DIGGING DEEP TO COMPLETE NZ'S TOUGHEST HDD PROJECT

Rust & fatigue

A strategic watermain laid through dense bush up in the hills behind Auckland City had become a big problem for its owner. The old cast Iron watermain laid during WWII mostly mimicked the topography and was left exposed in many locations. Ground movement and erosion led to high maintenance issues and poor performance and a new pipeline was desperately needed

The proposed pipeline would be a straight line over one kilometre long and would be a siphon. The pipeline would have a height difference between ends of 40m and a low point 80m below the high point. It would cross under five streams, pass beneath bluffs by up to 40m deep, intersect conglomerate gravel beds and pass through sections of faulted ground. Meanwhile above ground the route was covered in dense bush with no vehicle access.

HDD was the proposed construction method. On completion the pipeline would offer a smooth straight alignment with increased capacity, improved efficiency and security in this untamed, unstable environment.

After a lengthy pre award period the project was awarded to Universal Underground Ltd. UUL proposed a non standard pipe size to give the client the exact diameter it wanted. This provided the most cost effective tender price.

Going bush With 8 metres visibility

▲Universal HDD Rig (100 ton pull back)

A Universal 200 x 240 Drill Rig and a mud motor with a Digitrak magnetic steering tool was chosen for the pilot hole drilling. The pilot drilling progressed on plan from the low end unit passing under the third stream near the 600m mark. At this location drilling fluid started exiting in a wide area in and around the stream in this gully. This gully was later named "Tunnel Gully" due to its close proximity to the tunnel used for the cast iron pipeline. Progressing the pilot hole under this gully led to the drill string becoming jammed. A driller's worst nightmare.

A heli drill rig was dropped into the bush and two ground investigation bore holes undertaken revealing substantially weak beds of barely cemented sands. It was suspected that sand falling into the pilot hole had packing behind the mud motor caused the tool to jam. New down hole equipment was ordered from overseas and UUL went about salvaging as much of the drill string from the hole as possible. A company from the oil industry was employed to feed an explosive charge down the drill string and 350m of rods were eventually recovered. Grout injection was undertaken in tunnel gully to help stabilise the formation.

▲Heli rig used for grout injection and additional ground investigation

▲All equipment lifted in and out of tunnel gully by helichopter

When the new equipment arrived it was straight back into drilling the pilot hole. Pilot drilling progressed 900m before a hard turn upwards under the last stream was required to meet the exit target 140m from the end and 40m vertical climb. However the mud motor failed to achieve the targeted vertical gains and the exit location was going to be over shot.

A small drill rig was established on site and used to drill down the steep embankment and intersect the existing pilot hole 8 metres below the stream and 40 metres below the small drill rig platform. The difficulty of this manoeuvre was no small feat. The small drill had to land its drill string into a 260mm diameter pilot hole like landing an aeroplane. Simply drilling straight to the existing pilot hole would not work. The steep and densely vegetated embankment and depth of the drilling made the operation very tricky. The drill string had to achieve a depth of 18 metres before arriving under the stream on line and grade. Every longitudinal metre had a different grade to achieve as it bent around to eventually match the target grade. A survey and computer bore plan was undertaken for the shot and recalculated every 15m.

Although the interception drilling over shot the stream, the extremely skilled drill operator "Tim Mitchell" successfully landed the drill string into the existing pilot hole creating a 1km path through the job for the first time.

1038m of tunnel requiring 1.2 million rotations

▲Ditchwitch 30/20 drill rig utilised to drill down to and intercept the existing pilot hole

In order to keep the tunnel fluid pressure to a minimum, the drilling rig was relocated to the top platform. Fluid recycling was undertaken at the bottom site, before the cleaned fluid was pumped back to the drill rig at the top site and reused in the tunnel.

The pilot hole needed to be enlarged to just over 1 meter diameter and this was achieved with three sizing reamers.

As the reaming progressed, the 850Ø, 15m long pipes were delivered to the Water filter station where they were welded into two 520 metre strings. Each pipe string weighted almost 100 tons and manoeuvring the pipe up a windy metal track proved very difficult. To add to the difficulties there was a requirement to keep the track open to small vehicles in case emergency works were required at the dam head.

During reaming, the reamer came to a slow but complete stop under "Tunnel Gully". (coincidently this is right beside the jammed pilot tools). This did not make allot of sense at the time and many things were tried to get the reamer progressing but without success. The only remaining option was to trip the tool 500m out and see what the problem was. The tri-cone reamer was found completely packed with sand however was otherwise in good condition. The reamer was cleaned and tripped back to the face, this operation taking one week. 50m further on and the reamer again came to stop. Again the reamer was tripped back out the hole and found to be packed with sand. It was cleaned out and pulled back up to the face costing another week. Fingers crossed reaming once again proceeded. After clearing tunnel gully the reamer progressed without event.

The ground conditions under Tunnel Gully presented an unacceptable risk to the project so on completion of the reaming six swabbing passes under the gulley were undertaken.

▲1050mm diameter tunnel requiring three reamer passes

▲Butt fusion welding of the 850 OD, SDR12 PE pipe.

200 ton of pipe into one long tunnel

The drill rigwas now moved to the bottom platform in order to pull the pipe downhill. A 1.5 ton nose cone was fitted to the pipe and connected to the drill string. One bulldozer winch applying 40 tons of push on a double purchase was set up at the top platform and two winch trucks assisted the pipe as it snaked down the track. When the pulling/pushing forces started to climb water ballast was systematically added into the pipe to manage the pipe/tunnel roof friction. The water volume was carefully monitored because if the pipe was over filled, the water would become dead weight in the empty part of the tunnel. The pipe was installed over a five day period, this included stopping at the midway point to weld the two pipe strings together. Pleasingly the force required to install the 200 ton pipe didn't exceed half of the drills capability.

This was an extremely tough project in a sensitive ecological environment. Millions of litres of fluid were used to remove nearly a thousand cubic metres of tunnel material and protecting the environment was always a high priority. This project required a high level of skill and commitment and all though this project proved extremly tough, srill, perseverance & determination won in the end.

▲Towing head being connected to drill string