19th Australasian Tunnelling Conference – Acosta-Martínez, Stewart and Hudson-Smith (Eds.)
 ISBN 978-0-85825-002-4

Gold Coast light rail: An example of capitalising on underground space to deliver above ground infrastructure

A. Edney & D. Keating
Systra ANZ, Brisbane, QLD, Australia

A. Browne
John Holland, Gold Coast, QLD, Australia

ABSTRACT: Gold Coast Light Rail Stage 3 (Stage 3) project involves the construction of a new light rail route that runs from Broadbeach South Station, along the Gold Coast Highway, to Burleigh Heads. The 7km extension includes new dual-track light rail, eight new light rail stations, new light rail-bus connections, and new and upgraded intersections. The project alignment is located through a high-density urban area of the Gold Coast, and is surrounded by commercial and residential properties, with the Gold Coast Highway (GC Hwy) providing a major north-south transport corridor for the city.

Extensive stakeholder constraints on the project were a key driver of the construction methodology. Trenchless technologies have been adopted for a number of service relocations and new service installations across the project to minimise impacts (and reduce risks) on stakeholders, including road users, businesses, residents, and asset owners (for numerous utilities above and below ground).

1 INTRODUCTION

John Holland Pty Ltd has been awarded the Design & Construct Contract for the Gold Coast Light Rail Stage 3A (Stage 3). This major infrastructure project involves a 7km southern extension of the Gold Coast Light Rail system from Broadbeach South station to Burleigh Heads (Figure 1). The alignment is in a high-density urban area of the Gold Coast, surrounded by commercial and residential properties, with the Gold Coast Highway providing a major north-south transport corridor for the city.

Figure 1. Artist impression of Burleigh Heads bus terminal and light rail station

Key features of the project include:
- 7km of new dual-track in the centre of the GC Hwy
- Eight new light rail stations and five additional light rail vehicles (LRV's)
- Upgrade and expansion of the existing depot and stabling facilities
- New light rail-bus connections at Burleigh Heads and Miami
- Intersection upgrades including Intelligent Transport Systems
- New signalised pedestrian crossings and upgraded pedestrian and cycle facilities

As part of the project, significant Public Utility Plant (PUP) relocations are required to accommodate the new infrastructure. A key component was the relocation of all the overhead electrical mains that crossed the GC Hwy due to their interaction with the new overhead electrical wires that supply power to the tramway.

In total there were 38 HDD crossings completed, with diameters ranging from 100mm to 700mm. Approximately 11km of electrical conduits, and 260m of gas enveloper were installed.

2 KEY CONSTRAINTS/CONSIDERATIONS

2.1 *Geology – geotechnical assessments undertaken*

Most of the excavation on the Stage 3 project was within a loose sand environment, with some pockets of weathered rock and denser clays. Due to the loose sand geology, special consideration needs to be given to hole stability during the HDD process. If the hole cannot be supported by drilling fluids during boring, the risk of settlement within the roadway increases. This was a major design factor of the bore profile when drilling in sand.

2.2 *High density urban environment*

The Stage 3 alignment runs along one of the busiest arterial roads on the Gold Coast. Located along the alignment there are businesses, schools, low rise and medium rise residential, tourist accommodation and commercial dwellings. This presented many challenges.

2.3 *Interaction with ageing infrastructure*

One of the advantages of HDD as opposed to open trench construction, is the available depth that can be achieved. This is critical in addressing the interaction of new construction with existing infrastructure. There are two main challenges encountered during the construction of Stage 3:
- Asbestos pipes
- Existing buildings/hard structures (60+ year old properties)

2.4 *Asbestos pipes interaction with ageing infrastructure*

The key risk with asbestos concrete pipes was the stability and susceptibility to cracking once the ground surrounding it is excavated.

2.5 *Existing structures*

Working alongside existing infrastructure poses challenges in any environment. This is compounded when the infrastructure is greater than 60 years old. Certain structures were built to different building codes with limited as built records. In many cases doing investigation works had the potential to damage their structural integrity.

3 OPTIONEERING/CONSTRUCTABILITY

Three main options explored for electrical relocations were:
- Open trench conduit installation

— Microtunneling
— HDD

Table 1 provides a summary, exploring the advantages and disadvantages of each option.

Table 1. Comparison of different excavation options

	Open trench	Microtunneling	HDD
Description	Conventional services installation methodology using excavators and shoring to support open trenches for placement of new service conduits	Using a suitable Microtunnel Boring Machine (MTBM) to undertake the excavation.	Using a suitable HDD rig to excavate and install conduits within drilled excavation
Advantages	- Availability of suitable contractors on Stage 3 - No settlement risk under GC Hwy - Easily scalable – can increase the number of work fronts to reduce overall programme for works if required - No enveloper requirements	- Very low settlement risk – bore is continuously supported. Ideal for GC Hwy crossings - Laser guided installation accuracy - Minimal site footprint – small entry and exit pit	- Accurate installation - Some flexibility in alignment for ensuring clearances to existing infrastructure. Ideal for below ground services found on Stage 3 - No enveloper requirements - Cost effective compared to other methods explored on Stage 3
Disadvantages	- Costly traffic management requirements for GC Hwy closures - Invasive, more disruption to stakeholders - More time consuming to complete each crossing - Increased interface with existing services - potential for service strikes. Large number of below ground services located on Stage 3 alignment	- Costly site/equipment establishment - Site footprint required for shafts at entry and exit locations - Limited scope to adjust alignment along the length of the installation - Longer mobilisation and demobilisation time compared to HDD - Jacking pipe materials more expensive compared to other methods	- Specialised equipment/contractors - Large adjacent site laydown areas required during conduit string out works - Potential settlement risks - Inclement weather runoff into entry and exit pit locations

4 OUTCOMES AND APPLICATION OF HDD ON STAGE 3

HDD was chosen for 85% of the GC Hwy electrical relocations. Open trench installation was adopted for the remaining 15% of the crossings. The driving factor in adopting HDD over other methodologies was its program and constructability benefits. For its program benefits, HDD is a much quicker alternative to other methodologies. Its constructability benefits were being able to accurately intersect tight underground working envelopes between other below ground infrastructure. Below is a summary of the numbers relating to the HDD crossings.
— 32 Energex crossings: >11Km of electrical conduit under the GC Hwy
— 6 APA crossings: 260m of gas enveloper under GC Hwy
— 18 land access agreements into private property to facilitate the HDD works

4.1 *Typical construction methodology*

A typical HDD construction methodology was adopted for use on the project. This involved a 650mm diameter tunnel bore which allowed 9 x 140mm electrical conduits to be installed. To facilitate this an entry and exit pit were excavated. This enabled the drill rods to start boring at a location that was sub surface. This was key in managing drilling fluid levels in crossings where there were significant head level differences.

4.2 *Typical construction methodology*

During the design phase of each HDD, adjustments to the bore geometry were undertaken. This ensured the extent of the bore profile beneath the GC Hwy was always supported with drilling fluid. This included when the exit pit was required to be drained for tooling changes.

During tooling changes, the section of the bore within the existing project worksite was supported only by the drilling fluid filter cake. There was a greater risk of potential observed settlement through this zone. Where clay ground conditions are present the ground provides more short-term self-supporting properties, compared to the sandier conditions. As such, settlements are expected to be lower. It is recommended that construction traffic movements over the bore alignment are limited during these short tooling changes, when the bore beneath the service road/construction site will not be fully supported.

4.3 *Settlement monitoring*

At each location extensive monitoring was undertaken. Monitoring points were strategically placed at critical locations. These were predominantly within the GC Hwy road reserve and located where the HDD profile crosses critical infrastructure (i.e. water or sewer mains). These monitoring points were observed and monitoring reports produced from the data. Trigger levels were designed for each location. Various asset owners and stakeholders were involved in this process.

4.4 *HDD works within a dense urban environment*

A typical setup required a 10m x 2m footprint for the drill rig, along with 2m x 2m footprints for entry/exit pits. These working areas did not always fit within the available public road reserve that are typically used for construction. In certain instances, setups were required in private properties such as within front yards or schools. In some cases, emergency exits for buildings were blocked. This required adjustments to emergency plans and routes within their property.

4.5 *Mitigation of working in close proximity to structures*

4.5.1 *Working under/close to pipework*

Some of the bores went over or under existing pipework. In some cases, this required replacing the existing pipework if it was constructed out of asbestos or if the existing pipework was built out of a more durable material, supporting it during HDD construction. A complex cross section of the service crossing of the HDD alignment is shown in figure 2 & 3.

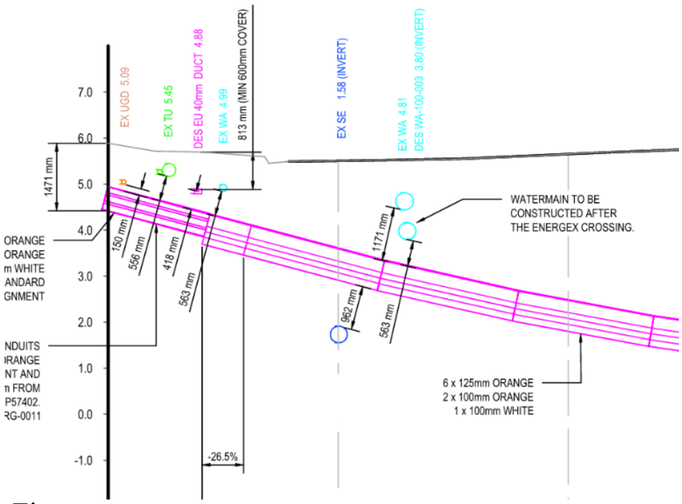

Figure 2. Cross section of service crossings

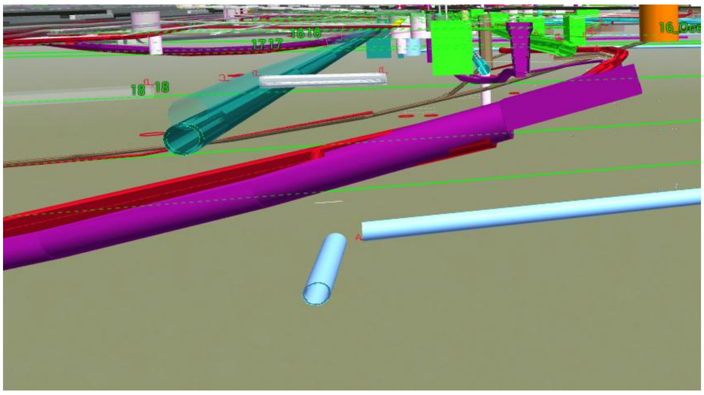

Figure 3. 3D model of service crossings

4.5.2 Working in close proximity to existing above ground infrastructure

Various construction locations required the removal or the support of existing infrastructure. These structures typically involved boundary walls, garden areas and fences. In certain cases, works involved complex temporary works, external stakeholder approvals and reinstatement works.

5 CONCLUSION

HDD was not feasible in all locations with respect to the underground electrical relocation scopes. The main reason was certain sites did not have the required space to mobilise and setup the HDD rig and associated plant. During the design and constructability process, HDD was the favoured starting point due to the benefits and advantages detailed above.

One of the key considerations going forward and applying it to future urban projects would be to explore the option of doing the HDD works as part of the project early works. This approach would minimise the interaction with adjacent project works. Another key element in the successful delivery of HDD on Stage 3 project was the use of specialised contractors and designers. They brought extensive HDD experience which was beneficial in terms of developing constructable solutions within the constraints of the project.