Waste Activated Sludge Pipeline Rehabilitation:

14,000 Linear Feet of Slip Lined Fusible PVC®

By: Marvin Lee, AEGION

The City of Peoria, AZ is a major suburban area for the greater Phoenix Metropolitan Area and located in the northwestern part of the Metro. The city is home to approximately 168,000 residents. In the 1950s, increased economic activity and the presence of Luke Air Force Base led to tremendous growth throughout the entire Salt River Valley. This further triggered a postwar construction boom, setting the stage for Peoria to become a suburb of the capital city of Phoenix as growth moved west. Today, Peoria's economic development focuses on growing the resort and leisure living sectors. In springtime, Peoria Sports Complex serves the San Diego Padres and Seattle Mariners for their player development program. In 2008, the city earned its place as one of the Top 100 Places to Live according to Money Magazine.

To support the city's growth, water conservation is key for Peoria. Peoria actively protects and preserves its diverse water supply through aquifer recharge, planning and building reliable water infrastructure, and direct reuse of reclaimed water for landscaping and other non-drinking water demands. In the past decade, this effort has cut Peoria's water consumption by 15 percent.

Currently, water treated at Beardsley Road Water Reclamation Facility, one of Peoria's three water reclamation facilities, produces a waste activated sludge (WAS) that cannot be processed at the plant. The sludge fills a holding tank before being cyclically pumped 14,000 feet along Beardsley Road to a manhole where it then flows by gravity line over 10 miles to Butler Drive Water Reclamation Facility, which has the ability to process the sludge. With rapid growth in Northern Peoria, Beardsley Road Reclamation Facility will likely be upgraded in the near future to have the same sludge processing capability, making this line obsolete.

Majority of 13 installs were over 1,000 feet, longest was 2,300 feet

The existing pipeline was 8-inch ductile iron installed in 1999. Peoria had several other ductile iron sewer lines citywide that experienced severe corrosion and had to be rehabilitated or replaced. Based on this history and the importance of this line, the city took the proactive approach and hired Dibble Engineering (Dibble) to provide an assessment on the Beardsley WAS line. Dibble took samples from four locations, and while the pipeline itself had yet to fail, significant deterioration and corrosion were observed. The engineer found that Hydrogen Sulfide gas (H_2S) was deteriorating the top of the pipe, most likely due to air pockets and clogged air vacuum valves that allowed the H_2S to accumulate. The city needed to rehabilitate the 20-year-old line before a failure occurred.

City engineers considered several rehabilitation options, including cured-in-place lining, slip-lining with fused thermoplastics, as well as compressed fit HDPE liner. Slip-lining with HDPE solid wall pipe was the initial solution before the engineers considered slip-lining with fused polyvinyl chloride pipe (FPVCP). HDPE pipe and FPVCP are both fused thermoplastic solid wall pipe systems and often specified as equivalents. HDPE pipe is more elastic and, thus, can accommodate tighter bend radius and alignment while FPVCP's higher tensile strength results in larger

inner diameter (ID) compared to HDPE pipe. On the other hand, the compressed fit HDPE liner is a specifically sized high density polyethylene pipe (HDPE) whose outer diameter is larger than the inner diameter of the host pipe it is lining. During installation, the outer diameter is temporarily reduced by passing through a multi-stage roller box that compresses the pipe. Once installed it expands its initial orientation memory, resulting in zero annular space between the liner and the host pipe. The city eventually requested quotes for the three options: slip-lining with HDPE pipe, slip-lining with FPVCP, and compressed fit HDPE liner.

Comparing material and fusion costs, the compressed fit HDPE liner option came in at approximately $500,000; HDPE option was at $200,000; and FPVCP option cost $130,000. To put this into perspective, new open cut installation for the replacement pipe would have cost upwards of $2 million more than a slip-line rehabilitation, mostly due to pavement repair costs and trench management. Although the city liked the idea of maximizing the liner ID, compressed fit HDPE liner became cost-prohibitive when it was compared to slip-lining with HDPE and FPVCP. Ultimately, the city chose to slip-line the existing 8-inch ductile iron pipe with 6-inch FPVCP because it provided the best blend between costs and traffic impact while resulting in an acceptable ID. Additionally, the engineers also liked FPVCP's compatibility with standard fittings and connections.

Generally, 2-inch annular space between the host pipe's ID and the slip lining pipe's outer diameter (OD) is recommended. The gap between the 8-inch ductile iron pipe (8-inch ID) and the 6-inch iron pipe size (6.63-inch OD) was tighter than normal, but maximizing the new pipe's ID was important to accommodate the forecasted flow capacity of the pipeline. Due to the size reduction of the pipeline, the whole system was designed to include new, smaller pumps. The bottle neck of the system was the amount of raw water going into the facility's wet well from the clarifiers – 120 gallons-per-minute. The smaller FPVCP and new pump configurations would have no problem emptying the tank. This design was more cost-effective than new open cut replacement with existing pumps, or compressed fit HDPE liner.

> *"Open cut installation would cost $2 million more than a slip-line rehabilitation, mostly due to pavement repair costs and trench management"*

The project was released under a Job Order Contract (JOC) with Achen-Gardner, a well-respected heavy civil general

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contractor in wet utility and roadway construction throughout Arizona. JOC simplifies the contracting process through multi-year contracts for a wide variety of construction projects, and Peoria uses them for applicable projects with a maximum project cost of $3 million. This particular project was unique and unusual to the city. Therefore, Peoria wanted qualified contractors' feedback for setting up the project and to have an all-inclusive price for the work. This contracting method was more suitable compared to the conventional Design-Bid-Build (DBB) method. Achen-Gardner was perfect for the job given their extensive resume on pipe-specific projects. The contractor worked with the city and engineer to design a construction plan, with Dibble also providing construction administration services.

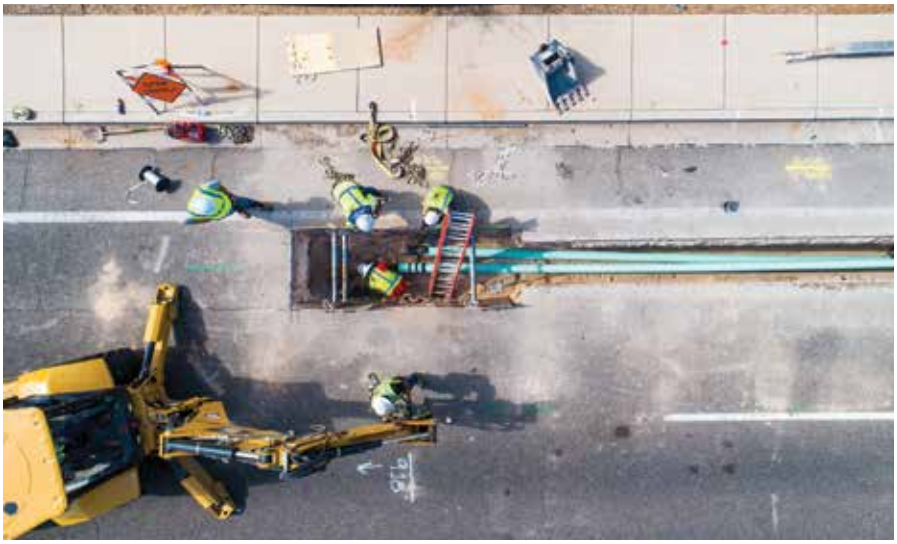
Funding for the project had to be spread over two fiscal years, and the schedule dictated that a certain section be completed during the summer break to eliminate impact to a nearby school. Achen-Gardner started immediately after Memorial Day, May 27, 2019. After setting up a temporary bypass, the contractor video surveyed sections of the pipeline and found it to be relatively straight and round but could only record about 2,500 feet of the 14,000 feet due to the extensive corrosion on the existing ductile iron. Following CCTV, the pipe was cleaned with jetting and blades, while several sections required chain knocking or flailing to clear. The available equipment only allowed the cleaning in 900-foot sections, so additional potholes were added to facilitate access and allow cleaning of the whole pipeline. For future projects, the contractor would consider other methods for cleaning longer lengths of pipe to limit the additional potholes required.

Underground Solutions (UGS) then fused the FPVCP on the street surface in a closed lane. The traffic control was straightforward. Fencing was used around open pits, while steel plates were used to cover open pits near intersections. While only a single lane was needed for fusion and insertion, both east bound lanes were closed, and traffic divided between the two west-bound lanes. The city was initially concerned about the impact of the lane closure, but later realized that it would expedite the construction while providing and very safe work environment with plenty of room to operate within. A total of three miles of the two east bound lanes were closed. The busier eastern end of Beardsley Road connects to Arizona Loop 101, so the project moved from east to west and lanes were reopened as sections were completed. The contractor prepared 4x13-foot pits with 40-foot long tail ditch per UGS's recommendation. After the pits were dug and the pipe strings were ready for installation, Achen-Gardner pulled them into the host pipe with a 5-ton cable winch. There were thirteen pulls in total. The majority of the installs were over 1,000 feet, and the longest one was 2,300 feet. Standard ductile iron fittings were not used because corrosion was a concern, so connections were completed with glued PVC fittings with restraint harnesses, providing a belt and suspenders approach.

The street portion of the project was completed in early September 2019 following pressure testing at 160 psi for two hours, approximately two months ahead of schedule.

There were some notable challenges in the construction process:

- The construction took place in summer with some 110°F days. Temperature is a key variable in the FPVCP fusion process. Although the heat helped with melting FPVCP ends prior to joint fusion, it also extended the joint cooling time, resulting in overall slower fused joint production. A tent was provided to mitigate the weather effects.



Compact site: 4x13-foot pits with a 40-foot long tail ditch were used

- One of the slip-lined sections had limited working area. Ideally, FPVCPs are fused into one pull-length string and pulled into the host pipe in one shot. When working area does not provide sufficient laydown area, FPVCP sections are fused and pulled in turns. While fusion time remains the same, the pull-in time is affected. For example, one section had only 60 feet of laydown space, which translated to 5.5-hour construction for a 460-foot pull. As a comparison, the longest pull, which was 2,300 feet, was completed in 2.5 hours.
- Given the tight annular space between the host pipe and the slip-lining pipe, a regular 6-inch pull-head could not be used. UGS re-designed and fabricated a specially-made internal pull-head for the job.
- Two sections provided curveballs. The WAS line was supposed to have a vertical realignment underneath a high-pressure gas line crossing; However, the original pipe installer went over the gas line, and used deflections in the joint (up to 8 degrees) to achieve the realignment. The stronger and more rigid FPVCP still had enough flexibility to line through this section with no issues. At another intersection, the host pipe was supposed to go straight through, but ended up with a 22.5-degree horizontal realignment from lane 1 to lane 2 in order to cross over three 48-inch storm drains. Achen-Gardner split the initial pull length that was supposed to go straight through the intersection into two separate pulls. Working on the eastern side first, they removed the 22.5-degree fitting, and pulled pipe up to that point. Then they dug an additional tail ditch in line with the crossing and pushed in a FPVC section through the host pipe up to the western fitting in order to pre-load the pipe. The eastern end connections were completed, and the pits were closed up. Achen-Gardner moved to the western side where the process was repeated. The 22.5-degree fitting and some of the original pipe were carefully removed from around the pre-loaded FPVCP. Pipe from the west was slip-lined toward the pit, connected with the crossing section, and then closed up. This allowed for minimal disruption to the busy intersection.

FPVCP was new to the City of Peoria, Dibble Engineering, and Achen-Gardner, but a collaborative effort resulted in an effective design, allowing the construction team to implement a slip-lined solution that was minimally intrusive to the neighborhood, saved significant costs from traditional open/cut replacement methods, and provided a long-term pipeline free from corrosive concerns. The successful rehabilitation of the WAS line will help to maintain continuous operation of Peoria's reclaimed water system and support the city's water conservation efforts.

ABOUT THE AUTHOR:

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