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The City of Fort Collins, in northern Colorado, has long been known for its outdoor allure. The city’s outdoor trail system consists of roughly 36 miles of paved and unpaved trails. This gives the public the opportunity to enjoy the beautiful landscape in and around the city. In an effort to expand this system, the city decided to construct a pedestrian trail tunnel, beginning in July 2016. It is now known as the Fossil Creek Trail Connection.

Phase I of this project was the tunnel itself, which is a section of Fossil Creek Trail near the Redtail Grove Natural Area in southern Fort Collins. The 14-foot-diameter tunnel was constructed under the Burlington Northern and Santa Fe Railway (BNSF) for the purpose of allowing pedestrians, cyclists and even equestrians riding horseback to traverse the trail without the need to cross the railway or route around it.

Phase II of the project will ultimately allow future connection of Fossil Creek Trail from College Avenue (east of the railway) to Shields Street (west of the railway).

The City of Fort Collins Planning and Development Department partnered with the City of Fort Collins Utilities Department to construct this project. BT Construction was the company chosen to build the tunnel. BT was selected partly because of their stature as one of the premier tunnel and boring contractors in the state of Colorado, not to mention their recent success in constructing the Michigan Ditch Tunnel near Cameron Pass for the City of Fort Collins.

Surveying for the Fossil Creek Tunnel

Boring a 14-foot-diameter tunnel requires precision measurement and it’s... well, far from boring.

By Curt Acklam; Douglas W. Chinn, PS; William Spencer Jr.; Scott Williams Jr.; and Robert Loane
Collins. BT Construction hired Acklam Inc. to provide land surveying services. Lithos Engineering and Stantec, who were also paramount to the successful completion of the Michigan Ditch Project, provided the geotechnical and civil design of the tunnel.

Acklam’s role was to provide a baseline measurement of the track; take measurements throughout the course of construction and again after construction. By recording all possible subsidences, the drillings were controlled and monitored.

Initial control was established by measuring rounds between six previously chosen survey points. Each target was then measured repeatedly to obtain the most precise horizontal and vertical datum practicable. These survey control locations were picked to allow the project surveyor flexibility in establishing free stations at a number of potential locations. Acklam set 30-inch No. 8 rebar inside cast iron monument boxes in various predetermined locations. Once local control was established, utilizing a Trimble S5 Robotic Total Station. These monuments were occupied and given X, Y and Z values, which would become the “baseline” data. Before excavation began, Acklam also had to provide layout for sheet piles and the centerline of guiderails for the casings to sit on.

**UNUSUAL EXCAVATION**

The excavation of the tunnel was unconventional. As opposed to utilizing a tunnel boring machine, a mini excavator was used to dig out the soil under the railway. It was then dropped into a large bucket, attached to a larger excavator, which lifted the bucket away to remove the material. Sheet piles were driven on either side of the tunnel prior to excavation to ensure the integrity of the railroad embankments would be maintained during the course of excavation. The tunnel was excavated in increments to accommodate the placement of metal casings, measuring 8 feet long and 14 feet in diameter. These casings were put in place to maintain the shape of the tunnel.

Instead of more conventional survey back sights, Acklam used six adhesive sticker targets in place of prisms and tripods. In making use of the Trimble S5 direct reflex technology, a surveyor working alone could greatly reduce the physical labor and time associated with setting up and dismantling conventional tripods. Acklam employed the onboard TSC3 resection algorithm to obtain easily repeatable free station locations while being able to move setups freely around the site. The collected data was entered daily into a derivation report. This Excel spreadsheet illustrated the changes from baseline values in a clear and quickly...
During the process of excavation and installation of the casings, it was critical for Acklam to monitor the deformation of the surrounding area. The integrity of the railway above could have easily been compromised during excavation, as the trains on the railway maintained their usual schedule.

Initially, Acklam monitored each control point twice per week, while the sheet piles were being driven and the shotcrete was applied. Once excavation began, monitoring increased to four times per day, and the tracks were also monitored for differential between the tracks themselves. While the excavation progressed, increased deformation was observed by Acklam. This settlement was not to exceed 0.5 inches on the tracks and 2 inches on the apron of the tracks. As this threshold of maximum settlement was being approached, this data became critical to the communication between BT and BNSF. This real-time data was also crucial to the timely employment of preventative measures by BT and BNSF to ensure that train traffic was not interrupted during the tunneling process.

In the last week of excavation, Acklam increased the monitoring locations to include the face of the west wall while the casing was being pushed through. This was to ensure that the deformation curve of the west wall was not greater than anticipated.

Breakthrough of the tunnel was on Feb. 21, 2017, and thanks to a team of highly skilled, hardworking individuals, the casing has come out in its designed location without incident. After a few days of cleanup and coordination, Acklam began the layout of the headwalls on either side of the tunnel, along with curb and gutter for the trail in the approach areas to each side of the tunnel. Monitoring continued during construction of the headwalls. Once all the concrete was poured and construction was complete, Acklam was tasked with creating an as-built drawing of the final product.

Phase II of the project is currently underway. The timeframe for Phase II is much more lenient, as it is being built on city land. It was critical for the tunnel to be built in a shorter timeframe, due to BNSF railroad stipulations. Overall project completion is slated for late 2017 or early 2018.

The Acklam team consists of: Curt Acklam, president; Douglas W. Chinn, PS, survey manager; William Spencer Jr., chief of parties; Scott Williams Jr., party chief; and Robert Loane, former project manager.

Established in 2010, Acklam is based in Brighton, Colo., providing professional land surveying and mapping services in the Front Range.

Above: It was critical for Acklam to monitor deformation throughout the project and when settlement thresholds were approached, preventive measures were taken. Above right: Acklam set 30-inch No. 8 rebar inside cast iron monument boxes in various predetermined locations.

By recording all possible subsidences, the drillings were controlled and monitored.