FOUNDATION EARTH SCIENCES

GEOTECHNICAL INVESTIGATION REPORT

Property Address

2-10 Berry Road, 14-16 Marshall Avenue and

5-9 Holdsworth Avenue, St Leonards NSW 2065

Prepared for

DASCO Property Development Services Pty Ltd

Date

27 May 2025

DOCUMENT CONTROL REGISTER

Document Information	
Reference No.	G511-2R1
Report Title	Geotechnical Investigation Report
Site Address	2-10 Berry Road, 14-16 Marshall Avenue and 5-9 Holdsworth Avenue St Leonards NSW 2065
Prepared for	DASCO Property Development Services Pty Ltd

Document Review Details			
Revision/ Document No.	**Issue Date**	**Description**	**Issued By**
0	21/05/2025	Initial Issue	Ben Buckley
1	27/05/2025	Updated the survey plan and details	Ben Buckley

Distribution Register		
Method	**Custodian**	**Issued to**
Electronic	Ben Buckley	Foundation Earth Sciences Office
Electronic	Dany Khoury	DASCO Property Development Services

Authorisation and Release			
–	**Signature**	**Name**	**Date**
Author		Chandrasekaran Muralitharan	27/05/2025
Reviewer		Ben Buckley	27/05/2025

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1.0 INTRODUCTION

1.1 General

DASCO Property Development Services Pty Ltd (the client) appointed Foundation Earth Sciences (FES) to undertake a Geotechnical Investigation (GI) for the property located at 2-10 Berry Road, 14-16 Marshall Avenue and 5-9 Holdsworth Avenue, St Leonards NSW 2065 (the site).

The purpose of this GI is to assess the surface and subsurface conditions to assist with the Development Application (DA) process and to provide initial insight into the subsurface conditions of the site for the design and construction processes. This report interprets and presents findings of the investigation that was carried out during the fieldwork, along with other information provided by the client.

1.2 Scope of Work

The following scope of works were carried out for the GI:

- Preparation of a Safe Work Method Statement (SWMS) tailored to the site conditions.
- Review of Before You Dig Australia (BYDA) plans and service locating.
- Mechanical drilling of four boreholes identified as boreholes BH1 to BH4.
- Standard Penetration Testing (SPT) within the augering of the boreholes.
- Installation of three groundwater wells identified as GW1 to GW3 within the boreholes BH1 to BH3, respectively.
- Subsequent field visit to the site to measure the standing groundwater level.
- Conduct following laboratory testing on the recovered soil and rock samples:
    - Point Load Index (PLI) tests.
    - Aggressivity and Salinity tests.

The following appendices are annexed together with this report:

- Appendix A – A site plan showing approximate locations of the boreholes and groundwater wells.
- Appendix B – The logs for boreholes and explanatory note for the logs.
- Appendix C – Photographs of recovered rock core samples during the drilling.
- Appendix D – Results of PLI tests conducted on recovered rock samples from the boreholes to assess rock strength.
- Appendix E – Results of laboratory tests, includes Aggressivity and Salinity testing on recovered soil sample to assess soil property.

1.3 Provided Information

The following information was provided to FES by the client during the preparation of this report:

- Geotechnical Investigation Report addressed '2-10 Berry Road, 14-16 Marshall Avenue and 5-9 Holdsworth Avenue, St Leonards NSW 2065, prepared by FES, reference to No. G511-1, and dated 11 October 2021.
- Architectural drawings addressed '14-16 Marshall Avenue, 5-9 Holdsworth Avenue & 2-10 Berry Road, ST Leonards', prepared by Peddle Thorp & Walker Pty Ltd (PTW), reference to number PA030600, and dated 15 May 2025.
- Survey Plan addressed '14-16 Marshall Ave, 2-10 Berry Road & 5-9 Holdsworth Ave, St Leonards', referenced job number 3438B, prepared by Project Surveyors and dated 21 September 2021. This includes the sheet no 1 of 6.

2.0 BACKGROUND

2.1 Site Description

The site is located within Sydney metropolitan area, approximately 4km north of Sydney CBD. The survey plan indicates that the topography of site slopes from the northwest to the southeast and Reduced Level (RL) of the site is in the order of 78.6m to 70.0m Australian Height Datum (AHD), respectively. Details of the site are summarised in Table 1 below.

Table 1: The Site Details

Site	Details	
Location	2-10 Berry Road, 14-16 Marshall Avenue and 5-9 Holdsworth Avenue St Leonards NSW 2065	
Lot and DP	Lots 38, 37, 36, 35, 34, 2, 1, 7, 8 and 9 Section 2 in DP7259	
Local Government Area	Lane Cove	
Shape and Area	Irregular-shaped land with approximate size of 5,874m^2	
Slope	From the northwest to the southeast	
Existing Structures	Twelve residential dwellings and associated structures	
Closest Watercourse	Berrys Creek is located approximately 350m west to the site	
Special Features	Holdsworth Avenue is situated about 3m below the adjacent properties, with a retaining wall running along the road	
Type of Neighbouring Properties	North East South West	Marshall Avenue's carriageway and road reserve Holdsworth Avenue's carriageway and road reserve Residential Type Properties Berry Road's carriageway and road reserve

2.2 Proposed Development

The architectural drawings listed above indicate that the proposed development is three high-raised buildings, identified as Building 13 to Building 15, with maximum 15-storey and five basement levels. Furthermore, they indicate that proposed basement levels of the buildings are connected to each other. The RL of lower basement level is inferred to be at 58.25m AHD. Due to the sloping nature of the natural ground level, it is inferred that approximately 12.0m (southeast) to 20.5m (northwest) of excavation is required for the proposed development.

2.3 Local Geology

Local geology was assessed using a geological map, 'Sydney 1: 1:100,000 Geological Series Sheet 9029-9130 Edition 1, 1983', from the Geological Survey of New South Wales. The map indicates that site is part of the Ashfield Shale (Rwa), Wianamatta Group, Middle Triassic age, and is described as 'Black to dark-grey shale and laminite'. The local geology description does not account any fill or soil that may be present at the site.

Further, site is located 60m north to Hawkesbury Sandstone (Rh), Wianamatta Group, Middle Triassic age, and is described as 'Medium to coarse-grained quartz sandstone, very minor shale, and laminite lenses'.

3.0 GROUND CONDITION

3.1 Ground Profile

Summary of encountered ground profiles are provided in Table 2 below. However, reference should be made to logs annexed in Appendix B for details.

Table 2: Summary of Ground Profile

Unit	Details	Depth (m)			
		BH1	BH2	BH3	BH4
	Existing Ground Level (RL m AHD)	77.9	75.2	73.1	72.1
Fill	Gravelly Silt, low plasticity, fine to medium gravel, moist, firm Includes brick pavement	0.0 – 0.1	0.0 – 0.1	0.0 – 0.4	0.0 – 0.4
Residual Soils	Silty/Sandy CLAY, medium to high plasticity, moist, stiff-very stiff, interbedded of sandstone, shale	0.1 – 4.0	0.1 – 2.5	0.4 – 4.4	0.14 – 2.9
Class V [1] Sandstone	SANDSTONE, interbedded with some clay and shale, extremely to highly weathered	4.0 – 5.7	2.5 – 4.9	4.4 – 7.0	2.9 – 6.2
Class IV [1] Sandstone	SANDSTONE, with some shale bands, moderately weathered	5.7 – 11.4	4.9 – 8.2	7.0 – 11.27	6.2 – 10.57
Class III [1] Sandstone	SANDSTONE, with some shale bands, slightly weathered	11.4 – 17.75	8.2 – 17.98	–	–

Note: [1] Bedrock was classified in accordance with the research paper of Pells P.J.N, Mostyn G. & Walker B.F. Foundations on Sandstone and Shale in the Sydney Region, Australian Geomechanics Journal, December 1998.

3.2 Groundwater

Groundwater seepage was observed during the augering of the borehole BH2. Also standing groundwater levels were measured within the installed groundwater wells. Details of groundwater are summarised in Table 3.

Further groundwater recharge rate test was carried out within the installed groundwater wells and results of the test also summarised in Table 3.

Table 3: Summary of the Groundwater Details

Details	Boreholes (Groundwater Wells)			
	BH1 (GW1)	BH2 (GW2)	BH3 (GW3)	BH4
Seepage	Not Observed until 5.65m	3.8m (RL 71.4m)	Not Observed until 1.31m	Not Observed until 1.34m
Standing groundwater level on 7/09/2021	6.9m (RL 71.0m)	5.8m (RL 69.4m)	4.0m (RL 69.1m)	–
Groundwater Recharge Rate (L/s/m^2)	1.16×10^{-3}	5.94×10^{-4}	3.23×10^{-4}	–
Hydraulic Conductivity K (m/s)	9.68×10^{-5}	1.17×10^{-7}	5.15×10^{-8}	–

Standing groundwater levels are also subject to a piezometric head at the drilled locations. Therefore, levels may not be representative of natural groundwater conditions of the site. Further, it should be noted groundwater levels within the site may be subject to seasonal fluctuations, rainfall, prevailing weather conditions and future developments of the areas and landforms.

3.3 Laboratory Tests

Aggressivity and Salinity tests were carried out on recovered soils and groundwater samples in accordance with Australian and NSW standards, guidelines and regulations.

Results of the Aggressivity and Salinity tests are summarised in Table 4 and Table 5, respectively.

Table 4: Results of Aggressivity Tests

Sample ID	Depth (m)	Soil Type	pH	Chloride (mg/kg)	Sulphate As SO_4 (mg/kg)
BH1	2.0	Silty CLAY	5.7	28	81
BH2	3.0	Sandstone	5.2	< 10	55
BH3	1.0	Sandy CLAY	5.6	< 10	55
GW1	–	–	6.9	30	32

Table 5: Summary of Salinity Tests

Sample ID	Depth (m)	Soil Type	Electrical Conductivity EC (µS/cm)	Factor	Saturated Extracted EC EC_e (dS/m)
BH1	2.0	Silty CLAY	74	7	0.52
BH2	3.0	Sandstone	39	14	0.55
BH3	1.0	Sandy CLAY	42	9	0.38
GW1	–	–	300	1	0.3
Environmental Planning & Assessment Regulation 1994				Saline	> 4
Dryland Salinity (1993)				Non-Saline Slightly Moderately Very Highly	< 2 2 – 4 4 – 8 8 – 16 > 16

4.0 DISCUSSIONS AND RECOMMENDATIONS

4.1 Excavation Conditions

Bulk excavation for the proposed development is expected to consist of fill, residual soils, and sandstone bedrock with varying strength. Excavation can typically be accomplished using conventional earthmoving equipment such as backhoes or tracked excavators, even down to very low strength of bedrock. However, if any stronger bedrock bands encountered within that level and/or for excavation below the very low strength bedrock, the use of rock breaking and ripping equipment will be necessary. It is important to note that rock breaking and ripping equipment will generate noise, vibration, and dust during the excavation activities.

Prior to commencement of excavation, the contractor should refer to the boreholes logs, photograph of core samples, and results of PLI tests from the geotechnical investigation to determine the strength and rippability of the bedrock. Subsequently, an assessment should be conducted by a qualified contractor to identify a suitable excavation method for the assessed bedrock materials.

4.2 Vibration Control

A Vibration Management Plan (VMP) is recommended to monitor the potential vibration effects caused by bulk excavation activities on neighbouring properties and road carriageways located along the site boundaries. It is advised to engage a suitably qualified consultant specialised in noise and vibration to prepare the VMP and monitor excavation at and below the low strength bedrock level. The preparation of the VMP should constitute a 'Hold Point'.

4.3 Dilapidation Survey

Preconstruction and post-construction dilapidation survey reports on all structures and road carriageways located within the zone of influence and vicinity of the site are recommended to be conducted by a qualified structural engineer. Preparation of dilapidation survey reports should constitute as 'Hold Point'.

Zone of influence can be identified by drawing a 45° line from the bottom of the bulk excavation to the natural ground level outside the bulk excavation. The area between the intersection of the 45° line with the natural ground level and the boundary of the bulk excavation will constitute the zone of influence.

4.4 Temporary Batter Slope

A temporary batter slope can only be considered at the boundaries where neighbouring structures and road carriageways are located outside the zone of influence and where sufficient space exists between the site and excavation boundaries. In areas where these conditions are not met, a suitable shoring system should be designed and constructed based on the ground condition provided in the geotechnical investigation report. The typical maximum temporary batter slope that can be adopted is provided in Table 6.

Table 6: Temporary Batter Slope

Ground Profile	Temporary Batter Slope (Horizontal: Vertical)
Fill and Residual Soils	2 : 1
Class V Sandstone	1 : 1
Class IV Sandstone	0.5: 1
Class III Sandstone	Semi Vertical

Excavation should be carried out in stages, with a maximum excavation height of 2.0m. The project Geotechnical Engineer should inspection the batter slope immediately after the excavation of each stage to confirm its stability before commencing the next stage. The validation of each excavation stage should constitute a 'Hold Point'.

The temporary batter slope should be supported by suitable retaining wall designed to last the design life of the proposed building. The area between the batter slope and proposed earth retaining structures should be backfilled with suitable materials. Detailed design for backfilling the area behind the retaining wall should be prepared by the project Structural Engineer. A drainage system should be installed according to the structural design before the commencement of the backfilling process.

Backfilling can be conducted using granular type material compacted in layers not exceeding 150mm thickness to 95% Standard Maximum Dry Density, provided that some settlement can be tolerated and there are no structures, pavements or services founded within the backfill. In cases where post-construction settlement needs to be minimised, the backfilling material should achieve to not less than 98% Standard Maximum Dry Density.

4.5 Retaining Walls

Wherever the temporary batter slope may not be considered suitable, a retaining wall consisted of a soldier pile wall system with concrete shotcrete, with piles spacing of three times the pile diameters, is considered suitable for the excavation boundaries.

Detailed retaining wall analysis should be carried out and a suitable shoring pile should be adopted based on the analysis to reduce earth movement and prevent collapse of excavation boundaries. Piles should be socketed into a suitable stratum based on the detailed design and at least 1.0m below the bulk excavation level. Suitable drainage system should be installed behind the retaining wall and should be discharged into site’s stormwater system for long term purpose. If required, the structures located within the zone of influence should be

assessed for the need for underpinning by conducting inspections and assessing their ground condition.

Due to presence of groundwater within the site, soldier piles wall system may cause excessive groundwater inflow into bulk excavation compared to contiguous or secant piles wall systems. It is recommended to conduct a detailed analysis of site's groundwater condition before finalising the shoring wall system. Further it is recommended that suitable shoring pile should be adapted not only to support the excavation boundaries, but also to limit the groundwater inflow into bulk excavation.

4.6 Design of Retaining Walls

The proposed basement cut faces should be supported temporarily during construction and in long-term using appropriate retaining walls. These retaining walls should be designed to withstand the applied lateral pressures of the soil and rock strata, the existing surcharges in their zone of influence, such as existing structures, live traffic and pedestrian loads, utility services, construction related activities, and water pressures if exists.

Rectangular or Trapezoidal Pressure Distribution may be considered for tied-back retaining wall system, as recommended in related standards and technical literature. In this case, temporary anchor or suitable alternative system should be design and constructed.

The active earth pressure distribution on the tied-back retaining wall system may be estimated as following equation:

$$\boldsymbol{\rho_h = 0.65\gamma kH}$$

Where,
ρ_h = Horizontal pressure (kN/m^2)
γ = Wet density (kN/m^3)
k = Coefficient of earth pressure (k_a or k_o)
H = Retained height (m)

For the design of flexible retaining walls, where some lateral movement is acceptable, an active earth pressure coefficient is recommended. Should it be critical to limit the horizontal deformation of a retaining structure, use of an earth pressure coefficient at rest should be considered. Recommended parameters for the design of retaining wall are presented in the Table 7.

Table 7: Retaining Walls Design Parameters

Ground Profile	Unit Weight Υ (kN/m^3)	Effective Cohesion c' (kPa)	Angle of Friction ϕ' (°)	Modulus of Elasticity E_{sh} (MPa)	Poisson's Ratio
Fill	18	0	26	8	0.35
Residual Soil	20	5	24	15	0.35
Class V Sandstone	22	10	28	75	0.30
Class IV Sandstone	24	100	34	300	0.25
Class III Sandstone	25	200	38	600	0.20

Preliminary coefficients of lateral earth pressure for the encountered ground profile are provided in Table 8. The coefficients provided are based on horizontal ground surface and fully drained conditions.

Table 8: Coefficient of Lateral Earth Pressure

Ground Profile	Active Pressure, Ka	At Rest, Ko	Passive Pressure, Kp
Fill	0.39	0.56	2.56
Residual Soils	0.42	0.59	2.37
Class V Sandstone	0.36	0.53	2.77
Class IV Sandstone	0.28	0.44	3.54
Class III Sandstone	0.24	0.38	4.20

It is recommended that design of earth retaining wall should be reviewed by a qualified geotechnical engineer to ensure adequate allowance has been made for the quality of the bedrock (defects and seams) prior to commencement of construction.

It should be noted that hydrostatic pressures due to ground water table (if present) and surcharge due to nearby structures (within the zone of influence) should also be taken into the account in the design of the retaining structures.

4.7 Temporary Anchoring System

If braced retaining structures is selected, a temporary anchoring system with a suitable number of anchors requires to provide a lateral support to minimise the lateral movement. It is recommended to carried out geotechnical modelling to find out the required number of anchors and estimated ground defections.

Adoptable allowable bond stresses for encountered bedrock layers are provided in Table 9 for designing of an anchoring system.

Table 9: Allowable Bond Stress for Anchoring

Ground Profile	Allowable Bond Stress (kPa)
Class V Sandstone	100
Class IV Sandstone	200
Class III Sandstone	400

Anchors should be extended behind the active zone (Zone of Influence) to allow an effective bonding with suitable bedrock. The basement floor slabs should be designed and constructed to provided permanent lateral support to the retaining wall system, and anchoring should consider as temporary option for construction stage. If anchoring system is impractical, consideration might be given to temporary support options such as installation of props associated with staged excavation or temporary berms in front of the wall with stage excavation.

Adopted allowable bond stresses recommended above is typical recommendable bond stress. Therefore, anchors should be installed with bond length of at least 3.0m and proof tested with 1.3 times the design working load before they lock off at working load.

Inspection and monitoring of the construction of shoring piles and temporary anchoring system should be carried out under the supervision of the project Geotechnical Engineer and should constitute 'Hold Points'.

4.8 Groundwater Management

It should be noted that the groundwater conditions of a site might change with climate and development variations. Based on the available information and proposed basement excavation depth, it is inferred that groundwater is likely to be encountered within the bulk excavation.

It is recommended to conduct long-term monitoring to assess groundwater fluctuations and determine a suitable dewatering system within the bulk excavation before finalising the shoring system. This should constitute a 'Hold Point'.

A groundwater modelling using a commercial software is recommended to carry out to the proposed shoring system to estimate groundwater inflow into the basement. Based on the modelling, groundwater impact to the neighbouring infrastructures should be assessed to ensure that the impact is within the acceptable limits. It is recommended to implement a Groundwater Management Plan (GMP) during the construction stage. GMP requires frequent update throughout the construction stage.

The basement floor slabs and walls, incorporating an adequate drainage system, should be designed by a suitably qualified engineer and constructed in accordance with local council specification. Validation of drainage system by a qualified Hydraulic Engineering is required and should constitute a 'Hold Point'.

4.9 Foundations

The foundation level of the proposed development is anticipated to be within the sandstone bedrock geology. It is therefore considered foundation system of proposed development are likely to be shallow foundations system such as pads and strips placed at a minimum depth of 0.5m below the bulk excavation level. Table 10 provides design parameters recommended for shallow and pile foundations.

Table 10: Foundation Design Parameters

Ground Profile	Allowable End Bearing Capacity (kPa)	Allowable Shaft Adhesion Compression (kPa)
Residual Soils	150	N/A
Class V Sandstone	1,000	100
Class IV Sandstone	2,500	250
Class III Sandstone	3,500	350

Note:

- Higher end bearing capacity can be adopted to the shallow foundations on 'Class III Sandstone' bedrock layer subject to spoon testing on at least 50% of the shallow foundations extending to approximately depth of 3.0m below the bottom of the foundation.
- With a minimum embedment depth of 0.5m for deep foundations and 0.4m for shallow foundations.
- Clean rock socket of roughness of at least grooves of depth 1mm to 4mm and width greater than 5mm at spacing of 50mm to 200mm.
- Shaft Adhesion in Tension is 50% of Compression, applicable to piles only.

It is recommended to carried out detailed geotechnical modelling of proposed foundation system to determine the magnitude and distribution of settlement occurring under working load. Where additional bearing pressure is required and/or excessive settlement has occurred, consideration should be given to adoption of pile foundation socking into stronger stratum.

Piles will also be used to increase the resistance against the lateral seismic and wind loads. Shallow and pile foundation can be designed in accordance with Australian Standards AS2870-2011 and AS2159-2009, respectively.

It is recommended that all foundations need to be founded on the same stratum to minimise and avoid potential future differential settlement. Detail design of the foundation system should be carried out by the project structural engineer and reviewed by project geotechnical engineer.

A qualified geotechnical engineer should inspect the foundation excavations to confirm the suitability of foundation materials and ensure that the required serviceability end bearing pressures can be met. Foundation excavations should be cleaned, with any water and/or debris removed before concrete placement. Validation of the capacity of the shallow and pile foundations through inspections is required, and these inspections should constitute 'Hold Points'.

4.10 Site Earthquake Classification

Based on the ground conditions and details of the proposed development, in accordance with Australian Standard AS 1170.4-2007, the site can be classified as 'Rock' (Class Be) for design of foundations and retaining walls embedded in the underlying bedrock. This classification is subject to foundation system of the development being extended and socketed into the underlying bedrock geology. The Hazard Factor (Z) is 0.08.

4.11 Aggressivity and Salinity

Soil and groundwater samples were tested for pH, Chloride and Sulphate for assessment of Aggressivity in accordance with Australian Standard AS219-2009. Based on the ground profile and test results, site is assessed to be 'Mild-Aggressive' to reinforced concrete foundations and 'Non-Aggressive' to steel foundations. It is therefore recommended that the design and construction of proposed foundation system should incorporate aggressiveness of the soil.

Assessment of the soil and groundwater electrical conductivity was carried out to assess the salinity of the soil. It is finding that site is 'Non-Saline' in accordance with EPA regulation (1994) and Dryland Salinity (1993).

4.12 Earthwork and Subgrade Preparation

Earthwork and subgrade preparation should be carried out in accordance with local council specifications and Australian Standard AS 3798-2007. The general procedure for development areas is as follows:

1. **Site Preparation:**
    - Remove fill materials, topsoils, or unsuitable materials from the site.
    - Stockpile excavated materials separately for reuse as engineering fill or for removal to spoil.
2. **Subgrade Treatment:**
    - Adjust the moisture condition of the exposed surface after excavation to within ±2% of its Optimum Moisture Content (OMC), and compact using a minimum 12-tonne vibrating compactor to the design density ratio.
    - Test the exposed surface with appropriate density testing and perform proof rolling with a smooth drum roller.
3. **Handling Soft or Loose Areas:**
    - Excavate soft or loose areas, treat with moisture, and then recompacted or replaced with suitable imported fill material.
4. **Compaction Recommendations:**
    - **Moisture Content:** Maintain fill materials at ±2% of OMC.
    - **Density Ratio:** Achieve a minimum density ratio of 98% of the standard maximum dry density.
    - **Layer Thickness:** Place loose thickness of fill layers should not exceed 200mm during compaction to achieve compacted thickness of 150mm.
5. **Imported Fill Material Suitability:**
    - **Cleanliness:** Materials should be clean (i.e., free of Steel Furnace Slag Aggregate, contaminants, deleterious, or organic material) and free of inclusions grated than 120mm in size.
    - **Moisture Content:** Avoid using materials with excessive moisture content.
    - **Compliance:** Materials should meet the requirements of Australian Standard AS 3798-2007.

4.13 Additional Work

The following additional geotechnical work is required for the design and construction of the proposed development.

Geotechnical Investigation

It is recommended to conduct additional deep boreholes after demolishing the existing structures to assess subsurface conditions where deep excavation is required and/or to obtain better coverage of the site condition. At least 3 boreholes should be conducted within the western portion of the site, reaching a minimum depth of 22m. This geotechnical investigation report should be reviewed and updated based on the findings from these additional boreholes, and the structural design should be revised accordingly.

Geotechnical Assessment

It is recommended to perform a geotechnical assessment using the Finite Element Analysis for the shoring wall design to ensure that ground deformation due to deep excavation remains within industrial-acceptable limits and does not adversely impact neighbouring assets.

Hydrogeological Assessment

A long-term groundwater assessment should be conducted in accordance with WaterNSW requirements. Groundwater modelling should be carried out prior to the design stage to determine the appropriate basement system.

5.0 CONCLUSIONS

This report presents the findings of the geotechnical investigation and provides recommendations for the proposed development at 2-10 Berry Road, 14-16 Marshall Avenue and 5-9 Holdsworth Avenue, St Leonards NSW 2065. It concludes that the proposed development is feasible on the site using industry-standard design and construction techniques, provided that the recommendations outlined in this report are followed.

For and on behalf of Foundation Earth Sciences

Prepared by

Chandrasekaran Muralitharan
Principal Geotechnical Engineer

Reviewed by

Ben Buckley
Director

6.0 LIMITATIONS

The assessment of the sub-surface profile within the proposed development area and the recommendations presented in this report are based on limited information available to date.

The recommendations and advice presented in this report on soil and rock condition is considered to be indicative only as only very limited areas were assessed on site to date. Site inspection by a consulting Geotechnical Engineer or Engineering Geologist are to be undertake when further investigation works are to be carried out to confirm the condition of founding materials in which this geotechnical assessment recommends.

Anecdotal evidence and Information provided by client is assumed to be relevant and to the best of knowledge be appropriate for its interpretation.

There is a possibility that the actual geotechnical and groundwater conditions across the site could differ from the inferred geotechnical assumptions and derivations on which our recommendations are presented in this report. In that case, Foundation Earth Sciences should be contacted for further advise and review of the information provided in this report. Foundation Earth Sciences does not accept any liabilities for the conditions not provided and/or accessible during the preparation of this report. Any ensuring liability resulting from use of this report by third parties cannot be transferred to Foundation Earth Sciences.

7.0 REFERENCES

1. Australian Standard – AS1726-2017 Geotechnical Site Investigation.
2. Australian Standard – AS 1170.4-2024 Structural Design Actions – Part 4: Earthquake actions in Australia.
3. Australian Standard – AS 2870-2011 Residential slabs and footings.
4. Australian Standard – AS 2159-2009 Piling - Design and installation.
5. Australian Standard – AS 3798-2007 Guidelines on earthworks for commercial and residential developments.
6. Pells, P.J.N, Mostyn, E and Walker, B F – Foundations on Sandstone and Shale in the Sydney Region, Australian Geomechanics Journal, Dec 1998.
7. Pells, P.J.N, Douglas D.J, Rodway, B, Thorne C, McManon B.K – Design Loadings for Foundations on Shale and Sandstone in the Sydney Region. Australian Geomechanics Journal, 1978.
8. Site Investigation for Urban Salinity, Department of Land and Water Conservation 2002.

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Appendix A

Site Plan

Key

Approximate Test Locations

Not to scale

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Ref #	Site Plan
G511-2	DASCO Property Development Services Pty Ltd
MM	2-10 Berry Rd, 14-16 Marshall Ave & 5-9 Holdsworth Ave, St Leonards

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Appendix B

Boreholes Logs

BOREHOLE : BH1

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CLIENT NAME: DASCO Property Development Services Pty Ltd **JOB NUMBER:** G511-2

SITE ADDRESS: 2-10 Berry Rd, 14-16 Marshall Ave & 5-9 Holdsworth Ave, St Leonards NSW **PROJECT:** Geotechnical Investigation

Date Started : 30/08/2021 **Completed :** 30/08/2021 **Logged By :** MM **Checked By :** MM

Borehole Location : Refer to Site Plan **Surface RL :** 77.9 **Datum :** m AHD

Equipment : Drilling Rig **Borehole Size :** 100mm **Slope :** -90°

Method	Water	Well Details	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Moisture	Consistence	Samples Tests Remarks	Additional Observations	Depth (m)
ADT	Not encountered within the augering		77.8	0.10		CH	FILL, gravelly silt, low plasticity, fine to medium gravel, grey-brown-red	M	F		Fill	1
							Silty CLAY, medium to high plasticity, grey	M	St-VSt	SPT 2, 4, 13 N=17	Residual Soils	2
										SPT 9, 26, Bouncing N > 50		3
			73.9	4.00			SANDSTONE, fine to medium grained, interbedded with some clay and shale, extremely weathered, extremely low strength, yellow-grey	M			Bedrock	4
			72.3	5.65			Borehole BH1 continued as cored hole from 5.65m				TC bit refusal	5
												6
												7
												8
												9
												10

Comments:

D - Dry, M - Moist, W - Wet

VS - Very Soft, S - Soft, F - Firm, St - Stiff, VSt - Very Stiff, H - Hard

VL - Very Loose, L - Loose, MD - Medium Dense, D - Dense, VD - Very Dense

FOUNDATION EARTH SCIENCES

BOREHOLE : BH1

CLIENT NAME: DASCO Property Development Services Pty Ltd **JOB NUMBER:** G511-2

SITE ADDRESS: 2-10 Berry Rd, 14-16 Marshall Ave & 5-9 Holdsworth Ave, St Leonards NSW **PROJECT:** Geotechnical Investigation

Date Started : 30/08/2021 **Completed :** 30/08/2021 **Logged By :** MM **Checked By :** MM

Borehole Location : Refer to Site Plan **Surface RL :** 77.9 **Datum :** m AHD

Equipment : Drilling Rig **Borehole Size :** 100mm **Slope :** -90°

Method	Water	Well Details	RL (m)	Depth (m)	Graphic Log	Material Description	Weathering	Estimated Strength (EL VL L M H VH EH)	$Is_{(50)}$ (MPa)	RQD %	Defect Spacing (mm) (20 60 180 540 1620)	Defect Description	Depth (m)
				1									1
				2									2
				3									3
				4									4
				5		Continued from non-cored borehole							5
NMLC			72.3	5.65		SANDSTONE, fine to medium grained, with some shale bands, grey-brown-dark grey	MW		D A 0.43 0.82 D A 0.15 0.8 D A 0.53 0.51	68 74		5.72m, B, P, S, 0-5° 5.76m, B, P, S, 0-5° 5.85m, B, P, S, 0-5° 5.90m, B, P, S, 0-5°, Fe 5.92m, B, P, S, 0-5° 6.00m, HB 6.10m, B, P, S, 10-15° 6.30m, B, P, S, 5-10° 6.32m, B, P, S, 0-5° 6.39m, B, P, S, 0-5° 6.53m, B, P, S, 0-5° 6.70m, EW, 10mm 6.80m, B, P, S, 0-5° 6.88m, B, P, S, 0-5° 6.92m, J, P, S, 0-5°, Fe 7.00m, HB 7.15m, B, P, S, 0-5°, Fe 7.16m, B, P, S, 0-5°, Fe 7.30m, J, Ir, R, 0-5° 7.35m, J, Ir, R, 70-75°, Fe 7.46m, EW+CS, 50mm 7.52m, B, P, R, 0-5°, Fe 7.62m, B, P, R, 10-15°, Fe 7.69m, B, P, R, 10-15°, Fe 7.80m, B, P, R, 0-5°, Fe 8.00m, HB 8.10m, B, P, S, 0-5° 8.21m, J, P, R, 0-5° 8.31m, B, P, S, 0-5° 8.38m, B, P, S, 0-5° 8.45m, MB 8.51m, B, P, S, 5-10° 8.77m, B, P, S, 0-5° 8.82m, EW, 20mm 9.00m, HB 9.27m, B, P, R, 0-5° 9.28m, B, P, R, 0-5° 9.39m, J, P, S, 10-15° 9.63m, B, P, S, 0-5° 9.65m, B, P, S, 10-15° 9.93m, B, P, S, 0-5°	6 7 8 9 10

Comments:

Weathering: EW - Extremely; HW - Highly; MW - Moderately; SW - Slightly; Fr - Fresh

EL - Extremely Low; VL - Very Low; L - Low; M - Medium; H - High; VH - Very High; EH - Extremely High

D - Diametral; A - Axial

J - Joint; B - Bedding Plan; CS - Clay Seams; FZ - Fractured Zone; IS - Infill Seam; SS - Sheared Seam; CZ - Crushed Zone

MB - Mechanical Break; HB - Handling Break; Pl - Planar; Ir - Irregular; Cu - Curved; St - Stepped

S - Smooth; R - Rough; P - Polished; Qz - Quartz; Fe - Iron Stain

FOUNDATION EARTH SCIENCES

BOREHOLE : BH1

CLIENT NAME: DASCO Property Development Services Pty Ltd **JOB NUMBER:** G511-2

SITE ADDRESS: 2-10 Berry Rd, 14-16 Marshall Ave & 5-9 Holdsworth Ave, St Leonards NSW **PROJECT:** Geotechnical Investigation

Date Started : 30/08/2021 **Completed :** 30/08/2021 **Logged By :** MM **Checked By :** MM

Borehole Location : Refer to Site Plan **Surface RL :** 77.9 **Datum :** m AHD

Equipment : Drilling Rig **Borehole Size :** 100mm **Slope :** -90°

Method	Water	Well Details	RL (m)	Depth (m)	Graphic Log	Material Description	Weathering	Estimated Strength (EL VL L M H VH EH)	$Is_{(50)}$ (MPa)	RQD %	Defect Spacing (mm) (20 60 180 540 1620)	Defect Description	Depth (m)
NMLC				11		SANDSTONE, fine to medium grained, with some shale bands, grey-brown-dark grey *(continued)*	MW		D 0.15 A 1.5	74		10.00m, HB 10.15m, B, P, S, 10-15° 10.17m, J, Ir, R, 85-90°, Fe 10.20m, J, Ir, R, 85-90°, Fe 10.22m, J, Ir, R, 85-90°, Fe 10.25m, J, Ir, R, 85-90°, Fe 10.28m, EW+CS, 50mm 10.40m, B, P, R, 0-5° 10.62m, B, P, R, 0-5° 10.70m, B, P, R, 0-5° 10.83m, B, P, R, 0-5° 11.00m, HB 11.08m, B, P, S, 0-5° 11.13m, B, P, S, 0-5°	11
				12			SW		D 1.09 A 0.95			11.22m, B, P, S, 0-5° 11.24m, B, P, S, 0-5° 11.35m, B, P, S, 0-5° 11.41m, B, P, S, 0-5° 11.48m, MB 11.50m, B, P, S, 0-5° 11.72m, B, P, S, 0-5° 12.00m, B, P, S, 0-5° 12.03m, B, P, S, 0-5° 12.31m, B, P, R, 0-5°	12
				13						85		12.72m, B, P, S, 0-5° 13.00m, HB	13
				14					D 1.1 A 0.87			13.25m, B, P, S, 0-5° 13.27m, B, P, S, 0-5° 13.37m, B, P, S, 0-5° 13.46m, B, P, S, 0-5° 13.54m, J, Ir, R, 0-5° 13.56m, B, P, R, 0-5° 13.60m, B, P, R, 0-5° 13.64m, B, P, R, 0-5° 13.72m, B, P, R, 0-5° 13.76m, B, P, R, 0-5° 14.00m, HB 14.30m, B, P, R, 0-5° 14.47m, MB	14
				15					D 1.84 A 1.39			14.81m, B, P, S, 0-5° 14.90m, EW, 10mm 14.97m, B, P, S, 0-5° HB 15.05m, B, P, S, 0-5° 15.44m, B, P, S, 0-5°	15
				16						89		15.90m, B, P, S, 0-5° 15.93m, B, P, S, 0-5° 16.00m, HB 16.02m, B, P, S, 0-5°	16
				17					D 1.17 A 1.1 D 1.2 A 1.71			16.90m, B, P, S, 0-5° 17.00m, HB	17
			60.2	*17.75* 18		BH1 terminated at 17.75m						17.75m, MB	18
				19									19
				20									20

Comments:

Weathering: EW - Extremely; HW - Highly; MW - Moderately; SW - Slightly; Fr - Fresh

EL - Extremely Low; VL - Very Low; L - Low; M - Medium; H - High; VH - Very High; EH - Extremely High

D - Diametral; A Axial

J - Joint; B - Bedding Plan; CS - Clay Seams; FZ - Fractured Zone; IS - Infill Seam; SS - Sheared Seam; CZ - Crushed Zone

MB - Mechanical Break; HB - Handling Break; Pl - Planar; Ir - Irregular; Cu - Curved; St - Stepped

S - Smooth; R - Rough; P - Polished; Qz - Quartz; Fe - Iron Stain

FOUNDATION EARTH SCIENCES

BOREHOLE : BH2

CLIENT NAME: DASCO Property Development Services Pty Ltd **JOB NUMBER:** G511-2

SITE ADDRESS: 2-10 Berry Rd, 14-16 Marshall Ave & 5-9 Holdsworth Ave, St Leonards NSW **PROJECT:** Geotechnical Investigation

Date Started : 31/08/2021 **Completed :** 31/08/2021 **Logged By :** RL/MM **Checked By :** MM

Borehole Location : Refer to Site Plan **Surface RL :** 75.2 **Datum :** m AHD

Equipment : Drilling Rig **Borehole Size :** 100mm **Slope :** -90°

Method	Water	Well Details	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Moisture	Consistence	Samples Tests Remarks	Additional Observations	Depth (m)
ADT			75.2	0.05			Brick Pavement, approximate thickness of 50mm	M	F		Fill	
			75.0	0.20		CH	FILL, gravelly silt, low plasticity, fine gravel, dark brown-dark grey	M	St-VSt		Residual Soils	
							Silty CLAY, medium to high plasticity, grey with red mottling					1
			74.0	1.20		CS	Sandy CLAY, medium to high plasticity, fine to medium grained sand, grey-red-brown	M	St-VSt	SPT 3, 6, 9 N=15		2
			72.7	2.50			SANDSTONE, fine to medium grained, interbedded with some clay and shale, extremely weathered, extremely low strength, yellow-grey	M-W			Bedrock	3
	▶										Seepage from 3.8m to 4.0m	4
											TC bit refusal	5
			70.3	4.90			Borehole BH2 continued as cored hole from 4.90m					6
												7
												8
												9
												10

Comments:

D - Dry, M - Moist, W - Wet

VS - Very Soft, S - Soft, F - Firm, St - Stiff, VSt - Very Stiff, H - Hard

VL - Very Loose, L - Loose, MD - Medium Dense, D - Dense, VD - Very Dense

FOUNDATION EARTH SCIENCES

BOREHOLE : BH2

CLIENT NAME: DASCO Property Development Services Pty Ltd **JOB NUMBER:** G511-2

SITE ADDRESS: 2-10 Berry Rd, 14-16 Marshall Ave & 5-9 Holdsworth Ave, St Leonards NSW **PROJECT:** Geotechnical Investigation

Date Started : 31/08/2021 **Completed :** 31/08/2021 **Logged By :** RL/MM **Checked By :** MM

Borehole Location : Refer to Site Plan **Surface RL :** 75.2 **Datum :** m AHD

Equipment : Drilling Rig **Borehole Size :** 100mm **Slope :** -90°

Method	Water	Well Details	RL (m)	Depth (m)	Graphic Log	Material Description	Weathering	Estimated Strength (EL VL L M H VH EH)	$Is_{(50)}$ (MPa)	RQD %	Defect Spacing (mm) (20 60 180 540 1620)	Defect Description	Depth (m)
				1									1
				2									2
				3									3
				4									4
				5		Continued from non-cored borehole							5
NMLC			70.3	4.90 5		SANDSTONE, fine to medium grained, with some shale bands, light grey-grey-brown	MW		D 0.45 A 0.62	52		4.95m, B, P, S, 0-5° 5.00m, B, P, S, 0-5° 5.11m, B, P, S, 10-15° 5.19m, J, Ir, R, 45-50° 5.27m, J, P, R, 10-15° 5.30m, J, P, R, 60-65°, Fe 5.34m, J, P, R, 60-65°, Fe 5.36m, J, P, R, 10-15° 5.46m, B, P, S, 0-5° 5.65m, B, P, R, 0-5° 5.73m, B, P, R, 0-5° 5.76m, CS, 10mm 5.83m, B, P, R, 0-5° 5.91m, EW, 20mm 6.00m, HB 6.05m, B, P, R, 0-5° 6.20m, MB 6.34m, B, P, S, 0-5° 6.68m, B, P, R, 5-10° 6.73m, B, P, S, 0-5° 6.91m, J, P, R, 5-10° 7.00m, B, P, S, 0-5° 7.10m, B, P, S, 0-5°	6
				7					D 0.29 A 1.28	73		7.32m, J, Ir, R, 0-5° 7.36m, B, P, S, 0-5° 7.45m, B, P, S, 0-5° 7.54m, EW, 20mm 7.62m, B, P, S, 0-5° 7.72m, B, P, S, 0-5° 7.83m, B, P, R, 0-5° 7.86m, B, P, S, 0-5° 7.88m, B, P, S, 0-5° 7.97m, B, P, S, 0-5° 8.00m, B, P, S, 0-5° 8.08m, B, P, S, 0-5° 8.21m, B, P, S, 0-5° 8.23m, B, P, S, 0-5° 8.33m, B, P, S, 0-5° 8.41m, B, P, S, 0-5° 8.74m, J, P, R, 5-10° 9.00m, HB	7
				8								9.15m, MB 9.21m, B, P, S, 0-5°	8
				9			SW		D 0.6 A 1.14				9
				10					D 0.73 A 1.11	91		9.82m, B, P, S, 0-5°	10

(EL VL L M H VH EH) (20 60 180 540 1620 4860)

Comments:

Weathering
EW - Extremely
HW - Highly
MW - Moderately
SW - Slightly
Fr - Fresh

EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

D - Diametral
A Axial

J - Joint
B - Bedding Plan
CS - Clay Seams
FZ - Fractured Zone
IS - Infill Seam
SS - Sheared Seam
CZ - Crushed Zone

MB - Mechanical Break
HB - Handling Break

PI - Planar
Ir - Irregular
Cu - Curved
St - Stepped

S - Smooth
R - Rough
P - Polished

Qz - Quartz
Fe - Iron Stain

FOUNDATION EARTH SCIENCES

BOREHOLE : BH2

CLIENT NAME: DASCO Property Development Services Pty Ltd **JOB NUMBER:** G511-2

SITE ADDRESS: 2-10 Berry Rd, 14-16 Marshall Ave & 5-9 Holdsworth Ave, St Leonards NSW **PROJECT:** Geotechnical Investigation

Date Started : 31/08/2021 **Completed :** 31/08/2021 **Logged By :** RL/MM **Checked By :** MM

Borehole Location : Refer to Site Plan **Surface RL :** 75.2 **Datum :** m AHD

Equipment : Drilling Rig **Borehole Size :** 100mm **Slope :** -90°

Method	Water	Well Details	RL (m)	Depth (m)	Graphic Log	Material Description	Weathering	Estimated Strength (EL VL L M H VH EH)	$Is_{(50)}$ (MPa)	RQD %	Defect Spacing (mm) (20 60 180 540 1620)	Defect Description	Depth (m)
NMLC				11		SANDSTONE, fine to medium grained, with some shale bands, light grey-grey-brown *(continued)*	SW		D 0.71 A 1.78	91		10.00m, HB 10.12m, HB 10.59m, B, P, S, 0-5° 10.96m, B, P, S, 0-10° 11.00m, HB 11.10m, B, P, S, 0-5° 11.12m, B, P, S, 0-5° 11.15m, B, P, S, 0-5° 11.17m, B, P, S, 0-5° 11.34m, B, P, S, 0-5° 11.36m, EW, 30mm 11.47m, B, P, S, 0-5° 11.67m, B, P, S, 0-5°	11
				12								12.00m, HB 12.09m,MB 12.41m, B, P, S, 0-5°	12
				13					D 0.71 A 0.98	98		12.61m, B, P, S, 0-5° 12.66m, EW, 20mm 12.93m, B, P, S, 0-5° 13.00m, HB 13.12m, B, P, S, 0-5° 13.23m, J, P, S, 20-30°	13
				14					D 1.37 A 1.57			14.00m, HB 14.18m, B, P, S, 0-5°	14
				15								15.00m, HB 15.02m, HB 15.05m, MB	15
				16					D 1.86 A 2.09			15.77m, B, P, S, 0-5° 16.00m, HB 16.07m, HB	16
				17					D 1.51 A 1.66	98		16.46m, B, P, S, 0-5° 17.00m, HB	17
				18					D 1.47 A 1.66			17.63m, B, Ir, R, 0-10° 17.98m, MB	18
			57.2	17.98		BH2 terminated at 17.98m							
				19									19
				20									20

Comments:

Weathering: EW - Extremely; HW - Highly; MW - Moderately; SW - Slightly; Fr - Fresh

EL - Extremely Low; VL - Very Low; L - Low; M - Medium; H - High; VH - Very High; EH - Extremely High

D - Diametral; A - Axial

J - Joint; B - Bedding Plan; CS - Clay Seams; FZ - Fractured Zone; IS - Infill Seam; SS - Sheared Seam; CZ - Crushed Zone

MB - Mechanical Break; HB - Handling Break; Pl - Planar; Ir - Irregular; Cu - Curved; St - Stepped

S - Smooth; R - Rough; P - Polished; Qz - Quartz; Fe - Iron Stain

FOUNDATION EARTH SCIENCES

BOREHOLE : BH3

CLIENT NAME: DASCO Property Development Services Pty Ltd **JOB NUMBER:** G511-2

SITE ADDRESS: 2-10 Berry Rd, 14-16 Marshall Ave & 5-9 Holdsworth Ave, St Leonards NSW **PROJECT:** Geotechnical Investigation

Date Started : 1/09/2021 **Completed :** 2/09/2021 **Logged By :** RL **Checked By :** MM

Borehole Location : Refer to Site Plan **Surface RL :** 73.2 **Datum :** m AHD

Equipment : Drilling Rig **Borehole Size :** 100mm **Slope :** -90°

Method	Water	Well Details	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Moisture	Consistence	Samples Tests Remarks	Additional Observations	Depth (m)
							FILL, silty clay, low to medium plasticity, brown-dark brown	M	F		Fill	
HA	Not encountered within the augering		72.8	0.40		CH	Sandy CLAY, medium to high plasticity, light brown-orange	M	St		Residual Soils	
				1							Hand Auger refusal	1
			71.9	1.31			Borehole BH3 continued as cored hole from 1.31m					
				2								2
				3								3
				4								4
				5								5
				6								6
				7								7
				8								8
				9								9
				10								10

Comments:

D - Dry
M - Moist
W - Wet

VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

FOUNDATION EARTH SCIENCES

BOREHOLE : BH3

CLIENT NAME: DASCO Property Development Services Pty Ltd **JOB NUMBER:** G511-2

SITE ADDRESS: 2-10 Berry Rd, 14-16 Marshall Ave & 5-9 Holdsworth Ave, St Leonards NSW **PROJECT:** Geotechnical Investigation

Date Started : 1/09/2021 **Completed :** 2/09/2021 **Logged By :** RL **Checked By :** MM

Borehole Location : Refer to Site Plan **Surface RL :** 73.2 **Datum :** m AHD

Equipment : Drilling Rig **Borehole Size :** 100mm **Slope :** -90°

Method	Water	Well Details	RL (m)	Depth (m)	Graphic Log	Material Description	Weathering	Estimated Strength (EL VL L M H VH EH)	$Is_{(50)}$ (MPa)	RQD %	Defect Spacing (mm) (20 60 180 540 1620)	Defect Description	Depth (m)
				1		Continued from non-cored borehole							1
NMLC			71.9	1.31		SHALE, interbedded with clay and sandstone, fine to medium grained, brown-red-grey	EW		D 1.54 A 2.26 D 0.01 A 0	0 0			2 3 4
			68.8	4.37		SHALE, interbedded with sandstone, fine to medium grained, dark grey-brown	HW		D 0.38 A 0.66 D 0.4 A 1.41	50 63		4.43m, B, P, S, 0-5° 4.46m, B, P, S, 0-5° 4.71m, J, Ir, R, 0-5° 4.86m, B, P, S, 0-5° 4.95m, B, P, S, 0-5° 5.00m, B, P, R, 0-5° 5.06m, B, P, S, 0-5° 5.11m, B, P, S, 0-10° 5.26m, B, Ir, S, 0-10° 5.29m, B, P, S, 0-5° 5.35m, B, P, S, 0-5° 5.43m, B, P, S, 0-5° 5.46m, B, P, S, 0-10° 5.51m, B, P, S, 0-5° 5.56m, B, P, S, 0-5° 5.70m, B, P, S, 0-5° 5.76m, B, P, S, 0-5° 5.84m, B, P, S, 0-5° 5.94m, MB 6.00m, B, P, S, 0-10° 6.02m, J, Ir, R, 0-10° 6.06m, J, Cu, R, 10-20° 6.09m, B, P, R, 5-10° 6.10m, B, P, R, 5-10° 6.17m, B, Ir, S, 0-10° 6.31m, B, P, S, 0-5° 6.32m, B, P, S, 0-5° 6.38m, EW, 10mm 6.55m, J, Cu, S, 10-30° 6.67m, B, P, S, 0-5° 6.69m, B, P, S, 0-5° 6.70m, EW, 10mm 6.80m, B, P, S, 0-5° 6.84m, B, Ir, S, 0-10° 6.86m, B, P, S, 0-5° 6.95m, EW, 10mm 7.00m, HB 7.14m, B, P, S, 0-5° 7.20m, HB 7.54m, MB 7.59m, B, P, S, 0-5° 7.75m, B, P, S, 0-10° 7.93m, J, Ir, S, 0-15° 7.98m, HB 8.00m, HB 8.11m, B, P, S, 0-5° 8.21m, B, P, S, 0-5° 8.26m, B, P, S, 0-5° 8.35m, B, P, S, 0-5° 8.42m, B, P, S, 0-5° 8.63m, B, P, S, 5-10° 8.69m, B, P, S, 5-10° 8.90m, B, P, S, 0-5° 8.95m, B, P, S, 0-5° 9.00m, HB	5 6 7
			66.2	7.00		SANDSTONE, fine to medium grained, with some shale bands, light grey-grey	MW-SW		D 0.41 A 0.33 D 0.57 A 0.52	69 75			8 9 10

Comments:

Weathering: EW - Extremely; HW - Highly; MW - Moderately; SW - Slightly; Fr - Fresh

EL - Extremely Low; VL - Very Low; L - Low; M - Medium; H - High; VH - Very High; EH - Extremely High

D - Diametral; A - Axial

J - Joint; B - Bedding Plan; CS - Clay Seams; FZ - Fractured Zone; IS - Infill Seam; SS - Sheared Seam; CZ - Crushed Zone

MB - Mechanical Break; HB - Handling Break; Pl - Planar; Ir - Irregular; Cu - Curved; St - Stepped

S - Smooth; R - Rough; P - Polished; Qz - Quartz; Fe - Iron Stain

FOUNDATION EARTH SCIENCES

BOREHOLE : BH3

CLIENT NAME: DASCO Property Development Services Pty Ltd **JOB NUMBER:** G511-2

SITE ADDRESS: 2-10 Berry Rd, 14-16 Marshall Ave & 5-9 Holdsworth Ave, St Leonards NSW **PROJECT:** Geotechnical Investigation

Date Started : 1/09/2021 **Completed :** 2/09/2021 **Logged By :** RL **Checked By :** MM

Borehole Location : Refer to Site Plan **Surface RL :** 73.2 **Datum :** m AHD

Equipment : Drilling Rig **Borehole Size :** 100mm **Slope :** -90°

Method	Water	Well Details	RL (m)	Depth (m)	Graphic Log	Material Description	Weathering	Estimated Strength (EL VL L M H VH EH)	Is(50) (MPa)	RQD %	Defect Spacing (mm) (20 60 180 540 1620)	Defect Description	Depth (m)
NMLC				11		SANDSTONE, fine to medium grained, with some shale bands, light grey-grey *(continued)*	MW-SW		D A 1.4 1.75	75		9.04m, MB 9.54m, CS, 10mm 9.62m, CS, 10mm 9.66m, B, P, S, 0-10° 9.71m, B, P, S, 0-5° 9.78m, B, P, S, 0-5° 9.90m, B, P, S, 5-10° 10.00m, HB 10.09m, EW, 10mm 10.18m, B, P, S, 0-5° 10.22m, B, P, S, 0-5° 10.37m, B, P, S, 0-5° 10.55m, MB 10.86m, B, P, S, 0-5° 11.00m, HB 11.09m, B, P, S, 0-5° 11.19m, B, P, S, 0-5° 11.22m, B, P, S, 0-5° 11.27m, MB	11
			61.9	*11.27*		BH3 terminated at 11.27m			D A 1.71 1.89	89			
				12									12
				13									13
				14									14
				15									15
				16									16
				17									17
				18									18
				19									19
				20									20

Comments:

Weathering
EW - Extremely
HW - Highly
MW - Moderately
SW - Slightly
Fr - Fresh

EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

D - Diametral
A Axial

J - Joint
B - Bedding Plan
CS - Clay Seams
FZ - Fractured Zone
IS - Infill Seam
SS - Sheared Seam
CZ - Crushed Zone

MB - Mechanical Break
HB - Handling Break
Pl - Planar
Ir - Irregular
Cu - Curved
St - Stepped

S - Smooth
R - Rough
P - Polished
Qz - Quartz
Fe - Iron Stain

FOUNDATION EARTH SCIENCES

BOREHOLE : BH4

CLIENT NAME: DASCO Property Development Services Pty Ltd **JOB NUMBER:** G511-2

SITE ADDRESS: 2-10 Berry Rd, 14-16 Marshall Ave & 5-9 Holdsworth Ave, St Leonards NSW **PROJECT:** Geotechnical Investigation

Date Started : 7/09/2021 **Completed :** 7/09/2021 **Logged By :** RL **Checked By :** MM

Borehole Location : Refer to Site Plan **Surface RL :** 72.1 **Datum :** m AHD

Equipment : Drilling Rig **Borehole Size :** 100mm **Slope :** -90°

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Moisture	Consistence	Samples Tests Remarks	Additional Observations	Depth (m)
						FILL, silty clay, low to medium plasticity, brown-dark brown	M	F		Fill	
HA	Not encountered within the augering	71.7	0.40		CH	Sandy CLAY, medium to high plasticity, light brown-orange	M	St		Residual Soils	1
		70.8	1.34			Borehole BH4 continued as cored hole from 1.34m				Hand Auger refusal	2

Comments:

D - Dry, M - Moist, W - Wet

VS - Very Soft, S - Soft, F - Firm, St - Stiff, VSt - Very Stiff, H - Hard

VL - Very Loose, L - Loose, MD - Medium Dense, D - Dense, VD - Very Dense

BOREHOLE : BH4

FOUNDATION EARTH SCIENCES

CLIENT NAME: DASCO Property Development Services Pty Ltd **JOB NUMBER:** G511-2

SITE ADDRESS: 2-10 Berry Rd, 14-16 Marshall Ave & 5-9 Holdsworth Ave, St Leonards NSW **PROJECT:** Geotechnical Investigation

Date Started : 7/09/2021 **Completed :** 7/09/2021 **Logged By :** RL **Checked By :** MM

Borehole Location : Refer to Site Plan **Surface RL :** 72.1 **Datum :** m AHD

Equipment : Drilling Rig **Borehole Size :** 100mm **Slope :** -90°

Method	Water	RL (m)	Depth (m)	Graphic Log	Material Description	Weathering	Estimated Strength (EL VL L M H VH EH)	$Is_{(50)}$ (MPa)	RQD %	Defect Spacing (mm) (20 60 180 540 1620)	Defect Description	Depth (m)
			1		Continued from non-cored borehole							1
NMLC		70.8	1.34		SANDSTONE, fine to medium grained, grey-brown, with some clay bands	EW		D 0.46 A 0.42	0			2
		69.2	2.90		SANDSTONE, interbedded with shale, fine to medium grained, grey-brown-red-light grey	HW		D 0.44 A 0.54	59		2.90m, B, P, S, 0-5° 2.97m, HB 3.00m, HB 3.14m, B, P, S, 0-5° 3.25m, B, Ir, S, 0-10° 3.33m, B, P, S, 0-5° 3.48m, EW, 10mm	3
			4					D 0.43 A 0.31	39		3.66m, J, P, R, 40-50° 3.71m, B, P, R, 0-5° 3.74m, B, P, R, 0-5° 3.82m, EW, 40mm 3.92m, B, P, R, 10-20° 3.96m, B, P, R, 0-5° 4.00m, MB 4.14m, B, P, S, 15-20° 4.37m, B, P, S, 15-20° 4.50m, B, P, S, 5-10° 4.60m, CS, 60mm 4.69m, CS, 20mm 4.80m, Core Loss, 90mm 4.91m, B, P, S, 0-5° 4.95m, B, P, S, 0-5° 4.99m, B, P, S, 0-5°	4
			5								5.00m, HB 5.04m, B, P, S, 0-5° 5.09m, B, P, S, 0-5° 5.13m, B, P, S, 0-5° 5.17m, B, P, S, 0-5° 5.21m, B, P, S, 0-5° 5.26m, B, P, S, 0-5° 5.30m, B, Ir, S, 0-10° 5.37m, B, P, S, 0-5°	5
			6					D 0.43 A 1.22	61		5.40m, J, Ir, S, 15-25° 5.43m, B, P, S, 0-5° 5.47m, B, Ir, S, 0-5° 5.49m, B, P, S, 0-5° 5.55m, MB 5.58m, B, Ir, S, 0-5° 5.64m, B, P, S, 0-5° 5.71m, B, P, S, 5-10°	6
		65.9	6.20		SANDSTONE, fine to medium grained, with some shale bands, light grey-grey	MW-SW						
			7								5.73m, B, P, S, 0-5° 5.92m, B, P, S, 0-5° 6.00m, B, P, S, 0-5° 6.03m, B, P, S, 0-5° 6.07m, B, Ir, S, 0-10° 6.08m, B, P, S, 0-5° 6.11m, B, P, S, 0-5° 6.13m, B, P, S, 0-5° 6.17m, B, P, S, 0-5° 6.33m, B, P, S, 0-5° 6.41m, B, P, S, 0-5°	7
			8					D 0.67 A 1.11	73		6.46m, B, P, S, 0-5° 6.56m, B, P, S, 0-5° 6.67m, B, P, S, 0-5° 6.77m, B, P, S, 0-5° 6.87m, B, P, S, 0-5° 7.00m, MB 7.08m, B, P, S, 0-5° 7.13m, B, P, S, 0-5° 7.27m, B, P, S, 0-5° 7.32m, B, P, S, 0-5° 7.39m, B, P, S, 0-5° 7.44m, B, P, S, 0-5° 7.54m, B, P, S, 0-5° 7.59m, B, P, S, 0-5° 7.70m, B, P, S, 0-5° 7.76m, B, P, S, 0-5°	8
			9					D 0.39 A 0.47	30		8.00m, HB 8.03m, HB 8.28m, B, P, S, 0-5° 8.54m, MB	9
			10					D 1.58 A 0.97	53			10

Comments:

Weathering: EW - Extremely; HW - Highly; MW - Moderately; SW - Slightly; Fr - Fresh

EL - Extremely Low; VL - Very Low; L - Low; M - Medium; H - High; VH - Very High; EH - Extremely High

D - Diametral; A - Axial

J - Joint; B - Bedding Plan; CS - Clay Seams; FZ - Fractured Zone; IS - Infill Seam; SS - Sheared Seam; CZ - Crushed Zone

MB - Mechanical Break; HB - Handling Break; Pl - Planar; Ir - Irregular; Cu - Curved; St - Stepped

S - Smooth; R - Rough; P - Polished; Qz - Quartz; Fe - Iron Stain

FOUNDATION EARTH SCIENCES

BOREHOLE : BH4

CLIENT NAME: DASCO Property Development Services Pty Ltd **JOB NUMBER:** G511-2

SITE ADDRESS: 2-10 Berry Rd, 14-16 Marshall Ave & 5-9 Holdsworth Ave, St Leonards NSW **PROJECT:** Geotechnical Investigation

Date Started : 7/09/2021 **Completed :** 7/09/2021 **Logged By :** RL **Checked By :** MM

Borehole Location : Refer to Site Plan **Surface RL :** 72.1 **Datum :** m AHD

Equipment : Drilling Rig **Borehole Size :** 100mm **Slope :** -90°

Method	Water	RL (m)	Depth (m)	Graphic Log	Material Description	Weathering	Estimated Strength (EL VL L M H VH EH)	$Is_{(50)}$ (MPa)	RQD %	Defect Spacing (mm) (20 60 180 540 1620)	Defect Description	Depth (m)
NMLC					SANDSTONE, fine to medium grained, with some shale bands, light grey-grey *(continued)*	MW-SW		D 1.23 A 1.96	53		8.56m, B, Ir, S, 0-10° 8.68m, B, P, S, 0-5° 8.75m, B, P, S, 0-5° 8.77m, CS, 20mm 8.83m, B, P, S, 0-5° 8.88m, B, P, S, 0-5° 8.98m, EW, 20mm 9.02m, J, Ir, S, 80-90° 9.03m, B, Ir, S, 0-10° 9.09m, B, P, S, 0-5° 9.10m, CS, 60mm 9.19m, B, P, S, 0-5° 9.24m, B, P, S, 0-5° 9.27m, MB 9.32m, B, P, S, 0-5° 9.37m, B, P, S, 0-5° 9.40m, B, P, S, 0-5° 9.44m, B, P, S, 0-5° 9.62m, B, P, S, 0-5° 9.67m, B, P, S, 0-5° 9.70m, B, P, S, 0-5° 10.00m, HB 10.10m, B, P, S, 0-5° 10.15m, B, P, S, 0-5° 10.17m, B, P, S, 0-5° 10.20m, B, P, S, 0-5° 10.27m, B, P, S, 0-5° 10.32m, B, P, S, 0-5° 10.35m, B, P, S, 0-5° 10.37m, B, P, S, 0-5° 10.48m, B, P, R, 20-30° 10.57m, MB	
		61.5	*10.57*		BH4 terminated at 10.57m							
			11									11
			12									12
			13									13
			14									14
			15									15
			16									16
			17									17
			18									18
			19									19
			20									20

EL VL L M H VH EH — 20 60 180 540 1620 4860

Comments:

Weathering
EW - Extremely
HW - Highly
MW- Moderately
SW - Slightly
Fr - Fresh

EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

D - Diametral
A Axial

J - Joint
B - Bedding Plan
CS - Clay Seams
FZ - Fractured Zone
IS - Infill Seam
SS - Sheared Seam
CZ - Crushed Zone

MB - Mechanical Break
HB - Handling Break
Pl - Planar
Ir - Irregular
Cu - Curved
St - Stepped

S - Smooth
R - Rough
P - Polished
Qz - Quartz
Fe - Iron Stain

FOUNDATION EARTH SCIENCES

METHODS OF SOIL DESCRIPTION USED ON BOREHOLE LOGS

FILL	ORGANIC SOILS (OL, OH, Pt)	CLAY (CL, CI, or CH)
COUBLES or BOULDERS	SILT (ML or MH)	SAND (SP or SW)
GRAVEL (GP or GW)	Combinations of these basic symbols may be sued to indicate mixed materials	

CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil is broadly classified and described in borehole logs using the preferred method given in AS 1726:2017, section 6.1 soil descriptions and classification.

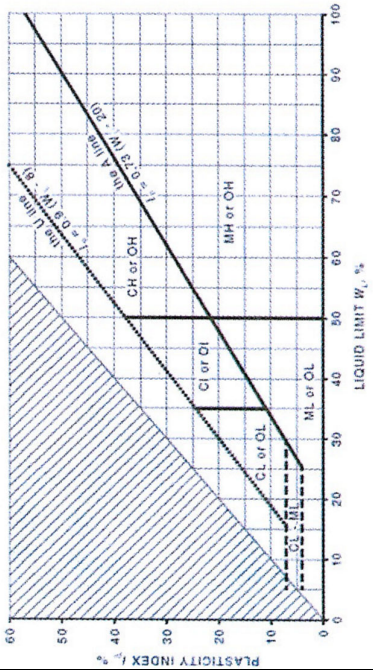
GROUP SYMBOLS

MAJOR DIVISIONS		SYMBOL	DESCRIPTION
COARSE GRAINED SOILS More than 65% of the soil excluding oversize fraction is greater than 0.075mm	**GRAVEL** More than 50% of the coarse fraction is >2.36mm	GW	Well graded gravel and gravel-sand mixtures, little or no fines.
		GP	Poorly graded gravel and gravel-sand mixtures, little or no fines.
		GM	Silty gravel, gravel-sand-clay mixtures.
		GC	Clayey gravel, gravel-sand-clay mixtures.
	SAND More than 50% of the coarse fraction is <2.36mm	SW	Well graded sand and gravelly sand, little or no fines.
		SP	Poorly graded sand and gravelly sand, little or no fines.
		SM	Silty sand, sand- silt mixtures.
		SC	Clayey sand, sandy -clay mixtures.
FINE GRAINED SOILS More than 35% of the soil excluding oversize fraction is less than 0.075mm	**Liquid limit less <50%**	ML	Inorganic silts of low plasticity, very fine sands, rock flour, silty or clayey fine sands.
		CL, CI	Inorganic slays of low to medium plasticity, gravely clays, sandy clays, silty clays
		OL	Organic silts and organic silty clays of low plasticity.
	Liquid limit > than 50%	MH	Inorganic silts of high plasticity.
		CH	Inorganic clays of high plasticity.
		OH	Organic clays of medium to high plasticity.
	Highly organic Soil	PT	Peat muck and other highly organic soils.

PARTICLE SIZE CHARACTERISTICS

Fraction	Components	Subdivision	Size mm
Oversize	BOULDERS		>200
	COBBLES		63-200
	GRAVEL	Coarse	19-63
		Medium	6.7-19
		Fine	2.36-6.7
	SAND	Coarse	0.6-2.36
		Medium	0.21-0.6
		Fine	0.075-0.21
	SILT		0.002-0.075
	CLAY		<0.002

PLASTICITY PREOPERTIES



FOUNDATION EARTH SCIENCES

ABBREVIATIONS AND DESCRIPTIONS FOR ROCK MATERIAL AND DEFECTS

MOISTURE CONDITION

Symbol	Term	Description
D	Dry	Non-cohesive and free running
M	Moist	Soils feel cool, darkened in colour. Soil tends to stick together.
W	Wet	Soils feel cool, darkened in colour. Soil tends to stick together, free water forms when handling.

Moisture content of cohesive soils shall be described in relation to plastic limit (PL) or liquid limit (LL) for soils with higher moisture content as follows: Moist, dry of plastic limit (w <PL); Moist, near plastic limit (w = PL); Moist, wet of plastic limit (w<PL); Wet, near liquid limit (w=LL), Wet, wet of liquid limit (w>LL),

CONSISTENCY

Symbol	Term	Undrained Shear Strength (kPa)	SPT "N" #
VS	Very Soft	< 12	<2
S	Soft	>12 to <25	>2 to <4
F	Firm	>25 to <50	>4 to < 8
St	Stiff	>50 to <100	>8 to 15
H	Hard	>200	>30
Fr	Friable	-	

DENSITY

Symbol	Term	Density Index %	SPT "N" #
VL	Very Loose	<15	0 to 4
L	Loose	>15 to <35	4 to 10
MD	Medium Density	>65 to < 85	10 to 30
D	Dense	>65 to <85	30 to 50

In the absence of test results, consistency and density may be assessed from correlations with the observed behaviour of the material. #SPT correlations are not stated in AS1726:2017 and may be subject to corrections for overburden pressure and equipment type.

MINOR COMPONENTS

TERM	ASSESSMENT GUIDE	PROPORTION BY MASS
Trace	Presence just detectable by feel or eye but soil properties little or no difference to general properties of primary component	Coarse grained soils: <%5 Fine grained soils: <15%
With	Presence easily detectable by feel or eye but soil properties little or no difference to general properties of primary component	Coarse grained soils: 5-12% Fine grained soils: 15-30%
Prefix	Presence easily detectable by feel or eye in conjunction with the general properties of primary component	Coarse grained soils: >12% Fine grained soils: >30%

CLASSIFICATION AND INFERRED STRATIGRAPHY

Rock is broadly classified and described in borehole logs using the preferred method given in AS 1726:2017, section 6.2 Rock identification, descriptions, and classification.

ROCK MATERIAL DESCRIPTION

Layering

Term	Description
Massive	No Layering apparent
Poorly Developed	Layering just visible; little effect on properties
Well Developed	Layering (bedding, foliation, cleavage) distinct; rock breaks more easily parallel to layering

Structure

Term	Spacing (mm)
Thinly Laminated	<6
Laminated	6-20
Very thinly bedded	20-60
Thinly bedded	60-200
Medium bedded	200-600
Thickly bedded	600-2,000
Very thickly bedded	>2,000

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT TYPES

Defect Type	Abbr.	Description
Joint	JT	Surface of a fracture or parting, formed without displacement, across which the rock has little or no tensile strength. May be closed or filled by ait, water, soil, or rock substance, which acts as cement.
Bedded Parting	BP	Surface of facture or parting, across which the rock has little or no tensile strength, parallel of sub-parallel to layering/bedding. Bedding refers to the layering or stratification of a rock, indicating orientation during deposition, resulting in planar anisotropy in the rock material.
Foliation	FL	Repetitive planar structure parallel to the shear direction or perpendicular to the direction of higher pressure, especially in the metamorphic rock, e.g., schistosity (SH)) and Gneissosity.
Contact	CO	The surface between two types or ages of rock.
Cleavage	CL	Cleavage planes appear as parallel, closely spaced, and planar surfaces resulting from mechanical fracturing of rock through deformation or metamorphism, independent of bedding.
Sheared Seam/ Zone (Fault)	SS/SZ	Seam or zone with roughly parallel almost planar boundaries of rock substance cut by closely space (often <50mm) parallel and usually smooth or slickensided joints or cleavage planes.
Crushed seam/ Zone (Fault)	CS/CZ	Seam or zone composed of disoriented usually angular fragments of the host rock substance, with rough parallel near-planar boundaries. The brecciated fragments may be of clay, silt, sand or gravel sizes or mixtures of these.
Decomposed seam/Zone	DS/DZ	Seam of soil substance, often with gradational boundaries, formed by weathering of the rock material in places.
Infilled Seam	IS	Seam of soil substance, usually clay or clayey, with very distinct roughly parallel boundaries, formed by soil migrating into joint or open cavity.
Schistocity	SH	The foliation in schist or other coarse grained crystalline rock due to the parallel arrangement of platy or prismatic mineral grains, such as mica.
Vein	VN	Distinct sheet-like body of minerals crystallised within rock through typically open-space filling or crack-seal growth.

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT SHAPE AND ROUGHNESS

Shape	Abbr.	Description	Roughness	Abbr.	Description
Planar	Pl	Consistent Orientation	Polished	Pol	Shiny smooth surface
Curved	Cu	Gradual change in orientation	Slickensided	SL	Grooved or stained surface, usually polished
Undulating	Un	Wavy surface	Smooth	S	Smooth to touch. Few or no surface irregularities
Stepped	St	One or more well defined steps	Rough	RF	Many small surface irregularities, amplitude generally <1mm. Feels like fine to coarse sandpaper
Irregular	Ir	Many sharp changes in orientation	Very Rough	VR	Many large surface irregularities, amplitude generally >1mm. Feels like very coarse sandpaper.

Orientation: **Vertical Boreholes-** The dip (inclination from horizontal) of the defect.
Inclined Boreholes- The inclination is measured as the acute angle to the core axis.

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT COATING

Coating	Abbr.	Description
Clean	CN	No Visible coating or infilling
Stain	SN	No visible coating but surfaces are discoloured by staining, often limonite (orange-brown)
Veneer	VNR	A visible coating of soil or mineral substances, usually too thin to measure (<1mm); may be patchy

DEFECT APERTURE

Aperture	Abbr.	Description
Closed	CL	Closed.
Open	O	Without any infill material
Infilled	-	Soil or rock i.e., clay, talc, pyrite, quartz, etc.

FOUNDATION EARTH SCIENCES

TERMS FOR ROCK MATERIAL STRENGTH AND WEATHERING

CLASSIFICATION AND INFERRED STRATIGRAPHY

Rock is broadly classified and described in borehole logs using the preferred method given in AS 1726:2017, section 6.2 Rock identification, descriptions, and classification.

ROCK MATERIAL STRENGTH CLASSIFICATION

Symbol	Term	Point Load Index $I_{s(50)}$ (MPa)#	Field Guide
VL	Very Low	0.03 To 0.01	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut triaxial sample by hand. Pieces up to 30mm can be broken by finger pressure.
L	Low	0.1 to 0.3	Easily scored with knife; indentations 1mm to 3mm show in the specimen with firm blows of pick point; has dull sound under hammer. A piece of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
M	Medium	0.3 – 1	Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty
H	High	1 to 3	A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken with a pick with a single firm blow; rock rings under hammer.
VH	Very High	3 to 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
EH	Extremely High	>10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

#Rock Strength Test Results ▼ Point Load Strength Index, I_s (50) Axial Test (MPa)

● Point Load Strength Index, I_s (50), Diametral test (MPa)

Relationship between rock strength test result ($I_{s(50)}$) and unconfined compressive strength (UCS) will vary with rock type and strength and should be determined on a site-specific basis. However, UCS is typically 20 x $I_{s(50)}$

ROCK MATERIAL WEATHERING CLASSIFICATION

Symbol		Term	Field Guide
RS		Residual Soil	Soil developed on extremely weathered rock; the mass structure and substance fabric no longer evident; there is a large change in volume, but the soil has not been significantly transported.
XW		Extremely Weathered	Rock is weathered to such an extent that it has soil properties- i.e., it either disintegrates or can be remoulded, in water.
DW	HW	Distinctly Weathered	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching or may be decreased due to decomposition of weathered product in pores. In some environments it is convenient to subdivide into highly weathered and moderately weathered, with the degree of alteration typically less for MW
	MW		
SW		Slightly Weathered	Rock slightly discoloured but shows little to no change of strength relative to fresh rock.
FR		Fresh	Rock shows no sign of decomposition or staining.

FOUNDATION EARTH SCIENCES

Appendix C

Photograph of Rock Core Samples

PHOTOGRAPH OF CORE SAMPLES

Borehole	Drilled Date	Start Depth (m)	End Depth (m)
BH1	30/08/2021	5.65	17.75

0	1	2	3	4	5	6	7	8	9	10	

Borehole	Drilled Date	Start Depth (m)	End Depth (m)
BH2	31/08/2021	4.90	17.98

0	1	2	3	4	5	6	7	8	9	10	

Borehole	Drilled Date	Start Depth (m)	End Depth (m)
BH3	1-2/09/2021	1.31	11.27

0	1	2	3	4	5	6	7	8	9	10	

Borehole	Drilled Date	Start Depth (m)	End Depth (m)
BH4	7/09/2021	1.34	10.57

0	1	2	3	4	5	6	7	8	9	10	

FOUNDATION EARTH SCIENCES

Appendix D

Results of Point Load Index Tests

FOUNDATION EARTH SCIENCES

Results of Point Load Index Tests

Client:	DASCO Property Development Services Pty Ltd	**Ref No:**	G511
Project:	Geotechnical Investigation	**Test:**	AS 4133.4.1
Location:	2-10 Berry Road, 14-16 Marshall Avenue & 5-9 Holdsworth Avenue, St Leonards NSW 2065	**Date:**	21/09/2021

Borehole	Depth (m)	Materials	Moisture Content	I_{s50} (MPa)	
				Diametral	Axial
BH1	6.65	Sandstone	Moist	0.43	0.82
BH1	7.95	Sandstone	Moist	0.15	0.80
BH1	9.35	Sandstone	Moist	0.53	0.51
BH1	10.80	Sandstone	Moist	0.15	1.50
BH1	12.10	Sandstone	Moist	1.09	0.95
BH1	13.50	Sandstone	Moist	1.10	0.87
BH1	15.10	Sandstone	Moist	1.84	1.39
BH1	16.80	Sandstone	Moist	1.17	1.10
BH1	17.45	Sandstone	Moist	1.20	1.71
-	-	-	-		
BH2	5.40	Sandstone	Moist	0.45	0.62
BH2	6.95	Sandstone	Moist	0.29	1.28
BH2	8.35	Sandstone	Moist	0.60	1.14
BH2	9.85	Sandstone	Moist	0.73	1.11
BH2	11.20	Sandstone	Moist	0.71	1.78
BH2	12.90	Sandstone	Moist	0.71	0.98
BH2	14.05	Sandstone	Moist	1.37	1.57
BH2	15.50	Sandstone	Moist	1.86	2.09
BH2	16.80	Sandstone	Moist	1.51	1.66
BH2	17.90	Sandstone	Moist	1.47	1.66

FOUNDATION EARTH SCIENCES

Results of Point Load Index Tests

Client:	DASCO Property Development Services Pty Ltd	**Ref No:**	G511
Project:	Geotechnical Investigation	**Test:**	AS 4133.4.1
Location:	2-10 Berry Road, 14-16 Marshall Avenue & 5-9 Holdsworth Avenue, St Leonards NSW 2065	**Date:**	24/09/2021

Borehole	Depth (m)	Materials	Moisture Content	I_{s50} (MPa)	
				Diametral	Axial
BH3	2.05	Shale	Moist	1.54	2.26
BH3	3.60	Shale	Moist	0.01	0.00
BH3	4.75	Shale	Moist	0.38	0.66
BH3	6.30	Shale	Moist	0.40	1.41
BH3	7.70	Sandstone	Moist	0.41	0.33
BH3	9.10	Sandstone	Moist	0.57	0.52
BH3	10.50	Sandstone	Moist	1.40	1.75
BH3	11.15	Sandstone	Moist	1.71	1.89
-	-	-	-		
BH4	1.75	Sandstone	Moist	0.46	0.42
BH4	3.20	Sandstone	Moist	0.44	0.54
BH4	4.55	Sandstone	Moist	0.43	0.31
BH4	5.95	Sandstone	Moist	0.43	1.22
BH4	7.40	Sandstone	Moist	0.67	1.11
BH4	8.60	Sandstone	Moist	0.39	0.47
BH4	9.50	Sandstone	Moist	1.58	0.97
BH4	10.50	Sandstone	Moist	1.23	1.96

FOUNDATION EARTH SCIENCES

Appendix E

Results of Laboratory Tests

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 277313

Client Details

Client	Foundation Earth Sciences Pty Ltd
Attention	Ben Buckley
Address	PO Box 4405, East Gosford, NSW, 2250

Sample Details

Your Reference	**G511, St Leonards NSW**
Number of Samples	3 soil
Date samples received	06/09/2021
Date completed instructions received	06/09/2021

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	13/09/2021
Date of Issue	13/09/2021

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Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By

Nancy Zhang, Laboratory Manager

Soil Aggressivity				
Our Reference		277313-1	277313-2	277313-3
Your Reference	UNITS	BH1	BH2	BH3
Depth		2.0	3.0	1.0
Date Sampled		30/08/2021	31/08/2021	01/09/2021
Type of sample		soil	soil	soil
pH 1:5 soil:water	pH Units	5.7	5.2	5.6
Electrical Conductivity 1:5 soil:water	µS/cm	74	39	42
Chloride, Cl 1:5 soil:water	mg/kg	28	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	81	55	55

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.

QUALITY CONTROL: Soil Aggressivity					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	103	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	100	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	88	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	101	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

pH/EC
Samples were out of the recommended holding time for this analysis.

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 277933

Client Details

Client	Foundation Earth Sciences Pty Ltd
Attention	Murali Muralitharan
Address	PO Box 4405, East Gosford, NSW, 2250

Sample Details

Your Reference	**G511**
Number of Samples	1 water
Date samples received	13/09/2021
Date completed instructions received	13/09/2021

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	20/09/2021
Date of Issue	20/09/2021

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Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By

Nancy Zhang, Laboratory Manager

Miscellaneous Inorganics		
Our Reference		277933-1
Your Reference	UNITS	BH3/GW3
Depth		-
Date Sampled		7/09/2021
Type of sample		water
Date prepared	-	14/09/2021
Date analysed	-	14/09/2021
pH	pH Units	6.9
Electrical Conductivity	µS/cm	300
Chloride, Cl	mg/L	30
Sulphate, SO4	mg/L	32

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.

QUALITY CONTROL: Miscellaneous Inorganics						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			14/09/2021	[NT]	[NT]	[NT]	[NT]	14/09/2021	[NT]
Date analysed	-			14/09/2021	[NT]	[NT]	[NT]	[NT]	14/09/2021	[NT]
pH	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	100	[NT]
Electrical Conductivity	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	97	[NT]
Chloride, Cl	mg/L	1	Inorg-081	<1	[NT]	[NT]	[NT]	[NT]	106	[NT]
Sulphate, SO4	mg/L	1	Inorg-081	<1	[NT]	[NT]	[NT]	[NT]	98	[NT]

Result Definitions

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Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

pH Samples were out of the recommended holding time for this analysis.