Crossing The Antonine Wall

By Siggi Finnsson

The pullback of the 16-in. (400-mm) product pipe commences.

McAllister Bros. Ltd. of Newry, Northern Ireland, recently completed a complicated bore in very difficult ground conditions under a historically sensitive area. The project involved installing an 890-ft (270-m) long gravity sewer at a 0.7 percent grade through ground conditions ranging from unconsolidated cobbles and gravels and flowing silts and sands.

The bore was in the Kelvin Valley, which is located near Glasgow in the heart of Scotland. Byzac Contractors had contracted McAllister Bros. to install a 15 ¾-in. (400-mm) SDR-11 pipe to divert sewer from a soon to be abolished Kilsyth sewage plant. A 36-in. (900-mm) pipeline had already been installed some 890 ft (270 m) away with conventional means, and the new pipe was to connect with that one. The bore would reach a maximum depth of about 48 ft (12.5 m) while maintaining very tight line and grade requirements. The connection to the 36-in. (900-mm) pipe would take place at a depth of 14.9 ft (3.9 m), and the allowable deviation was only 12 in. (300 mm).

A few obstacles were between the sewage plant and the 36-in. (900-mm) pipeline. The obstacles included a farm with various sheds, outhouses and associated farm equipment: a 39.4-ft (12-m) hill; the Burn River; and last but not least, the Antonine Wall built by the Romans in 140 A.D. to keep the marauding Picts from the north out of Roman England. Obviously, the only way to achieve the desired result without encroaching on the sanctioned area around the wall would be to use trenchless means.

Geological Conditions

The ground conditions in the whole of the valley varied quite a bit and further problems were encountered due to a high water table with mobile silts and sands. The first 165 ft (50 m) of the crossing consisted of sands and gravels with interspersed boulders, some as large as 3.3 ft (1 m) in diameter. Over the next 330 ft (100 m), the geology consisted mainly of consolidated, fairly hard sandstone and siltstone. During the following 345 ft (90 m), boulders again became more prevalent while the final 100 ft (30 m) consisted of very loose silts and sands. Due to the high water table and loose formation, the exit pit required sheet pilings to the depth of 16.5 ft (5 m) and a large dewatering system to keep the pit reasonably dry.

Site Setup and Equipment Selection

The machine McAllister Bros. had selected for the project was a newly delivered American Augers DD6, which was on its maiden voyage. This machine has approximately 60,000 lbs (267 kN) of push/pull and about 13,600 Nm of rotary torque. The machine, complete with the mud mixing system and recycling plant, was set up within the sewage plant. Given the tight tolerances for the pilot bore, McAllister Bros. decided to employ its new DigiTrak Eclipse locating system. This system is capable of measuring pitch in 1/10 percent increments, which was exactly the kind of accuracy needed.

The crew included Barry McAllister, who served as project manager for McAllister Bros. and also tracked the tool; Brad Boote, who operated the drill; and Pat Sheehan, one of McAllister's foremen, who represented Byzac Contractors.

Due to the stringent requirements of the pilot bore, a wireline guidance system was kept on standby at the site.

Pilot Boring

After securing a clearance from the landowner for walkover locating, pilot boring commenced. Of particular concern were the difficult ground conditions and the ability to control the head. When installing gravity sewers using

HDD, patience is the order of the day, and Boote, while getting used to a new machine, was able to very closely follow the drill plan.

The pitch information from the Eclipse transmitter was very reliable and fast. As the tool progressed, the obstacles above ground slowed this progress. The bore path would take them under a number of sheds, filled with various types of farming machinery. At this point, the pilot bore was at about 39.4-ft (12-m) depth. Nonetheless, pitch and roll signal was consistently reliable, and between the sheds, the front locate point provided Boote with confirmation that the bore was still on line. According to Boote, who was using the Eclipse system for the very first time, it was extremely easy to use, accurate and reliable even at a 39.4-ft (12-m) depth.

Once the pilot had progressed past the machinery sheds, the tool could be tracked continuously. Due to a gradual change in topography, which resulted in decreased depths, the ease of use of the Eclipse became apparent. As the planned path had been staked, except for the area surrounding the wall, which was off limits, determining line was very simple. The front locate point was easily found and the pitch information ensured that the grade was being maintained.

The pilot bore hit the intended target within the 12-in. (300-mm) line and grade tolerance, which, according to one of Byzacs' engineers, was very impressive considering the ground conditions and the length of the bore.

The Importance of Mud

As a side note, the importance of proper mud mixture cannot be over emphasized. Mud serves a multitude of purposes, one of which is to decrease friction, which not only allows more efficient machine torque usage but also creates a cooler environment for transmitters.

Due to the extensive dewatering circumstances at the exit side, the drill pipe sat in the hole for three days before pre-reaming began. Nonetheless, the torque required for the reaming process was surprisingly low, a testament to the mud mixture doing its job.

During any directional drilling project, there are five primary factors at work, the drill plan, the ground conditions, the drill rig, the mud mixture and the locating system. A careful evaluation of all of the above is critical to the success of the project and the more complex the project, the more important the above analysis becomes. The Kilsyth sewer project is an excellent example of how, with proper planning and equipment selection, even the most challenging projects can be completed successfully.

Barry McAllister and Brad Boote consider their next move to finish the project.

Finally, some 891 ft (270 m) later, the product comes home.

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