North Charleston Sewer District’s Ashley Interceptor Sewer Rehabilitation by Cured-in-Place Pipe Methodology

for
North Charleston Sewer District

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EXISTING SYSTEM

The North Charleston Sewer District (NCSD) System includes 60 pump stations and approximately 500 miles of gravity and force main piping. The infrastructure serves approximately 31,000 customers and a total population over 100,000. The Felix C Davis Wastewater Treatment Plant (WWTP) is permitted to treat 32 million gallons per day (MGD) and is the only plant utilized by NCSD. Currently, the plant averages approximately 18 MGD from the 59-square-mile service area.

The backbones of NCSD’s collection system are two interceptor lines, the Cooper and the Ashley, shown in Figure 1. The interceptors were named for the two large rivers flowing into Charleston Harbor. In doing so, they form the peninsula where the City of Charleston is located as well as the “neck” area of the peninsula which separates the City of Charleston and the City of North Charleston. The “neck” is also the location of NCSD’s Felix C. Davis (WWTP). The two interceptors transport wastewater flows from the North Charleston sewer service area. The Cooper Interceptor flows along the south and west side of the Cooper River, and the Ashley Interceptor along the north and east side of the Ashley River, until they combine into a single (combined) interceptor sewer flowing nearly two miles in a southeastern direction to the WWTP. This is a case study of the rehabilitation of approximately 10,700 linear feet (LF) of the Ashley Interceptor just upstream of the confluence with the Cooper Interceptor.

REHABILITATION HISTORY

The main arteries of the system, the Combined, Cooper and Ashley Interceptors are reinforced concrete pipe (RCP) sewers that were originally constructed primarily between 1966 and 1969 in conjunction with the WWTP. Several factors contribute to high hydrogen sulfide (H₂S) production in the interceptors: 1) the sewers are laid on a shallow grade, i.e. little slope, 2) they accept flows from many long force mains, and 3) the hot, humid lowcountry of South Carolina creates a conducive environment in the pipelines. As would be expected, this environment has resulted in significant corrosion and deterioration of the interceptor sewers. The
Cooper Interceptor is approximately ten miles in length and includes 36-inch, 42-inch, 48-inch, and 54-inch diameter segments.

The Ashley Interceptor is approximately seven and one-half miles in length and includes 36-inch, 42-inch, and 54-inch diameter segments. The Cooper and Ashley Interceptors converge in a junction box forming the Combined Interceptor with flow leaving the box in a 60-inch RCP, eventually increasing in size to a 66-inch RCP before entering the treatment plant.

NCSD has utilized CIPP rehabilitation since the early 90s on 8-inch, 10-inch, and 12-inch lines that pre-date the treatment plant. NCSD focused on these lines due to their over-50-yr age and material, mainly vitrified clay or concrete. However, during this same time, the RCP interceptor lines were unknowingly and rapidly deteriorating due to H2S corrosion.

In 2005, the top portion of a section of 42-inch RCP Cooper Interceptor running along a CSX railroad collapsed. This section was immediately downstream of 8-inch and 30-inch force main discharges. Closed-circuit television (CCTV) footage revealed 3,000 feet of pipe in this area needing replacement. Since the pipe was in an open area forty (40) feet away from the tracks and extremely deteriorated, this section was replaced with ductile iron pipe as required by CSX.
Due to this collapse, a H2S study was performed at various locations along the Cooper and Ashley Interceptor lines. Utilizing this information, and the assumption H2S would be concentrated near force main discharges, CCTV was performed on approximately five miles of the Interceptor lines. This information was then used to develop a rehabilitation plan for the most critical areas needing rehabilitation.

In 2006, 2,300 feet of 42-inch RCP on the Ashley Interceptor was rehabilitated using slip lining technology. Slip lining inserts a reduced diameter fiberglass pipe inside the host pipe. Although the diameter of the host pipe is ultimately decreased, the capacity of the line is roughly the same as the friction factor of the fiberglass is considerably less than the friction factor of RCP. Slip lining works well with straight segments and eliminates the need to bypass pump. In 2007, an additional 8,200 feet of 36-inch and 42-inch RCP along the Ashley and Cooper interceptors were slip lined. CIPP became more cost competitive in 2008 and a 5,000 LF section of the 42-inch Ashley Interceptor was rehabilitated using this methodology.

NCSD inspected an additional 13 miles of Interceptor lines in 2010 to develop a master rehabilitation plan to rehabilitate the entire Interceptor system using CIPP methodology, thereby turning their large-diameter liabilities into valuable assets. Whereas the existing, deteriorated sewer is minimally a source of inflow and infiltration and at its worst is a possibility for catastrophic failure, as a host conduit for new pipe constructed by CIPP, it is an opportunity to construct a new pipeline. Well-constructed CIPP can have a useful service life of fifty years or more.

The master plan rated the interceptor segments on a scale of one (1) to five (5) with five being the most deteriorated. Interceptor segments were grouped based on rating, constructability, and funding and placed in the five (5) year Capital Improvement Plan (CIP). Since 2011, an additional 34,000 feet of Cooper and Ashley Interceptor and 8,800 LF of the Combined Interceptor were rehabilitated using CIPP. The 2017 budget year called for this portion of the Ashley Interceptor to be rehabilitated.

PROJECT BACKGROUND

This project rehabilitated 10,700 feet of 54-inch RCP using CIPP and 120 feet of 36-inch RCP with centrifugally cast geopolymer lining. A total of 485 vertical feet of manholes were restored using a cementitious structural base covered with a 250- mil polymer resin-based or epoxy topcoat. The influent splitter box at the downstream, Virginia Chemical (VC) Pump Station was rehabilitated to the same standards as the manholes. The project was bid in March 2017. Seven general contractors were pre-qualified to bid and attended the required pre-bid meeting in February. Six responsive bids were received, the low one at $4.95 million and the highest at $9.24 million. The four lowest were within a $700,000 range. Kenny Construction Company of Northbrook, IL submitted the low bid and was selected to construct the project. The contract was awarded in April 2017, with the Notice to Proceed on June 1st and a 270-day construction period. The project was substantially complete by February 2018 at a finished cost of $4.832 million.

The project section of Ashley Interceptor, constructed in the late 1960s, is largely laid along low bluffs or within the tidal marshes associated with the Ashley River. Prior to the original construction of the interceptor, numerous neighborhood collector laterals drained directly to the river, before passage if the Clean Water Act. These laterals were tied into the new interceptor at that time, sending the raw wastewater discharges to the river. The marsh route
presented a challenge for accessing the project, but there were others as well. Other properties along the route included an industrial park at the upstream end, heavily wooded properties, an orphanage and a cemetery. The final 5,000 LF of the route paralleled the Interstate 26 (I-26) right-of-way, creating additional access issues, and then passed beneath SC Hwy 7 (Cosgrove Avenue), a major thoroughfare, at the incline to the North Bridge over the Ashley River. Beyond the Cosgrove crossing the sewer interceptor continues downstream across low i.e., very wet marshlands to the VC Pump Station.

![Figure 2 – Ashley Interceptor looking south (downstream) with Ashley River and North Bridge to the right](image)

**BYPASS**

The bypass route is usually the most complicated technical issue to for large diameter CIPP projects. The bypass for this project was installed where possible within the sewer easement associated with the interceptor. However, since the sewer lay within jurisdictional wetlands for a majority of the route it was alternately laid above the upland boundary of these wetlands. Therefore, the bypass piping, dual 24-inch HDPE pipelines, occupied private properties and the I-26 right-of-way. Because of the access limitations the CIPP was installed using onsite, or over-the-hole, wet-out lining procedures. This is an alternative to using remotely wet-out liners delivered to the site in a refrigerated truck. Onsite wet-outs facilitated much longer lining sections (shots) and reduced the number of inversions and therefore access manholes. Inversion lengths ranged from 1,165 LF to 1,708 LF.

The project segment of the Ashley Interceptor lies between the Brickyard Pump Station and the VC Pump Station, the last pump station upstream of the Felix C. Davis WWTP. The average daily flow (ADF) is 7 MGD and the peak capacity is 21 MGD. The bypass system was
designed for these flow quantities. The bypass consisted of the primary bypass for the interceptor and eight (8) secondary bypasses for collection sewers downstream of the main bypass setup. Figure 3 shows the primary bypass setup at an industrial park on the upstream end of the project.

The primary bypass route crossed the six-lane Cosgrove Avenue near the foot of the North Bridge. Figure 4 shows the bypass utilizing the bridge as the means to traverse the highway crossing with a short jog to the west. The jog avoided a bore and jack or other means of crossing the highway.
After crossing Cosgrove Avenue, the bypass continued to the south as shown in Figure 5. The bypass paralleled the acceleration onramp to I-26 and was laid on the upland border of the marsh (wetland).
PERMITTING

Permits were required from the US Army Corps of Engineers (US ACOE) and the SC Department of Health and Environmental Control – Office of Ocean and Coastal Resource Management (DHEC – OCRM) due to the work within and adjacent to the wetlands. The best management practices included avoiding the wetlands with the bypass route where feasible and conducting all activities within the marshes from wetland protection matting to prevent rutting and permanent damages to the vegetation. Figure 5 and Figure 6 show the matting and the operations on the matting installed in the marshes.

Figure 6 – The camera truck and an inversion setup on wetland protection matting

An Encroachment permit and traffic control plans were required by the SC DOT and the US Federal Highway Commission. Two construction entrances were installed from SC Hwy 7 (Cosgrove) and two were installed on the I-26 right-of-way. The construction entrances for Cosgrove and the entrance from the I-26 acceleration (on-ramp) were located on high speed, heavy traffic thoroughfares requiring careful monitoring, signage and flagging for safe access.
CONSTRUCTION ISSUES

In addition to the difficulties described for the bypass route and installation, the inversion setup and execution as well as the manhole rehabilitations were made difficult by the wooded locations, and even more so by the wetland locations.

![Figure 7 – An aerial view of an inversion setup and the bypass crossing the worksite](image)

Water for cleaning, water-head inversion and curing was generally available despite the remote setup locations. On the final inversion into the VC Pump Station, water was unavailable due to a locked fire hydrant, and the great Charleston snowfall (4-6”) of 2018. The water provider was unable to get to the site to provide the water, so wastewater was utilized for the various processes.

The weather had an impact on the project in another way, as well. During the access preparation and bypass installation phase of the project, Hurricane Irma’s passage bought tropical storm winds with hurricane-force gusts accompanied by significant storm surge at the project site. By grace the event didn’t occur during a later phase of the project when more personnel, equipment and vehicles would have been at risk. Figure 8 shows the effects of the wind and surge on the wetland protection matting. After the access matting was replaced to the pre- Irma locations, new anchoring techniques were utilized to keep them from relocating themselves. While there were no additional tropical events, the extremely high “king” tides did present additional problems during full and new moon phases. Namely, the wetland matting tended to float, manholes were overtopped, and access was particularly difficult.

There were also occasions, besides the rainfall with Irma, when heavy rainfall made the worksites nearly inaccessible and difficult to areas to work, considering the heavy equipment – fully-loaded flatbed with the liner, crane, conveyors, four resin tankers for each shot, front-end loaders and other accessory vehicles. In Kenny Construction’s opinion, the biggest disruption
was the high tidal water levels, with or without the storm surge, that caused their wetland protection matting to float and rearrange themselves on a regular basis. To give sufficient elevation above the high tides Kenny increased the matting from one to four layers, which kept the vehicles, personnel and equipment above the higher, high tides. Additionally, the mats were bolted together to prevent separation as they floated on the high tides and settled back onto the marsh on the outgoing tides. Another challenge presented by the salt marshes was the “pluff mud”, with its pudding-like consistency, that constitutes the substrate supporting the marshlands. An attempt to walk on the mud would have a man quickly up to his waist, as in quicksand.

The entire CIPP rehabilitation was completed in seven (7) installations. The longest inversion, No. 4, was 1,708 linear feet of 54-inch diameter CIPP at 30 mm thickness. This shot took nearly 24 hours to install and another 12 hours to cure (cook) at 130° F at the terminus end of the curing liner. Inversion No. 5 was 1,550 LF of 30 mm, 54-inch CIPP and was install following several inches of rain and in miserable conditions.

CONCLUSIONS

The success of the project, despite the difficult aspects of the site and the work completed can be attributed to the spirit of teamwork demonstrably applied during every stage of the project. The teamwork began with the relationship between the NCSD and WK Dickson, who have undertaken numerous challenging projects involving their collection system over the past several years. These projects require early planning, an intimate familiarity with the route of the host pipe and alternative for the bypass in the design and construction. Adjustments and field revisions on the fly are the norm, rather than the exception. The CIPP rehabilitation of other
large diameter sections of the Cooper Interceptor and the Combined Interceptor served as training for the Ashley Interceptor.

The marshland and roadway crossings were large obstacles, but not unique nor new to the design team. The initial planning by engineers from the NCSD and WK Dickson along with the feasibility analysis by Jacobs Engineering Group’s sewer rehabilitation specialist, Stephen Lindsey, gave the confidence that the project would be successful. The affected property owners and regulatory agencies bought in and assisted as they could to facilitate finalization of the plans, permits, and regulatory agreements to allow the project to get underway. Lastly, the contractor joined the project with a cooperative, team-oriented approach and proceeded to construct the project in an efficient and professional manner. Kenny Construction demonstrated their desire to accept the challenges and execute the project. The contractor with their subcontractors and the other participants and stakeholders pulled together with cooperative efforts to complete this rather large and complex project.