. An average capacity of up to 5 mgd is expected. Benefits include recharge to the Upper Floridan and surficial aquifers, wetland rehydration, and ecologically valuable wetland habitat creation.

The county's reclaimed water has moderate levels of nitrate. This system is expected to fully denitrify and achieve total N levels near background before it reaches the groundwater (Figure 5).

This now-constructed project (Figure 6) includes an ecologically diverse system with areas of shallow, transitional, and deep water that will be operated seasonally to achieve healthy wetland hydroperiods within the cells, as well as maximize driving head for infiltration.

This system provides the reuse capacity needed to manage wet weather flows and excess reclaimed water by providing regional and site benefits to water resources and aquatic ecosystems. Since operation began in 2017, the system has received approximately 3 mgd, and water quality results indicate that complete nitrate reduction is being achieved by measuring water quality in the surficial aquifer within 4G Ranch.

The Ocala Groundwater Recharge Park: City of Ocala

The City of Ocala is constructing a large-scale infiltration wetland system by using reclaimed water and stormwater to recharge the aquifer, protect water quality, and recover and enhance flows to Silver Springs. The Silver Springs system is subject to restrictive TMDL regulations for nitrate and has a recovery strategy to help meet its established MFLs. This project supports both nitrate load reductions and recharge to help augment flows in the springshed.

In addition to the environmental benefits that drive this project, the city is creating a pub-

Figure 6. 4G Ranch Wetlands Cells 1-4

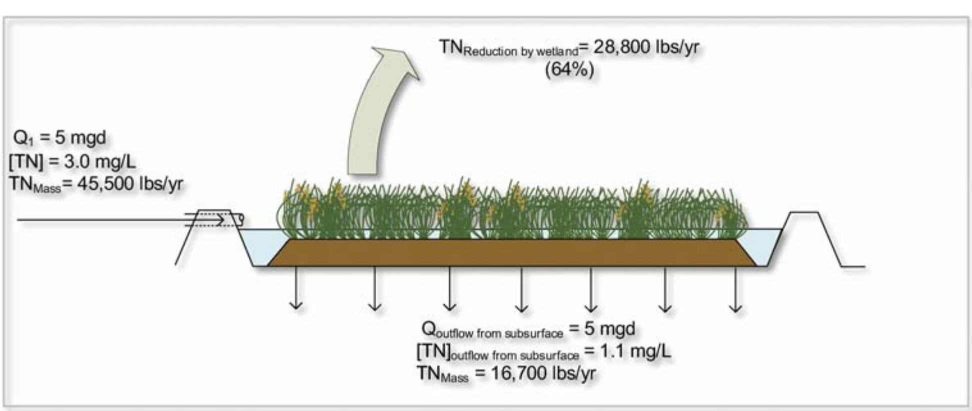

Figure 7. Ocala Wetland Water Quality Performance Forecasting

lic park, with exhibits related to wetland ecology, hydrogeology, and their connectivity to Florida springs.

Hydrogeologic investigation onsite consists of soil borings across the site and the construction of pumping and monitoring wells to produce the site-specific data needed to calibrate a groundwater model that was used to evaluate the site's capacity to recharge the aquifer and evaluate the fate of the applied water to recover flows in the Silver Springs system. These efforts included innovative applications of a calibrated groundwater model, combined with a wetlands treatment model to quantify recharge, while ensuring the protection of water quality. It was determined that this system will have a capacity of up to 5 mgd and will reduce nitrate levels to background concentrations.

Based on wetland treatment performance calculations at rates assessed from other groundwater recharge wetlands in the state, it's estimated that this system will remove approximately 28,800 lbs per year of TN (Figure 7), while providing 5 mgd of recharge to the Floridan aquifer system.

A wetland system of 36 acres divided into three cells to receive 5 mgd of reclaimed and stormwater has been designed and is currently under construction. The design includes organically shaped cells graded in place without the need for import or export of material to construct berms. The design maximizes wetland habitat diversity by creating different ecotones across the cells that range from deep open water to shallow wetlands, islands, and rookery areas.

The design also includes an innovative distribution header that controls flows to each cell independently, depending on water levels within the wetland cells. This will allow for seasonal operation of water levels to maximize recharge and wetland ecological value by mimicking wetland hydroperiods that are driven by seasonal rainfall patterns.

The benefits to the Silver Springs system quantified for this project led it to be top-ranked for funding from SJRWMD and secured Springs funding from FDEP in 2018.

The City of Ocala Wetland Groundwater Recharge Park will provide far greater benefits to the region than the current practices of disposing of excess reclaimed water through sprayfields by providing far more groundwater recharge and nutrient reduction to the impaired Silver Spring system.

Summary

Current conventional methods for managing wet weather excess reclaimed water often contribute to nutrient loads and do not return water from the hydrologic systems from where they came, causing hydrologic alterations in aquifers and surface waters. Wetlands can provide an approach that maximizes the benefits that can be realized from excess reclaimed water, transforming these flows into a valuable asset.

Both natural wetlands and constructed wetlands can create multifunctional and multi-beneficial projects that can open the door for funding sources and create regionally important improvements to water resource availability and aquatic ecology, while avoiding expensive upgrades to WWTFs and creating nutrient removal systems that require little to no power. Ancillary benefits, such as public uses, green spaces, and park amenities, make this technology an even greater asset to ratepayers.