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Case study:

Hurricane preparation and recovery for sanitary sewer systems

Organizations:

Public works departments in coastal areas of Florida

Product application:

The use of Airvac vacuum sewer systems reduced the time and cost of preparing for hurricanes and prevented sewer system failures during widespread electrical outages

Storm survival

Vacuum sewers withstand Florida's hurricane barrage.

BY STEVE GIBBS

Catastrophic weather is a public works director's worst nightmare. A massive storm can wreck infrastructure on an epic scale, and the costs to the city and the local economy can be staggering. Public works directors in Florida will forever remember 2004 as the "Year of the Hurricane." Four major storms, all Category 2 storms or worse, pummeled the peninsula during a six-week period. The last time four hurricanes hit one state in a single year was in Texas in 1886.

For officials responsible for sanitary sewer operations, hurricanes are especially troubling. The loss of electrical power, a

common occurrence with hurricanes, means that pump stations shut down. Raw sewage can backup into homes or spill out

into the environment. Public works personnel have to scramble to get portable generators on line to keep sewage flowing. Meanwhile, massive amounts of stormwater infiltrate the system and overwhelm treatment plants, which then have to bypass untreated, combined sewer overflow into local streams and rivers.

Public works directors all over Florida had to deal with these and other sewer-related problems during the aftermath of hurricanes Charley, Frances, Ivan, and Jeanne. However, a few communities using vacuum sewer technology survived the hurricanes with few, if any, sewer issues.

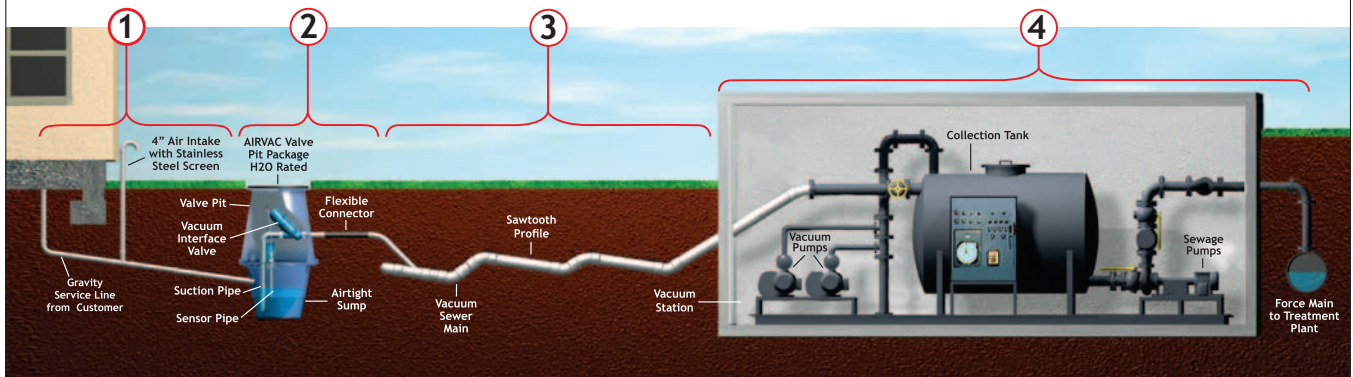
Hurricane Charley made landfall on Friday, Aug. 13, along the Southwest Florida coast. Packing nearly 150-mph winds, it was the most powerful storm to hit Florida since Hurricane Andrew in 1992. Stock Island, located a few miles northeast of Key West, took a glancing blow from Hurricane Charley, knocking out electrical power for several hours.

In 2003, the community had installed an Airvac vacuum sewer system to serve several hundred of its residents. The

Public works departments in Florida had to deal with preparations for and recovery from four successive hurricanes in 2004, which caused widespread flooding and electrical power outages that impacted wastewater systems.

Project Case Study

Figure 1: This schematic shows how an Airvac vacuum sewer system works: 1) A gravity line carries wastewater from a building (customer) to a valve pit; 2) When 10 gallons of wastewater collect in the sump, a valve opens and differential pressure propels the contents into the vacuum main; 3) Wastewater travels at 15 to 18 fps in the vacuum main, which is laid in a saw tooth fashion to ensure adequate vacuum levels at the end of each line; 4) Wastewater enters the collection tank. When the tank fills to a predetermined level, sewage pumps transfer the contents to the treatment plant via a force main. Vacuum pumps cycle on and off as needed to maintain a constant level of vacuum on the entire collection system.



vacuum station is housed in a building that is above the 100-year flood level and strong enough to withstand a Category 5 hurricane. The island also has a force main gravity sewer system with 16 lift stations. Both systems are serviced by Keys Environmental, Inc., based in Key West, Fla., under contract to Key West Resort Utilities.

When power is lost at lift stations, crews often have to bring in large portable generators to maintain sewer service. Christopher Johnson, president of Keys Environmental, said that handling large three-phase generators in high winds and pounding rain is not only difficult, it can be dangerous. Fortunately, the vacuum sewer system required minimal attention both before and after the hurricane hit. A standby generator kicked in when electrical power was lost, and it maintained service until power was restored. Johnson also noted that several mainland communities with gravity systems were still without sewer service weeks after the hurricane had come and gone.

With a vacuum system, one vacuum pump station often can replace seven or eight lift stations, a significant benefit for public works departments that must decide whether to invest in expensive backup generators for each station and that have to prepare each station for oncoming storms.

“When we assess our Hurricane Preparedness Plan, the advantages of the vacuum system really stand out,” said Johnson. “The preparation that is required to ready the vacuum system is miniscule compared to the enormous amount of effort it takes to prepare the force

main/gravity system.”

For example, in Englewood, Fla., about 30 miles northwest of Fort Myers, Fla., about two-thirds of the community’s sewer system is vacuum and about one-third is conventional gravity sewer. There are five vacuum pump stations, but 60 lift stations for the gravity sewers. “We have a lot of work to do in preparation for a hurricane,” said Mike Ray, operations manager for Englewood Water District. “We had all kinds of problems with our gravity sewers, but the vacuum sewers never missed a beat. If all our sewers were gravity sewers, we would have 150 to 200 lift stations. You can imagine the amount of work it would require to keep up with that many lift stations before and after a hurricane. We don’t have the budget or the manpower to handle that amount of work.”

As Florida was cleaning up the wreckage left by Charley, Hurricane Frances made landfall on the state’s east coast on Sept. 5 as a Category 2 storm with winds up to 110 mph and storm surges of 6 to 8 feet. Frances knocked out power throughout Palm Beach County, and more than 40 gravity sewer lift stations were shut down.

“One of our vacuum stations is housed in a building that can withstand a Category 5 hurricane and is equipped with a backup generator,” explained Robert Campbell, vacuum system technician for the Village of Palm Springs, Fla. “We didn’t have to do anything [to the vacuum station]; it had been running since the power went out.” The village’s other vacuum station did not have backup power, but it was back on line quickly once a portable generator was brought in.

The third storm, Ivan, a Category 3 hurricane, came ashore on Sept. 16, near Mobile, Ala., racking the Florida panhandle with high winds and rain. National Weather Service warnings provided some time to prepare, but most public works departments lacked the manpower and resources to get everything secured before the storm hit. Those with vacuum systems benefited because they had fewer lift stations to check. Additionally, the systems are sealed completely, which prevents infiltration and inflow, and most of the lift stations had backup electrical power to eliminate service interruptions.



This vacuum building (foreground) on Stock Island, Fla. — the only part of the vacuum sewer system that requires power — houses four pumps, which provide vacuum pressure for the entire collection system. The building is designed to withstand a Category 5 hurricane and is connected to a diesel-powered, 150,000 W/150 kW standby generator (right).

“Our vacuum stations required zero preparation before the storm hit, so this allowed us to spend time on other things, like filling sand bags, anchoring street signs, and so forth,” explained Thomas Voght, public works director in Cedar Grove, Fla., which is near Panama City. “After the storm, other cities had problems

with their lift stations. Cedar Grove was the only town in Bay County that didn't experience any sewer problems."

Sarasota County also took a glancing blow from Ivan, but Craig Bliss, manager, Water Reclamation Facilities of Sarasota County Utilities, said its vacuum sewers were unaffected. "We had very good success with our vacuum system during the hurricane. The vacuum station required very little preparation, and we never lost service in that area, even though we lost electrical power. We currently have about 500 gravity lift stations. That many lift stations require a significant amount of preparation before a storm hits and a lot of service afterward."

The final storm to rumble into Florida was Hurricane Jeanne, packing 130-mph winds and storm surges as high as 12 feet. It made landfall on Sept. 25, less than 10 days after Ivan. Cities that had been affected by one or all of the preceding storms still were dealing with the cleanup efforts.

Palm Springs' Campbell and his staff

were overwhelmed with issues at their 40-plus gravity lift stations, but there were minimal problems from the vacuum sewers. "We had zero occurrences of sewage spilling on the ground from the vacuum systems," said Campbell. "Basically, it was because of the holding capacity of the valve pits and the sealed system. Other municipalities were, understandably, allowing sewage to flow onto the ground because they had no power."

According to James Moore, assistant water superintendent of Carrabelle, one of Florida's panhandle cities, "Other than checking the fuel and oil in the backup power units, the vacuum sewers required none of our time during and after the storms. The system had no downtime and continued to service our customers."

Although vacuum stations are two to three times more costly than a lift station, replacing seven or eight gravity lift stations with one vacuum lift station reduces total system costs by about 20 percent to 25 percent, according to Airvac. From a design perspective, vacuum sewer systems

are similar to gravity systems, however, engineers must take into account that vacuum systems have a hydraulic limit, which is a function of elevation, flow, and pipe length (see Figure 1).

Gradually, several Florida communities are expanding the use of vacuum sewer systems. For example, the Englewood Water District installed its first vacuum system in 1996 and continues to expand the number of stations and customers served. Sarasota County Utilities currently is installing vacuum sewer systems throughout the county. "When the project is complete, we will have more than 20 new vacuum stations to service about 30,000 homes," said Bliss. "That will mean a lot fewer headaches for us the next time a hurricane comes through." ■

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Advantages of Vacuum Systems in Hurricane Prone Areas

ADVANTAGE	WHY?
Treatment Plant Not Affected	Vacuum systems are sealed, so massive amounts of I & I cannot enter the system and overwhelm the treatment plant.
Uninterrupted Service	All vacuum stations have either a fixed or portable standby generator, which ensures uninterrupted service to customers.
Less Hurricane Preparation is Required	Vacuum systems eliminate the threat of massive I & I and sewage spills. In coastal areas one vacuum station typically replaces 7-8 lift stations – less storm prep work for your staff.
Safer Working Conditions for the Maintenance Staff	Most vacuum stations have the fixed generators that automatically start during a power outage. A vital safety feature – no need to expose your maintenance staff to the severe weather.
As a Last Resort, a Vacuum System Can Be Shut-off	If water levels rise to the point where the air-intakes are in danger of flooding, the entire vacuum system can easily be turned off, thus preventing damage to the system.