Linda Duffy, Apropos Research, USA, describes how survey data adds value throughout the pipeline lifecycle.

Data for a longer lifecycle

Natural gas pipelines are subject to strict regulations intended to maintain public safety. Ensuring compliance requires a large volume of survey data to support the integrity of the natural gas pipeline system, including a record of survey information for numerous features of every pipe segment and centimeter-level location accuracy. In contrast, pipelines for water or sewer require only a minimal amount of data to be collected, such as top-of-pipe elevation, to provide depth of cover and approximate geographic location.

During the installation of a new natural gas pipeline in northern Michigan (USA), surveying and engineering firm, Wade Trim, faced numerous surveying challenges to deliver the details required for installation. These large data sets required daily processing and network adjustments to create a precise GIS containing as-built pipeline data and orthometric aerial imagery of the pipeline corridor.

Integrating Trimble® Access™ Pipelines software into the process optimised the collection and combination of all survey data into the master project database to deliver the utility company's required metadata of the pipeline system. Electronic access to the entire survey dataset using one application helped streamline tasks,

Figure 1. Working in northern Michigan's remote, hilly terrain without a reliable cellular network, numerous challenges were addressed to deliver construction survey data with the accuracy and details required for the utility's US$109 million Traverse City-Alpena Reinforcement Project.

monitor construction progress, verify the accurate position of each pipe segment, and validate completion of required work.

Throughout the project, surveyors and construction team members had access to the database to answer questions and solve problems quickly. In the future, these comprehensive records will support maintenance efforts and extend the life of this major infrastructure investment.

Reduce risk with complete information

Natural gas pipeline accidents and failures can be catastrophic, so protecting the public and environment is paramount. Efforts to mitigate the risk of pipeline material or weld failures, as well as corrosion, have increased regulations, requiring more survey-related tasks during pipeline construction.

Survey as-built asset measurements reduce these risks by linking the recorded data to the associated location of underground pipeline assets, critical failure points, and construction information, usually within a few centimeters. To increase the reliability of the natural gas supply system that serves more than 51 000 customers in northwest Michigan, the US$109 million Traverse City-Alpena Reinforcement Project (TCARP) added a second natural gas pipeline.

Wade Trim was responsible for providing extensive survey construction staking and as-built measurements for 23 miles of natural gas pipeline and modifications for seven stations to comply with rigorous federal regulatory agency and utility company requirements.

"TCARP was a high-profile pipeline, and we wanted to be absolutely sure that everything went smoothly," said Nick Grim, Vice President and Survey Area Lead, Wade Trim. "This project gave us an opportunity to learn more about the comprehensive capabilities of our Trimble Access Pipelines software and fully leverage the large amounts of data collected."

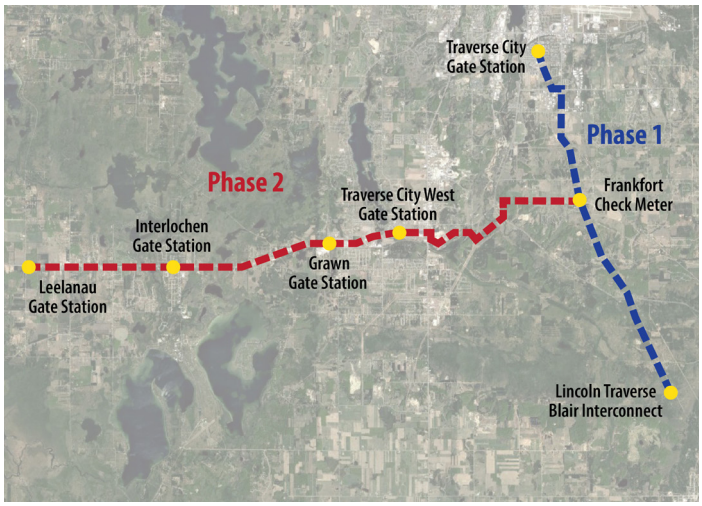

Figure 2. This second natural gas pipeline was constructed to increase the reliability of the natural gas supply system serving more than 51 000 customers in northwest Michigan.

Figure 3. A precise GIS geodatabase of as-built pipeline data and orthometric aerial imagery of the pipeline corridor was created. Large datasets received daily data processing and network adjustments to achieve the centimeter-level accuracy and details required.

Gain efficiency from detailed pipeline attribute inventory

Wade Trim performed pre-construction surveying, construction staking and as-built measurements of the TCARP natural gas pipeline. Construction staking included right-of-way, pipeline alignment and stationing, wetland limits, access roads, erosion control measures, existing pipeline infrastructure, and other utilities near the pipeline corridor.

Due to remote, hilly terrain and poor cellular service, survey signals from the Michigan Department of Transportation's (MDOT) Continuously Operating Reference Stations (CORS) were not reliable to accurately calculate positions. Instead, 30 pairs of control points along the pipeline route were established for GNSS base station locations and checkpoints. Coordinates and elevations were derived by completing multiple rapid static GNSS baseline sessions using Trimble R12 GNSS receivers. Utilising Trimble Business Center software, the baseline measurements were verified and passed the Chi squared test at 95% confidence level.

Thousands of data points were collected along the pipeline to create an inventory database for all sections of pipe installed. Manufacturer data collected during preconstruction pipe tally included each pipe segment's unique pipe number, heat number, length, thickness, coatings, and bend radius. During construction, this data was linked to as-built measurements of weld locations, depth of cover, X-ray inspection data, and cathodic and erosion control measures.

Utilising Trimble Access Pipelines software, pipeline attribute data was categorised and delineated throughout the construction phase for use by the utility company, contractors, pipeline inspectors, land agents, and others. This combined survey data set supports adherence to mandatory regulatory requirements set by the US Department of Transportation and the Federal Energy Regulatory Commission and is critical for long-term integrity of the pipeline. For example, if a section of

pipe is later determined deficient, the defective section can easily be geolocated for immediate repair using the locational data collected.

After a road subbase failed during pipeline boring under US Route 31 through a heavily travelled urban district in Traverse City, daily survey measurements of the busy roadway were taken for settlement monitoring to verify ground subsidence. For the safety of Wade Trim's surveyors and to minimally impede motorists, data was collected using the Trimble SX10 combined terrestrial lidar and robotic total station from the shoulder of the road. This approach contributed to surveyor safety and stability of the roadway, avoided temporary lane closures, and maintained normal traffic flow for tourists travelling to summer destinations.

All survey data was uploaded daily from each survey crew using Trimble Sync Manager to transfer it to the office, via the cloud, for processing, QA/QC, and reports. Office technicians were notified of new data uploads and would confirm all data was processed and results were within the project's accuracy tolerances. By collecting and validating the pipeline inventory in the field from the pre-construction pipeline tally to as-built measurements during construction, many operational tasks were completed more efficiently.

Centralised database provides stakeholder benefits

The process of bringing all datasets from multiple sources together into a single place was accomplished with fewer staff and less time than initially anticipated. Field staff had access to the complete dataset, making it easy to identify any missing pipeline information. Use of Trimble software, including Trimble Access Pipelines, Trimble Business Center, and Trimble Sync Manager, yielded a 10% savings in construction survey costs. In addition, the turnaround time on deliverables was greatly reduced. Data for final pipe footage, tally reports, drain tiles, and alignment sheets could be provided to all project stakeholders, before the contractor left the pipeline corridor.

Accurately identifying the extents of potential slope failures throughout the project helped maintain pipeline integrity for the lifespan of the system, and survey staking these critical locations facilitated pipe installation. In addition, the corridor restoration phase was streamlined by utilising a meticulous pre-construction survey that collected site-specific documentation and geolocated photos of all existing site features within the pipeline right-of-way.

"After completing this project, we feel more confident about unlocking the full utility of Trimble Access. We are more efficient and can validate the data with a few clicks of a button," Grim said. "We were able to produce a much broader deliverable than the utility company first envisioned, and the centralised database provides a path to sustainability by allowing everyone to identify locations and proactively solve problems at a moment's notice, thus extending the life of this major infrastructure investment."

Extending the life of a pipeline

From preliminary route surveying to construction staking to as-built surveying, Wade Trim thoroughly documented the existing conditions of the pipeline corridor, supported construction activities, and collected extensive pipeline attribute and as-built data. The precise GIS containing comprehensive data provided information necessary for issues to be addressed before and during construction and facilitated communication between stakeholders. Going forward, the data set created for this buried asset will be critical to the utility company's future maintenance needs to ensure pipeline integrity.

Trimble Access Pipelines and Trimble Business Center software streamlined the complexities of the survey workflow, enabling all data to be accurately recorded and stored in a single place and quick generation of status reports to support construction. Successful completion of the complex TCARP project demonstrated the value of a centralised database to enhance sustainability and extend the useful life of valuable infrastructure.