Figure 1: Sewer Outfall Flowing From Right to Left Under the Centerline Indicated by the Flag

Sewer Outfall Replacement

Relies on Piers

Riverview subdivision is located at the southwest corner of Prince George's County, Md. It is a 35-year-old community with water access and views of Swan Creek and the Potomac River. The Washington Suburban Sanitary Commission (WSSC) has provided the water and sewer services for the area since the community was established.

The sewer pipelines for the subdivision consist of 8″ and 10″ gravity sewers constructed of 4′ lengths of unreinforced concrete pipes. The 10″ pipelines are used primarily for the sewer outfall next to Swan Creek (Figure 1). The outfall collects and discharges the wastewater of the subdivision to the WSSC collection system along Swan Creek Road. The topography in the area is sloping toward the waterways with natural drainage ravines channeling runoff to

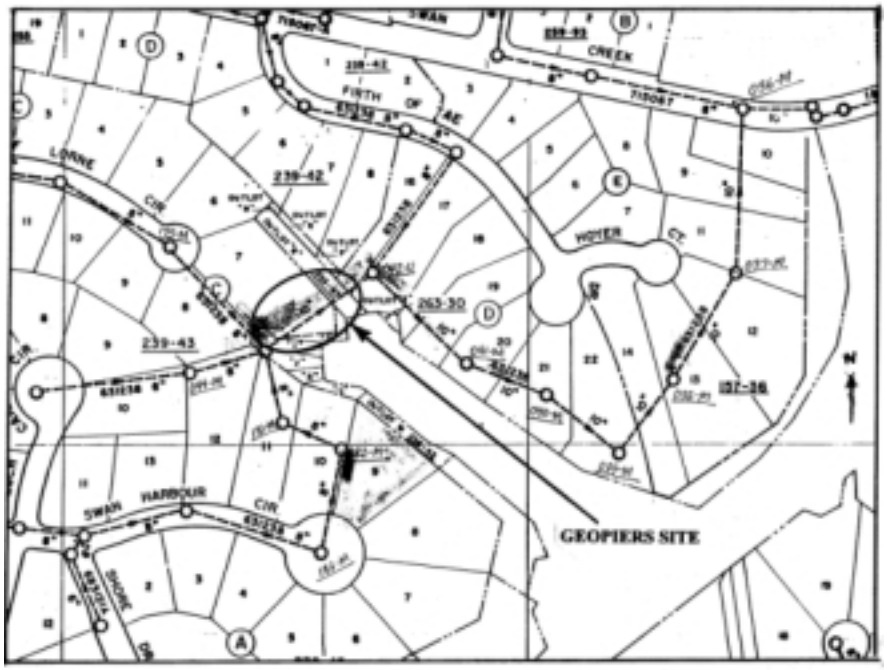
the creek and river. Due to the existing topography and surface water elevations, the sewer was designed to be shallow as it winds through the backyards within the subdivision.

Chronic Sewer Backups

As shown on the as-built drawings of the original contract, the topography of the area dictated a sewer design with less than the minimum pipe slope for portions of the sewer as it skirted the harbor and boat docks serving the homes. Slopes of 0.4 and 0.3 percent were used for the 8″ and 10″ lines, respectively. These slopes are the exceptions to the WSSC current design standards. Since the mid-1970s, approximately nine years after the original construction, the sewers have experienced chronic problems with periodic stoppages, surcharges and backups.

The problematic sewers were televised many times to locate the problems. A variety of cable drags, power rods and jettings was used to alleviate them. While addressing the chronic sewer problems, the WSSC systems maintenance staff also noticed depressions in portions of the sewer. The most pronounced location occurred in a 10″ pipe with a 0.3 percent slope where the depression was one half to a full pipe diameter. Following the discovery of the sewer depressions, it was realized that the long-term solution for the sewer problems was to replace the sewer.

Figure 2: Geopiers Site Between MH 42 and MH 43



The win-win solution needed to be an option that would cause the least disruption and environmental damage to the community during construction.

Remedial Approach

The remedial measure to relay the entire 10″ outfall sewer involved significant expense and disruption to the community. Since the work area was within the proximity of a Chesapeake Bay tributary, a construction permit from the Chesapeake Critical Area Commission was secured. The environmental impact from the construction was a primary concern for the project. Minimum disturbance to the area is the main goal of the remedial approach. Remedial design considerations included using smaller and lighter construction equipment to relay the problem pipelines according to the existing design and elevations. A piece-by-piece pipe replacement approach using pump around or sewer bypass construction was chosen as the remedy for the project.

Settlement Investigation

TLB Associates, Inc., was contracted to drill soil borings along the existing pipeline alignment. This drilling was to obtain the subsoil information to evaluate the pipe depression and ground settlement. From the as-built drawings and the soil boring information, it became obvious that most of the pipe settlement occurred at locations where the ground was filled. The most severe settlement occurred between manholes 042-U (MH 42) and 043-U (MH 43) where the depth of fill below the pipeline was the greatest (Figure 2). The recent soil borings indicated that the fill material mainly consisted of a mixture of clay, silt and sand. It did not appear that borrowed cohesionless materials were used during the original construction. Although compaction of the trench backfill in 6″ lifts was called for on the original drawings, it appears that the compaction was not effective as indicated by the generally low blow counts of SPT tests during soil drilling.

The as-built drawings indicate that during the original construction between MH 42 and MH 43 in 1963, the areas occupied by two streams were filled to form two embankments to support the pipeline for the crossing. The recent survey indicated that two storm drain pipes of 15″ and 24″ diameters were installed near the bottom elevation of each of the original streams and the constructed embankments. Two soil borings drilled in this area indicated that the upper in-situ soil consisted of black organic silt or stiff clay with sand.

Replacement Pipes and Geopiers

In an effort to provide a bridging effect for the settlement areas, ductile iron pipe class 50 was selected as the replacement pipe for the project.

Figure 3: Geopier Installation

Polyethylene encasement of the pipe was specified to isolate the pipeline from the surrounding corrosive soil.

Ground enhancement below the pipe invert elevations between MH 42 and MH 43 was considered necessary to ensure no future settlement problems. Two design options were initially considered for the project. The first option was to install 24″ diameter Geopiers along the centerline of the sewer outfall at 8 foot intervals. The second option was to excavate and replace the existing soft fill below the pipe invert elevations with compacted and well-graded bank run gravel, CR-6 or 67 stones. It was anticipated that a significant amount of excavated material would be required to be hauled away and an increased environmental impact would be caused by this option. The Geopiers option was finally selected in consideration of the concerns expressed at a public hearing with the residents.

Geopier is a patented product of Geopier Foundation Company, Inc. They are short aggregate piers composed of highly densified graded aggregate that are placed in thin lifts within a drilled excavated cavity. The system prestresses the soil vertically at the bottom of the cavity, and horizontally during construction of the thin lifts. The end result is a very stiff soil/aggregate layer that can support loads with very little settlement.

The pier cavities are excavated by conventional drilling techniques, using "dangle drill" equipment mounted on an excavator. The aggregate used for the pier construction typically is high quality crushed rock such as the aggregate used for highway base course construction. The elements are constructed in lifts of approximately 12″ thick with each lift rammed vertically and laterally using the patented tamper.

Installation

A temporary bypass sewer line was installed by the contractor between MH 42 and MH 43 prior to the start of the sewer replacement. A backhoe was used to excavate down and remove a section of the existing concrete sewer at each pier location. Each excavation was backfilled with the native soil and the individual piers were constructed at predetermined locations along the sewer outfall centerline (Figure 3). Each Geopier for this project is eight feet long below the bottom of the pipe bedding. The Dynamic Penetration Test (ASTM STP399) was used to verify the installation. The project specification called for a test to be performed every third pier installed each day at every one third length of the pier. The last test was at the top of the pier. Penetration resistance measured was a minimum of 15 blows per 1.75 inch vertical movement.

After all the piers were installed, a pipe trench was excavated through the completed element. The bottom of the trench is one foot below the invert elevation of the replacement ductile iron sewer line. Compacted crushed stone CR-6 was used to backfill the trench from the bottom of the excavation to the top of the pipe.

Conclusions

The challenge of this project was to remedy the settlement of an old sewer outfall installed at a less than desirable pipe gradient on compressible fill. Various more conventional options were available to correct the problem to ensure that the replacement pipe would experience minimal long-term settlement. However, the win-win solution needed to be an option that would cause the least disruption and environmental damage to the community during construction. The Geopiers support system proved to be well suited for the conditions of this project. A cost-effective and reliable sewer outfall replacement finally was realized.

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