Contamination | Remediation | Geotechnical

MANLY PROPERTY GROUP NO.2 PTY LTD

Geotechnical Investigation

27 East Esplanade, Manly, NSW

E26867.G03
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Copies	Recipient
Soft Copy (PDF – Secured, issued by email)	Manly Property Group No.2 Pty Ltd Level 1, 3/599 Pacific Hwy, ST LEONARDS NSW 2065
Original (Saved to Digital Archives)	EI Australia Suite 6.01, 55 Miller Street, PYRMONT NSW 2009

Author	Technical Reviewer
Sven Padina Principal Geotechnical Engineer	Stephen Kim Associate Geotechnical Engineer

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1. Introduction

1.1 Background

At the request of Manly Property Group No.2 Pty Ltd (the Client), EI Australia (EI) has carried out a Geotechnical Investigation (GI) for the proposed redevelopment of 27 East Esplanade, Manly, NSW (the site). The site locality and location is shown on the attached **Figure 1**.

This GI report has been prepared to provide general geotechnical advice and recommendations to assist in the preparation of designs for the proposed development. The investigation was carried out in general accordance with the scope of works outlined in EI's proposal ref P23427.1, dated 5 June 2025.

For this project, EI also has completed the following report;

- Detailed Site Investigation (DSI) Report; reference E26867.E02_Rev0, dated 11 September 2024 which makes an assessment of the potential for land contamination to be present at the site.

1.2 Proposed Development

The following documents supplied by the Client were used to assist with our understanding of the currently proposed development:

- Concept Design Architectural drawings prepared by MHN Design Union – Project No. 25-042, revision 01, dated 29 May 2025;
- Site Survey Plan prepared by LTS Surveyors– Referenced 52520 001DT, dated 4 April 2025.

Based on the Clients brief and these supplied documents, EI understands that the proposed development will comprise the demolition of the existing three level residential unit block at the site for the construction of a six level residential unit block, with a three-level basement car park. The lowest basement level is proposed to have a design Finished Floor Level (FFL) of RL -4.40 m AHD. On this basis we expect that bulk excavations for the basement will be between 9 m to 10 m deep. Locally deeper excavations may be required for footings, lift overrun pits, and service trenches.

1.3 Objectives

The objective of this GI was to obtain information on ground conditions at the site as a basis for general geotechnical comment and recommendation on the following aspects of the proposed development:

- Excavation conditions, stability, and indicative excavation retention geotechnical design parameters.
- Protection of adjoining properties.
- Groundwater considerations for basement design.
- Building footings and indicative geotechnical design parameters.
- Soil and groundwater aggressivity to buried steel and concrete elements.

1.4 Fieldwork Methodology

The geotechnical investigation scope of works and methodology was as follows:

- Two Cone Penetration Tests (CPT01M and CPT02M) each to a depth of approximately 19m below existing ground surface levels carried out using a small track mounted rig. The CPT test consists of pushing an instrumented cone into the ground which continuously record cone tip resistance, sleeve friction immediately behind the cone tip, and pore water pressure at the tip. This information can then be interpreted to produce a continuous log of soil type and groundwater pressure conditions.
- Drilling of one hand augered borehole (BH07) to a depth of 2.7m.
- The approximate geotechnical investigation locations are shown on the attached Figure 2 (Investigation Location Plan).
- We note that an additional 5 shallow hand augers boreholes (BH03 to BH06 and BH08) were drilled to depths of 0.7 m to 1.0m for the concurrent land contamination DSI investigation. The logs of these boreholes are included in the EI DSI report.
- EI's Geotechnical Engineer was present full-time onsite to set out the investigation locations, direct the drilling, collect soil samples, and log the observed ground conditions.
- The resulting CPT and borehole logs are attached as Appendix A, together with EI Australia's Soil and Rock Description Explanation Sheets that define the descriptions and terminology used on the borehole logs.
- The approximate surface levels shown on the borehole logs were interpolated from spot levels shown on the supplied survey plan.
- On completion of CPT testing and borehole drilling, a groundwater observation standpipe was installed at each location to depths of between 2.6 m and 4.7 m. The standpipes consist of a 50 mm diameter PVC pipe with a machine slotted screen and 2mm graded sand filter, capped off at ground level with a steel gatic cover. The standpipe installation logs are included with the CPT and borehole logs in **Appendix A**.
- Following the fieldwork, soil samples were sent to the National Australian Testing Authority (NATA) accredited STS Geotechnics Pty Ltd (STS) and SGS Australia Pty Ltd (SGS) laboratories for the following geotechnical index and chemistry testing:
  - One (1) Particle Size Distribution (PSD) test (by STS);
  - Two (2) Soil Aggressivity tests, i.e. pH, Sulfides, Chlorides, and Electrical Conductivity (by SGS);

  The laboratory test reports are attached as **Appendix B**.
- Approximately one and a half weeks after the completion of the CPT/borehole fieldwork, EI field engineer returned to site to measure groundwater levels in the standpipes.

2. Site Description

2.1 Site Description and Identification

The site identification and a summary description are presented in **Table 2-1** below, with an aerial photograph of the site following this table as **Plate 1**.

Table 2-1 Summary of Site Information

Information	Detail
Street Address	27 East Esplanade, Manly, NSW
Lot and Deposited Plan (DP) Identification	CP in Strata Plan (SP) 39838
Brief Site Description	At the time of our investigation, the site was occupied by a three-level brick unit block with single level basement car park. The unit block had a small backyard at the rear (north-eastern end) which comprised a lawn area with some small trees and shrubs. At the front of the site there was an elevated lawn which was approximately 0.7m higher than the East Esplanade Footpath, and was retained by a low brick wall. A concrete driveway into the basement car park runs along the northern site boundary from East Esplanade with a concrete retaining wall along the boundary, together with brick and concrete block walls around the perimeter of the basement car park.
Site Area	The site area is approximately 520 m^2

Plate 1 Satellite image of the site (MetroMap, base image dated 13 March 2025)

2.2 Local Land Use

The site is situated in a residential area. Current uses on the surrounding land at the time of our investigation are summarised in **Table 2-2** below.

Table 2-2 Summary of Local Land Use

Direction Relative to Site	Land Use Description
North-east	Property at No. 6 Victoria Parade which was occupied by a four level rendered unit block with a basement car park. This building was set back approximately 2m from the subject site boundary. The surface levels at the rear of this building appeared to be approximately 0.5 m to 1 m higher than the subject site. Beyond are similar multi-level residential unit blocks, with then Manly Beach approximately 350m further to the east.
North-west	Property at No. 2 Victoria Parade which was occupied by a three-storey brick unit block that does not have a basement car park. Part of this building extends up to the subject site boundary, with the rest of the building set approximately 2m back from the subject site boundary.
South-west	East Esplanade, comprising a two lane asphalt-paved road. Beyond this road is the East Esplanade Park and East Manly Cove Beach approximately 30m to the west of the site.
South-east	Property at No. 26 East Esplanade which was occupied by a three-storey brick unit block that does not have a basement car park. This building was set approximately 3m back from the subject site boundary.

2.3 Regional Setting

The site topography and geological information for the locality is summarised in **Table 2-3** below.

Table 2-3 Topographic and Geological Information

Attribute	Description
Topography	The site is located on the north-east side of East Esplanade within relatively level low lying topography between East Manly Cove Beach 30m to the west of the site, and Manly Beach 350m to the east if the site. The site itself gently slopes down to the west at 1º to 2º with site levels varying from approximately RL 5 m AHD at the eastern end of site, down to RL 4 m AHD at the western end of site.
Regional Geology *(Source: MinView)*	An excerpt of the NSW Seamless Geology dataset (V2.5, 2025, corresponding to the Sydney 1:100,000 Geological Series Sheet) is presented as **Plate 1** and indicates that the site is underlain by Quaternary aged Marine-deposited and Aeolian-reworked coastal sands (QH_bd). From our experience in the area these sands are then underlain by Hawkesbury Sandstone (Tuth) at depths of at least 40m to 50m below current ground surface levels.

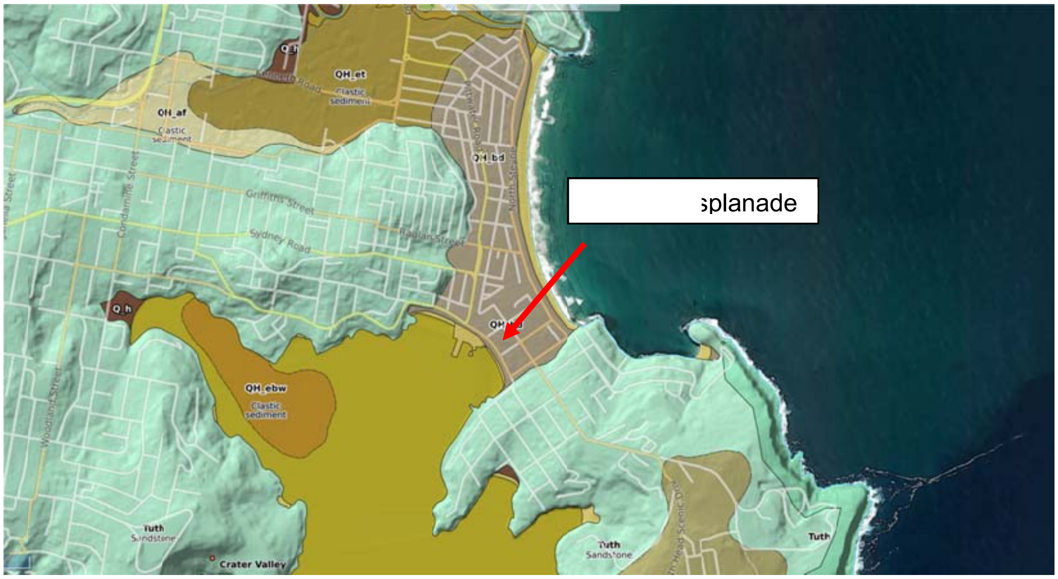

Plate 2 Excerpt of geological map showing location of site.

3. Investigation Results

3.1 Encountered Ground Conditions

For a detailed description of subsurface conditions at each investigation location, reference should be made to the CPT and borehole logs attached in **Appendix A**.

In summary the encountered ground conditions comprised shallow sandy Fill that was between 0.3 m to 1.0 m thick, over deep Marine Sands.

The Marine Sands were asses to be fine to medium grained and initially of loose relative density. The relative density of the Marine Sands increases with depth to become medium dense from a depth of approximately 4.5m to 6.5m, and then dense from a depth of approximately 17 m to 18.5m below current ground surface levels.

The CPT logs also indicate that within this sand profile there is a 1 m thick band of lower strength clay and silty sands at an approximate depth of 9 m to 10.5 m.

3.2 Groundwater Observations

During the CPT testing groundwater was inferred from a depth of between 3.0 m to 4.0 m below exiting ground surface levels.

To enable further site groundwater levels observation and sampling groundwater standpipes were installed at both CPT locations and in BH07 as summarised in **Table 3-1** below.

Table 3-1 Standpipe Installation Details

Standpipe ID	Approx. Ground Surface RL (m AHD)	Standpipe Depth		Top of Sand filter and Screen Section		Screened Material
		Depth (m)	RL (m AHD)	Depth (m)	RL (m AHD)	
CPT01M	3.0	4.6	-1.6	2.5	0.5	Loose Sand
CPT02M	4.0	4.7	-0.7	1.3	2.7	Loose Sand
BH7M	2.7	2.6	0.1	1.1	1.5	Loose Sand

EI field engineers returned to site on 15 August 2025 to measure groundwater levels in the standpipes. The recorded groundwater levels are presented in **Table 3-2** below.

Table 3-2 Groundwater Levels within the Standpipes

Monitoring Well ID	Groundwater Levels		
	Measurement Date	Depth (m BEGL)	RL (m AHD)
CPT01M	15/08/2025	2.4	0.6
CPT02M	15/08/2025	3.6	0.4
BH7M	15/08/2025	2.1	0.6

We note that at this site groundwater levels may fluctuate both tidally and seasonally.

3.3 Laboratory Test Results

A summary of the laboratory soil test results is provided in **Table 3-3** below. The laboratory test reports are presented as **Appendix B**.

Table 3-3 Summary of Soil Laboratory Test Results

Test / Sample ID	**CPT01_0.6-0.8**	**BH3_0.1-0.3**	**BH2M_0.6-0.8**
Material description	Marine Sand	Fill: Silty Sand	Marine Sand
Soil Aggressivity			
Chloride Cl (ppm)	5.0	6.9	-
Sulfate SO_4 (ppm)	<5.0	22	-
pH	7.3	7.4	-
Electrical Conductivity (µS/cm)	19	70	-
Particle Size Distribution			
Gravel (%)	-	-	0
Sand (%)	-	-	96
Clay & Silt fines (%)	-	-	4

4. Discussion and Recommendations

4.1 Inferred Geotechnical Model

In summary the observed stratigraphy can be modelled and grouped into five Geotechnical Units as presented in **Table 4-1** below.

Table 4-1 Indicative Geotechnical Model and Units

Unit	Unit Name	Description	Approx. Depth to Top of Unit (m BEGL)/[RL]	Approx. Thickness (m)
1	Fill	Fine to medium grained silty sand and sandy gravels. At each investigation location this material was overlain by a 130mm to 190mm thick concrete pavement.	At surface	0.3 - 1.0
2A	Loose Marine Sands	Fine to medium grained, loose sand.	0.3-1.0m	4.0 - 6.0
2B	Medium Dense Marine Sands	Fine to medium grained, medium dense sand.	4.5-6.5 [-0.5 to -2.0]	12.0 - 13.0
2C	Interbedded Clays and Silty Sands	Fine to medium grained sand interbedded with clays and silt sands within the Unit 2B Medium Dense Sands.	9.0 to 10.5 [-5.0 to -6.0]	1.0
2D	Dense Marine Sand	Fine to medium grained, dense sand.	17.0-18.5 [-13 to -14]	-

4.2 Basement Excavation and Design

4.2.1 Key Geotechnical Issues for Basement Excavation and Design

The key geotechnical issues for design of the proposed basement at this site are as follows;

- As it is proposed to extend the basement below groundwater levels, the permanent basement structure will have to be fully tanked, i.e. a drained basement is not feasible.
- It is expected that to facilitate excavations below groundwater levels, a groundwater cutoff wall together with effective and continuous construction stage site dewatering to a level of at least 1m below the deepest proposed excavation level will be required.
- For the protection of all neighboring properties and structures, detailed specialist geotechnical and groundwater design assessments will be necessary for design, together with geotechnical and groundwater monitoring during construction.
- At floor level of bulk excavations there may be a lower strength layer of clay and/or silty sand that may require specialist treatment or over-excavation to a sound base for general site trafficability and construction of the lowest floor slab and footings.

4.2.2 Excavation Conditions

Prior to any excavation commencing, we recommend that reference be made to the Safe Work NSW Excavation Work Code of Practice, dated January 2020. Excavation contractors should also review the presented groundwater information and attached investigation logs to make their own assessment of excavation methodology, plant suitability, and production rates.

Based on a lower basement design floor level of RL -4.40m it is expected that bulk excavations across the site will be between 9 m to 10 m deep, and comprise excavation of Unit 1 Fill together with Unit 2A and Unit 2B Marine Sands below groundwater levels. The primary issues associated with this will be the provision of adequate support to adjoining structures/infrastructure and groundwater dewatering so that excavations can be carried in ‘dry’ conditions. In this regard, it is recommended that groundwater levels always be maintained at a depth of at least 1m below excavation levels.

On the basis that there is effective and continuous dewatering during excavations, it is expected that the Unit 1 Fill and Unit 2A and Unit 2B Marine Sands would be readily excavatable using conventional earthmoving plant such as a large excavator. If any lower strength Unit 2C Clays and/or Silty Sands are exposed at the floor of excavations then a bringing/capping layer or over excavation down to a sound base may be required for general site maintenance and trafficability.

4.2.3 Excavation Retention

Due to the relative shallow groundwater level and limited set back to the neighbouring properties, unsupported cuts or battering of the Unit 1 Fill and Unit 2A Loose Sands above the Groundwater Table are generally not considered to be feasible or is recommended.

For bulk excavations it is expected that a full depth watertight excavation retention/groundwater cut-off wall will first have to be installed around the perimeter of the basement footprint. Common retaining/groundwater cut off wall types used in Sydney include:

- Secant piled walls. However the use of conventional bored piles will not be feasible, instead Continuous Flight Auger (CFA) piles will be required together with a high level of construction quality control to ensure well-formed and interlocking piles are constructed below the Groundwater Table.
- Cutter Soil Mix (CSM) Walls.
- Diaphragm Walls.
- Sacrificial Sheet Pile walls, provided vibrations from sheet pile driving/installation will not affect surrounding buildings and structures. Typically a permanent watertight basement walls would then be constructed on the inside of the sheet pile wall.

Due to the proposed depth of excavations, it is also expected that the retaining walls will have to be progressively anchored or internally propped for lateral support as excavations progress, with the walls to then be permanently propped by the basement and ground floor slabs. On this basis the relative height, required stiffness, anchor/propping layout, and analytical tools utilised for the design will determine the geotechnical design parameters, earth pressure magnitude, and pressure distribution adopted for design. As a guide, **Table 4-2** below presents general geotechnical design parameters that may be adopted for initial retaining wall design.

Table 4-2 Geotechnical Design Parameters for Retaining Walls

Material	Bulk Density (kN/m^3)	Effective Cohesion c’ (kPa)	Effective Friction Angle ϕ’ (degrees)	Earth Pressure coefficient			Vert. Elastic Modulus (MPa)	Horiz. Elastic Modulus (MPa)
				(K_a)	(K_0)	(K_0)		
Unit 1 Fill	18	0	25	0.33	0.5	3.0	15	10
Unit 2A Loose Marine Sands	18	0	30	0.33	0.5	3.0	15	10
Unit 2b Medium Dense Marine Sands	20	0	33	0.29	0.5	3.4	30	20
Unit 2C Interbedded Clays and Silty Sands	18	0	25	0.33	0.5	3.0	15	10
Unit 2D Dense Marine Sands	21	0	38	0.25	0.5	4.2	100	75

Retaining wall analyses will also need to consider any surcharges or footing loads from adjacent structures and hydrostatic pressure.

If it is proposed to use temporary ground anchors for lateral support, permission from adjacent property owners and council would be required to install anchors that extend beneath the adjacent properties and roads. Alternatively, internal props may be required.

Conventional grouted anchors in sands typically have low load capacity. A multi-bonded anchor system or alternative anchor types would be required where higher capacities are required. It is recommended that specialist contractors with sand anchor design and construction experience be engaged for design and construction. All installed anchors must also be proof load tested in accordance with the project requirements and relevant Australian Standards.

As an initial guide to anchor extents, design should be based on allowing effective anchorage to be developed by having the anchor bond length behind an 'active zone', determined by drawing a line at 45° from the base of the wall up to the ground surface behind the excavated face.

4.2.4 Protection of Neighbouring Structures

For the protection of neighbouring structures the type of structure, location, layout, and embedment/footing depth should be assessed at the commencement of project design works. Consideration then should be made for the following potential geotechnical impacts from the proposed basement excavation works;

- Induced ground movements due to retaining wall deformation as the excavation progress.
- Induced ground settlement due to construction stage dewatering works lowering groundwater levels outside the site perimeters.
- Induced settlement of loose sands around the site due to construction vibrations.

Lateral ground movements from retaining wall deformation will be dependent on the type, design, and construction of the retention system. Experience and published data suggest that lateral movements of an adequately designed and installed retention system in sands will be between 0.2% and 0.5% of the retained height. Additional ground settlement surrounding the site could also occur from construction groundwater drawdown and/or excessive vibrations impacting loose sands that immediately surround the site.

It is recommend that for basement excavation planning and design, specific geotechnical retaining wall deformation, groundwater drawdown/settlement, and vibration impact assessment be carried out to identify and assess the potential to impact to surrounding properties.

Where it is assessed that excavations may affect neighbouring structures, construction stage ground deformation, groundwater drawdown, and vibration management and monitoring plans will be required that document the required construction monitoring for excavation works, together with assessed limits, trigger levels, and response actions.

Prior to excavation and construction, we also recommend that dilapidation surveys be carried out on all structures surrounding the site that are within the zone of influence of the excavation. The zone of influence for the excavation may initially be defined by a distance back from the excavation perimeter equal to up to 3 times the total excavation depth, depending on the predicted extent of groundwater drawdown. The dilapidation survey reports would then provide a record of existing conditions prior to commencement of the work. A copy of each report should also be provided to the adjoining property owner and be asked to confirm that it represents a fair assessment of existing conditions.

4.2.5 Groundwater Considerations

With reference to the encountered subsurface conditions and observed groundwater levels, we would expect that where it is proposed to excavate below groundwater levels a fully tanked basement structure will be required, i.e. a drained basement will not be feasible for this project.

For the initial design of a tanked basement, and subject to any outcomes from further site groundwater level monitoring, it is recommended to allow for both potential seasonal/extended wet weather fluctuations and future rises in the water table through climate change over the building design life. Consideration and design of the basement and building footings will also be required to account for any groundwater uplift/buoyancy pressures for the tanked structure.

We would suggest that advice on dewatering is sought from a specialised contractor. For construction it is expected that temporary construction phase dewatering could be carried out using either temporary sumps or spear wells within the excavation footprint. Detailed analysis and groundwater modelling will be required to assess basement wall embedment depths for effective cut off, dewatering/pumping requirements, estimated volumes of extracted water, and evaluation of dewatering induced ground settlements beyond the excavation boundary. At this stage it is expected that the loose to medium dense sand would have a have a permeability, k, of the order of $1x10^{-4}$m/s to $1x10^{-5}$ m/s but this would have to be confirm by further groundwater investigation and possible laboratory testing of site soils.

A critical factor relating to dewatering of the site is maintenance of the depressed groundwater levels until such a time as the building has significant weight to prevent movement should the pump system fail and the groundwater level rise. A detailed monitoring program should be implemented to identify the risks and trigger levels decided for when the contingency measures need to be taken

We also note that for approval of the required temporary construction dewatering, it will have to be assessed in detail in accordance with the Department of Planning and Environment (DPIE) guidelines "*Minimum requirements for building site groundwater investigation and reporting*", dated October 2022, and will require additional groundwater investigation, long term monitoring, and inflow seepage analysis, followed then by application to Council and the relevant state authorities for construction stage dewatering and discharge to the stormwater system. Temporary dewatering for construction purposes is normally allowed provided it is properly designed and managed to ensure that the likely drawdown will have no adverse impact on adjoining structures/infrastructures. A dewatering licence may also be required. Additional groundwater quality testing, particularly with regard to acidity generated as a result of acid sulfate soils, will be required to permit discharge into the stormwater system.

4.3 Building Foundations

Following bulk excavation for the basement, we expect Unit 2B Medium Dense Sands and possibly some Unit 2C Clays Silty Sands will be exposed across the floor of the excavation.

On the basis that the basement will be tanked and the lowest basement floor will comprises a thick reinforced concrete slab, the following foundation options should be considered for the development:

- Raft Slab.
- Piled Raft Slab, where piles are used as necessary to provide additional bearing capacity and/or stiffening under concentrated building loads.
- Pile footings into in the Unit 2B Medium Dense and Unit 2D Dense Sands.

4.3.1 Raft and Piled Raft Slabs

Raft slabs are well suited to uniform sandy subgrade conditions and building loads. For design detailed geotechnical and structural evaluation of expected ground and raft performance, including the evaluation of both global and localised allowable bearing pressures and settlements is required once design loads, founding levels, and column layout are known.

As an initial guide for planning purposes, it is expected that the ultimate bearing capacity for the Unit 2B Medium Dense Sands expected at founding levels would be in the order of 500 kPa to 800 kPa. However to better assess this, additional geotechnical investigation across the whole building footprint to assess the uniformity of this material across the site and initial building raft feasibly assessments are recommended. The raft feasibility assessments will involve analysis by both geotechnical and structural engineers, and may require multiple iterations.

If the Raft Slab requires additional bearing capacity or there is a need to limit settlement and specific locations due to concentrated loads such as building columns, then a piled raft solution with pile footings into the Unit 2B Medium Dense and Unit 2D Dense Sands could be used. Further discussion on the design of piles, together with indicative geotechnical design parameters is presented in **Section 4.3.2** below.

Protection and preparation of the sandy subgrade for the raft slab will also be important for the performance of the raft foundation system. If a raft solution is adopted, a geotechnical engineer should assess the initially exposed subgrade and conduct testing to assess uniformity. The exposed subgrade should also be proof rolled with at least a 2 tonne dead weight smooth drum vibratory roller, with the final pass of the proof rolling inspected by a geotechnical engineer or experienced earthworks foreman to detect any weak subgrade areas. It may be necessary to excavate and re-compact any loose subgrade to reduce variability. Sands should be compacted to a minimum Density Index of 75%.

During construction works the unconfined surface of a sand subgrade will be difficult to maintain. In general for the protection of the sand subgrade, a 200mm thick layer of good quality durable coarse granular material such as recycled concrete or crushed rock is recommend to be placed and compacted over the prepared surface. This layer helps confine the sandy soils and protect it from disturbances.

4.3.2 Piles in Sand

As an alternative to the use of a Raft Slab, the new building could also be founded on pile footings into the Unit 2B Medium Dense and Unit 2D Dense Sands.

Due to the collapsible nature of the sands and groundwater, conventional bored piles will not be feasible. It is expected that grout injected Continuous Flight Auger (CFA), Displacement, or Driven Piles would be a suitable for use.

Actual geotechnical design parameters including end bearing, and skin friction and ultimate pile capacities can only be assessed once the pile loading, pile type, dimensions, and layouts can be defined. Pile design should be completed by an experienced pile design engineer and be based on limit state design as per Australian Standard AS2159-2009 Piling – Design and Installation. However for planning, **Table 4-3** below provides some initial guidance on indicative CFA pile design geotechnical parameters.

Table 4-3 Indicative Geotechnical Design Parameters for CFA piles

Geotechnical Unit	Ultimate End Bearing (MPa)	Ultimate Shaft Adhesion (kPa)	Vertical Elastic Modulus (MPa)	Horizontal Elastic Modulus (MPa)
Unit 2B Medium Dense Sand	2000	20	50	35
Unit 2D Dense Sand	5000	50	100	75

The end bearing capacity values in **Table 4-3** assume a 600mm diameter pile, with a minimum penetration of at least 10 pile diameters below bulk excavation levels and that the assumed bearing stratum extends for at least 5 pile diameters below the pile toe.

The shaft adhesion should be ignored to a depth of at least 2 pile diameters below the pile cap. For uplift loads, the shaft adhesion values should be multiplied by a factor of 0.7, in addition to the geotechnical strength reduction factor. Where CFA piles are designed to found in dense sand the contractor should demonstrate that suitable techniques and appropriate machinery will be used to prevent de-densification of the sand during the drilling and casting process.

For limit state design in accordance with AS2159-2009, a geotechnical reduction factor (Φg) is to be applied to the ultimate geotechnical pile capacity assessed using the ultimate shaft resistance and end bearing values shown in **Table 4-3** to derive the design ultimate geotechnical pile capacity.

Φg is dependent on assignment of an Average Risk Rating (ARR), which considers various geotechnical uncertainties, redundancy of the foundation system, construction supervision, and the quantity and type of pile testing. The assessment of Φg depends on the structural design of the foundation system as well as the design and construction method, and pile testing to be employed by the designer and piling contractor. An appropriate programme of pile testing may enable adoption of an increased Φg value that leads to a more economical pile design. For preliminary design, a geotechnical strength reduction factor, Φg, of 0.4 is recommended for use with the parameters in **Table 4-3.**

The use of limit state design also requires that serviceability performance of the foundation system be assessed, including pile group interaction effects. Such assessment should be carried out by an experienced geotechnical professional using well-established, soundly based methods. It should be recognised that the accuracy of settlement prediction is a function of construction methodology as well as the assessed values of material stiffness, both of which involve considerable uncertainty. Hence the accuracy of settlement predictions may be no better than ± 50%. Where foundation settlement is critical to structural performance, serviceability pile load testing should be carried out to verify design assumptions and prediction accuracy.

Pile integrity testing is also recommended for CFA piles. AS 2159-2009 provides guidance for the frequency/ percentage of pile load and integrity tests.

4.4 Soil and Groundwater Aggressivity

With reference AS 2159:2009 ‘Piling – Design and Installation’, the results of the pH, Chloride content, Sulfate content, and Electrical Conductivity testing of the near surface sands above the groundwater table indicate that ground conditions above the Groundwater Table may be ‘Mild’ for buried concrete and steel elements.

However as the site is located close to the foreshore it is expected that groundwater at this site would be at least brackish, if not saline. On this basis it is expected that exposure classification for concrete and steel elements below the Groundwater Table may range from ‘Moderate’ to” Severe”. We recommend that further testing of groundwater samples from the site be carried out to confirm the actual exposure classification for design of structural elements below the Groundwater Table.

5. Further Geotechnical Inputs

In addition to the routine geotechnical design and construction support activities typically required for a project of this type, it is expected that the following additional geotechnical investigation and assessments will also be required to support project planning, detailed design, regulatory approvals, and construction works:

- Further deep investigations to assess the uniformity of the Unit 2B Medium Dense and Unit 2D Dense Sand founding layers across the building footprint.
- Testing of groundwater samples to determine groundwater aggressivity for structural elements below the Groundwater Table.
- Detailed groundwater investigation, testing, long term groundwater level monitoring, and a groundwater seepage/drawdown analysis to support construction stage temporary dewatering design and the approvals process with reference to the DPIE (2022) guidelines.
- Geotechnical design, stability, and ground deformation assessments for excavation retaining structure design.
- Geotechnical settlement and construction vibration assessments for the protection of adjoining properties during construction works.
- Specialist geotechnical engineering assessments to initially assess the feasibility for the use of a Raft Slab footing followed by detailed geotechnical analysis and design in support slab/building structural design.
- Geotechnical construction stage, ground deformation/settlement, groundwater and vibration monitoring for the protection of adjoining properties.
- We also recommend that a meetings be held both after initial structural design has been completed to confirm that our recommendations have been correctly interpreted, and at the commencement of construction to discuss the primary geotechnical issues and inspection requirements.

6. Statement of Limitations

This report has been prepared for the exclusive use of Manly Property Group No.2 Pty Ltd who is the only intended beneficiary of EI’s work. The scope of the assessment carried out for the purpose of this report is limited to those agreed with Manly Property Group No.2 Pty Ltd.

No other party should rely on the document without the prior written consent of EI, and EI undertakes no duty, or accepts any responsibility or liability, to any third party who purports to rely upon this document without EI's approval.

The GI was limited by the intent of the investigation and the presence of an existing building that occupied most of the site surface area.

EI has used a degree of care and skill ordinarily exercised in similar investigations by reputable members of the geotechnical industry in Australia as at the date of this document. No other warranty, expressed or implied, is made or intended. Each section of this report must be read in conjunction with the whole of this report, including its appendices and attachments.

The conclusions presented in this report are based on a limited investigation of conditions, with specific sampling and test locations chosen to be as representative as possible under the given circumstances.

EI's professional opinions are reasonable and based on its professional judgment, experience, training and results from analytical data. EI may also have relied upon information provided by the Client and other third parties to prepare this document, some of which may not have been verified by EI.

EI's professional opinions contained in this document are subject to modification if additional information is obtained through further investigation, observations, or validation testing and analysis during construction. In some cases, further testing and analysis may be required, which may result in a further report with different conclusions.

We draw your attention to the document “Important Information”, which is included in **Appendix C** of this report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be. The document is not intended to reduce the level of responsibility accepted by EI, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

Should you have any queries regarding this report, please do not hesitate to contact EI.

References

AS1289.6.3.1:2004, *Methods of Testing Soils for Engineering Purposes*, Standards Australia.

AS1726:2017, *Geotechnical Site Investigations*, Standards Australia.

AS2159:2009, *Piling – Design and Installation*, Standards Australia.

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AS4678-2002, *Earth-retaining Structures,* Standards Australia.

Safe Work NSW Excavation Work Code of Practice, dated January 2020 – WorkCover NSW

New South Wales Seamless Geology dataset, Version 2.4 [Digital Dataset]. Geological Survey of New South Wales, Department of Regional NSW

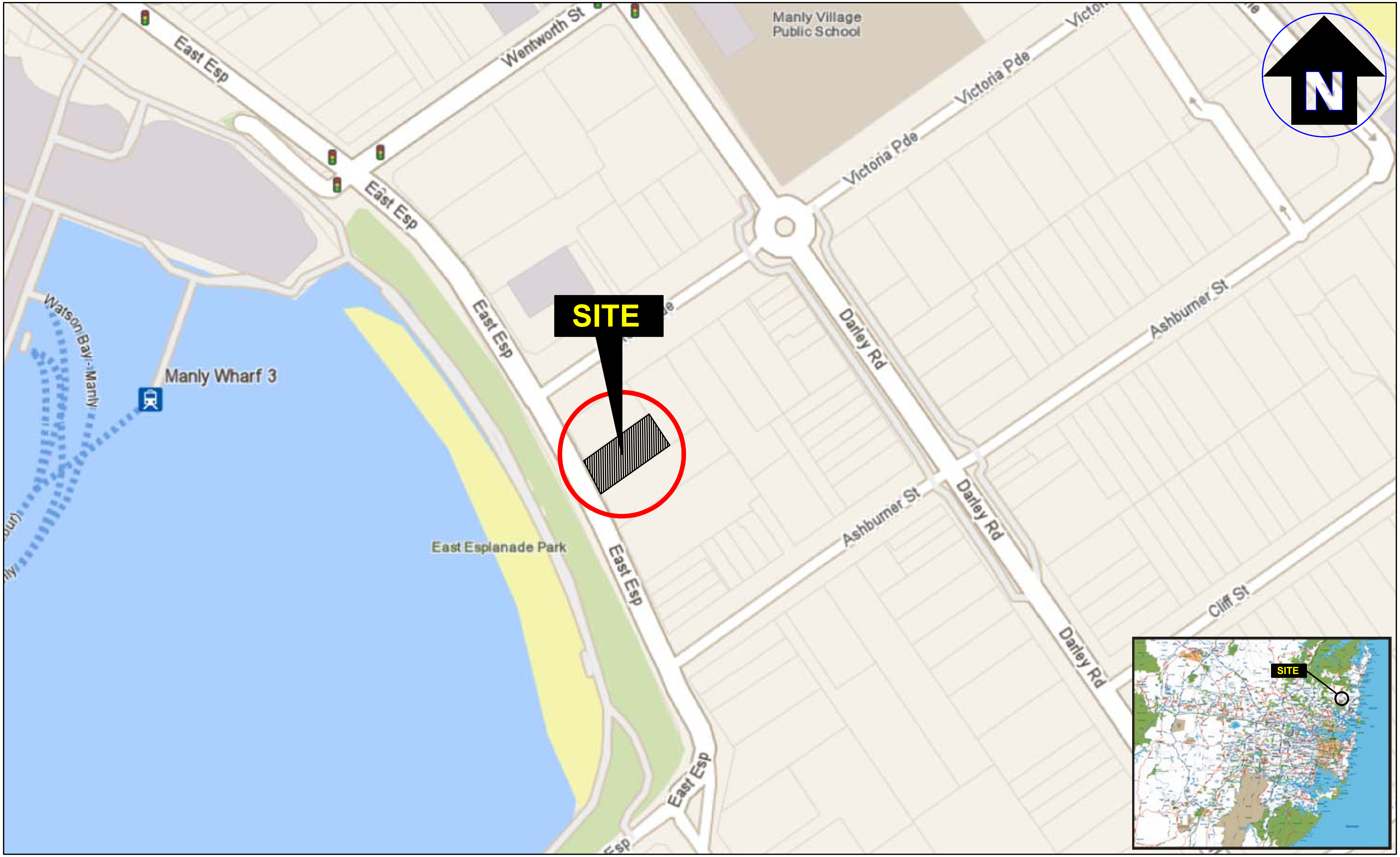
NSW Department of Planning and Environment (DPIE), (2022) Minimum requirements for building site groundwater investigation and reporting, version 2.2210 October 2022

NSW Department of Customer Service (Spatial Services), Spatial Digital Twin (SDT) map viewer, www.portal.spatial.nsw.gov.au/explorer

Abbreviations

AHD	Australian Height Datum
AS	Australian Standard
BEGL	Below Existing Ground Level
BH	Borehole
CPT	Cone Penetration Test
DP	Deposited Plan
EI	EI Australia
FFL	Finished Floor Level
GI	Geotechnical Investigation
NATA	National Association of Testing Authorities, Australia
RL	Reduced Level
SGS	SGS Australia Pty Ltd
STS	STS Geotechnics Pty Ltd

Figures



eiaustralia
Contamination | Remediation | Geotechnical
Suite 6.01, 55 Miller Street, PYRMONT 2009
Ph (02) 9516 0722 Fax (02) 9518 5088

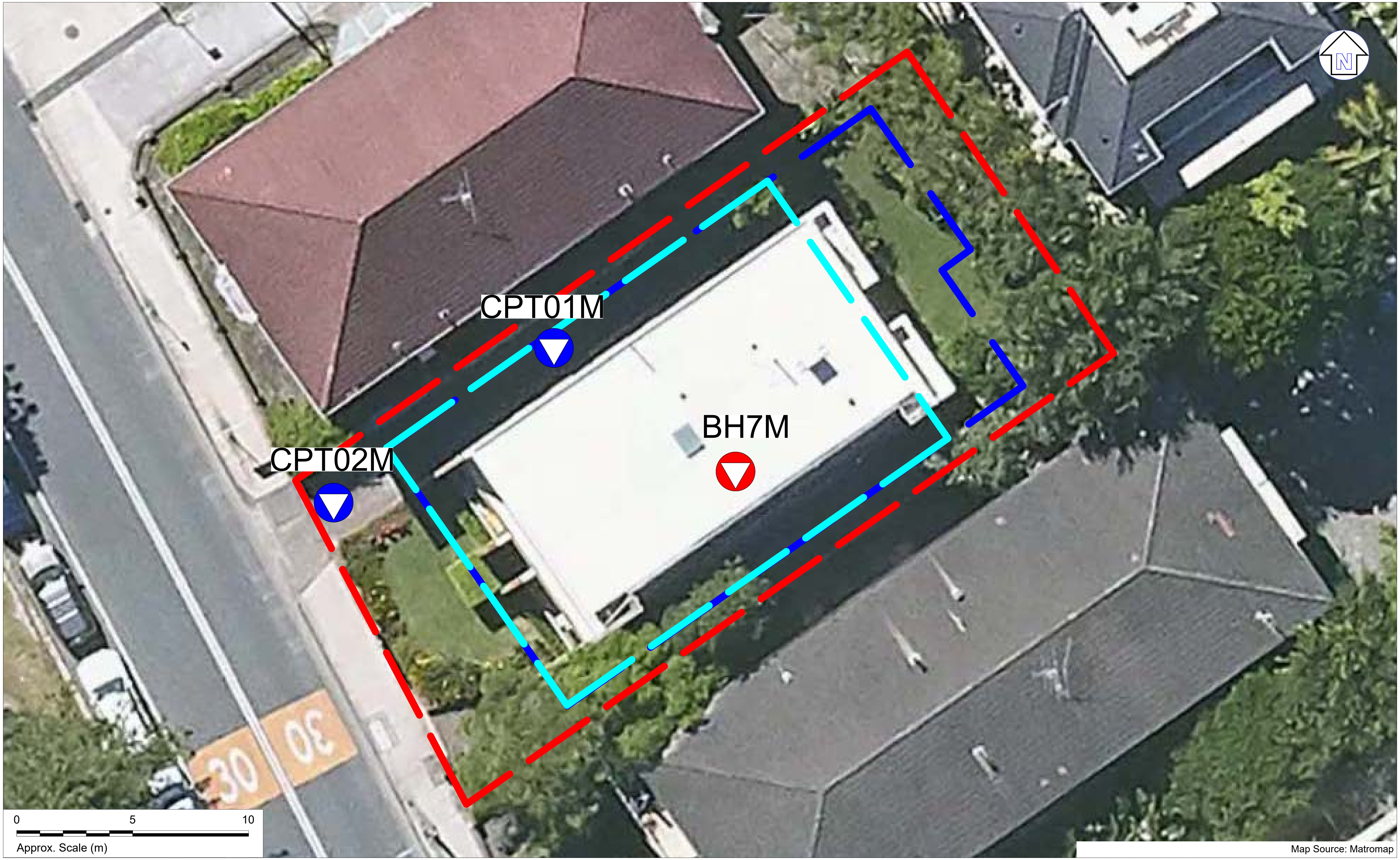
Drawn:	J.F.
Approved:	G.B.
Date:	12-08-25
Scale:	Not To Scale

Manly Property Group No.2 Pty Ltd
Geotechnical Investigation
27 East Esplanade, Manly, NSW

Site Locality Plan

Figure: 1

Project: E26867.G03



LEGEND (All Locations are Approximate)

- – – – Site boundary
- – – – Basement 1 and 2 boundary
- – – – Basement 3 boundary
- ▼ CPT and monitoring well location
- ▼ Hand Auger Borehole/monitoring well location

eiaustralia
Practical Solutions for Built Environments
Suite 6.01, 55 Miller Street, PYRMONT 2009
Ph (02) 9516 0722 Fax (02) 9518 5088

Drawn:	J.F.
Approved:	G.B.
Date:	12-08-25

Manly Property Group No.2 Pty Ltd
Geotechnica Investigation
27 East Esplanade, Manly, NSW

Investigation Location Plan

Figure:
2

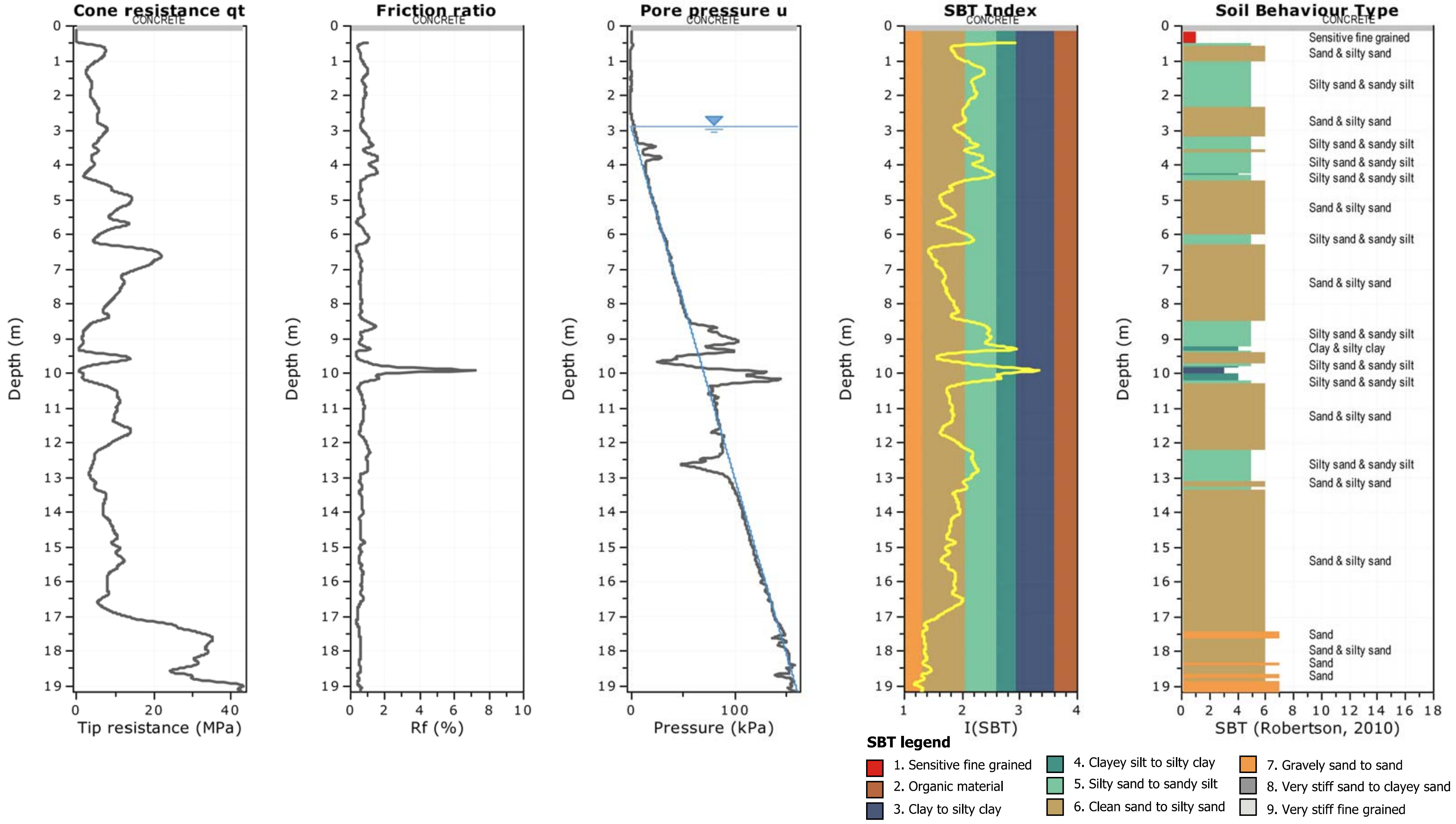
Project: E26867.G03

Appendix A CPT Logs, Borehole Logs, and EI Explanatory Notes

EI Australia
Suite 6.01, 55 Miller Street,
PYRMONT NSW 2009
www.eiaustralia.com.au

Project: **Geotechnical Investigation**
Location: **27 East Esplanade, Manly NSW**

CPT: CPT01M
Total depth: 19.17 m, Date: 7/08/2025
Surface Elevation: 3.00 m
Cone Type: Piezocone
Cone Operator: Stratacore



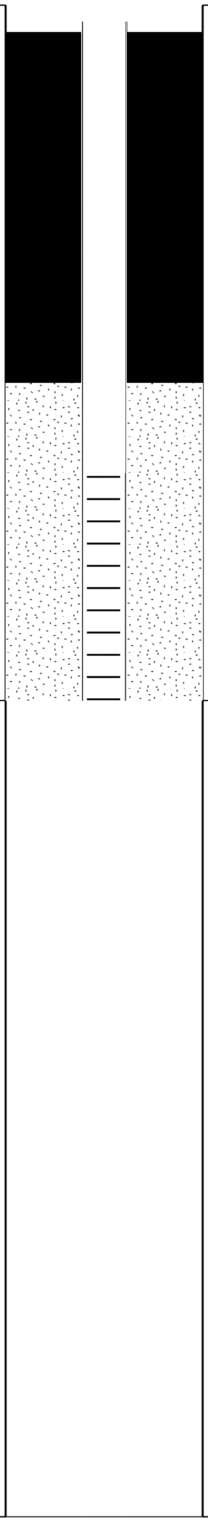
MONITORING WELL LOG

BH ID: CPT01M

Location	27 East Esplanade, Manly NSW	**Started**	07 August 2025		
Client	Manly Property Group No.2 Pty Ltd	**Completed**	07 August 2025		
Job No.	E26867.G03	**Logged By**	JF	**Date**	07 August 2025
Sheets	1 of 1	**Review By**	STP	**Date**	29 September 2025

Drilling Contractor	Stratacore	**Surface RL**	≈3.00 m (AHD)	**Latitude**	-
Plant	Tracked Rig	**Inclination**	90°	**Longitude**	-

WATER	SAMPLES & FIELD TESTS	DEPTH (m)	RL (m AHD)	MATERIAL DESCRIPTION	MOISTURE CONDITION	BACKFILL DETAILS	STANDPIPE DETAILS
		0.00	3.00	CONCRETE: 150mm thick	-	Steel Cover at Surface	Well Stickup =-0.11m (RL 2.89m)
15/08/2025 11:51 AM		0.15	2.85	SAND: fine to medium grained, pale grey	M W	Bentonite 0.18m - 2.50m Sand 2.50m - 4.60m	0.11m - 3.10m PVC casing (50mm Ø) 3.10m - 4.60m PVC screen (50mm Ø)
		4.60	-1.60	Terminated at 4.60m. Target Depth Reached.			

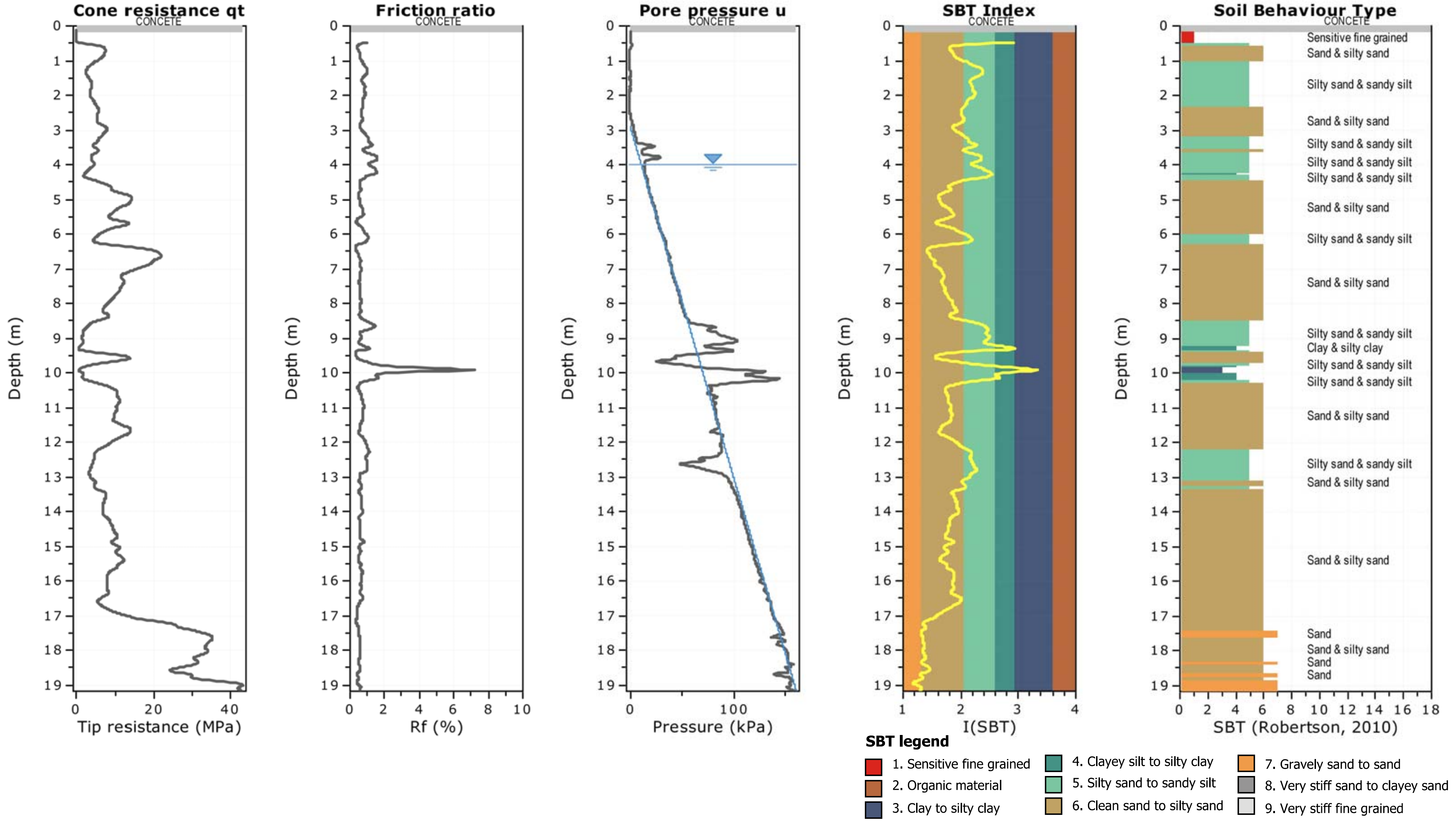


This log should be read in conjunction with EI Australia's accompanying explanatory notes.

EI Australia
Suite 6.01, 55 Miller Street,
PYRMONT NSW 2009
www.eiaustralia.com.au

Project: **Geotechnical Investigation**
Location: **27 East Esplanade, Manly NSW**

CPT: CPT02M
Total depth: 18.89 m, Date: 7/08/2025
Surface Elevation: 4.00 m
Cone Type: Piezocone
Cone Operator: Stratacore



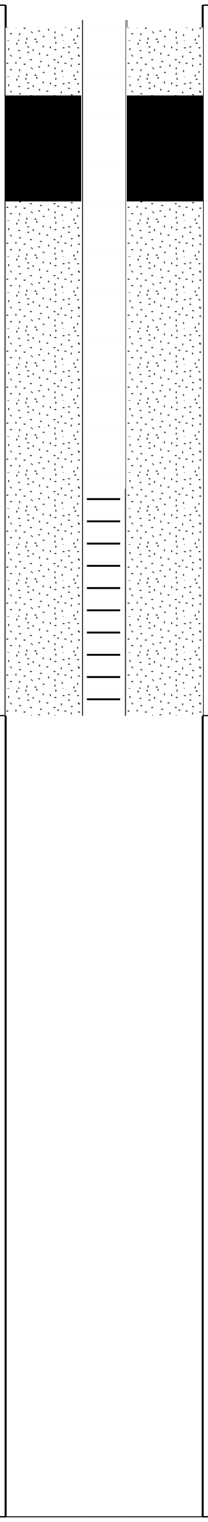
MONITORING WELL LOG

BH ID: CPT02M

Location	27 East Esplanade, Manly NSW	**Started**	07 August 2025		
Client	Manly Property Group No.2 Pty Ltd	**Completed**	07 August 2025		
Job No.	E26867.G03	**Logged By**	JF	**Date**	07 August 2025
Sheets	1 of 1	**Review By**	STP	**Date**	29 September 2025

Drilling Contractor	Stratacore	**Surface RL**	≈4.00 m (AHD)	**Latitude**	-
Plant	Tracked Rig	**Inclination**	90°	**Longitude**	-

WATER	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	RL (m AHD)	MATERIAL DESCRIPTION	MOISTURE CONDITION	BACKFILL DETAILS	STANDPIPE DETAILS
15/09/2025 11:58 AM		0.00		4.00	CONCRETE: 190mm thick	-	Steel Cover at Surface	Well Stickup =-0.10m (RL 3.90m)
		0.19		3.81	SAND: fine to medium grained, pale grey	M W	Sand 0.15m - 0.60m Bentonite 0.60m - 1.30m Sand 1.30m - 4.70m	0.10m - 3.20m PVC casing (50mm Ø) 3.20m - 4.70m PVC screen (50mm Ø)
				-0.70	Terminated at 4.70m. Target Depth Reached.			



BOREHOLE LOG

BH ID: BH7M

Location	27 East Esplanade, Manly NSW	**Started**	07 August 2025		
Client	Manly Property Group No.2 Pty Ltd	**Completed**	07 August 2025		
Job No.	E26867.G03	**Logged By**	JF	**Date**	07 August 2025
Sheets	1 of 1	**Review By**	STP	**Date**	29 September 2025

Drilling Contractor	-	**Surface RL**	≈2.70 m (AHD)	**Latitude**	-
Plant	Hand Auger	**Inclination**	90°	**Longitude**	-

METHOD	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	SAMPLE RECOVERY	DEPTH (m)	GRAPHIC LOG	RL (m AHD)	MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY / REL. DENSITY	MATERIAL ORIGIN & OBSERVATIONS
DT				0.00		2.70	CONCRETE: 130mm thick	-	-	CONCRETE
HA		BH7M_0.40-0.50	■	0.13		2.57	FILL: Silty SAND: fine to coarse grained, dark grey, trace fine to medium grained sub-angular and angular igneous gravel	M	-	FILL
	▽ 5/08/2025 12:10 PM	BH7M_1.20-1.30	■	0.60		2.10	SAND: fine to medium grained, pale grey	M W	L	MARINE SOIL
				2.60		0.10	Terminated at 2.60m. Target Depth Reached.			

This log should be read in conjunction with EI Australia's accompanying explanatory notes.

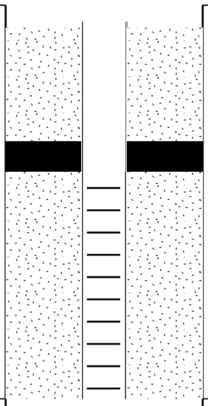
MONITORING WELL LOG

BH ID: BH7M

Location	27 East Esplanade, Manly NSW	**Started**	07 August 2025		
Client	Manly Property Group No.2 Pty Ltd	**Completed**	07 August 2025		
Job No.	E26867.G03	**Logged By**	JF	**Date**	07 August 2025
Sheets	1 of 1	**Review By**	STP	**Date**	29 September 2025

Drilling Contractor	-	**Surface RL**	≈2.70 m (AHD)	**Latitude**	-
Plant	Hand Auger	**Inclination**	90°	**Longitude**	-

WATER	SAMPLES & FIELD TESTS	DEPTH (m)	RL (m AHD)	MATERIAL DESCRIPTION	MOISTURE CONDITION	BACKFILL DETAILS	STANDPIPE DETAILS
		0.00	2.70	CONCRETE: 130mm thick	-	Steel Cover at Surface	Well Stickup =-0.11m (RL 2.59m)
	BH7M_0.40-0.50	0.13	2.57	FILL: Silty SAND: fine to coarse grained, dark grey, trace fine to medium grained sub-angular and angular igneous gravel	M	Sand 0.15m - 0.90m	0.11m - 1.10m PVC casing (50mm Ø)
5/08/2025 12:10 PM	BH7M_1.20-1.30	0.60	2.10	SAND: fine to medium grained, pale grey	M W	Bentonite 0.90m - 1.10m Sand 1.10m - 2.60m	1.10m - 2.60m PVC screen (50mm Ø)
		2.60	0.10	Terminated at 2.60m. Target Depth Reached.			



This log should be read in conjunction with EI Australia's accompanying explanatory notes.

Appendix B Laboratory Certificates

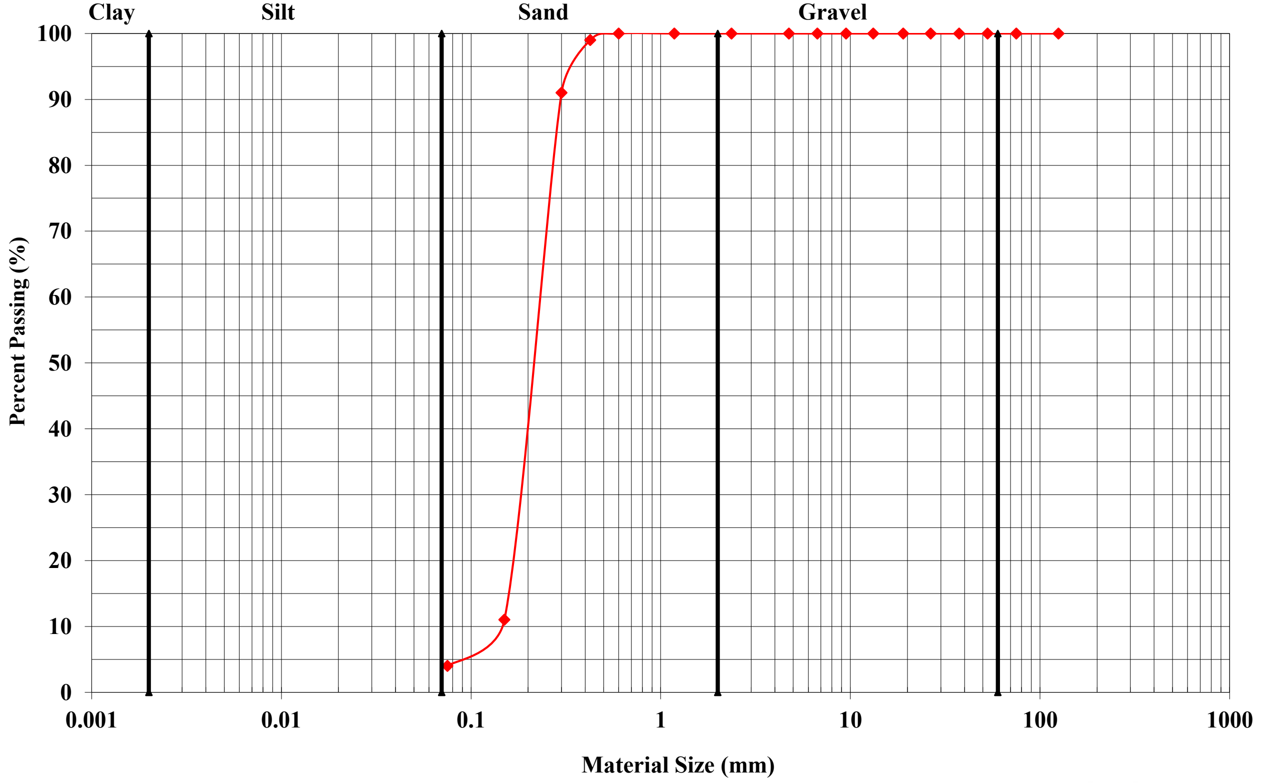
STS Geotechnics Pty Ltd
14/1 Cowpasture Place, Wetherill Park NSW 2164
Phone: (02)9756 2166 | Email: enquiries@stsgeo.com.au

Particle Size Distribution

Project: E26867.G03 27 EAST ESPLANADE, MANLY, NSW
Client: EI AUSTRALIA
Address: Suite 6.01, 55 Miller Street, Pyrmont NSW 2009
Test Method: AS1289.3.6.1
Sampling Procedure: Samples Supplied By Client (Not covered under NATA Scope of Accreditation)
Material Description: Silty SAND, pale brown, trace Clay

STS / Sample No.: 1
Sample Location: BH2M
Depth (m): 0.6- 0.8
Date Sampled: 7/08/2025
Date tested: 14/08/2025

Project No.: 31380/ 1123E-L
Report No.: 25/2090
Report Date: 14/08/2025
Page: 1 of 1
Client Project No: -



Sample Washed: Y

Sieve Size (mm)	Percent Passing (%)
125.0	100.0
75.0	100.0
53.0	100.0
37.5	100.0
26.5	100.0
19.0	100.0
13.2	100.0
9.5	100.0
6.7	100.0
4.75	100.0
2.36	100.0
1.18	100.0
0.60	100.0
0.425	99.0
0.30	91.0
0.15	11.0
0.075	4.0

Remarks:

Approved Signatory.......

Technician: SP

Bala Velupillai - Laboratory Supervisor

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	Gregory Briscoe
Client	EI AUSTRALIA
Address	SUITE 6.01 55 MILLER STREET PYRMONT NSW 2009
Telephone	61 2 95160722
Facsimile	(Not specified)
Email	Greg.Briscoe@eiaustralia.com.au
Project	**E26867.G03 27 East Esplanade, Manly, NSW**
Order Number	**E26867.G03**
Samples	2

LABORATORY DETAILS

Manager	Shane McDermott
Laboratory	SGS Alexandria Environmental
Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	+61 2 8594 0400
Facsimile	+61 2 8594 0499
Email	au.environmental.sydney@sgs.com
SGS Reference	**SE287554 R0**
Date Received	12/8/2025
Date Reported	15/8/2025

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing. NATA accredited laboratory 2562(4354).

SIGNATORIES

Ly Kim HA
Organic Section Head

Shane MCDERMOTT
Laboratory Manager

Ying Ying ZHANG
Laboratory Technician

pH in soil (1:5) [AN101] Tested: 14/8/2025

			BH1M_0.6-0.8 SOIL - 7/8/2025 SE287554.001	BH3_0.1-0.3 SOIL - 7/8/2025 SE287554.002
PARAMETER	UOM	LOR		
pH	pH Units	0.1	7.3	7.4

Conductivity and TDS by Calculation - Soil [AN106] Tested: 14/8/2025

			BH1M_0.6-0.8 SOIL - 7/8/2025	BH3_0.1-0.3 SOIL - 7/8/2025
PARAMETER	**UOM**	**LOR**	**SE287554.001**	**SE287554.002**
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	19	70

Soluble Anions (1:5) in Soil/Solids by Ion Chromatography [AN245] Tested: 14/8/2025

			BH1M_0.6-0.8 SOIL - 7/8/2025	BH3_0.1-0.3 SOIL - 7/8/2025
PARAMETER	UOM	LOR	SE287554.001	SE287554.002
Chloride	mg/kg	0.25	5.0	6.9
Sulfate	mg/kg	5	<5.0	22

METHOD	METHODOLOGY SUMMARY
AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN101	pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode and is calibrated against 3 buffers purchased commercially. For soils, sediments and sludges, an extract with water (or 0.01M CaCl2) is made at a ratio of 1:5 and the pH determined and reported on the extract. Reference APHA 4500-H+.
AN106	Conductivity and TDS by Calculation: Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos/cm or µS/cm @ 25°C. For soils, an extract of as received sample with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Salinity can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. Reference APHA 2510 B.
AN245	Anions by Ion Chromatography: A water sample is injected into an eluent stream that passes through the ion chromatographic system where the anions of interest ie Br, Cl, NO2, NO3 and SO4 are separated on their relative affinities for the active sites on the column packing material. Changes to the conductivity and the UV-visible absorbance of the eluent enable identification and quantitation of the anions based on their retention time and peak height or area. APHA 4110 B

FOOTNOTES

*	NATA accreditation does not cover the performance of this service.	-	Not analysed.	UOM	Unit of Measure.
**	Indicative data, theoretical holding time exceeded.	NVL	Not validated.	LOR	Limit of Reporting.
***	Indicates that both * and ** apply.	IS	Insufficient sample for analysis.	↑↓	Raised/lowered Limit of Reporting.
		LNR	Sample listed, but not received.		

Unless it is reported that sampling has been performed by SGS, the samples have been analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:
a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC and MU criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: www.sgs.com.au/en-gb/environment-health-and-safety.

Appendix C Important Information

Important Information

SCOPE OF SERVICES

The geotechnical report ("the report") has been prepared in accordance with the scope of services as set out in the contract, or as otherwise agreed, between the Client And EI Australia ("EI"). The scope of work may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

RELIANCE ON DATA

EI has relied on data provided by the Client and other individuals and organizations, to prepare the report. Such data may include surveys, analyses, designs, maps and plans. EI has not verified the accuracy or completeness of the data except as stated in the report. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations ("conclusions") are based in whole or part on the data, EI will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to EI.

GEOTECHNICAL ENGINEERING

Geotechnical engineering is based extensively on judgment and opinion. It is far less exact than other engineering disciplines. Geotechnical engineering reports are prepared for a specific client, for a specific project and to meet specific needs, and may not be adequate for other clients or other purposes (e.g. a report prepared for a consulting civil engineer may not be adequate for a construction contractor). The report should not be used for other than its intended purpose without seeking additional geotechnical advice. Also, unless further geotechnical advice is obtained, the report cannot be used where the nature and/or details of the proposed development are changed.

LIMITATIONS OF SITE INVESTIGATION

The investigation programme undertaken is a professional estimate of the scope of investigation required to provide a general profile of subsurface conditions. The data derived from the site investigation programme and subsequent laboratory testing are extrapolated across the site to form an inferred geological model, and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour with regard to the proposed development. Despite investigation, the actual conditions at the site might differ from those inferred to exist, since no subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies. The engineering logs are the subjective interpretation of subsurface conditions at a particular location and time, made by trained personnel. The actual interface between materials may be more gradual or abrupt than a report indicates.

SUBSURFACE CONDITIONS ARE TIME DEPENDENT

Subsurface conditions can be modified by changing natural forces or man-made influences. The report is based on conditions that existed at the time of subsurface exploration. Construction operations adjacent to the site, and natural events such as floods, or ground water fluctuations, may also affect subsurface conditions, and thus the continuing adequacy of a geotechnical report. EI should be kept appraised of any such events, and should be consulted to determine if any additional tests are necessary.

VERIFICATION OF SITE CONDITIONS

Where ground conditions encountered at the site differ significantly from those anticipated in the report, either due to natural variability of subsurface conditions or construction activities, it is a condition of the report that EI be notified of any variations and be provided with an opportunity to review the recommendations of this report. Recognition of change of soil and rock conditions requires experience and it is recommended that a suitably experienced geotechnical engineer be engaged to visit the site with sufficient frequency to detect if conditions have changed significantly.

REPRODUCTION OF REPORTS

This report is the subject of copyright and shall not be reproduced either totally or in part without the express permission of this Company. Where information from the accompanying report is to be included in contract documents or engineering specification for the project, the entire report should be included in order to minimize the likelihood of misinterpretation from logs.

REPORT FOR BENEFIT OF CLIENT

The report has been prepared for the benefit of the Client and no other party. EI assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of EI or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own inquiries and obtain independent advice in relation to such matters.

OTHER LIMITATIONS

EI will not be liable to update or revise the report to take into account any events or emergent circumstances or fact occurring or becoming apparent after the date of the report.