PARSONS

CUTTERHEAD

Tunnel And Underground Newsletter

VOL 12 / MAY 2021

Delaware Aqueduct Bypass Tunnel, Newburg, NY

INSIDE

SOUTHERN NEVADA WATER AUTHORITY LOW LAKE LEVEL PUMPING STATION

Las Vegas, NV

Parsons was retained by the Southern Nevada Water Authority (SNWA) to provide design management and construction management services for the Low Lake Level Pumping Station Project, at Lake Mead, in Southern Nevada. Since April 2020, we have been working for the SNWA on closeout projects related to the completion of the third intake and the Low Lake Level Pumping Station, such as repaving the portion of the National Park Service's Lakeshore Road that had been used for site access since 2008. The Low Lake Level Pumping Station Project has secured a reliable water supply for the Las Vegas area, even in the event of extremely low lake levels in Lake Mead. The underground portion of the work included a 527-foot-deep, 26-foot-diameter access shaft; thirty-four 91-inch-diameter pump well shafts with 6-foot-diameter steel casings; and a forebay that is 377 feet long, 36 feet high, and 33 feet wide. The underground contractor was given the notice to proceed in September 2015, and the underground work was completed in December 2018. The surface portion of the work was also performed by the underground contractor via a January 2017 amendment to the original work package. The surface portion included the installation of 34 submersible pumps, discharge headers with isolation valves, electrical controls and starting equipment for the pumps, a building for housing electrical gear and controls, an open-topped reservoir for low-lift pump surge control, a hydro-pneumatic tank for high-lift pump surge control, a 220-ton gantry crane, final grading for an access pad and drainage, and an access road to the pumping station site. Installation of submersible pumps commenced on February 25, 2019, and was completed on January 10, 2020. The surface work was completed in April 2020.

Photo Credit: Mike Cowan Photography

Southern Nevada Water Authority Low Lake Level Pumping Station

CATSKILL AQUEDUCT REPAIR AND REHAB

Newburgh, NY

Parsons continues to provide construction management services for multiple contracts related to the repair and rehabilitation of the upper Catskill Aqueduct (CAT-RR) between the Ashokan and Kensico reservoirs for the New York City Department of Environmental Protection (NYCDEP). The CAT-RR projects will attempt to restore the capacity of the Catskill Aqueduct, which has been lost over time due primarily to the accumulation of biofilm (a naturally occurring layer of microorganisms) along the aqueduct's interior surface and to leaks. To maintain capacity improvements after cleaning, chlorine will be added to the aqueduct to prevent the regrowth of biofilm. A new chlorination facility is near completion at the Ashokan Screen Chamber, in Ulster County, New York, with a dechlorination facility 74 miles downstream in Westchester County, New York, just north of the Kensico Reservoir. The new dechlorination facility is scheduled to undergo startup and testing in the early summer of 2021. In addition to the removal of biofilm, the rehabilitation has included a full inspection of the aqueduct, repair of leaks, repair of valves and other mechanical equipment, and the addition of air vents to facilitate the flow of water through the system.

The project's total estimated construction cost is approximately $175 million, and the project is scheduled to be completed by the spring of 2022, before the scheduled connection of the 2.5-mile-long Delaware Aqueduct Bypass Tunnel, under the Hudson River, in 2022. The third of the three scheduled 10-week Catskill Aqueduct shutdowns was completed successfully on February 8, 2021. The contract completed all accessible biofilm removal, siphon valve replacement, steel-pipe siphon inspection and repair, blow-off flap gate valve replacement using saturation divers under 400 feet of water, fiberglass reinforcement of new boat holes, and leak repair. A fourth, additional shutdown of the aqueduct is being planned by the NYCDEP for next year to perform additional repairs on sections of the aqueduct that were not available for work during the latest shutdown. Parsons will remobilize the team of engineers and inspectors for the fourth 10-week shutdown during the fall of 2021. The new completion date for the contract will be the summer of 2022.

DEER CREEK SANITARY TUNNEL AND PUMP STATION

St. Louis, MO

Parsons has been working with the Metropolitan St. Louis Sewer District (MSD) since 2011. In 2016, design work was completed for the Deer Creek Sanitary Tunnel project. The contract was awarded to SAK Construction for $147.8 million and construction began in fall 2017. The tunnel is approximately 4 miles long with an inside diameter of 19 feet and is 175 feet below the surface in solid rock in a highly urbanized area of St. Louis. It will have the capacity to store more than 38 million gallons during wet-weather events and will be pumped dry after high flows have subsided and the downstream treatment plant capacity is available. In addition to the tunnel, SAK is constructing eight shafts that are required to provide tunnel access for collection sewers, for the pump station that will be at the downstream end of the tunnel. Diversion structures were designed to divert flow to the tunnel once the flow in the existing sanitary sewer system has reached a critical depth. Gates will be used to control the flow in the existing sewer and prevent sewer surcharging that could cause basement backups during wet-weather rain events. Mining of the tunnel began in March 2019 and was completed in January 2020 when the massive chomper, Mrs. Nancy, reached her final destination. Her task wasn't an easy one because the path wasn't straight. A 22-foot-diameter tunnel-boring machine (TBM), Mrs. Nancy maneuvered through 14 designed curves at a grade of 0.20 percent. She arrived at the correct horizontal and vertical location as planned. Since TBM breakthrough, SAK has been performing cast-in-place concrete lining operations and expects them to be completed this spring.

The next phase of the project is the pump station. The design was completed in February 2020. The contract was awarded to KCI Construction Company for $29 million and construction began in September 2020. The pump station was designed to control the discharge rate from the tunnel, which will be limited due to downstream sewer capacity issues and capacity issues at the treatment plant serving the project area. Different pump types were evaluated to determine which system is the most economical, reliable, and maintainable. Work on this contract includes one wet-well and two dry wells in shafts constructed by SAK, one wet-well building, one dry-well building, one effluent vault structure, and numerous site improvements. Construction will be completed by October 2022.

Deer Creek Sanitary Tunnel

DOWNTOWN RAIL EXTENSION PROJECT

San Francisco, CA

In November 2020, Transbay Joint Powers Authority (TJPA) executed a professional service agreement with Parsons for General Engineering Consultant (GEC) services for the Transbay Program Phase 2 (Downtown Rail Extension). The agreement is for a four-year term, with an option to extend it for two three-year periods. The GEC services will comprise of project management, project development, and project procurement. It will also include engineering support during construction for Phase 2 of the Transbay Program, which mainly covers the Downtown Rail Extension (DTX) project. The DTX project includes: a new Fourth and Townsend Street station for Caltrain and— potentially— California High Speed Rail; completion of the Transit Center's underground train station, including a pedestrian connection to BART and Muni; and a new inter-city bus facility. The main portion of the project includes a 1.3-mile rail extension (1.95 miles of total construction length) to be constructed principally below grade using cut-and-cover and mined tunneling methods underneath Townsend and Second Streets.

CALIFORNIA HIGH-SPEED RAIL PROJECT – CONSTRUCTION PACKAGE 1

Madera To Fresno, CA

Tutor-Perini/Zachry/Parsons (TPZP) crews working on the Fresno Trench portion of the California High-Speed Rail Project – Construction Package 1 (CP1) completed the staged, top-down construction of the box underneath State Route 180. The construction team continues to construct the Fresno Trench heading north and construct substructure walls for the Tulare Street Undercrossing. The construction team also continues to use a trenchless technique to construct several large-diameter storm-drain segments under existing railroads with as-needed ground improvements. The trenchless segments consist of open-shield tunneling and horizontal directional-drilling activities.

DELAWARE AQUEDUCT BYPASS TUNNEL (BT-2)

Newburgh, NY

Parsons has provided comprehensive construction management (CM) services for New York City's Delaware Aqueduct Bypass Tunnel project since construction began in January 2013. The Delaware Aqueduct, in service since 1944, is the longest tunnel in the world. The bypass tunnel project is the most significant repair project in the history of the largest municipal water supply utility in the United States. The new tunnel will bypass and cutoff a leaking portion of the Delaware Aqueduct, under the Hudson River, thereby improving the conveyance and reliability of the City's water supply system.

Construction of two access shafts (located on opposite sides of the Hudson River) to service the new bypass tunnel began in 2013 and were completed 2 weeks ahead of schedule, in 2016. One shaft is 900 feet deep with a 30-foot-diameter, and the second shaft is 700 feet deep with a diameter of 33 feet. The new 2.5-mile-long tunnel was then bored by a 21.5-foot-diameter hard-rock tunnel-boring machine (TBM). The TBM completed the tunnel excavation in August 2019. The state-of-the-art, hard-rock TBM was designed to withstand 30 bars of water pressure as it mined under the Hudson River through zones of highly permeable and heavily fractured ground.

The 14-foot-diameter final lining of the tunnel is nearing completion. The lining incorporates a 9,200-foot-long, triple-lined section through water-bearing zones, which includes a 16-foot-diameter steel interliner pipe. The interliner was backfilled with low-density cellular concrete, placed between the interliner pipe and segmental lining. The final layer, a 1-foot-thick, reinforced structural concrete lining was then placed inside the interliner pipe. The reinforced concrete final lining is designed to withstand the high internal-water pressures when the new bypass tunnel is in service. The first opportunity to connect the bypass tunnel to the Delaware Aqueduct is expected to take place later in 2022.

Parsons provides planning, including preconstruction services, CM, environmental health and safety, ISO 9000 quality assurance/quality control, risk management, regulatory compliance, community outreach, and communications/coordination. We received an Excellence Award in Construction Management from the NYCDEP in 2017. We developed a unique approach to connect the new tunnel to the existing tunnel, reducing the tunnel shutdown/outage from 16 months to 6 months. The project continues to be ahead of schedule.

Delaware Aqueduct Bypass Tunnel

PROJECT UPDATES

City Of Houston Facilities Consolidation – Chelford City Diversion Package 3

Houston, TX

Parsons is providing engineering services to the City of Houston for the Chelford City Diversion Package 3 project. The project scope is to design gravity sewers to abandon the Green Crest Lift Station and divert the flow to the Upper Braes Wastewater Treatment Plant (WWTP). This project is the fourth segment of the overall plan to divert wastewater flows currently being treated at the Chelford City WWTP to the City of Houston Upper Braes WWTP. The project consists of the following: (1) 6,500 linear feet of 24-inch HOBAS pipe to be installed by microtunneling; (2) 800 linear feet of 36-inch steel casing to be installed by microtunneling with 24-inch carrier pipe for a crossing beneath State Highway 6; (3) three diversions of flow from existing surface sewers; (4) decommissioning and demolition of Green Crest LS after the proposed gravity sewer is in service. The project is at the 90 percent design level and construction is expected to start in the first quarter of 2022.

DC-02 AND DC-03 SANITARY RELIEF SEWER

St. Louis, MO

The DC-02 and DC-03 Sanitary Relief Sewer project was designed by Parsons and broken out into two construction phases. Construction of Phase 1, by J.H. Berra Construction, is complete. It consisted of 5,075 linear feet of 8- to 78-inch-diameter sanitary sewers and appurtenances, one diversion structure, eight junction chambers, 24 manholes, three flow-metering manholes, and other associated work. Phase 2 is currently under construction by Kolb Grading. It consists of 8,190 linear feet of 8- to 72-inch-diameter sanitary sewers and appurtenances (including 1,780 feet of tunnel), six junction chambers, 28 manholes, one flow-metering manhole, and other associated work. Challenges presented by the project include a mixture of suburban and rural areas, active railroad crossings, arterial roadways, and interstate highway crossings.

Construction of the sewer was by open-cut excavation, trenching, and tunneling. Sections where tunneling is being used were to avoid congested commercial areas, interstate highways, and railroads. In addition to the sewer work, there will be a major diversion structure to divert excess flows from the DC-02/03 Sanitary Relief to the Deer Creek Sanitary Storage Tunnel and Pump Station, also designed by Parsons and currently under construction. When completed, the sewer will not only provide additional system capacity but also help comply with an EPA consent decree by removing seven sanitary sewer overflows and helping prevent sewer backups during wet weather.

Parsons performed preliminary design for the entire project and was responsible for the final design of Phases 1 and 2 of four phases. Parsons has been retained by MSD for engineering services during construction. Construction cost for Phase 1 was $20.8 million and for Phase 2 is $25.5 million. Construction of Phase II is expected to be completed in May 2021.

DC-02 And DC-03 Sanitary Relief Sewer

PROJECT UPDATES

Delta Conveyance Project

Sacramento, CA

Parsons is providing program management services to the Delta Conveyance Design and Construction Joint Powers Authority. Delta Conveyance refers to State Water Project (SWP) infrastructure in the vast network of waterways comprising the Sacramento–San Joaquin Delta (Delta) that collects and moves fresh, affordable water to homes, farms, and businesses throughout major regions of the state from the Bay Area to Southern California. The proposed Delta Conveyance Project would modernize SWP conveyance by adding new diversions in the north Delta to promote a more resilient and flexible SWP in the face of unstable future conditions.

The SWP relies on the Delta's natural channels to convey water. The Delta is vulnerable to earthquake and sea level rise. As sea levels continue to rise, the Delta will be faced with increasing saltwater intrusion, which threatens fresh-water supplies flowing through the Delta. Climate change is also expected to affect the type and timing of precipitation. Certain pumping restrictions in the south Delta can prevent the SWP from reliably capturing water when it is available, especially from storm events.

The Delta Conveyance Design and Construction Authority (DCA), under the direct supervision of the Department of Water Resources (DWR), conducts concept engineering and design work to better position the DWR environmental review process for the proposed Delta Conveyance Project to accurately assess impacts and identify effective mitigation measures, and to better inform concepts in the final environmental documents, leaving fewer unknowns to future design.

Detroit Windsor Tunnel

Detroit, MI

In 2020, Parsons provided services for both ceiling and floor beam inspections on the Detroit land side as an ongoing part of American Roads structural inspection procedures. In the past, the condition of the beams had been largely kept in excel files with only descriptions. We prepared an inspection report with photos of all beams showing signs of distress along with a prioritized rehabilitation method with recommended timing. The report was well received by the client. This year we received a renewed as-needed engineering services contract. Current tasks include the investigation of icing pop-out of interior wall panels and evaluation of electrical needs for a new ventilation fan being placed into service in 2021. By building on the trust gained through our previous assignments, we continue to get more frequent requests from the client. Our relationship with American Roads has grown to include other US tolling locations that they operate.

Dubai Strategic Sewerage Tunnels

Dubai, United Arab Emirates

The Dubai Strategic Sewerage Tunnels (DSST) team has been progressing with tender specifications, bills of quantity, and instructions to tenders for the tunnel and terminal pump station packages. Pre-qualification of design and build contractors for the tunnels and pump stations and of engineering consultants for the detailed design of the link sewers has been delayed due to the impact of the COVID-19 pandemic, but the client's team is hopeful this will commence toward the end of 2021.

Foothill Gold Line Extension, Phase 2

Glendora, San Dimas, La Verne, And Pomona, CA

In October 2019, the Foothill Gold Line Construction Authority awarded a design-build (DB) contract for Phase 2B of the Foothill Gold Line extension to Kiewit-Parsons, a joint venture (KPJV). This project will extend the current Metro Gold Line 9.1 miles and add four new LRT stations in the cities of Glendora, San Dimas, La Verne, and Pomona. The project runs in a shared corridor with LRT and freight tracks. The awarded DB contract includes an $805 million base scope for the first 9 miles of the project from Glendora to Pomona. As part of this DB contract, bridges, pedestrian underground crossings and ramps, guideway retaining walls, and protect-in-place buried structures are being designed and constructed by KPJV.

Dubai Strategic Sewerage Tunnels

JOINT WATER POLLUTION CONTROL PLANT SEWER TUNNEL OUTFALL PROJECT

Los Angeles, CA

Parsons has completed the final design and bidding phases for the Joint Water Pollution Control Plant (JWPCP) Effluent Outfall Tunnel project and is entering into the engineering services phase during construction. Seventeen of the Sanitation Districts of Los Angeles County are signatory to a joint outfall agreement that provides for a regional, interconnected system of wastewater management facilities known as the Joint Outfall System (JOS). The JOS provides wastewater collection, treatment, reuse, and disposal for residential, commercial, and industrial users, and it includes seven treatment plants, the largest of which is the JWPCP, located in the city of Carson. Currently, secondary-treated effluent from the JWPCP is conveyed through two 6-mile-long tunnels, 8 feet and 12 feet in diameter, to a manifold structure near White Point on the Palos Verdes Peninsula. The new effluent outfall tunnel will be approximately 7 miles long, have an 18-foot internal diameter, and include 1,350 feet of 16-foot-diameter steel liner at crossings of the Palos Verdes Fault.

The new tunnel will allow for inspection of the existing tunnels, provide redundancy for the effluent management system, ensure capacity for future growth, and convey peak storm flows. The upstream end of the project will include the construction of junction structure to connect the tunnel to an active 14-foot-diameter force main. The existing manifold structure at the downstream end of the project will be demolished and a new manifold structure will be constructed. As the existing tunnels and main outfalls are always required to be in service, a temporary bypass system will be constructed and operated during this phase of the project.

Notice to proceed (NTP) was in April 2019, and construction is expected to be completed in 7.5 years. Construction of the 55-foot-by-115-foot-deep launch shaft has been completed and grouting/ excavation for both the tail and starter tunnels is in progress. Fabrication of the 21-foot-diameter TBM was completed in Germany and on-site assembly of the TBM and slurry treatment plant is ongoing. Tunneling is scheduled to start in May 2021, and the project is estimated to be completed in 2026. Once built, the 18-foot tunnel and associated structures will ensure that the wastewater needs of the JOS are fulfilled for the foreseeable future.

Photo Credit: Santation Districts of Los Angeles County

Joint Water Pollution Control Plant Sewer Tunnel Outfall Project

LOUIS-HIPPOLYTE-LA FONTAINE TUNNEL

Quebec, Canada

The Ministère des Transports du Québec (MTQ) is currently undertaking a major rehabilitation project for the Louis-Hippolyte-La Fontaine Tunnel to ensure the sustainability of this infrastructure and to ensure that it can continue to play its key role in the mobility of people and goods along Highways 20 and 25. Inaugurated in 1967, the Louis-Hippolyte La Fontaine Tunnel is an important road link for the region for users and freight transport not only in the region but also in Quebec and Canada. An integral part of Highway 25, it connects the east end of the Island of Montreal to Longueuil, via Île Charron. It is the largest underwater tunnel in Canada, 1.5 kilometers long and connected to a 457-meter-long bridge.

Parsons, in a joint venture (JV) with TetraTech, has been acting as the owner's engineer on this mandate since March 2018. The JV was in charge of preparing the technical specifications and establishing the performance criteria. The JV also assisted the client during the request for proposal and is presently providing technical support throughout the construction. This project is being carried out in design-build-finance (DBF) mode.

The rehabilitation project of the Louis-Hippolyte-La Fontaine Tunnel and its approaches includes the following:

1. Rehabilitation of various components of the tunnel, including the concrete screed, walls, vault, joints, and drainage
2. Reconstruction of the concrete pavement of Highway 25 on either side of the tunnel between Île Charron and Sherbrooke Street in Montréal
3. Modernization of electrical, lighting, ventilation, monitoring, and communication systems
4. Addition of fire protection equipment
5. Implementation of mitigation measures in public transit, including a highway widening and the addition of bus-dedicated lanes at different locations of the provincial roadway network
6. Construction of two new and modification of two existing incentive parking lots
7. Tunnel architectural features i.e., arches at the portals, lighting, and landscaping

Photo Credit: Ministère des Transports du Québec

Photo Credit: Ministère des Transports du Québec

Louis-Hippolyte-La Fontaine Tunnel

Ottawa River Outfalls Rehabilitation And Reconstruction

Ottawa, Canada

In the fall of 2017, Parsons was engaged by the City of Ottawa for the rehabilitation/reconstruction of 22 Ottawa River outfalls within a 35-kilometer stretch of the Ottawa River. The complexity of the project required the outfalls to be broken down into the following four packages:

- Package 1 consisted of three less-complex outfalls on City-owned lands. Construction was completed in 2020.
- Package 2 consists of the less-complex outfalls owned by the City and located on federally owned lands. The outfalls are also located adjacent to the Sr John A Macdonald Parkway and Stage 2 of the City of Ottawa Light Rail Transit project currently in construction. Although the design of these outfalls was less complex, the stakeholder management and approval coordination were very complex and time consuming. Construction substantial completion was achieved in 2020. One outfall posed a challenging construction methodology, was delayed, and will be completed in 2021.
- Package 3 consists of the complex outfalls, which are all owned by the City and located on City-owned lands, federally owned lands, and provincially owned lands. The complex Fleet Street outfall includes redirecting storm sewer flow from one outfall to a second outfall that is 11 meters below the shallower outfall. Outside-the-box thinking has led to the design of a maintenance hole with a vertically cored shaft at the bottom of the maintenance hole and entering the top of the deeper 2,100-millimeter-diameter sewer. To add to the complexity of this outfall design, construction can only occur during the yearly drawdown of the Tailrace water course. The Tailrace is the discharge channel for the Fleet Street pumping station, which is used for hydraulic power to pump more than 50 percent of the City of Ottawa's potable water.

  A second complex outfall, known as the Boteler outfall, includes the redirection of a submerged 2,100-millimeter-diameter outfall to outlet to the river's edge. The work will require the removal and replacement of an 8-meter-deep maintenance hole that is 2.4 meters by 3.0 meters and located in bedrock and only 1 meter from the edge of the only access roadway to the Ottawa Rowing Club. In addition, there is a 2:1 slope from the top of the maintenance hole to the edge of the river. In 2020 the federal government (NCC) brought forward a concern with a retaining wall which is located adjacent to the south of the outfall. With this new information, construction of this outfall is delayed until the investigation on the federal wall is completed. The scheduling of this outfall has created scheduling challenges in that the low river-water elevation is from July to late August, the rowing club access needs to remain open and can only close in November (when the river water is too high for construction), construction cannot occur without closing access to the rowing club, construction in November will lead to ice and snow (freezing of the river), a separate construction project is scheduled for the 2021 construction season (which will not allow the Boteler outfall to be constructed at the same time), and as of 2020 construction cannot proceed until the stability investigation of the federal wall is completed.
- Package 4 is a third complex outfall that consists of the twin 1,500-millimeter-diameter outfall that extends 95 meters from the shoreline and is on the bottom of the Ottawa River. This outfall requires ice scour protection methods that include dredging the bottom of the Ottawa River. At the moment, further investigations are required to determine the design method to be used, allowing for possible construction in the summer of 2022.

San Francisco Public Utilities Commission (SFPUC) Sewer System Improvement Program

San Francisco, CA

In 2011, Parsons, in a joint venture with AECOM, was awarded a program management services contract for the $6.9 billion Sewer System Improvement Program (SSIP), which includes various conveyance and flood resilience projects. Parsons continues to assist in several tunneling and trenchless projects, providing tunneling and geotechnical expertise to SFPUC and San Francisco Public Works, for alternative analyses and conceptual engineering reports, independent reviews, technical expertise, and final design reviews of SSIP projects. Example projects include the Kansas and Marin Streets Sewer Improvement Design-Build, Folsom Area Stormwater Improvement, 15th Avenue and Wawona Street Stormwater Management, Lower Alemany Area Stormwater Improvement, and Channel Force Main Redundancy projects. In a separate contract, Parsons is also providing construction management services for SFPUC's Southeast Treatment Plant improvement projects.

PROJECT UPDATES

Southeast Collector Trunk Sewer Rehabilitation Project

Ontario, Canada

York Region is a regional municipality in Southern Ontario, Canada, between Lake Simcoe and Toronto. It has a population of 1.2 million and is experiencing rapid growth. Its new Southeast Collector wastewater conveyance system was commissioned and put into service in January 2015. The Southeast Collector Trunk Sewer (SEC) is a 3,000-millimeter-internal-diameter sewer extending more than 10 miles and into multiple municipalities.

A warranty inspection and other operation visits revealed early deterioration of the internal concrete surface due to hydrogen sulfide corrosion at a number of shafts and downstream tunnel sections. Parsons was selected to provide engineering services for this project. The overall goal of this project was to rehabilitate the tunnels and shafts, so the system continues to work as intended. The main objectives of the Southeast Collector Rehabilitation were to extend the remaining useful services life of Shafts 4E, 6, and 9 and segmental tunnel downstream of Shafts 4E and 6 to a minimum of 50 years, while maintaining full-flow conveyance capacity when the rehabilitation is completed. An engineering opinion on the condition of the tunnel downstream of Shaft 9 as well as tunnel rehabilitation (if any) were also included. The scope of work included project and quality management services, field investigation and reporting, a technical memo to select rehabilitation methodology, detailed design and tender, construction and contract administration, and engineering services during the warranty and project closeout stage.

The Parsons team conducted two rounds of site inspections in the shafts and tunnels using various methods to determine the impact of corrosion on the concrete structure. A two-step rehabilitation technology selection was applied (“must” level and “want” levels) considering technical, constructability, social/environmental, cost, and scheduling factors. A surface spray application has been identified as the preferred solution, and the team is finalizing the design. The project is expected to tender in the fall of 2021.

Tunnel Stabilization And Sewer Pipeline Replacement

Laguna Beach, CA

Parsons provided value engineering, design review and seismic stability analyses, risk assessment, value engineering (VE) and risk workshops with the South Coast Water District Board of Directors, construction review, construction management, and program management for the Laguna Beach Interceptor Repair project. The project includes the enlargement for an approximately 10,000-foot-long rehabilitation of 5-foot-wide by 6-foot-high tunnel to replace aging 24-inch-diameter Techite pipe and re-mine tunnel to provide sustainable new tunnel liner for the 8-foot-wide horseshoe-shaped tunnel. The project is being constructed in four phases.

Parsons began working for the district in 2015, performing VE and risk assessments in preparation for this project. We have been providing CM and design review since the project began in 2016, and PM since December 2017. Currently, Parsons is providing CM and risk management for the project.

Tunnel Stabilization And Sewer Pipeline Replacement

Westside Subway Extension Section 1

Los Angeles, CA

Los Angeles Metro's Purple Extension Section 1 project is the first of three sections along the new 9.1-mile corridor. Section 1 extends the subway 3.92 miles starting at the existing Wilshire/Western Station and ending in Beverly Hills. Section 1 will consist of three new stations constructed along the alignment, which consists of 4 tunnel reaches. The three stations are Wilshire/La Brea, Wilshire/Fairfax, and Wilshire/La Cienega (there will also be a retrieval shaft at Wilshire/Western). Section 1 of the Purple Line Extension is scheduled to be operational in 2023.

In 2020, two 23-foot-diameter earth-pressure–balanced tunnel-boring machines (TBMs), BR-red and BL-purple, completed Reach-2, with the BR TBM completed in April 2020 and BL TBM completed in May 2020. Both TBMs averaged 45 LF/WD, crossing under the urbanized Los Angeles metropolitan area and the iconic La Brea Tarpits. Shortly after both TBMs broke through Fairfax Station, Reach-3 began mining with the BR TBM launched in May 2020 and the BL TBM in July 2020. As of February 2021, the BR tunnel has reached about 2,900 feet (88 percent complete) with the best day at 115 feet, averaging approximately 30 LF/WD, and the BL tunnel has reached about 2,750 feet (83 percent complete) with the best day at 110 feet, averaging 35 LF/WD. Both TBMs broke through La Cienega Station in April 2021. Reach-4 will mine thereafter and is expected to be completed by April 2021. Also known as Tail Tracks, Reach-4 is approximately 550 feet long and will be connected to Purple Line Section-2 Tunnel operations.

Cross-passage (XP) mining on Reach-1 began in January 2020 and has a total of 12 XPs (XP-04 to XP-15). As of February 2021, excavation of 11 of 12 XPs has been completed, with seven XPs' final lining completed. XP-07 will be the last excavation within Reach-1 and is expected to be completed by the end of February 2021. There are a total of 12 XPs (XP-04 to XP-15) located within Reach-1, six XPs (XP-16 to XP-21) located within Reach-2, three XPs (XP-22 to XP-25) located within Reach-3, and one XP (XP-26) located at Tail Tracks. Parsons is the primary designer and engineer of record for all the XP design on Purple Line Section-1.

In addition to the tunnel, the station shafts range from about 75 feet to 80 feet below ground surface and were designed with soldier pile lagging and a series of struts to support excavation with challenging geology. Western Station met the design subgrade elevation and the TBM slab was poured in October 2018. The interior walls/concourse slabs/roof of La Brea Station is continuing to be poured; at the same time, strut removals are being performed on Level A on the east end and on Level B/C on the west end of the station, while localized dewatering continues. Fairfax Station had many challenges due to the tar-impacted sands but successfully reached design subgrade elevation in March 2019 and the invert slab was poured in August 2019. Concurrently the entrance structure excavation started in January 2020 and was completed in May 2020. Currently at Fairfax Station interior walls are continuing to be poured and struts are being removed from Level D and C. Excavation of La Cienega Station was completed in October 2019 and pouring of the invert slab was finished in February 2020. The construction activities at La Cienega Station consist of de-strutting Level B/C struts, pouring interior walls, and preparing the tunnel eyes to receive both TBMs to complete Reach-3, while localized dewatering continues. Construction is expected to be completed by 2023.

Regarding La Brea Station, its appendage excavation began in September 2020, with Appendage-1 completed in December 2020 and Appendage-3 completed in February 2021. La Brea Station has a total of seven appendages. Regarding La Cienega Station, excavation of its appendages was completed in March 2021.

Parsons' role on the project continues to be as the prime designer for the design-build team and design engineer of record (EOR) for the project.

Westside Subway Extension Section 1*

* The picture was taken prior to February 2020 before Safer At Home Orders and social distancing mandates were in place.

NYCDEP DELAWARE AQUEDUCT BYPASS TUNNEL STEEL INTERLINER

By Eric Jordan, P.G.

The new Delaware Aqueduct Bypass Tunnel is in the Mid-Hudson Valley of New York. The new tunnel design includes a 9,200-foot-long section of final lining with a 1-inch-thick steel pipe called the “interliner.” The interliner’s design and length were based on the underlying geology. The center portion of the tunnel bore includes a thick limestone formation that yields high groundwater flow and pressure at certain locations. The interliner extends several hundred feet beyond the contacts of the limestone rock formation in lower New York.

The interliner steel was procured in 2016. It was fabricated from Russian steel ingots that were sent to Denmark and rolled into plates. The plates were transported by ship to Louisiana where they were trimmed into 10-foot-wide by 50-foot-long plates and then rolled and welded into 40-foot-long by 16-foot-diameter cylinder (which produced 230 sections of pipe). Each 40-foot pipe was then braced internally with two rectangular braces for transportation to New York. Each section of pipe weighed 84,000 pounds.

Interliner Transport (Header Image) And Fit Out

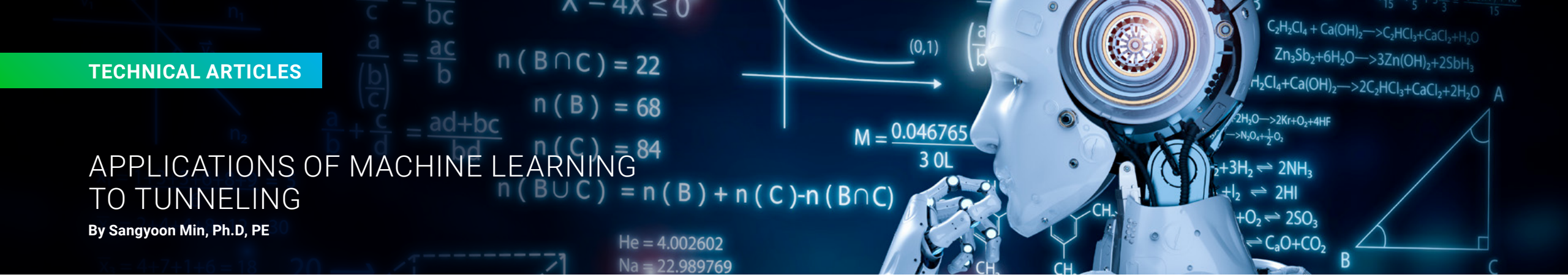
Per the contract, each pipe included three ports, one in the invert and two in the arch, to aid in dewatering the pipe as backfill cellular concrete and grout was placed between the interliner and the tunnel segments. The contractor added six small, additional holes: four in the arch for float pins and two centered on the spring line for lifting and pivoting the pipe while lowering it into the tunnel. Twenty-two pipes were mitered to facilitate installation through the two curves in the tunnel alignment.

The pipes were then loaded onto a barge and transported from Louisiana, around the Florida Keys, then north up the East Coast to the Hudson River to docks in Newburgh, New York, at a temporary storage facility. The pipes were then transferred to the site during the overnight hours with a police escort. Due to the height of the load, specialty trailers were used to provide necessary clearance above and below. More than 80 overhead utilities were raised or relocated along the 7-mile journey to the project site.

Once on site, each pipe was fitted out with steel reinforcement rebar and an elevated rail system that increased the weight to 110,000 pounds. Each pipe was then placed onto a custom-built rail dolly and pushed on a runway over the shaft onto a steel cover where it was picked up at the center by the double-hoist headframe system. The rotation of the pipe was controlled by two winches and then each pipe was lowered down the shaft, approximately 900 feet.

From the bottom of the shaft, the pipe was trammed into the tunnel using a system of four custom-built, heavy-duty, low-profile dollies in tandem, which were pushed in by a 35-ton locomotive. The dollies were outfitted with a jacking system to adjust and lock in each pipe on surveyed, line and grade. The interliner sections were then fully welded together from the support gantries, traveling on the elevated rail. The interliner was installed successfully over a 7-month period.

Lowering And Installation In The Reinforced Precast Segmental Tunnel



APPLICATIONS OF MACHINE LEARNING TO TUNNELING

By Sangyoon Min, Ph.D, PE

Machine learning (ML) is a method of data analysis that automates analytical model building. It is a branch of artificial intelligence (AI) based on the idea that systems can learn from data, identify patterns, and make decisions with minimal human intervention [1]. The practice of ML has experienced immense recent growth, driven by advances in computational performance, sensing technology, and data storage.

A wide range of ML techniques has been developed for tunneling applications. Areas of application include tunnel-boring machine (TBM) automation, TBM performance prediction, tunnel condition assessment, anomaly detection, tunnel profile measurement, resilience assessment, structural defect identification, tunnel face stability, rockburst prediction, and intelligent building information modeling [2].

Prediction Of Tunnel-Boring Machine Penetration Rate

Suitable prediction of TBM performance parameters such as penetration rate (PR) and advance rate (AR) can provide useful information to reduce potential risks including high capital costs for a mechanized tunneling operation. Because the TBM penetration rate is a continuous target variable, ML techniques such as an artificial neural network, support vector machine, and fuzzy inference system have been used for modeling for TBM performance parameters considering classification and regression of TBM data [3].

Tunneling-Induced Settlement Prediction

ML models are adopted for the prediction of tunneling-induced soil settlement and tunnel convergence. Given the complex nature, the number of parameters used in these models is notably greater. These parameters include a mix of soil, tunnel geometry, and TBM operational parameters [2].

Ground Condition Prediction Ahead Of Tunnel

To obtain actionable information during tunneling, soil conditions or potential obstacles need to be forecasted in advance of the TBM [2]. Among various approaches, Wei et al. [5] documented one of the most comprehensive applications of ML to a new “tunnel look-ahead imaging prediction system” (Tulips). The Tulips imaging approach consists of three sets of GPR antennae and seismic imaging. An experimental campaign showed that buried obstacles can be successfully identified and tracked using this methodology.

Cutterhead Design Optimization

For the cutter layout, the optimization process has been typically undertaken to minimize eccentric forces of the whole system by maximizing cutterhead symmetry, maximize excavation efficiency by ensuring that adjacent cutters score the tunnel face successively, and minimize excavation-induced stress on the cutterhead [6]. On the geometric design of individual cutters, Xia et al. [7] used genetic algorithm (GA) and multi-objective and multi-geologic condition optimization to optimize the cutter’s cutting-edge angle, cutting edge width, transition arc radius, and caulking ring width between bearings. The optimization process sought to minimize the cutter bearing load.

References:
[1] https://www.sas.com/en_us/home.html
[2] Sheil BB, Suryasentana SK, Mooney MA and Zhu H (2020). “Machine learning to inform tunnelling operations: recent advances and future trends.” *Proceedings of the Institution of Civil Engineers – Smart Infrastructure and Construction*, 20.00011.
[3] H. Xu, J. Zhou, P. Asteris, D. J. Armaghani, and M. M. Tahir (2019). “Supervised machine learning techniques to the prediction of tunnel boring machine penetration rate.” *Applied Sciences* 9 (2019) 3715.
[4] Schaeffer K and Mooney MA (2016). “Examining the influence of TBM–ground interaction on electrical resistivity imaging ahead of the TBM.” *Tunnelling and Underground Space Technology* 58: 82–98.
[5] Wei L, Magee DR and Cohn AG (2018). “An anomalous event detection and tracking method for a tunnel look-ahead ground prediction system.” *Automation in Construction* 91: 216–225.
[6] Ji Z, Guo B, Xia Y and Tang L (2016). “TBM cutterhead structure optimization based on sensitivity analysis.” *In Proceedings of the 2016 12th IEEE/ASME International Conference on Mechatronic and Embedded Systems and Applications*, Auckland, New Zealand, pp. 1–8.
[7] Xia Y, Zhang K and Liu J (2015). “Design optimization of TBM disc cutters for different geological conditions.” *World Journal of Engineering and Technology* 3(4).

Publications

Title	Author(s)
Rapid Excavation And Tunneling Conference (RETC), June 12—16, 2021, Las Vegas, NV	
The Bypass Tunnel: Excavation, Interliner And Lining	Ted Dowey, **Eric Jordan**, Sean McAndrew, Grant Miliner, and George Schmitt
Unreinforced Slurry Walls As Temporary Support Of Excavation For Shafts	**Pooyan Asadollahi**, Arash Dahi Taleghani, and Guoqiang Li
Tunnel Lining Design In Active Fault Zone: Case Histories And Innovations	**Peter Chou, Pooyan Asadollahi,** and **Danny Lin**

Recognitions

Achievement Of The Lowest OSHA Recordable Rate

The BT-2 (Delaware Aqueduct Bypass Tunnel) has achieved the lowest OSHA recordable rate since the New York Department of Environmental Protection (DEP) has been keeping records. The BT-2 contract was instrumental in helping the DEP with their commitment of maintaining environmental health and safety management systems to insure they achieve their goal of running the safest, most environmentally compliant capital construction program in the United States.

Delaware Aqueduct Bypass Tunnel – OSHA*

* The picture was taken prior to February 2020 before Safer At Home Orders and social distancing mandates were in place.

NEW HIRES

Amy Getchell

Environmental Engineer

Amy joined Parsons in December as a geotechnical/ environmental engineer for the infrastructure department in Boston, Massachusetts. She is currently working as a project engineer for the barrier wall design team at the BF Goodrich Superfund site, in Kentucky. Amy has extensive geotechnical laboratory (consolidation, shear, small strain, and rheological testing) and field testing (CPTu, DMT, field vane, and LWD) experience. Amy completed her undergraduate degree in civil engineering at the University of Maine and her master's degree in geotechnical engineering at the University of New Hampshire. She is currently finishing her PhD in geotechnical engineering at Purdue University where her research has focused on the effects of pore fluid rheology on the shear response of sand providing insight to the behavior of complex geomaterials.

Joseph Torg

Construction Engineer

Joseph is a geologist by trade who recently finished his Master of Science from the University of Pennsylvania. He works as a construction engineer and inspector on the NYC Delaware Aqueduct Rondout West Branch Bypass Tunnel Repair Project. He is interested in exploring new technologies in 3D modeling and computer visualization of underground work, bringing together established mining and geology practice with emerging visualization and modeling techniques.

Khawar Sajjad Khawaja

Geotechnical Supervisor

Khawar is a versatile, proactive, and qualified construction management professional specializing in geotechnical/ material engineering. He has a master's degree in construction management and a BS in geological engineering. He has more than 28 years of engineering and project management experience with multinational geotechnical/materials-testing firms. His experience includes supervising soil improvement works for various onshore and offshore construction projects in the Arabian Gulf. Khawar currently works as a senior geotechnical supervisor with Parsons International in Abu Dhabi, UAE, and as a researcher in international business at the Martti Ahtisaari Institute, in the Oulu Business School, in Finland.

NEW HIRES

Mohamed Ismail Maghazy, PhD

Tunnels Lead (MEA)

Mohamed is the tunnels lead for Parsons Middle East and Africa (MEA). He has more than 33 years' experience in complex mega infrastructure, including the design, technical management, and delivery of tunnels, underground structures, and foundations of elevated structures and technical buildings for metro and different infrastructure projects. His tunnel experience includes design, supervision, and project delivery, with different techniques of excavation including tunnel-boring machines and the conventional New Austrian tunneling method (NATM). Mohamed also has experience in geotechnical and structural engineering for underground works.

Tom Wilshusen

Senior Project Manager

Tom returned to Parsons after having worked for us for 13 years through 2005. He is a civil/environmental engineer specializing in water and wastewater infrastructure. He has significant experience in tunneling and other trenchless methods for wastewater conveyances. Before rejoining Parsons, he was based in Latin America, working on projects in more than 20 countries for 15 years. There, he was the lead civil engineer for a 5-mile, 10-foot-diameter sewer tunnel in Panama, working on the project from conceptual engineering through construction and putting into service. He also was part of a project team developing a tunnel for a metro line under the Panama Canal. He also worked on extensive pipeline rehabilitation projects for large sectors in Lima, Peru, and in Medellín, Colombia. During his earlier stint with Parsons, he worked on the Austin Downtown Tunnel study. With a different consultant, he worked on the design of the Austin Little Walnut Creek wastewater tunnel.

SAFETY MESSAGE

Parsons team members work in a multiplicity of work settings. We are working at field sites, in Parsons-managed offices, and at client sites per job requirements, and we will continue to do so. Our employees who are temporarily working from home and will be returning to field or client sites should follow guidelines set at those locations, enhanced, as applicable, by our own guidelines.

We realize these are unprecedented times in our lifetime, and we want everyone to be comfortable with their working arrangement. As local governing bodies begin modifying or lifting restrictions, we want you to know that if you wish to continue working remotely you can do so with the support from your manager. We also recognize that working remotely can be less effective for some. If this applies to you, please talk to your manager about returning to the office as permitted under guidelines issued by local authorities.

Employees working in a Parsons-operated office will notice additional safety and wellness measures with a focus of keeping everyone healthy and confident about their work location.

In Parsons-operated offices:

Face coverings are required in general common areas, including bathrooms, and when 6-foot social distancing cannot be achieved.

Social distancing (maintaining a 2-meter/6-foot distance) from others is expected.

Frequent handwashing and avoiding touching your face, mouth, nose and eyes.

Clean and disinfect all shared areas and equipment routinely.

For additional safety tips and to learn more about COVID-19, visit www.cdc.gov/coronavirus.

Fight The Spread Of Germs!

Proper hand washing is the most effective way to prevent the spread of infections.

1 WET

Wet your hands with clean running water and apply soap.

2 RUB

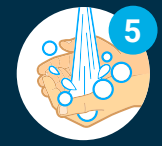
Rub your hands together and scrub them well.

3 SCRUB

Scrub the backs of your hands, between your fingers, and under your nails.

4 SING

Sing the "Happy Birthday" song twice while lathering (20 seconds).



5 RINSE

Rinse your hands well under running water (10 seconds).

6 DRY

Dry your hands using a clean towel or air dry.

Further information please contact:

STEVE MINASSIAN / Tunnel Contact
Steve.Minassian@parsons.com

SANGYOON MIN / Newsletter Editor
Sangyoon.Min@parsons.com