DOING THE JOB IN-HOUSE

Putnam County saves time and money tackling the challenges of hilly terrain and a recurring hydrogen sulfide problem

By Dan Heim

The Putnam Public Service District is nestled against the foothills of the Appalachian Mountains in West Virginia's Putnam County. The hilly terrain is scenic, but it presents some significant challenges for the local collections system.

The PPSD provides sewer and water for the area. When established in 1959, the utility inherited a combined system, one of 712 remaining in the United States. Additional small combined systems were assimilated in the 1970s and '80s. PPSD is now engaged in an ongoing program of system upgrades and recently started an ambitious in-house manhole, lift station and pipe rehab effort.

"When we started compiling our assets for GIS back in 2006 and began to video the pipes and manholes, we learned we had a real problem with hydrogen sulfide," says Tom Forth, PPSD foreman for Maintenance and Construction. "We've been working on it for 10 years now, just completed our GIS, and are starting to see some results."

Their 5,800 manholes, the oldest of which date to the 1970s, are a mix of concrete, brick and cinderblock. Those materials are prone to corrosion from sulfuric acid excreted by bacteria that "eat" hydrogen sulfide. And those manholes are the major source of I&I. PPSD also saw some acid damage in their lift stations and mains.

Appalachian aggravations

Being located in the foothills of the Appalachians brings many benefits, not the least of which is a reliable supply of drinking water from the local watershed. It needs to be processed but is relatively clean. No groundwater is required (beyond private wells in remote locations). PPSD has garnered several awards for their water quality.

But there's a dark side to that topography. The 411-foot change in elevation over the PPSD service area requires 74 lift stations and mostly pumped lines. Gravity is used where possible, but excavation is complicated by rocky soil. Another complication is the widespread presence of expandable clays.

With the need for pumped lines comes the need for grinders. "We use 350 E/One grinders, mainly where gravity is impossible," notes Forth. "There's some places where you just need to have force mains.

"And that's where we have some of our biggest FOG problems. People dump the wrong stuff down the drains and it ends up clogging the grinders, so we have to go out and service them. Those so-called 'disposable' wipes are another big problem."

PPSD's customers are concentrated in three widely separated areas: along a 9-mile stretch of I-64 between Culloden and Teays Valley, a 5-mile stretch on both banks of the Kanawha River between Poca and Red House, and a 6-mile stretch downstream between Rumer and Fraziers Bottom.

Treatment plants are located where needed rather than piping all the sewage to fewer central plants. As it is, three of PPSD's pipes run under the Kanawha. "We've got five plants total," says Forth. "Two of them are ours and the rest are under contracts with other local governments. We're helping them reduce system costs and redundancies."

Combined system

PPSD's combined system was a logical choice for early planners. The topography is hilly and, in places, difficult to excavate. Of course, this means the treatment plants get increased loads during the rainy season.

"Hard to say just how much the impact is," Forth explains, "since the rain can be pretty localized and where it goes depends on the topography, but there's a lot of it that ends up in our system."

All PPSD plants are fully metered. Forth provided representative numbers for their Hurricane plant: October saw 2.78 inches of rain and the meters clocked 10,633,271 gallons input. Customer usage was 9,273,398 gallons. That means they had 1,359,873 gallons infiltration, or 12 percent. In September, that number was 9.1 percent. PPSD sees similar variations across their whole system.

Tom Forth, foreman of Maintenance and Construction at the Putnam Public Service District, on the job in Scott, West Virginia. (Photography by Sam Owens)

Top: Putnam Public Service District maintenance crew member Jeremiah Campbell applies grout to a manhole wall at Scary Creek Industrial Park in Scott Depot, West Virginia. Above: Tom Forth pumps grout through the Step Up 120 (Imer Group) grout pump and spray machine while his crew sprays the inside of a manhole.

When PPSD sees a spike in one area, they follow up with an inspection crew that looks at every manhole and checks for cross connections. With all assets now mapped in GIS, the crew can quickly diagnose the problem. Since PPSD started their manhole rehab program, they've seen significant reductions in I&I.

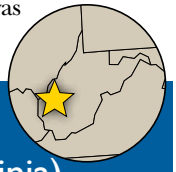
Cross connections are another issue. Residences and businesses are reasonably compliant with guidelines for diverting runoff, but violations are ongoing. The usual notification protocols are attempted before fines are issued.

"We've got a whole lot of that," says Forth. "And we've got a program to deal with it. Our inspectors always catch it. If we find a manhole with unusually full flow we video the pipes to find the cause. If it's I&I in our own pipes, we fix it. If it's not, we do a smoke test. That's how we find the violations and that's when the letters go out."

Hydrogen sulfide problems

Some of the 5,800 manholes in PPSD's system are pushing 50 years old and are made from materials susceptible to corrosion. They've added some new manholes as needed for growth, but the old ones are nearing the end of their design life. Aging is accelerated by aerobic bacteria called *thiobacillus concretivoru*. Those bugs will "eat" hydrogen sulfide, excreting sulfuric acid in the process.

"All the hydrogen sulfide in our system comes from waste," Forth explains. "The soils here are low in sulfates, so there's no contribution from I&I. We find some damage in our lifts and pipes, but the worst is where force mains enter manholes. We had some where the main was delivering 1,200 to 1,400 gpm,



PROFILE:
Putnam (West Virginia) Public Service District Sewer System

SERVICE AREA:
19 square miles (in Putnam County, West Virginia)

CUSTOMERS:
10,558 residential, 560 commercial

POPULATION DENSITY:
162 per square mile

INFRASTRUCTURE:
270 miles of mains, mix of asbestos cement, ductile, PVC and terracotta, diameters 4-16 inches; 74 lift stations (5-25 hp); 5,800 manholes (concrete, brick, cinderblock); 350 E/One grinders; 5 treatment plants (2 of their own, 350,000 and 325,000 gpd capacities, 3 additional plants under contract)

EQUIPMENT:
CUES sewer cam, SEA 747 trailer jet, 6 portable and 19 stationary 240/480VAC generators, portable grout pump, no-dig pipe patch equipment
Fleet: F-650 single-axle dump, F-550 mechanics truck, F-350 single-axle dump, F-350 maintenance truck, GMC 3500 sewer maintenance truck
Other: Case 4x4 rubber tire hoe, Kubota 121 track hoe, Kubota U45 track hoe

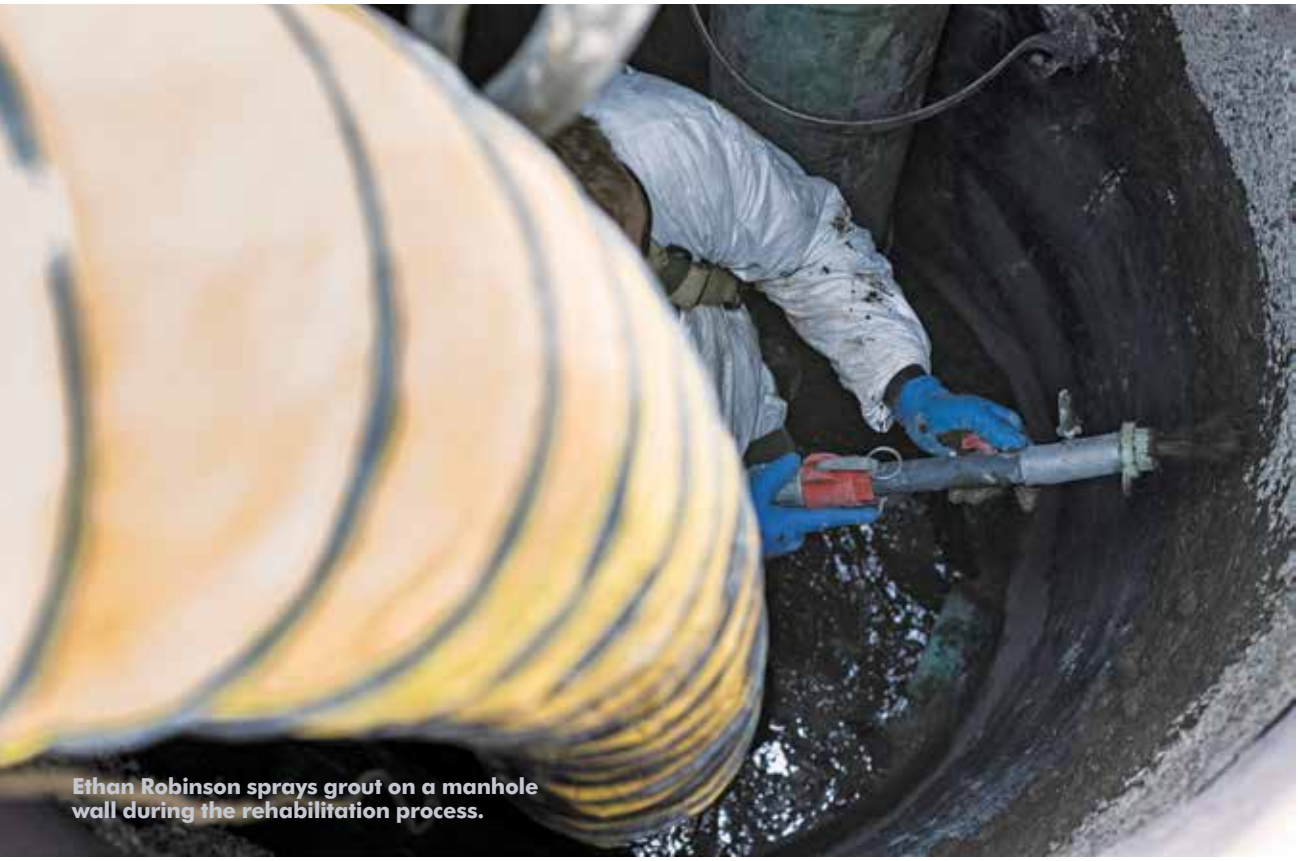
ANNUAL BUDGET:
$302,000 capital, $7.34 million operational

EMPLOYEES:
41

AVERAGE PRECIPITATION:
55 inches per year (41 rain, 14 snow)

SOIL TYPE:
Highly varied: sand, clay, shale, rock, river-bottom soil with an elevation change of 441 feet (640-1,081 feet)

WEBSITE:
www.putnampsd.com



Ethan Robinson sprays grout on a manhole wall during the rehabilitation process.

and they were in bad shape.

"That generates a lot of turbulence and mixing and brings oxygen to the bacteria, helping them grow. So we keep an eye on those manholes, inspecting them regularly and prioritizing them for rehab work."

Not all repairs are related to hydrogen sulfide. Some of the oldest manholes are made of materials structurally weaker than concrete, and they can contribute to I&I even without corrosion.

Hydrogen sulfide solutions

"We went with a manhole lining system based on aluminum nitrate," notes Forth. "It had one of the best ratings for resistance to corrosion. So the first 11 manholes were subbed out. When I watched the process, with my construction experience I knew we could do that in-house. So I went to my boss and he gave me the green flag."

What they got was an increase in speed and a decrease in cost. When they subbed out that job they were paying about $300 per foot. When they tried it in-house applying the lining by hand, that cost dropped to $177 per foot. But it was difficult work, with the 13 manholes they tackled ranging from 8 to 14 feet deep.

"That work nearly killed us," recalls Forth laughing. "So I started some research and decided to buy that grout pump from Parson Environmental. It got our cost down to around $130 to $140 per foot."

Doing as much rehab work as possible in-house saves time and money. "That wasn't a tough decision," Forth proudly observes. "We've got a good fleet and the right equipment. Plus our guys can do the job. Bottom line is it keeps our costs

SELF-HEALING CONCRETE

There's an interesting development underway at Delft University of Technology in the Netherlands. Utilities with hydrogen sulfide problems, take note. Dr. Henk Jonkers, a microbiologist working at Delft, is developing a special blend of concrete that when cracked or corroded can actually repair itself.

The product promises a huge increase in the service life of concrete, whether in buildings, bridges or wastewater systems. But it's not an additive or coating — it's a blend of concrete with embedded bacteria that can fill cracks and pits as they form.

"I was inspired by the way the human body can repair itself, and I started thinking about how that same ability could be transferred to structural materials," Jonkers says. His research eventually led to a unique mix of organics and inorganics.

Many types of living organisms are capable of producing structural materials — from human bone to coral reefs to the calcium carbonate excretions of certain bacteria. Bacteria can remain dormant for long periods, deprived of light and water, so they were good candidates for further investigation.

Concrete has a high pH when liquid (11-13), so what was needed was a bacterium that not only excreted calcium carbonate but could also tolerate an alkaline environment. Additionally, it had to be a spore-producing bacterium.

The bacteria Jonkers chose are dormant *Bacillus* and/or *Sporosarcina*, contained in pellets with a food source (calcium lactate). The pellets are produced as a fine powder that is mixed into the concrete before pouring. These bacteria will remain dormant but viable until needed. When a crack or pit forms, something amazing happens.

Water seeps in and reactivates the bacteria. They eat the food and excrete a hard calcium carbonate ($CaCO_3$) filler, essentially organically generated limestone. This seals the breach and prevents water from reaching the rebar. Rebar expands when it rusts and can cause additional cracks that compromise structural integrity.

In the case of sewer pipes, lift stations and manholes, bacteria cause damage by excreting sulfuric acid metabolized from hydrogen sulfide. The acid forms pits in the exposed surface of the concrete. As the pits grow, the structure eventually fails.

If the concrete is Jonkers' blend, those pits would be sealed with limestone. It's not a permanent fix, since limestone is also dissolved by sulfuric acid. But the concrete will last far longer before succumbing to structural failure.

and rates low. In fact, we've got one of the lowest rates for utilities in this region."

The utility has relined 31 manholes to date and is on a one-per-week schedule (when weather permits). "We've also done 2,462 inspections and 668 repairs in addition to those 31 relines," Forth adds. "For damaged pipes we use the Source One Environmental pipe patch system. It's a no-dig CIPP process and can even get into the laterals."

Dealing with growth

According to the Putnam County COC, the local population continues to increase by about 300 residents each year. Some settle in smaller municipalities with independent sewer systems. Still, within PPSD's service area development requires system expansion. And, unrelated to growth, some lines have been extended to provide remote customers with sewer and water service and take them off wells and septic systems.

"We just completed a $16 million extension to bring in two rural areas," Forth says. "And Poca sold us their sewer. They gave up on it and contracted us to do it for them. That added 920 manholes to our system. We still need to do some upgrades on their stations, so it's a work in progress over there."

PPSD also extended lines to outside Putnam County and now provides service for parts of St. Albans to the south and Culloden to the west. Another in-county extension added Buffalo on their northern boundary.

As a nonprofit public service district to the state, PPSD relies on sewer and water fees for most of their $7.34 million operational budget. Customers can access a convenient online payment gateway for a variety of options. For larger capital projects, federal and state money is available. It must be repaid, but the interest rates are low.

Keys to success

PPSD has won many water-quality awards since 2006: seven from agencies in West Virginia, and three from regional and national organizations. Several have been repeats over consecutive years. Multiple factors contributed to this recognition.

"For those water-quality awards, we had automated our treatment plant in 2006. We also built a new sediment basin to increase our capacity to 4 million gpd," Forth explains. "We built a 600-million-gallon reservoir back in the '90s, and it's far enough upstream that it gets the really good water."

The sewage treatment plants discharge into the Kanawha River, a tributary of the Ohio. Discharges are monitored closely with reports to the state and EPA sent quarterly. Since 2006, PPSD has consistently met all state and EPA standards.

Forth says there are many factors involved in the utility's success. "We've got pretty good staff retention, so they know their jobs and are all hard workers committed to our mission. We've got permanent crews for specific tasks so they work as a team, but most are cross-trained. And we've got the equipment we need."

Forth has been with PPSD for 11 years and worked in the bridge construction industry before that. He brings his production-oriented project management experience to the job, as well as excellent problem-solving skills. And with his construction experience, he's got a good intuition for what can or cannot be done out in the field.

"I have to add that we have the support of an extremely receptive administration and Board of Commissioners," Forth says. "Mike McNulty (PPSD manager) gets us whatever we need to fix the problem. And the board just built us a new maintenance facility for around $1.5 million. That makes us all feel appreciated." ✦