Providing Resiliency in the Operation of a Transmission System

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The South Seminole and North Orange County Wastewater Transmission Authority (authority) was created by an act of the Florida Legislature in 1978 as a separate local agency of the government, with powers designed to meet the particular needs of the various municipalities within the area in relation to the transmission of wastewater to a single/solitary regional sewage treatment plant.

Design work for the authority began in the spring of 1979. Construction grants were obtained from the U.S. Environmental Protection Agency (EPA), and bond anticipation notes were issued during 1981 in the amount of $7 million. Construction on the system began in February 1982. Initial flows into the system began in February 1983 and the total system was completed in the fall of that year.

The authority's responsibilities include funding, planning, operating, and maintaining a wastewater transmission system (transmission system) that serves its five local municipal members, including Seminole County, City of Casselberry, City of Winter Park, City of Maitland, and City of Winter Springs. The transmission system consists of 32 pump stations, over 105 system valves, more than 115 air release valves (ARVs), and approximately 37.5 mi of transmission force mains that transport the wastewater to a gravity sewer manhole that flows to the City of Orlando's Iron Bridge Regional Water Reclamation Facility. Figure 1 shows the authority's service area boundary, pump stations, and transmission mains.

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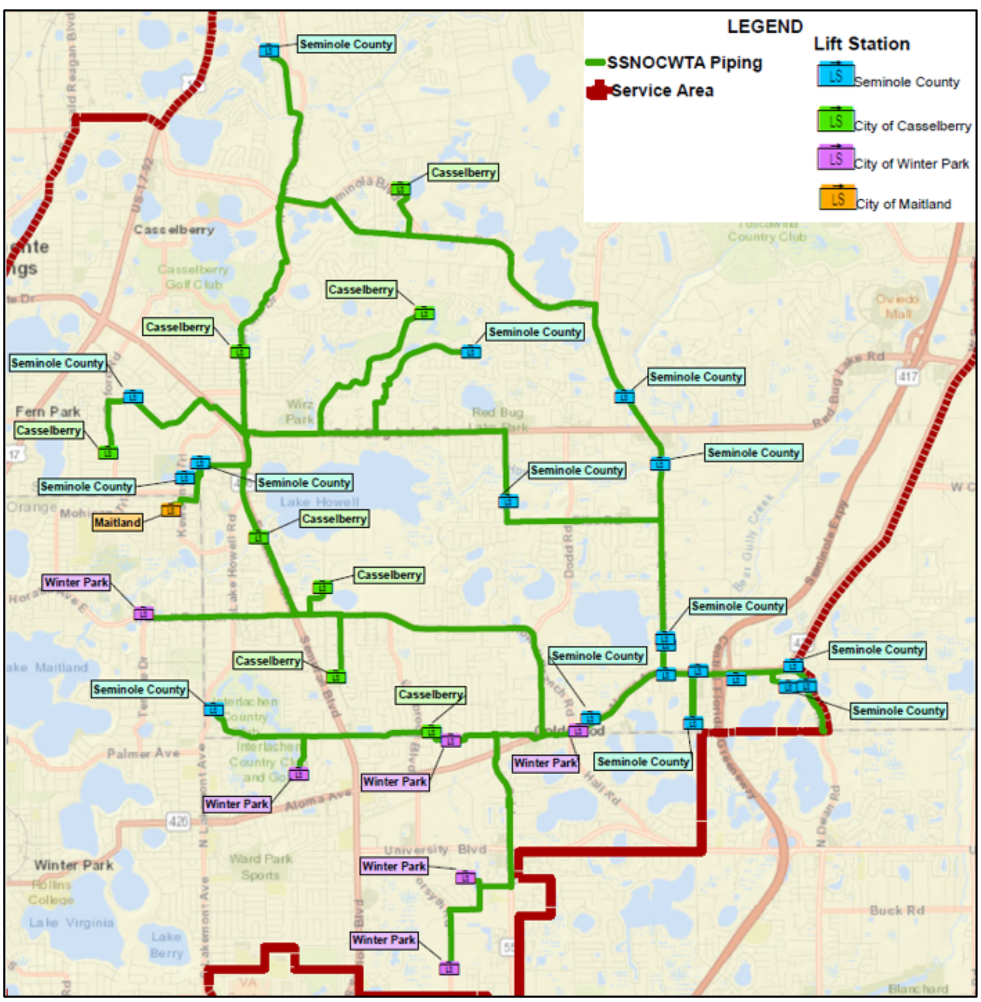

Figure 1. South Seminole and North Orange County Wastewater Transmission Authority Service Area

In 2013 the authority's staff was reduced to one employee (an executive director) who oversees and manages the day-to-day duties. The physical operation and maintenance (e.g., removing/installing pumps, site maintenance, etc.) of the pump stations is the responsibility of each member entity within their respective service areas. The remaining responsibilities required to run the transmission system, with continuous and uninterrupted service to customers, falls under the responsibility of the program management consultant team, which oversees and manages both the nonphysical and limited physical operation and maintenance of the authority's transmission system.

This article will present the challenges that the authority faces every day as it strives to provide an uninterrupted transmission system to its members, and how, through its program management, has been successful thus far in achieving that goal.

Wastewater System Management

When it comes to managing a transmission system, protecting public health is paramount. Two primary goals of wastewater operations are to provide uninterrupted wastewater transmission and mitigate overflows into streams, lakes, and private properties. These goals are accomplished by utilizing leading-edge technology, system management, and long-range maintenance, as well as fiscal and environmental stewardship.

Approximately 20 percent of households in the United States are on septic tanks, where owners are more likely to know what happens to their household wastewater once it's flushed or disappears down a drain because they're

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responsible for the maintenance of their own sewage treatment systems. The remaining 80 percent of households that don't use a septic system are served by a municipal transmission system. When their wastewater is flushed or disappears down a drain, it's removed from their homes, never to be seen, smelled, or thought of again.

To ensure that wastewater customers never have to think about their wastewater once it leaves their property, a utility with a transmission system needs to be proactive and consider all possibilities that could cause an interruption of service. These possibilities can be broken down into two main categories: daily maintenance and upkeep, and natural disasters.

Daily Maintenance and Upkeep

Failure of a transmission system due to maintenance and upkeep typically can be narrowed down to two locations.

The first is at the wastewater pump station. When pumps or electrical systems fail, wastewater is not discharged, wet wells fill, gravity sewers must surcharge, and wastewater overflows onto roads or into private residences.

The second is along the transmission pipeline, when a pipeline break occurs. The pipeline break not only causes a discharge of wastewater to the environment at the location of the incident, but it also impacts any upstream pump stations that discharge into the pipeline that experienced the break. In order to avoid these types of transmission system failures, it's necessary to maintain and upkeep the transmission system.

Natural Disasters

The failure of a transmission system due to natural disasters is most typically attributed to hurricanes and other major storm events. When a hurricane is forecasted to make landfall, community partners and residents of Florida (or any other state) within the path of the bad weather are encouraged to prepare by stocking up on bottled water and taking other measures to have enough water on hand for drinking, food preparation, and sanitation. This is a must, especially if the local water treatment plant loses power and can no longer provide potable water.

Not much thought, however, is given to wastewater disposal. The consequences of a pump station losing power has the same consequences as the failure to maintain and upkeep a pump station, but they're magnified due to the added factor of inflow and infiltration, which increases the fill rate and surcharge of the system.

Recently, with better communication systems, local municipalities are able to send out alerts to their citizens and inform them to limit their wastewater discharge, but residents will still need to use their bathrooms regardless of the weather. Failures attributed to natural disasters can be mitigated by installing emergency generators, which will provide continuous power during a power loss—as long as fuel is available.

Ensuring the absolute reliability of a transmission system means maintaining every working part of that system to prevent any interruption in service. The authority and its program management consultant have worked closely to provide the support, technical knowledge, and expertise to achieve absolute reliability. The actions taken are further explained.

Table 1. Criteria Table

Item	Criteria	Weight	Classification Categories	Ranking
1	Condition Assessment	5	Maximum Condition	1 - 5
		3	Average Condition	
2	Age	5	Rehab is < 10-years old	1
			Rehab is 10 to 19-years old	2
			Rehab is 20 to 29-years old / Unknown	3
			Rehab is ≥ 30-years old	4
3	Flows	3	Conveys <0.5 million gallons per day to system AADF	1
			Conveys 0.5 to 0.9 million gallons per day to system AADF	2
			Conveys 1.0 to 2.0 million gallons per day to system AADF / Unknown	3
			Conveys > 2.0 million gallons per day to system AADF	4
4	Station Capacity	3	Capacity Available (Ratio of Firm Capacity/Design Peak Flow ≥ 2.0)	1
			Capacity Exceeded in Future (Ratio of Firm Capacity/Design Peak Flow 1.5 - 1.99)	2
			Currently at Capacity & Unknown (Ratio of Firm Capacity/Design Peak Flow 1.0 - 1.49)	3
			Capacity Exceeded Currently (Ratio of Firm Capacity/Design Peak Flow 0 - 0.99)	4
5	Station Operation	2	Equipment is in good condition (Pump Exceeds Pump Curve)	1
			Equipment requires some maintenance (Pump 0% to 49% below Pump Curve)	2
			Equipment requires some maintenance in order to maintain operations (Pump 50% to 99% below Pump Curve)	3
			Equipment is near failure (Pump ≥ 100% below Pump Curve)	4

Pump Station and Pipeline Maintenance

In 2013 and 2014, an evaluation of the authority's pump stations was completed. Seven criteria items were evaluated, including physical condition, age, flow, station capacity, station operation, station type, and environmental factors. Table 1 shows a section of this criteria table. Each item was scored based on a predetermined ranking system, which allowed development of a priority list of repairs and rehabilitations for the pump stations. Over the subsequent five years, four pump stations underwent upgrades and rehabilitations, and seven emergency generators were added to pump stations that did not have a generator, or to replace a generator that had reached the end of its service life.

The transmission system pipelines underwent a similar assessment to that of the pump stations. The specific criteria used to evaluate the pipelines were different, and included pipe corrosion, age, capacity (velocity), pipe material, location within the transmission system, and environmental factors. The pipeline assessment was more of a challenge by virtue of the underground pipeline location. Without the ability to set eyes on the infrastructure and formulate a first-hand visual assessment, the method chosen to formulate a priority list included limited physical inspection.

Over the last nine years, the authority has been performing ultrasonic testing throughout the transmission system to obtain pipeline thickness data. The pipeline inspection data obtained have been limited in comparison to the 37.5 mi of transmission system; therefore, extrapolation of the condition assessment information to pipelines of similar material of construction, location, and age was done. In addition, the age criterion required record drawing information to determine when the pipeline was installed, but this information was not always available, which required coordination with each individual member entity and engineering judgement to develop a ranking system.

The 2013 condition assessment has been a valuable tool, and in 2019 the executive director of the authority requested an update to be performed. The update was completed to account for the increase in flows and reflect modifications of piping and pump stations to better evaluate the current system capacity and operational abilities of the authority's system.

The 2019 evaluation was completed, and a new set of priority lists was created.

Air Release Valve Management Program

When the authority's transmission system was constructed, approximately 100 ARVs were located throughout the system. Hydrogen sulfide gas, which is released by wastewater, naturally rises and collects at high points within the pipeline. The trapped gas can cause water hammer or pressure surges, flow issues, and corrosion, all of which impact the integrity of the pipelines. The ARVs, which are installed at the high points in a pipeline where trapped gas collects, help dissipate these trapped gases and extend the service life of pipelines. The effectiveness of an ARV depends on how well it's operated and maintained.

Prior to the authority's current program manager taking over the ARV management program, maintenance consisted of cleaning the ARVs on an as-needed basis, and repairing or replacing damaged ARVs within a 10- to 12-week turnaround period.

In order to improve the ARV management program, an assessment was made to determine the needs, and a new program was created that included the following:

- *Cleaning Schedule* – Most ARVs were placed on a quarterly cleaning schedule. The ARVs that require more maintenance are cleaned quarterly, while ARVs that require less are cleaned biannually or once a year. Furthermore, data collected at each quarterly cleaning are used to update the cleaning schedule for each individual ARV.
- *ARV Repairs* – Repairs that used to rely on contractors to retrieve the ARV, and repair and return it into service, are now completed by program management staff. The most common failures that cause an ARV to go offline are damaged flapper seals, O-rings, springs, and stems/floats; therefore, additional parts have been added to the inventory to allow for more-rapid repairs when an ARV is found to be offline.
- *Odor Checks* – When an ARV releases trapped gas, the gas is released into the atmosphere surrounding the ARV. The odorous release of hydrogen sulfide gas is unpleasant to anyone nearby. Even though the release of the gas does not impact the operation of the transmission system, it's unpleasant to utility customers and the general public, so monthly odor control checks on ARVs that are known to release high amounts of hydrogen sulfide are performed. These ARVs are fitted with odor control systems and the odor control media are replaced when they are no longer effective.

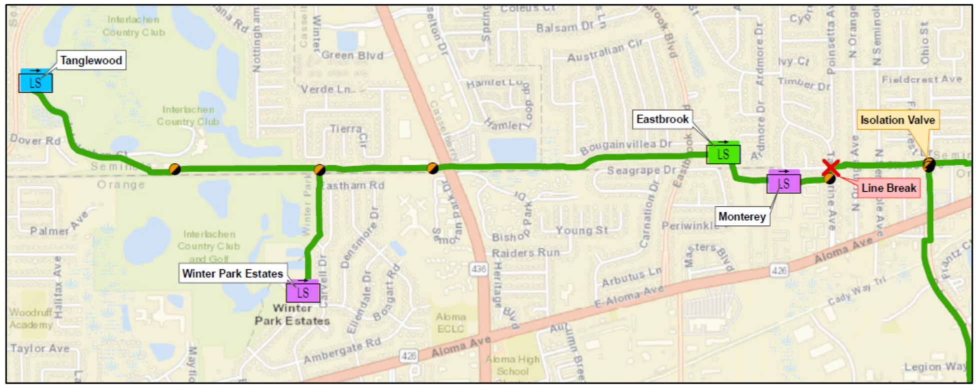

Figure 2. Citrus Avenue Pipeline Break

Figure 3. Vacuum Trucks in Service

The action of replacing every foot of pipeline that reaches the end of its service life, or has deteriorated quicker than anticipated, is not an option for most utilities. Often, the best option is to maintain the reliability of the existing pipeline by current means and methods that are often lower cost and less impactful to the community than excavation and replacement of the pipe. It's still necessary to ensure that the rehabilitation means are properly executed and not ignored after completion.

It's impossible to say that the authority's pipelines have maintained their operation for as long as they have solely because of the ARV management program, but what can be said is that the program does not damage or deteriorate the pipelines.

Pump Management Program

In 2016, the executive director noticed that expenses to repair or replace pumps had gradually increased over the previous year. In order to control costs, a pump management program was created.

The program consisted of a pump inspection checklist that would be completed by a pump contractor for each pump within the transmission

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system. It was understood that the checklist evaluation approach was limited since it was to be completed in the field instead of in the contractor's shop, where the pump can be disassembled and a detailed inspection completed.

The checklist results, once completed, often identified preliminary problems that could potentially lead to larger problems for the pump. Based on the checklist results, and in close coordination with each member entity, preventive maintenance repairs for pumps were prioritized. Once the contractor was selected to complete the repairs, close coordination among the member entity, contractor, and program manager took place to ensure that spare pumps were installed each time a pump was removed for service.

The same pump contractor who removed the pumps took them to his shop and repaired them based on the checklist results. During the repair process, the contractor also identified additional issues that were not identified in the field. This process has extended the service life of many pumps and has avoided potential issues or problems, which if left unchecked, would have resulted in more-complex and costly repairs.

In the past three years, authority costs to repair or replace pumps have been reduced approximately 38 percent, demonstrating that the pump management program's proactive approach is both beneficial to service reliability and cost savings.

Emergency Response

Pipeline or pump station failures cannot be predicted, but when they do occur, the response requires immediate action and coordination to limit the consequences of the failure. The authority developed an emergency response protocol, in which the first numbers to call in an emergency are the personal cell phone numbers of the program management staff members. Once the emergency call is received, the protocol outlines the responsibilities and actions required. The following is an example of the protocol in action during an emergency.

In September 2014, an 18-in. pipeline along Citrus Avenue broke due to a fracture in the polyvinyl chloride (PVC) pipe. The pipeline caused an immediate spill at the location of the break and impacted three upstream pump stations that discharged into the broken pipeline (Figure 2).

The goal for the authority was to minimize the wastewater spill and coordinate repairs as quickly as possible. The following tasks were completed soon after notification of the pipeline break:

1) Contact the member entity to request assistance with the repair of the broken pipeline.
2) Identify the downstream valve to isolate the system.
3) Coordinate the required vacuum truck (Figure 3) for the three downstream pump stations that could no longer discharge into the broken pipeline.

The pipeline break caused a spill of approximately 400,000 gal at the location. Following the repair of the damaged pipe, program management staff placed "No Fishing/No Swimming" signs at the downstream stormwater discharge point, where they remained for more than a week until laboratory results showed that there was no longer any contamination from the spill, and sanitizer could be applied at the location of the break.

More importantly, none of the three upstream pump stations experienced any wastewater spills. The coordination of appropriately sized vacuum trucks, based on the capacity of each pump station and in close coordination with each member entity on the location for the vacuum trucks to be emptied, was successful.

This specific pipeline break on Citrus Avenue was repaired and the transmission system returned to normal operating conditions in under 10 hours.

In the last five years, the authority's program manager has responded to two other emergencies, including one wet well overflow and one damaged pipeline caused by construction activities not related to the authority. In each emergency response, the ability of the program management staff to respond quickly allowed the authority to minimize interruptions to its transmission system.

Conclusion

The authority, like any transmission system, strives to never have an interruption of service. Emergencies or failures cannot always be prevented, but steps can be taken to minimize them when they occur. The close working relationship between the authority and its program manager has developed into a proactive approach to the operation and maintenance of the transmission system, with the goal to reduce the probability and consequences of system failures, whatever their causes. Activities, such as routine condition assessments and pump/ARV management programs, help to increase system reliability.

Coupled with a commitment to responsiveness by the authority's program management team, operational and emergency response efforts are focused and adapted to where and when they are needed—most every hour of every day.