Recap/Highlights
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The Broad Creek Project in Maryland consists of 10 trenchless installation segments – 8 constructed by microtunneling and 2 by conventional tunneling machine.

- Consists of 4.8 miles of new sewer pipeline, an upgraded and expanded pump station and wastewater treatment plant upgrades.
- The pipeline portion were constructed under 3 separate contracts. Along with the existing conveyance system, it will provide maximum capacity.
- Obstacles and design constraints that led to trenchless installation included: crossing Broad Creek, 2 crossings of Hwy SR210, and the heavily trafficked Fort Washington Rd & Livingston Rd intersection, and several environmentally sensitive areas.
Trenchless Technologies Conquer Design, Planning, and Construction Challenges on a Washington DC Area

- The new conveyance system uses 3 pipe designs: 48-in force main, 60-inch gravity sewer, and 42-in pressure sewer.
- Design team: Joint Venture – Gannett Fleming and Mott MacDonald. Contractor: for the north & south contract was Northeast Remsco; Force main/Pump Station contract was Norair.
- During heavy rain events, flows to the pump station exceed capacity resulting in SSO’s. To alleviate this problem, a parallel conveyance pipeline system was recommended to increase the capacity of the existing Broad Creek interceptor from 35 MGD to a firm capacity of 75 MGD.
- The alignment study investigated numerous alternatives with a preference in public right of way to minimize the need for easements and provide better access for construction & maintenance.
- One of the first areas identified for trenchless construction was crossing Piscataway Creek. Due to shallow soft nature of the creek geotechnical investigation was impractical, so subsurface conditions were uncertain.

Figure 2. Tunnel 7 Crossing Piscataway Creek to the Piscataway Water Resource Recovery Facility
The Broad Creek alignment included 5 road crossing. One of them had to be extended 400 ft to the west due to utility conflicts (2 large sewers) and eroding hillside of loose sand & gravel. It required a 735-foot tunnel construction, shown below.
At the Swan Creek area, heavy traffic and community impacts drove the design to implement a longer tunneled installation, see fig 4. These intersections carry heavy local and commercial traffic and is the primary access to the Fort Washington Medical Center. Therefore a longer tunneled installation was proposed. During construction, the contractor had concerns with the site limitations for both the launch and receiving shaft locations and recommended extending the tunnel almost 500 feet north.
Assessment of Trenchless Methods

- Trenchless construction alternatives were evaluated again to identify areas where trenchless construction could help avoid environmental community or constructability issues.
- Several drives exceeded 1,000 feet in length which eliminated auger boring.
- Subsurface conditions vary across the project, but high groundwater with permeable sands and gravels were expected in several areas. Several trenchless methods could be adapted for these conditions but slurry microtunneling for all but two short crossings was the method selected. The two short crossings were proposed to be horizontal auger bore construction.
- The contractor was not precluded from proposing alternative methods for consideration, but it was expected that a single construction method would be used for all of the large tunnel construction as mobilization of equipment for multiple tunnel systems would not be cost-effective.
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- Once microtunneling was identified, the team evaluated options to extend proposed tunnels or use microtunneling in other areas to reduce or avoid impacts or constructability concerns.
  - Tunnel 2 was extended 700 feet to eliminate trenched construction. This avoided disturbance across the Harmony Hall Regional Center site, a commercial property and existing utilities.
  - A summary of the trenchless drives are presented in Table 1.

| Table 1. Summary of Trenchless Drives as Constructed |
|---|---|---|---|---|
| Tunnel Number | Description | Nominal Casing Diameter | Tunnel Type | Tunnel Shaft Designation | Tunnel Length (feet) |
| 1 2 | National Park Service Fort Washington Road | 66 Inches 66 Inches | Microtunnel Microtunnel | 1A 1B/2A | 1.550 1.172 |
| 9 | Cornett Street | 66 Inches | Microtunnel | 9A | 578 |
| 3 | Swan Creek Road | 66 Inches | Microtunnel | 3A | 1,295 |
| 8 | Stream Crossing | 66 Inches | Microtunnel | 8A | 162 |
| Total Force Main/Pump Station Contract | | | Microtunnel | | 2,722 |
| 4N 4S | Old Fort Road (N) Old Fort Road (S) | 66 Inches 66 Inches | Microtunnel Microtunnel | 4A 4B | 1,161 791 |
| 5 | MD 210 | 60 Inches | Microtunnel | 5A | 121 |
| 6 | MD 210 | 60 Inches | Microtunnel | 5B | 734 |
| 7 | Piscataway Creek | 60 Inches | Microtunnel | 7A | 1,328 |
| Total North Contract | | | Microtunnel | | 2,004 |
| Total South Contract | | | Microtunnel | | 4,135 |
| Total Project | | | Microtunnel | | 8,861 |

*Tunnels 5 and 8 were designed as horizontal auger boring and constructed by conventional TBM tunneling.*
Risk Management and the Geotechnical Baseline Report

- Trenchless technology is not without its risks. A risk register was designed and included risks, associated impact and likelihood, solutions to those risks and the resulting reduction in impact.

- Risks included sands and silts, cemented sands, alluvium containing significant amounts of timber up to 100% of the tunnel face.

- Risks were managed using Geotechnical Baseline Reports. This document establishes a contractual interpretation of anticipated subsurface conditions to be encountered during construction. It also determines the owners desired allocation of risk between themselves and the contractor.

- Where conditions were more adverse than baselined, the risk was owned by the agencies and the contractor would be entitled to additional compensation. This method helped the agencies to keep contractor bid prices low by reducing uncertainty in the bids.
Construction of all shafts and tunnels across the three contracts was performed by Northeast Remsco.

The design team determined the approximate sizes of the shafts, but contractor was ultimately responsible for the final size and design of the shaft.

The contractor initially elected to use sheet piles, but after the absence of flowing water in the first couple of shafts, they proposed H-Pile and steel plate lagging design not originally allowed by the contract. The design team approved the proposal.

The following picture shows shaft 7B that required a larger diameter because of a Multifunction Vault. The contractor initially began construction with sheet piles, but ground conditions consisted of cemented sands and sandstone corestones making it difficult to advance sheet piles. Contractor designed a 39-feet diameter 49 feet deep liner plate and ribbed shaft and used a deep dewatering well and submersible pumps during construction and sump pump during microtunneling operations.
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Trenton Cohen, Mott MacDonald, California

Dennis Funk, Gannett Fleming, Baltimore, Maryland

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Figure 5. Tunnel 7 Launch Shaft 7B. 39-foot diameter liner plate and rib construction, 49-feet deep
Microtunneling

The microtunneling drives on the project required either a 60-inch diameter steel casing to carry the 42-inch carrier pipe or a 66-inch diameter steel casing to carry the 48-inch carrier pipe.

The contractor completed all the microtunneling drives using a Herrenknecht AVN-1200 slurry MTBM. The contractor selected the tooling on the MTBM face based on the ground conditions baselined in the GBR.

For the two drives designed as 72-inch horizontal auger bores due to the presence of cobbles and boulders, the contractor proposed an alternative method, the Akkerman C720—a conventional TBM with closed face cutting wheel. This method allowed access to the face to remove boulders and providing better line and grade control. The change was accepted and tunnel 5 under the freeway was completed with no incidents.

However, for tunnel No. 8, the TBM encountered a large boulder that could not be removed. An intervention shaft was excavated to extract the TBM, with the short remainder of the drive excavated by open cut.
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Figure 7. Tunnel 4N Hole-Through
Conclusions

GBR are only as good as the information gathered from the geotechnical investigations. In tunnel 2 no geotechnical boreholes had been located within the segment where organic material was encountered, because this tunnel was extended late in the design phase to address access and easement acquisition issues.

Trenchless technologies are sometimes thought of as high-cost alternatives, but increasingly trenchless drives are being specified to minimize traffic or environmental impact, constructability, or to simply cut down on permitting time.
Rehabilitation of Ailing Sewer in the City of Los Angeles

Celso Perez, Cindy Pham, City of Los Angeles

The Normandie Sewer was built in 1915 with a brick liner at the crown and a concrete base at the invert. It services an area of approximately 22 square miles located in South LA. Flows are generated mainly from commercial and industrial businesses.

CCTV of the sewer was conducted in 1997. It showed the grout attaching the bricks to the wall of the sewer was corroded causing the bricks to fall off and filling the invert with debris and bricks. A second attempt to video the sewer in 2008 failed due to the pipe flowing almost full.

Sewer backups were reported in this area during wet weather conditions. Several methods of rehabilitating the sewer were investigated:

- Removal and replacement by open trench was not an option due to heavy traffic.
- Sliplining was a viable option but it would require excavation to re-establish connections between the new pipe and house service pipes.
- Cured-in-place (CICP) lining was recommended because it minimizes traffic impact and house connections can be re-established by robotic cutting.
Rehabilitation of Ailing Sewer in the City of Los Angeles

- Ultraviolet (UV) CIPP liner manufactured by BKP Beroliner Co. was selected due to the short installation time.
- The liner is composed of fiberglass (Advantex E-CR glass) and resin (Atlac E-nova).
- This project was awarded to J.R. Pipeline Co. on May 2016 for $9.5 million.
- The scope of work includes lining over 8,000 feet of sewer pipes and rehabilitating 28 existing maintenance holes. Project was completed on May 2018.

Preparing Sewer for Lining

- Cleaning the Normandie Sewer was found to be more difficult than expected. At multiple locations, the top of the pipe was found missing thus exposing the soil above. At one location, the void migrated to the ground surface creating an unsafe condition and possibly undermined the foundation of a building nearby.
- The layers of bricks at the invert captured fat, grease and other debris which required special equipment to remove.
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- Mechanical method used to clean the sewer: 2 winches were staged at the upstream and downstream MHs of the sewer to move a mandrel back and forth inside sewer to remove debris.
- In one location the mandrel got stuck at the invert of the pipe. It took 5 days to prepare the sewer for man entry to safely extricate the mandrel. The mandrel had to be modified so it could maneuver through the uneven invert. Several mandrels of different sizes were utilized to accommodate the changes in sewer diameter.

Photo No.1 – Mandrel was used to remove debris
At one point the debris and bricks collected at the bottom of the sewer became so heavy that the mandrel could not scoop up the bricks. An I beam was lowered into the sewer to break apart thick layers of bricks before cleaning process could continue.
The contractor encountered MHs and sewer filled with solid grease that was so thick that it was impossible to pull the cleaning chain from one MH to another. A specialized sub-contractor was deployed to use a vacuum truck to remove grease at the MHs.

To loosen the grease in the pipes, a metal cylindrical tube covered with steel hooks was attached to the front of the mandrel. The tube rotated and the hooks broke up solid grease for the mandrel to scoop up debris.

It took 5 months to clean the entire 8,000 feet of sewer.

Once the cleaning phase was completed, the sewer was televised to assess its condition. It revealed that the invert and crown were severely deteriorated or missing at several locations.

To reconstruct the crown a piece of steel metal was installed at the location of the crown of the pipe and the void over the metal was filled with concrete slurry from the ground surface.
Repairing the missing inverts was more arduous as it was done without mechanical equipment. Workers had to remove the water at the voids using buckets and then filled the voids with gravel and concrete. Photo below shows the deep void almost to the knees of the construction worker.
Laser profiling was also performed to determine dimensions of the host pipes to verify that the gap between the host pipe and the liner did not exceed the manufacturer’s recommendation.

Photo 4 the sewer suffered mild corrosion at the top but it still maintained the round shape of the crown:
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- Photo 5 shows severe corrosion appeared at the top of the sewer with void at one location:

![Photo No. 5 – Profile of sewer with severe corrosion](image)
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Installation of the UV liner

- Install protective guiding foil the entire invert of the sewer line from MH to MH to create a smooth surface so as to prevent damaging the liner:

Photo No. 6 – Protective Foil for Liner Protection
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Installation of the UV liner
- Insert the liner into the sewer line through a MH

Photo No. 7 – A Crane hoisting the Liner Into the Sewer
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Installation of the UV liner

- After the liner was inserted, end cans were installed at both ends of the liner so the liner can be inflated. A cloth ring was inserted between the liner and the end cap to seal the connection.
- The liner was then inflated with the help of an air compressor to a pressure recommended by the manufacturer.

Photo No. 8 – End Cap
With the air still being pumped into the liner, the light train was lowered into the inflated liner through a hatch at the top of the end can. The light train has a built-in camera to inspect the condition of the liner during curing process.

Once the condition is verified, the light train was position at the far end of the liner and stayed there until that portion of the liner was cured before being moved to cure the next section.

House connections were reinstated by coring a hole at location of house connection. This work was done by a robot.
To speed up the curing process the contractor assembled light train with 12 lights. Each light delivering 1000 Watts which substantially reduced the curing time of the liner. The contractor was able to complete lining a 350-foot reach in 18 hours with an average time of 22 hours per reach.

Conclusion

- The short curing time of UV liner allowed the contractor to complete the lining work on long sections of sewer with minimum disruption of service to the customers.
- The Normandie Sewer is currently in service and there has not been any report of problem.
- Because of short shelf life and sensitivity to light, efficient sewer preparation work and careful coordination of installation schedule is critical.
- This operation requires night work, multiple shift for the contractor and construction management team. Being a light industrial area, a night work permit was relatively easy to obtain.
THANK YOU!

All papers can be obtained through the WEFTEC website