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Smart Metering…for Sewers?

Massive Low-Pressure Sewer System Project Benefits from Real-Time Trends and Analysis

By Joseph Harmes

The alert pinging smart phones, tablets and computers at South East Water in Australia's Mornington Peninsula seem facile, even boring, to anyone but a proactive utility: a customer's grinder pump was activating beyond normal cycles. The company called and requested a leak analysis. The homeowner had been unaware his toilet is running continuously and a simple fix lowered his utility bill and preserved water in an environmentally sensitive region where rain harvesting is not uncommon.

Historically — almost since Rome's invention of the gravity sewer around 700 B.C. — problem spotting and resolution in the wastewater industry has relied on the eye test and reactive repairs which aren't made until surface water appears, indicating a broken pipe; sewage emerges in a basement after a storm; or, someone tires of jiggling the toilet handle and calls a plumber.

But, if the Internet of Things now enables a "smart" refrigerator to text its owner a shopping list for butter, milk and beer, it also opens the door for utility companies to quarterback their sewer systems. Smart America Challenge, a White House initiative, forecasts "Smart Water Assets and sensors will fill a major gap currently existing in the water, wastewater and environmental industry affecting how utilities routinely collect, transmit, process and create system and asset data."

Pioneering the Architecture of the Intelligent Sewer

A potentially industry-shaping transformation is underway in Mornington Peninsula where 16,000 grinder pumps manufactured by Environment One Corp., are each supervised by a OneBox created by iota, an in-house R&D subsidiary of South East Water. The new low-pressure sewer system — the largest project of its kind on the planet — is supplanting an epidemic of failing septic tanks (a 19th century wastewater disposal technique).

Integrated into a utility's supervisory control and data acquisition (SCADA) network, OneBox relays real-time trends and analysis of set points, tank storage capacities, leaks, power failures, blockages and other fault detections. "OneBox was designed by a utility for a utility," says Eric LaCoppola, president of E/One. "Combined with the durability of the E/One All-Terrain Sewer (ATS) OneBox is the first technology that allows utilities or developers to take control of their sewer network."

By constantly interfacing with the OneBox, a "smart" utility captures complete visibility and command of its ATS grid — whether it's an entire small town; a golf, ski or seaside resort; even large swaths of a city — enabling it to diagnose and manage flows to and from individual properties, streets or networks of scale.

The intelligent ATS is a game changer compared to "dumb" gravity and septic where problems many times are isolated only by observable evidence (frequently, wet feet or illness in the case of septic), guesswork or sending highly-paid employees into the field with acoustic or 3D optical scanning devices and reacting only after the problem requires attention. During flood events, a gravity sewer's ungovernable swings in flow are left to nature's mercy, putting public and private assets in peril.

E/One's ATS is a cost-effective turn-key solution activated countless times daily by more than one million end-users in more than 40 countries. The heart of the ATS begins with a tank about the size of a dishwasher that is buried in the ground, often in the same footprint of a decommissioned septic system. Interior components include a one-horsepower, semi-positive pump that grinds waste into fine slurry. Its robust torque can propel the liquid through the inflow and infiltration-free pressurized 2-in. to 4-in. pipe buried just below frost level for a distance of more than two miles — even uphill — to a force main or treatment plant.

With the OneBox telemetry system, each grinder pump becomes a sewer smart meter. Information is gathered and transmitted via 3G networking, although South East Water has tests underway to transition to the Narrowband-Internet of Things (NB-IoT). Teamed with sensors and software the NB-IoT technology will enable low power monitoring and cheaper oversight of remote pumps like unoccupied vacation homes.

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The Biggest Rewards Come Downstream

“The financial benefit from OneBox is downstream of the E/One equipment,” says Christopher Greco, E/One’s director of global sales.

A utility’s paybacks aren’t derived from sensing toilet leaks but manipulating its pump operations to protect infrastructure. Switched to storm mode, the intelligent sewer can empty grinder pump tanks for storage (up to 500-gallon capacity) until a storm passes, permitting a regulated flow to the treatment plant and delivering an automated report after each downpour, identifying which pumps activated more frequently than normal. Peak shifting mode smooths the diurnal flow profile by delaying pumping for a few hours, or longer. The flushing mode allows the required velocity for daily scouring.

According to Phil Thompson, managing director of iota, the company’s goal was to even out and control the flows of the entire system. This reduces pressure on the treatment plants by removing the peaks and drops, which in Mornington Peninsula are multifarious given its seasonal coastal weather disturbances and extreme fluctuations between crushing tourist populations and their absence. With actionable performance analysis at hand, engineers can disregard the old edicts of sewer design where pipes were sized for peak diurnal flows and future design based on obsolete textbook standards and incomplete knowledge of daily and annual flows.

“Water treatment costs money. Not having to design a treatment process to handle these peaks, but instead a level loaded inflow, can result in significant savings in the cost of infrastructure (reduced pipe sizes, storage facilities and construction) as well as treatment itself,” says E/One project engineer Cory Tubbs. “Unpredictability can be costly, having to over-design systems for potential worst cases. With better control over the input to the plant, operators can plan ahead, treatment can be more predictable and therefore less expensive.”

Inflow and infiltration (I&I) can create catastrophic sewage overflows, especially with basements or lakes, the ocean or drinking water. Routinely, it’s the nemesis of wastewater treatment plants.

I&I “can be problematic, expensive and potentially come with legal obligations at the wastewater treatment plant,” Greco says. “During a rain event the WWTP will receive high levels of water over and above typical wastewater flows. If there are higher than normal flows, capacity issues at the WWTP present themselves and the WWTP needs to spend extra money to treat the additional volume of water and wastewater.

“With OneBox, the WWTP operator can remote control the ATS to stop pumping and retain the wastewater and I&I at each individual residential grinder pump station. Once the rain event is over, the WWTP operator can tell the pumps to pump the additional capacity downstream in a manageable approach,” Greco adds. “The largest savings will lie in the reduced sizing in building or expanding new wastewater treatment plants, by roughly 30-50 percent.”

Christchurch Replacing Gravity with Intelligent Sewers

Buildings and infrastructure in Christchurch, New Zealand’s third largest city, were severely damaged by a series of earthquakes and aftershocks between 2010 and 2012. Today, it is installing

an ATS system after recognizing its poor soil conditions, high groundwater levels, an increased long-term risk in groundwater infiltration and lurking seismic shifts are unsuitable for gravity sewers.

Nearly 2,000 E/One pumps have been installed in the Christchurch vicinity during earthquake rebuild works and conservative estimates see an additional 6,000 in the next decade (9,000 E/One pumps operate elsewhere in New Zealand). In 2015 the city began testing 100 OneBox units to vet their performance.

The Christchurch City Council commissioned a study calculating a gravity wastewater network draining to a central pump station would produce an expected peak flow of 47 liters per second (L/s). “If this was developed as a normal pressure sewer network, using the E/One method of estimating peak flow based on the probability of a number of pumps operating at any one time, the peak flow was expected to be 25 L/s,” the study said. “An E/One ATS with iota OneBox control panels in peak shifting mode reduces the peak flow to 12 L/s,” the study concluded.

Christchurch estimates a potential savings of $2.3 million dollars derived from “the utilization of existing infrastructure, downsizing of proposed new infrastructure and a reduction of risk/O&M costs,” says Derek Lachut, E/One’s Oceania regional manager (in Mornington Peninsula a gravity project would have cost an estimated $500 million U.S. compared to $357 million for the intelligent ATS).

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Bringing the Intelligent ATS to U.S. Homeowners

The OneBox replaces the grinder pump’s alarm panel. Instead of advising homeowners first of a problem, it instead notifies the utility which frequently can diagnose and repair a pump before the homeowner realizes anything is wrong. In effect, the pump becomes invisible to the customer.

“The benefit to all of this,” Greco says, “is OneBox gives the homeowner the confidence they would have using traditional gravity collection systems, where individual grinder pumps are not present at each home.” Eventually, Greco imagines, “I can see E/One offering Sewer-as-a-Service (SaaS) as a common method of wastewater collection. Think about it, homeowners can pay for what they pump.”

E/One currently is in talks with several major U.S. municipalities to incorporate its ATS with OneBox in wastewater upgrades. One project involves 800 city homes with failing septic tanks leaking into a river and ocean. Gravity is cost-prohibitive (around $25-per-ft compared to $13 for ATS) and impractical due to narrow city streets and home lot density. The ATS also eliminates a $1 million intermediate lift station.

“The ideal client has a population of failed septic systems, probably greater than 100 homes, or a greenfield of land to develop,” LaCoppola says. “This could be a municipality that just hasn’t gotten to install sewer collections to a part of the city or town and is experiencing environmental impairments of a body of water or water source. The value proposition is further strengthened if the amount of homes is greater than 1,000 and a wastewater treatment plant needs to be constructed as part of the project,” he adds.

“E/One ATS systems traditionally have been known as the best solution when an alternative to gravity is needed,” LaCoppola says. “Our intelligent sewer offering breaks this paradigm and, in many cases, positions E/One as the appropriate solution over gravity and other technologies.”