Appendix 8

Engineering Report (Cossil & Webley)

LOCAL STRUCTURE PLAN ENGINEERING REPORT LOT 9004 TARONGA PLACE, EGLINTON

August 2021

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CONTENTS

1. EXECUTIVE SUMMARY

This report has been prepared by Cossill & Webley Pty Ltd (CW) for the Lot 9004 Taronga Place, Eglinton Central Precinct Local Structure Plan. It summarises the results of a review of the civil engineering aspects which have informed and support the delivery of the structure plan amendment for a proposal to residential and are related to the future servicing of the developed land.

This report provides details on each major infrastructure type and a servicing strategy for the implementation required for the residential development of the "Central" precinct of the LSP area. The Central Precinct is the portion of the Site which is bound by the proposed Yanchep Rail line to the west and the future Mitchell Freeway extension to the east. The level of detail provided is consistent with the requirements of a Local Structure Plan, and acknowledges further detailed work will be required at the time of subdivision.

The engineering review has covered siteworks, roadworks, stormwater drainage, sewerage, water supply and utility services.

The investigation has found the land is capable of supporting development in accordance with the proposed Local Structure Plan with a logical progressive extension of infrastructure and base capacity..

The existing ground conditions and past land uses will not limit the proposed urban development.

Road access to the development will be provided either via either an extension of the existing Scotthorn Drive, Hara Street and Buchanan Ave.

Sewer infrastructure for the southern portion of the Site will be provided via a connection to the existing sewer reticulation south of the Site within the Shorehaven Development which grades to the existing Alkimos Waste Water Pump Station No 59, which ultimately pumps sewage to the Alkimos Waste Water Treatment Plant south-west of the site. A Waste Water Pumping Station (Alkimos WWPS "P") will be required to be constructed to service the northern portion of the Central cell.

Water supply can be provided via an extension of the existing water reticulation network to the south.

Initial power supply can be provided by extension of the existing high voltage HV underground infrastructure in Marmion Avenue from the Romeo Road (Yanchep) Zoned Substation. It is likely within approximately ten years (subject to individual dwelling loads and rate of development) the capacity of the Romeo Road (Yanchep) Zoned Substation will be exceeded and a new substation will be required to be constructed in Eglinton as planned through the Alkimos Eglinton District Structure Plan.

Telecommunications and gas are available from existing services to the south. We understand there is capacity in the existing network to service the proposed development.

The investigations and preparation of this report is largely based on preliminary advice from the various service authorities. The information is current as of June 2021, and is subject to change as development proceeds in the Perth north-west corridor resulting in the extension of service infrastructure and the creation of new capacity.

2. INTRODUCTION

This report has been prepared by Cossill & Webley Pty Ltd (CW) for the Lot 9004 Taronga Place, Eglinton Central Precinct Local Structure Plan. It summarises the results of a review of the civil engineering aspects which have informed and support the delivery of the structure plan amendment and are related to the future servicing of the developed land.

The preparation of the Lot 9004 Taronga Place, Eglinton Central Precinct Local Structure Plan has been carried out by a team of consultants, led by CLE on behalf of Urban Quarter and covers an area of approximately 35 hectares which could yield approximately 480 residential allotments.

The Lot 9004 LSP area is identified by the red boundary presented below in Figure 1

Figure 1

Figure 1 - Site Plan (MNG Maps 2021)

3. SITE DESCRIPTION

The Lot 9004 LSP is situated within the City of Wanneroo, approximately 45 kilometres north of the Perth city centre. The Site is bound by the existing Shorehaven Development to the south, the future Mitchell Freeway road reserve to the north & east, and Rail Reserve and future & existing residential development to the west. Approximately 60% of the Site is covered with vegetation, which mostly consisting of shrubs and low lying bushes. The balance of the land is cleared of large vegetation, which was completed in 2008 under a clearing permit, and more recently by the PTA for the stockpiling of material generated from the Yanchep Rail Extension Project. *Figure 2* below refers.

Figure 2 – Aerial Photography (MNG Maps 2021)

3.1 Acid Sulphate Soils

A desk top review of the Department of Environment and Conservation's ASS Risk Map for the North Metropolitan Region for potential acid sulphate soils (ASS) indicates the site has no known risk of ASS occurring within 3m of the natural soil surface (or deeper).

3.2 Existing Topography

The Site comprises undulating dunes ranging in elevation from a peak of 45m AHD at the southern end of the western boundary where it abuts the Yanchep Rail Reserve, to a low of approximately 22m AHD on the north-eastern boundary with the Future Mitchell Freeway reserve as presented in *Figure 3* below.

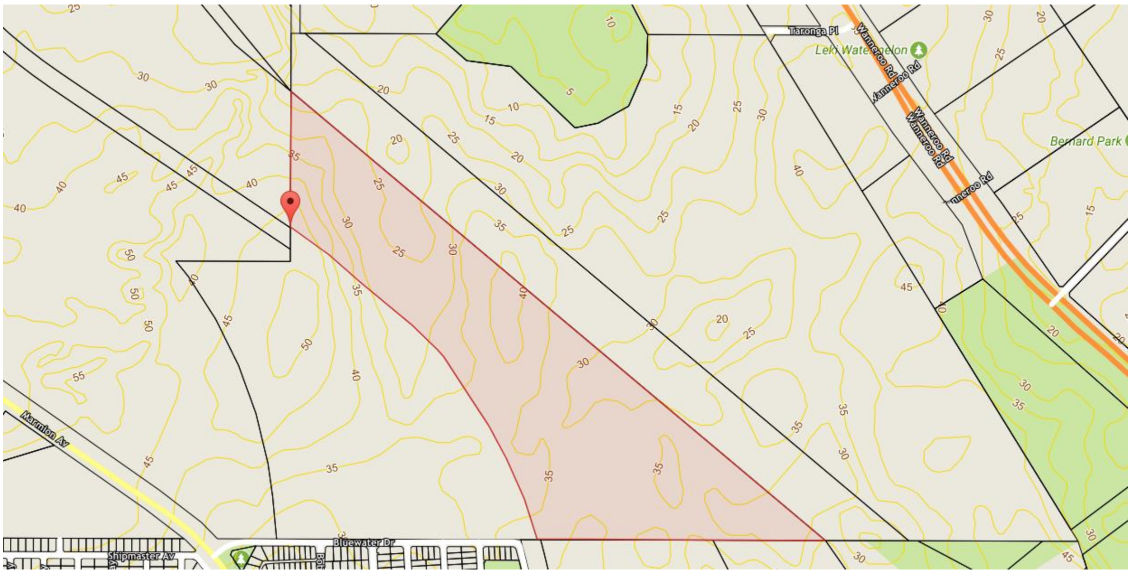


Figure 3 – Site Contours (MNG Maps, 2018)

Other significant topographical features include a ridge running in a north-south direction at the mid point of the Site at approximately 40m AHD, and a low point of 26.0m AHD in the south-eastern corner of the site.

3.3 Geology and Landform

The Geological Survey of Western Australia Perth Metropolitan Region Soils Maps indicates the majority of the Site is generally characterised by Sand derived from Tamala Limestone (S_7) and Tamala Limestone as presented in *Figure 4* below.

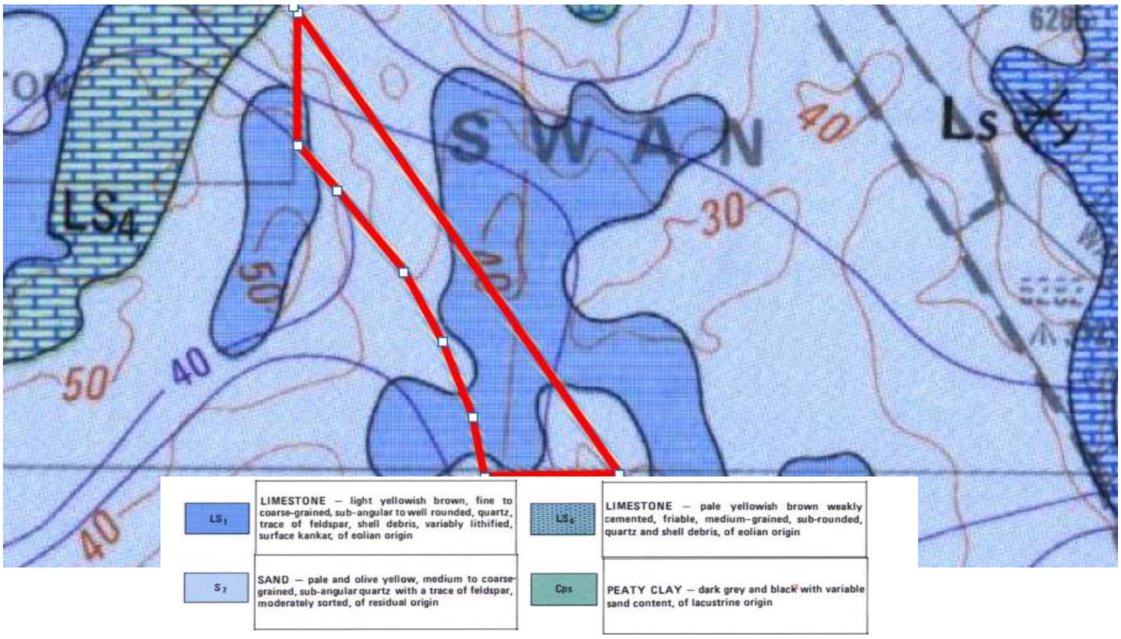


Figure 4 - Geotechnical Information (Geological Survey of WA)

Both of these soil types are well suited to urbanisation, and are generally very permeable, allowing for the on-site disposal of runoff from newly created roads and lots.

Although a detailed geotechnical investigation has not been completed across the whole Site, it is anticipated that some surface rock will be present, predominately as cemented limestone along ridge lines within the existing dunes.

We anticipate, based on the above geological conditions, the majority of the Site will be Class A under the Australian Standard AS2870 – Residential Slabs and Footings code.

Based on our experience on similar projects within the area, the Site is well suited for future urban development in terms of topography and soils and will provide a suitable foundation for roads, infrastructure and residential development.

3.4 Karstic Formations

Karstic ground formations are known to occur in the limestone rock in a north-south band along the eastern side of Wanneroo Road.

A visual inspection of the Site was undertaken by the Western Australian Speleological Group (WASG) in 2007 identifying surface karst, confirming the likely presence of subterranean voids.

Subsequently, CMW Geosciences were engaged to review the likely impact of karst formations on future development, and confirmed the eastern portion is likely to be within a recognised zone of potential karst features. *Figure 5* below presents the likely inferred western edge of a potential karst risk zone within the DSP amendment area. CMW Geosciences has previously prepared a Preliminary Karst Landform Management Methodology report which describes the manner in which any karst identified within the Site can be treated, which is presented in Appendix B for information, and is discussed further in Section 4.2 below.

Figure 5: Inferred Potential Karst Risk Zone (CMW Geosciences)

CMW has also undertaken a more detailed geotechnical investigation within the potential Karst risk zone in the DSP area. This investigation did not encounter any specific Kaarst formations within the identified Kaarst risk zone in the DSP area, however maintained the recommendations of the previous report for dealing with the potential risk of Kaarst through managed engineering outcomes. This investigation is included in Appendix C of this report.

3.5 Unexploded Ordnance

The Department of Fire and Emergency Services (DFES) Unexploded Ordinance (UXO) has confirmed the Site lies within the north eastern portion of the former WWII Eglinton Training area where there may still be a slight risk from UXO contamination.

There are no known previous UXO assessments or survey over the Site, so whilst the risk from UXO is minimal, a limited UXO assessment survey (Field Validation Search @ 10% Coverage) is likely to be required as a condition of Subdivision to confirm or discount whether explosive filled munitions have impacted the Site. If no evidence is found, then the area can be regarded as at very low risk and no further assessment or survey will be required by DFES at or during any future planned subdivision works. The awarded Site Contractor will be required to consider UXO in their Safety Management Plans.

3.6 Groundwater

The Annual Average Maximum Groundwater Level (AAMGL) varies from approximately RL 3.0m AHD on the western boundary to just over RL 4.0m AHD at the eastern boundary according to the Department of Water's Perth Groundwater Map. Given the natural ground levels across the Site provide at least 20 metres separation to groundwater, it is not anticipated that the proposed development will impact on groundwater adversely, nor will groundwater affect the design of the proposed development.

4. SITEWORKS & EARTHWORKS

4.1 Typical Earthwork Strategy

Siteworks for urban development typically comprise the clearing of existing vegetation and, where necessary, the earthworking of existing ground to facilitate future development.

In Perth it is often the case that the extent of siteworks is dictated by the density and nature of development and by the finished ground shape required for building houses. Increased densities and decreasing lot sizes has led to a current trend for the development areas to be fully earthworked to create level lots which are terraced utilising inter-allotment retaining walls.

This approach provides a number of positive outcomes:

- It reduces house building costs.
- It rationalises retaining wall layouts and designs consistent with Local Authority specifications.
- It enables lots to be terraced up natural slopes to maintain elevation and views.

The Lot 9004 Central LSP has been designed in accordance with the following objectives:

- To allow for the retention of some existing vegetation and topography within the designated open space.
- To allow for roads and development sites to be graded to best follow the existing topography and to best reflect the coastal landscape.

A preliminary earthworks design has been prepared for the Lot 9004 Central DSP area and is presented in Appendix A in Drawing 5826-00-SK18. This design generally allows for the retention of vegetation within the northern and central public open space, tying into existing and proposed levels of the Shorehaven Development to the South, maintaining a level at or above (average of 3 metres separation) to the proposed rail design levels to the west and future freeway design levels to the east to optimise noise considerations.

4.2 Mitigation of Karst Risk

Historically, subterranean void failure usually occurs in karst risk zones when there is a concentration of water in one location above a subterranean void. If water is concentrated near a void, this can cause soil to migrate into the void leading to a collapse at the surface.

Advice from CMW Geosciences confirms the risk of karst collapse is negligible within the Karst Risk zone in areas of deep fill (greater than 10 metres), as the placement and compaction of sand layers will disperse any water discharged through soakwells or detention basins and provide a bridge of compacted ground that will attenuate surface settlements due to the potential loss of ground/collapse at depth. CMW advised that subterranean void collapses are most likely in areas where the existing natural thickness of sand overlying limestone is in the order of 5 metres.

In these areas, CMW's preliminary assessment recommends the following treatment to mitigate the karst risk:

- Any exposed fissures should be over-excavated and backfilled in accordance with the geotechnical engineer's requirements;
- During cut-to-fill earthworks, areas in excess of 10m fill require no further mitigation, as the material above potential karst features will form an adequate raft to spread loads and dissipate stormwater infiltration;
- Areas of fill up to 3m thick should include a 2m thick crushed limestone layer to act as a stiffened raft/geogrid layer in addition to attenuating concentrated stormwater inflows from the surface;
- Areas of fill less than 3m thick or areas of cut should be over-excavated to 3m below finished design levels, and backfilled to incorporate a 2m thick crushed limestone layer as described above; and

5. DRAINAGE STRATEGY

5.1 Integrated Urban Water Management

The Lot 9004 LSP Taronga Place, Eglinton Local Water Management Strategy (LWMS) has been prepared by Cossill & Webley as a separate document. This provides a basis for ongoing development to ensure that appropriate allowances are made for total water management including the minimisation of scheme water use and the maximisation of recharge of stormwater runoff.

Stormwater drainage management is proposed by adopting a Water Sensitive Urban Design (WSUD) approach. Objectives of WSUD include:

- Detention of stormwater rather than rapid conveyance;
- Use of stormwater to conserve potable water;
- Use of vegetation for filtering purposes; and
- Water efficient landscaping.

For the Lot 9004 LSP, the main WSUD practices which should be incorporated into the ongoing implementation of the site as follows:

1.5.1 Stormwater Management

Stormwater recharge of the shallow aquifer should be maximised through the adoption of ‘Best Management Practices’, which promote the dispersion and infiltration of runoff. These include the use of porous paving for roads and car parks, the diversion of runoff into road medians and road-side swales, drainage soakwells to infiltrate runoff from buildings and private open space areas and the disposal of road runoff into infiltration basins within areas of public open space POS.

1.5.2 Water Quality Management

The maximisation of the quality of recharge water through the adoption of “Best Management Practices”, which promote the disposal of runoff via water pollution control facilities (including vegetated swales and basins, detention storage and gross pollutant traps) and the implementation of non-structural source controls (including urban design, street sweeping, community education, low fertiliser landscaping regimes, etc.).

5.2 Stormwater Collection and Management

The Lot 9004 LSP land consists of free draining sand with substantial cover to the prevailing groundwater. Overall, therefore, the land is highly suited to the implementation of the WSUD management practices outlined above.

It is anticipated that runoff within future residential allotments will be contained on-site. Stormwater disposal will be via soakwells or other infiltration facilities which form part of the building and private open space development.

Drainage from public roads and lanes can be managed in a number of ways depending on the nature of the adjacent land uses, the extent of traffic and pedestrians and the objectives for drainage management.

For the development of the Lot 9004 LSP it is proposed to adopt the WSUD approach advocated by the Department of Water (DoW) to provide an improved environmental outcome. DOW’s target of infiltrating storms up to 1 in 1 year ARI at source (dispersed throughout the drainage catchments) may however be difficult to economically achieve throughout the catchment where there are highly urbanised roads. Conservatively, CW has assumed some of the 1:1 year event will be conveyed to the local low points within public open space. Stormwater runoff will soak efficiently into the ground and return a significant proportion of the runoff to the unconfined aquifer.

Infiltration could also be via swales within or adjacent to road reserves, via gully pits with permeable bases, slotted drainage pipes, porous road pavements or under road storages subject to the City of Wanneroo approval.

Runoff from storms up to 1 in 5 years ARI would be conveyed via an underground pipe system to low point infiltration basins consistent with the requirements of the City of Wanneroo.

Roads and POS will be designed to cater for the surface overflow for more severe storms with building pads constructed at least 300 millimetres above the 1 in 100 year ARI flood or storage level at any location.

The dispersion of stormwater disposal will maximise the area of recharge down through the soil profile to the shallow aquifer, thereby, maximising the potential for nutrient stripping and water quality improvements.

The LWMS details the stormwater drainage plan for the Lot 9004 LSP. The plan shows the approximate location of stormwater disposal sites based on a preliminary assessment of finished development levels.

The LWMS also includes tabulated data for areas required at each low point infiltration swale to cater for the 1 in 1 year, 1 in 5 year and 1 in 100 year ARI storms.

6. Roadworks & Footpaths

6.1 Traffic and Transportation

An assessment of the traffic and transport planning for the Lot 9004 Central LSP area has been undertaken by GTA.

The results of this assessment include a recommended hierarchy for the roads within the Lot 9004 Central LSP amendment and the future subdivision development together with recommendations for public transport services, pedestrian and cyclist facilities.

In all cases the engineering review has taken account of the recommendations outlined in the GTA Consultant report and they will be incorporated into future detailed subdivision planning and design.

6.2 Regional Roads

Main Roads WA has extended the Mitchell Freeway to Hester Avenue, Clarkson. The State and Federal Governments have allocated money within their budget to further extend the Mitchell Freeway to Romeo Road, with works commenced and programmed to be complete by mid 2023. There is currently no program for the extension of the Freeway beyond this. It is unlikely, without Government intervention, this state infrastructure will be extended to the Site in the foreseeable future.

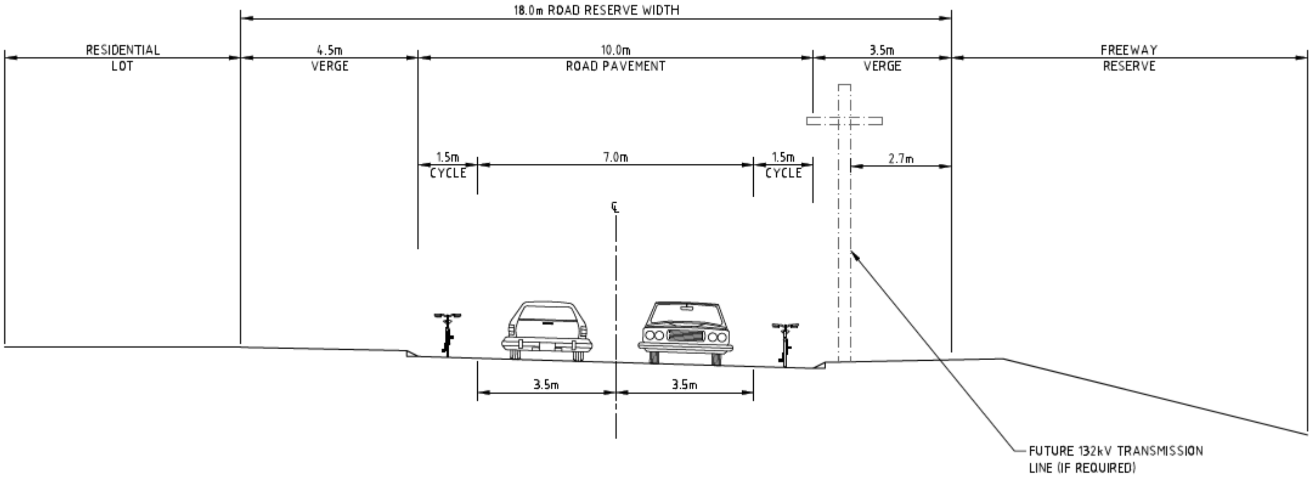
On this basis, Marmion Avenue will be required to provide a regional road access function for the development until the freeway is further extended in the longer term and access to the freeway via Alkimos Drive (to the south) will become the second region linkage. Therefore in the interim, Marmion Avenue provides the only direct primary distributor function in the absence of the freeway.

Road access to Marmion Ave would currently occur via connection to Scotthorn Drive to the South, and then connection to Bluewater Drive, which connects onto Marmion Avenue west of the Site. The intersection of Bluewater Drive with Marmion Ave has been constructed as a full movement T-intersection, consistent with the City of Wanneroo’s Marmion Ave Access Policy.

6.3 Development Roads

The Lot 9004 Central LSP area comprises a network of development roads including a Neighbourhood Connector running south-east to north-west, and local access roads and laneways. The Lot 9004 Central LSP proposes an urban design hierarchy for the development roads, which is an expansion of the traffic hierarchy, to better reflect the intended functions of the roads and their corresponding streetscape characters.

In all cases the road cross-sections will be designed to cater for utility services, on standard verge alignments, street trees, parking embayments where appropriate, off-street and on-street cycling lanes in accordance with the overall pedestrian and cycling network. An example of the typical Neighbourhood Connector Cross Section proposed in GTA’s traffic report for the LSP is shown below.



INDICATIVE NEIGHBOURHOOD CONNECTOR ROAD RESERVE CROSS SECTION
1:100

The engineering design of roads will be carried out to comply with the Department of Planning's Liveable Neighbourhoods recommendations for design speeds and sight distances and with the requirements of the City of Wanneroo. Roadworks will generally consist of kerbed and asphalted pavements.

In particular, it is proposed that the development roads be designed to suit lower vehicle operating speeds to ensure safer operation and improved pedestrian movement. The lower speeds on local roads will also support initiatives to adopt smaller street truncations and associated intersection curve radii where suitable.

6.4 Footpaths

Footpaths will be provided in accordance with *Liveable Neighbourhoods* and the City of Wanneroo standards and will consist of one path in every road, and shared paths in Neighbourhood Connector and other roads as outlined in the GTA Consultants Traffic Report accompanying the LSP.

6.5 Public Transport

The Alkimos Eglinton District Structure Plan Report (AE DSP) makes provision for the extension of the Perth Transit Authority's (PTA) northern corridor metropolitan railway network to the east of Marmion Ave, with a station under construction at the Eglinton District Centre north of Eglinton Drive.

The existing rail network extends to the Butler railway station, with funding and plans in place to extend the rail further north to Yanchep, with construction works for the rail line well underway and proposed to be complete in 2022.

There is currently a bus service utilising Marmion Avenue to connect Yanchep – Two Rocks to destinations south of the site. The PTA is likely to develop additional bus services as the broader Eglinton area is occupied by residents and demand justifies the service.

The Alkimos Eglinton DSP makes provision for a 'Secondary Transit System' (STS) which is likely to comprise a high frequency bus service.

6.6 Noise Attenuation

The Western boundary of the LSP area abuts the future northern corridor metropolitan railway extension, and the eastern boundary the future Mitchell Freeway extension. Hence in accordance with State Planning Policy 5.4 “Noise Considerations”, Lloyd George has been engaged to prepare an Acoustic Report to assess the requirements for the site for transportation noise from the railway and freeway

Some noise mitigation strategies will be required for these interfaces and could consist of noise bunds, noise walls, facade protection and/or in-house acoustic mitigation techniques.

7. WASTEWATER

The Site falls within the Water Corporation’s Alkimos Sewer District as shown in *Figure 6* below.

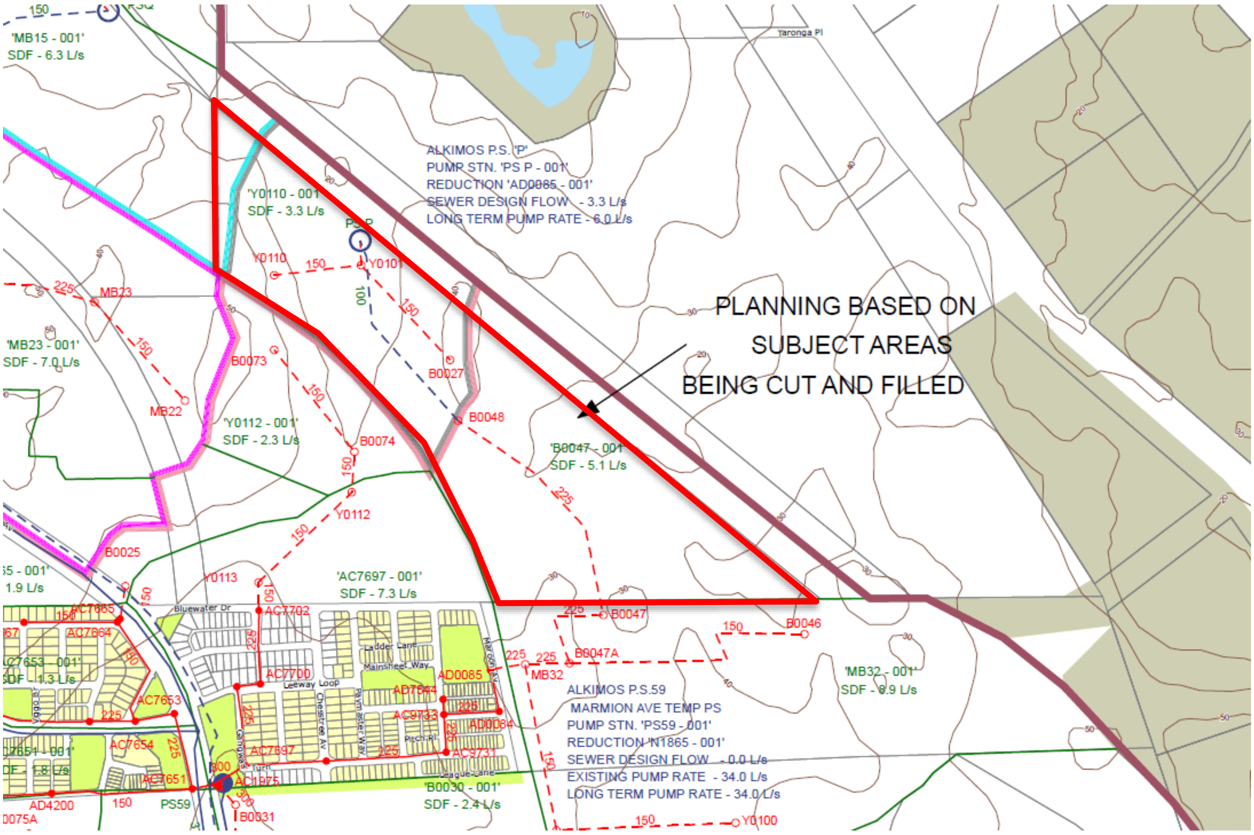


Figure 6 - Conceptual Long Term Wastewater Scheme Planning (Water Corporation, 2015)

Water Corporation planning indicates that the southern portion of the Site is to be serviced by a connection to the existing sewer reticulation network located within the Shorehaven Development south of the Site. Sewage flows gravitate via this connection to the existing Alkimos WWPS (Waste Water Pumping Station) No 59, which ultimately discharges to the Alkimos Wastewater Treatment Plant (WWTP) located south west of the Site.

The planning indicates that a small WWPS (Alkimos WWPS “P”) will be required to be constructed to service the northern portion of the Central cell. This WWPS is proposed to discharge into the proposed sewer reticulation network within the southern portion of the site.

There is a small section in the North-western extremity of the Site which Water Corporation planning suggests will fall within the catchment of proposed Alkimos WWPS Q further to the north. Based on the preliminary design levels prepared over the central cell, it is anticipated that all of the northern portion of the Site will be able to be accommodated in WWPS P.

8. WATER RETICULATION

8.1 Water Resources

The Alkimos Eglinton area has been identified by the Water Corporation as a future ground water source for potable water supply. Provision has been made for some time for the development of this ground water resource.

Water supply to the area will ultimately be via a series of groundwater bores, located throughout the Alkimos Eglinton area, linked by collector water mains to a central treatment plant and reservoir.

8.2 Initial Water Supply Network

The Water Corporation has constructed a DN700 trunk water main in Marmion Avenue to Shorehaven Boulevard. On this basis, it is anticipated there will be no off-site water headwork infrastructure required to service the development.

It is anticipated the initial stages of the proposed development can be supplied with water from an extension of the existing DN250 water main in the Shorehaven development to the south of the Site. Areas of urban development will be serviced by a network of distribution water mains, from the reservoir, connected to the reticulation network.

8.3 Ultimate Water Supply Network

The Water Corporation has long term distribution network planning that includes the construction of a DN900 water main in Romeo Road (Alkimos City Centre), linking a DN1200 main in east Romeo Road with the other trunk distribution mains south into Butler.

The Water Corporation has reviewed the latest date the trunk water main in Romeo Road is required. The timing for this main had previously been estimated to coincide with approximately 8,000 to 10,000 allotments in the Alkimos Eglinton area, when the security of supply and capacity of the single Marmion Avenue trunk main would require augmentation.

The balance of the trunk water main network will be progressively expanded by the Water Corporation directly or through Developer Constructed Works with negotiated pre-funding arrangements. The Water Corporation is currently planning to fund capital works associated with the orderly development of urban areas without prefunding by the developers.

9. GAS SUPPLY

The existing high pressure gas network has recently been extended in Marmion Ave from Butler to Yanchep by Atco Gas. Atco has confirmed this main will have capacity for development in the Butler, Jindalee, Alkimos and Eglinton areas. Therefore we do not anticipate there will be any gas supply capacity issues.

Gas reticulation will be supplied and funded by Atco Gas and installed by the Contractor concurrent with other service installation.

10. ELECTRICAL POWER SUPPLY

10.1 Power Network

There is an existing 22kV high voltage underground power cable in Marmion Ave (eastern verge) which extends power from the existing "Yanchep Zone Substation" on Romeo Road south of Lot 6 to Yanchep. This same feed is currently used to supply Shorehaven, Amberton, Alkimos, Jindowee, Allara, Capricorn and Yanchep Golf Estate. This existing cable is approaching its capacity based on existing developments utilising this cable.

There is also an existing overhead power cable that runs from the Yanchep zone substation north in Wanneroo Road and west on Pipidinny Road as depicted below in Figure 7.

The Yanchep Zone Substation is located at the intersection of Romeo Road and Wanneroo Road and is a two transformer outdoor 132/22 kV zone substation with provision for a third transformer to be installed to service additional load in the surrounding areas, including the Alkimos Eglinton area.

It is expected that the new Eglinton zone substation (currently shown south of Eglinton Drive and between the Railway reserve and the Mitchell Freeway reserve but a site has not been acquired by Western Power) will need to be established to accommodate the growth of new and existing loads in the region. Due to factors such as changing energy use, more efficient appliances, and emerging technologies, the timing of the substation is uncertain and is expected to be beyond the next 10 years.

It is anticipated that the local network will be incrementally extended from the 22kV HV feed in Marmion Avenue into the Site. Western Power will also require interconnections to be made between the 22kV feeders on Wanneroo Road with the feeder on Marmion Ave which will entail a future freeway crossing.

A series of HV feeds, switch stations and transformers will be required throughout Lot 6 to meet individual site requirements.

Additional reinforcement of the power network by the developer of Lot 6 may be required, however, further details of the proposed load within the development are required to confirm this.

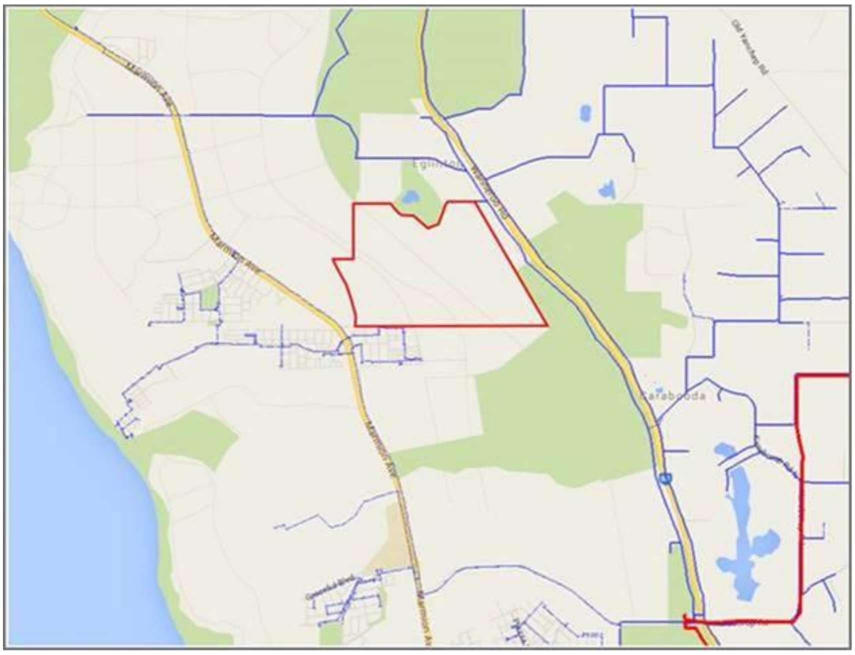


Figure 7 – Existing Overhead Powerlines (Western Power)

10.2 Future 132kV HV Feeder

Western Power has historically advised that an easement will be required to allow for the construction of a potential future 132kV overhead transmission line along the western boundary of the freeway east of the Site. The anticipated width of the power line corridor is 24 metres, however this may vary if Western Power confirm the detailed design requirements prior to construction of the subdivision.

The requirement for the HV feeder was incorporated into the Alkimos Eglinton District Structure Plan when it was first approved in 2008. At the time Western Power requested provision be made for the feeder based on anticipated future demand in the northern corridor, with a new zone substation also proposed to be constructed in the AEDSP area.

The timing and potential need for the provision of this infrastructure has varied since the AEDSP was prepared. Following the implementation of the AEDSP, several Local Structure Plans have been prepared, and development has commenced on several fronts within the DSP area. Discussions were held with Western Power in 2011 on some earlier LSP's prepared for the area where the 132kV feeder was proposed to run through. At this point in time Western Power advised that the feeder would likely be required within the next 10 years. The feeder has not yet been required nor constructed in this timeframe.

In more recent discussions with Western Power they have indicated that the planning surrounding the need for the transmission line was based on anticipated load requirements from the time that the AEDSP was prepared in 2008. In the past decade there has been considerable take up and implementation of a number of energy conserving measures at both residential and commercial level, including but not limited to the take-up of solar power. This has seen the load demands placed on Western Power's network vary significantly such that Western Power has no program for the installation of this line, and anticipate it could be some 15 to 20 years away at this stage, or potentially not required. Further network modelling would be required to confirm this.

The proponent for the LSP has had significant discussions with Western Power regarding the 132kV feeder which are ongoing. As part of these discussions the proponent has indicated a strong preference for the infrastructure to be relocated from outside of future residential area, and has suggested some alternative alignments for Western Power's consideration.

Western Power has advised that they would be amenable to an alternative alignment of the transmission line outside of the LSP area, taking it away from residential land use areas. Alternative alignments of the transmission line could include utilising the Mitchell Freeway alignment, or placing the line east of the freeway, including utilising the existing Wanneroo Road reserve, which is the current alignment of the existing feeder south of Romeo Road.

Given the uncertainty regarding the timing of the need and construction of the HV feeder, the potential utilisation of the Mitchell Freeway reserve is a logical potential alternative for the future delivery of the HV feeder. There is uncertainty regarding the status of the corridor from a planning perspective, and locating the asset in the freeway reserve would ensure the feeder is readily accessible. Placing key power infrastructure within the freeway reserve would achieve a more consolidated urban form and adopt a more "all-of-government" approach promoted by the Sub-Regional Planning Framework which considers social and economic aspects of the relationship between future urban land and infrastructure. The Sub Regional Planning Framework has an expectation that servicing agencies will work collaboratively to maximise future shared infrastructure corridors and sites. Utilising the existing freeway reserve for the future delivery of the 132kV feeder provides an excellent opportunity in this regard if managed appropriately, and moves the infrastructure out of the less compatible residential area.

If an alternative alignment could not be found we note that there is still the option of placing the HV feeder underground when it is needed in future. This would not only align with the objectives of the AEDSP which requires that all utility services be installed underground to maximise amenity, but also provides greater protection to the feeders. It is noted that it is mandatory for all new power infrastructure delivered at development level to be provided underground for this reason. If the new feeder were to be provided underground, at least through proposed residential areas, this would eliminate the need for an easement.

Given the potential timing, and indeed need for the delivery of this infrastructure in the future still remains uncertain some time after it was first included in the AEDSP, further investigation into the provision for the feeder is warranted.

The proposed structure plan has sufficient flexibility to accommodate a range of possible outcomes, subject to the finalisation of discussions with Western Power.

11. TELECOMMUNICATIONS

The Site is within NBN's fixed line footprint, and hence can be serviced with optic fibre under their roll-out scheme for greenfield developments.

Under the Federal Government's Telecommunications in New Developments Policy, developers are responsible for contributing to the cost of delivering the NBN™ network in new developments. This includes contributing to part of the costs of the build (civils and any backhaul required) as well as a $600 per lot deployment change.

Through the NBN, the ownership issues of delivering the wholesale fibre to the home system have been transferred to the Government with more than 100 retail service providers offering services over the network. There are other private telecommunication providers that can also offer similar services.

Developers of new residential estates have the option to pay NBN or an alternative service provider for provision of a high speed broadband network. In either case the developer will install pit and pipe infrastructure that can accommodate a future high speed broadband network.

The current design practice for road reserves, pavement and verge provisions will make adequate allowance for services including broadband in accordance with the agreed Utilities Service Providers handbook. There will be some local land requirements for equipment sites, similar to current provisions which will be accommodated at detailed subdivision stage.

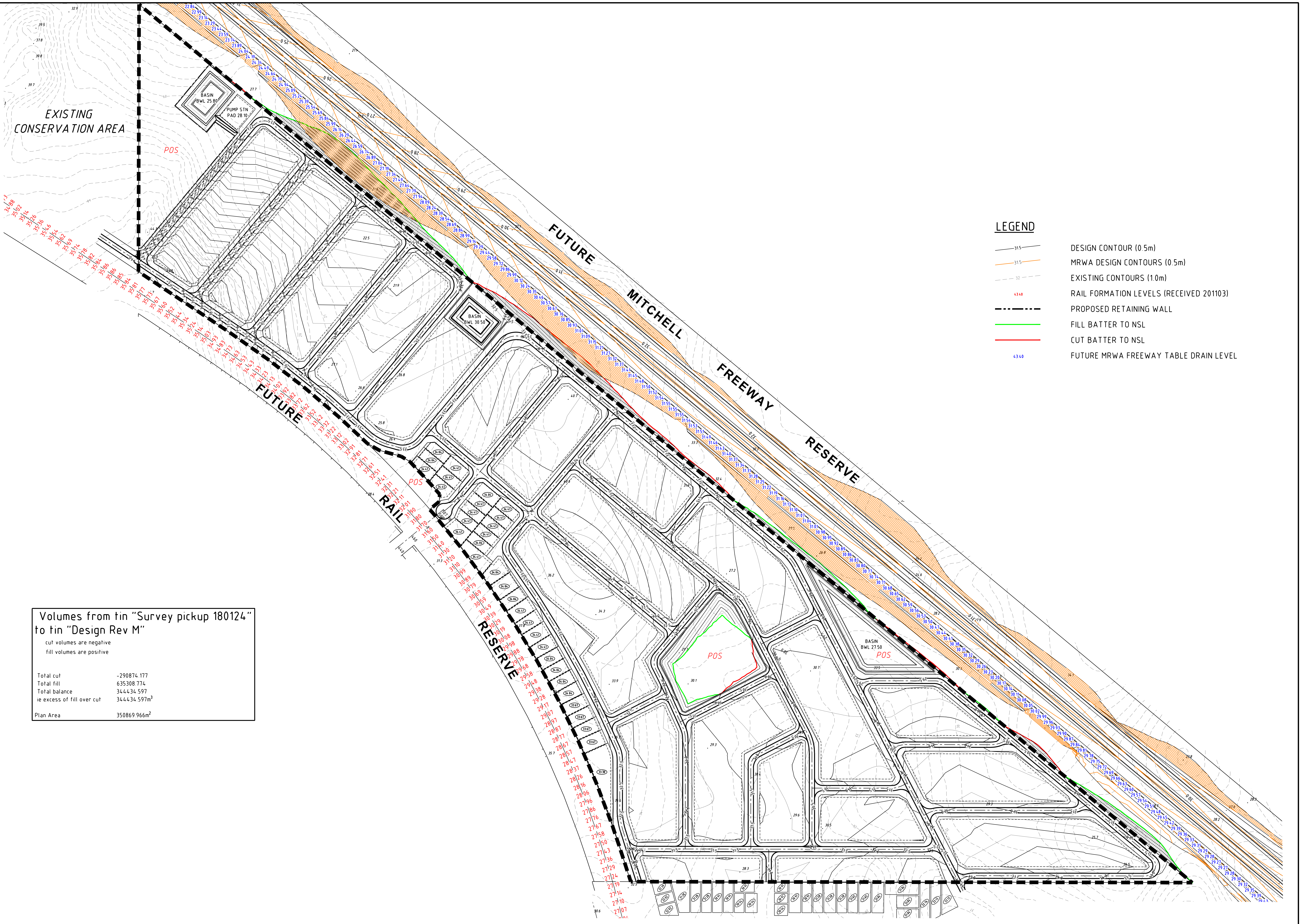
12. CONCLUSION

The Lot 9004 Taronga Place Eglinton Central LSP area has planned strategies for water and sewerage supply and other public utility services are available or can be extended to service the proposed urban area.

There are no engineering impediments to the development, though co-ordination and co-operation with the relevant Service Authorities will be required as the development progresses.

Appendix A

Drawings



LEGEND

31.5	DESIGN CONTOUR (0.5m)
31.5	MRWA DESIGN CONTOURS (0.5m)
32	EXISTING CONTOURS (1.0m)
43.40	RAIL FORMATION LEVELS (RECEIVED 201103)
▬ ▪ ▪ ▬	PROPOSED RETAINING WALL
🟩	FILL BATTER TO NSL
🟥	CUT BATTER TO NSL
43.40	FUTURE MRWA FREEWAY TABLE DRAIN LEVEL

Volumes from tin "Survey pickup 180124" to tin "Design Rev M"

cut volumes are negative

fill volumes are positive

Total cut	-290874.177
Total fill	635308.774
Total balance	344434.597
ie excess of fill over cut	344434.597m^3
Plan Area	350869.966m^2

1:2000 0 40 80 120

REV	DATE	DRN	CKD	APP	AMENDMENT
A	26.07.21	MS			ISSUED FOR COMMENT

N

This plan shall only be printed in full colour. If this plan is printed in black and white or grey scale it is not to be used for construction

This plan is not to be used for construction unless issued as revision 0 or higher

Cossill & Webley
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CLIENT
URBAN QUARTER

APPROVED 26.07.21

DESIGNED DPM

SCALE 1:2000

PROJECT LOT 19 TARONGA PLACE, EGLINTON

TITLE
CENTRAL CELL NSL AND
PRELIM DESIGN CONTOURS

WAPC No.

DRAWING No. 5826-CP-SK18

REVISION A

ORIGINAL SIZE A1

P:\5826 Lot 6 Spiers\5826-CP (Central Precinct)\Acad\Sketches\5826-CP-SK18.dwg, 20/07/2021 12:03:14 AM, marcos, Digital Signing PDF.pc3, 1:1, - CW Reference

Appendix B

CMW Preliminary Karst Landform Management Methodology

9 August 2016

LOT 19 TARONGA PLACE, CARABOODA

PRELIMINARY KARST LANDFORM MANAGEMENT METHODOLOGY

Urban Quarter WA
Ref. PER2016-0480AB Rev1

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Figures

Appendices

1 INTRODUCTION

This report outlines recommended development strategies to manage potential risks associated with karst landforms within Lot 19 Taronga Place, Carabooda. The work was commissioned by Mr Jason Wallis of Urban Quarter WA (Urban Quarter) on 2 August 2016.

It is understood that the 150ha site is proposed for urban development comprising a mixture of residential and commercial subdivision. The strategies in this report are aimed at providing an outline of tasks that will be performed as a precursor to development of a Karst Landform Management Strategy. It also outlines engineering design elements that can be adopted during construction of the subdivision in order to limit the risks associated with karst landforms to a level no greater than those acceptable for other developments on the Swan Coastal Plain. These strategies will be confirmed following detailed site investigations.

2 AVAILABLE INFORMATION

CMW has previously undertaken a desktop and reconnaissance study at the site. Information available for the previous study comprised the following:

- 1:50,000 scale geological mapping (Yanchep Sheet - 2034 IV) produced by the Geological Survey of Western Australia (GSWA) including 1:100,000 scale geomorphology mapping.
- A Western Australian Speleolgical Group field survey report dated 12 December 2007.
- Various project drawings including vegetation mapping, concept plan, existing ground surface contours and proposed finished levels.
- Observations of the site during a reconnaissance drive/walk over.

The available information has been incorporated with our experience of karst areas on the Swan Coastal Plain to allow consideration of development strategies with respect to potential karst ground conditions.

It is noted that the author has extensive knowledge and experience of urban development within areas of potential karst landform risk within the Swan Coastal Plain and has published technical papers on the subject including Mather P.J, 2013. Geotechnical Aspects of Karst within the Swan Coastal Plain, Western Australia. Australian Geomechanics, Vol. 48 No. 2, a copy of which is attached to this letter for reference.

3 DISCUSSION

The eastern part of the site is within a recognised zone of potential karst features as outlined by previous GSWA mapping. The location of the western extent of this potential karst zone has been slightly modified on the basis of local geomorphology observed during site reconnaissance. The inferred western extent of the potential karst zone is shown on the attached Figure 1. Within the areas west of the line shown in Figure 1, the risks associated with potential karst are considered to be very low and therefore can be managed by normal geotechnical investigation and design processes.

The hazards associated with development within areas of karst cannot be eliminated but geotechnical design strategies can be adopted to reduce and manage the risks to acceptable levels. The extent of remediation and modification of foundations to reduce the risk of karst is dependent on the severity of karst phenomenon and sensitivity of proposed development. By international standards karst occurrence on the Swan Coastal Plain is at the lower end of severity. Some internationally accepted design strategies to manage karst risk, in general order of increasing severity, are as follows:

- Drainage control
- Grout/fill open fissures
- Stiffen footings (rafts or ground beams)
- Geogrids
- Driven piles to rock head
- Cap grouting at rock head
- Groundwater abstraction control
- Bored piles to rock head
- Combinations of the above techniques

The key trigger mechanisms for karst collapse on the Swan Coastal Plain is concentrated storm water runoff. The control and management of concentrated surface water discharge away from structures is considered to be the key factor in limiting the potential risks and impacts of sinkhole formation. Design recommendations for previous developments within karst areas of CoW (e.g. Lots 201 and 202 Breakwater Drive) have included the provision for domestic soak wells to be located no less than 10m from footings and road drainage basins to include a 30m development exclusion zone around their perimeter. Additional strategies that have been adopted locally include the stiffening of residential footings.

Other strategies that could be adopted to adequately reduce the risks in susceptible areas include large scale earthworks involving over excavation and replacement with a 2m thick layer of crushed limestone covered with a 1m thick surface layer of free draining sand. The 2m thick layer of compacted crushed limestone will act as a stiffened raft/geogrid layer in addition to attenuating concentrated stormwater inflows from the surface.

4 PROPOSED MEASURES TO MANAGE KARST

Subject to further, more detailed investigations, we believe the following measures or combination of measures would reduce the karst risk associated with this site to equal or less than that associated with other developments on the Swan Coastal Plain:

- Any exposed fissures should be over-excavated and backfilled in accordance with the geotechnical engineer’s requirements;
- During cut-to-fill earthworks, areas in excess of 10m fill require no further mitigation, as the material above potential karst features will form an adequate raft to spread loads and dissipate stormwater infiltration;
- Areas of fill up to 3m thick should include a 2m thick crushed limestone layer as described in Section 3 above;
- Areas of fill less than 3m thick or areas of cut should be over-excavated to 3m below finished design levels, and backfilled to incorporate a 2m thick crushed limestone layer as described in Section 3 above; and,
- Further geotechnical investigations such as EFCPT probes should be undertaken upon completion to assess the presence of karst features at an inter-allotment scale prior to development

Some variation to the excavation and replacement option outlined above is likely to be appropriate based on the anticipated range of ground conditions. For example, in areas of cut which expose a limestone surface that is free of any indication of voids, the required thickness of crushed limestone could be reduced to 1m. Other variations such as backfilling exposed voids and heavy compaction of loose sand zones prior to fill placement may be appropriate depending on the local ground conditions and thickness of fill prosed within specific areas.

Prior to development, further geotechnical site investigation will be required to assess the extent of potential karst risk within the site and refine appropriate remediation options for urban development. It is likely that the results of detailed investigation will identify significant areas of very low risk within the potential karst risk zone, allowing remedial options to be targeted towards areas of higher potential risk.

It is anticipated that the adoption of a range of engineering design strategies as outlined above, targeted across the site on the basis of further detailed geotechnical investigation will result in the reduction of risks associated with karst to a level compatible with development outside of karst areas.

5 SUMMARY

Lot 19 Taronga Place, Carabooda is located partially across an area of the Swan Coastal Plain which has the potential for karst landforms. By international standards the karst risk is relatively low but will need to be addressed as part of the urban residential and commercial development proposed at the site. A range of engineering strategies are available to limit the risks associated with karst. Information obtained from further detailed geotechnical site investigation across the site can be incorporated into an assessment of suitable risk reduction strategies. Appropriate strategies will vary across the site depending on the severity of the ground conditions and proposed land uses. The aim of the design modifications will be to limit the risks associated with development at this site to those applicable to other developments on the Swan Coastal Plain that are outside the zone of potential karst.

6 CLOSURE

We trust this report meets your current project requirements. If you have any queries or require additional information please contact the undersigned.

For and on behalf of
CMW Geosciences Pty Ltd

Philip Mather
Principal

Distribution:	1 copy to Urban Quarter WA (electronic)	Original held by CMW Geosciences Pty Ltd

Figures

LEGEND:

▬ ▬ ▬ ▬ INFERRED WESTERN EDGE OF POTENTIAL KARST RISK ZONE

— — SITE BOUNDARY

NOTES:

1. BASE PLAN ADAPTED FROM: ROBERTS DAY CONCEPT PLAN, DRAWING NO. RD1 016, REV A, DATED 29.06.15

0 75 150 225 300 375 m

1:7500

CMW Geosciences Pty Ltd
Chapman Morton Woodward

CLIENT:	URBAN QUARTER WA	DRAWN: DE	PROJECT: PER2016-0780
PROJECT:	LOT 19 TARONGA PLACE, CARABOODA, WA	CHECKED: PJM	FIGURE: 01
		REVISION: 0	SCALE: 1:7500
TITLE:	PRELIMINARY KARST LANDFORM MANAGEMENT	DATE: 09/08/2016	SHEET: A3 L

Appendix A

Geotechnical Aspects of Karst within the Swan Coastal Plain, Western Australia.

Geotechnical Aspects of Karst within the Swan Coastal Plain, Western Australia

Philip Mather

Coffey Geotechnics Pty Ltd – Perth, Western Australia

ABSTRACT

The occurrence of karst limestone conditions within Western Australia is not well recognised within the general community but can be of major engineering significance for developments that are impacted by it. The presence and engineering significance of karstic limestone on the Swan Coastal Plain has been recorded by local Engineering Geologists with the first officially published recognition presented in the 1:50,000 scale Environmental and Engineering Geology Series Yanchep Sheet in 1986. The Geological Survey of Western Australia (GSWA) mapping highlighted a significant, well defined zone of karst phenomena within Tamala Limestone extending from Joondalup to Two Rocks. Increasing pressure from urban development along Perth's northern corridor lead to several "near miss" incidents which precipitated the incorporation of a requirement for all development applications within the City of Wanneroo to include consideration of the potential for karst.

To date, the published literature relating to karst on the Swan Coastal Plain has been limited to geological descriptions of the phenomena. Although the potential karst hazard is now widely recognised within the geotechnical community there has been very little published information relating to geotechnical design considerations and strategies for urban development within areas affected by karstic limestone relating specifically to the Swan Coastal Plain. Considerable work has been completed over the past decade relating to the identification of karstic ground conditions and geotechnical design strategies to manage potential risks. In addition, the existence of additional areas of karstic limestone has been identified within the City of Cockburn and City of Mandurah.

1 INTRODUCTION

The occurrence of karst limestone conditions within Swan Coastal Plain of Western Australia is restricted to specific localised areas that, for many years, were of limited interest to those other than speleologists and caving enthusiasts. The coincidence of low lying swales with shallow groundwater and interdunal lakes resulted in karstic zones often being amongst areas of market garden and semi rural land uses. The pressure from urban expansion on the coastal plain has increasingly resulted in urban development encroaching into these previously less intensely developed areas. Although often not well recognised by property developers and the general public, the presence of karstic limestone can be of major engineering significance for developments that are impacted by it.

The occurrence of karst limestone was recognized by local Engineering Geologists such as Ray Gordon (2003) who was involved with local authorities to study and assess the potential risks/liabilities associated with this geohazard. These studies were greatly assisted by the work of local Speleologists such as Lex Bastion. Later work by Bob Gozzard with the resources of the Geological Survey of Western Australia (GSWA) resulted in the first official engineering recognition of the occurrence of karst within the Swan Coastal Plain presented on the 1:50,000 scale Environmental and Engineering Geology Series Yanchep Sheet published by the GSWA in 1982. The initial mapping highlighted a significant, well defined zone of karst phenomena within Tamala Limestone extending from Joondalup to Two Rocks.

Increasing pressure from urban development along Perth's northern corridor resulted in several sink hole occurrences associated with residential developments. In recognition of this potential hazard the City of Wanneroo has developed a draft of new requirements for all development applications to include consideration of the potential for karst.

Geotechnical investigations over the last decade have identified additional areas within the Swan Coastal Plain where karstic conditions occur and has focussed consideration of geotechnical design strategies to limit risks for developments.

The purpose of this paper is to provide an introduction to the geotechnical aspects of karst as follows:

- Case studies of karst collapse that have occurred within the Swan Coastal Plain that demonstrate the main features of sink holes and common trigger events.
- Updated geology map outlining two additional zones of significant karst, within the southern part of the Swan Coastal Plain and Mandurah that have never been published.

- Current geological/geomorphological hypotheses relating to the formation of karst environments within the Swan Coastal Plain.
- The effectiveness of various geotechnical investigation techniques available to identify the presence and significance of karstic limestone.
- Geotechnical design issues for development within areas of karst and potential options/solutions to limit associated risks.

2 CASE STUDIES

2.1 REGATTA DRIVE, EDGEWATER

Several sinkhole collapse features occurred within a road drainage basin following a significant rainfall event (Figure 1). The road basin is located within an urban residential development characterised by sand overlying pinnacled limestone at shallow depth. The collapses occurred in the mid 1990's and were investigated by Ray Gordon (2003) who has presented a schematic cross section of the site. No damage to the adjacent houses was reported. Remediation work included replacement of some sections of the boundary fences and precautionary underpinning of the foundations on one of the neighbouring residences.

Figure 1 – Road drainage basin at Regatta Drive, Edgewater showing sinkholes on left and at rear.

2.2 EMERALD DRIVE, CARABOODA

Sinkhole collapse occurred within a road runoff discharge area following winter rainfall soon after construction for a Special Rural subdivision (Figure 2). The collapse occurred in the early 2000's within an area of sand overlying shallow limestone between areas of scattered limestone outcrop. There was no damage reported, however, this example further highlights the potential risks associated with large volumes of concentrated runoff from road drainage basins triggering collapse events.

Figure 2 - Sinkhole within road drainage discharge area, Emerald Drive, Carabooda.

2.3 SWIMMING POOL COLLAPSE, WOODVALE

Undermining of a swimming pool due to sinkhole collapse occurred in March 2007 (Figure 3). The contribution of uncontrolled water discharge from a range of possible sources adjacent to the pool was suspected of contributing to progressive development of the sinkhole over many years which finally resulted in sudden collapse of the pool. Limited investigation at the site indicated a ground profile comprising sand overlying limestone at a depth of approximately 6 m.

Figure 3 - Woodvale swimming pool with bracing following collapse

2.4 BREAKWATER DRIVE, TWO ROCKS

Sinkhole collapse about 4 m wide and 3 m to 4 m deep occurred in December 2007 located approximately 12 m from the edge of a residence within a Special Rural subdivision (Figures 4a and 4b). The site is underlain by a 3 m to 6 m thick surface sand layer overlying limestone. A combination of CPT and air core borehole investigation identified loose ground conditions within and overlying the limestone and the original building envelope was relocated away from an area within the Lot where numerous small voids had been encountered within the limestone at depths of between 11 m and 15 m.

The collapse occurred at the location of a bore water discharge point within the Lot. The bore discharge arrangement comprised of two child paddle pools. One pool received water from the bore which overflowed into the second pool. The bore was run for about an hour approximately 3 times per week. Water from the pools was bucketed out and distributed around the yard.

This arrangement had been in place for over a year prior to the collapse occurring. On the day of the collapse the owner had turned on the bore pump and then been distracted at the front of the property for between half to one hour with the pump running and pools overflowing. On his return to collect water from the pools they had “disappeared” down the sinkhole. One pool was completely gone and the corner of the second pool was visible at the base of the sinkhole.

Figure 4a – Breakwater Drive, Two Rocks. View of sinkhole from balcony of residence

Figure 4b - Breakwater Drive, Two Rocks. Close up view of sinkhole. Note tension crack around edge of failure zone

Common features with the case studies presented above include a surface layer of sand approximately 5 m thick and, more significantly, the action of concentrated surface water discharge providing a trigger mechanism for sudden sinkhole collapse.

3 GEOLOGY OF THE SWAN COASTAL PLAIN

A broad outline of the geology of the Swan Coastal Plain as presented by Davidson 1995 is shown in Figure 5. The existing 1:50,000 Geological Survey of Western Australia, Yanchep Sheet (Gozzard, 1982) outlines a zone referred to as “Interbarrier depression with prominent karst phenomena” extending between Joondalup and Two Rocks. This zone has been well documented and is well recognised throughout the geotechnical community and includes tourist features and cave systems within the Yanchep National Park.

Field experience from geotechnical site investigations and studies over the years has revealed additional, similar zones with karstic limestone conditions in the Lake Coogee – Munster area and further south along the western margins of the Peel Inlet at Dawesville and Mandurah. Additional isolated occurrences have also been encountered at Gwelup and Warwick. More localised occurrences are likely within similar geomorphological environments that have been revealed in the past and /or will be encountered in the future.

Figure 6 outlines a useful cross section presented by Grimes (2006) based on work by Lex Bastian in the Yanchep area. Meteoric water and groundwater undersaturated in $CaCO_3$ migrating west out of the Bassendean Sand dissolves the carbonate matrix to form “slots” within the limestone at the groundwater interface which enlarge over time through roof collapse to form caves.

Karst on the Swan Coastal Plain is considered to fit into Grimes’s category of syngenetic karst which has formed within a soft, porous, soluble sediment at the same time as it has been cemented into a rock. This is quite different to the classical “hardrock” karst which involves dissolution of carbonate along pre-existing joints and fractures within a previously formed limestone or dolomite rock mass.

On the Swan Coastal Plain there appears to be a spatial association with low lying wetland areas where the water table is exposed at the surface and significant deposits of organic rich and peaty soils occur. The association with these wetlands introduces a possible influence of organic acids from peat deposits reducing the pH of groundwater and enhancing/”reinvigorating” the dissolution of carbonates within the adjacent or underlying limestone.

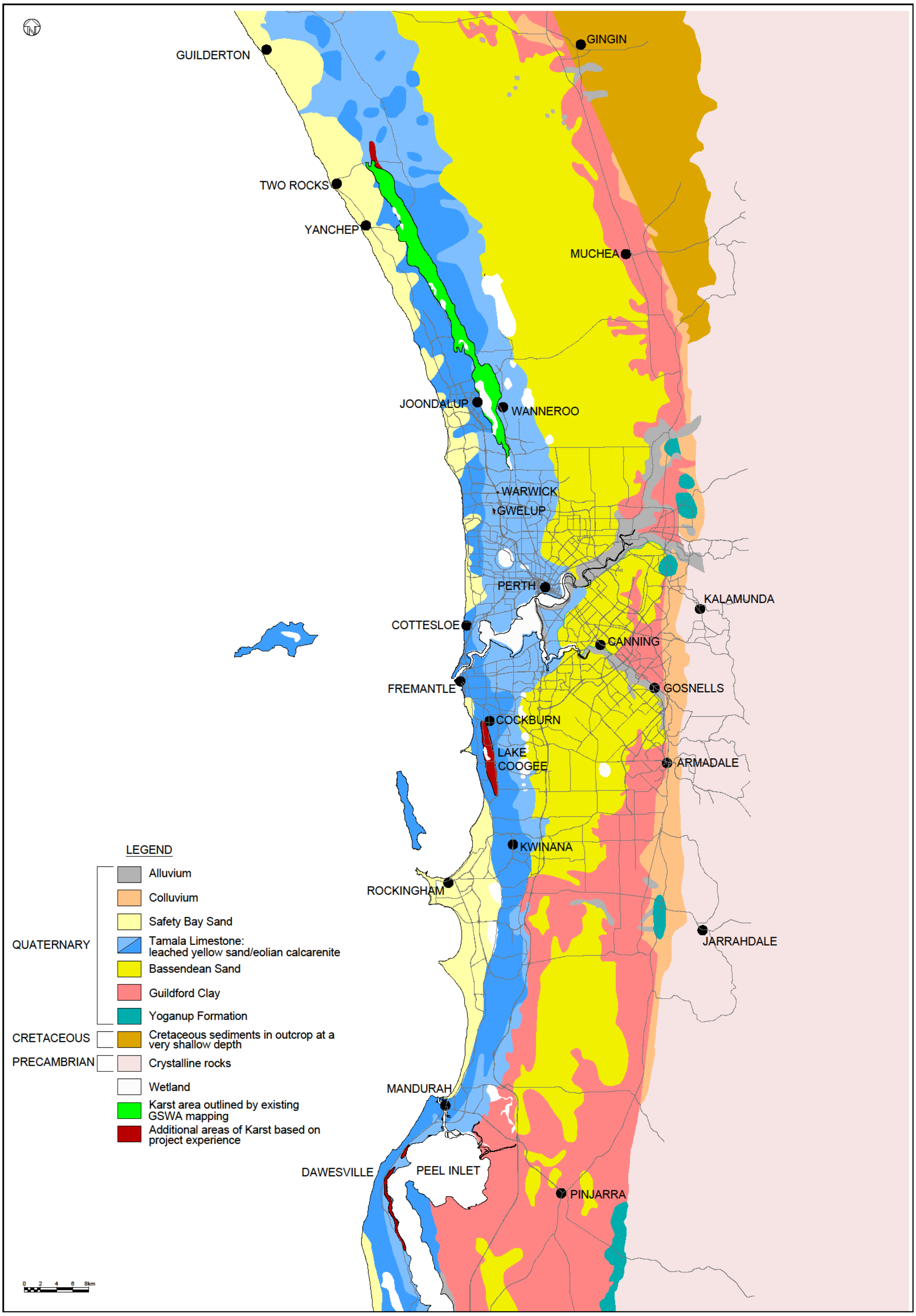

Figure 5 – Geology of the Swan Coastal Plain (from Davidson 1995)

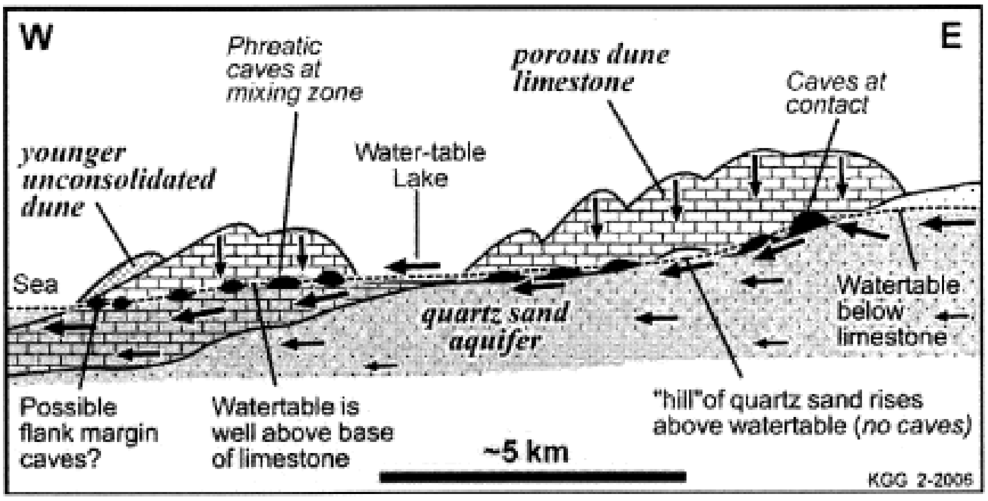

Figure 6 – Hydrology of the Yanchep Area (Grimes 2006 after Bastian)

Karst manifests itself as loose sand near the surface and cavities within the underlying limestone. Surface features include dolines, closed depressions and sinkholes. It is common to observe a characteristic topographic signature of closed depressions on surface contour maps and in particular from surface reconnaissance and field mapping within localised areas where the form of the ground surface appears inconsistent or disrupted within the broader landscape.

Waltham and Fookes (2003) present a classification of sinkholes as shown on Figure 7. Within the Swan Coastal Plain the occurrence of Waltham's Collapse sinkholes and Caprock sinkholes are rare. A more common occurrence highlighted by the case histories and author's experience are Buried sinkholes and Suffusion sinkholes which occur in areas of sand cover over the limestone.

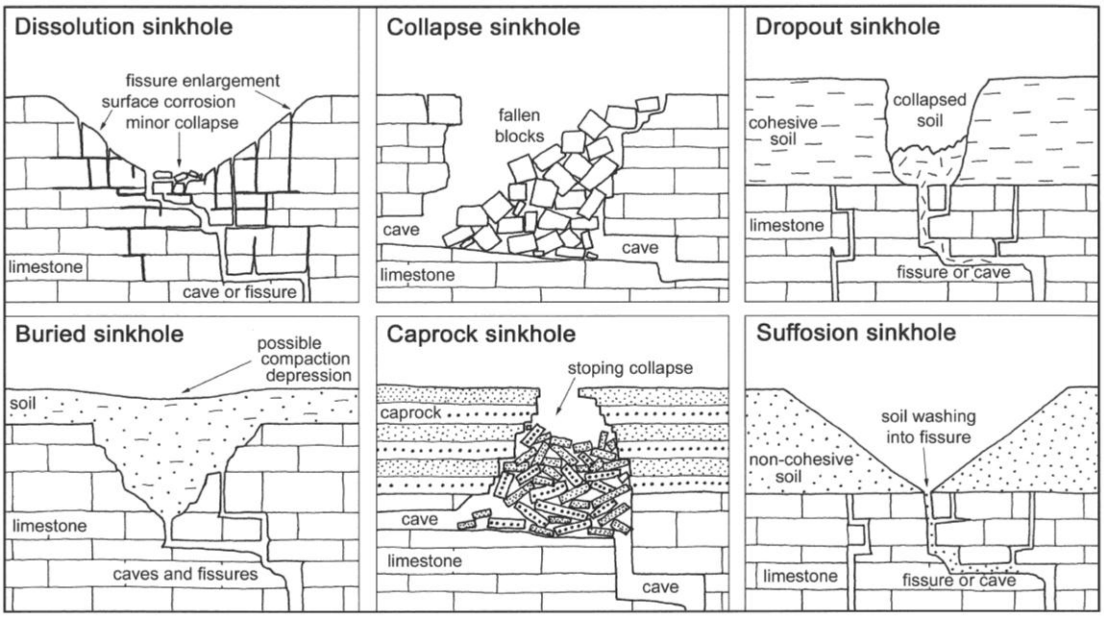

Figure 7 – Classification of Sinkholes via Mechanism of Ground Failure (Waltham and Fookes 2003).

Experience of sinkhole collapse on the Swan Coastal Plain suggests an increased hazard exists where the thickness of sand cover above limestone is in the order of 5 m. It is possible that when the thickness of sand cover exceeds 10m to 15 m it is sufficient to allow bridging of voids within the limestone and distribute any loss of ground over a broader soil zone thereby attenuating the magnitude and timing of ground movements experienced at the surface. In addition the influence of concentrated surface water infiltration is greatly diminished with depth. In areas where the thickness of sand cover is limited to a few metres it appears that the potentially significant sinkhole collapses have already occurred. In addition there is often clear surface evidence to alert the geologist to the presence of voids within the underlying limestone when it is at shallow depth.

Very loose zones within the overlying sand represent an additional hazard within areas of karst. Fortunately loose sand is relatively easy to identify and manage during development. The difficult hazard to manage results from “hidden” features where sudden collapse may be triggered by disturbance and/or changed conditions arising from new development.

4 GEOTECHNICAL INVESTIGATION TECHNIQUES

Extensive loose and very loose sand zones are a common feature of karst areas on the Swan Coastal Plain. Cone Penetrometer Testing (CPT) is an excellent technique to assess the condition of overlying sand and will sometimes penetrate the limestone to encounter voids at depth below the rock head. CPT is relatively quick and cost effective compared to drilling and provides continuous data about the ground conditions. A disadvantage of the CPT is that it can refuse on the limestone rock head. Drilling techniques are limited to the provision of less reliable data due to issues arising from ground disturbance at the bit face, core loss and discontinuous SPT test intervals. Drilling of all techniques is a relatively crude tool from which it is often difficult to distinguish between very loose sand, core loss and voids. However, within areas of very shallow limestone drilling to investigate the near surface ground conditions represents a method of overcoming early CPT refusal to obtain direct information.

Sinkholes are spectacular through their sudden and dramatic impact but are very isolated and, due to their association with concentrated surface water discharge, provide some scope to be managed through strict control of surface water drainage. Within areas of karst on the Swan Coastal Plain it is the loose sand zones overlying voided limestone that represents the significant risk to structures. These loose sand zones are inferred to have a general association with deeper voids and therefore can provide an indication of where hazards may exist within the underlying limestone. Individual voids within the limestone are extremely difficult to investigate. Drilling and probing is “hit and miss”. A range of drilling techniques including auger, mud flush, diamond coring and air coring have been utilised. Despite careful observation of the drilling process it is often very difficult to distinguish reliably between air filled voids, sand filled voids, loose sand zones and very weakly cemented limestone. Compared to the crude data derived from drilling the use of intensive CPT testing to investigate the condition of the overlying sand, often penetrating the weaker and voided limestone at depth provides a valuable method to obtain reliable data on which to characterise the ground for input into geotechnical design.

Various geophysical techniques have been utilized with ground probing radar (GPR) typically being the most commonly adopted to assess karst on the Swan Coastal Plain. The author is not aware of any geophysical techniques that reliably indicate the presence, or not, of voids within limestone on the Swan Coastal Plain. Elsewhere surface and borehole seismic techniques have been used with some success to investigate voids at specific locations such as below a building foundation or for linear projects such as tunnel alignments (Whiteley, 2012). For larger areas geophysics can provide a generalised profile of ground conditions that may be useful to target more detailed investigation techniques, however, it provides very little useful information about the condition of the overlying sand which is often a more important factor for geotechnical design than knowing the specific location of voids. In the author’s opinion, the use of geophysical techniques to conclusively demonstrate the absence of voids over large areas is unlikely to be practicable but they can provide complementary data for critical infrastructure at specific locations where investigation budgets allow.

5 GEOTECHNICAL DESIGN CONSIDERATIONS

The main considerations during geotechnical design within areas of potential karst are as follows:

- Excessive settlement within areas of loose sand under the load of structures.
- Sudden collapse of ground resulting from sinkholes.
- Concentrated surface and/or subsurface water flow which has been associated with every sinkhole occurrence observed by the author.
- Changes in land use which can concentrate surface water flows leading to a new generation of sinkholes to occur.
- The existence and effectiveness of geotechnical investigation guidelines. For example the City of Wanneroo has recently prepared a draft of new development guidelines for minimum geotechnical investigation requirements specifically related to karst. Other local Authorities are likely to follow.

6 CONCLUSIONS AND DESIGN STRATEGIES

The potential for sinkholes is a real and significant engineering issue within potential karst areas on the Swan Coastal Plain. The GSWA 1:50,000 mapping provides an excellent guide to the distribution of the potential karst zone north of Perth. Additional areas of karst have been encountered outside those shown on published geological mapping. Additional areas are likely to be revealed as urban development expands into areas of less intensive development. Investigation by drilling and probing is “hit and miss”. The use of CPT has proved a reliable investigation technique on which to base engineering design within areas with a reasonable thickness of sand cover and can provide some indication of the strength of the underlying limestone sometimes penetrating the rock layer and intersecting voids to provide direct evidence of their existence. In the absence of any investigation techniques that can reliably detect the location of voids within limestone it is considered prudent that once karst conditions have been identified through surface mapping, drilling and probing, geotechnical design is based on the assumption that voids are present within the underlying limestone. For critical structures more specifically targeted techniques incorporating geophysics and intensive, close spaced drilling/probing may be justified.

The control and management of concentrated surface water discharge away from structures is considered to be the key factor in limiting the potential risks and impacts of sinkhole formation. Design recommendations for developments typically include the provision for soak wells to be located no less than 10m from footings. Road drainage basins are typically recommended to include a 30m development exclusion zone around their perimeter. Other design strategies include stiffening of footings to accommodate potential settlements associated with loose zones within sand and loss of ground above sinkholes. Structural assessments indicate that under typical loads associated with masonry residential structures a stiffened beam adopted for a site classification of M in accordance with AS2870-2011 will span a 1.8m wide void.

The hazards associated with development within areas of karst cannot be eliminated but geotechnical design strategies can be adopted to reduce the risks.

7 ACKNOWLEDGEMENTS

The author gratefully acknowledges the contribution and assistance from Geoff Cocks and Alan Moon during the preparation of this paper.

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Appendix C

CMW Geotechnical Investigation

28 March 2018

LOT 6 TARONGA PLACE, EGLINTON, WA

GEOTECHNICAL INVESTIGATION REPORT

Urban Quarter

PER2018-0005AB Rev 0

PER2018-0005AB		
Date	Revision	Comments
28 March 2018	0	

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Figures

Appendices

1 INTRODUCTION

1.1 General

CMW Geosciences Pty Ltd (CMW) was authorised by Urban Quarter to carry out a geotechnical investigation of a site located at Lot 6 Taronga Place, Eglinton by way of a signed authorisation dated 25 January 2018. The scope of work and associated terms and conditions of our engagement were detailed in our services proposal letter PER2017-0480AA Rev 1 dated 29 January 2018.

The proposed development consists of a residential development.

1.2 Scope of Work

The geotechnical investigation scope of work, as described in our services proposal (Ref. 2018-0005AA Rev 1, dated 29 January 2018), is summarised as follows:

- Project organisation and management comprising:
    - Desktop study of available geotechnical information including documented design parameters and available historical aerial photographs; and
    - A dial before you dig service search to identify underground services.
- Fieldwork comprising:
    - 28 CPT probes to a depth of up to 13.6m using a track mounted CPT rig to assess the underlying ground conditions and the relative density profile of the sand within the zone of influence of foundations;
    - 15 test pits across the proposed fill and shallow cut areas to depths of up to 3m using a 8.5 tonne backhoe to investigate the depth of sand and limestone and to facilitate sampling;
    - 5 hand auger boreholes to facilitate soil sampling at proposed POS in areas of cut and for permeability assessment;
    - Perth Sand Penetrometer (PSP) tests adjacent to test pit locations to provide soil density profiles; and
    - 2 test pit soakage tests at a depth of up to 5m BGL (additional scope of works).
- Laboratory testing comprising:
    - Organic content of the topsoil;
    - Point load index testing of recovered limestone samples; and
    - Permeability assessment of collected sand samples from the hand auger boreholes and soakage test locations.
- Compilation of collected data into a concise geotechnical report, providing relevant parameters.

2 SITE DESCRIPTION

2.1 Location and Topography

The proposed residential development is situated approximately 43km NNW of Perth, east of the Marmion Avenue and Bluewater Drive intersection in Eglinton. The site is bound by Bluewater Drive to the south and rural property to the north, east and west. The location, layout of the site and the position of the field investigation activities are shown on the Site Location Plan provided in Figure A.

Topographically, the site ranges in elevation from RL 29m AHD To RL 52m AHD. The ground surface consists of sand. The majority of the site is covered in vegetation with some partially cleared areas and fire breaks/tracks.

2.2 Geology

The 1:50000 Yanchep Geological Map (Sheet 2034 IV) indicates that the site is underlain by sand derived from Tamala Limestone and Tamala Limestone.

Previous works conducted identified a potential karst risk zone within the northern portion of the site.

3 BACKGROUND INFORMATION & PROPOSED DEVELOPMENT

A Preliminary Karst Assessment was conducted by CMW Geosciences (reference PER2016-0407AB Rev 0 dated 17 February 2016), of which this site forms part of. This risk assessment identified part of the site being within a karst risk zone and suggested additional geotechnical investigation would be required. The report states that 10 – 15m sand cover above limestone would be required to reduce any potential settlement associated with sinkhole collapse

The Earthworks Staging Concept Plan from Cossill and Webley (reference 5826-00SK31 Rev C) depict a 28Ha site for the development of residential lots plus associated roads, accessways and public open spaces. The plan shows that there is up to 12m of cut and up to 11m of fill involved during the earthworks.

4 FIELD INVESTIGATION

Following a dial before you dig search the field investigation was carried out between 19 February and 13 March 2018. All fieldwork was carried out under the direction of CMW Geosciences Pty Ltd in general accordance with AS1726 (2017) Geotechnical Site Investigations. The scope of fieldwork completed was as follows:

- Undertake a walkover survey of the site to assess the general landform and site conditions;
- 28 Cone Penetrometer Tests, denoted CPT01 to CPT28, advanced to depths of up to 13.6m to define the ground model. Results of the CPT's, presented as traces of tip resistance (qc), friction resistance (fs) and friction ratio are presented in Appendix A;
- 15 test pits, denoted TP01 to TP15, excavated using a 8 tonne hydraulic excavator fitted with a 600mm wide bucket to depths of between 1.2m and 3.0m below existing ground levels. TP10, TP12, TP13 and TP14 were terminated early due to refusal on limestone. Representative bulk samples were collected to provide samples for subsequent laboratory testing. Engineering logs and photographs of the test pits are presented in Appendix B;
- Perth Sand Penetrometer (PSP) tests carried out adjacent to each hand auger borehole, in general accordance with AS1289.6.3.3, to depths of up to 2m to provide soil density profiles, for use as a comparison with the CPT data and to provide a subgrade CBR value for pavement design purposes. Graphical results of the PSP testing are presented on the borehole logs in Appendix B;
- 5 hand auger boreholes, denoted PERM01 to PERM05, drilled using a 10mm diameter auger to target depths of up to 6.0m below existing ground levels to visually observe the near surface soil profile and to facilitate in-situ permeability testing. PERM02 and PERM05 were terminated early due to refusal on limestone. Engineering logs of the hand auger boreholes are presented in Appendix B;

- In-situ falling head permeability tests completed in the open standpipe piezometers established in PERM01 to PERM05 at varying depths. Results of the permeability tests are presented in Appendix C; and
- Soakage tests within test pits conducted at 2 locations, denoted ST01 and ST02, to reach a specific target depth, within the limestone. Results of the tests are presented in Appendix C.

The approximate locations of the respective investigation sites referred to above are shown on the attached Site Plan (Figure A). Test locations were measured using hand held GSP/tape measure from site features to an accuracy of 5m. Elevations were inferred from the feature survey plan provided.

5 LABORATORY TESTING

Laboratory testing was carried out generally in accordance with the requirements of the current edition of AS 1289 (where applicable).

All testing was scheduled by CMW and carried out by Liquid Labs (a NATA registered Testing Authority) or CMW personnel.

The extent of testing carried out to provide the geotechnical parameters required for this study are presented in Table 1.

Table 1: Laboratory Test Schedule Summary

Type of Test	Test Method	Quantity
Organic tests	ASTM: D2974-07a Test Method C	6
Point Load Test Index	-	6
Particle Size Distribution	AS1289.3.6.1	1
Dry Density & Moisture Content	AS1289.5.2.1	1
Saturated Hydraulic Conductivity	-	3

Certificates for the test results outlined above are presented in Appendix D.

6 GROUND MODEL

6.1 Subsurface Conditions

The ground conditions encountered and inferred from the investigation were considered to be generally consistent with the published geology for the area and can be generalised according to the following subsurface sequence:

TOPSOIL	sand, 1 – 2.4% organic content;
SAND (SP)	loose to medium dense, orange, fine to coarse grained, non-plastic, sub-angular to sub-rounded, trace fines, overlying;
LIMESTONE	low/high strength, variable pinnacle formation.

The distribution of these units is summarised in Table 2.

Table 2: Summary of Encountered Soil Stratigraphy

Description	Depth to base of layer (m)		
	Minimum	Maximum	Average
TOPSOIL / SAND	0.2	0.2	0.2
SAND (very loose to dense)	0.5	13.6	4.4
LIMESTONE	Base of layer not encountered. Limestone was not encountered at every location.		

Figure B shows the target depth and termination depth of each location. Termination depth which did not reach the target depth is inferred to be on a limestone horizon. Figure C shows a geological cross-section of the site including proposed bulk earthwork levels.

6.2 Groundwater and Ground Level

Survey information provided by the client states that the ground level at this site varies from RL29m AHD to RL52mAHD.

The Perth Groundwater Atlas suggests groundwater levels are approximately RL 1-2m AHD. This equates to a groundwater level in excess of 28m below the current ground level.

Groundwater was not encountered during our investigation.

6.3 Permeability

The results of the falling head permeability tests carried out were used to estimate the soil coefficient of permeability in accordance with the methods described in CIRIA Report No. 113 (falling head test) and BRE Digest 365. Table 3 summarises the results obtained.

Table 3: Summary of Falling Head Permeability Tests

Location	Depth (m BGL)	Approximate Permeability	
		(m/sec)	(m/day)
PERM01	6	2.49E-04	21.5
PERM02*	2.9	2.60E-04	22.5
PERM03	1.4	5.44E-04	47.0
PERM04	2.4	5.60E-04	48.4
PERM05a*	2.4	4.65E-04	40.2
ST01	5.0	1.6E-04	17.8
ST02	3.0	1.1E-04	9.5

*Target depth not reached. PERM02 replaced with ST01. PERM05 replaced with ST02.

6.4 Laboratory Test Results

Results of the laboratory tests provided in Appendix E are summarised below.

Table 4: Summary of Organic Content

Test Location	Depth (mbgl)	Ash Content (%)	Organic Content (%)
TP01	0 - 0.2	98.4	1.6
TP04	0 - 0.2	977	2.3
TP09	0 - 0.2	98.4	1.6
TP11	0 - 0.2	99.0	1.0
TP12	0 - 0.2	98.4	1.6
TP15	0 - 0.2	97.6	2.4

Table 5: Summary of Point Load Test Index

Test Location	Depth (mbgl)	Corrected Point Load Strength (Is50) (MPa)	Strength
TP06	2.0	0.164	Low
TP06	2.0	0.1	Low
TP12	1.0	0.6	Medium
TP12	1.0	1.4	High
ST01	4.0	0.0	Very Low
ST01	4.0	0.0	Extremely Low
ST02	2.5	0.1	Very Low
ST02	2.5	0.2	Low

Table 6: Particle Size Distribution

Test Location	Depth (mbgl)	Particle Size Distribution (% by weight)		
		Fines (<0.075mm)	Sand (<2.36mm, >0.075mm)	Gravel (<75mm, >2.36mm)
ST01	2.0 – 3.0m	5	93	2

Table 7: Dry Density & Moisture Content Relation of Soil

Test Location	Depth (mbgl)	Maximum Dry Density (t/m^3)	Optimum Moisture Content (%)
ST01	2.0 – 3.0m	1.745	13.0
ST02	2.0 – 2.5m		
PERM04	1.5 – 2.0m		

Table 8: Hydraulic Conductivity

Test Location	Hydraulic Conductivity (mm/hr)	Hydraulic Conductivity (m/day)	Bulk Density (g/cm^3)
ST01_2.0-3.0m	504	12.0	1.598
	331	7.9	1.607
	259	6.2	1.653
	179	4.3	1.703
ST02_2.0-2.5m	346	8.3	1.573
	230	5.5	1.635
	191	4.6	1.655
	108	2.6	1.737
PERM04_1.5-2.0m	540	13.0	1.585
	353	8.5	1.609
	237	5.7	1.651
	155	3.7	1.682

7 GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS

7.1 Limestone Features and Karst Risk

The geotechnical investigation results show that the depth to limestone varies considerably across the site. These conditions and our experience in this geological setting suggest that pinnacled limestone exists across the site.

Previous work on this area (CMW reference PER2016-0407AB Rev 0 dated 17 February 2016) states that part of the site is within a zone of potential karst features. During geotechnical design within areas of potential karst, consideration must be made in regard to excessive settlement under load of structures (including building collapse), sudden collapse of the ground and sinkhole occurrence due to concentration of surface and sub-surface water. The hazards associated with development within areas of karst cannot be eliminated, but geotechnical design strategies can be adopted to reduce and manage the risks to acceptable levels. Earthworks as outlined in Section 7.2 should be undertaken to mitigate these hazards.

As assessment of the western boundary of the Karst Risk Zone (see Figure C) in relation to an adjustment has been made. During the field investigation, significant CPT probing was conducted within the Karst Risk zone, following on from this, there is not significant evidence to justify moving the boundary. This Karst Risk Zone is given based on current ground levels.

7.2 Earthworks

7.2.1 General

Earthworks will likely involve up to 12m of cut and 11m of fill. All earthworks must be in accordance with AS3798.

7.2.2 Topsoil Stripping and Re-use

Within the footprint of proposed roads, access ways, buildings or areas of other construction, topsoil (typically 100mm thick) and unsuitable organic material must be excavated and removed to designated waste stockpile areas. The root bulbs of any trees must be grubbed out. Based on the organic content laboratory tests conducted, topsoil is to be blended at a ratio of 1:2 (topsoil:sand) to ensure an organic content of less than 2%. This blend ratio may be reduced to 1:1, depending on the laboratory testing results following such blending.

7.2.3 Proof Compaction

Beneath the footprint areas of proposed roads, access ways, buildings or areas of other construction, the ground surface must be proof compacted with suitable equipment to achieve a dry density ratio of at least 95% of Modified Maximum Dry Density (MMDD). The upper 200mm may require moisture conditioning to near optimum moisture content in order to achieve the required density ratio. This shall be judged to occur where at least 8 blows per 300mm penetration is achieved when tested with a PSP. Any weak areas that deform excessively, or organic materials observed during this proof compaction must be removed and replaced with suitably compacted general fill.

7.2.4 Fill Placement

General fill material must be placed in layers not exceeding 300mm in loose lift thickness based on the use of standard construction compaction equipment. General fill must be moisture conditioned to within ±3% of the optimum moisture content, placed and compacted with suitably sized equipment. A dry density ratio of at least 95% of Modified Maximum Dry Density (MMDD) is considered suitable for general fill. This shall be judged to occur where at least 8 blows per 300mm penetration is achieved when tested with a PSP.

7.2.5 Fill Material

It is considered that fill materials such as road basecourse will need to be imported to the site. The in-situ soils are suitable sources of structural fill. Materials used as structural fill must be “clean sand” free of deleterious inclusions with a maximum particle size of 100mm, and particles finer than 75 microns not exceeding 5%.

7.2.6 Suitability of Existing Ground for Vehicles

Conditions across the site may become boggy due to the loose ground encountered on tracks. Trafficability with 8.5 tonne and 28 tonne excavators during the geotechnical investigation site work was good.

7.2.7 Excavation Conditions

Excavation conditions for the units across the site have been preliminarily assessed during our investigation using a JCB 9CX 8 tonne backhoe and a 28 tonne excavator. A target depth of 3.0m was met at the majority of our test pit locations whilst using the 8 tonne backhoe. Where limestone was intercepted the 8 tonne backhoe experienced refusal. In accordance with Pettifer and Fookes, 1994, the excavatability of the limestone would require hard digging/easy ripping. The levels at which limestone was encountered is shown in Figures B and C.

7.2.8 Slopes

Recommended batter angles for cut and fill slopes less than 2m high have been presented in Table 9. Temporary cut slopes must be regularly monitored to confirm their stability during the project. The Code of Practice: Excavation 2005 by the Government of Western Australia requires shoring where a person is required to work in a vertical trench excavation that is deeper than 1.5m. Shoring shall be designed in accordance with AS4678-2002.

Table 9: Summary of Recommended Slope Angles

Geological Unit	Temporary Batter Angles*	Permanent Batter Angles*
SAND	1V:2H	1V:3H
*For slopes less than 2m high, above the groundwater table with no applied loads.		

7.2.9 Specific Requirements for Karst Risk Zone

Within the Karst Risk Zone, sand cover above limestone is to be in excess of 10m. This is deemed to be sufficient to allow bridging of voids within the limestone and distribute any loss of ground over a broader soil zone.

Based on the proposed increase in site levels as per the plans supplied (reference Cossill and Webley 5826-00SK31 Rev C and 5826-00-101 Rev B), this should be achievable. CMW must be made aware of any changes to site levels. Should site levels decrease, a bridging layer of 2m thick layer of crushed limestone covered with a 1m thick surface layer of free draining sand, would be appropriate wherever less than 10m of sand cover is proposed. The 2m thick layer of compacted crushed limestone will act as a stiffened raft below residential structures in addition to attenuating concentrated stormwater inflows from the surface. The placement and compaction of these layers should be undertaken in accordance with the requirements of Section 7.2.

Based on the plans supplied, POS areas have not been planned within the Karst Risk Zone. Drainage basins are not to be placed within the Karst Risk Zone.

7.3 Retaining Walls

Design parameters for permanent and temporary retaining walls are summarised in Table 10:

Table 10: Retaining Wall Design Parameters

Soil Unit	ϒ (kN/m^3)	Ø' (deg)	K_0	E' (MPa)	No wall friction	
					K_a	K_p
SAND	18	34	0.44	40	0.28	3.54

Retaining structures should be designed in accordance with AS 4678-2002 "*Earth Retaining Structures*" or an alternate approved factor of safety approach. The compaction equipment used to compact backfill behind any walls must be carefully selected and preferably light-weight compaction equipment should be used. The load any retaining walls due to compaction equipment may be estimated from Figure J5 in AS4678-2002 *“Earth Retaining Structures”*.

It is noted that some ground movement will occur behind temporary or permanent retaining walls. By definition, movement of the wall must occur to fully mobilise the active and passive earth pressure coefficients provided in Table 10 above. The extent of this movement is dependent on the height of retaining, type of wall selected and construction methodology. This must be considered during the design and construction of the retaining walls to ensure adjacent facilities are not adversely affected.

Any ground anchors associated with retaining wall construction should be designed on the basis of the above effective stress soil parameters and using appropriate design standards such as BS8081.

7.4 Pavement CBR

Based on the in-situ test results across the site, it is recommended that pavements be designed on the basis of a subgrade CBR value of 12%.

This design CBR value is subject to the exposed subgrade being moisture conditioned and compacted in accordance with the recommendations provided in Section 7.2 above. It is recommended that QA / QC testing be undertaken on subgrade materials during construction.

7.5 Site Classification

A site classification of Class A with little or no ground movement due to seasonal moisture changes to AS2870, is recommended subject to the foundation preparation recommendations provided herein.

7.6 Stormwater Disposal

The results of infiltration testing indicate a good drainage rate for the in-situ sand materials across the site. Soakage/drainage systems may be designed on the basis of a soil coefficient of permeability as stated in Table 3 and Table 8 subject to being located a distance of at least 3m away from any building foundations. Past experience with Tamala Limestone indicates highly variable permeability rates ranging from less than 0.1m/day to in excess of 10m/day depending on the localised conditions of the limestone.

For drainage design, it must be noted that a build-up of silt, oil and organic material over time may form a clogged layer within the floor of the soak well and reduce the effective infiltration performance. It is therefore recommended to adopt a lower design permeability value than indicated by the field testing to allow for the development of a clogged layer within soak wells.

It is recommended that the permeability of the ground is reassessed once final earthworked levels have been reached.

8 CLOSURE

The findings contained within this report are the result of limited discrete investigations conducted in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, can it be considered that these findings represent the actual state of the ground conditions away from our investigation locations.

If the ground conditions encountered during construction are significantly different from those described in this report and on which the conclusions and recommendations were based, then we must be notified immediately.

This report has been prepared for use by Urban Quarter in relation to the Lot 6 Taronga Place, Eglinton project in accordance with generally accepted consulting practice. No other warranty, expressed or implied, is made as to the professional advice included in this report. Use of this report by parties other than Urban Quarter and their respective consultants and contractors is at their risk as it may not contain sufficient information for any other purposes.

For and on behalf of
CMW Geosciences Pty Ltd

AK Yates

Amy Yates
Project Engineering Geologist

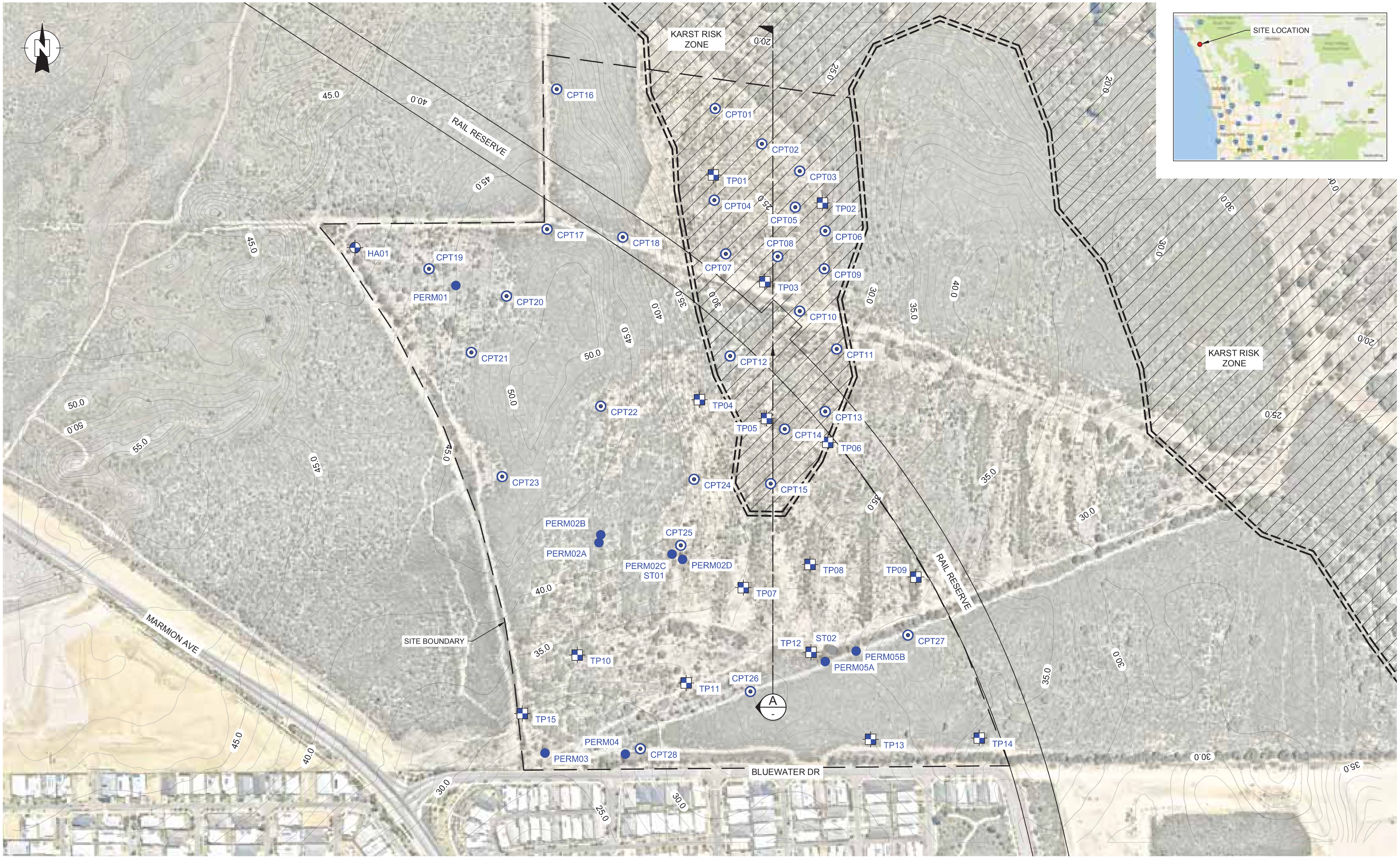
Alex Petty
Associate Geotechnical Engineer

Distribution: 1 copy to Urban Quarter (electronic)
Original held by CMW Geosciences Pty Ltd

9 REFERENCES

- AS 1289, *Methods of testing soils for engineering purposes,* Standards Australia, Sydney
- AS 1726 (inc. amendments 1 & 2), *Geotechnical Site Investigations,* Standards Australia, Sydney, 1993
- AS 2870, *Residential slabs and footings,* Standards Australia, Sydney, 2011
- AS 3798 (inc. amendment 1), *Guidelines on earthworks for commercial and residential developments,* Standards Australia, Sydney, 2007
- AS 4678 (inc amendments 1 & 2), *Earth retaining structures,* Standards Australia, Sydney, 2002
- ASTM D2974-13, Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils, ASTM International, West Conshohocken, PA, 2013, www.astm.org
- *Perth Groundwater Atlas,* Second Edition, Perth: Department of Environment, 2004
- Perth Metropolitan Region Environmental Geology Series, Geological Survey of Western Australia, 1986
- Robertson P K, *Soil classification using the cone penetration test,* Canadian Geotechnical Journal, 27 (1): 151-158, 1990

Figure A
Site Location Plan



LEGEND:

⊕	HA01	HAND AUGER (HA) LOCATION
⊙	CPT01	CONE PENETROMETER TEST (CPT) LOCATION
▩	TP01	TEST PIT (TP) LOCATION
●	PERM01	PERM TEST LOCATION
●	ST01	SOAKAGE TEST LOCATION

NOTES:

1. IMAGE FROM NEARMAP 11.02.18
2. BACKGROUND SURVEY SUPPLIED

1:4000 0 40 80 120 160 200 m

CMW Geosciences

CLIENT: URBAN QUARTER	DRAWN: DE	PROJECT No: PER2018-0005
PROJECT: LOT 6 TARONGA PLACE, EGLINTON	CHECKED: AKY	DRAWING: 01
	REVISION: 0	SCALE: 1:4000
TITLE: SITE INVESTIGATION PLAN	DATE: 028.03.18	SHEET: A3 L

S:\01 PROJECTS\PER\PER2018\PER2018_0001 TO PER2018_0050\PER2018-0005 LOT 6 TARONGA PLACE EGLINTON COSSILLS\07 DRAWINGS\PER2018-0005-01 SI PLAN 010318.DWG

Figure B
Termination Depth of Exploratory Locations

Figure B - Termination Depth of Exploratory Locations

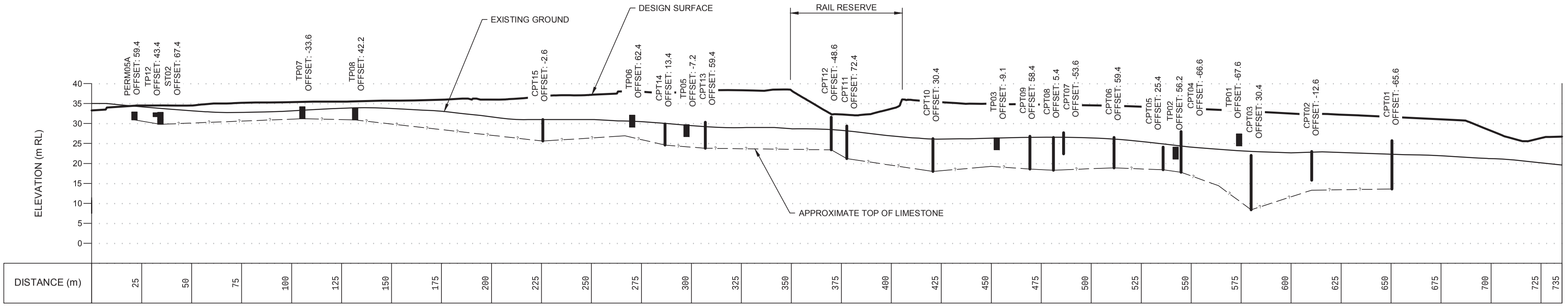
Test Location	**Target Depth (m)**	**Termination Depth (m)**	**Target Depth Reached?**
CPT01	8	12.1	Yes
CPT02	8	7.2	No
CPT03	8	13.6	Yes
CPT04	8	10.2	Yes
CPT05	8	5.7	No
CPT06	8	7.6	No
CPT07	8	5.3	No
CPT08	8	8.2	Yes
CPT09	8	8.2	Yes
CPT10	8	8.2	Yes
CPT11	8	8.2	Yes
CPT12	8	8.2	Yes
CPT13	8	6.5	No
CPT14	8	5.3	No
CPT15	8	5.4	No
CPT16	11	1.6	No
CPT17	10	2.7	No
CPT18	8	0.5	No
CPT19	8	5.7	No
CPT20	9	4.1	No
CPT21	8	3.4	No
CPT22	9	5.1	No
CPT23	7	2.1	No
CPT24	5	5.2	Yes
CPT25	6	3.3	No
CPT26	5	2.8	No
CPT27	6	2.4	No
CPT28	5	5.2	Yes
HA01	1.4	1.4	Yes
PERM01	6	6	Yes
PERM02A	5	2.9	No
PERM02B	5	2.9	No
PERM02C	5	3.6	No
PERM02D	5	2.8	No
PERM03	1.4	1.4	Yes
PERM04	2.4	2.4	Yes
PERM05A	3	2	No
PERM05B	3	1.8	No
TP01	3	3	Yes
TP02	3	3	Yes

Figure B - Termination Depth of Exploratory Locations (continued)

TP03	3	3	Yes
TP04	3	3	Yes
TP05	3	3	Yes
TP06	3	3	Yes
TP07	3	3	Yes
TP08	3	3	Yes
TP09	3	3	Yes
TP10	3	2.9	No
TP11	3	3	Yes
TP12	3	1.25	No
TP13	3	2.8	No
TP14	3	2.6	No
TP15	3	3	Yes

Figure C

Cross-Section Showing Approximate Limestone Level



SECTION A
SCALE: H 1:2000,V 1:1000.

1:2000 0 20 40 60 80 100 m

CMW Geosciences	CLIENT: URBAN QUARTER	DRAWN: DE	PROJECT No: PER2018-0005
	PROJECT: LOT 19 TARONGA PLACE, EGLINTON	CHECKED: AKY	DRAWING: 02
		REVISION: 0	SCALE: AS SHOWN
	TITLE: LONGITUDINAL SECTION A	DATE: 28.03.18	SHEET: A3 L

S:\01 PROJECTS\PER\PER2018\PER2018_0001 TO PER2018_0050\PER2018-0005 LOT 6 TARONGA PLACE EGLINTON COSSILLS\07 DRAWINGS\PER2018-0005-01 SI PLAN 010318.DWG

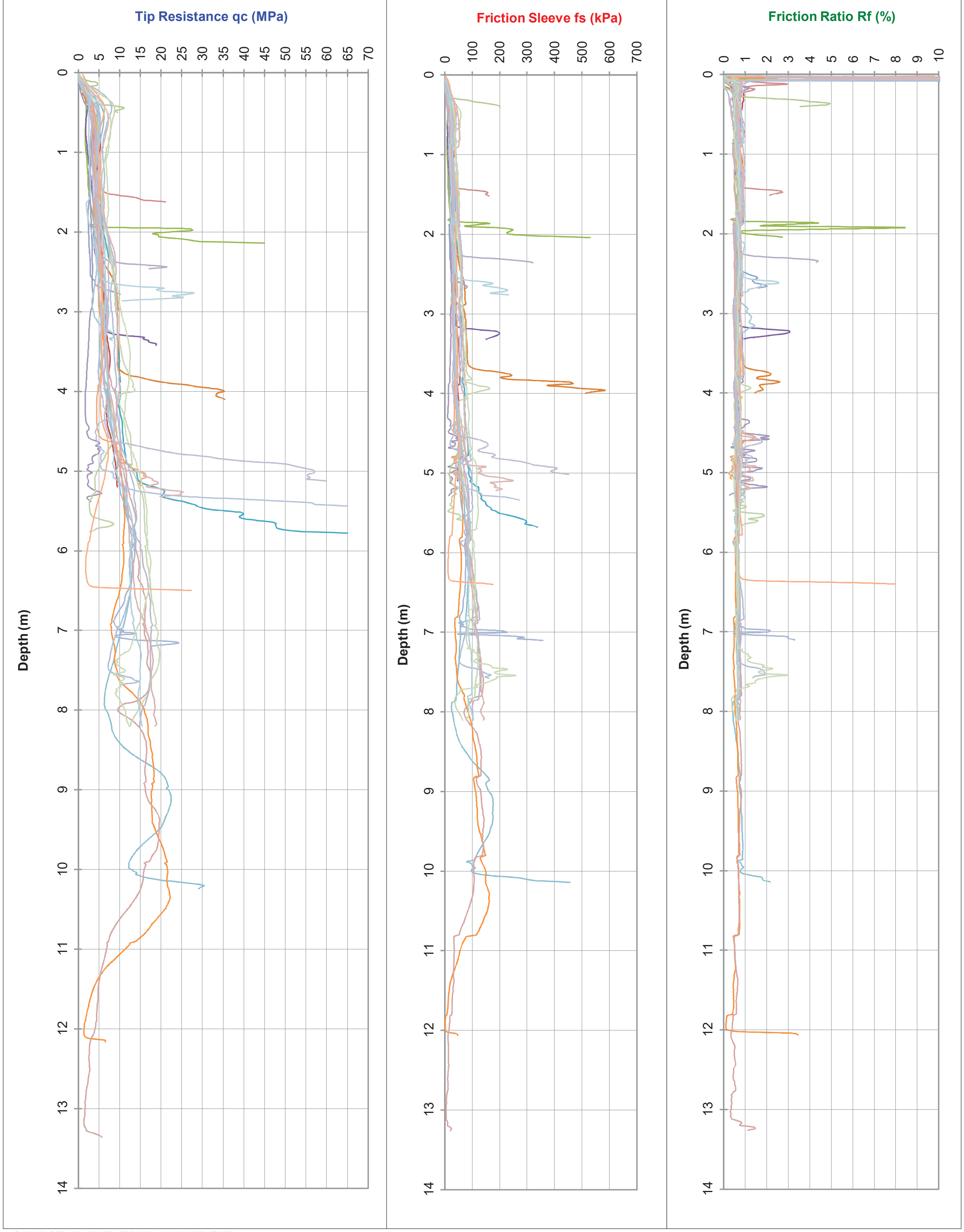
Appendix A
CPT Investigation Results

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Urban Quarter
PROJECT: Lot 19 Toronga Place
LOCATION: Eglinton

Job No.: PER2018-0005
Date/s: 22-23/2/18

ALL DATA



PROBEDRILL
GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

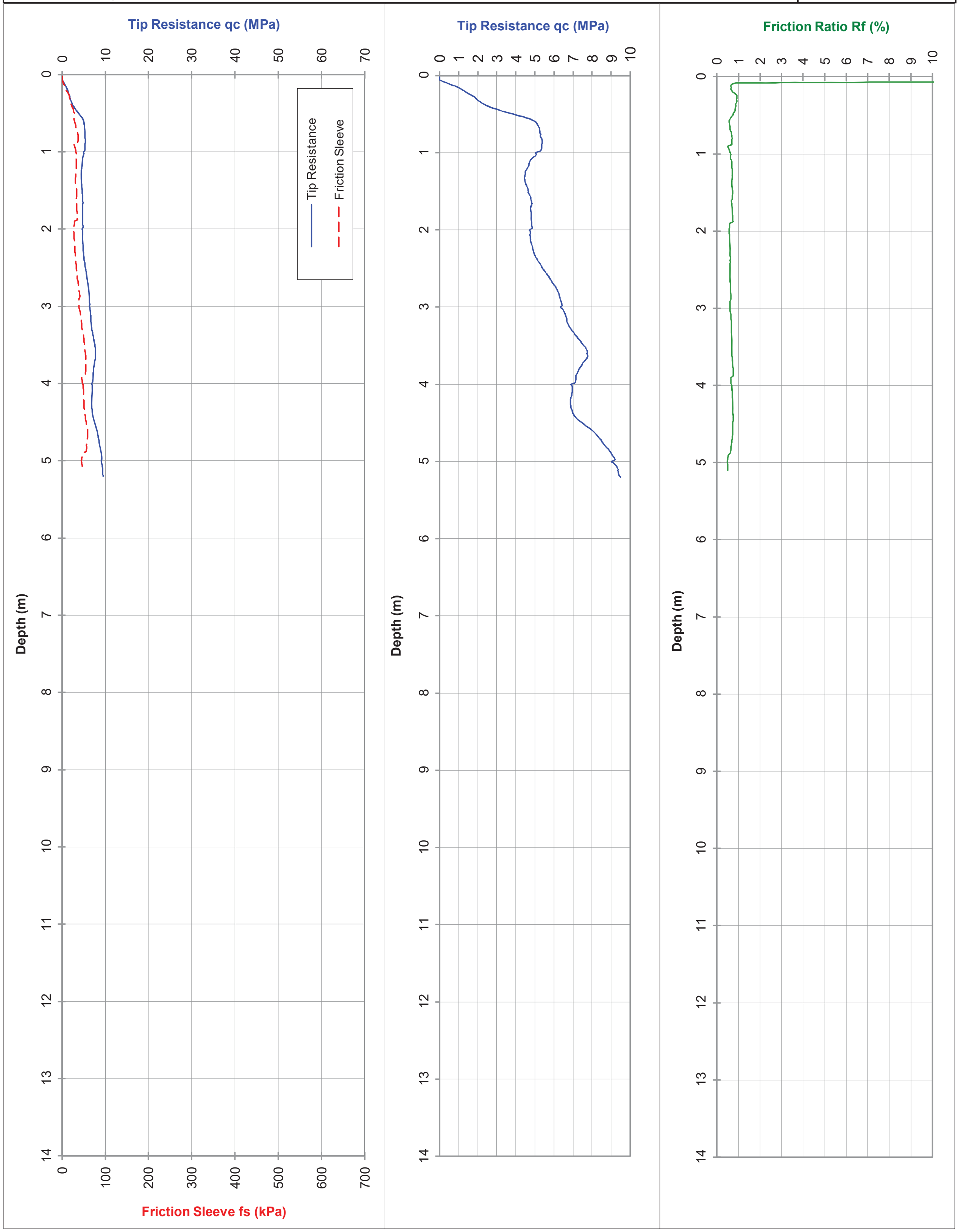
Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Urban Quarter
PROJECT: Lot 19 Toronga Place
LOCATION: Eglinton

Job No.: PER2018-0005
RL (m):
Co-ords:

Probe I.D
CPT 28
22-Feb-18



PROBEDRILL
GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 5.2
Dummy probe to (m):
Refusal:

Cone I.D.: EC02
File: CW0069M
Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Urban Quarter

PROJECT: Lot 19 Toronga Place

LOCATION: Eglinton

Job No.: PER2018-0005

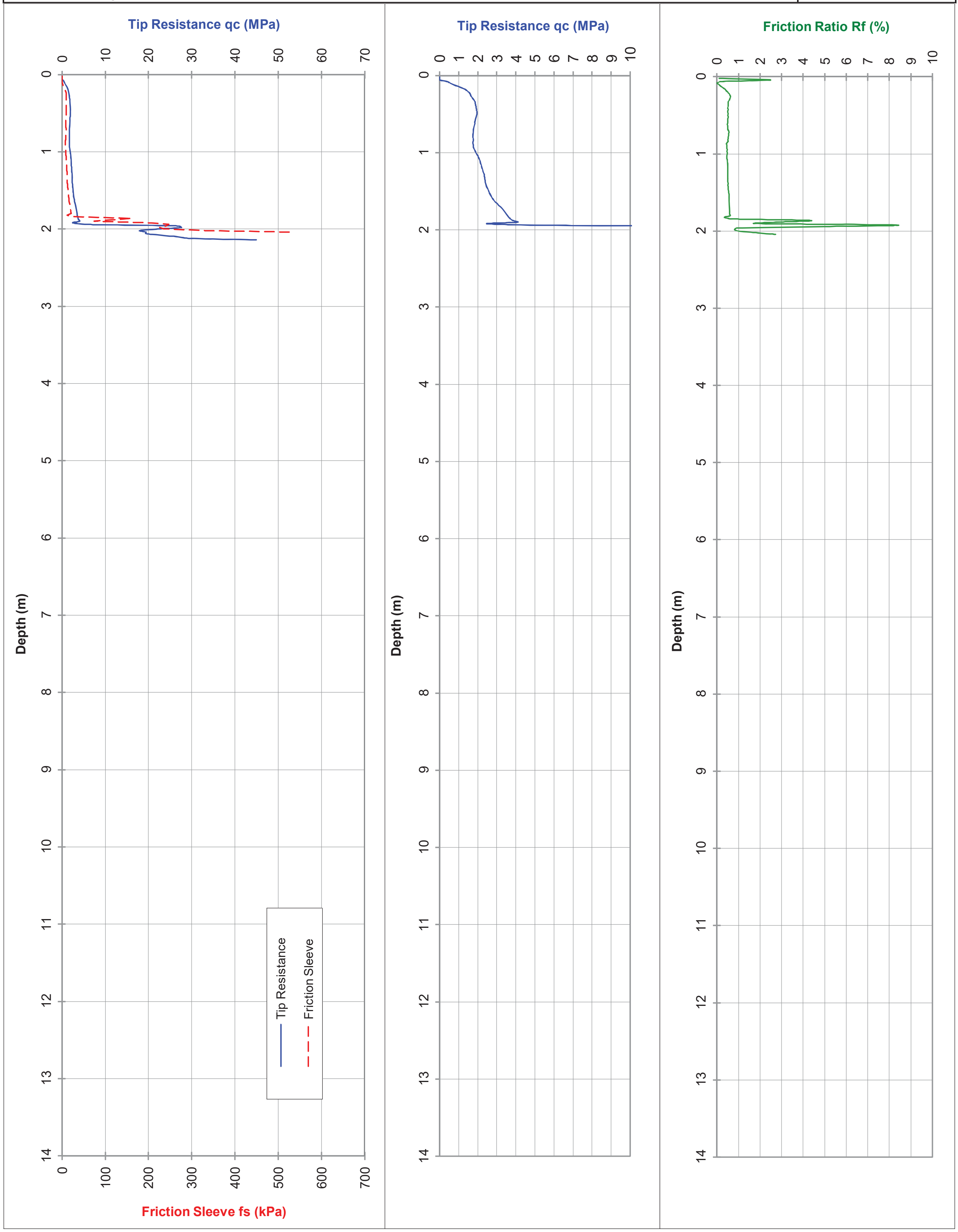
RL (m):

Co-ords:

Probe I.D

CPT 23

22-Feb-18



PROBEDRILL
GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m):

Dummy probe to (m):

Refusal: Inclination

Cone I.D.: EC02

File: CW0070M

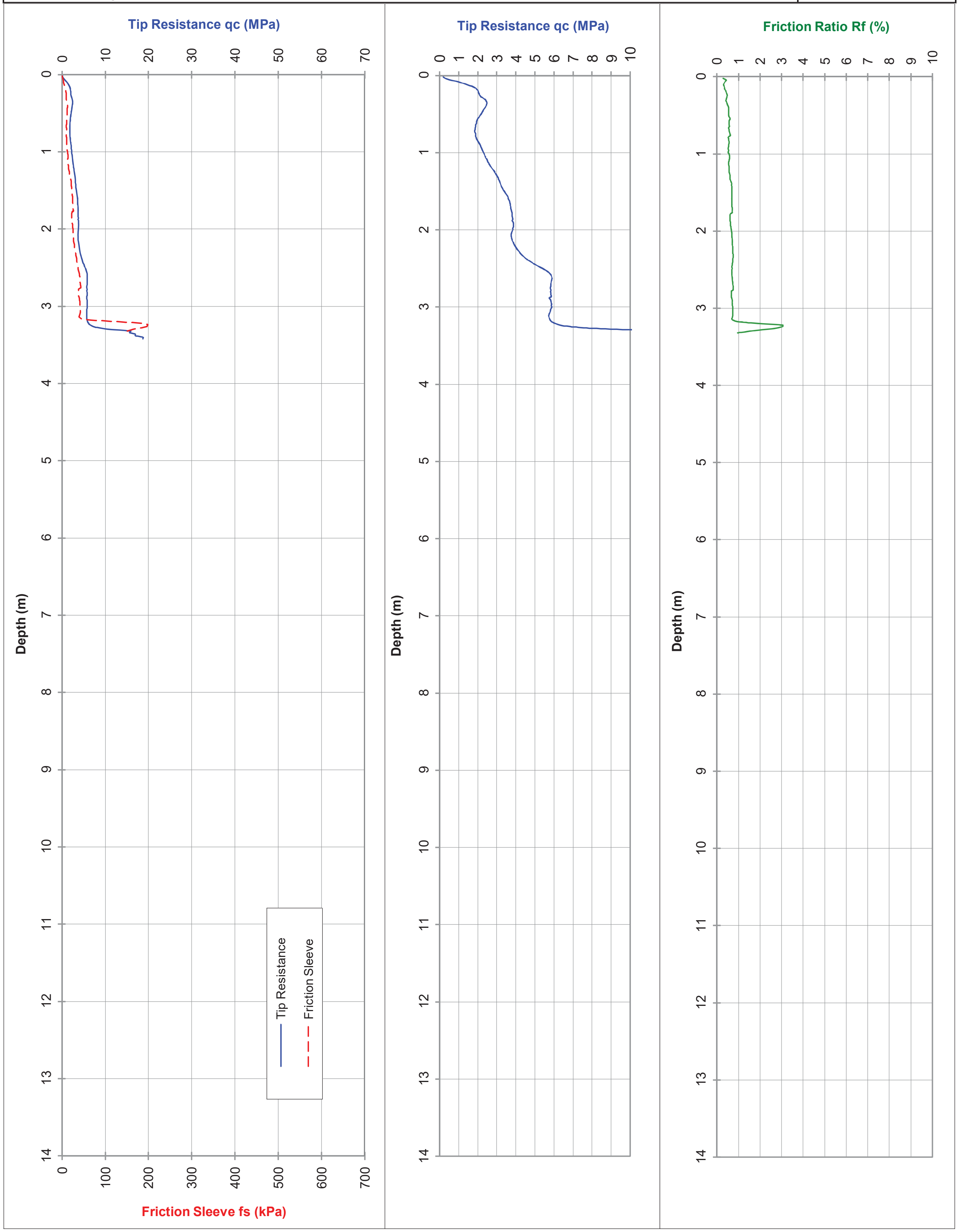
Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Urban Quarter
PROJECT: Lot 19 Toronga Place
LOCATION: Eglinton

Job No.: PER2018-0005
RL (m):
Co-ords:

Probe I.D
CPT 21
22-Feb-18



PROBEDRILL
GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 3.4
Dummy probe to (m): Inclination
Refusal:

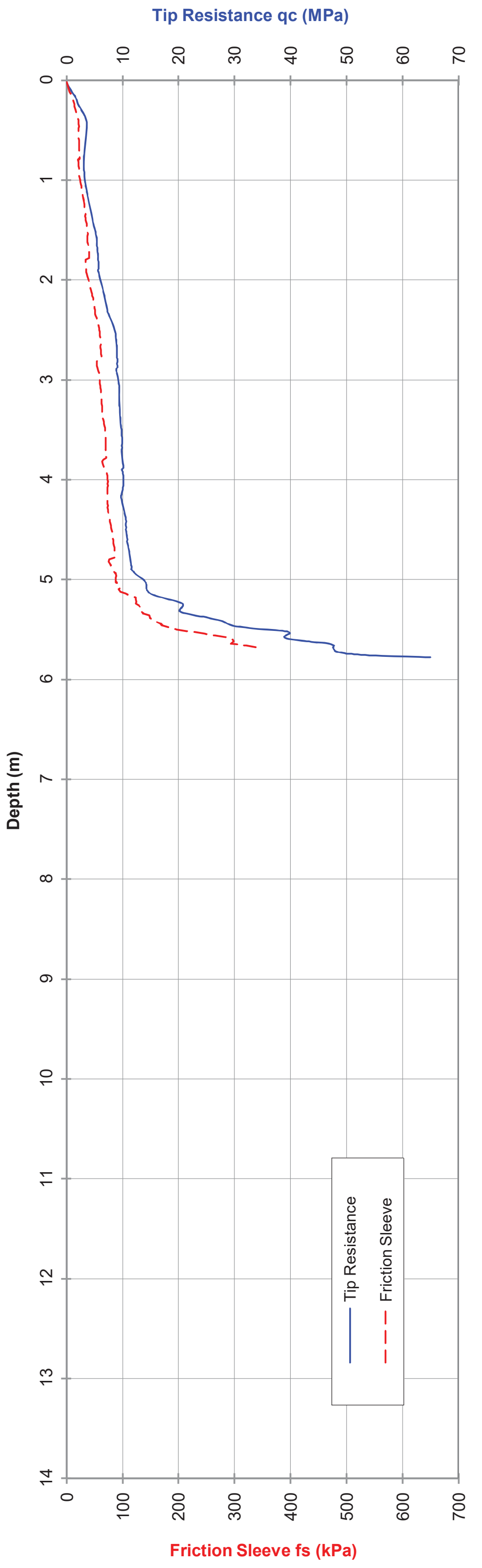
Cone I.D.: EC02
File: CW0071M
Rig Type: 12 tonne track (M1)

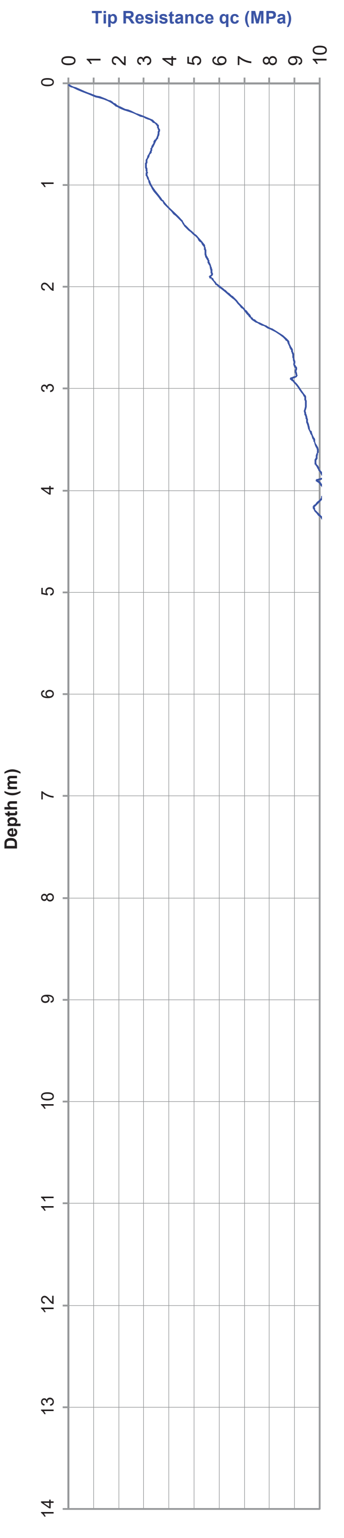
ELECTRIC FRICTION-CONE PENETROMETER

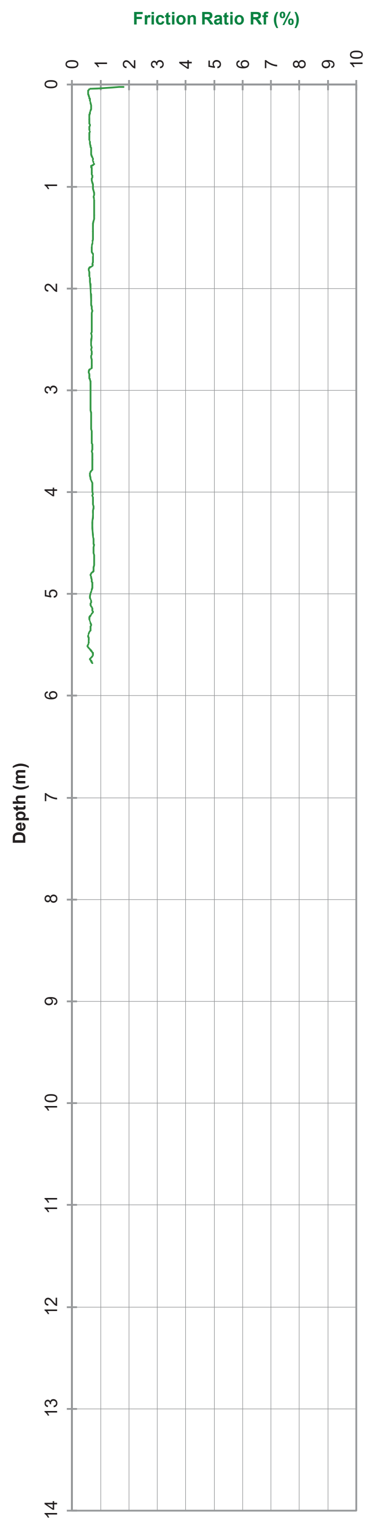
CLIENT: Urban Quarter
PROJECT: Lot 19 Toronga Place
LOCATION: Eglinton

Job No.: PER2018-0005
RL (m):
Co-ords:

Probe I.D
CPT 19
22-Feb-18







PROBEDRILL
GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 5.7

Dummy probe to (m):

Refusal: 65MPa

Cone I.D.: EC02

File: CW0072M

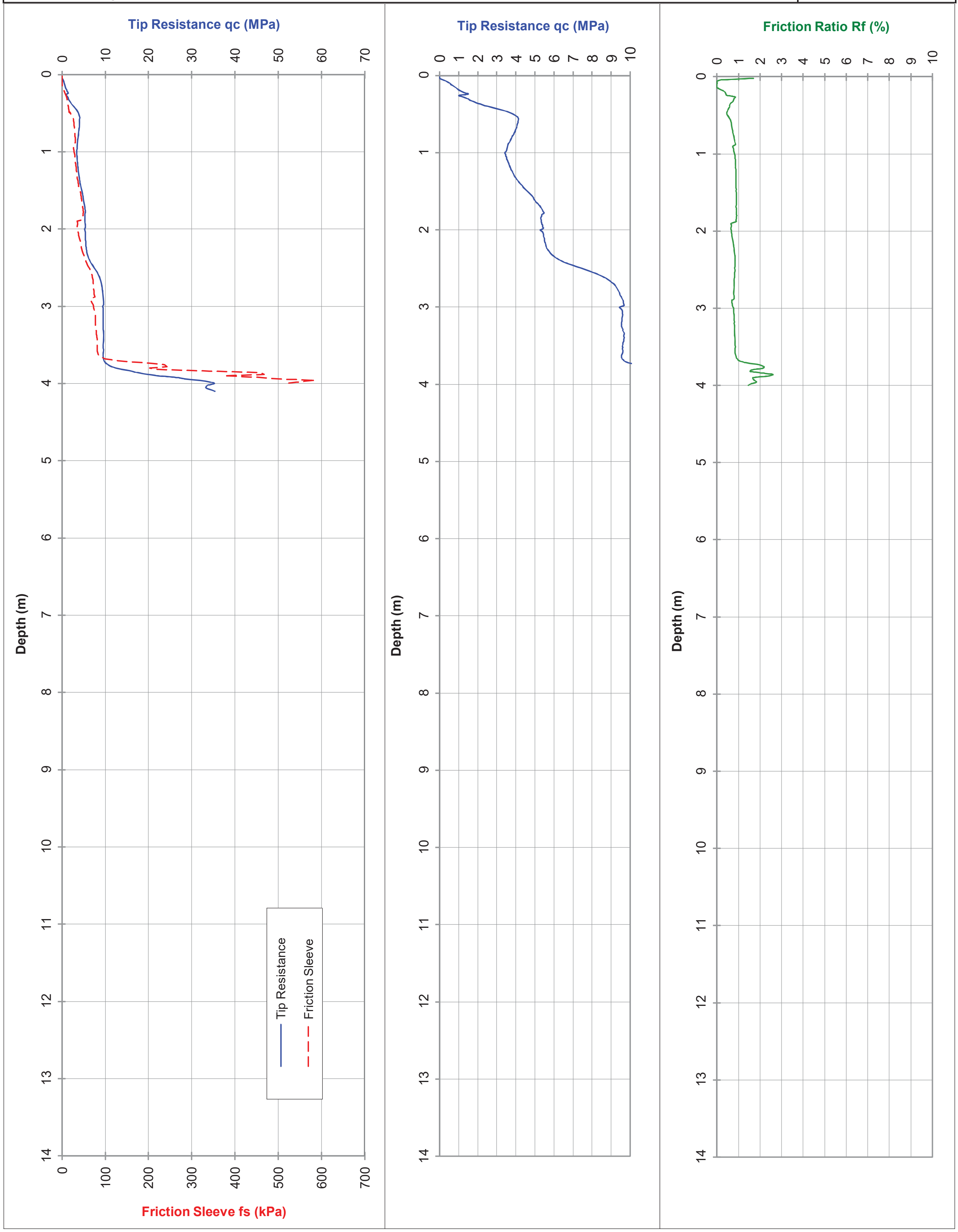
Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Urban Quarter
PROJECT: Lot 19 Toronga Place
LOCATION: Eglinton

Job No.: PER2018-0005
RL (m):
Co-ords:

Probe I.D
CPT 20
22-Feb-18



PROBEDRILL
GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 4.1
Dummy probe to (m):
Refusal: Inclination

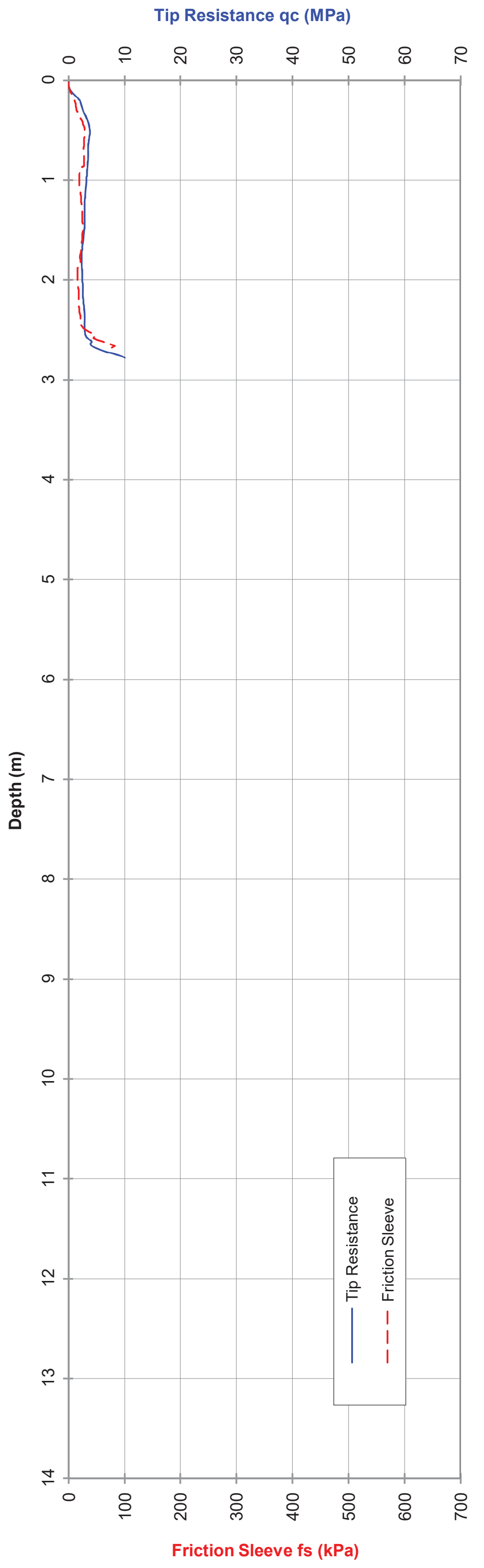
Cone I.D.: EC02
File: CW0073M
Rig Type: 12 tonne track (M1)

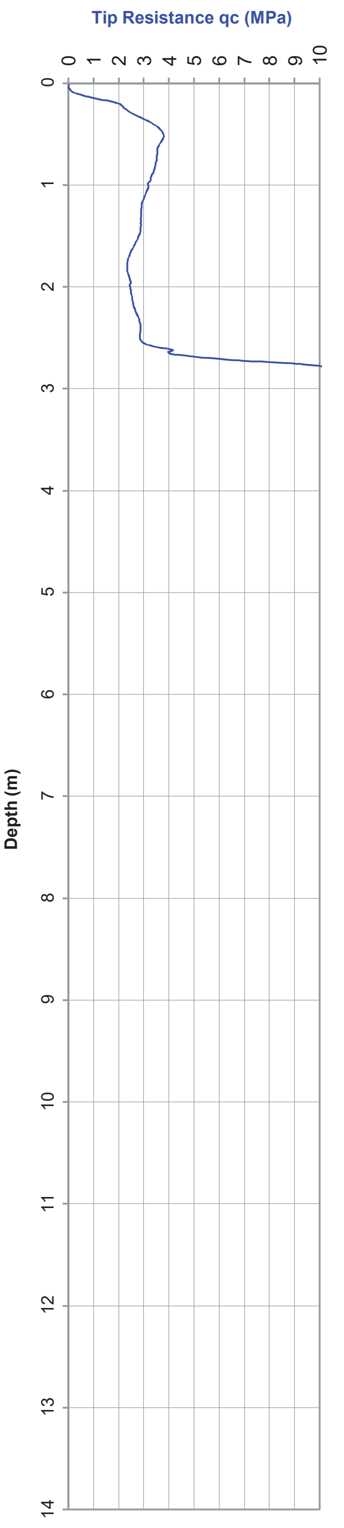
ELECTRIC FRICTION-CONE PENETROMETER

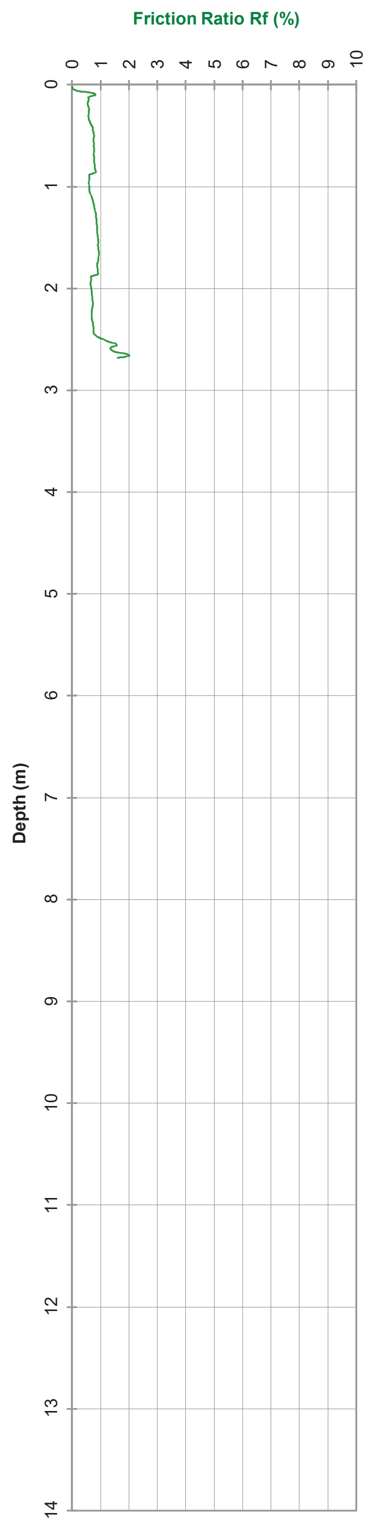
CLIENT: Urban Quarter
PROJECT: Lot 19 Toronga Place
LOCATION: Eglinton

Job No.: PER2018-0005
RL (m):
Co-ords:

Probe I.D
CPT 17
22-Feb-18







Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 2.7

Dummy probe to (m):

Refusal: Inclination

Cone I.D.: EC02

File: CW0074M

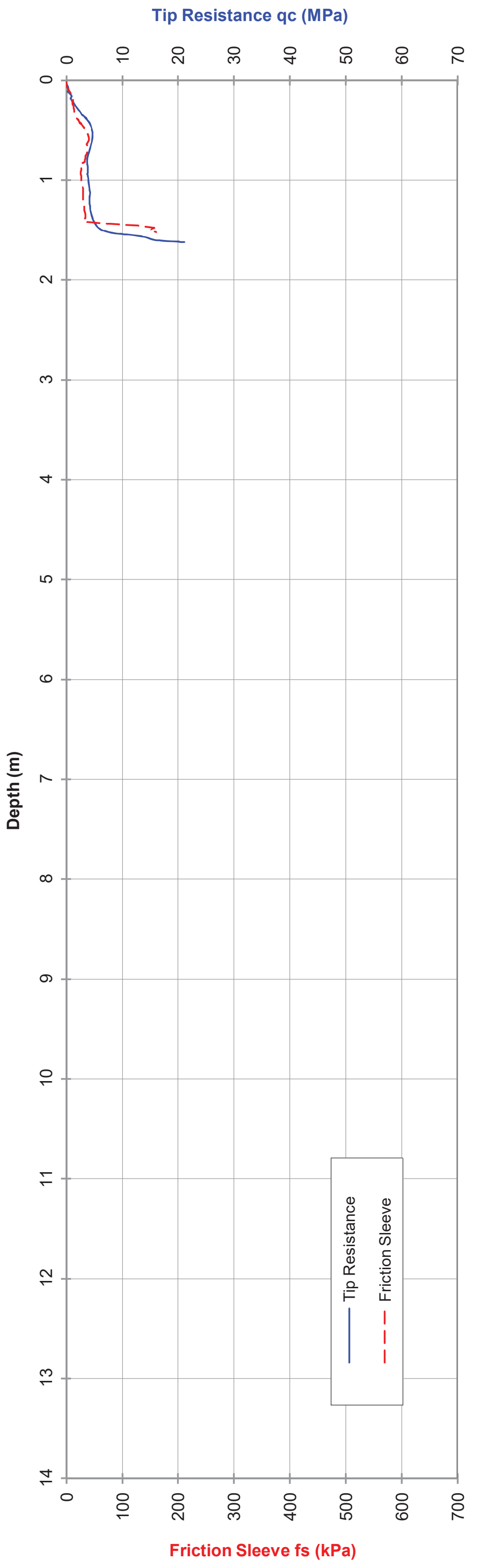
Rig Type: 12 tonne track (M1)

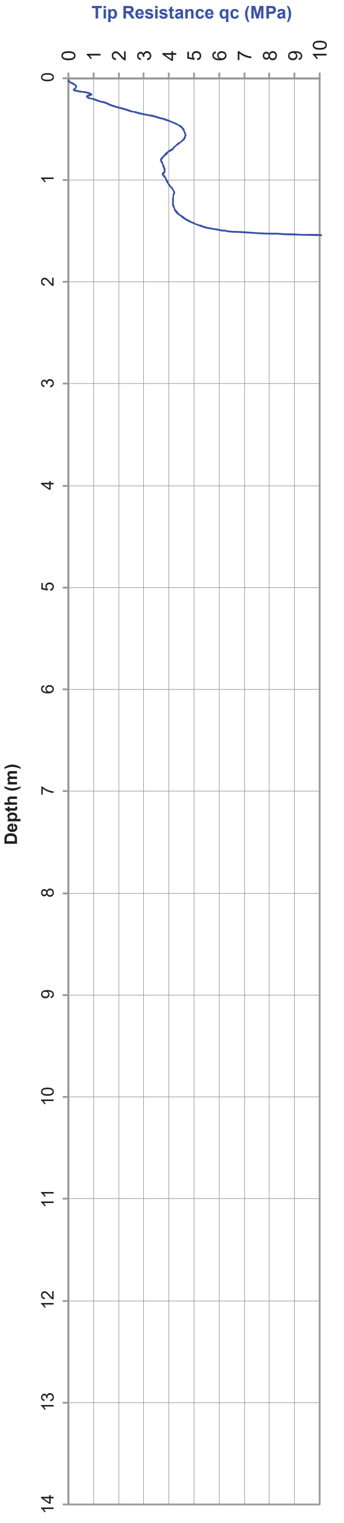
ELECTRIC FRICTION-CONE PENETROMETER

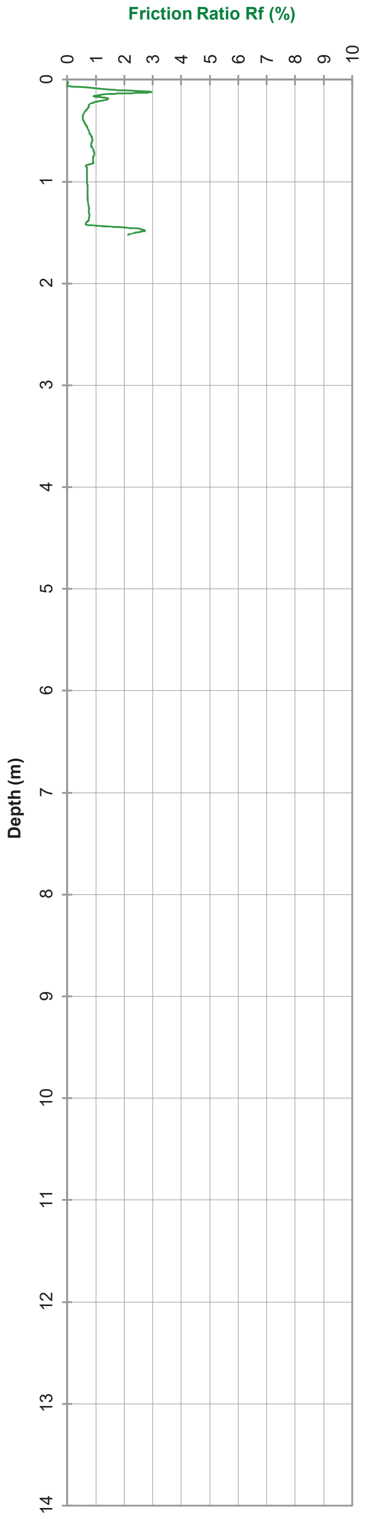
CLIENT: Urban Quarter
PROJECT: Lot 19 Toronga Place
LOCATION: Eglinton

Job No.: PER2018-0005
RL (m):
Co-ords:

Probe I.D
CPT 16
22-Feb-18







PROBEDRILL GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 1.6
Dummy probe to (m):
Refusal: Inclination

Cone I.D.: EC02
File: CW0075M
Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Urban Quarter

PROJECT: Lot 19 Toronga Place

LOCATION: Eglinton

Job No.: PER2018-0005

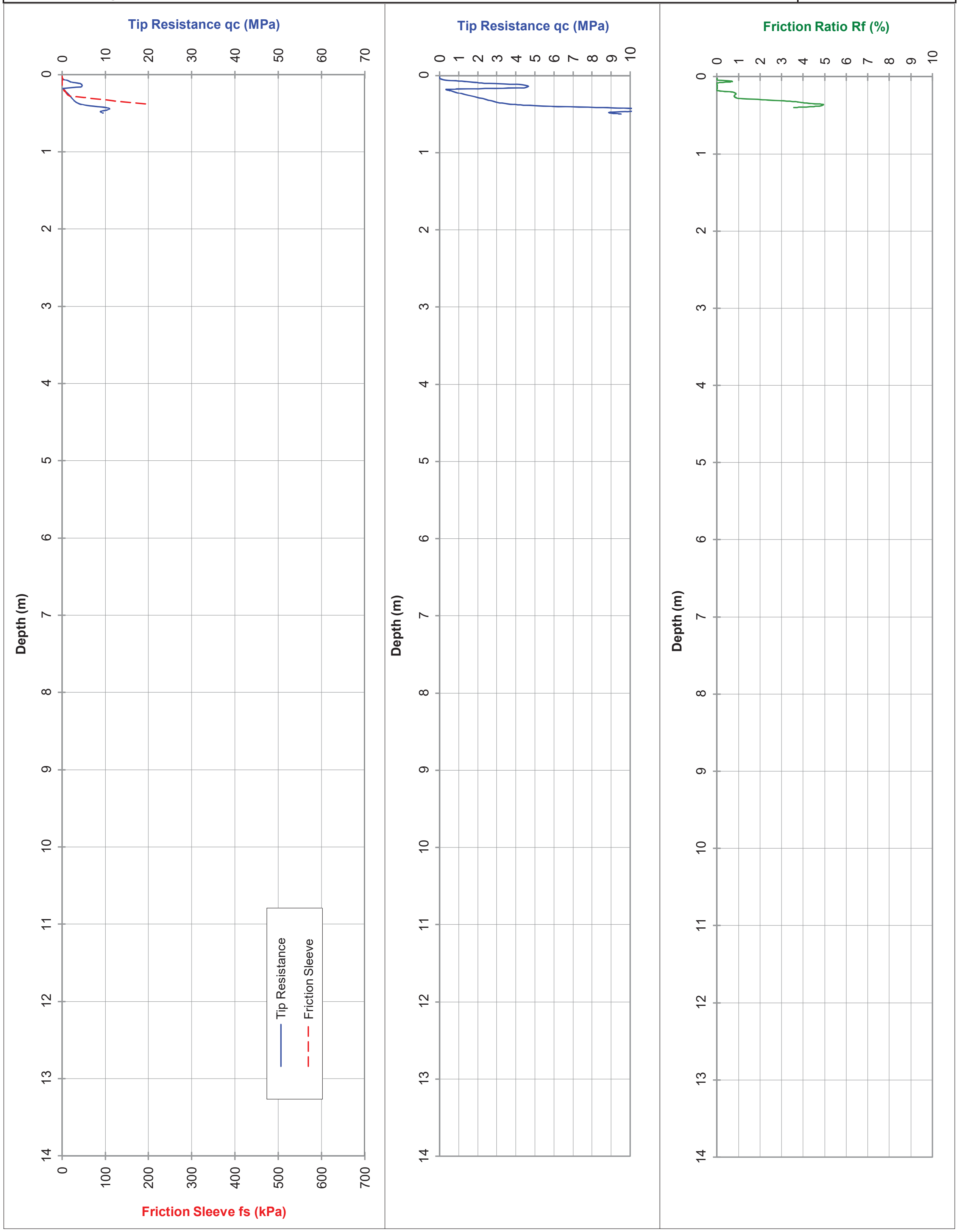
RL (m):

Co-ords:

Probe I.D

CPT 18

22-Feb-18



Tested in accordance with AS 1289.6.5.1-1999 and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 0.5

Dummy probe to (m):

Refusal: Inclination

Cone I.D.: EC02

File: CW0076M

Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Urban Quarter

PROJECT: Lot 19 Toronga Place

LOCATION: Eglinton

Job No.: PER2018-0005

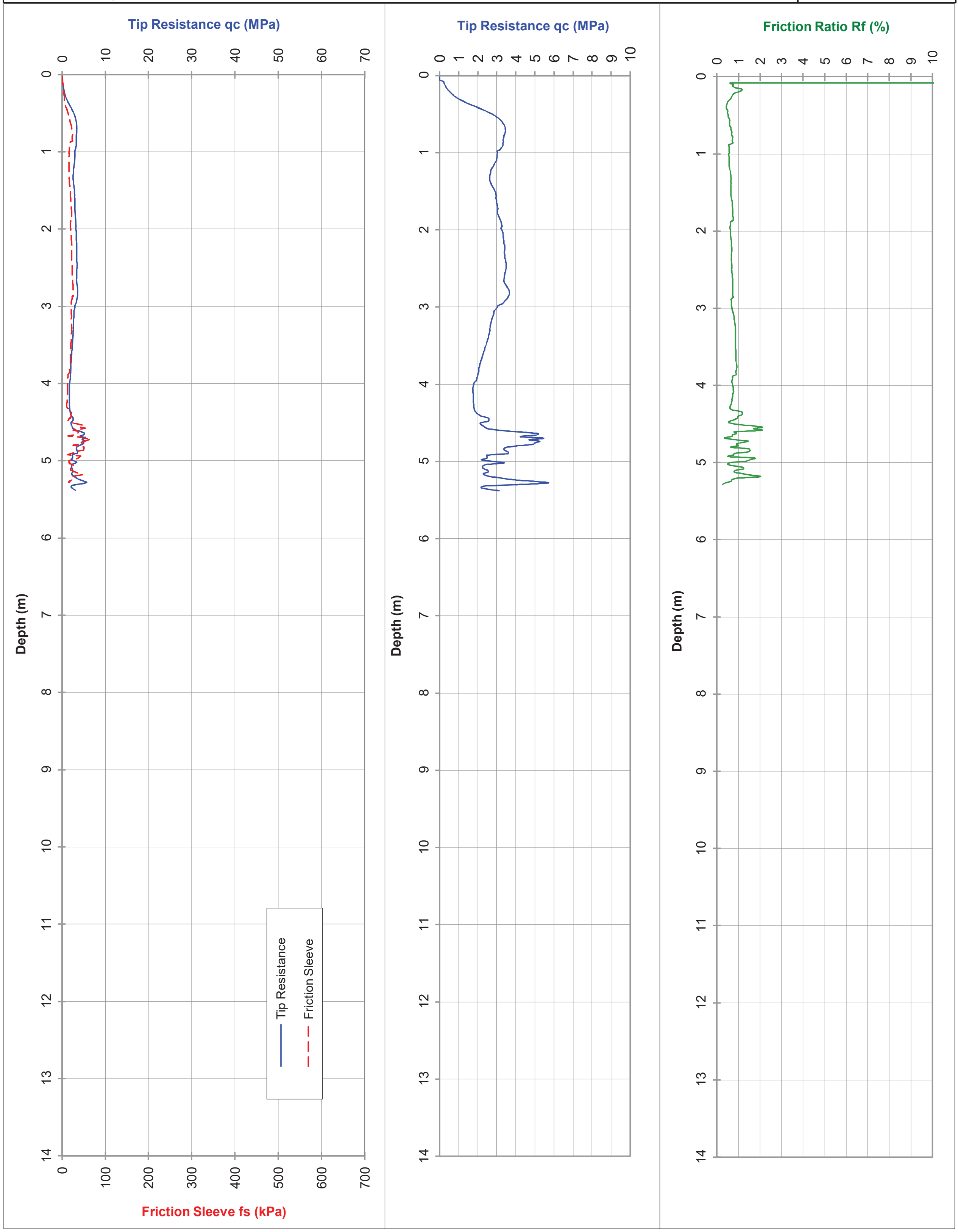
RL (m):

Co-ords:

Probe I.D

CPT 7

22-Feb-18



PROBEDRILL GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 5.3

Dummy probe to (m):

Refusal: Inclination

Cone I.D.: EC02

File: CW0077M

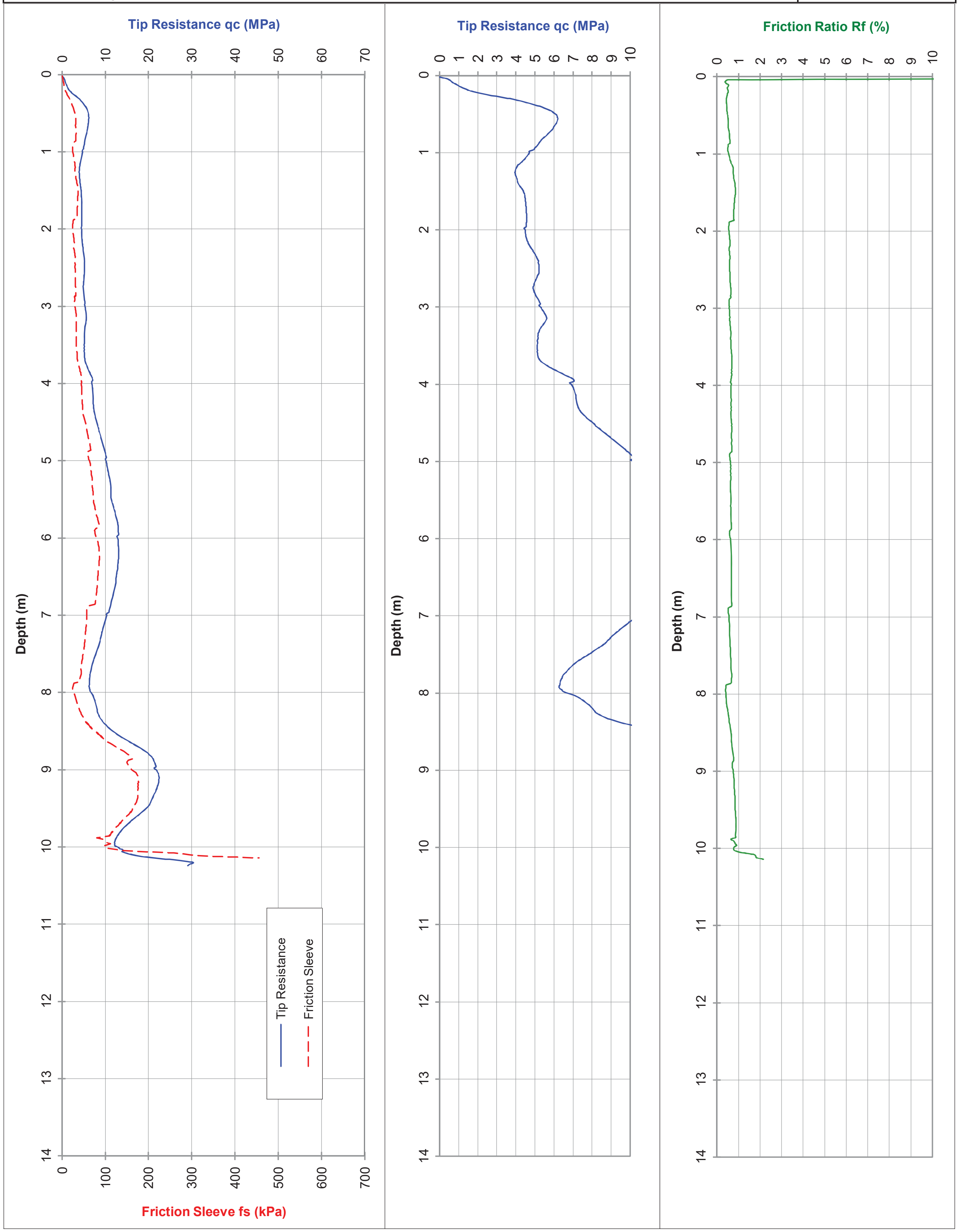
Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Urban Quarter
PROJECT: Lot 19 Toronga Place
LOCATION: Eglinton

Job No.: PER2018-0005
RL (m):
Co-ords:

Probe I.D
CPT 04
22-Feb-18



PROBEDRILL
GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 10.2
Dummy probe to (m):
Refusal: Inclination

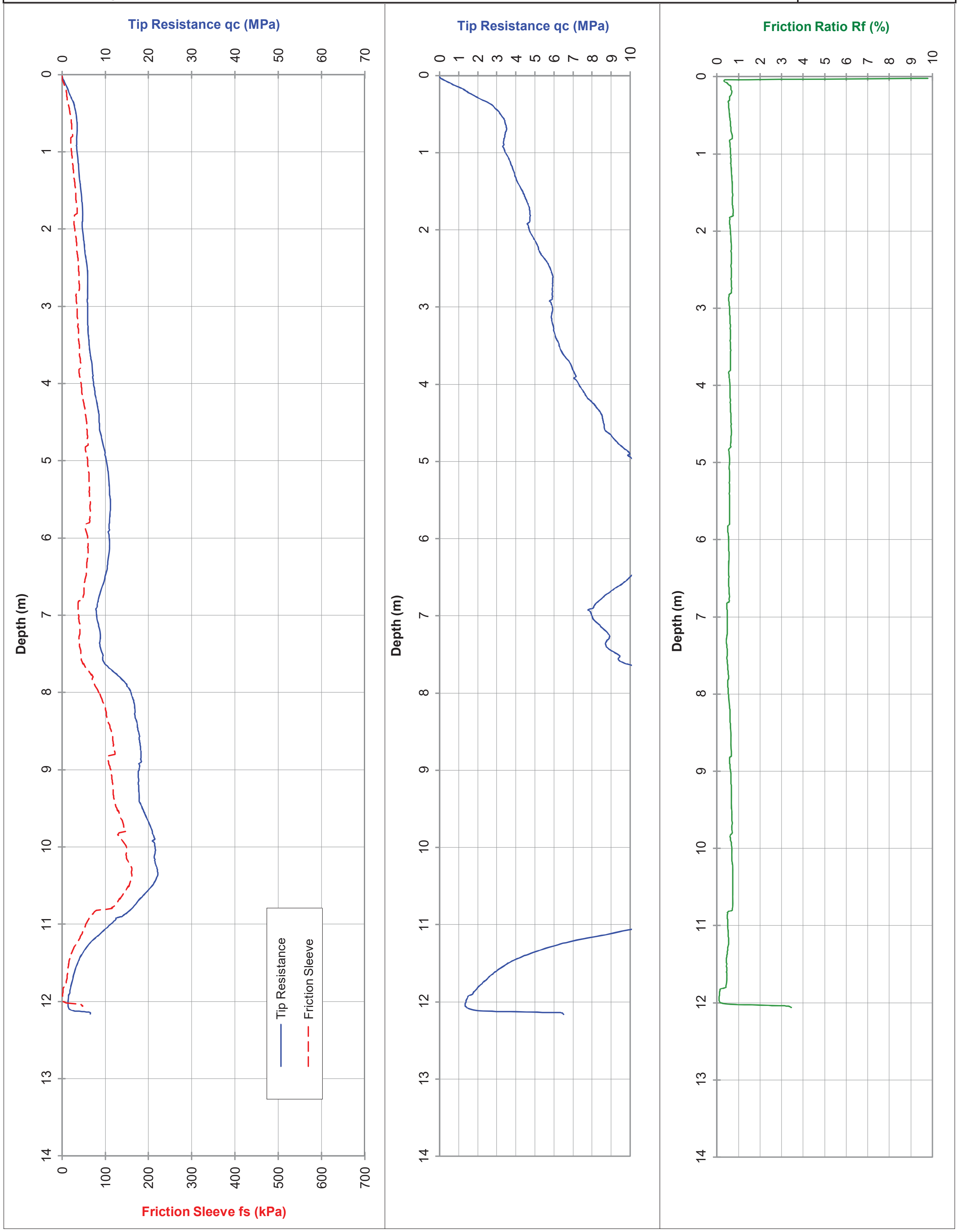
Cone I.D.: EC02
File: CW0078M
Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Urban Quarter
PROJECT: Lot 19 Toronga Place
LOCATION: Eglinton

Job No.: PER2018-0005
RL (m):
Co-ords:

Probe I.D
CPT 01
22-Feb-18



PROBEDRILL
GEOTECHNICAL SURVEY
Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 12.1
Dummy probe to (m):
Refusal: Inclination

Cone I.D.: EC02
File: CW0079M
Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Urban Quarter

PROJECT: Lot 19 Toronga Place

LOCATION: Eglinton

Job No.: PER2018-0005

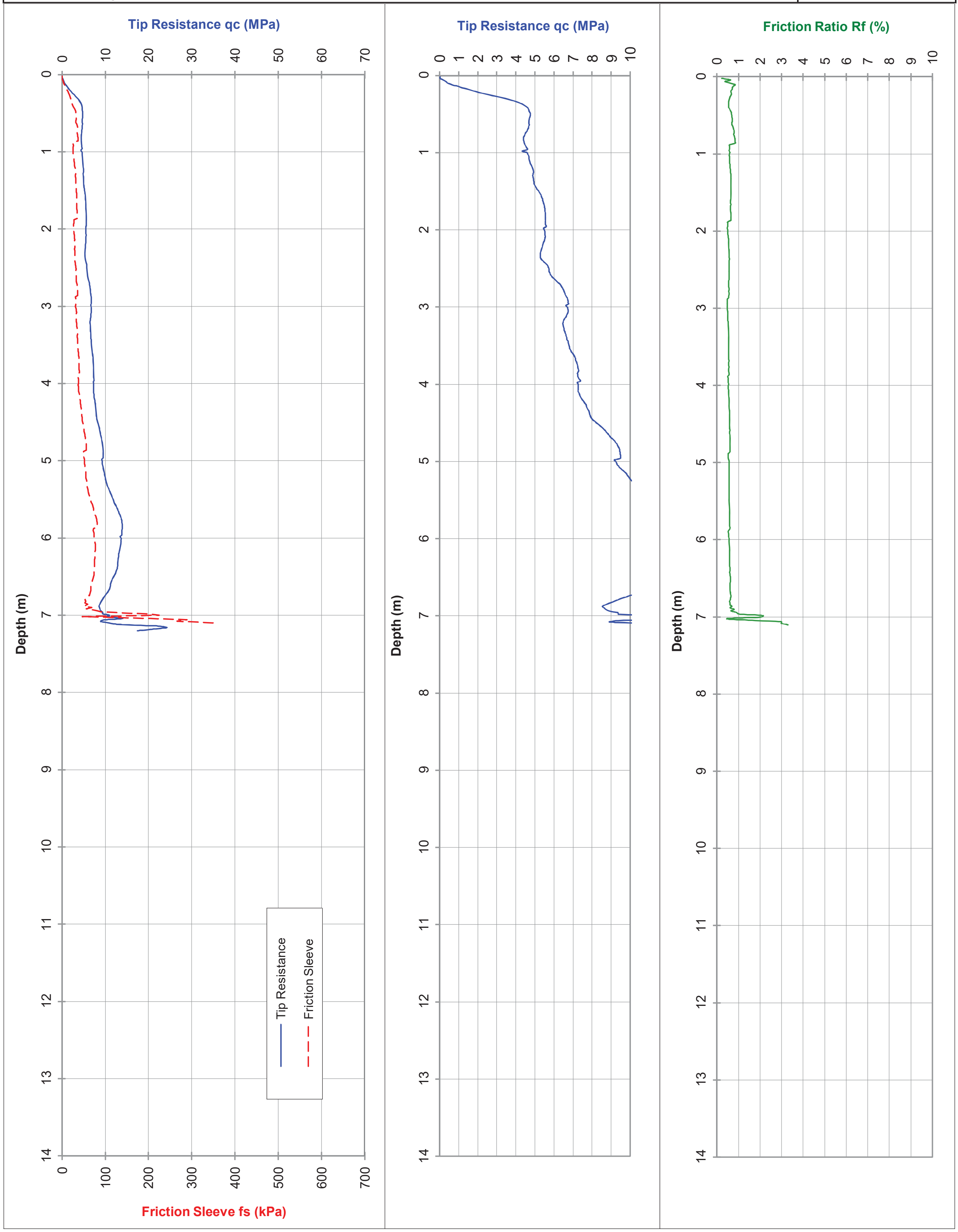
RL (m):

Co-ords:

Probe I.D

CPT 02

22-Feb-18



PROBEDRILL
GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 7.2

Dummy probe to (m):

Refusal: Inclination

Cone I.D.: EC02

File: CW0080M

Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

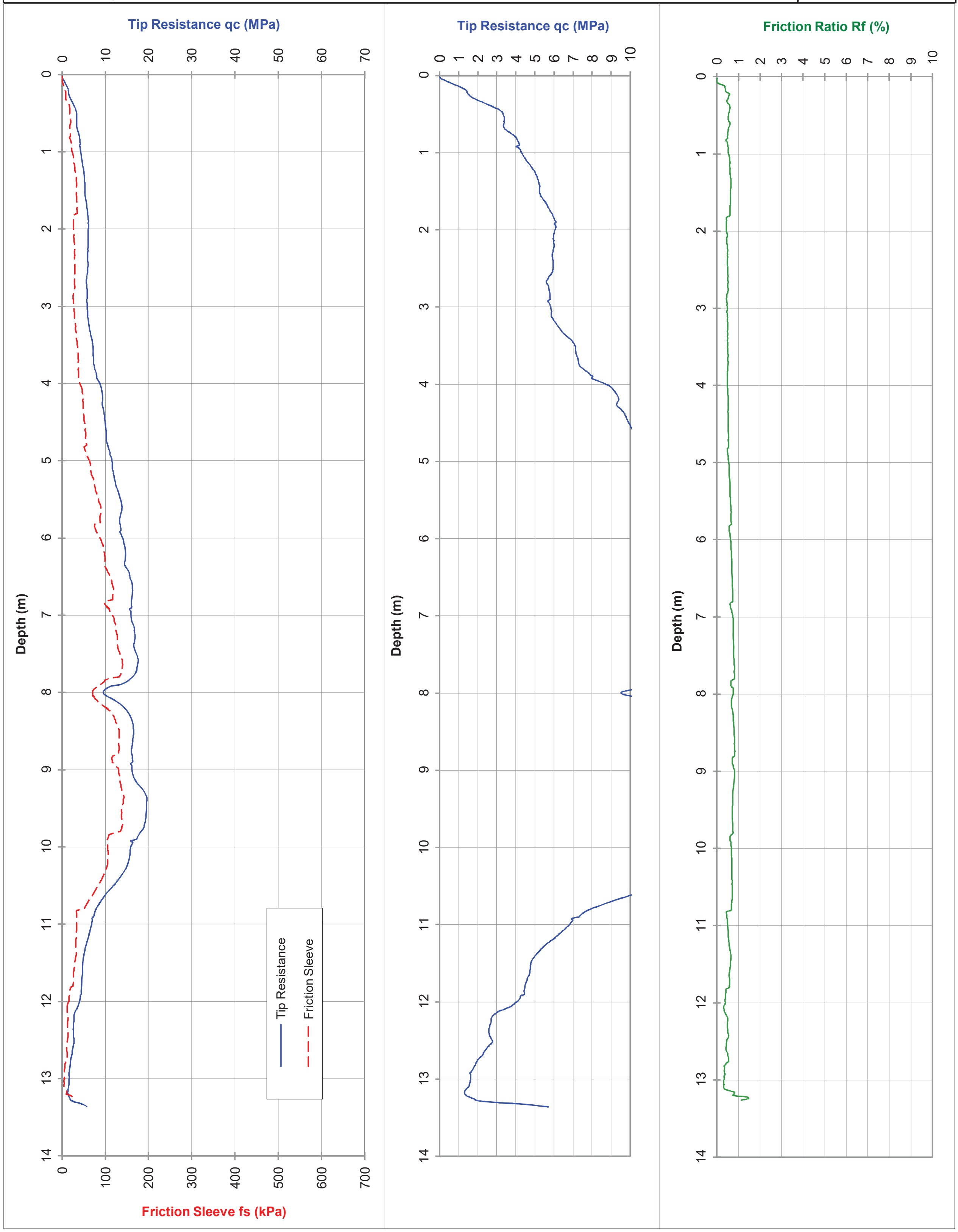
CLIENT: Urban Quarter
PROJECT: Lot 19 Toronga Place
LOCATION: Eglinton

Job No.: PER2018-0005
RL (m):
Co-ords:

Probe I.D

CPT 03

22-Feb-18



PROBEDRILL
GEOTECHNICAL SURVEY

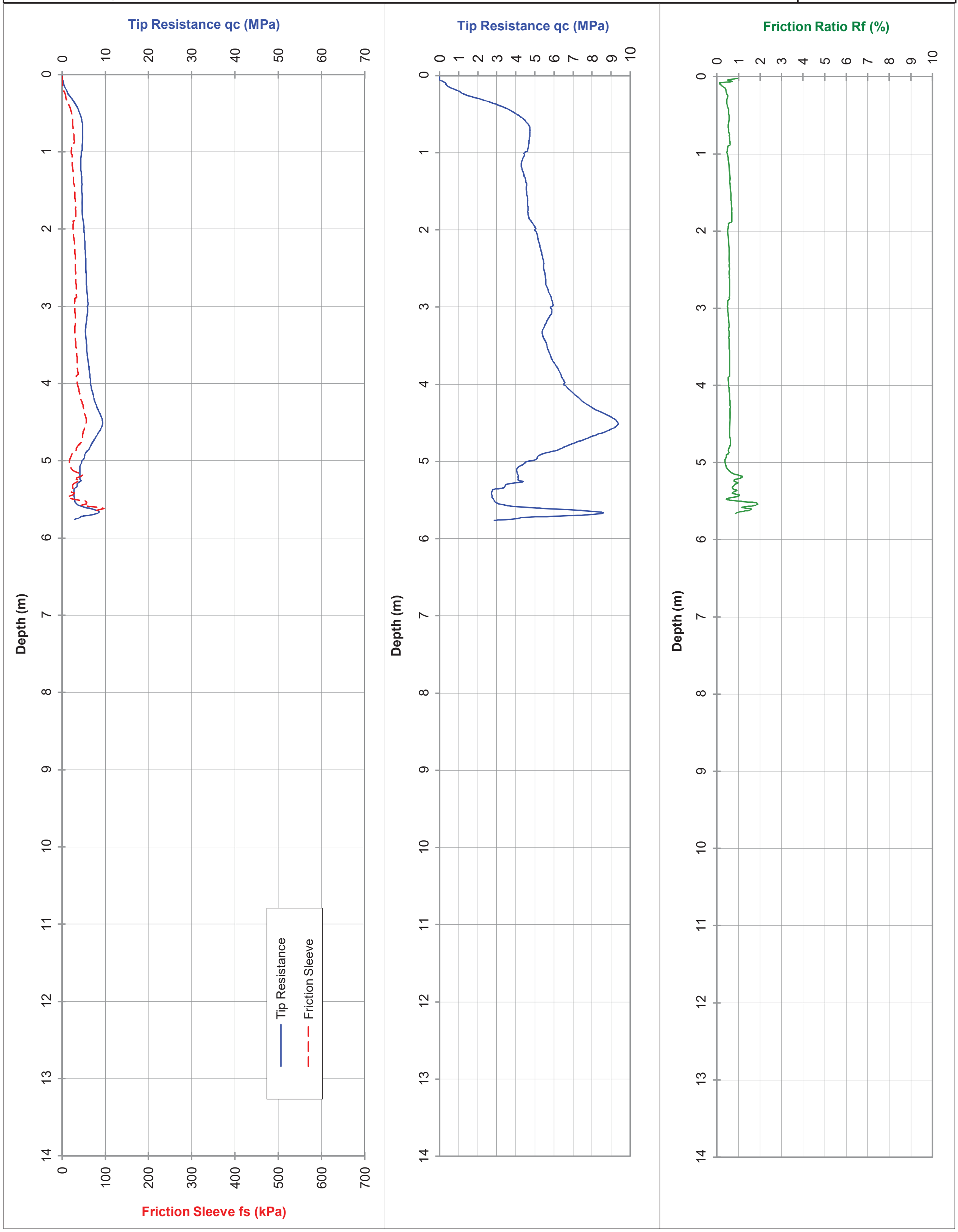
Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 13.6
Dummy probe to (m):
Refusal: Inclination

Cone I.D.: EC02
File: CW0081M
Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT:	Urban Quarter	Job No.: PER2018-0005	Probe I.D
PROJECT:	Lot 19 Toronga Place	RL (m):	**CPT 05**
LOCATION:	Eglinton	Co-ords:	22-Feb-18



PROBEDRILL
GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 5.7

Dummy probe to (m):

Refusal: Inclination

Cone I.D.: EC02

File: CW0082M

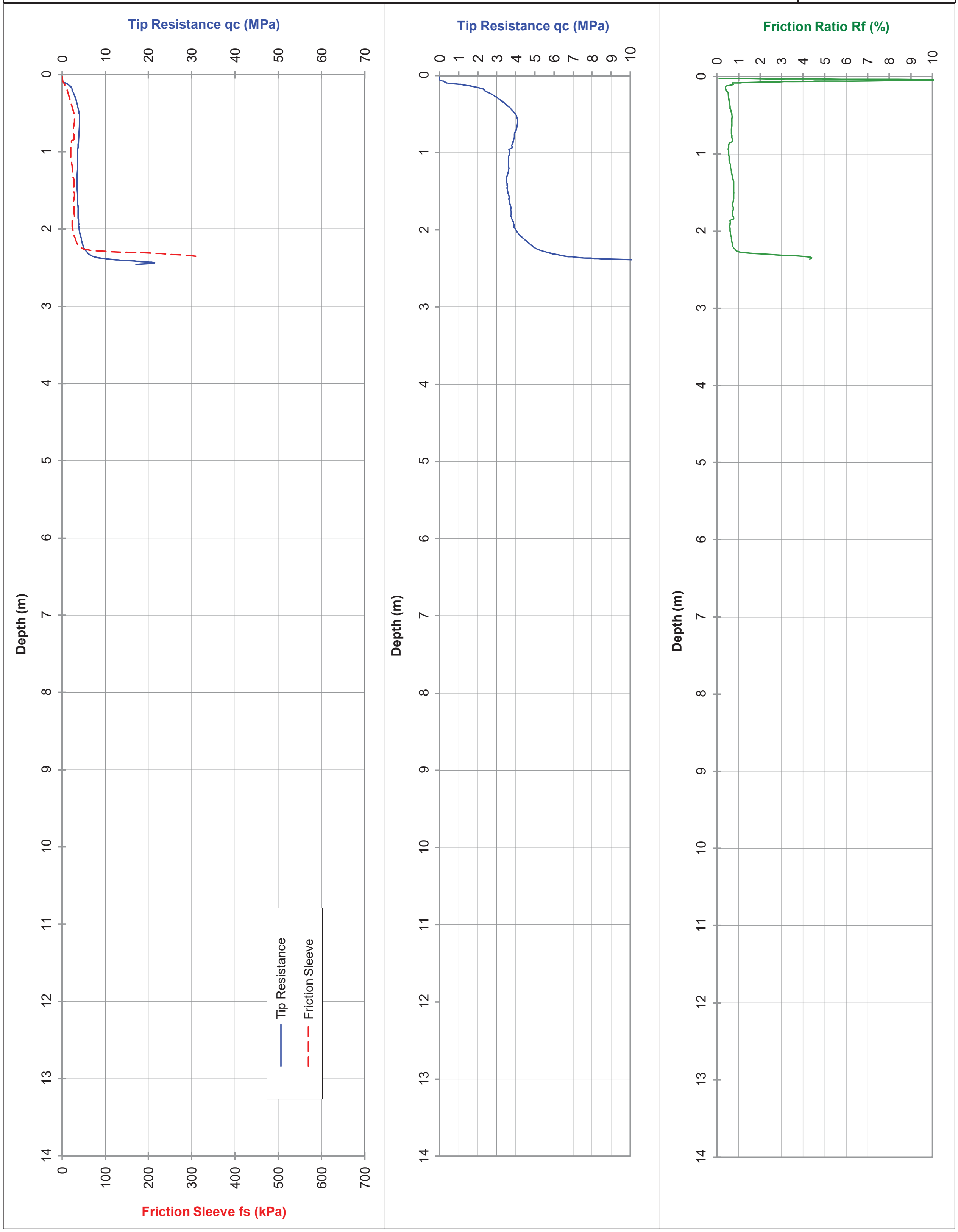
Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Urban Quarter
PROJECT: Lot 19 Toronga Place
LOCATION: Eglinton

Job No.: PER2018-0005
RL (m):
Co-ords:

Probe I.D
CPT 27
22-Feb-18



PROBEDRILL
GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 2.4

Dummy probe to (m):

Refusal: Inclination

Cone I.D.: EC02

File: CW0083M

Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Urban Quarter

PROJECT: Lot 19 Toronga Place

LOCATION: Eglinton

Job No.: PER2018-0005

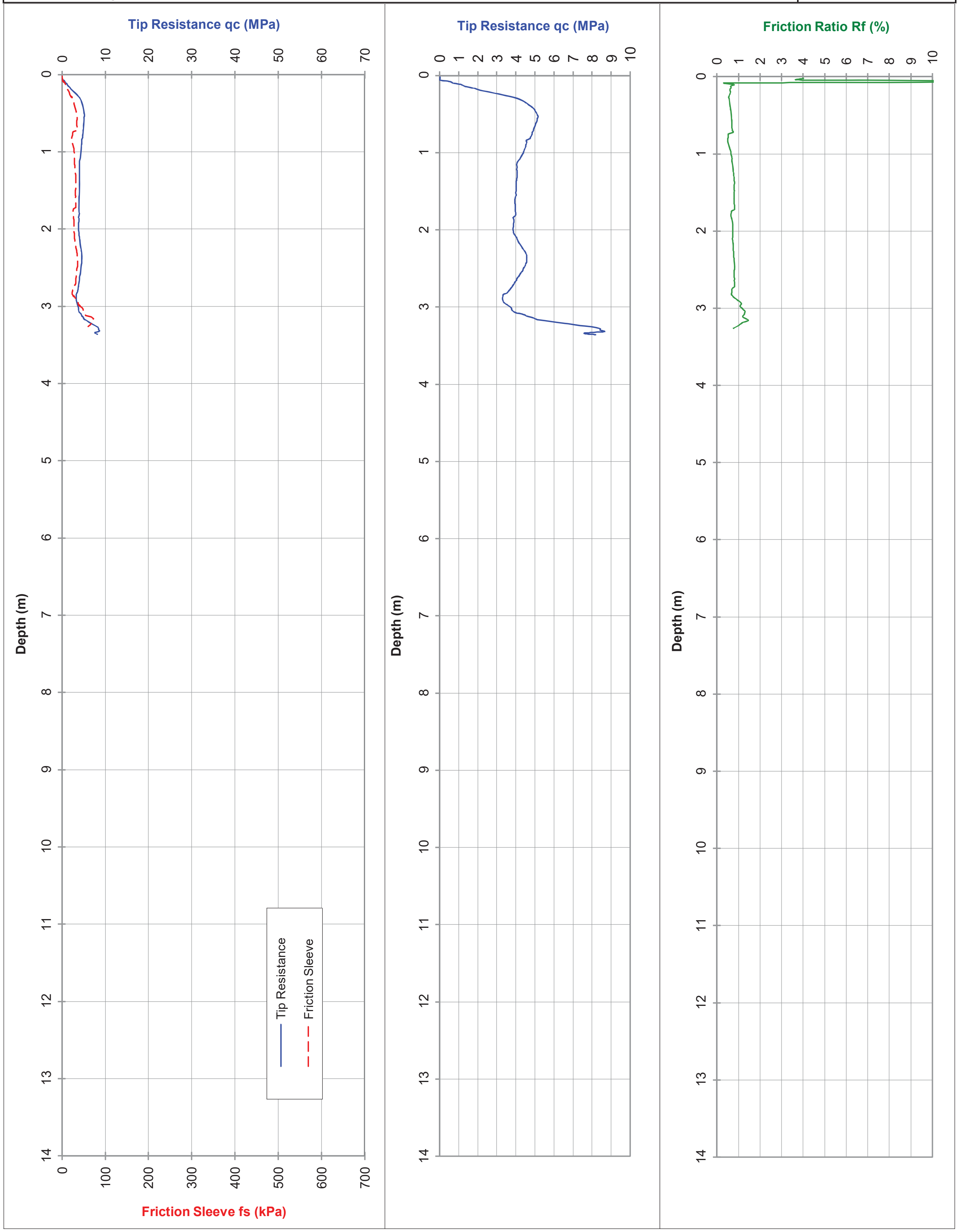
RL (m):

Co-ords:

Probe I.D

CPT 25

22-Feb-18



PROBEDRILL
GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 3.3

Dummy probe to (m):

Refusal: Inclination

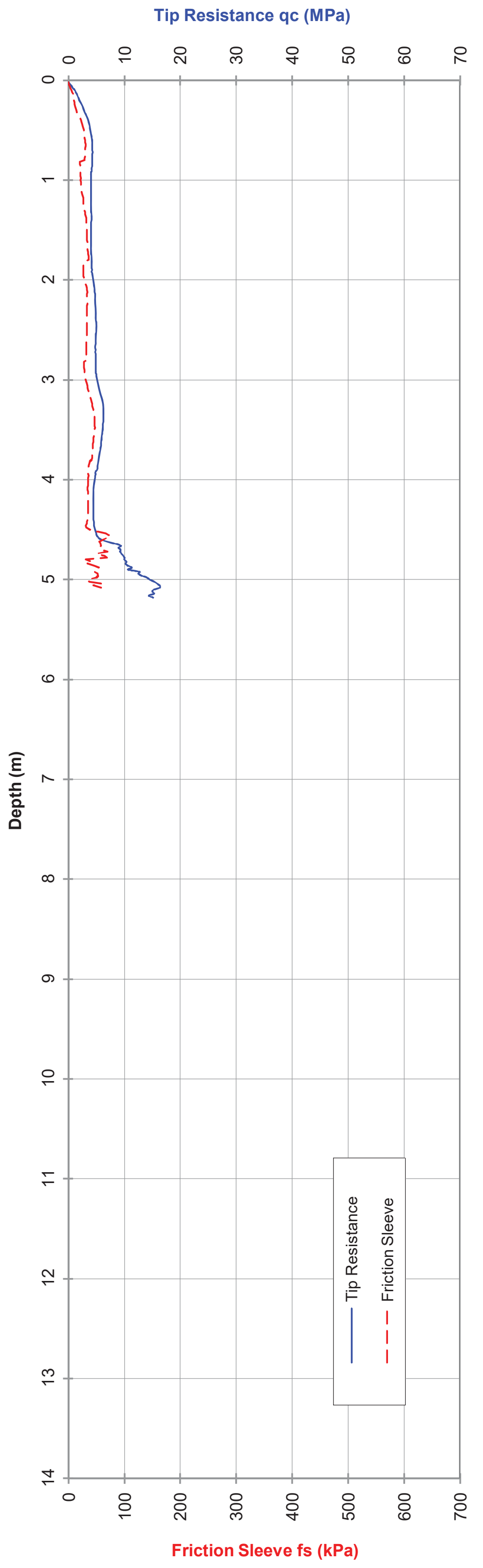
Cone I.D.: EC02

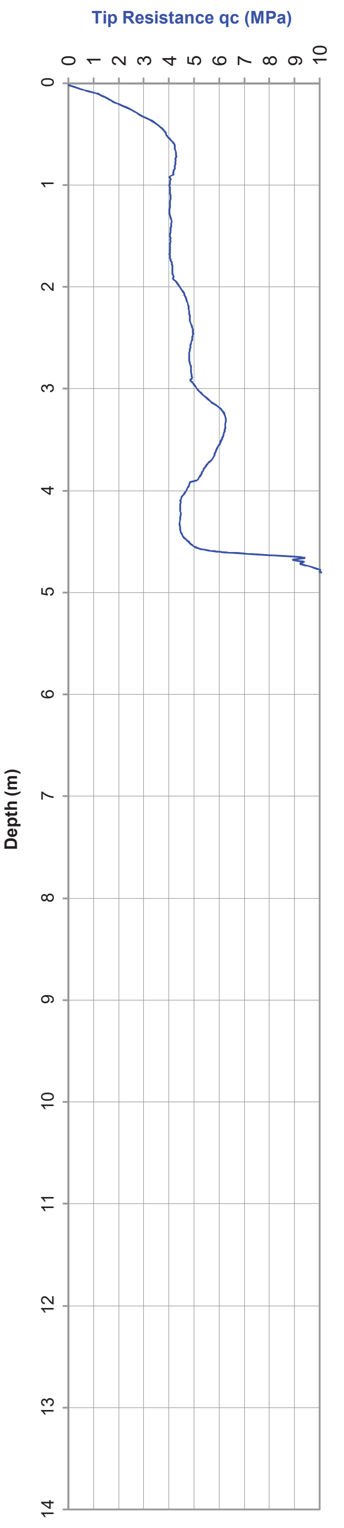
File: CW0084M

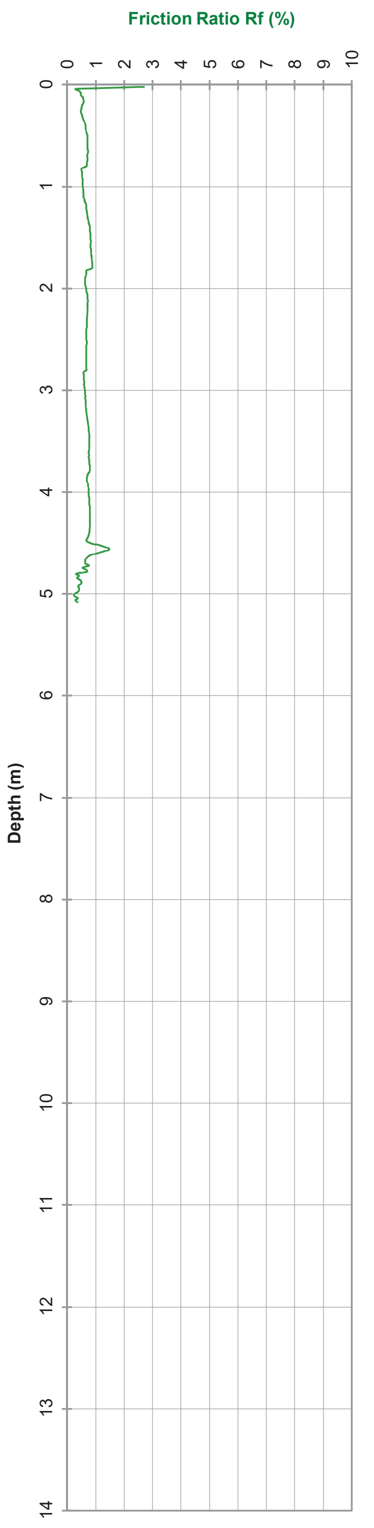
Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Urban Quarter	Job No.: PER2018-0005	Probe I.D
PROJECT: Lot 19 Toronga Place	RL (m):	**CPT 24**
LOCATION: Eglinton	Co-ords:	22-Feb-18







PROBEDRILL
GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 5.2

Dummy probe to (m):

Refusal:

Cone I.D.: EC02

File: CW0085M

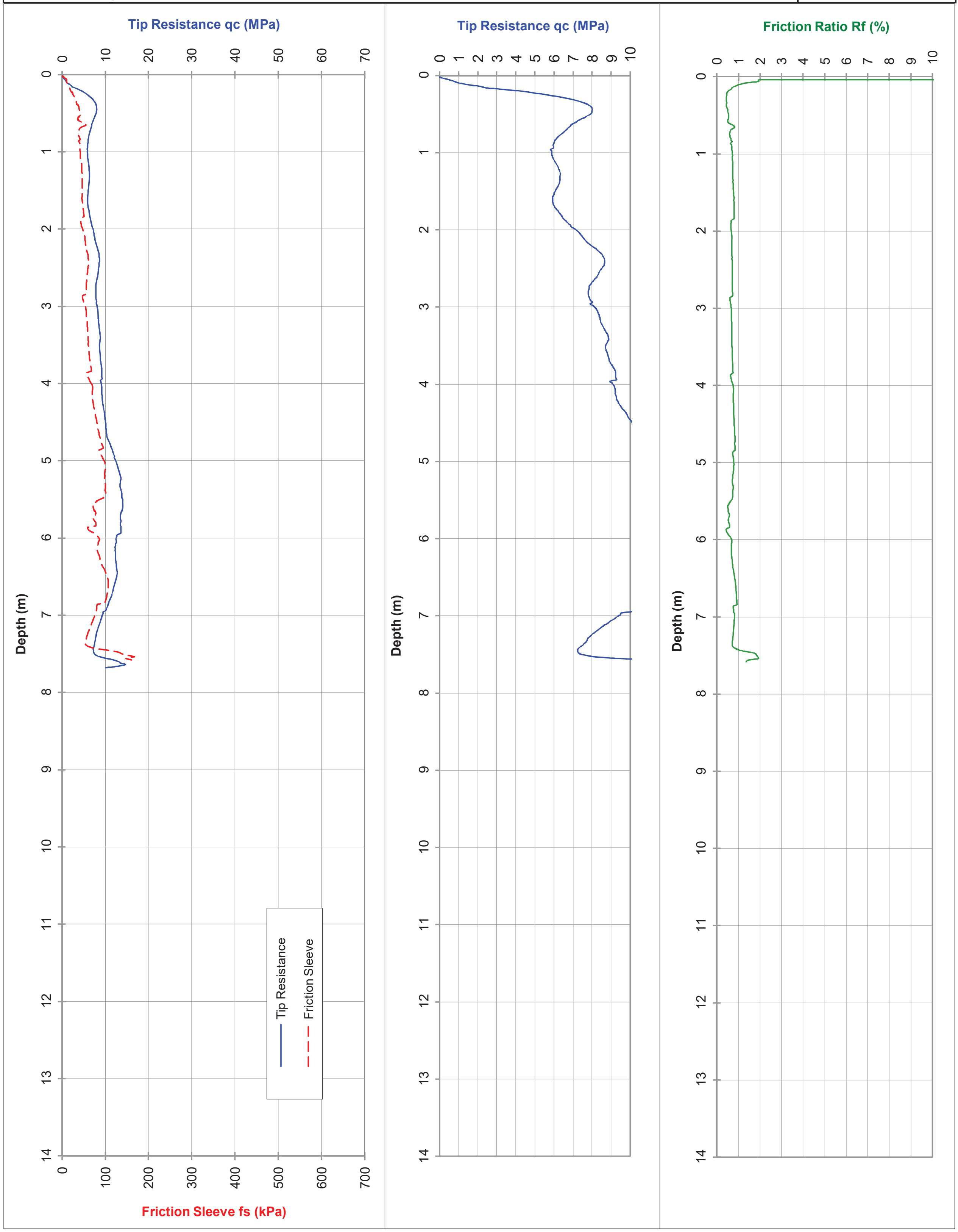
Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Urban Quarter
PROJECT: Lot 19 Toronga Place
LOCATION: Eglinton

Job No.: PER2018-0005
RL (m):
Co-ords:

Probe I.D
CPT 06
23-Feb-18



PROBEDRILL GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 7.6

Dummy probe to (m):

Refusal: Inclination

Cone I.D.: EC02

File: CW0086M

Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Urban Quarter

PROJECT: Lot 19 Toronga Place

LOCATION: Eglinton

Job No.: PER2018-0005

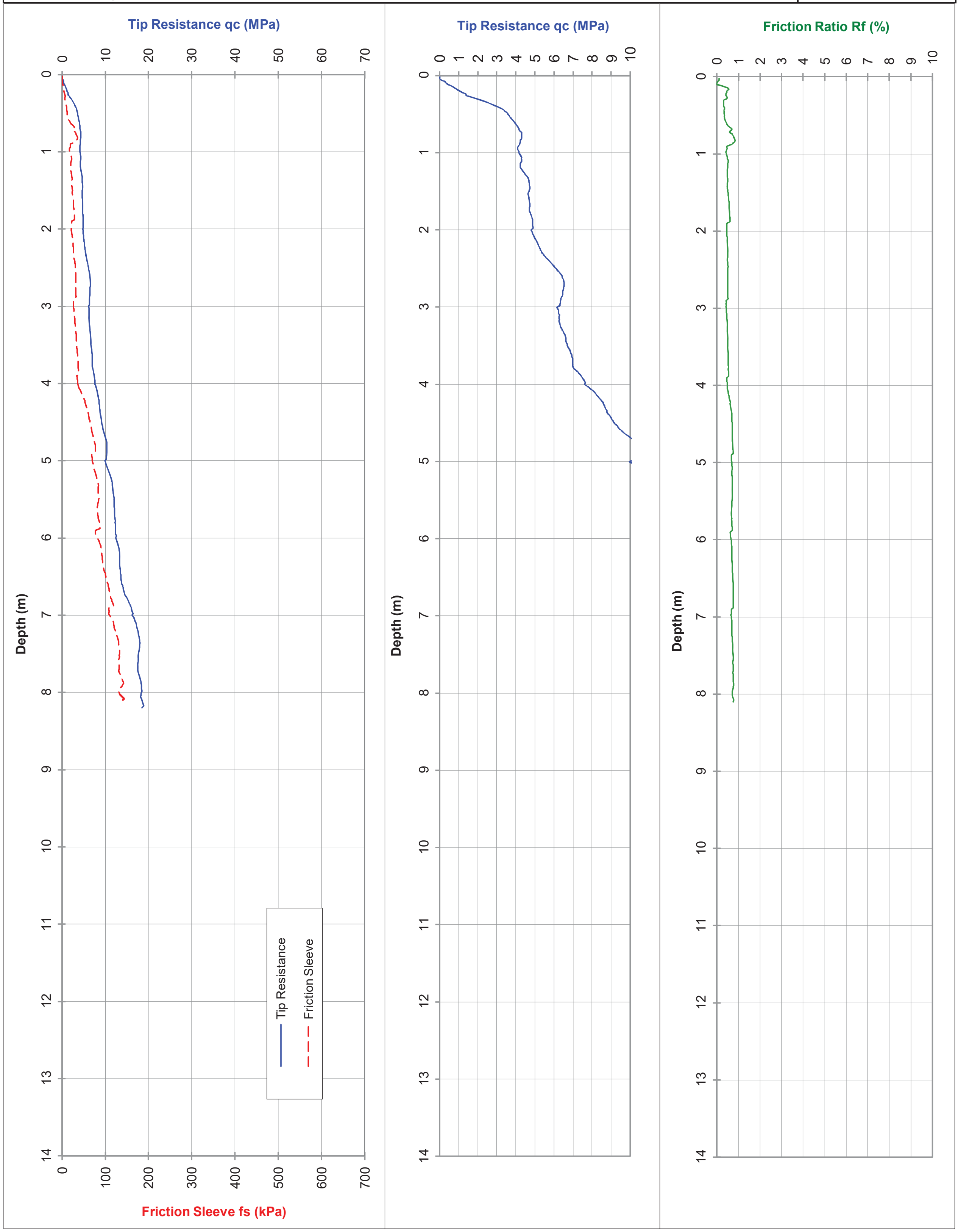
RL (m):

Co-ords:

Probe I.D

CPT 09

23-Feb-18



PROBEDRILL
GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 8.2

Dummy probe to (m):

Refusal:

Cone I.D.: EC02

File: CW0087M

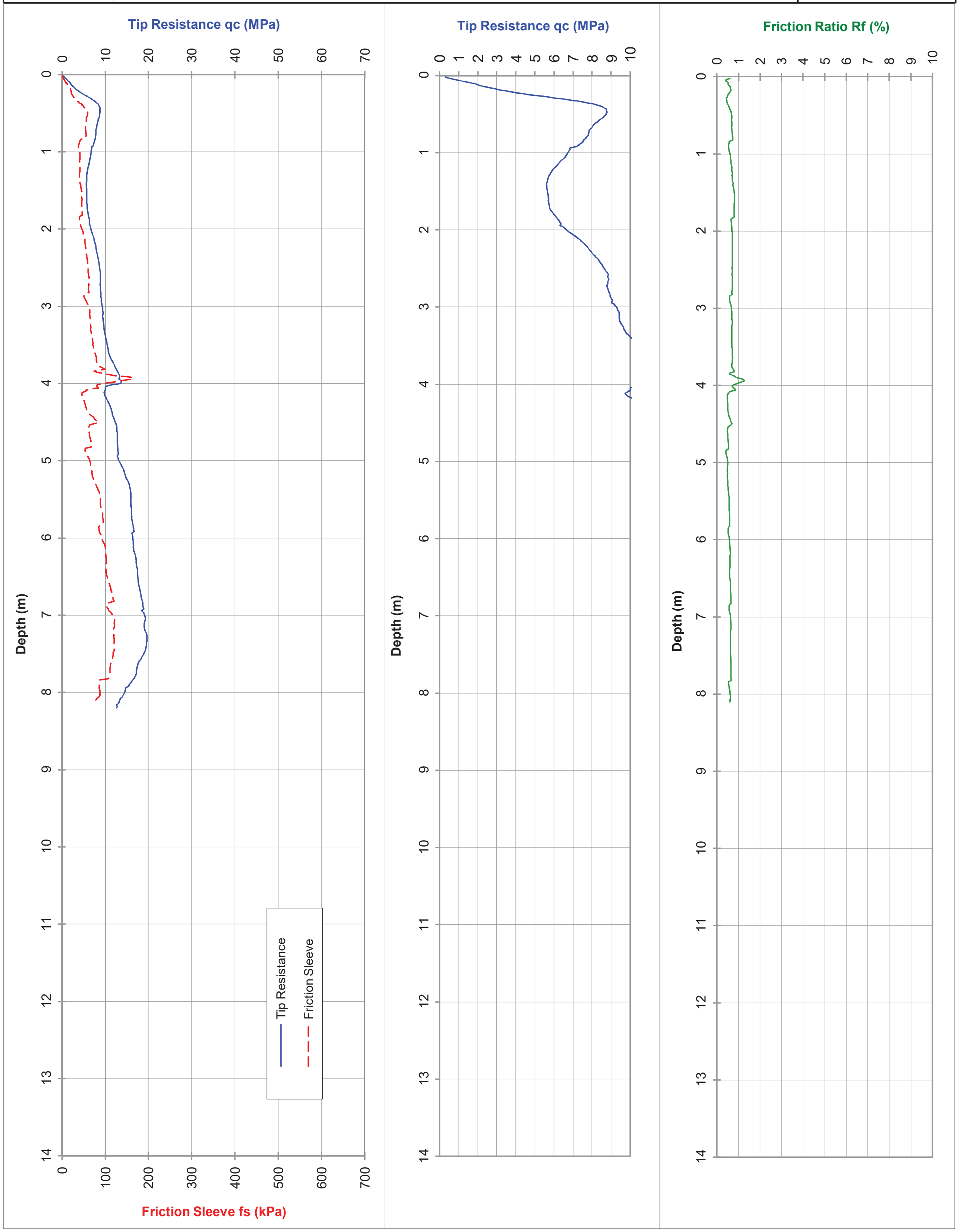
Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Urban Quarter
PROJECT: Lot 19 Toronga Place
LOCATION: Eglinton

Job No.: PER2018-0005
RL (m):
Co-ords:

Probe I.D
CPT 08
23-Feb-18



PROBEDRILL
GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 8.2

Dummy probe to (m):

Refusal:

Cone I.D.: EC02

File: CW0088M

Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

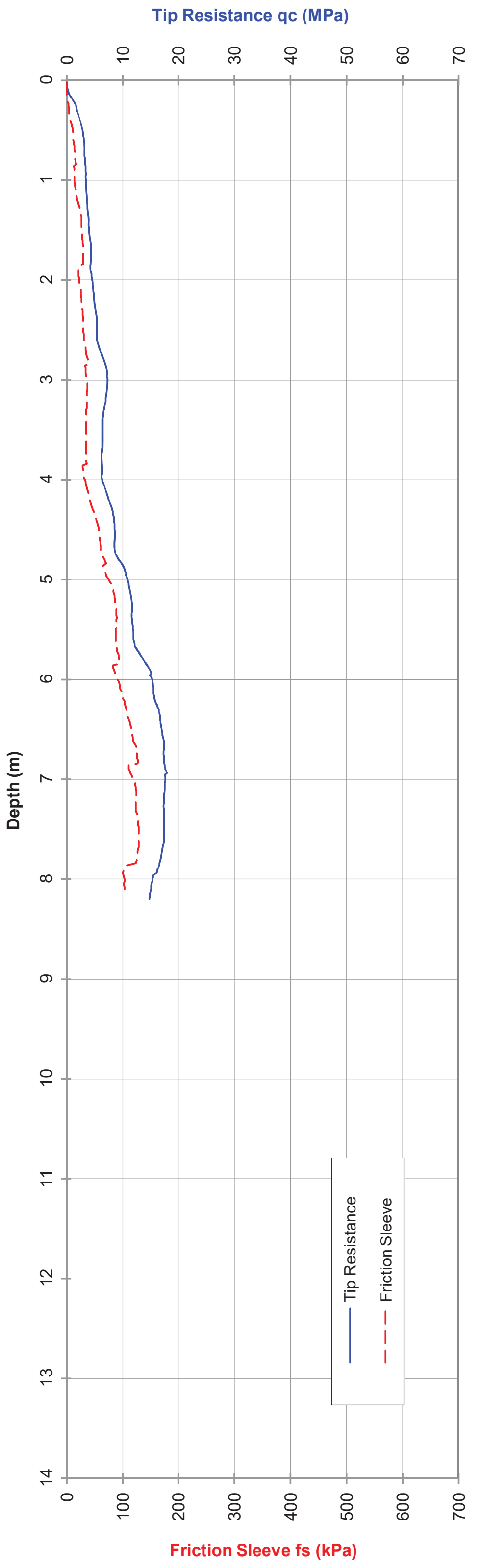
CLIENT: Urban Quarter
PROJECT: Lot 19 Toronga Place
LOCATION: Eglinton

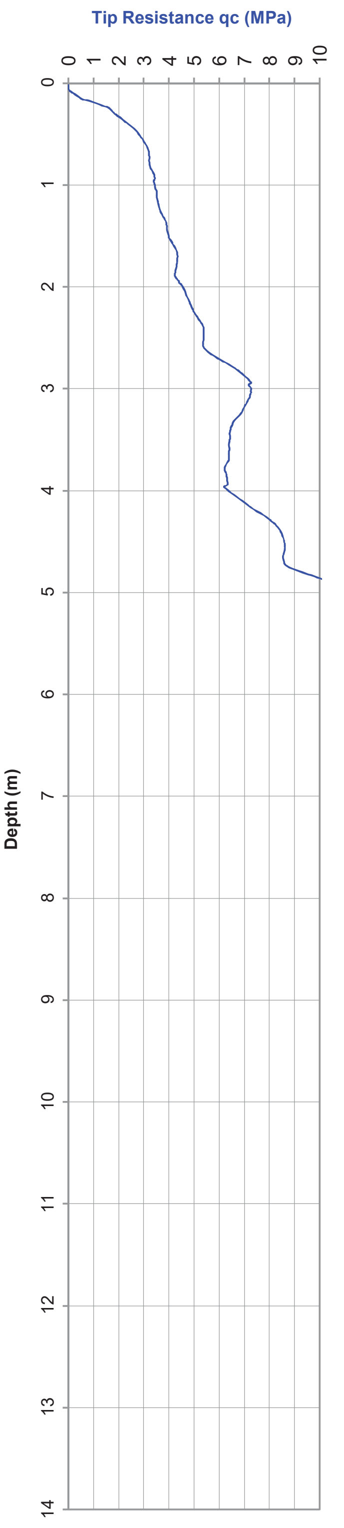
Job No.: PER2018-0005
RL (m):
Co-ords:

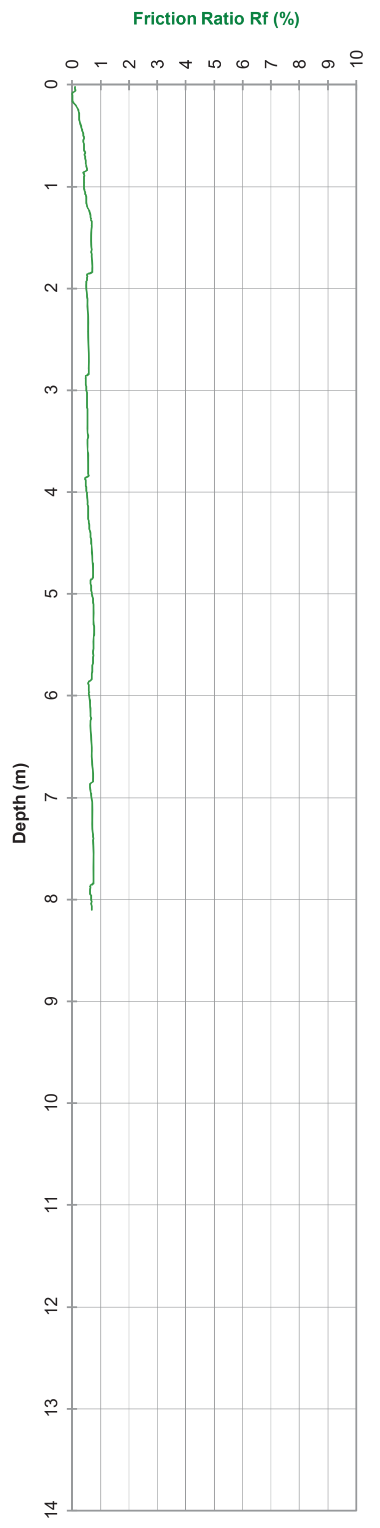
Probe I.D

CPT 10

23-Feb-18







PROBEDRILL
GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 8.2
Dummy probe to (m):
Refusal:

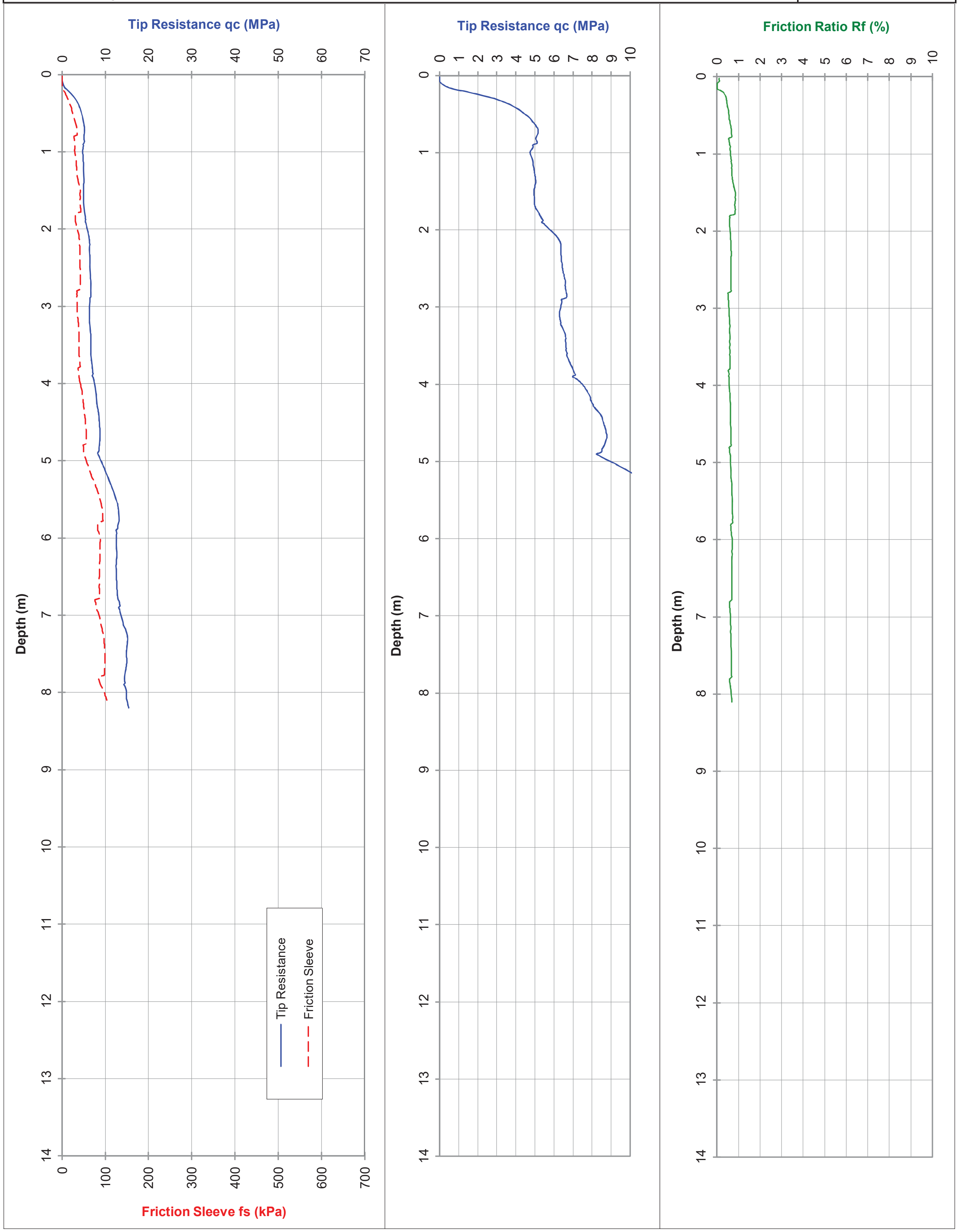
Cone I.D.: EC02
File: CW0089M
Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Urban Quarter
PROJECT: Lot 19 Toronga Place
LOCATION: Eglinton

Job No.: PER2018-0005
RL (m):
Co-ords:

Probe I.D
CPT 11
23-Feb-18



PROBEDRILL
GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 8.2
Dummy probe to (m):
Refusal:

Cone I.D.: EC02
File: CW0090M
Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Urban Quarter

PROJECT: Lot 19 Toronga Place

LOCATION: Eglinton

Job No.: PER2018-0005

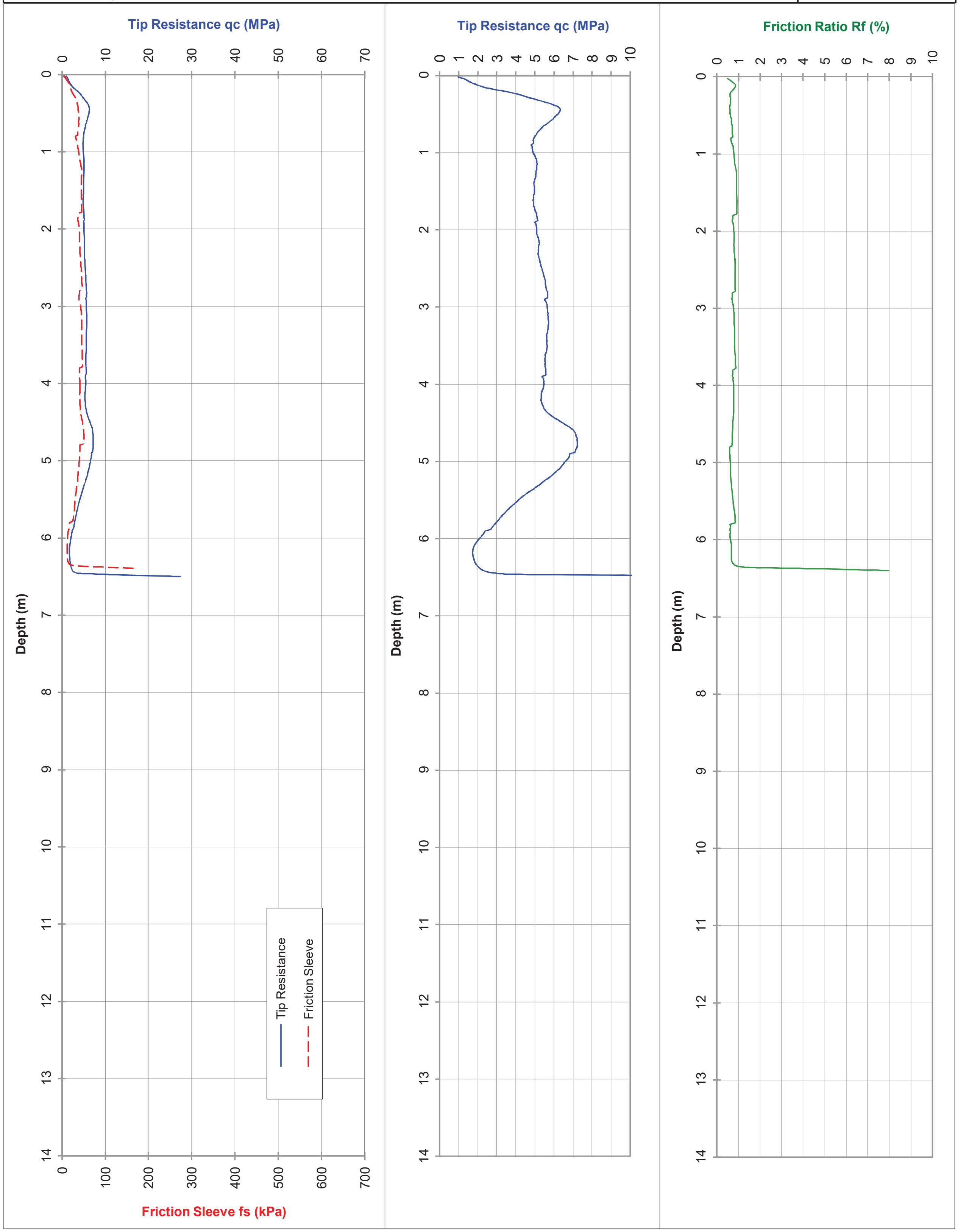
RL (m):

Co-ords:

Probe I.D

CPT 13

23-Feb-18



PROBEDRILL
GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 6.5

Dummy probe to (m):

Refusal: Inclination

Cone I.D.: EC02

File: CW0091M

Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

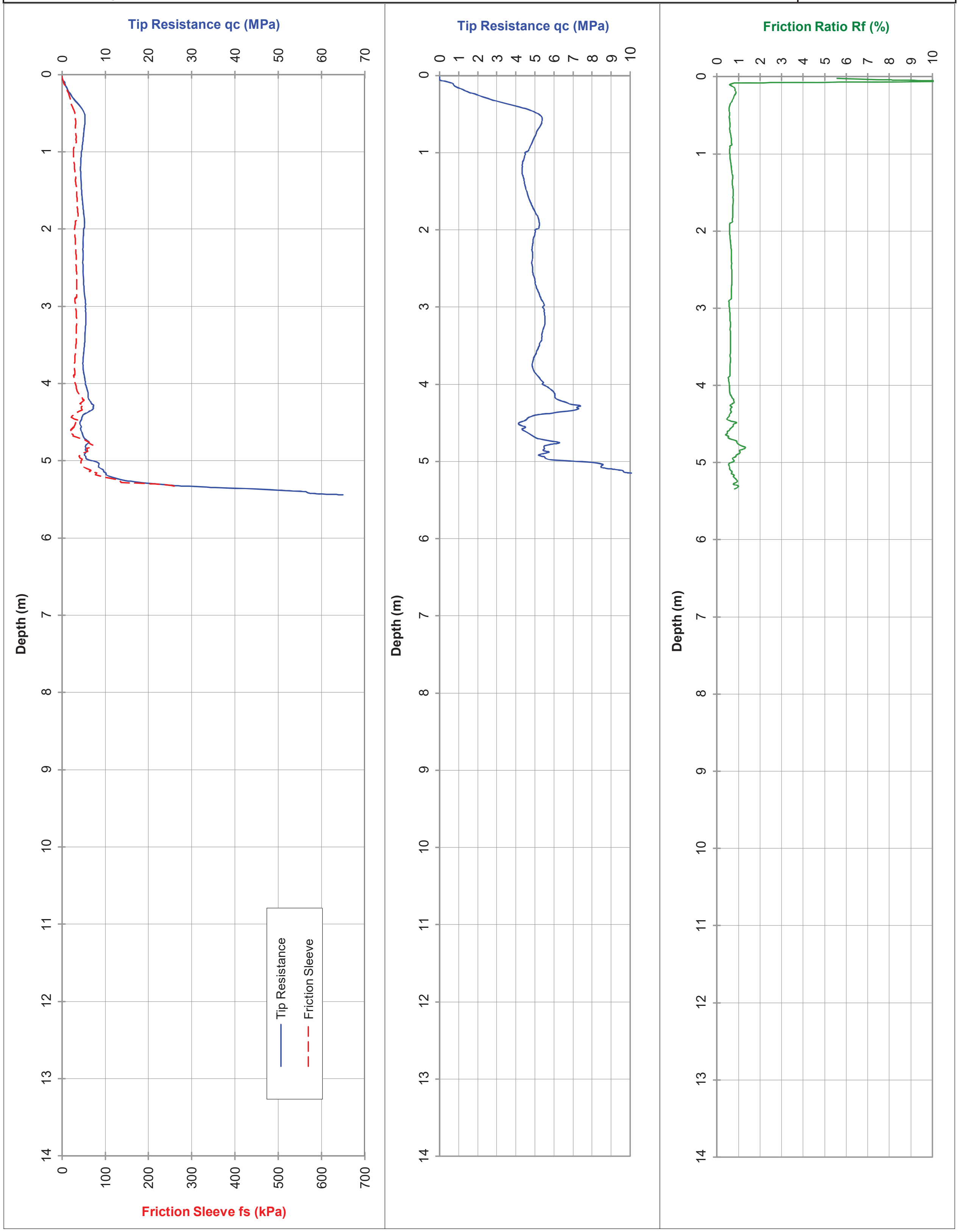
CLIENT: Urban Quarter
PROJECT: Lot 19 Toronga Place
LOCATION: Eglinton

Job No.: PER2018-0005
RL (m):
Co-ords:

Probe I.D

CPT 15

23-Feb-18



PROBEDRILL
GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 5.4

Dummy probe to (m):

Refusal: 65MPa

Cone I.D.: EC02

File: CW0092M

Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

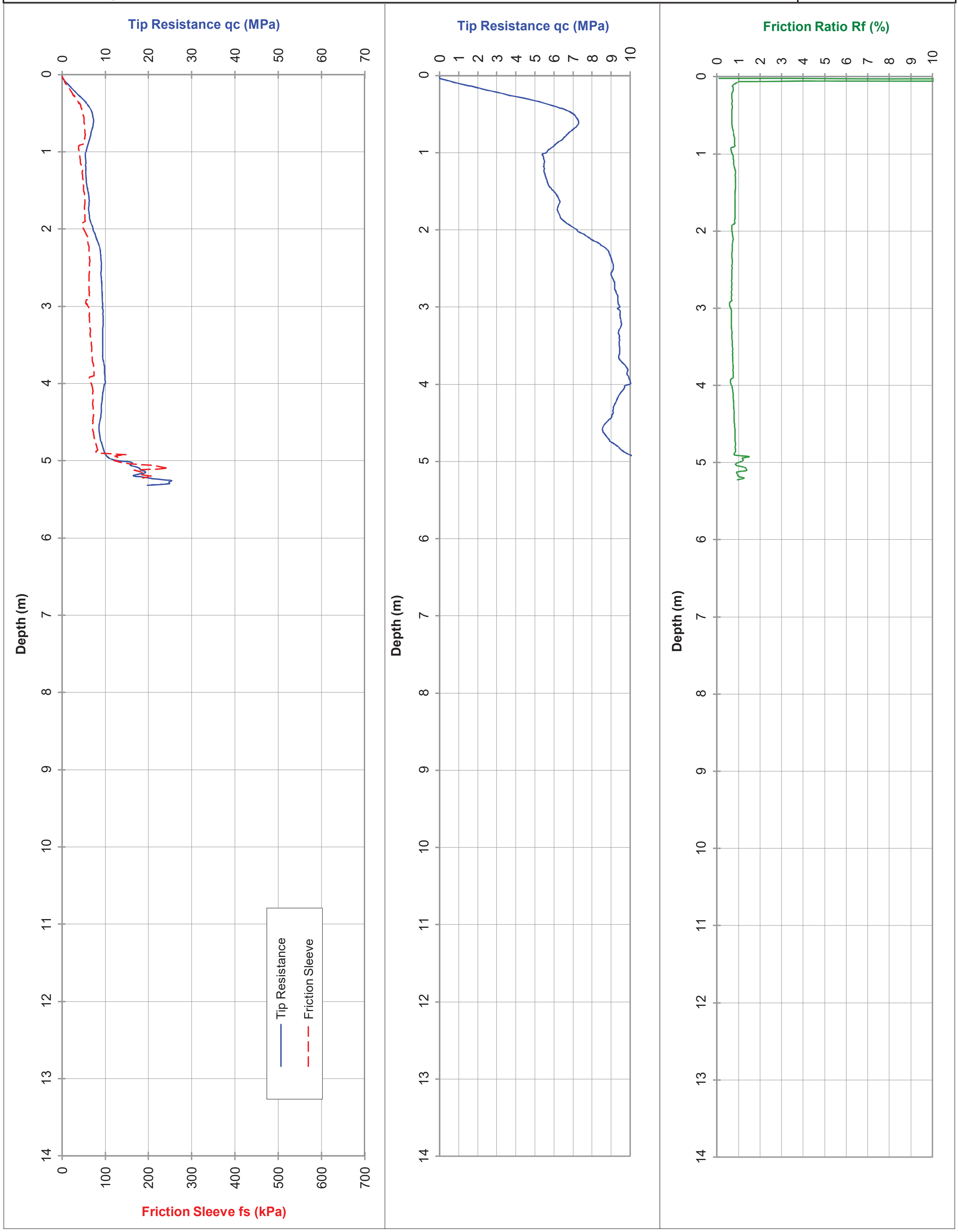
CLIENT: Urban Quarter
PROJECT: Lot 19 Toronga Place
LOCATION: Eglinton

Job No.: PER2018-0005
RL (m):
Co-ords:

Probe I.D

CPT 14

23-Feb-18



PROBEDRILL
GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 5.3

Dummy probe to (m):

Refusal: Inclination

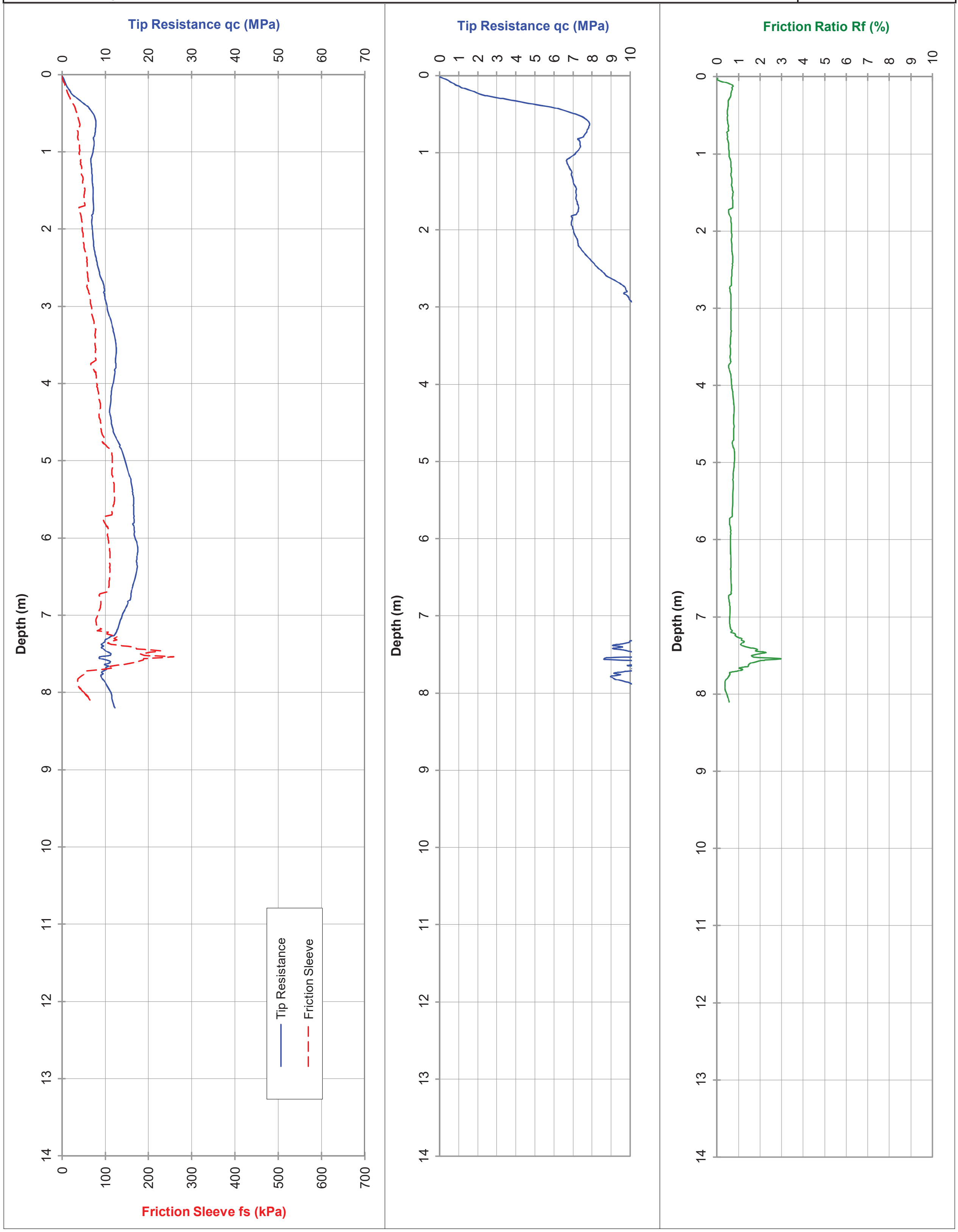
Cone I.D.: EC02

File: CW0093M

Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Urban Quarter	Job No.: PER2018-0005	Probe I.D
PROJECT: Lot 19 Toronga Place	RL (m):	**CPT 12**
LOCATION: Eglinton	Co-ords:	23-Feb-18



PROBEDRILL
GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 8.2

Dummy probe to (m):

Refusal:

Cone I.D.: EC02

File: CW0094M

Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Urban Quarter

PROJECT: Lot 19 Toronga Place

LOCATION: Eglinton

Job No.: PER2018-0005

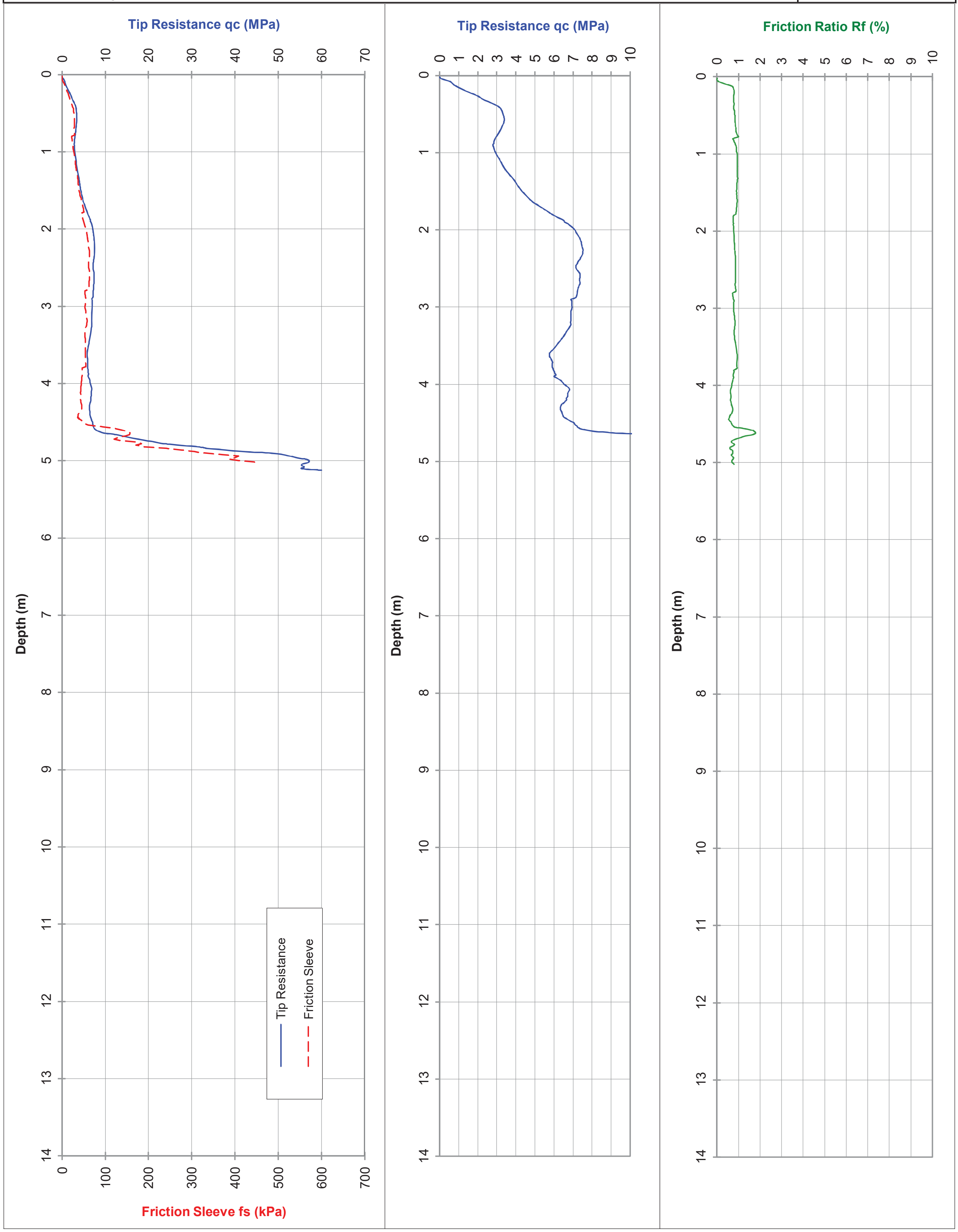
RL (m):

Co-ords:

Probe I.D

CPT 22

23-Feb-18



PROBEDRILL
GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 5.1

Dummy probe to (m):

Refusal: 60MPa

Cone I.D.: EC02

File: CW0095M

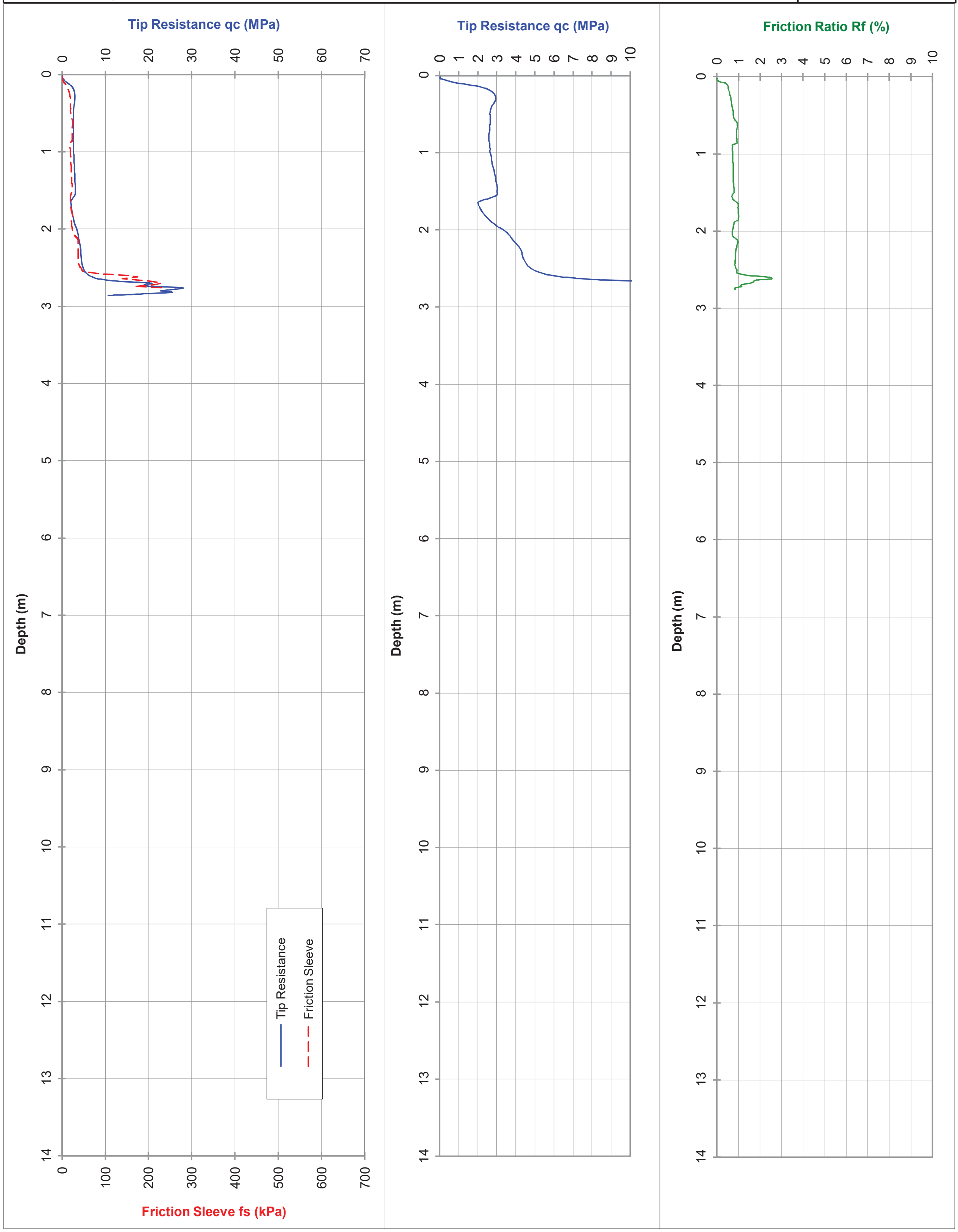
Rig Type: 12 tonne track (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Urban Quarter
PROJECT: Lot 19 Toronga Place
LOCATION: Eglinton

Job No.: PER2018-0005
RL (m):
Co-ords:

Probe I.D
CPT 26
23-Feb-18



PROBEDRILL GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1-1999
and IRTP 2001 for friction reducer

Approx. Water (m): Dry to 2.8

Dummy probe to (m):

Refusal: Inclination

Cone I.D.: EC02

File: CW0096M

Rig Type: 12 tonne track (M1)

Appendix B
Machine / Hand Auger Borehole Logs

BOREHOLE LOG - HA01

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project ID: PER2018-0005
Date: 20/02/2018

CMW Geosciences

1:20
Sheet 1 of 1

Logged by: JN
Checked by: AP
Position: E.374853m N.6503810m (MGA 50)
Elevation: 38.8 m (AHD)
Plant used: Hand Auger

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observations
		Depth	Type & Results							
						▨	SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D		
				38.6		░	SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines	D to M		
					1	░				
				37.4			Borehole terminated at 1.4 m			
					2					
					3					
					4					

Termination Reason: Target Depth Reached
Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - PERM01

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project ID: PER2018-0005
Date: 20/02/2018

1:20 Sheet 1 of 2

Logged by: JN Position: E.374967m N.6503767m (MGA 50) Plant used: Hand Auger
Checked by: AP Elevation: 44.9 m (AHD)

Well	Groundwater	Samples & Insitu Tests Depth	Samples & Insitu Tests Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observations
							SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D		
				44.7			SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines			
					1					
					2					
								D to M		
					3					
					4					

Termination Reason: Target Depth Reached
Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - PERM01

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project ID: PER2018-0005
Date: 20/02/2018

1:20 Sheet 2 of 2

Logged by: JN Position: E.374967m N.6503767m (MGA 50) Plant used: Hand Auger
Checked by: AP Elevation: 44.9 m (AHD)

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observations
		Depth	Type & Results							
							SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines			
					5					
				38.9	6		Borehole terminated at 6.0 m			
					7					
					8					

Termination Reason: Target Depth Reached
Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - PERM02A

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project ID: PER2018-0005
Date: 20/02/2018

1:20 Sheet 1 of 1

Logged by: JN
Checked by: AP
Position: E.375130m N.6503475m (MGA 50)
Elevation: 41.8 m (AHD)
Plant used: Hand Auger

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observations
		Depth	Type & Results							
						▨	SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D		
				41.6	1 2	⁘	SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines	D to M		
				38.9	3 4		Borehole terminated at 2.9 m			

Termination Reason: Refusal on limestone
Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - PERM02B

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project ID: PER2018-0005
Date: 20/02/2018

1:20 Sheet 1 of 1

Logged by: JN Position: E.375132m N.6503484m (MGA 50) Plant used: Hand Auger
Checked by: AP Elevation: 42.3 m (AHD)

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observations
		Depth	Type & Results							
						▨	SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D		
				42.1	1 2	░	SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines	D to M		
				39.4	3 4		Borehole terminated at 2.9 m			

Termination Reason: Refusal on limestone

Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - PERM02C

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project ID: PER2018-0005
Date: 23/02/2018

1:20 Sheet 1 of 1

Logged by: LF Position: E.375213m N.6503462m (MGA 50) Plant used: Hand Auger
Checked by: AP Elevation: 39 m (AHD)

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observations
		Depth	Type & Results							
				38.8		▨	SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D		
					1 2 3	░	SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines	D to M		
				35.4	4		Borehole terminated at 3.6 m			

Termination Reason: Refusal on limestone
Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - PERM02D

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project ID: PER2018-0005
Date: 23/02/2018

1:20 Sheet 1 of 1

Logged by: LF Position: E.375225m N.6503456m (MGA 50) Plant used: Hand Auger
Checked by: AP Elevation: 38.4 m (AHD)

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observations
		Depth	Type & Results							
						▨	SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D		
				38.2		⁘	SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines			
					1	⁘				
						⁘		D to M		
					2	⁘				
				35.6			Borehole terminated at 2.8 m			
					3					
					4					

Termination Reason: Refusal on limestone
Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - PERM03

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project ID: PER2018-0005
Date: 20/02/2018

1:20 Sheet 1 of 1

Logged by: JN Position: E.375069m N.6503236m (MGA 50) Plant used: Hand Auger
Checked by: AP Elevation: 26.6 m (AHD)

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observations
		Depth	Type & Results							
						▨	SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D		
				26.4		░	SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines	D to M		
					1					
				25.2			Borehole terminated at 1.4 m			
					2					
					3					
					4					

Termination Reason: Refusal on limestone
Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - PERM04

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project ID: PER2018-0005
Date: 20/02/2018

1:20 Sheet 1 of 1

Logged by: JN Position: E.375160m N.6503235m (MGA 50) Plant used: Hand Auger
Checked by: AP Elevation: 27.9 m (AHD)

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observations
		Depth	Type & Results							
						▨	SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D		
				27.7		░	SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines	D to M		
					1	░				
					2	░				
				25.5			Borehole terminated at 2.4 m			
					3					
					4					

Termination Reason: Target Depth Reached
Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - PERM05A

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project ID: PER2018-0005
Date: 20/02/2018

CMW Geosciences

1:20 Sheet 1 of 1

Logged by: JN Position: E.375387m N.6503340m (MGA 50) Plant used: Hand Auger
Checked by: AP Elevation: 32.9 m (AHD)

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observations
		Depth	Type & Results							
				32.7		▨	SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D		
					1	░	SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines	D to M		
				30.9	2		Borehole terminated at 2.0 m			
					3					
					4					

Termination Reason: Refusal on limestone
Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - PERM05B

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project ID: PER2018-0005
Date: 23/02/2018

1:20 Sheet 1 of 1

Logged by: LF Position: E.375422m N.6503352m (MGA 50) Plant used: Hand Auger
Checked by: AP Elevation: 34.3 m (AHD)

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observations
		Depth	Type & Results							
						▨	SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D		
				34.1	1	░	SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines	D to M		
				32.5			Borehole terminated at 1.8 m			
					2					
					3					
					4					

Termination Reason: Refusal on limestone
Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

TEST PIT LOG - ST01

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project: PER2018-0005
Date: 13/03/2018

1:30

Sheet 1 of 2

Logged by: AY
Checked by:AP

Position: E.375213m N.6503462m
Elevation:

Plant: 28t Excavator
Contractor:

Dimensions : 5.00m x 7.00m

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observations
	Depth	Type & Results							
						SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/ brown, trace to with organic material, trace fines. (Topsoil)			
				1 2 3		SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines			
						LIMESTONE: fine to medium grained, low strength			
	4.0 - 4.1	1 BLK		4					

Termination Reason: Target Depth Reached

Remarks: Groundwater not encountered.

TEST PIT LOG - ST01

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project: PER2018-0005
Date: 13/03/2018

1:30

Sheet 2 of 2

Logged by: AY
Checked by:AP

Position: E.375213m N.6503462m
Elevation:

Plant: 28t Excavator
Contractor:

Dimensions : 5.00m x 7.00m

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observations
	Depth	Type & Results							
						LIMESTONE: fine to medium grained, low strength			
				5		Test pit terminated at 5.00 m			
				6					
				7					
				8					

Termination Reason: Target Depth Reached

Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

TEST PIT LOG - ST02

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project: PER2018-0005
Date: 13/03/2018

1:30

Sheet 1 of 1

Logged by: AY	Position: E.375395m N.6503353m	Plant: 28t Excavator	
Checked by:AP	Elevation: 32.8 m	Contractor:	Dimensions : 5.00m x 5.00m

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observations
	Depth	Type & Results							
					▨	SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/ brown, trace to with organic material, trace fines. (Topsoil)			
			32.6	1	⁚	SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines			
	2.5 - 3.0	1 BLK	31.0	2	▦	LIMESTONE: fine to medium grained, medium strength			
			29.8	3 4		Test pit terminated at 3.00 m			

Termination Reason: Target Depth Reached
Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

TEST PIT LOG - TP01

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project: PER2018-0005
Date: 19/02/2018

CMW Geosciences

1:30 Sheet 1 of 1

Logged by: AY
Checked by:AP

Position: E.375260m N.6503893m (MGA 50)
Elevation: 27.4 m (AHD)

Plant: 8t Backhoe
Contractor: ANH Contracting

Dimensions : 0.70m x 1.80m

Groundwater	Samples & Insitu Tests Depth	Samples & Insitu Tests Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm) 5 10 15	Structure & other observations
	0.0 - 0.2	1 B	27.2			SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D			
				1 2		SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines	D to M	L	2 3 3 3 4 3 1 2 3 3 3 3	
			24.4	3 4		Test pit terminated at 3.00 m				

Termination Reason: Target Depth Reached

Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

TEST PIT LOG - TP02

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project: PER2018-0005
Date: 19/02/2018

1:30 Sheet 1 of 1

Logged by: AY	Position: E.375384m N.6503861m (MGA 50)	Plant: 8t Backhoe	
Checked by:AP	Elevation: 24.1 m (AHD)	Contractor: ANH Contracting	Dimensions : 0.70m x 1.80m

Groundwater	Samples & Insitu Tests Depth	Samples & Insitu Tests Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm) 5 10 15	Structure & other observations
					▨	SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D			
			23.9	1 2	░	SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines	D to M	D L MD	4 6 5 6 5 6 1 3 3 4 5 5	
			21.1	3		Test pit terminated at 3.00 m				
				4						

Termination Reason: Target Depth Reached

Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

TEST PIT LOG - TP03

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project: PER2018-0005
Date: 19/02/2018

1:30

Sheet 1 of 1

Logged by: AY
Checked by:AP

Position: E.375318m N.6503771m (MGA 50)
Elevation: 26.4 m (AHD)

Plant: 8t Backhoe
Contractor: ANH Contracting

Dimensions : 0.70m x 1.80m

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm) 5 10 15	Structure & other observations
	Depth	Type & Results								
						SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D			
			26.2	1 2		SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines	D to M	D VL-L	6 8 6 5 5 5 1 2 3 2 3 3	
			23.4	3		Test pit terminated at 3.00 m				
				4						

Termination Reason: Target Depth Reached

Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

TEST PIT LOG - TP04

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project: PER2018-0005
Date: 19/02/2018

CMW Geosciences

1:30

Sheet 1 of 1

Logged by: AY	Position: E.375244m N.6503637m (MGA 50)	Plant: 8t Backhoe	
Checked by:AP	Elevation: 35 m (AHD)	Contractor: ANH Contracting	Dimensions : 0.70m x 1.80m

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description: Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm) 5 10 15	Structure & other observations
	0.0 - 0.2	1 B	34.8		▨	SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D			
				1 2	⁛	SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines	D to M	L	1 2 4 2 2 2 1 3 2 3 3 3	
			32.0	3		Test pit terminated at 3.00 m				
				4						

Termination Reason: Target Depth Reached

Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

TEST PIT LOG - TP05

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project: PER2018-0005
Date: 19/02/2018

1:30 Sheet 1 of 1

Logged by: AY
Checked by:AP

Position: E.375320m N.6503616m (MGA 50)
Elevation: 29.7 m (AHD)

Plant: 8t Backhoe
Contractor: ANH Contracting

Dimensions : 0.70m x 1.80m

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm) 5 10 15	Structure & other observations
	Depth	Type & Results								
			29.5			SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D			
						SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines	D to M	L-MD	3 4 3 4 3 4	
				1				L	1 2 2 3 2 3	
				2						
			26.7	3		Test pit terminated at 3.00 m				
				4						

Termination Reason: Target Depth Reached

Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

TEST PIT LOG - TP06

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project: PER2018-0005
Date: 19/02/2018

1:30

Sheet 1 of 1

Logged by: AY
Checked by:AP

Position: E.375390m N.6503589m (MGA 50)
Elevation: 32.1 m (AHD)

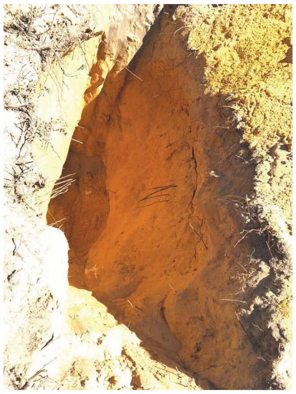
Plant: 8t Backhoe
Contractor: ANH Contracting

Dimensions : 0.70m x 1.80m

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm) 5 10 15	Structure & other observations
	Depth	Type & Results								
						SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D			
			31.9	1 2		SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines. Limestone pinnacle (low strength) encountered at 2.0m	D to M	MD-D L	4 6 7 6 6 5 2 3 2 3 3 3	
			29.1	3 4		Test pit terminated at 3.00 m				

Termination Reason: Target Depth Reached

Remarks: Groundwater not encountered.



This report must be read in conjunction with accompanying notes and abbreviations.

TEST PIT LOG - TP07

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project: PER2018-0005
Date: 19/02/2018

1:30 Sheet 1 of 1

Logged by: AY
Checked by:AP

Position: E.375294m N.6503424m (MGA 50)
Elevation: 34.2 m (AHD)

Plant: 8t Backhoe
Contractor: ANH Contracting

Dimensions : 0.70m x 1.80m

Groundwater	Samples & Insitu Tests Depth	Samples & Insitu Tests Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm) 5 10 15	Structure & other observations
					▨	SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D	L-MD	2 4 3 4 4 3	
			34.0	1 2	⁚	SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines	D to M	L L-MD	1 2 2 3 4 3	
			31.2	3		Test pit terminated at 3.00 m				
				4						

Termination Reason: Target Depth Reached

Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

TEST PIT LOG - TP08

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project: PER2018-0005
Date: 19/02/2018

1:30 Sheet 1 of 1

Logged by: AY	Position: E.375370m N.6503450m (MGA 50)	Plant: 8t Backhoe	
Checked by:AP	Elevation: 33.9 m (AHD)	Contractor: ANH Contracting	Dimensions : 0.70m x 1.80m

Groundwater	Samples & Insitu Tests Depth	Samples & Insitu Tests Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm)	Structure & other observations
					▨	SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D			
			33.7			SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines	D to M	D L MD	3 6 7 8 8 7 2 3 3 3 4 5	
			30.9	3		Test pit terminated at 3.00 m				

Termination Reason: Target Depth Reached
Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

TEST PIT LOG - TP09

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project: PER2018-0005
Date: 19/02/2018

1:30

Sheet 1 of 1

Logged by: AY	Position: E.375490m N.6503436m (MGA 50)	Plant: 8t Backhoe
Checked by:AP	Elevation: 33.9 m (AHD)	Contractor: ANH Contracting — Dimensions : 0.70m x 1.80m

Groundwater	Samples & Insitu Tests Depth	Samples & Insitu Tests Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm)	Structure & other observations
	0.0 - 0.2	1 B				SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D			
			33.7			SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines	D D to M	D	3 5 5 5 6 7 5 5 5 6 5 6	
			30.9	3		Test pit terminated at 3.00 m				

Termination Reason: Target Depth Reached

Remarks: Groundwater not encountered.

TEST PIT LOG - TP10

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project: PER2018-0005
Date: 19/02/2018

1:30 Sheet 1 of 1

Logged by: AY
Checked by:AP

Position: E.375105m N.6503348m (MGA 50)
Elevation: 33.5 m (AHD)

Plant: 8t Backhoe
Contractor: ANH Contracting

Dimensions : 0.70m x 1.80m

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm) 5 10 15	Structure & other observations
	Depth	Type & Results								
			33.3		▨	SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D			
				1 2	⁘	SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines	D to M	L MD	3 3 3 3 2 2 2 2 3 2 5 4	
			30.6	3 4		Test pit terminated at 2.90 m				

Termination Reason: Target Depth Reached
Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

TEST PIT LOG - TP11

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project: PER2018-0005
Date: 19/02/2018

1:30

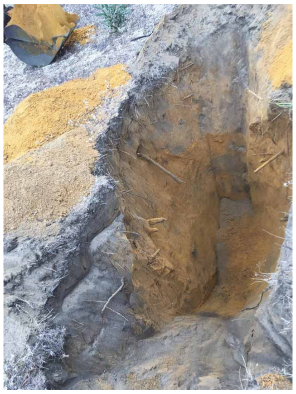
Sheet 1 of 1

Logged by: AY	Position: E.375229m N.6503316m (MGA 50)	Plant: 8t Backhoe	
Checked by:AP	Elevation: 31.8 m (AHD)	Contractor: ANH Contracting	Dimensions : 0.70m x 1.80m

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm) 5 10 15	Structure & other observations
	Depth	Type & Results								
	0.0 - 0.2	1 B			▨	SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D			
			31.6		⁙	SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines			1 2 2 2 2 2	
				1	⁙			L	1 2 2 3 2 3	
					⁙		D to M			
				2	⁙					
			28.8	3		Test pit terminated at 3.00 m				
				4						

Termination Reason: Target Depth Reached

Remarks: Groundwater not encountered.



TEST PIT LOG - TP12

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project: PER2018-0005
Date: 19/02/2018

1:30

Sheet 1 of 1

Logged by: AY	Position: E.375371m N.6503351m (MGA 50)	Plant: 8t Backhoe	
Checked by:AP	Elevation: 32.7 m (AHD)	Contractor: ANH Contracting	Dimensions : 0.70m x 1.80m

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm) 5 10 15	Structure & other observations
	Depth	Type & Results								
	0.0 - 0.2	1 B	32.5		▨	SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D			
					⁘	SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines	D to M	L	2 3 2 2 2 2 1 2 2 2 2 2	
	1.0	1 BLK		1						
			31.4			Test pit terminated at 1.25 m				
				2						
				3						
				4						

Termination Reason: Target Depth Reached

Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

TEST PIT LOG - TP13

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project: PER2018-0005
Date: 19/02/2018

CMW Geosciences

1:30

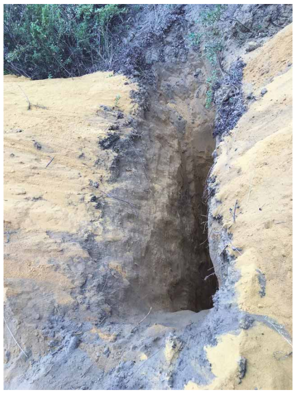
Sheet 1 of 1

Logged by: AY	Position: E.375439m N.6503252m (MGA 50)	Plant: 8t Backhoe	
Checked by:AP	Elevation: 33.1 m (AHD)	Contractor: ANH Contracting	Dimensions : 0.70m x 1.80m

Groundwater	Samples & Insitu Tests Depth	Samples & Insitu Tests Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm) 5 10 15	Structure & other observations
			32.9			SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D			
				1 2		SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines	D to M	L MD	3 3 3 2 2 3 1 2 3 4 4 4	
			30.3	3 4		Test pit terminated at 2.80 m				

Termination Reason: Target Depth Reached

Remarks: Groundwater not encountered.



This report must be read in conjunction with accompanying notes and abbreviations.

TEST PIT LOG - TP14

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project: PER2018-0005
Date: 19/02/2018

1:30

Sheet 1 of 1

Logged by: AY	Position: E.375562m N.6503253m (MGA 50)
Checked by:AP	Elevation: 33.6 m (AHD)

Plant: 8t Backhoe
Contractor: ANH Contracting
Dimensions : 0.70m x 1.80m

Groundwater	Samples & Insitu Tests Depth	Samples & Insitu Tests Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm) 5 10 15	Structure & other observations
					▨	SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D			
			33.4			SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines	D to M	D	4 5 5 4 5 5 5 6 6 5 6 7	
				1						
				2						
			31.0			Test pit terminated at 2.60 m				
				3						
				4						

Termination Reason: Target Depth Reached

Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

TEST PIT LOG - TP15

Client: Urban Quarter
Project: Lot 6 Taronga Place, Eglinton
Location:
Project: PER2018-0005
Date: 19/02/2018

CMW Geosciences

1:30

Sheet 1 of 1

Logged by: AY	Position: E.375043m N.6503281m (MGA 50)	Plant: 8t Backhoe
Checked by:AP	Elevation: 30.4 m (AHD)	Contractor: ANH Contracting

Dimensions : 0.70m x 1.80m

Groundwater	Samples & Insitu Tests Depth	Samples & Insitu Tests Type & Results	RL (m)	Depth (m)	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observations
	0.0 - 0.2	1 B		0.0	SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, grey/brown, trace to with organic material, trace fines. (Topsoil)	D		
			30.2	0.2	SP: SAND: fine to coarse grained, non-plastic, sub-angular to sub-rounded, orange, trace fines	D to M	L	
			27.4	3	Test pit terminated at 3.00 m			

Perth Sand Penetrometer (Blows/150mm)

Depth (m)	Blows
0.15 - 0.30	3
0.30 - 0.45	3
0.45 - 0.60	3
0.60 - 0.75	3
0.75 - 0.90	2
0.90 - 1.05	3
1.05 - 1.20	1
1.20 - 1.35	1
1.35 - 1.50	2
1.50 - 1.65	3
1.65 - 1.80	2
1.80 - 1.95	2

Termination Reason: Target Depth Reached

Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

Appendix C

In-situ Permeability Test and Soakage Test Results

CLIENT: **Urban Quarter**
PROJECT: **Lot 6 Taronga Place, Eglinton**
-
TITLE: **PERM01**

DESIGNER: AY
CHECKED: AP
REVISION: 0
DATE: 23/03/2018
PROJECT: PER2018-0005

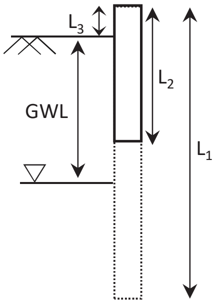
Specifications - Open-Ended Tube

Length L_1:	6	m
Diameter:	90	mm
Non-Perm L_2:		m
Above Gnd L_3:		m

Ground Conditions

GWL: m BGL (Blank = Bottom of hole)
Permeability Anisotropy
m: 1 $m = \sqrt{k_h/k_v}$

Bottom of Test Hole: 6.00 m BGL



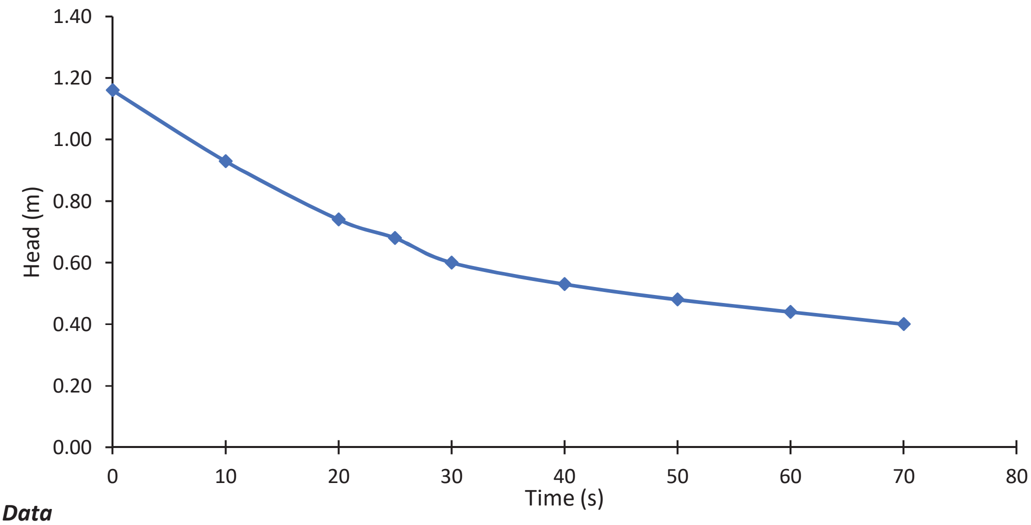
Hydraulic Conductivity (k)

Note: CMW considers the CIRIA 113 value the most appropriate method for most purposes.

CIRIA 113: Somerville (1986), *Control of groundwater for temporary works,* CIRIA Report 113, Appendix 4

$$k = \left(\log\frac{h_1}{h_2} - \log\frac{2h_1+d}{2h_2+d}\right)\cdot\frac{(h_1+h_2)}{2(t_2-t_1)} =$$

2.49E-04 ms^{-1} = 21.54 m/day



STRATIGRAPHIC LOG

Sand

EOH @ 6m

Data

Time (s)	Tape Avg (m)	Head (m)	Perm. Length (m)		Hvorslev 'k' Case G (ms^{-1})	CIRIA 113 'k' (ms^{-1})
0	4.840	1.160				
5						
10	5.070	0.930				
15						
20	5.260	0.740				
25	5.320	0.680	0.710		6.66E-05	3.11E-04
30	5.400	0.600	0.640		1.05E-04	4.58E-04
40	5.470	0.530	0.565		5.64E-05	2.25E-04
50	5.520	0.480	0.505		4.82E-05	1.78E-04
60	5.560	0.440	0.460		4.47E-05	1.55E-04
70	5.600	0.400	0.420		5.16E-05	1.68E-04
80	5.630	0.370	0.385		4.43E-05	1.37E-04
90	5.660	0.340	0.355		5.02E-05	1.47E-04
100	5.680	0.320	0.330		3.74E-05	1.04E-04
110	5.710	0.290	0.305		6.32E-05	1.68E-04
120	5.730	0.270	0.280		4.79E-05	1.20E-04
130	5.750	0.250	0.260		5.34E-05	1.28E-04

CMW Geosciences

CLIENT:	**Urban Quarter**	DESIGNER:	AY
PROJECT:	**Lot 6 Taronga Place, Eglinton** **-**	CHECKED:	AP
		REVISION:	0
TITLE:	**PERM02**	DATE:	23/03/2018
		PROJECT:	PER2018-0005

Specifications - Open-Ended Tube

Length L_1:	3.2	m
Diameter:	90	mm
Non-Perm L_2:		m
Above Gnd L_3:	0.3	m

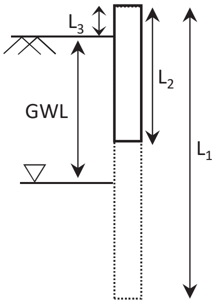
Ground Conditions

GWL: m BGL (Blank = Bottom of hole)

Permeability Anisotropy

m: 1 $m = \sqrt{k_h/k_v}$

Bottom of Test Hole: 2.90 m BGL



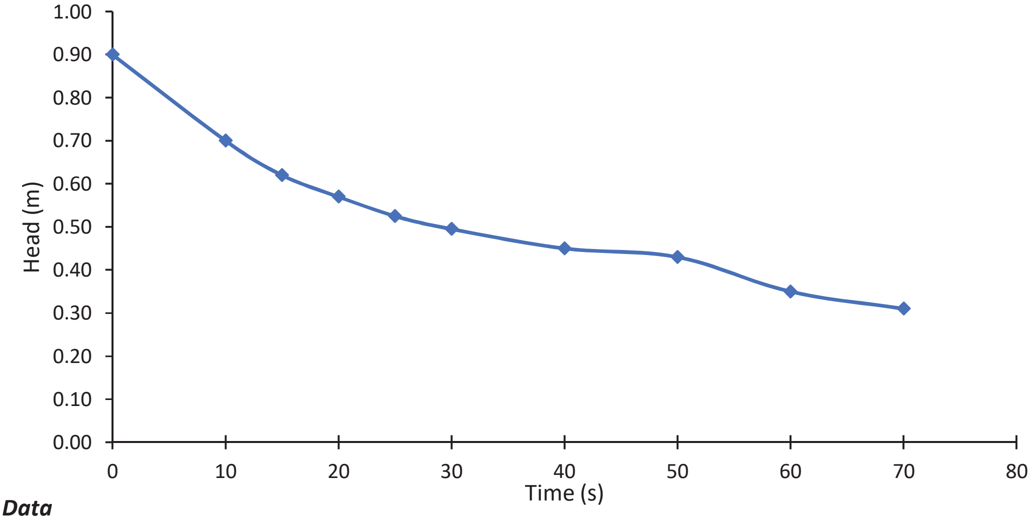
Hydraulic Conductivity (k)

Note: CMW considers the CIRIA 113 value the most appropriate method for most purposes.

CIRIA 113: Somerville (1986), *Control of groundwater for temporary works,* CIRIA Report 113, Appendix 4

$$k = \left(log\frac{h_1}{h_2} - log\frac{2h_1 + d}{2h_2 + d}\right)\cdot\frac{(h_1 + h_2)}{2(t_2 - t_1)} =$$

2.60E-04 ms^{-1} = 22.49 m/day



STRATIGRAPHIC LOG

Sand

EOH @ 2.9m

Data

Time (s)	Tape Avg (m)	Head (m)	Perm. Length (m)		Hvorslev 'k' Case G (ms^{-1})	CIRIA 113 'k' (ms^{-1})
0	2.300	0.900				
5						
10	2.500	0.700				
15	2.580	0.620	0.660		1.00E-04	4.45E-04
20	2.630	0.570	0.595		7.40E-05	3.06E-04
25	2.675	0.525	0.548		7.62E-05	2.97E-04
30	2.705	0.495	0.510		5.69E-05	2.11E-04
40	2.750	0.450	0.473		4.82E-05	1.70E-04
50	2.770	0.430	0.440		2.40E-05	8.06E-05
60	2.850	0.350	0.390		1.16E-04	3.63E-04
70	2.890	0.310	0.330		7.49E-05	2.09E-04
80	2.940	0.260	0.285		1.17E-04	2.98E-04
90	2.970	0.230	0.245		8.75E-05	2.03E-04
100	3.000	0.200	0.215		1.06E-04	2.26E-04
110	3.030	0.170	0.185		1.31E-04	2.56E-04
120	3.050	0.150	0.160		1.06E-04	1.91E-04
130	3.060	0.140	0.145		6.05E-05	1.03E-04

CMW Geosciences

CLIENT:	Urban Quarter	DESIGNER:	AY
PROJECT:	Lot 6 Taronga Place, Eglinton -	CHECKED:	AP
		REVISION:	0
TITLE:	PERM03	DATE:	23/03/2018
		PROJECT:	PER2018-0005

Specifications - Open-Ended Tube

Length L_1: 1.43 m

Diameter: 90 mm

Non-Perm L_2: m

Above Gnd L_3: 0.1 m

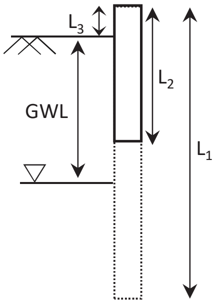
Ground Conditions

GWL: m BGL (Blank = Bottom of hole)

Permeability Anisotropy

m: 1 $m = \sqrt{k_h/k_v}$

Bottom of Test Hole: 1.33 m BGL

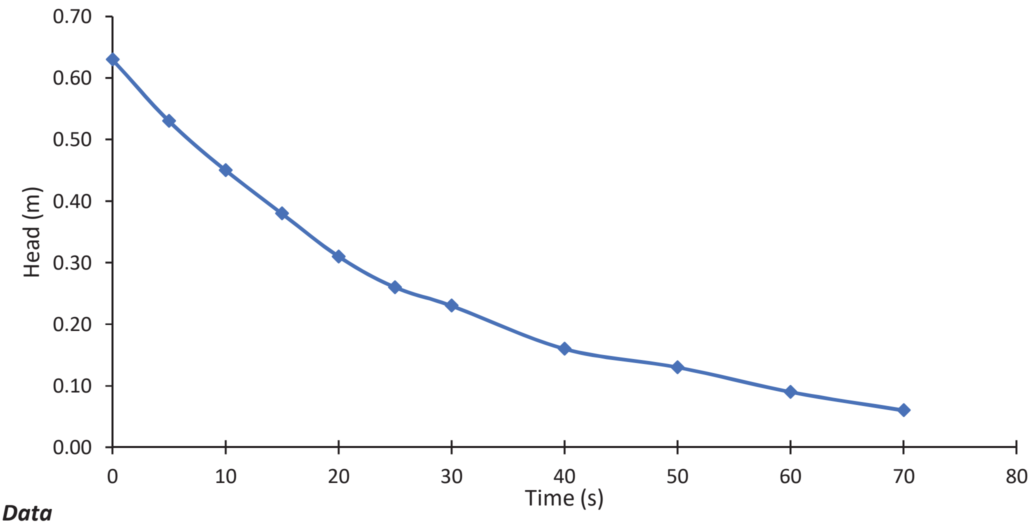


Hydraulic Conductivity (k)

Note: CMW considers the CIRIA 113 value the most appropriate method for most purposes, but also provides the analysis method as outlined by Hvorslev if desired.

CIRIA 113: Somerville (1986), *Control of groundwater for temporary works,* CIRIA Report 113, Appendix 4

$$k = \left(\log\frac{h_1}{h_2} - \log\frac{2h_1+d}{2h_2+d}\right)\cdot\frac{(h_1+h_2)}{2(t_2-t_1)} =$$ 5.44E-04 ms^{-1} = 47.02 m/day



STRATIGRAPHIC LOG

Sand

EOH @ 1.33m

Data

Time (s)	Tape Avg (m)	Head (m)	Perm. Length (m)		Hvorslev 'k' Case G (ms^{-1})	CIRIA 113 'k' (ms^{-1})
0	0.800	0.630				
5	0.900	0.530	0.580		1.55E-04	6.30E-04
10	0.980	0.450	0.490		1.62E-04	5.88E-04
15	1.050	0.380	0.415		1.84E-04	5.99E-04
20	1.120	0.310	0.345		2.45E-04	7.08E-04
25	1.170	0.260	0.285		2.34E-04	5.96E-04
30	1.200	0.230	0.245		1.75E-04	4.06E-04
40	1.270	0.160	0.195		2.86E-04	5.86E-04
50	1.300	0.130	0.145		1.82E-04	3.11E-04
60	1.340	0.090	0.110		3.49E-04	5.17E-04
70	1.370	0.060	0.075		4.15E-04	5.02E-04
80	1.390	0.040	0.050		4.35E-04	4.22E-04
95	1.420	0.010	0.025		1.03E-03	6.88E-04

CMW Geosciences

CLIENT:	Urban Quarter	DESIGNER:	AY
PROJECT:	Lot 6 Taronga Place, Eglinton -	CHECKED:	AP
		REVISION:	4
TITLE:	PERM04	DATE:	23/03/2018
		PROJECT:	PER2018-0005

Specifications - Open-Ended Tube

Length L_1:	2.4	m
Diameter:	90	mm
Non-Perm L_2:		m
Above Gnd L_3:	0.1	m

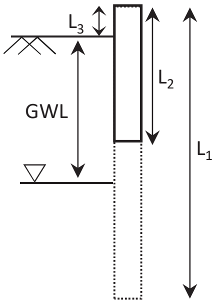
Ground Conditions

GWL: m BGL (Blank = Bottom of hole)

Permeability Anisotropy

m: 1 $m = \sqrt{k_h / k_v}$

Bottom of Test Hole: 2.30 m BGL



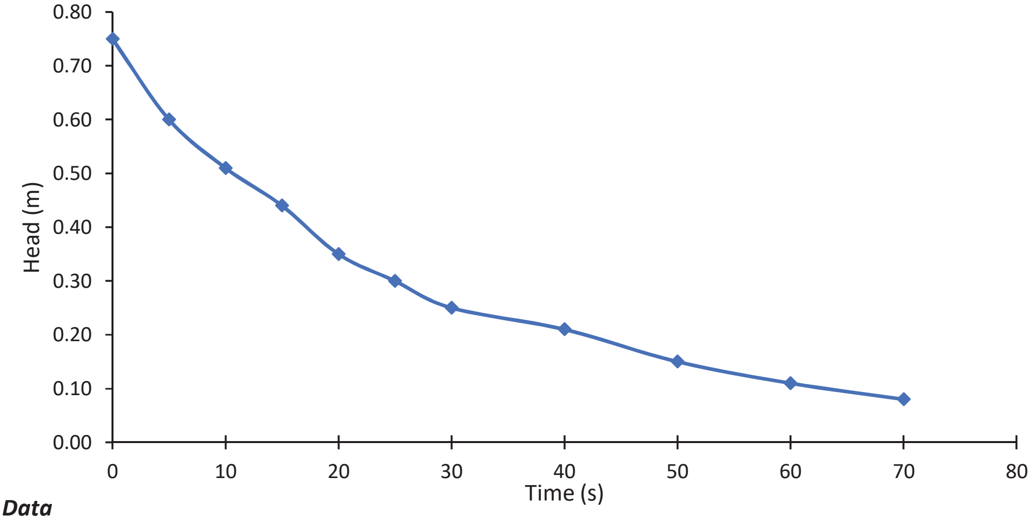
Hydraulic Conductivity (k)

Note: CMW considers the CIRIA 113 value the most appropriate method for most purposes.

CIRIA 113: Somerville (1986), *Control of groundwater for temporary works,* CIRIA Report 113, Appendix 4

$$k = \left(\log\frac{h_1}{h_2} - \log\frac{2h_1+d}{2h_2+d}\right)\cdot\frac{(h_1+h_2)}{2(t_2-t_1)} =$$

5.60E-04 ms^{-1} = 48.37 m/day



STRATIGRAPHIC LOG	
	Sand
EOH @ 2.3m	

Data

Time (s)	Tape Avg (m)	Head (m)	Perm. Length (m)		Hvorslev 'k' Case G (ms^{-1})	CIRIA 113 'k' (ms^{-1})
0	1.650	0.750				
5	1.800	0.600	0.675		1.82E-04	8.24E-04
10	1.890	0.510	0.555		1.49E-04	5.90E-04
15	1.960	0.440	0.475		1.49E-04	5.29E-04
20	2.050	0.350	0.395		2.56E-04	8.09E-04
25	2.100	0.300	0.325		1.92E-04	5.31E-04
30	2.150	0.250	0.275		2.46E-04	6.15E-04
40	2.190	0.210	0.230		1.28E-04	2.86E-04
50	2.250	0.150	0.180		2.73E-04	5.33E-04
60	2.290	0.110	0.130		2.81E-04	4.55E-04
70	2.320	0.080	0.095		3.12E-04	4.26E-04
80	2.360	0.040	0.060		7.31E-04	8.01E-04
90	2.370	0.030	0.035		3.16E-04	2.47E-04
100	2.390	0.010	0.020		1.23E-03	6.85E-04
110	2.400	0.000	0.005		#DIV/0!	#DIV/0!

CMW Geosciences

CLIENT: **Urban Quarter**
PROJECT: **Lot 6 Taronga Place, Eglinton**
-
TITLE: **PERM05a**

DESIGNER: AY
CHECKED: AP
REVISION: 4
DATE: 23/03/2018
PROJECT: PER2018-0005

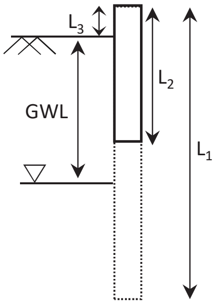
Specifications - Open-Ended Tube

Length L_1: 2.4 m
Diameter: 90 mm
Non-Perm L_2: m
Above Gnd L_3: 0.1 m

Ground Conditions

GWL: m BGL (Blank = Bottom of hole)
Permeability Anisotropy
m: 1 $m = \sqrt{k_h/k_v}$

Bottom of Test Hole: 2.30 m BGL

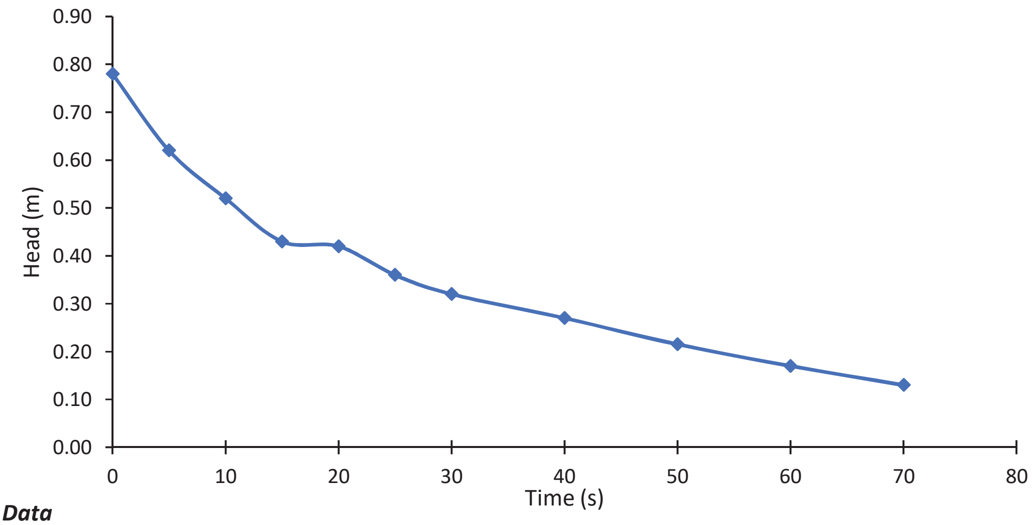


Hydraulic Conductivity (k)

Note: CMW considers the CIRIA 113 value the most appropriate method for most purposes.

CIRIA 113: Somerville (1986), *Control of groundwater for temporary works,* CIRIA Report 113, Appendix 4

$$k = \left(log\frac{h_1}{h_2} - log\frac{2h_1+d}{2h_2+d}\right)\cdot\frac{(h_1+h_2)}{2(t_2-t_1)} =$$ 4.65E-04 ms^{-1} = 40.20 m/day



STRATIGRAPHIC LOG

Sand

EOH @ 2.3m

Data

Time (s)	Tape Avg (m)	Head (m)	Perm. Length (m)		Hvorslev 'k' Case G (ms^{-1})	CIRIA 113 'k' (ms^{-1})
0	1.62	0.780				
5	1.78	0.620	0.700		1.83E-04	8.50E-04
10	1.88	0.520	0.570		1.59E-04	6.40E-04
15	1.97	0.430	0.475		1.92E-04	6.82E-04
20	1.98	0.420	0.425		2.53E-05	8.32E-05
25	2.04	0.360	0.390		1.74E-04	5.42E-04
30	2.08	0.320	0.340		1.43E-04	4.07E-04
40	2.13	0.270	0.295		1.11E-04	2.89E-04
50	2.185	0.215	0.243		1.63E-04	3.78E-04
60	2.23	0.170	0.193		1.86E-04	3.75E-04
70	2.27	0.130	0.150		2.32E-04	4.07E-04
80	2.3	0.100	0.115		2.46E-04	3.71E-04
90	2.33	0.070	0.085		3.58E-04	4.61E-04
100	2.37	0.030	0.050		9.10E-04	9.12E-04
110	2.4	0.000	0.015		#DIV/0!	#DIV/0!

CMW Geosciences

SOIL INFILTRATION RATE TEST

See B.R.E. Digest 365, 1991, Soakaway Design.

Site: Lot 6 Taronga Place, Eglinton
Jb Number: PER2018-0005
Date of Test: 13/03/2018

Trial Pit Number.............	**ST01**	
Length.............................	1.50	m
Width..............................	0.70	m
Depth..............................	1.00	m
Groundwater Level.........	Dry	

Remarks -

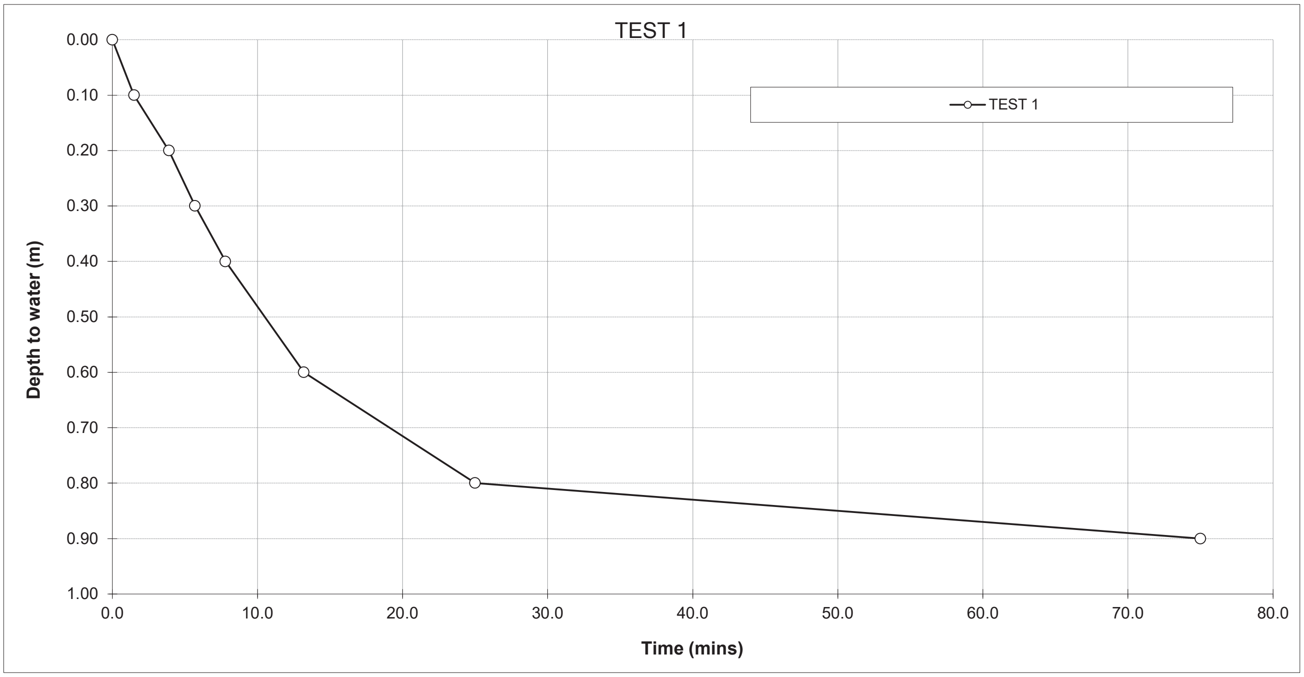
Test carried out in limestone.

TEST 1

Time(min)	Depth to Water (m)
0.0	0.00
1.5	0.10
3.9	0.20
5.7	0.30
7.8	0.40
13.2	0.60
25.0	0.80
75.0	0.90

Effective Storage Depth	m	1.00
75% Effective Storage Depth	m	0.75
(i.e. depth below GL)	m	0.25
25% Effective Storage Depth	m	0.25
(i.e. depth below GL)	m	0.75
Effective Storage Depth 75%-25%	m	0.50
Time to fall to 75% effective depth	mins	5.0
Time to fall to 25% effective depth	mins	22
V (75%-25%)	m3	0.53
a (50%)	m2	3.25
t (75%-25%)	mins	17.00
SOIL INFILTRATION RATE	m/s	**1.6E-04**

DESIGN SOIL INFILTRATION RATE, f **1.6E-04 m/s**



SOIL INFILTRATION RATE TEST
See B.R.E. Digest 365, 1991, Soakaway Design.

Site: Lot 6 Taronga Place, Eglinton
Jb Number: PER2018-0005
Date of Test: 13/03/2018

Trial Pit Number.............	**ST02**	
Length.............................	1.50	m
Width..............................	0.90	m
Depth..............................	0.50	m
Groundwater Level.........	Dry	

Remarks -

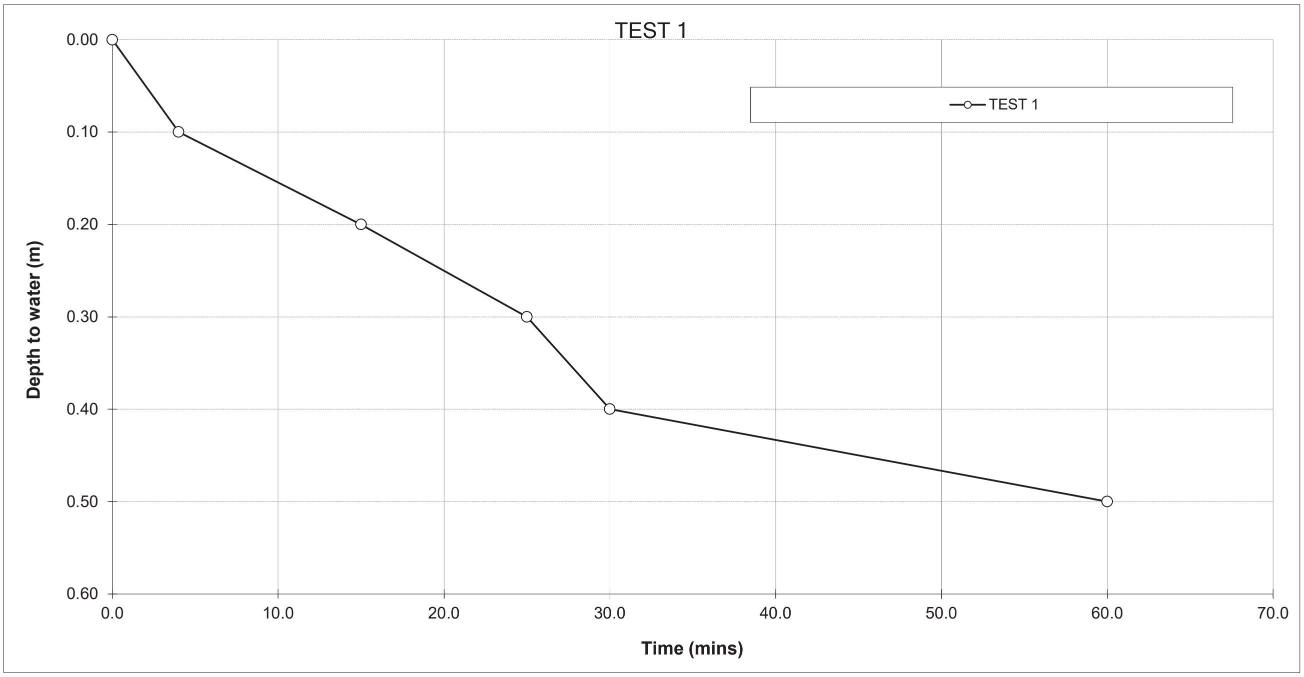
Test carried out in limestone.

TEST 1

Time(min)	Depth to Water (m)
0.0	0.00
4.0	0.10
15.0	0.20
25.0	0.30
30.0	0.40
60.0	0.50

Effective Storage Depth	m	0.50
75% Effective Storage Depth	m	0.38
(i.e. depth below GL)	m	0.13
25% Effective Storage Depth	m	0.13
(i.e. depth below GL)	m	0.38
Effective Storage Depth 75%-25%	m	0.25
Time to fall to 75% effective depth	mins	8.0
Time to fall to 25% effective depth	mins	28
V (75%-25%)	m3	0.34
a (50%)	m2	2.55
t (75%-25%)	mins	20.00
SOIL INFILTRATION RATE	m/s	**1.1E-04**

DESIGN SOIL INFILTRATION RATE, f **1.1E-04 m/s**



Appendix D
Laboratory Test Results

LIQUIDLABSWA
CONSTRUCTION MATERIALS TESTING LABORATORY
UNIT 4, 96 BRIGG ST, WELSHPOOL, WA 6106 LIQUIDLABSWA.COM.AU

ORGANIC CONTENT - TEST REPORT

In accordance with **ASTM D 2974-07a**

Client	**CMW Geosciences**	Ticket No.	**S1428**
Client Address	**Unit 19/127 Herdsman Parade, Wembley WA 6014**	Report No.	**LLS18/894-899 _1_ORG**
Project	**Material Assessment - PER101785**	Sample No.	**LLS18/894-899**
Location	**Lot 19, Taronga Place, Eglinton**	Sampled By	**Client**
Sample Identification	**See Below**		

Sampling Method: **Tested as Received**

LOSS ON IGNITION METHOD

Sample Number	Sample ID	Ash Content (%)	Organic Content (%)
LLS18/894	TP01 0.0-0.2m	**98.4**	**1.6**
LLS18/895	TP04 0.0-0.2m	**97.7**	**2.3**
LLS18/896	TP09 0.0-0.2m	**98.4**	**1.6**
LLS18/897	TP11 0.0-0.2m	**99.0**	**1.0**
LLS18/898	TP12 0.0-0.2m	**98.4**	**1.6**
LLS18/899	TP15 0.0-0.2m	**97.6**	**2.4**

Comments:

Approved Signatory

Name	M. van Herk
Function	Laboratory Manager
Issue Date	02-March-2018

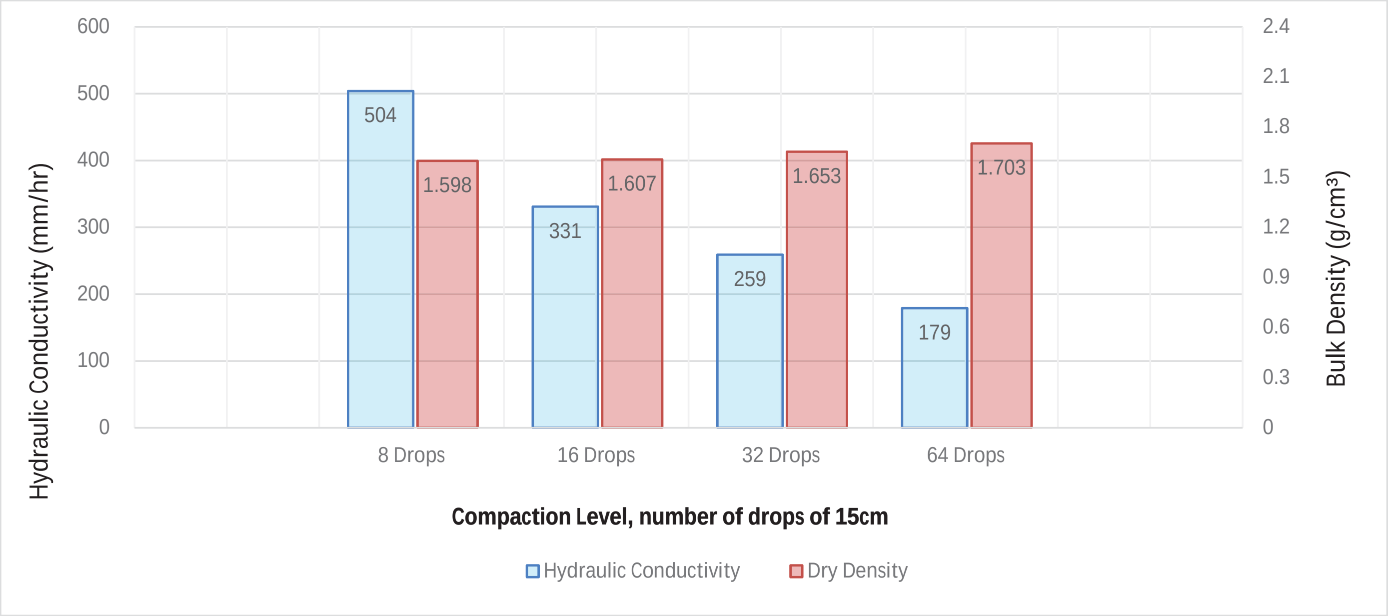
LIQUIDLABSWA
CONSTRUCTION MATERIALS TESTING LABORATORY
UNIT 4, 96 BRIGG ST, WELSHPOOL, WA 6106
LIQUIDLABSWA.COM.AU

HYDRAULIC CONDUCTIVITY - TEST REPORT

In accordance with Jakobsen and McIntyre Method

Client	**CMW Geosciences**	Ticket No.	**S1479**
Client Address	**19/127 Herdsman Parade, Wembley WA 6014**	Report No.	**LLS18/1068_1_HC**
Project	**Geotechnical Permeability Assessment**	Sample No.	**LLS18/1068**
Sampling Location	**Not Specified**	Sampled By	**Client**
Sample Identification	**ST01 2.0-3.0m**		
Sampling Method	**Tested as Received**	Preparation Method	**AS 1289.1.1**
Sample History	**Air Dried**		

SATURATED HYDRAULIC CONDUCTIVITY (Ksat) AND BULK DENSITY



Comments: *8 Drops K (sat) - 1.4 x 10(-^{4}), 16 Drops K (sat) - 9.2 x 10(-^{5}), 32 Drops K (sat) - 7.2 x 10(-^{5}), 64 Drops K (sat) - 4.8 x 10(-^{5})*

Approved Signatory

Name	M. van Herk
Function	Laboratory Manager
Issue Date	20-March-2018

TEST REPORT

DRY DENSITY & MOISTURE CONTENT RELATION OF SOIL

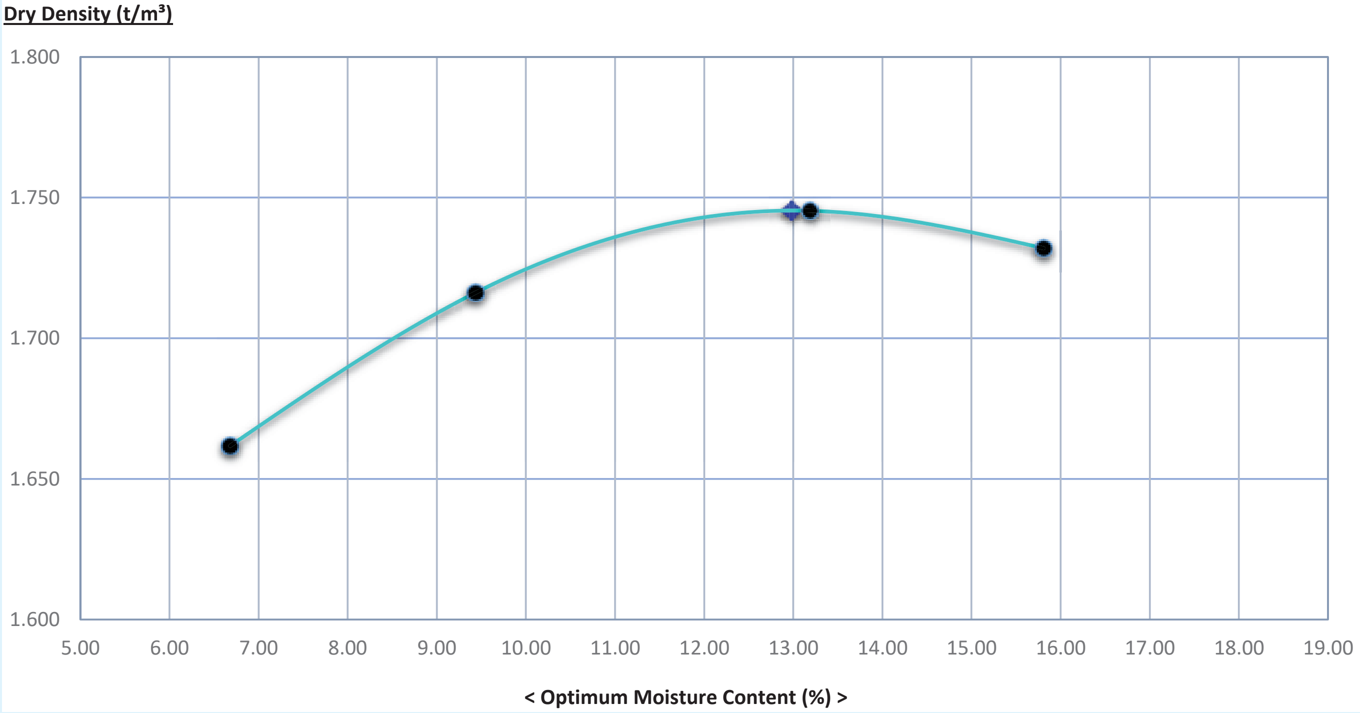
In accordance with **AS 1289.5.2.1**

Client	**CMW Geosciences**	Ticket No.	**S1479**
Client Address	**19/127 Herdsman Parade, Wemley 6104**	Report No.	**LLS18/1068_1_MMDD**
Project	**Geotechnical Material Assessment**	Sample No.	**LLS18/1068**
Sampling Location	**Permeability Testing**	Date Received	**15/03/2018**
Sample Identification	**ST01 (2.0-3.0m), ST02 (2.0-2.5m) & Perm04 (1.5-2.0m)**	Date Tested	**15/03/2018**
Sampling Method	**Sampled by client, tested as received**	Preparation Method	**AS 1289.1.1**
Liquid Limit Method	**Visual/tactile assessment by competent technician**	Sample Curing Time	**2 Hrs**

	Oversize Material
Retained 19.0mm (%)	**0.4**
Retained 37.5mm (%)	-

AS 1289.5.2.1, 2.1.1, 1.1	**Laboratory Moisture & Density Results**				
Moisture Content (%)	**6.7**	**9.4**	**13.2**	**15.8**	
Dry Density (t/m³)	**1.662**	**1.716**	**1.745**	**1.732**	

Plot: Dry Density vs. Moisture Content



Maximum Dry Density (t/m³)	**1.745**
Optimum Moisture Content (%)	**13.0**

Comments:

Accredited for compliance with ISO/IEC 17025 - Testing

Accreditation No. 19872

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Approved Signatory:

Name: M. van Herk
Function: Laboratory Manager
Date: 19-March-2018

LIQUIDLABSWA
CONSTRUCTION MATERIALS TESTING LABORATORY
UNIT 4, 36 BRIGGS ST, WELSHPOOL, WA 6106 LIQUIDLABSWA.COM.AU

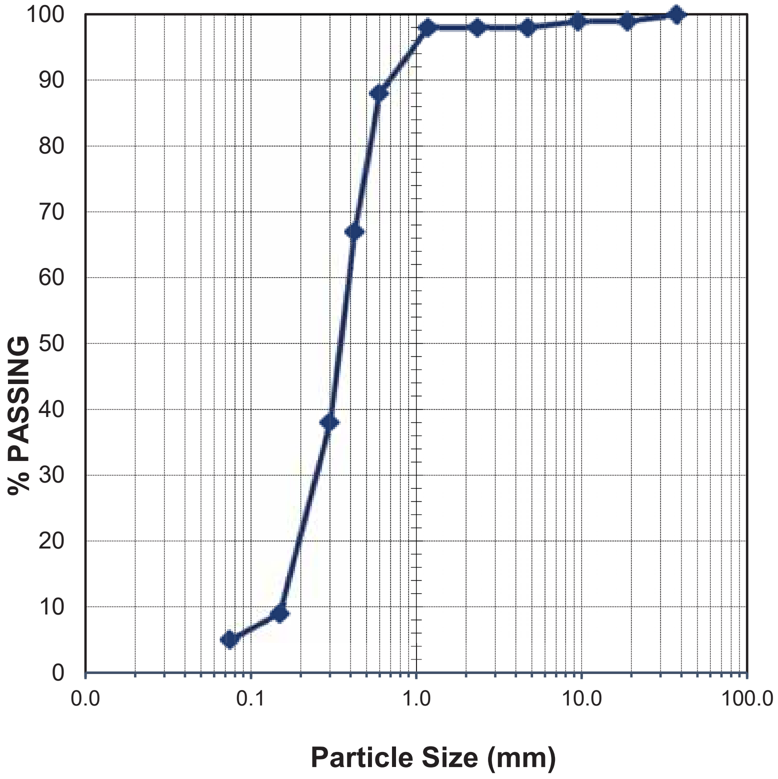
SOIL CLASSIFICATION - TEST REPORT

In accordance with **AS 1289.3.6.1**

Client	**CMW Geosciences**	Ticket No.	**S1479**
Client Address	**Unit 19/127 Herdsman Parade, Wembley WA 6014**	Report No.	**LLS18/1068 _1 _PSD**
Project	**Geotechnical Permeability Assessment**	Sample No.	**LLS18/1068**
Job Number	**-**	Sampled By	**Client**
Sample Identification	**ST01 2.0-3.0m**		
Sampling Method	**Tested as Received**	Preparation Method	**AS 1289.1.1**
Sample History	**Air-Dried**	Wet or Dry Sieved	**Dry Sieved**

PARTICLE SIZE DISTRIBUTION - ANALYSIS BY SIEVING

AS 1289.3.6.1



Sieve Size (mm)	Percent Passing Sieve (%)
75.0	
37.5	100
19.0	99
9.5	99
4.75	98
2.36	98
1.18	98
0.600	88
0.425	67
0.300	38
0.150	9
0.075	5

Comments:

NATA
WORLD RECOGNISED ACCREDITATION

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Approved Signatory	
Name	M. van Herk
Function	Laboratory Manager
Issue Date	20-March-2018

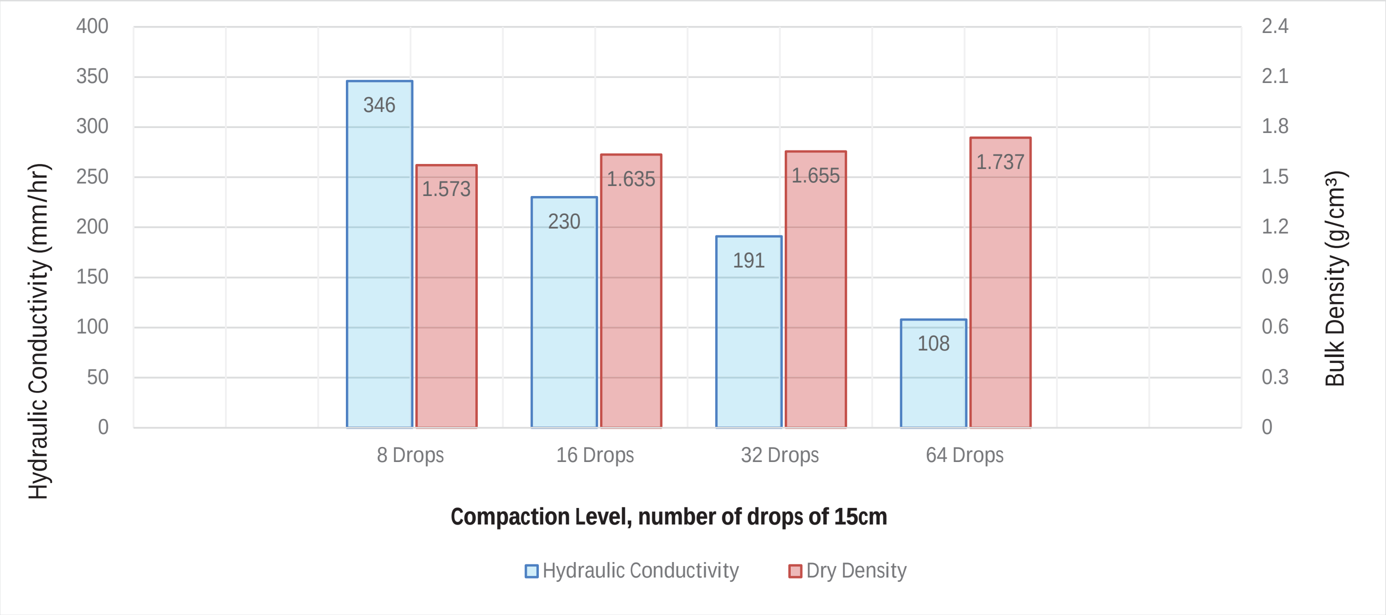
LIQUIDLABSWA
CONSTRUCTION MATERIALS TESTING LABORATORY
UNIT 4, 96 BRIGG ST, WELSHPOOL, WA 6106 LIQUIDLABSWA.COM.AU

HYDRAULIC CONDUCTIVITY - TEST REPORT

In accordance with Jakobsen and McIntyre Method

Client	**CMW Geosciences**	Ticket No.	**S1479**
Client Address	**19/127 Herdsman Parade, Wembley WA 6014**	Report No.	**LLS18/1069_1_HC**
Project	**Geotechnical Permeability Assessment**	Sample No.	**LLS18/1069**
Sampling Location	**Not Specified**	Sampled By	**Client**
Sample Identification	**ST02 2.0-2.5m**		
Sampling Method	**Tested as Received**	Preparation Method	**AS 1289.1.1**
Sample History	**Air Dried**		

SATURATED HYDRAULIC CONDUCTIVITY (Ksat) AND BULK DENSITY



<u>Comments:</u> *8 Drops K (sat) - 9.6 x 10(-^{5}), 16 Drops K (sat) - 6.4 x 10(-^{5}), 32 Drops K (sat) - 5.3 x 10(-^{5}), 64 Drops K (sat) - 3.0 x 10(-^{5})*

Approved Signatory	
Name	M. van Herk
Function	Laboratory Manager
Issue Date	20-March-2018

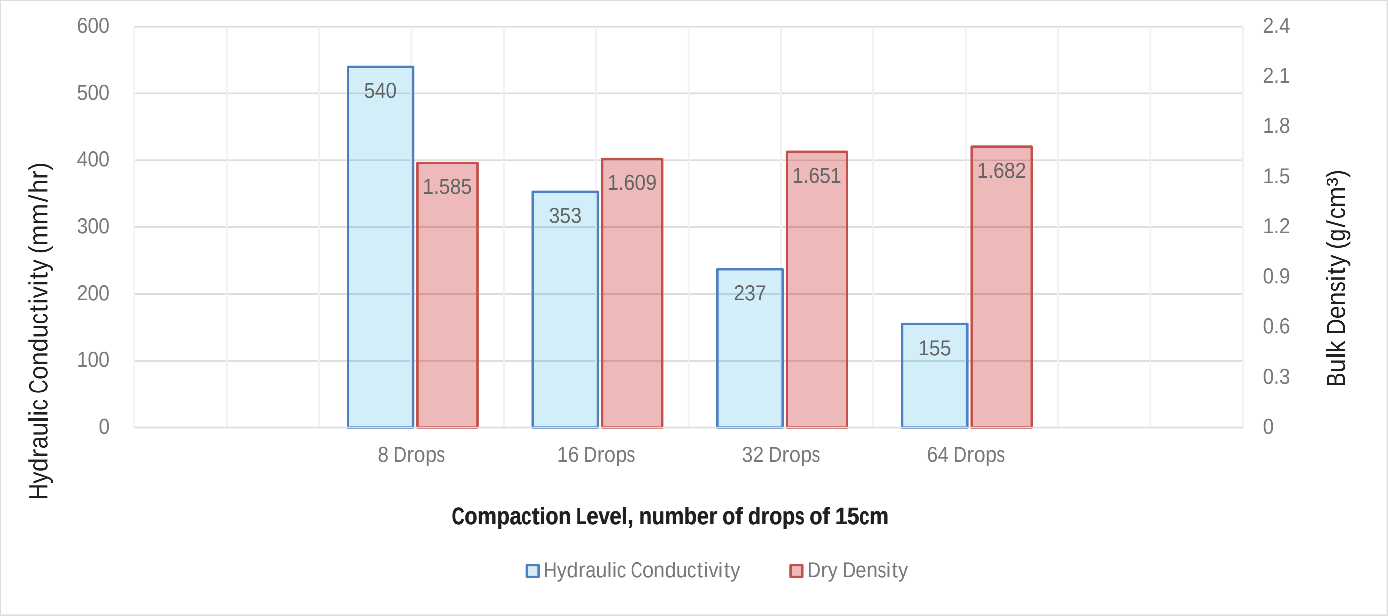
LIQUIDLABSWA
CONSTRUCTION MATERIALS TESTING LABORATORY
UNIT 4, 96 BRIGG ST, WELSHPOOL, WA 6106 LIQUIDLABSWA.COM.AU

HYDRAULIC CONDUCTIVITY - TEST REPORT

In accordance with Jakobsen and McIntyre Method

Client	**CMW Geosciences**	Ticket No.	**S1479**
Client Address	**19/127 Herdsman Parade, Wembley WA 6014**	Report No.	**LLS18/1070_1_HC**
Project	**Geotechnical Permeability Assessment**	Sample No.	**LLS18/1070**
Sampling Location	**Not Specified**	Sampled By	**Client**
Sample Identification	**Perm04 1.5-2.0m**		
Sampling Method	**Tested as Received**	Preparation Method	**AS 1289.1.1**
Sample History	**Air Dried**		

SATURATED HYDRAULIC CONDUCTIVITY (Ksat) AND BULK DENSITY



<u>*Comments:*</u> *8 Drops K (sat) - 1.5 x 10(-^{4}), 16 Drops K (sat) - 9.8 x 10(-^{5}), 32 Drops K (sat) - 6.6 x 10(-^{5}), 64 Drops K (sat) - 4.3 x 10(-^{5})*

Approved Signatory

Name	M. van Herk
Function	Laboratory Manager
Issue Date	20-March-2018

Point Load Test Results

Site: Lot 19 Taronga Pl, Eglint
Job No: PER2018-0005
Client: Urban Quarter
Date: 14/03/2018

BH / Sample Reference	Sample Depth (m below G.L)	Test Type (d, a, b or i - see key below)	Platen Separation (d) (mm)	Sample Width (w) (mm)	Load at Failure (P) (kN)	Equivalent Core Diameter ^{2} (De^2) (mm^2)	Uncorrected Point Load Strength (Is) (MPa)	Corrected Point Load Strength (Is50) (MPa)*	Specimen Description	Strength
TP06	2.00	i	38	100	0.9	4838	0.19	**0.164**	Limestone	Low
TP06	2.00	i	32	110	0.6	4482	0.1	**0.1**	Limestone	Low
TP12	1.00	i	12	120	2.2	1833	1	**0.6**	Limestone	Medium
TP12	1.00	i	12	140	5.5	2139	2.6	**1.4**	Limestone	High
ST01	4.00	i	53	100	0.3	6748	0.0	**0.0**	Limestone	Very Low
ST01	4.00	i	30	120	0.1	4584	0.0	**0.0**	Limestone	Extremely Low
ST02	2.50	i	27	130	0.4	4469	0.1	**0.1**	Limestone	Very Low
ST02	2.50	i	33	90	0.7	3782	0.2	**0.2**	Limestone	Low

Notes:
Point load strength calculated in accordance with ISRM Suggested Method for Determing Point Load Strength

Key to test types: d=Diametral, a=Axial, b=Block, i=Irregular lump.