

Hand-Tunneling In D.C.

Back-To-The-Basics Technique Proves Best Solution For Sewer Project

Extending a new sewer line in Washington, D.C. has posed some serious challenges to local contractor Anchor Construction, particularly when district officials recently opted to locate the new baseball stadium for the Washington Nationals major league team in an area where new development has been welcomed.

The location is on the west side of South Capital, just north of the Anacostia River bridge. The site is adjacent to the Navy Yards and the O Street Pumping Station. Most of the development created by its new location is occurring to the north, past M Street. This development is further supported by the Metro Station whose entrance is at M Street and New Jersey (the underground station extends a full block to the west and is directly under the new sewer alignment). The development created by the stadium has resulted in new office buildings and 3,000 new condominium units in nine new buildings.

In order to accommodate this development, the sewer infrastructure in the area had to be improved, upsized and extended. M Street had to be crossed with a 21-inch diameter line.

Limiting options

M Street is a busy, east-west corridor and because of the volume of traffic, open cutting of the sewer crossing was not an option. Existing conditions posed challenges for trenchless construction of the sewer line:

- The crossing was located directly over the top of Metro Station subway station, at the intersection of 1st Street South and M Street. The subway tunnel rails were 46-feet below the flow line of the proposed sewer pipe;
- The Metro Station tunnel was originally open-cut and constructed with extensive shoring. Some of the original shoring is still in place and presented an obstacle to the proposed sewer line;
- The backfill of the Metro Station tunnel was of unknown consistency;
- A high voltage duct bank ran along M Street. Although it was reported to be deeper than the proposed line, it posed a danger if the information was inaccurate;
- The only available area for a work pit was in the middle of 1st Street South which was congested with existing utilities; and



Right: Construction of the new baseball stadium for the Washington National has helped generate a construction boom in the area, necessitating the installation of an adjacent new sewer line.

Top: Some of the new development created by the stadium construction is apparent in this photo. This picture is looking north across M Street and shows the small pit required by the liner plate tunnel construction. There was one lane open to traffic on each side of the pit.

Bottom: The job foreman Oscar Ventura is shown here checking things at the front of the work.



- 1st Street South had to remain open to traffic.

After considering the impact of the existing conditions, sewer contractor Anchor Construction decided to construct a tunnel by hand using liner plate. This solution addressed the challenges of the existing conditions:

- By “hand mining” the crew could remove any obstacles encountered;
- Of all the options, using tunnel liner plate necessitated the smallest work pit; and
- When encountering existing obstacles, delays can be problematic to tunnel construction. Using liner plate allowed the crew to grout the completed tunnel each day, thereby lessening the impact of any uncontrollable delays that might arise.

Protection

Tunneling in unknown ground conditions (the backfill of the tunnel station) required the use of a shield for the protection of the workers as they excavated the material and loaded a muck cart. The shield also protected the men while they assembled the liner plate.

Anchor Construction requested Tenbusch Inc. fabricate a suitable tunnel shield and ancillary equipment for the application. The equipment package consisted of the following:

- Launch track;
- Articulating tunneling shield;
- Muck cart and track; and
- Hydraulic power unit.

The leading edge of the tunneling shield included a canopy to protect the men as they excavated. In order to stay on grade, the shield was designed to articulate and allow for the (vertical) steering of the unit. The shield was fitted with hydraulic cylinders at the trailing end to allow for advancement. The unit was designed to advance by pushing off the face of the assembled liner plate. The rear end of the shield was fitted with a “skirt” to protect the men as they assembled the liner plate sections within the shield. Once the excavated material was loaded into the muck bowl, the bowl was rolled out into the pit, lifted out, dumped and returned for another cycle.

Anchor Construction began installing 48-inch liner plate for the 90-foot tunneling project on Dec. 26. The liner plate was supplied by American Commercial Inc. The assembled liner plate was grouted at the end of each day. The only delays were caused by the removal

Hand Mining

Hand mining is essentially digging a tunneling by manual labor. Digging a tunnel by hand often conjures up images from World War II movies where the POWs are escaping.

In modern construction practices, hand mining is a viable and cost-effective method of constructing a tunnel. There are some obvious limitations such as size. Hand mining will not be a viable method where the tunnel is too small for man entry and in large tunnels where there is a large volume of material to be excavated. The size range of hand mining is generally accepted as 42 - 60 inches.

Tunnels are needed for a number of uses including storm water conduits, sanitary sewer piping, raw water and treated water conveyance, material handling and industrial piping. In order to discuss this methodology, it is helpful to focus on the type of lining to be used in the tunnel.

Some tunnels are constructed using the finished pipe product as the tunnel liner and the materials commonly used are fiberglass and concrete pipe. Other tunnels are constructed using a tunnel liner and a carrier pipe is then inserted through the lined

tunnel. The following products are commonly used as a liner:

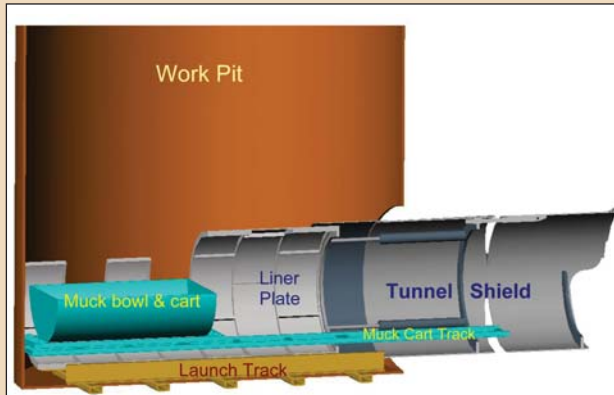
- Liner plate;
- Corrugated metal;
- Steel casing;
- Beam and lagging;
- Concrete pipe; and
- Wood box tunnel.

There are specific job site related parameters including the ground condition that will dictate what lining and what method is appropriate. However, hand mining is normally appropriate for all of the pipe products and liner products listed above.

Hand mining is normally limited to reasonable ground conditions in the following soil types: rock (soft or hard), clay and stiff sand and gravels. Some groundwater can be tolerated, especially if the tunnel is being constructed heading uphill.

In all ground conditions and with all of the above pipe products, hand mining is safer and more efficient if it is done from within a shield. The shield not only protects the men but also allows for more control over the ‘heading’ of the tunnel. Many shields can be steered either mechanically or with hydraulic power.

Some shields are advanced by the advancing column of new pipe, as is the case with welded steel casing pipe or concrete pipe. Other shields have the ability to advance forward by pushing off of the tunnel liner product. In this configuration, the liner is constructed within the protection of the rear of the shield, as is the case when using liner plate or beam and lagging.



Normal sequence of construction:

1. Excavate the pit to the appropriate elevation taking into account the launch track and the liner plate dimensions.
2. Set the launch track on a firm stabilized floor.
3. Excavate a short entrance hole for the shield.
4. Set the shield on the launch track and assemble the liner plate behind it. This will allow the shield to advance by pushing off of the assembled liner plate. The liner plate must be only partially assembled at the rear of the pit for the egress of the men and to allow the muck bowl to be removed.
5. When the liner plate assembly has advanced beyond the wall of the pit, the annular space will be grouted. This grout-

ing will be done at least as often as the end of each day. When sufficient liner plate has been grouted, the liner plate in the pit can be removed. Note – the lower sections of liner plate will remain to support the muck cart track in the launch track.

6. The new liner plate sections will be assembled at the rear of the shield and the shield will be advanced forward. When the shield is advanced enough, another section of liner plate will be assembled and the tunnel will progress to the other end.
7. Note – the work pit and the tunnel require specific safety procedures and training.

Hand-Tunneling

of the existing shoring left from the Metro Station construction years before. After breaks for Sundays and holidays, the tunnel was completed January 8. The 21-inch sewer line was installed on a rail constructed in the center of the tunnel. The annular space between the carrier pipe and tunnel liner plate was grouted and the project was complete.

FOR MORE INFORMATION

Utility contractor:

Anchor Construction Corporation, (202) 269-6694, anchorconst.com

Tunnel shield equipment:

Tenbusch Insertion Method, (972) 221-2304, tenbusch.com



Above: The staging area was limited to the sidewalk and a few parking spaces behind the curb on the west side of the intersection. The shield is sitting on the launch track and is ready to be lifted into the work pit.

Below: This photo was taken in the pit before the dirt began to fly. It shows the liner plate and the shield, with the muck cart, bowl, and track.

