Orange County Sanitation District team members work on grouting joints in one of two aging sewer trunk lines where inflow and infiltration had been a problem.
PHOTOGRAPHY BY ED CARREON AND THE ORANGE COUNTY SANITATION DISTRICT

GROUTING AGAINST I&I

Orange County takes a joint-specific approach to reducing inflow and infiltration

By Giles Lambertson

Why line an entire sewer pipe when grouting the pipe's joints will stop the inflow and infiltration? That was the question Orange County (California) Sanitation District Senior Engineer Dickie Fernández first asked himself and then the utility's engineering managers.

"The pipe segments were in great shape. I saw minimal cracking," Fernández says about his engineering condition assessment of two sewer trunk lines and a sewer interceptor pipeline targeted for repair in OC San's 380 miles of sewer main. "I proposed that if we just performed chemical grout injection on leaking joints, we would control the existing inflow and infiltration and could extend the life of the pipe another 50 years. They agreed."

That was in 2019. After work actually began on the rehab project in 2021, the decision to rely on chemical grout for the bulk of the repair work looked better and better. While there were some unexpected outcomes — mostly stemming from the variety of pipe in the rehabilitated sections — the bottom line was a $3 million savings in the cost of the project.

Alternative solution

OC San is a public agency that provides wastewater collection, treatment and recycling services for approximately 2.6 million people in central and northwest Orange County. OC San is a special district governed by a 25-member board of directors composed of 20 cities, four special districts and one representative from the Orange County Board of Supervisors. OC San has two operating facilities that treat wastewater from residential, commercial and industrial sources, treating approximately 180 mgd of influent. In cooperation with the Orange County Water District, OC San provides secondary treated effluent to OCWD for advanced filtration and production of 130 mgd of potable water, the largest operation of its kind in the world.

OC San has moved in recent years from an emphasis on expansion and building out of the system to rehabilitation and maintenance, according to Andrew Brown, OC San's engineering supervisor. "Now the core assets are in place and we just need to keep them running," he says, adding that a more systematic inspection program has been implemented. "Some of the lines are nearing the end of their useful life, so we're ramping up rehab and replacement. About 80% of our capital improvements budget next year will be for that."

Much of the collections system is more than 50 years old, Brown says. In the three rehabbed pipelines — two trunk sewers and one interceptor sewer — two of the lines date from 1959, another from 1976. After an initial assessment of the segments in 2018, the decision was made to rehabilitate the pipelines using a cured-in-place technology.

That would have involved lining 40,000 feet of vitrified clay pipe, which ranged from 21 inches to 39 inches in diameter. Another 600 feet of pipe was in such poor condition that it needed to be replaced entirely. In addition, about a hundred manholes would be repaired or replaced.

Then, Fernández offered his alternative solution

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>
> **Andrew Brown**

PROFILE:
Orange County, CA Sanitation District

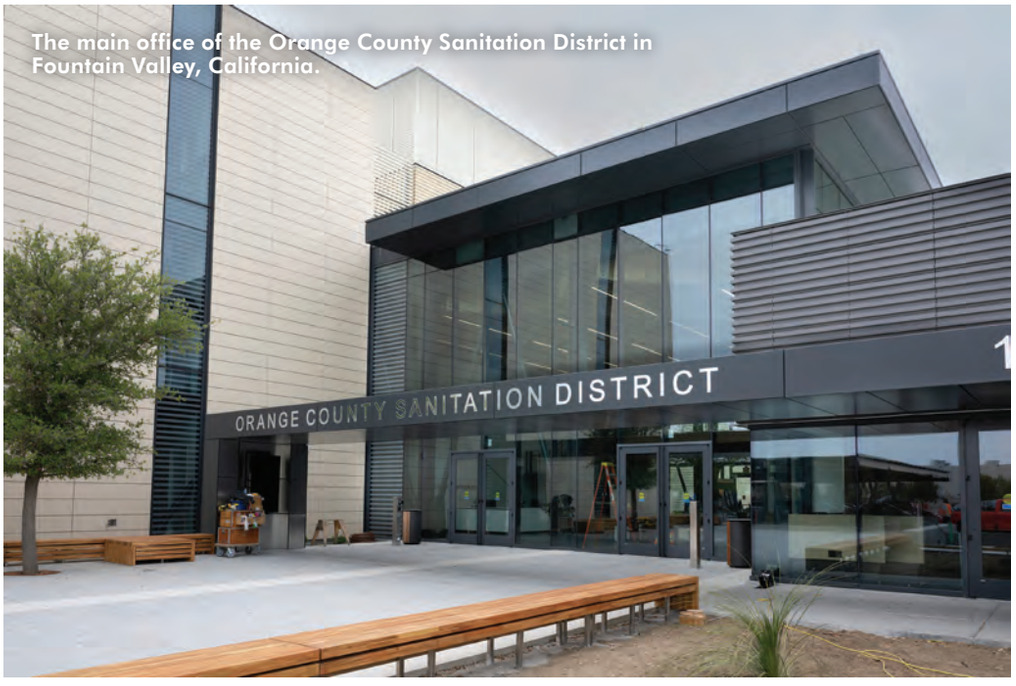
ESTABLISHED:
1998

SERVICE AREA:
479 square miles in central and northwestern Orange County

PEOPLE SERVED:
2.6 million

INFRASTRUCTURE:
388 miles of sewer line, 15 pump stations, and two 100-acre reclamation facilities

WEBSITE:
www.ocsan.gov



The main office of the Orange County Sanitation District in Fountain Valley, California.

and the project headed in a different direction. "Cured-in-place pipe lining is a great product and I'm a great fan of it," the senior engineer says, "but given the pipeline's great structural condition, I did not see a need for CIPP, but a need to stop inflow and infiltration."

OC San engineers were familiar with chemical grouting, though not as the grout would be used on this project. Grout can also be employed in conjunction with cured-in-place projects when there's a need to seal off areas of a pipe experiencing active infiltration, which would jeopardize curing of the CIPP liner.

Wholesale chemical grouting of joints using a sophisticated remote-controlled packer was something new for OC San. It scouted around for contractors who are experienced with the technology in the immediate Orange County area and in the San Francisco Bay Area. The project eventually was awarded to Steve P. Rados Inc. as the prime contractor. Performance Pipeline Technologies (subcontractor) ended up performing both the grouting and the approximately 3,000 feet of CIPP installation.

The project began by putting each joint under 10 psi of air pressure, with the requirement that the joint sustain the pressure for at least 30 seconds. "If the joint passed, it received no grout. If it failed, we injected grout and retested," Fernández says of the process.

If a joint failed to hold pressure after being grouted, more grout was injected until it passed the air pressure test. Overall, the 1959 pipe had far more joints failing the air pressure test — 2,043 to the newer pipe's 336.

Defying expectations

Surprises experienced in the course of the project began almost immediately. When Performance Pipeline Technologies started cleaning the pipe and removing the calcium deposits prior to injecting grout, it didn't go as planned. The contract stipulated "the work shall be performed through the use of a CCTV-operated robotic system capable of traversing up to 600 linear feet and removing the obstruction through the use of a high-pressure water stream."

The specifications also stated, "The use of lumberjacks, chain knockers, rotary cutters or mechanically driven systems are not acceptable." However, this restriction was later relaxed and the subcontractor employed a combination of a CCTV-operated water stream and mechanical cleaning methods, mainly a robotic cutter.

Another surprise: Fernández presumed more chemical grout would be injected into joints of the 1959 sewer pipe than into joints of the newer pipe. That seemed logical. After all, the National Clay Pipe Institute had informed him that joints in the older pipe probably employed field-applied oakum rope seals, whereas the 1976 pipe had more effective factory-installed polyurethane seals.

"I naturally assumed the older pipe would require more grout per joint," he says. "What I found was completely the opposite."

As measured by the amount of grout injected into failed joints per inch of pipe diameter, the results defied expectations. The 1959 pipe joints required an average of 5.8 gallons of grout. The failed joints in the newer pipe needed an average 9.5 gallons of grout — about 80% more! However, as expected, the 1959 installation had significantly more failing joints; approximately 60% of them failed while the rate of failing joints in the 1976 installation was approximately 10%.

How could that be? Calcium. When the older pipe joints failed dramatically, calcium deposits clogged the joints and protruded into the interior of the pipe. Though precleaning of the pipe had removed the visible buildup of calcium inside the pipe, the jetting or robotic cutting did not extend into the joints themselves. Consequently, the same calcium that announced failure of a joint also partly filled the joints and became part of the sealing solution.

CONSULTING WITH OTHER UTILITIES

The trunk and interceptor pipelines of Orange County Sanitation District are well situated for longevity. For one thing, they are laid deeper in the ground than most sewer lines.

OC San is a regional wastewater authority that serves a total of 25 member agencies; 20 cities, four special districts and unincorporated areas of Orange County. Each member agency has its own sewer collections system, which discharge into OC San's trunk and interceptor sewer pipelines and convey the flow to either its Plant 1 or Plant 2 wastewater treatment facilities. As a result, OC San's pipelines are deeper than those of its member agencies and consequently closer to or beneath the groundwater table. Generally, OC San's pipelines are 15 to 20 feet underground.

As for the impact of Orange County soils on pipe, that is of less concern to OC San's Senior Engineer Dickie Fernández. The soils mostly are clay, loam and sand, types of earth materials that pose little threat to the vitreous clay in the OC San system. Furthermore, because the pipe often is buried beneath a public right of way, tree roots are rarely a threat, Fernández says.

What sometimes is found deeper underground, however, is water, and that is more problematic.

When OC San opted to stem inflow and infiltration into some of its lines by grouting the joints, Fernández "put in a lot of research" to determine if that was a realistic solution. He consulted with peers in Miami, Florida, and San Francisco, where grout is more frequently employed to cure leaking pipe. After all, the water table in Miami is notably high. Pipe material, type of pipe joints, soils and groundwater table are other variables that Fernández considered in his engineering recommendations.

"Based on my conversations with Miami and San Francisco, I felt chemical grout was a great option given the right circumstances. Chemical grout injection is now another tool OC San can use in future projects."

"I naturally assumed the older pipe would require more grout per joint."

Dickie Fernández

"We needed to inject less grout into the cracks to seal them because the calcium already was there," Fernández says. The reverse was true in the newer pipe: There, the absence of calcium buildup meant that some failed joints required quite a lot more grout. In fact, 28 of those joints each needed 20 gallons or more to seal. Seven of them required 40 gallons or more.

Though that surprised the engineers, the bottom line for the project did not disappoint anyone. With all the variables included, approximately 15,000 gallons of chemical grout were injected into the joints to make them whole again.

By project's end, instead of spending $7 million to line the sewer pipe, OC San expended about $4 million for grouting.

Working upstream

OC San is continuing its rehab and repair of sewer infrastructure this year. It's working on upstream portions of the same trunk and interceptor sewers grouted previously. Chemical grout again will be employed and Fernández and other OC San engineers are hunching over computers and calculators attempting to come up with good numbers to guide them.

"It is difficult to estimate the volume of grout," Fernández says, which at this point seems like an understatement. "We don't know how many joints will fail, but the presence of calcium deposits or visible infiltration confirms the joint is not sealed. We don't know the condition of the trench hosting or the potential voids in it. We're flying in the dark a little bit."

If the next "flight" is anything like the last one, the betting is it will be a smooth and successful one, if not totally unsurprising. ✦

FOCUS ON THE JOINTS

Orange County Sanitation District experienced success when, beginning in 2021, it rehabbed some 40,000 feet of trunk and interceptor sewer pipe by grouting joints in the pipeline. Success was measured three ways — in dollars and cents (opting to grout the joints instead of lining the pipe saved $3 million), minimized traffic impact (the work was performed at night with temporary traffic control) and reduced aggravation (the contractor did not have to reroute wastewater flow to avoid work areas).

Given all that, one might conclude that grout is now the go-to solution for failing infrastructure. Unfortunately, the chemical grouting process cannot heal every ailing pipeline.

"You need to have a pipe that is in pretty good shape," says Dickie Fernández, OC San senior district engineer and a proponent of grouting. "If joints are leaking, grout can fix that. But if the pipe shows a lot of cracks and fractures, this is not going to be a good solution."

The reason is air. The chemical grout is injected into the narrow space where the ends of pipes meet in a manufactured joint. The integrity of the new grout seal is tested by putting the joint under 10 psi of air pressure and measuring any loss over 30 seconds. If there is none, the joint is sealed.

However, the remotely operated injection and air-testing equipment functions within a short span of the pipe, just enough distance to fully incorporate a joint. Therefore, a crack running lengthwise along a pipe cannot be contained for air testing.

"The air testing can only be done at the joints," Fernández says. "If you have fractures running the length of the pipe, it is not worth testing it because it will fail the air pressure test." And without being tested, it is unknown whether a grouted joint has been made whole. Such speculative results are not highly valued.

Under such conditions, cured-in-place pipe lining (for maintaining the same diameter) or pipe bursting (to increase the diameter) solutions are appealing.

The city of Winter Haven eventually will be encircled by a roughly 30-mile-long underground transmission pipeline for reclaimed water that will help restore roughly 19 wetland areas, providing a bounty of recreational opportunities and enhancing wildlife habitat for the Central Florida city.

The wetlands — about 5,000 acres in all — will become part of a project known as the Sapphire Necklace, a connected chain of natural jewels: parks, lakes and green spaces. They'll be connected by an approximately 40-mile, multimodal trail system. The 12-foot-wide trail eventually will connect with a statewide trail system, says Gary Hubbard, director of the city's water department.

But the wetlands, which historically have been ditched and drained, will serve another purpose, too: help recharge the Upper Floridan Aquifer from which the city pumps its water.

The Sapphire Necklace will include about 20 lakes within nature parks. (Winter Haven is known as the "Chain of Lakes City" because 50 lakes of varying sizes lie either within or border on the city limits.)

The wetlands will be filled by reuse water from a new, $420 million wastewater treatment plant expected to be built by 2028. The plant will be capable of treating 12 million gallons of sewage per day, Hubbard says.

The restored wetlands will also help fill local lakes, which are well below their predevelopment levels, according to the Southwest Florida Water Management District.

The transmission ring, which will consist of 20-inch-diameter PVC and HDPE pipe, will be completed in around five years. It will connect to both wastewater treatment plants and allow the city's water utility to transfer reclaimed water anywhere it's needed around the city.

The western half of the loop is already completed — a 22,850-foot-long, 24-inch-diameter reclaimed waterline completed in 2022. The rest of the transmission ring is being built as development occurs; developers are required to partially pay for these various segments, he says.

"We don't want to arbitrarily install the transmission ring and then have to move it to accommodate the best route through properties," Hubbard adds. "So we'll do it in conjunction with development."

Excess water from the wetlands will be used to recharge the aquifer through a combination of injection wells and rapid-infiltration basins, Hubbard says.

"Over a 50-year period, those wetlands could store 83 billion gallons of water," he says. "Projects such as this are part of a bigger plan to restore, recharge, reclaim and reuse water resources in Winter Haven to the fullest extent."