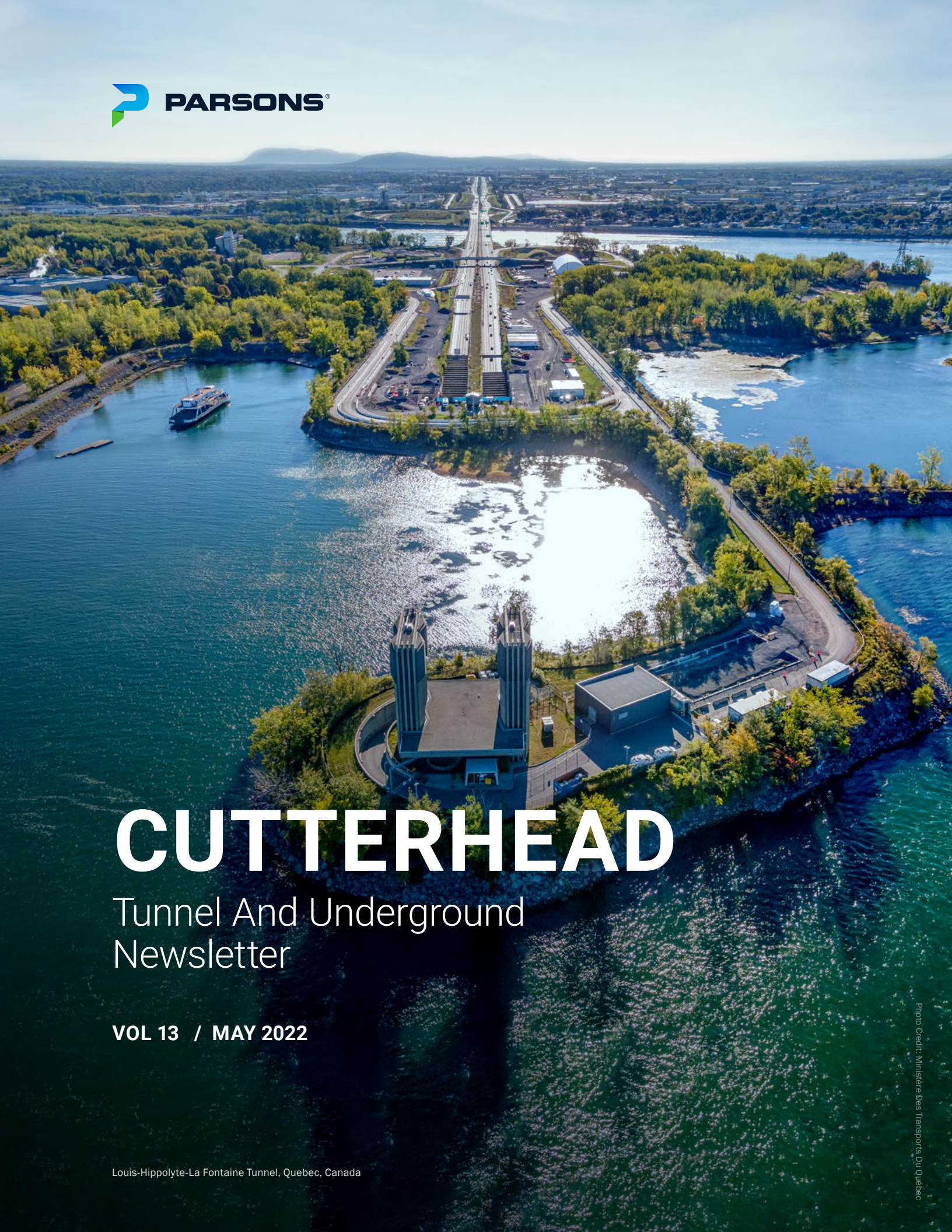

PARSONS®

CUTTERHEAD

Tunnel And Underground Newsletter

VOL 13 / MAY 2022

Louis-Hippolyte-La Fontaine Tunnel, Quebec, Canada

Photo Credit: Ministère Des Transports Du Québec

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Photo Credit: Ministère Des Transports Du Québec

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 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.

Construction in progress

- Wall repair in tunnel corridor
- Electrical building construction near the ventilation towers
- Wall repair at the portals
- Replacement of portal support beams
- Saccardo ventilation building at the portals

Completed construction

- Construction of three incentive parking lots for public transit
- Road works on Highway 20, including new pavement, drainage, and signage
- Multi-use path and noise barrier wall bordering Curatteau street
- 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

Construction to come

- Rehabilitation of various components of the tunnel, including the concrete screed, walls, vault, joints, and drainage
- Reconstruction of the concrete pavement of Highway 25 on either side of the tunnel between Île Charron and Sherbrooke Street in Montréal
- Modernization of electrical, lighting, ventilation, monitoring, and communication systems
- Addition of fire protection equipment
- Tunnel architectural features i.e., covered structure at the portals, lighting, and landscaping

Louis-Hippolyte-La Fontaine Tunnel

JOINT WATER POLLUTION CONTROL PLANT (JWPCP) SEWER TUNNEL OUTFALL PROJECT

Los Angeles, CA

We completed the final design and bidding phases for the Joint Water Pollution Control Plant (JWPCP) Effluent Outfall Tunnel project and are entering into the engineering services phase during construction. The Sanitation Districts of Los Angeles County (Sanitation Districts) are 24 independent special districts serving the wastewater and solid waste management needs of approximately 5.6 million residents in Los Angeles County. Seventeen of the Sanitation Districts 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 Joint Water Pollution Control Plant (JWPCP), located in the City of Carson. Currently, secondary treated effluent from the JWPCP is conveyed through two 6-mile-long tunnels, 8 and 12 feet in diameter, to a manifold structure located near White Point on the Palos Verdes Peninsula. Four sea-floor outfalls extend offshore from the manifold structure. The two main outfalls are 90 and 120 inches in diameter and extend approximately 1.5 miles offshore, discharging at a depth of approximately 200 feet below sea level. 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 project will be demolished and a new manifold structure will be constructed. Since the existing tunnels and main outfalls are always required to be in service, a temporary bypass system will be construction and operated during this phase of the project. Construction of the tunnel and associated structures is packaged under a single contract, which was awarded to Dragados USA (DUSA) in January 2019. 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 and the tail and starter tunnels have been completed. The 21-foot diameter Tunnel Boring Machine (TBM) was fabricated in Germany and delivered to the site in May 2021 for on-site assembly. Assembly includes the TBM and 18-gantry cars that house all the equipment needed for tunneling operations. Fabrication of the precast tunnel segments started in April 2021 and is currently in full production. TBM advance started in October of 2021. The TBM and launch shaft will be fully mobilized for continuous production tunneling in April 2022. 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.

JWPCP Sewer Tunnel Outfall Project – Tunnel Gantries

Photo Credit: Sanitation Districts of Los Angeles County

PURPLE LINE EXTENSION SECTION 1

Los Angeles, CA

Los Angeles Metro's Purple Line Extension Section 1 project is the first of three sections along the new 9.1-mile subway 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. The three stations are Wilshire/La Brea, Wilshire/Fairfax, Wilshire/La Cienega and a retrieval shaft at Wilshire/Western. Section 1 of the Purple Line Extension is scheduled to be operational in 4Q 2024.

The project is currently 75 percent complete. Tunneling of the twin bore tunnels was completed in May 2021 and one of the two tunnel boring machines has since been disassembled. The second tunnel boring machine is in the process of being disassembled. Tunnel construction is divided into four separate reaches. Reach 1 is between the existing Wilshire/Western and Wilshire/La Brea stations, Reach 2 is between the Wilshire/La Brea and Wilshire/Fairfax stations, Reach 3 is between the Wilshire/Fairfax and Wilshire/La Cienega stations, and Reach 4 extends West past the Wilshire/La Cienega station to the tie-in connection point to the Purpleline Section 2 project. Tunnel construction includes 23 crosspassages (XP) that connect the twin bore tunnels along the alignment. All 12 XP's in Reach 1 have been completed, the 6 XP's in Reach 2 are scheduled to be completed in April 2022 and the five remaining XP's in Reaches 3 and 4 will be fully constructed by September 2022. Tunnel invert and walkway construction for Reach 1 were completed in January 2022 and track installation has begun. Tunnel construction for the entire project is scheduled to be completed by January 2023.

Station construction is also on-going. Structural concrete work for all three stations and the transition structure to the existing Wilshire/Western station will be completed by the end of November 2022. Upon completion of the structural concrete work, backfill over each of the station roof structures will proceed below the temporary decking, which will subsequently be removed over full weekend traffic closures. Construction of street improvements along Wilshire Boulevard and the adjacent side streets will extend into 2023.

Our role in the project continues as the prime designer for the design-build team and design engineer of record (EOR) for the project.

Purple Line Extension Section 1 - Fairfax Station Tunnel Eyes (East)

Photo Credit: LA Metro

DEER CREEK SANITARY TUNNEL AND PUMP STATION

St. Louis, MO

We have 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 constructed 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.

A 22-foot-diameter tunnel-boring machine (TBM) maneuvered through 14 designed curves at a grade of 0.20 percent. It arrived at the correct horizontal and vertical locations as planned. Cast-in-place lining operations are complete as well as all of the diversion structures and adits. The contractor reached substantial completion in December and is currently completing surface work in dog park that is being restored in the flood plain.

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. 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. KCI has completed work on the effluent vault and is proceeding as scheduled. The pumps are expected to be installed soon and the buildings are starting to take shape.

Deer Creek Sanitary Tunnel


RT33S

CITY OF HOUSTON FACILITIES CONSOLIDATION – CHELFORD CITY DIVERSION PACKAGE 3

Houston, TX

We are 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: 6,500 linear feet of 24-inch HOBAS pipe to be installed by microtunneling, 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, three diversions of flow from existing surface sewers, and decommissioning and demolition of Green Crest LS after the proposed gravity sewer is in service. Final design was completed, and construction is expected to start in July 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 construction by Kolb Grading is substantially complete. 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.

We performed preliminary design for the entire project and were 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.

DC-02 And DC-03 Sanitary Relief Sewer

DELAWARE AQUEDUCT BYPASS TUNNEL (BT-2)

Newburgh, NY

We provide comprehensive Construction Management (CM) services for New York City's Delaware Aqueduct Bypass Tunnel project located in the Mid-Hudson Valley of Lower New York. We have been the CM on the Project since construction began in January 2013.

The Delaware Aqueduct, in service since 1944, supplies upwards of 50 percent of New York City's daily water consumption. At 85 miles long, the Delaware Aqueduct is the longest tunnel in the world. The Bypass Tunnel project is designed to replace a leaking portion of the Delaware Aqueduct. The Bypass Tunnel is the most significant, capital construction repair project in the history of New York City's drinking water supply system. The new tunnel will bypass and cutoff a leaking section of the Delaware Aqueduct, thereby improving the reliability of the City's water supply system.

Construction of the new Bypass Tunnel began in 2013. The initial phase of construction included two, deep shafts in rock- one 900 feet deep and another that was 760 feet deep. Both shafts were completed ahead of schedule, in 2016.

Once the shafts were completed, more than 1,300 feet of tunnel was excavated by drill and blast techniques followed by a 12,500 long bored tunnel, using a Robbins manufactured TBM. The TBM bored tunnel was completed in August of 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.

Late last year, the reinforced, concrete final lining of the tunnel was completed. The final lining includes a unique 1-inch thick, solid steel interliner that is sandwiched in between two layers of reinforced concrete. The final lining was completed in a ten-step process by November of 2021.

Recently, finishing work at both shafts resumed with construction of the Access Chambers that are located at the top of each shaft. Each Access Chamber receives a 1-inch-thick steel access pipe, a ring beam to anchor the bottom of each access pipe, several permanent utility pipes to assist with making the connection to the existing Delaware Aqueduct, and permanent Access Chamber building to access the tunnel for inspection and repair in the future. Work is on schedule and planning for the Connection Phase (connection the Delaware Aqueduct) is ongoing. The first attempt to Connect to the Delaware Aqueduct is scheduled to begin in October of 2022.

We provide 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. Our team developed a unique approach to connect the new tunnel to the existing tunnel, reducing time of the shutdown tunnel outage from 16 months to six months.

Delaware Aqueduct Bypass Tunnel – Shaft 5B Access Chamber

DELTA CONVEYANCE PROJECT

Sacramento, CA

Parsons continues to provide program management services to the Delta Conveyance Design and Construction Joint Powers Authority (DCA).

We provide overall management, technical/engineering consultant, and project controls for the DCA including staffing and software for activity scheduling and reporting, risk management, program budget/cost planning and monitoring, performance metrics development and reporting, program documentation, and other related professional services.

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, clean, and affordable water to homes, farms, and businesses throughout major regions of the state from the Bay Area to Southern California.

The Delta is at the center of California's vital water distribution system. Two-thirds of California's water originates in the Sierra Nevada Mountains as snowpack and eventually flows through the Delta. The State Water Project collects and delivers water from the Delta to more than 27 million Californians and 750,000 acres of farmland, consistent with water rights and applicable water quality requirements. The infrastructure that enables conveyance for California's primary water supply is critical to the health of local communities and the success of the state's economy.

Because the SWP relies on the Delta's natural channels to convey water, it is vulnerable to earthquakes and sea level rise. Upgrading SWP infrastructure protects against these threats and secures the longevity of the SWP and the future reliability of SWP water supplies. Department of Water Resources' (DWR's) fundamental purpose in proposing the project is to develop new diversion and conveyance facilities in the Delta to restore and protect the reliability of SWP water deliveries consistent with the State's Water Resilience Portfolio in a cost-effective manner. DWR is considering the Delta Conveyance Project to address sea level rise and climate change, minimize water supply disruption due to seismic risk, protect SWP water supply reliability, and provide operational flexibility to improve aquatic conditions in the Delta.

The Delta Conveyance Design and Construction Authority (DCA), under the direct supervision of the 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.

While three alternative alignments are being considered in DWR's environmental review process, only one alignment, utilizing one tunnel, would potentially be chosen.

Delta Conveyance Project

NOTE: These maps are for discussion purposes only and are subject to change. They do not represent a decision by the Delta Conveyance Design and Construction Authority or California's Department of Water Resources (DWR). Final decisions about the project will be made by DWR and will NOT be made until the concluding stages of the California Environmental Quality Act process.

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 four-station light rail project is now more than 40 percent complete overall; with the grade crossing work more than 65 percent complete, freight track relocation more than 60 percent complete, and the bridgework nearing 30 percent complete (90 percent of the freight bridge construction is now complete). As part of this DB contract, pedestrian underground crossings and ramps, guideway retaining walls, and protect-in-place buried structures are also being constructed by KPJV.

Foothill Gold Line Extension Phase 2A

DOWNTOWN RAIL EXTENSION PROJECT

San Francisco, CA

We provide General Engineering Consultant (GEC) services to Transbay Joint Powers Authority (TJPA) for the Transbay Program. The GEC services include project management, project development, and project procurement. It also includes engineering support during construction for the next phase of the Transbay Program. The Downtown Rail Extension (DTX) will connect Caltrain's regional rail system and the California High-Speed Rail Authority's statewide system to the Salesforce Transit Center in downtown San Francisco. The rail alignment will be constructed principally below grade to provide a critical link for Peninsula commuters and travelers on the state's future high-speed rail system. Major elements of the project include the DTX tunnel using both cut-and-cover and mined tunneling methods, a new underground Fourth and Townsend Street Station, emergency egress and ventilation structures, systems and trackwork, fit-out of the below-grade rail station at the Salesforce Transit Center, and a train box extension of the existing station structure.

HORIZON LATERAL PROJECT

Las Vegas, NV

We have been selected by the Southern Nevada Water Authority (SNWA) to continue providing program and construction management services to improve and increase the water supply to Las Vegas. Continuing a partnership that began in 1993, the new contract will focus on water distribution and watershed sustainability. The three-year, $21 million contract includes the option for three additional three-year extensions, totaling 12 years. We will support program and construction management, construction inspection, project controls, labor relations and compliance, and project management information system support. Among the major construction and capital plan (MCCP) by SNWA, we are currently working on Horizon Lateral Project.

The Horizon Lateral Project is a $1.6 billion water transmission pipeline, 7 – 8 miles of which is in tunnel(s), to the southwestern part of the Las Vegas Valley. There are two tunnel alignments being considered. Currently preliminary design, survey, right-of-way, and geotechnical drilling are proceeding for both alignments. The final design of the selected alignment is anticipated in 2024-2025, and construction is anticipated to commence in 2024.

SAN FRANCISCO PUBLIC UTILITIES COMMISSION (SFPUC) SEWER SYSTEM IMPROVEMENT PROGRAM

San Francisco, CA

Since 2011, Parsons, in a joint venture with AECOM, has been providing program management services for the SFPUC's $6.9 billion Sewer System Improvement Program (SSIP), which includes various conveyance and flood resilience projects. We continue 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, we are also providing construction management services for SFPUC's Southeast Treatment Plant improvement projects.

TUNNEL STABILIZATION AND SEWER PIPELINE REPLACEMENT

Laguna Beach, CA

The South Coast Water District operates the Beach Interceptor Sewer Tunnel located beneath the coastal bluffs in the city of Laguna Beach, California. The rehabilitation efforts of the 70-year-old sewer tunnel includes the stabilization and enlargement of a 10,000-feet from 5-foot-wide by 6-foot-high tunnel to an 8-foot-wide by 8-foot-high horseshoe-shaped tunnel. Additionally, the existing deteriorated Techite and VCP pipes will be upgraded to a new 24-inch DR-25 PVC pipe.

We began working on the project in 2015, providing value engineering, seismic stability analyses and risk assessment to the South Coast Water District Board of Directors. Additionally, we have been providing construction management services, bid support and design reviews since 2016. The project is being constructed in four phases and is currently in the last phase of construction. Completion of the tunnel excavation is projected by mid of 2022, with forecasted completion of the new 24-inch replacement pipe installation and final connection by June 2023.

EMERGING LIDAR TECHNOLOGIES FOR TUNNEL INSPECTIONS

By Joseph Torg

The Delaware Aqueduct, at 85 miles long, is the longest tunnel in the world. One of three major aqueducts in New York City's (NYC) water supply system, the Delaware Aqueduct provides half of New York City's daily potable water supply. Parsons has been engaged, as construction management, in rehabilitation and new construction activities at certain segments of the Aqueduct.

New tunnel construction has come in the form of the Delaware Aqueduct Bypass Tunnel (BT-2) that was constructed underneath the Hudson River, just north of the city of Newburgh. Tunnel construction consisted of rock boring via Tunnel Boring Machine (TBM), placement of concrete segments, installation of a steel interliner pipe, and a reinforced concrete lining over 130+ subsequent placements (38,000+ cubic yards) of specialized concrete to build the final 14-foot finished diameter to secure reliable potable water supply to the city.

As concrete was placed during finishing, we mapped the conditions of the tunnel's final lining using a 2D (unrolled cylinder) method developed by the US Army Corp of Engineers. Mapping shadowed the final lining heading as it advanced along the 2.5-mile length of the new Bypass Tunnel.

As mapping progressed the COVID-19 pandemic developed, resulting in staffing and access to the sites becoming more restrictive. Our field engineers sought to implement new mapping technology to improve communication and reporting with staff with limited access to the day-to-day tunnel environment. The technology came in the form of a tablet computer (approximately $1,100 dollars) equipped with LIDAR integrated camera systems,

Fig. 1. Highly zoomed out view of a 400-foot section of tunnel before concreting.

the first of its kind. LIDAR is a type of laser sonar, a scanning tool that accurately measures distances to the Earth or surrounding surfaces by measuring time it takes light sent from the camera to reflect back to the camera.

Fig. 2. Horizontal view of a 30-inch stretch of 14-inch diameter bypass tunnel.

Laser scans of subsurface environments such as tunnels or mines have, in the past, generally required specialized contractors and expensive equipment which displace production activities. This process can cost from tens to hundreds of thousands of dollars.

The LIDAR type mapping method enabled Parsons representatives to produce a simple, easy to use, cost effective deliverable for tunnel construction. The order of operations is simple: boot up the device, open the software, record the model with the press of a button and a walk around the desired area, then allow the model to process the digital photographic data on the tablet before opening a three-dimensional (3-D) model to study, evaluate, and communicate or send via text or email.

Field tests revealed that, in a short amount of time, even inexperienced staff could capture high quality models in areas of varying shapes and dimensions. The LIDAR models were accurate within one to two inches and allowed for, within the tablet software, measurements, and analysis of the scanned areas. Additionally, the models can be processed and manipulated further in a desktop environment in programs like Blender 3D. The models have shown to be efficient supplemental images included with typical digital photo routines, helping to process questionable features or perspectives.

In the future these models will supplement daily tunnel inspection tasks. We found them useful for recording and visually communicating significant conditions such as contract defined defects, or support of excavation initial rock support, record keeping, and safety information in the form of concrete final lining conditions or geotechnical assessment.

While enacted late in the Bypass Tunnel project, the outlook for the LIDAR integrated camera systems in tunnel construction is bright for upcoming projects.

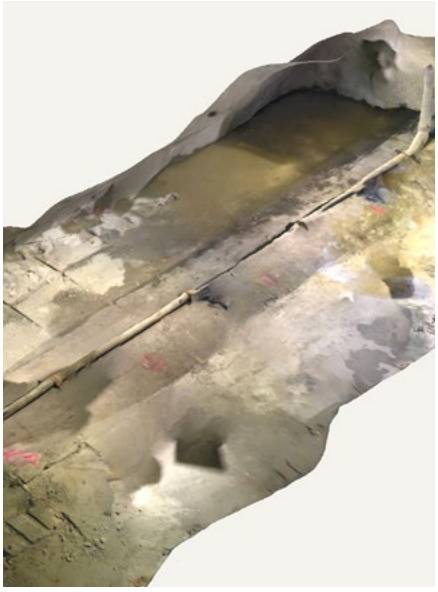

Fig. 3. These depict the same area. The model (right) allows for manipulation to determine length, widths, and other spatial references.

Fig. 4. Inspection model taken to document water seepage.

POLYMER CONCRETE SEGMENTAL LINER FOR SEWER TUNNELS

By Pooyan Asadollahi, Ph.D, PE, PMP

Polymer concrete is made from chemically inert mineral fillers, polymer resin, and selected reinforcing media without any Portland cement. Besides its superior mechanical properties (i.e., compressive, flexural, and tensile strength), polymer concrete is proven to have an excellent corrosive resistance and a life expectancy of over 300 years in severe environments such as sewer tunnels. In addition, polymer concrete is impermeable and eliminates sewage exfiltration and groundwater contamination. While sewer underground industry has been using polymer concrete precast manholes for several decades, there are not much case histories of past tunneling projects in which polymer concrete segments were utilized as the tunnel support or in rehabilitation of the existing tunnels. We, in collaboration with P3 Polymers, recently designed and constructed polymer concrete segmental liner with an internal diameter of 16 feet and thickness of 3 inches for rehabilitation of Michigan North Interceptor PCI-4. The four universal segments are to be bolted and glued by a patented polymer joint sealant to form a watertight ring and then the rings are to be lowered into the construction shaft and sliplined inside the tunnel. At their final position, the rings are to be connected with each other by the same polymer joint sealant at the circumferential joints and the installation is to be completed by backfill grouting. The joint sealant has been tested to resist over 3 bars of water pressure providing an adequate factor of safety against internal and external leakages.

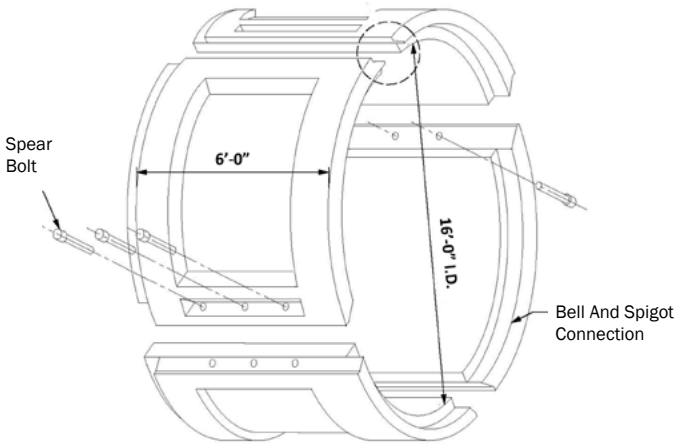

Fig. 1. Isometric View

Fig. 2. Three pieces of four segment ring (Courtesy of Mr. Daniel Jones).

Publications

Title	Author(s)
North American Tunneling Conference (NAT), June 19-22, 2022, Philadelphia, PA	
Tunnel Rehabilitation Through Historic Landslides in Laguna Beach	**Scott Zylstra** and **Shimi Tzobery**
Microtunneling Short Course, April 27-29, 2022, Scottsdale, AZ	
Houston's Approach to Microtunneling	**Monica Suarez** and Markos Mengesha
International Conference and Exhibition on Building Materials and Construction Technologies, April 06-08, 2021, Dubai, UAE	
Michigan's Oakland-Macomb Interceptor Rehabilitation using Polymer Concrete Segments	**Pooyan Asadollahi**
Dubai DS215 Deep Strategic Sewer Tunnels -Design and Innovations	**Glynn Monks**
DS 215 Link Sewers in Old Dubai by Parsons	**Javid Salem**
Association of Environmental & Engineering Geologists annual Conference, San Antonio, TX	
The NYCDEP Bypass Tunnel – A Triumph in Tunneling: TBM hard rock mining through difficult ground and high groundwater pressure in the Mid-Hudson Valley of New York	**Eric Jordan**
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**

RECENT TUNNEL EXPERIENCE

PROJECT TITLE	Drill And Blast	Adits To Tunnel Connection	Deep Shaft	Conventional Support	Water Control Grouting	Critical Schedule	Underground Safety	Design	Study	Geotech	Program Management	Construction Management	Construction	Inspection Services	General Engineering Consultant	Procurement Method	Length (ft)	Diameter (ft)	Ground Type	Tunnel Methodology	Tunnel Type	Year(s)
West Vaughn Sewer Tunnel			✔	✔	✔	✔	✔	✔	✔	✔						DBB	49,000	12.1	S	EPB	WW	2015-2028
San Francisco Downtown Rail Extension (DTX), Design-Build		✔		✔	✔	✔	✔	✔	✔	✔					✔	DB	6,900	varies	S	TBM & NATM	TR	2005-2031
Deer Creek Sanitary Tunnel			✔	✔	✔		✔	✔		✔	✔					DBB	20,000	18.0	HR	TBM	WW	2012-2022
NYDEP Delaware Aqueduct Bypass Tunnel	✔		✔	✔	✔	✔	✔					✔			✔	DBB	16,000	22.0	HR	TBM, D&B	W	2012-2025
Beach Interceptor Tunnel Stabilization		✔		✔		✔	✔		✔			✔			✔	DBB	10,500	varies	HR	Roadheader	WW	2017-2022
LA Metro Purple Line Extension, Design-Build		✔		✔	✔	✔	✔	✔		✔						DB	2 x 18,000	19.0	SR	EPB, NATM	TR	2014-2022
Dubai Strategic Sewerage Tunnel, Design-Build								✔	✔		✔					DB	230,000	12-25	SR	EPB	WW	2016-2030
LACSD JWPCP Tunnel And Ocean Outfall			✔		✔	✔	✔	✔	✔	✔						DBB	100,000	22.0	SR	EPB	WW	2002-2022
Riyadh Metro, Design-Build		✔		✔	✔	✔	✔				✔	✔			✔	DB	79,000	33.0	SR	EPB, CC	TR	2013-2021
California High-Speed Rail, CP1, Design-Build				✔	✔	✔		✔	✔	✔			✔			DB	510	35 x 50	S	CC	TR	2013-2021
Dubai Metro Route 2020: Red Line Extension To EXPO 2020, DB					✔	✔	✔				✔	✔				DB	10,500	30.5	S	EPB	TR	2016-2020
Ohio Canal Interceptor Tunnel (OCIT)	✔	✔	✔	✔	✔	✔	✔					✔		✔	✔	DBB	6,250	30.5	S	EPB, D&B	WW	2014-2020
South Hartford Conveyance And Storage Tunnel	✔			✔			✔		✔			✔				DBB	22,000	22.0	HR	TBM	WW	2013-2023
Maliakos-Kleidi Motorway And Tunnels, Greece, P3	✔	✔	✔	✔	✔		✔	✔								PPP	42,650	33 x 54	HR, SR	D&B	TR	2010-2018
Lake Mead Intake No. 2 And No. 3 Project, Design-Build	✔	✔	✔	✔	✔	✔	✔		✔		✔	✔		✔	✔	DB	22,150	14 - 20	HR	TBM, D&B	W	1996-2017
Ohio River Bridges - East End Crossing Tunnel, P3	✔			✔	✔	✔	✔		✔	✔		✔			✔	PPP	2 x 1,710	32 x 55	HR	NATM, D&B	TR	2007-2017
DC Water Anacostia River Tunnel (ART), Design-Build		✔	✔	✔	✔	✔	✔	✔		✔			✔	✔		DB	12,300	23.0	S	EPB, NATM	WW	2013-2017
Eglinton Crosstown East Tunnel, Canada, P3		✔	✔	✔	✔	✔	✔					✔		✔		PPP	2 x 10,800	21.7	S	EPB	TR	2013-2017
Downtown Tunnel/Midtown Tunnel/MLK Extension, P3							✔		✔		✔					PPP	4,300	28 x 54	S	Immersed Tube	TR	2012-2016
South Cobb SSO Tunnel	✔		✔	✔	✔	✔	✔					✔		✔	✔	DBB	29,000	24 - 27	HR	TBM, D&B	WW	2008-2015
Caldecott Tunnel New Fourth Bore				✔		✔	✔	✔	✔		✔					DBB	3,450	40.0	SR	NATM	TR	2009-2014
San Vicente Pipeline Tunnels	✔		✔	✔	✔	✔	✔		✔		✔	✔		✔	✔	DBB	57,400	12.0	HR, SR	TBM, D&B	W	2001-2011
Dubai Metro Red And Green Lines						✔	✔				✔	✔				DBB	70,550	33.1	S	EPB	TR	2005-2011

LEGEND

DBB: Design-Bid-Build
PPP: Public-Private Partnership
DB: Design-Build
HR: Hard Rock
WR: Weathered Rock
S: Soil
SR: Soft Rock
NATM: New Austrian Tunneling Method
TBM: Tunnel Boring Machine
EPB: Earth Pressure Balance
SPB: Slurry Pressure Balance
D&B: Drill And Blast
CC: Cut-And-Cover
TR: Transportation Tunnel
WW: Wastewater Tunnel
W: Water Tunnel

PARSONS®

5875 Trinity Parkway, Suite 140
Centreville, Virginia 20120
Direct: +1 703.988.8500
parsons.com