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EBMUD 3rd St. Interceptor Rehabilitation Phase 2

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ABSTRACT:

The East Bay Municipal Utility District (EBMUD) operates a wastewater collection and treatment system that serves approximately 700,000 residents along the east shore of the San Francisco Bay. EBMUD's South Interceptor has been in service for nearly 70 years and was in need of rehabilitation to address its corrosion issues. The 3rd Street Interceptor Rehabilitation Phase 2 Project included sliplining of approximately 4,700 feet of existing 105-inch diameter pipe with new 96-inch diameter fiberglass mortar pipe. The total project cost was $14 million and construction was completed in December 2019.

The project was completed one year ahead of schedule, and the construction cost was estimated to be 40% lower compared to other similar EBMUD pipe rehabilitation projects. The contractor used a high-capacity pipe pushing machine to maximize the pipe-pushing reaches, therefore minimizing the amount of sliplining pits needed for the project. This significantly reduced traffic, noise, and odors in both residential and industrial work areas.

Odor impacts were further mitigated by dosing the interceptor upstream of the project with sodium hypochlorite. Not only did this reduce odors at the street level, but also significantly reduced harmful hydrogen sulfide gases in the interceptor, which made for a safer work environment when interceptor-entry was required.

1. INTRODUCTION AND BACKGROUND

EBMUD's wastewater system serves approximately 700,000 residents along the east shore of San Francisco Bay. EBMUD is in the midst of a major sewer interceptor rehabilitation program to address corrosion that has occurred over time since the interceptor was constructed in the 1950s.

The South Interceptor was constructed of cast-in-place concrete using traditional cut-and-cover or tunneling method. Corrosion occurs when hydrogen sulfide gas reacts with the unprotected concrete, which reduces the structural strength of the concrete pipe. Based on a prior condition assessment on the pipe, EBMUD confirmed that the large-diameter sections of the interceptor was near the end of its useful life and was in need of rehabilitation. A photo from a previous South Interceptor rehabilitation project in 2013 is shown in Figure 1.

Figure 1. EBMUD South Interceptor showing severe corrosion

The 3rd Street Interceptor Rehabilitation Phase 2 Project (project), completed in December 2019 and budgeted at $14 million, included rehabilitation of approximately 4,700 feet of 105-inch diameter pipe and five manholes in a congested area in West Oakland.

2. TECHNOLOGY EVALUATION

Due to the size of the interceptor (105-inches diameter, thumbnail shaped) and the inability to take the interceptor out of service, only a limited number of rehabilitation technologies could be considered. The main technologies evaluated were: crown liner, spiral liner, and sliplining.

Crown liners provide a protective layer over the upper circumference of the pipe interior, where corrosion is typically more widespread. An advantage of crown liners is that there is little to no reduction of pipe capacity. The main challenge with crown liners is that the majority of the work to install the liner must occur by personnel inside the interceptor, which is a potential safety hazard for the contractor. There is no redundancy in the interceptor, and external bypassing is cost-prohibitive; therefore, the contractor has to work in live sewer flows. Work hours would be limited to when flows were low, typically for 3 to 4 hours during the early mornings. EBMUD recently completed a PVC crown liner project on a section upstream of the Project. That project needed to be extended by another year due to the difficulty in achieving anticipated production rates installing the PVC crown liner.

Spiral liners are similar to crown liners in that they are both constructed using a PVC material. Spiral liners are different in that it rehabilitates the entire circumference of the pipe by winding a continuous piece of PVC inside the host pipe. However, installation of a spiral liner requires very low interceptor operating depths, which is infeasible for the South Interceptor. The installed cost of spiral liners is the most expensive when compared to crown liners and sliplining, primarily due to the need for a bypass pumping system. A typical cross-section of crown liner system and spiral liner system is shown in Figure 2.

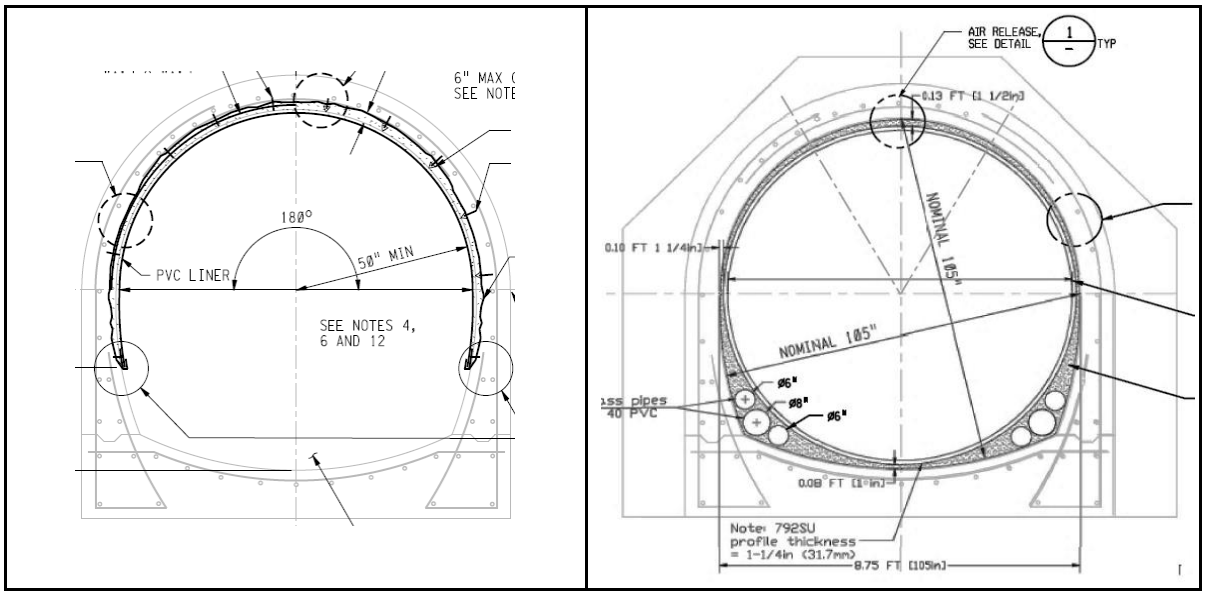

Figure 2. Typical cross-section of crown liner (left) and spiral liner (right)

Sliplining is a rehabilitation method where a new pipe is inserted into the existing pipe through pits that are excavated along the pipe alignment. The number of pits and distance between pits is dependent on existing utilities, location of pipe inflections, and construction impacts to the surrounding areas. Sliplining is advantageous for pipe segments with long straight runs (to minimize the number of pits) and if grit accumulation is an issue in the system. Sliplining also provides an entirely new pipe without an extensive amount of worker entry into live sewer flow. The primary drawback of sliplining is that it reduces the volumetric capacity of the sewer because the inside diameter (I.D.) of the new pipe has to be at least 2 to 5 inches smaller than the existing host pipe. A typical cross-section of a sliplining system is shown in Figure 3.

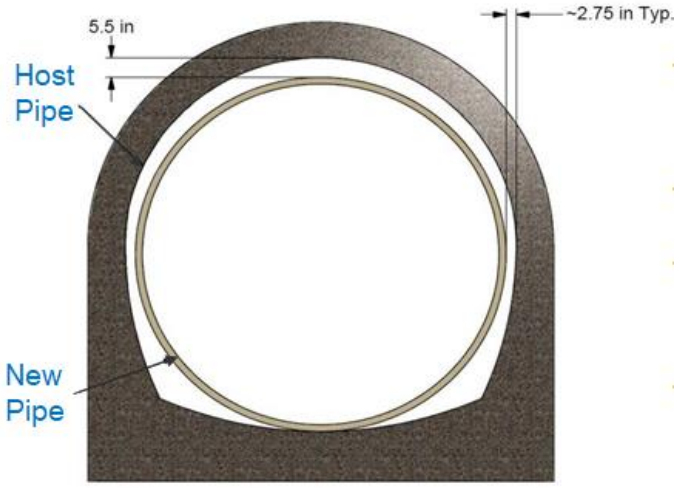

Figure 3. Typical cross-section of sliplining system

EBMUD selected sliplining as the rehabilitation method on the Phase 2 Project due to its relatively low cost, ease of installation, shorter construction schedule, safety, reduced grit accumulation, and relatively low impacts to the surrounding environment. A reduction of volumetric capacity was not a significant concern because the South Interceptor has excess capacity compared to the capacity of the treatment plant; furthermore, the flow capacity in the pipe would not be reduced due to a smoother pipe surface. The project only contained two pipe inflection points, which means the number of sliplining pits can be reduced.

3. DESIGN

Sliplining is typically performed using fiberglass reinforced polymer mortar pipe (FRPMP) or polyvinyl chloride (PVC) pipe. Due to the limited availability of large-diameter PVC pipe, FRPMP was selected as the pipe material. Based on the dimensions of the existing interceptor, it was determined that the largest pipe that could be inserted is 98 inches inside diameter (I.D. However, such a size would limit the project to only one confirmed pipe manufacturer, which could significantly increase the project cost. Therefore, the pipe I.D. was reduced to 96 inches to allow more than one pipe manufacturer to bid on the project.

EBMUD conducted a light detection and ranging survey (LiDAR) and sonar-based virtual mandrel analysis to confirm the feasibility of installing a 96-inch diameter pipe (100-inch outside diameter) in a 105-inch diameter host pipe. Hydraulic analysis was performed with the new pipe to confirm that it would not reduce flow capacity.

Up to five sliplining pits were planned for this project, and were strategically located at interceptor bends or midpoints of long reaches. Community impacts, construction staging, traffic and underground utility conflicts were also considered when locating the pits. Extensive underground utility searches were completed by utility locating, ground penetration radar, and potholing during the design phase to identify these potential conflicts. The locations of the five potential pits are shown in Figure 4. Contractors were to assume these five pre-defined pits were utility-free and were allowed to use as many or as few as they wanted.

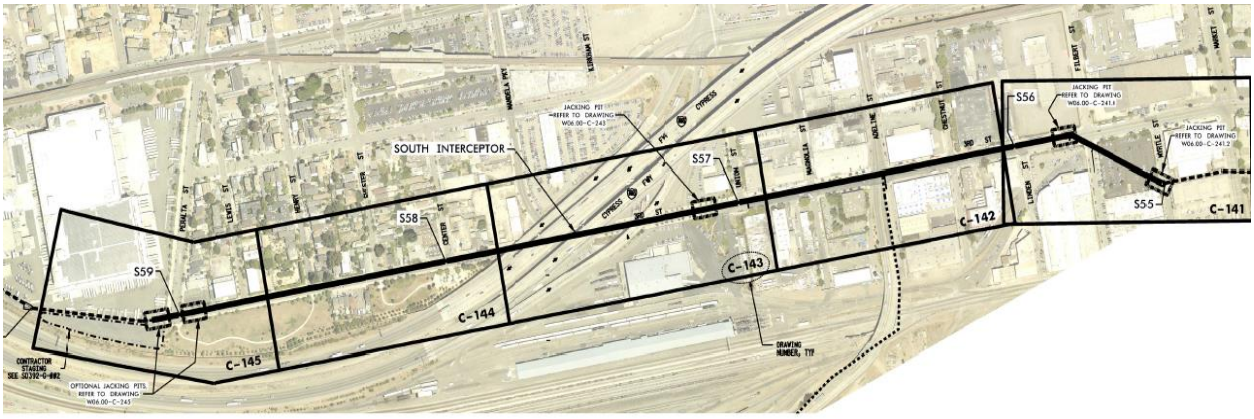

Figure 4. Locations of the five planned sliplining pits

EBMUD solicited potential contractors at the 90% design stage to discuss possible constructability and bid-ability concerns. The contractors provided valuable feedback that strengthened our specification language. Therefore, the contractor's minimum qualifications became more stringent to reduce the risk of having under-qualified contractors.

While the pipe technical requirements and sliplining pit locations were well-established in the bid documents, the construction of the pits and sliplining method were largely left to the contractor's means and methods. This allowed bidders to apply their ingenuity to minimize the construction cost and schedule.

Five bids were received, with the three lowest bids within 3% of one another. The low bid was $12.5 million from Mladen Buntich Construction Company.

4. PUBLIC OUTREACH AND IMPACT MITIGATION

EBMUD notified neighbors of the project well in advance of the start date. EBMUD also held in-person meetings with businesses who were directly adjacent to the project work zones to discuss potential impacts. Two months before the construction project, notification flyers were sent to all neighboring residents and businesses. Three weeks before the construction project, door hangers were distributed.

The project alignment stretches through residential and industrial neighborhoods along 3rd Street in West Oakland. Third Street is a major thoroughfare for truck traffic from the Port of Oakland, as well as bike traffic. Therefore, traffic control plans had to be prepared and approved by the City of Oakland so that the pits can be constructed on Third Street. EBMUD had to coordinate extensively with the City of Oakland, bike coalition groups, and other stakeholders to ensure that the traffic control plans would not adversely disrupt neighborhood traffic and businesses.

Sewer odors were expected to be generated from the sliplining pits, especially when the top of the existing pipe was open during the pipe insertion phase. To reduce the presence of odor causing hydrogen sulfide gas, EBMUD required the contractor to install and operate a temporary chemical feed system, using sodium hypochlorite, upstream of the project work area. EBMUD had adopted this method from its previous Phase 1 project, which had worked effectively to

reduce hydrogen sulfide to non-detectable levels on the street and inside the pipe. This made for a safer work environment and reduced nuisance odors in the areas surrounding the work zone. Prior tests were performed with varying sodium hypochlorite dosing rates to determine an optimal dosing rate of 3 gallons per minute of 15% solution. A chart summarizing the test results is shown in Figure 5.

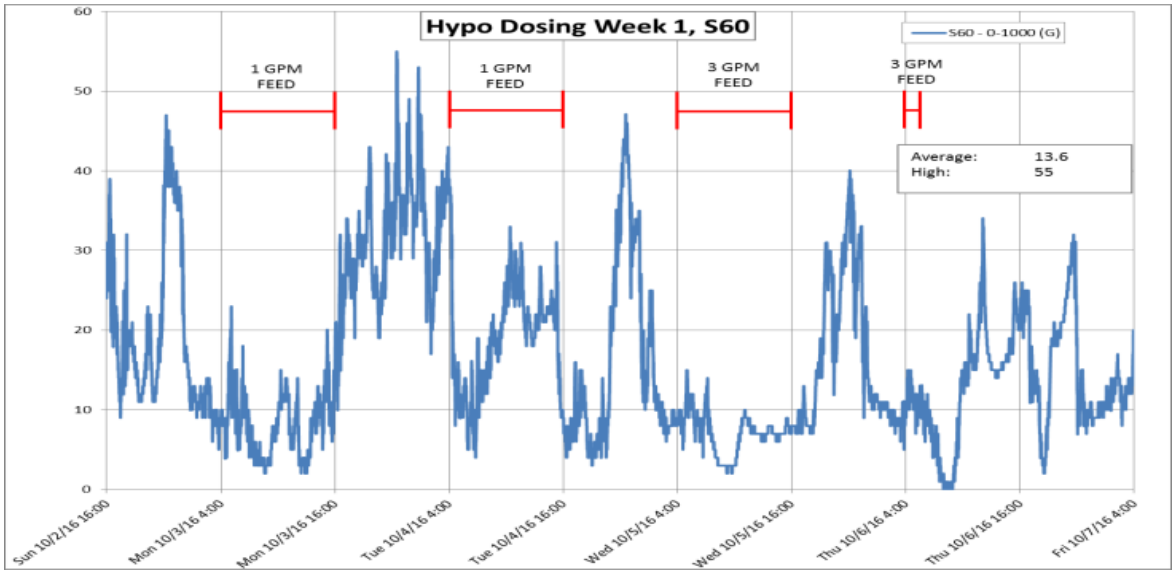

Figure 5. Hydrogen Sulfide Concentrations at Various Sodium Hypochlorite Dosing Rates

Since part of the pipe alignment is in a residential area, noise and work hours had to be within the City of Oakland's ordinances. Although two optional sliplining pits were planned for the residential area, the Contractor was able to forego them by procuring a high-capacity pipe pushing machine, which allowed them to install longer pipe runs and reduce the overall construction cost. Therefore, the majority of the sliplining work occurred in the industrial part of the project, where noise and work hours were less of a concern.

5. CONSTRUCTION CHALLENGES AND ACHIEVEMENTS

Sliplining can be advantageous because pipe can be installed much faster than other technologies for large-diameter applications. An inherent challenge is being able to ship pipe to the project site fast enough to keep up with the installation rate. It is difficult to stockpile pipe in the congested work area due to amount of space each 20-foot piece of pipe occupies. To balance the pipe installation and shipping rates, the Contractor had to accurately forecast how much pipe would be needed three days in advance so that the pipe manufacturer could ship pipe accordingly. Ultimately, the sliplining portion of the work required approximately 20 working days for a majority of the 4,700-feet reach of the project. A photo of the pipe being lowered into the pit is shown in Figure 6.

Figure 6. New pipe being lowered into pit, and next pipe ready to be lowered

The contractor procured a high-capacity pipe pushing machine specifically for the Project to allow them to push longer reaches of pipe, which eliminated the need for two extra sliplining pits. Pushing longer reaches has its challenges due to the amount of force required with each additional pipe that is installed; each 20-foot section of pipe weighed 11,250 pounds. In order to overcome the frictional force to push the new pipe, the contractor made the new pipe more buoyant by diverting more flow outside of the new pipe, which effectively increases the upward force on the new pipe. This approach allowed the contractor to push 2,500 feet of 96-inch diameter pipe in a single reach.

6. CONSTRUCTION COST SAVINGS

In addition to the cost savings from a shorter overall construction schedule, the project cost was lower because of a more cost-effective rehabilitation method. Based on bid results, sliplining was approximately $1,300 less expensive per linear foot than PVC crown lining. This translates to a $6 million cost savings for a 4,700-foot project.

The construction contract included allowances to account for unforeseen changes in site conditions, hazardous debris that was encountered in the interceptor, and additional community impact mitigation measures. This allowed EBMUD and contractor to quickly resolve changes so that the schedule would not be delayed.

7. CONCLUSION

The 3rd Street Rehabilitation Phase 2 Project addressed severe corrosion issues in nearly a mile of EBMUD's 105-inch diameter interceptor. Rehabilitation was completed using sliplining with a 96-inch diameter pipe while the interceptor remained in service. Construction was originally

planned over two years using five sliplining pits. The contractor purchased special equipment allowing the work to be completed in one year and with only three sliplining pits. This significantly reduced costs and community impacts from the construction, including traffic, safety, noise, and odors.

Construction cost savings for sliplining compared to other recent rehabilitation methods used by the District on similar projects are estimated at 40%. This equates to a $6 million cost saving, helping keep customer rates affordable.