Case Study Citico Pump Station, Chattanooga, Tennessee

Using Analytics to Improve Pump Reliability and Performance

OVERVIEW

The City of Chattanooga in Tennessee, operates a combined sewer system with approximately 1,200 miles of collection system, serving approximately 400,000 people. This includes 96 remote sites, which includes seven large pumping stations, 53 underground wet well mounted submersible pumping stations, eight combined sewer overflows (CSOs), regulators and the 230 million gallons per day (MGD) high purity oxygen Moccasin Bend Wastewater Treatment Plant.

KEY TAKEAWAYS

- Deviation alarms alert operators to pump plugging as it occurs
- 9.6% energy savings by operating pumps differently; 4-month project payback period
- DPO indicated that pumps had lost up to 16% of their capacity due to wear, and up to an additional 43% due to chronic plugging
- DPO recommended pump repair resulted in 300% ROI on project and recovered 6 MGD station capacity as a result of DPO recommendations

CITICO PUMP STATION

Citico Pump Station is the largest custom-built wastewater station in the Chattanooga system. It was designed to handle 120 MGD, and to respond quickly to infiltration events typical of Combined Sewer Overflow (CSO) facilities.

The station was scheduled to undergo major refurbishment in 2024 which would include replacement of all pumps, VFDs, switchgear and controls. Prior to the refurbishment, the City engaged Specific Energy to provide a comprehensive analysis of the current pump sizing, force main hydraulics and control strategies to determine if changes should be made.

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CHALLENGES

Ahead of the Citico Pump Station refurbishment, the City wanted to know whether its pumps were optimally sized for the existing and future forcemains, and whether the program controlling the station was operating efficiently.

Specific Energy's analysis showed that both pump wear and elevated friction losses in the forcemain had reduced that actual hydraulic capacity of the station by approximately 15% (18 MGD). This is a significant issue, as infiltration and inflow (I/I) in the combined system often leads to flows approaching or even exceeding the station's original design capacity. It also showed that operational setpoints needed to be changed to keep the pumps within their preferred operating ranges during dry weather periods because the pumps were over-designed to operate together to deliver peak flows.

Two other issues were identified by the Dynamic Pump Optimizer. In addition to the loss of capacity due to wear and tear and additional friction, the DPO conclusively indicated that additional capacity was being lost to chronic and excessive ragging of the pumps caused by flushable wipes and other debris in the sewer system. Not only did this significantly reduce station capacity, it also impacted energy efficiency, causing excessive energy expenditures. In extreme instances, individual pumps lost as much as 50% of their capacity. This situation put the City at a much greater risk of experiencing overflows during significant rainfall events.

The other issue identified by DPO was that the station's PID (proportional-integral-derivative) controls would periodically oscillate the speeds of the pumps from minimum to maximum. This is akin to driving with one foot on the accelerator and one on the brakes. Ramping motors in this fashion is damaging and significantly reduces their expected life.

> I deal with hundreds of different contractors, and I would say Specific Energy has been one of the most responsive and the most collaborative.
>
> They are open to discussion, giving their experience, asking questions, talking to us, hearing what our feedback is – it's really been great.
>
> **Jacob McCrary**
> **Director of Operations, City of Chattanooga**

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SOLUTIONS

The DPO went live at Citico in August 2021 and immediately started providing value to the City. DPO continually analyzes station data to determine the condition of the pumps, motors, and piping and determines if equipment is operating within optimal conditions.

Once DPO brought the plugging and oscillation issues to light, Specific Energy, the City, and the City's integrator worked collaboratively to address the challenges.

Mike Bernard, Vice President of Business Development, Specific Energy, said: "We were able to do some interesting and innovative things at Citico. Their PID controller was programmed to ramp pumps to full speed before starting the next pump in the sequence. This is how almost every pump station in the world is programmed. Unfortunately, because these pumps are oversized for rainfall events, they should not be run to full speed by themselves. "

"The PID controller would also periodically oscillate the speeds of the pumps as high flow events subsided. Specific Energy helped to develop a new control scheme that remedied the oscillation, but also appropriately sequenced the pump speeds to keep every pump withing POR at all flows. This gentler operation of pumps should extend the life of these pumps while significantly reducing energy costs."

The DPO detects and alarms based on 'deviations' in the productivity and power consumption data, sending text message alerts directly to operations staff. As the pumps plug with solids, operators can see the performance changes in real time. When the deviation exceeds 25%, they each receive an alert on their cell phones recommending flushing of the specific pump avoiding costly issues like seal and bearing failures.

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Mike Bernard
Vice President of Business Development, Specific Energy

Jacob McCrary, Director of Operations, City of Chattanooga, added: "What would have resulted in a total failure requiring pump replacement was caught and fixed in a week because of Specific Energy's alert." The DPO also detected and notified staff to a bearing failure on one of the pumps in January 2024.

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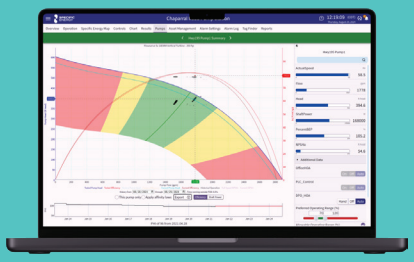
OUTCOMES

The DPO software visualizes the pump stations performance in real-time, much like a car's dashboard. Complex hydraulic equations are solved in near real-time and translated into simple graphics that operators can glance at to tell what condition their systems are in. The software also predicts the effects of repairs and refurbishment of equipment and provides return on investment (ROI) calculations to assist asset managers with proactively maintaining equipment to assure adequate capacity while operating equipment efficiently.



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> Jacob McCrary

"I can give their reports to my administrator and to the mayor and his cabinet, because they are really easy to digest and they can easily see the improvements," Jacob McCrary adds.

"The software also lets us see the effects of any changes we make, for example, if we have an older pump and we know that the impeller is worn, we might take it out and rebuild it, put it back, and then visually we can see the actual difference that has made," he adds.

Dynamic Pump Optimizer has allowed every member of Chattanooga's wastewater team (operators, managers, and engineers) access to real time analytics to improve the overall performance of the station. It is an essential tool in their toolbox to serve their community and protect the Tennessee River basin.

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