



Douglas Partners
Geotechnics | Environment | Groundwater

Report on
Preliminary Geotechnical Investigation

African Safari, Taronga Zoological Park
Bradleys Head Road, Mosman

Prepared for
Taronga Conservation Society Australia

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Integrated Practical Solutions



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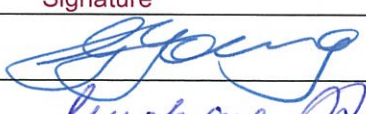
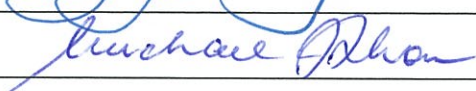
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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

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Report on Preliminary Geotechnical Investigation

African Safari, Taronga Zoological Park

Bradleys Head Road, Mosman

1. Introduction

The report describes the results of a geotechnical investigation undertaken for the African Safari project at Taronga Zoological Park at Bradley Head Road, Mosman. The work was undertaken for the Taronga Conservation Society Australia.

It is understood that the a new facility and animal exhibits are being considered and that preliminary information is required for planning and design purposes. As such there are no details of the development layout including excavation depth and footing requirements.

Geotechnical investigation was undertaken to provide information on subsurface conditions on the site and included the drilling of twenty-nine boreholes to the top of rock and site observations of rock outcrops. Details of the field work and comments relating to design and construction are provided in this report.

The geotechnical investigation was carried out concurrently with a contamination assessment which is reported separately.

2. Site Description and Geology

The area of the proposed African Safari project is located in the western portion of the zoo and includes existing animal exhibits and a number of buildings. It is bounded by maintenance and service area in the north, the gorilla enclosure in the east, the elephant enclosure in the south and the Roar and Snore in the west. The site is shown on Drawing 1, Appendix B.

The site is located on the southern side of a steep slope that dips towards Athol Bay. The site has been extensively terraced and many retaining walls provide level areas which house exhibits and walking paths/roadways. Many sandstone rock faces and cuttings are evident on the wider zoo site. The surface levels in the area of the development vary from about RL 55 m relative to the Australian Height Datum (AHD) in the north-east portion to about RL 40 m AHD in the south-west.

The area experiences high pedestrian traffic and occasional use by service vehicles.

Extensive underground services are present in this area, particularly within the footpath or along the pavement kerb, with manholes observed at the time of field work.

The Sydney 1:100 000 Geological Series Sheet shows that the site underlain by Hawkesbury Sandstone which typically comprises medium to coarse-grained quartz sandstone with minor shale and laminite lenses.

3. Site Observations

A site walkover and mapping of rock outcrops was undertaken on the site. The rock outcrops are shown graphically on Drawing 2 in Appendix B and site specific observations together with site photographs are presented in Appendix C.

The site is located on a Hawkesbury Sandstone slope, typical of the Sydney region. Over geological time, the sandstone cuttings were exposed to the weather and the seawater environment. The results are erosion of the sandstone faces, often resulting in undercutting of sandstone beds, collapse of the overhangs onto the underlying ledges. Hawkesbury Sandstone tends to form a series of cliffs and ledges. Colluvial material washed down from upslope tends to accumulate on the ledges together with fallen sandstone blocks forming a wedge between the cliff and ledges. The wedge material is commonly called talus.

The topography described above appears to be typical for the site as can be seen in Photos 11, 12, 13, 18, 19 and 20. Development of the site, however, has seen other areas worked so as to produce relatively level or landscaped enclosures. This has involved, among other activities, levelling the ground, removal of some talus, some filling on other areas, landscaping, construction of retaining walls using sandstone boulders and blocks, shotcreting some weathered sandstone faces and localised excavation for moats, etc.

The main observations on the site are:

- The site is considered typical of a Hawkesbury Sandstone topography with the bedrock forming a number of cliffs and ledges;
- In undeveloped areas, such as downslope of the rehabilitation yards, there is talus on the site which forms a slope;
- In the developed areas, the site has been reworked. A typical profile appears to be with shallow depth of soil, expected to be mainly filling, overlying sandstone;
- Many retaining walls have been constructed on rock ledges or on top of cliffs to provide level benches;
- The sandstone exposed in the outcrop and cliffs tends to be medium to high strength. Areas covered by shotcrete probably consist of low strength sandstone;
- Water seepage over the top of rock and through bedding partings and joints below top of rock is common.

4. Field Work Methods

Twenty-nine boreholes (A01 to A29) were drilled to depths ranging from 0.5 m to 1.5 m using a bobcat drilling rig or a hand auger. The bores were commenced using solid flight augers or a hand auger to drill through the overburden material. The borehole would then be terminated near the top of the rock strata or prior refusal. The materials observed in the boreholes were logged by a geotechnical engineer.

The locations of the boreholes are shown in Drawing 1 in Appendix B. The ground surface levels at the test locations were approximated from the survey plan, provided by the client.

5. Field Work Results

The subsurface conditions encountered in the boreholes are present in the borehole logs in Appendix D. Notes defining descriptive terms and classification methods are included in Appendix A.

The boreholes encountered:

- FILLING – asphalt and concrete surfacing, roadbase, organic silt/sand, underlain by clayey sand and silty sand to depths of 0.3 m to 1.8m; and
- BEDROCK – sandstone bedrock generally initially of extremely low strength from depths 0.2 m to 1.5 m increasing in strength with depth.

Rock as not encountered in all bores

Table 1 summarises the levels at which the different materials were encountered in the boreholes.

Table 1: Summary of Material Strata Level in Boreholes

Bore	RL of Top of Stratum (m, AHD)		
	Ground Surface/Filling	ELS Sandstone	Base of Borehole
A01	55.8	NE	55.6
A02	55.4	54.8	54.8
A03	56.5	55.1	55.1
A04	49.7	NE	49.0
A05	49.8	49.1	49.0
A06	49.8	48.6	48.6
A07	49.8	49.2	49.2
A08	49.6	48.6	48.6
A09	49.8	NE	49.7
A10	50.1	49.6	49.6

Bore	RL of Top of Stratum (m, AHD)		
	Ground Surface/Filling	ELS Sandstone	Base of Borehole
A11	60.1	59.9	59.9
A12	56.3	NE	55.6
A13	55.1	54.6	54.6
A14	54.3	NE	53.5
A15	52.7	51.5	51.2
A16	44.9	44.6	44.4
A17	50.8	50.5	50.5
A18	46.2	45.8	45.8
A19	41.8	41.4	41.4
A20	51.8	51.2	51.2
A21	50.2	NE	49.6
A22	51.0	NE	49.5
A23	50.6	50.1	50.1
A24	50.7	50.0	50.0
A25	50.5	50.0	50.0
A26	51.5	51.3	51.3
A27	53.2	52.6	52.6
A28	53.4	52.3	52.3
A29	54.0	53.3	53.3

Notes: ELS = extremely low strength; NE = not encountered

Seepage or ground water was not observed during auguring in the boreholes. Two cross-sections of the site are shown on Drawings 3 and 4 in Appendix B.

6. Geotechnical Model

The boreholes, located in developed areas, indicate that the site is underlain by filling over Hawkesbury Sandstone bedrock. The filling in the bores was generally less than 1 m thick, but this may vary over the site. There may also be some remnant talus left under the filling in some locations. The bedrock, which is exposed at the surface in some locations, and in the cliffs, steps down with the surface slope towards Athol Bay, so rock levels are likely to vary over short distances. Buried sandstone is likely to have a thin veneer of weathered material over medium to high strength sandstone.

The site observations confirm the presence of rock ledges and cliffs down the site. In undeveloped areas (which were not subjected to drilling bores), the rock ledges are often covered with a sloping combination of sands, clays and sandstone boulders (talus).

7. Proposed Development

It is understood that the area is being considered for redevelopment and that preliminary information is required for planning and design purposes. Details of the proposed construction including excavation depths and footing requirements are yet to be finalised.

The geotechnical issues that may be relevant to the proposed development include excavation, excavation support, slope stability, site preparation, ground water and foundations.

8. Comments

8.1 Excavation

Excavation for the proposed redevelopment, may be required within the filling, natural soils and sandstone bedrock. Excavation in filling, soils and extremely low strength sandstone should be readily achievable using an excavator with bucket attachment.

In currently undeveloped areas, landscaping the area may involve removal of talus material. Large boulders would be expected within the talus and may require breaking up in order to be removed.

Excavation in sandstone, expected to be mainly in medium and high strength rock, will probably require ripping, hammering and / or sawing.

8.2 Excavation Support

Excavations in filling, soils and weathered rock will not be able to stand vertically for extended periods of time but may be able to be supported by temporary batters where space permits. A maximum temporary batter slope of 1(H):1(V) is recommended for excavations of up to about 2 m depth in these materials provided they are protected against erosion. Permanent batters should be flattened to no steeper than 2(H):1(V).

Medium and high strength rock should be able to stand vertically provided adverse jointing is not present.

Retaining walls (temporary and or permanent) may be required in some areas of the site and could be designed using the material and strength parameters outlined in Table 2.

Table 2: General Material and Strength Parameters for Retaining Structures

Material	Bulk Unit Weight (kN/m ³)	Coefficient of Active Earth Pressure (K _a)	Coefficient of Earth pressure at Rest (K ₀)	Ultimate Passive Earth Pressure (kPa)
Filling	20	0.4	0.6	
Natural Soil	20	0.3	0.45	
ELS Sandstone	22	0.2 ¹	0.3 ¹	750 ²
LS/MS/HS Sandstone	22	0 ¹	0 ¹	3000 ²

 Notes: ¹ Unless unfavourable jointed;

² Only below ground level and where jointing is favourable;

ELS = extremely low strength;

LS = low strength;

MS = medium strength;

HS = high strength.

A triangular lateral earth pressure distribution could be assumed for cantilevered walls, and a rectangular lateral earth pressure distribution for walls propped at their top and base. Lateral pressures due to surcharge loads from sloping ground surfaces, adjacent buildings, construction machinery and vehicles should be included where relevant. Hydrostatic pressure acting on the retaining walls should also be included in the design where adequate drainage is not provided behind the full height of the walls.

8.3 Slope Stability

The overall site is located on a slope which has generally been landscaped for its present use. It is generally underlain by a thin layer of filling (0.5 m to 1.5 m deep) overlying a stepping sandstone profile. The slope is considered to have a low risk of major slope instability. Excavations will need to be battered or retained in accordance to Section 8.2 to reduce the risk of localised slope instability.

8.4 Site Preparation

Areas of the site that require filling to raise site levels should be stripped of vegetation and existing filling materials prior to proof-rolling with a minimum 10 t steel smooth drum roller. Any areas exhibiting significant heaving should be assessed by a geotechnical engineer to determine any rectification measures that may be required. Proof-rolling will not be required if the subgrade is sandstone bedrock.

Approved filling should then be placed on the prepared subgrade in 250mm thick layers and compacted to achieve a dry density ratio of at least 98% relative to Standard compaction. This density criteria could be relaxed to a dry density of at least 95% relative to Standard compaction in areas that are not required to support structures or pavements. The moisture content of the filling should be within 2% of optimum if it exhibits clay like properties. Density testing should be undertaken in accordance with the provisions of AS 3798 – 2007 *Guidelines on earthworks for commercial and residential developments*.

The subgrade in non-structural and unpaved areas where filling and excavation are not required such as in animal enclosures, it would be prudent to proof roll the areas to detect any soft spots which require repairs. Some moisture conditioning and compaction of the surface may be required.

8.5 Groundwater

The regional groundwater table is expected to be well below the bedrock surface and flow in a southerly direction towards Athol Bay. However, seepage through and along strata boundaries and jointing in the rock should be expected and this should be considered in the design of the drainage systems on the site. There was a significant amount of seepage over rock faces observed on the site during the site visit.

8.6 Foundations

Due to relatively shallow depth of rock on the site it is recommended that all new structure be founded on the sandstone bedrock on spread footings (e.g. pad footings and strip footings) or on short bored piles. The footings and piles could be designed using the design bearing pressures and shaft adhesions provided in Table 3.

Table 3: Preliminary Design Parameters for Spread Footing and Bored Piles.

Material Description	Allowable End-Bearing Pressure (kPa)	Allowable Shaft Adhesion¹ (kPa)
ELS Sandstone	700	50
LS/MS/HS Sandstone	3000	300

Notes: ¹ Only for piles where adequate socket-roughness has been achieved;
ELS = extremely low strength; MS = medium strength; HS = high strength

Higher bearing pressures for the sandstone bedrock are possible based on the strength of the rock outcrops, but would require further investigations and some rock strength testing to justify the higher parameters.

The settlement of a footing is dependent on the dimension of the footing, the load applied and the underlying foundation conditions. Spread footings and piles designed using the information contained in this report should experience settlement of less than 10 mm upon application of the design load.

All new footings should be inspected by an experienced geotechnical professional to check the suitability of foundation material. Additionally in the case of bored piles the socket roughness and the base cleanliness should be checked.

8.7 Pavements

Each pavement area should be individually assessed based on the subsurface profile and the loading. For lightly loaded pavements on the existing filling, it may be possible to found on the filling after a satisfactory proof roll. For heavy loaded pavements, some treatment of the underlying filling may be required before the pavement is constructed.

8.8 Further Investigation

The above comments are preliminary in nature as detailed proposal for the site is unknown. When the layouts are known further investigation may be required for detailed design purposes.

9. Limitations

Douglas Partners (DP) has prepared this report for this project at Bradleys Head Road, Mosman in accordance with DP's proposal dated 7 April 2016 and acceptance received from Mr Andrew Chippindall. The work was carried out under DP's Conditions of Engagement. The report is provided for the use of the Taronga Conservation Society Australia for this project only and for the purpose(s) described in the report. It should not be used for other projects or by a third party.

The results provided in the report are indicative of the sub-surface conditions only at the specific sampling or testing locations, and then only to the depths investigated and at the time the work was carried out. Subsurface conditions can change abruptly due to variable geological processes and also as a result of anthropogenic influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be limited by undetected variations in ground conditions between sampling locations. The advice may also be limited by budget constraints imposed by others or by site accessibility. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

This report must be read in conjunction with all of the attached notes and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by a statement, interpretation, outcome or conclusion given in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP.

Douglas Partners Pty Ltd

Appendix A

About this Report

About this Report

Douglas Partners



Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;

- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

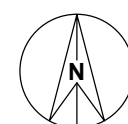
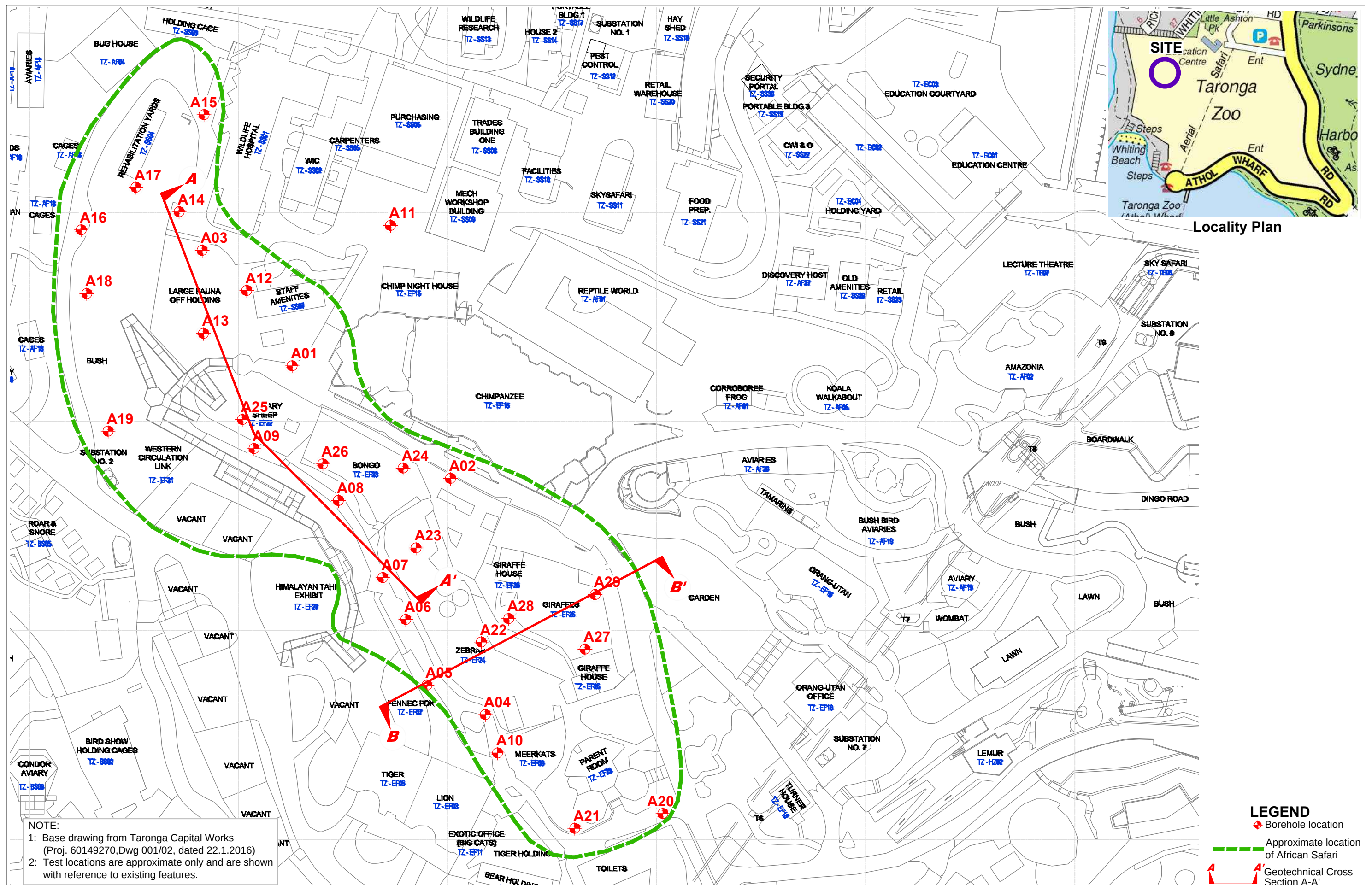
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

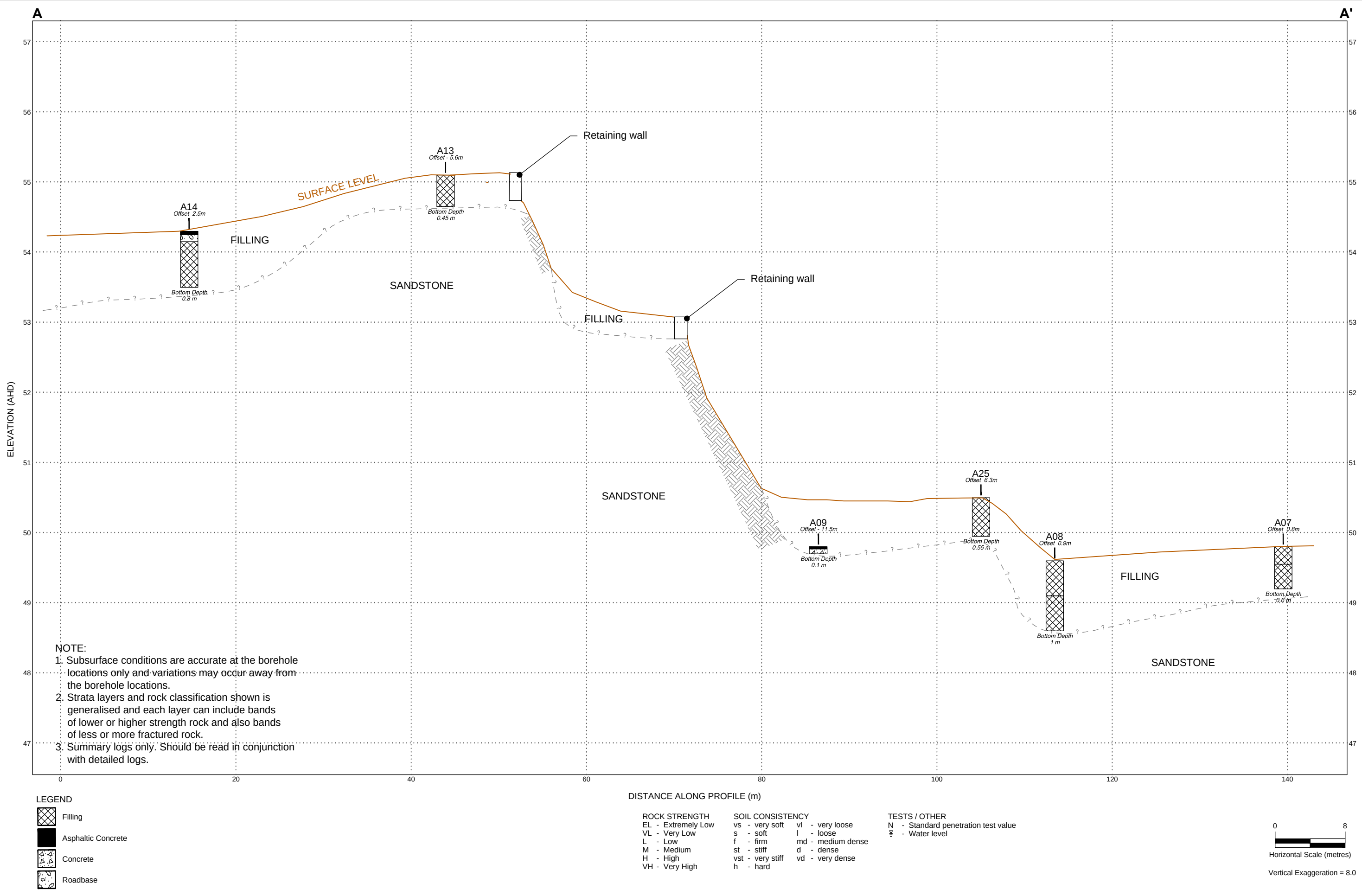
Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

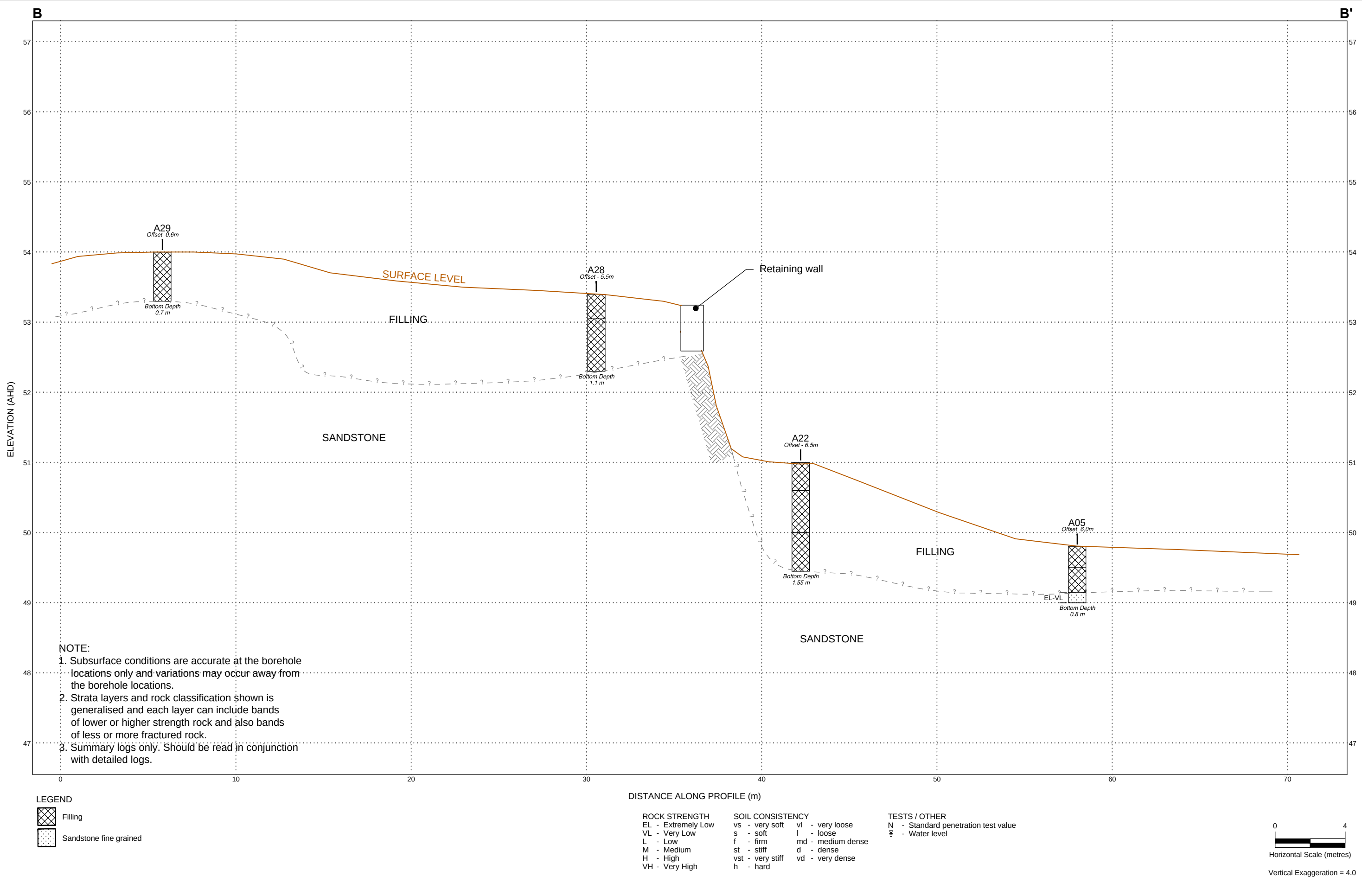
Appendix B

Drawings





 Douglas Partners <i>Geotechnics Environment Groundwater</i>	CLIENT: Taronga Zoo Conservation Society Australia		TITLE: Cross-section A-A' African Safari Bradleys Head Road, Mosman	PROJECT No: 85537.00	
	OFFICE: Sydney	DRAWN BY: AT/LD		DRAWING No: 3	
	SCALE: 1:400 (H) 1:50 (V) @ A3	DATE: 28.07.2016		REVISION: 0	



Appendix C

Site Observations

NOTES FROM WALKOVER

- A. Chimpanzee enclosure: Profile appears to be a shallow sandy soil over rock with undulating slope down to viewing area. There is some outcropping rock in slope as well as stacked sandstone boulders for landscaping purposes. See Photos 1 and 2.
- B. Chimpanzee enclosure: Medium to high strength sandstone exposed along water moat edge. Some of the rock has excavation marks. See Photo 3.
- C. African Safari Hut: - There is outcrops of medium to high strength sandstone bedrock along northern side of hut with seepage over the rock. See Photo 4.
- D. Large Fauna Off Holding: Sandstone boulders on slope appears to have been placed for erosion purposes.
- E. Barbary Sheep enclosure: Sandstone bedrock is present at high side of enclosure. Concrete has been used to cover the area and provide steps in slope. See Photo 5.
- F. Barbary Sheep enclosure: Sandstone outcrop is exposed near fence with ledge covered with boulders and concrete. Water seeping over top of concrete. See Photo 6.
- G. Bongo Enclosure: Medium to high strength sandstone exposed in rear, northern wall. There are also sections of shotcrete in rock face and sandstone block wall constructed on top of bedrock. See Photo 7.
- H. Zebra Enclosure: The rear of enclosure is some exposed sandstone and shotcrete face forming a vertical wall. See Photo 8.
- I. (not used)
- J. Giraffe Enclosure: Medium to high strength sandstone observed in road side wall of enclosure. See Photo 9.
- K. Stairs to lower level behind Giraffe enclosure: Medium to high strength sandstone floaters present on bedrock. Gorge marks are visible on large rounded outcrops below stairs. Many detached sandstone blocks with soil infill. See Photo 10.
- L. Bushland below Western Circulation Link. Colluvial profile has with large boulders/floaters on surface and wet zones with seepage. See Photo 11 to 13.
- M. Tahir Exhibit: Vertical face of sandstone and possible a retaining wall is obscured by vegetation. There is some claystone near gated area. See Photos 14 and 15.
- N. Area above zig zag ramp: Medium to high strength, rounded sandstone bedrock with a small overhang is present. It is rounded and boulders have been placed on top as a retaining structure. See Photos 16 and 17.
- O. (not used)
- P. Area at bottom of zig zag ramp: Rounded outcrop of medium to high strength sandstone with small overhangs present on natural slope stepping down in terraces with scattered floaters and boulders. Some weathering has occurred at bedding partings and joints resulting in openings. See Photos 18 to 20.
- Q. Next to Wildlife Hospital: There is a small retaining wall adjacent to the hospital supporting a slope with some outcropping rock. See Photo 21. Also appears to be some filling on the slope.
- R. Downslope of Rehabilitation Yards: This is a talus slope. There are outcrops of rock above and below road with road cut through sandstone. See Photos 22 to 26.



Photo 1 – Rock outcrop and landscaped rocks in Chimpanzee enclosure



Photo 2 – Landscaping in Chimpanzee enclosure. Some rock exposure in the background



Site Photographs

African Safari, Taronga Zoological Park
Bradleys Head Road, Mosman

CLIENT: Taronga Conservation Society
Australia

PROJECT: 85537.00

PLATE No: 1

REV: 0

DATE: 1 Aug 2016



Photo 3 – Rock outcrop with gorges in Chimpanzee enclosure



Photo 4 – Rock outcrop near African Safari Hut

Site Photographs

African Safari, Taronga Zoological Park
Bradleys Head Road, Mosman

CLIENT: Taronga Conservation Society
Australia

PROJECT: 85537.00

PLATE No: 2

REV: 0

DATE: 1 Aug 2016



Photo 5 – Rock Outcrop in Barbary Sheep enclosure



Photo 6 – Outcropping rock and concrete in Barbary Sheep enclosure

Site Photographs

African Safari, Taronga Zoological Park
Bradleys Head Road, Mosman

CLIENT: Taronga Conservation Society
Australia

PROJECT: 85537.00

PLATE No: 3

REV: 0

DATE: 1 Aug 2016



Photo 7 – Rock outcrop, block retaining wall, shotcrete in Bongo enclosure



Photo 8 – Shotcrete and sandstone in Zebra enclosure

Site Photographs

African Safari, Taronga Zoological Park
Bradleys Head Road, Mosman

CLIENT: Taronga Conservation Society
Australia

PROJECT: 85537.00

PLATE No: 4

REV: 0

DATE: 1 Aug 2016



Photo 9 – Sandstone exposure in Giraffe enclosure



Photo 10 – Floater exposed near stairs



Site Photographs

African Safari, Taronga Zoological Park
Bradleys Head Road, Mosman

CLIENT: Taronga Conservation Society
Australia

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Photo 11 – Sandstone floaters



Photo 12 – Rock bedrock and floaters

 Douglas Partners Geotechnics Environment Groundwater	Site Photographs		PROJECT: 85537.00
	African Safari, Taronga Zoological Park		PLATE No: 6
	Bradleys Head Road, Mosman		REV: 0
	CLIENT: Taronga Conservation Society Australia	DATE: 1 Aug 2016	



Photo 13 – Sandstone bedrock and floaters



Photo 14 – Sandstone and possibly retaining wall cliff covered with vegetation

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Photo 15 – Sandstone bedrock at base of wall covered with vegetation



Photo 16 – Sandstone bedrock above path

 Douglas Partners Geotechnics Environment Groundwater	Site Photographs		PROJECT: 85537.00
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Photo 17 – Sandstone bedrock with boulders and soil on top adjacent to path



Photo 18 – Sandstone bedrock with floaters

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Photo 19 – Sandstone bedrock with floaters



Photo 20 – Sandstone bedrock with floaters

 Douglas Partners Geotechnics Environment Groundwater	Site Photographs	PROJECT: 85537.00
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	Bradleys Head Road, Mosman	REV: 0
	CLIENT: Taronga Conservation Society Australia	DATE: 1 Aug 2016



Photo 21 – Sandstone outcrop at back of Wildlife hospital



Photo 22 – Sandstone outcrop

 Douglas Partners Geotechnics Environment Groundwater	Site Photographs		PROJECT: 85537.00
	African Safari, Taronga Zoological Park		PLATE No: 11
	Bradleys Head Road, Mosman		REV: 0
	CLIENT: Taronga Conservation Society Australia	DATE: 1 Aug 2016	



Photo 23 – Sandstone outcrop



Photo 24 – Sandstone outcrop

 Douglas Partners Geotechnics Environment Groundwater	Site Photographs		PROJECT: 85537.00
	African Safari, Taronga Zoological Park		PLATE No: 12
	Bradleys Head Road, Mosman		REV: 0
	CLIENT: Taronga Conservation Society Australia	DATE: 1 Aug 2016	



Photo 25 – Sandstone outcrop



Photo 26 – Sandstone outcrop

 Douglas Partners Geotechnics Environment Groundwater	Site Photographs		PROJECT: 85537.00
	African Safari, Taronga Zoological Park		PLATE No: 13
	Bradleys Head Road, Mosman		REV: 0
	CLIENT: Taronga Conservation Society Australia	DATE: 1 Aug 2016	

Appendix D

Results of Field Work



Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low

reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:
4,6,7
N=13
- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:
15, 30/40 mm

Sampling Methods

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.



Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 - 5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Symbols & Abbreviations

Douglas Partners



Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core Drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U ₅₀	Undisturbed tube sample (50mm)
W	Water sample
pp	pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

General



Asphalt



Road base



Concrete



Filling

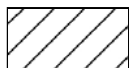
Soils



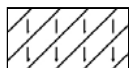
Topsoil



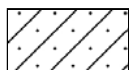
Peat



Clay



Silty clay



Sandy clay



Gravelly clay



Shaly clay



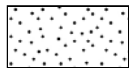
Silt



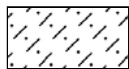
Clayey silt



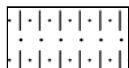
Sandy silt



Sand



Clayey sand



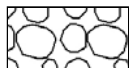
Silty sand



Gravel



Sandy gravel

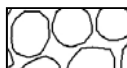


Cobbles, boulders



Talus

Sedimentary Rocks



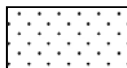
Boulder conglomerate



Conglomerate



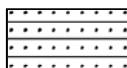
Conglomeratic sandstone



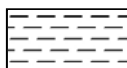
Sandstone



Siltstone



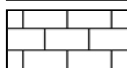
Laminite



Mudstone, claystone, shale

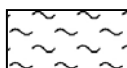


Coal

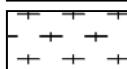


Limestone

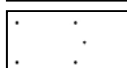
Metamorphic Rocks



Slate, phyllite, schist

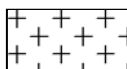


Gneiss

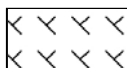


Quartzite

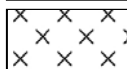
Igneous Rocks



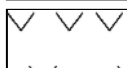
Granite



Dolerite, basalt, andesite



Dacite, epidote



Tuff, breccia



Porphyry

BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 55.8 AHD
EASTING: 337120
NORTHING: 6253905
DIP/AZIMUTH: 90°/--

BORE No: A01
PROJECT No: 85537.00
DATE: 17/6/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
	0.05	ASPHALTIC CONCRETE								
	0.08	ROADBASE GRAVEL - dark grey, igneous fine gravel and some grey silt and some brown sand			0.1					
		FILLING - well compacted, grey, fine crushed concrete and igneous gravel and grey fine to medium sand		A/E						
	0.2	Bore discontinued at 0.2m - refusal on concrete			0.2					

RIG: Bobcat

DRILLER: GM

LOGGED: AT

CASING: Uncased

TYPE OF BORING: 110mm diameter solid flight auger to 0.2m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND					
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 55.4 AHD
EASTING: 337164
NORTHING: 6253872
DIP/AZIMUTH: 90°/--

BORE No: A02
PROJECT No: 85537.00
DATE: 20/6/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
		FILLING - loosely compacted, dark grey silt (topsoil) - some organics (rootlets)			0.1							
				A/E	0.2							
		0.3m: becoming variably compacted grey-brown sand filling			0.5							
				A/E	0.6							
	0.6	Bore discontinued at 0.6m - refusal on concrete/asphalt, possible sandstone										

RIG: Hand tools

DRILLER: AT

LOGGED: AT

CASING: Uncased

TYPE OF BORING: Hand auger to 0.6m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND					
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U _s	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W _s	Water seep	S	Standard penetration test
E	Environmental sample	W _l	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 56.5 AHD
EASTING: 337082
NORTHING: 6253940
DIP/AZIMUTH: 90°/--

BORE No: A03
PROJECT No: 85537.00
DATE: 21/6/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
		FILLING - variably compacted, dark grey sandy silt, traces of rootlets, organic odour (topsoil)			0.1							
				A/E	0.2							
	0.25	FILLING - variably compacted, grey-brown silty sand filling with sandstone cobbles										
				A/E	0.5							
					0.6							
	1											
	1.1	FILLING - variably compacted, dark grey silt and clay filling, some dark grey shale and crushed glass			1.2							
				A/E	1.3							
	1.4	Bore discontinued at 1.4m - refusal on possible sandstone bedrock										

RIG: Bobcat

DRILLER: GM

LOGGED: AT

CASING: Uncased

TYPE OF BORING: Hand auger to 1.4m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U _s	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W _s	Water seep
E	Environmental sample	W _l	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 49.7 AHD
EASTING: 337172
NORTHING: 6253809
DIP/AZIMUTH: 90°/--

BORE No: A04
PROJECT No: 85537.00
DATE: 21/6/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
		FILLING - well compacted, orange-brown to grey, silty sand filling, some fine sandstone gravel		A/E	0.1							
	0.5	FILLING - variably compacted, dark grey silty sand filling with some fine shale and sandstone gravel		A/E	0.5							
					0.6							
	0.7	Bore discontinued at 0.7m - refusal on possible floater		A/E	0.7							
	1											

RIG: Bobcat

DRILLER: GM

LOGGED: AT

CASING: Uncased

TYPE OF BORING: 110mm diameter solid flight auger to 0.7m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)



Douglas Partners
 Geotechnics | Environment | Groundwater

BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 49.8 AHD
EASTING: 337159
NORTHING: 6253811
DIP/AZIMUTH: 90°/--

BORE No: A05
PROJECT No: 85537.00
DATE: 21/6/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
		FILLING - variably compacted, red-brown clayey sand filling with traces of silt			0.1							
				A/E	0.2							
	0.3	FILLING - variably compacted, grey sandy silt filling, organic odour, some igneous gravel										
				A/E	0.5							
					0.6							
	0.65	SANDSTONE - extremely low to very low strength, highly weathered sandstone			0.75							
				A/E	0.8							
	0.8	Bore discontinued at 0.8m - target depth reached										

RIG: Bobcat

DRILLER: GM

LOGGED: AT

CASING: Uncased

TYPE OF BORING: 110mm diameter solid flight auger to 0.8m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND					
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 49.8 AHD
EASTING: 337153
NORTHING: 6253825
DIP/AZIMUTH: 90°/--

BORE No: A06
PROJECT No: 85537.00
DATE: 21/6/2016
SHEET 1 OF 1

[illegible]

RIG: Bobcat

DRILLER: GM

LOGGED: AT

CASING: Uncased

TYPE OF BORING: 110mm diameter solid flight auger to 1.2m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W	Water seep
E	Environmental sample	W	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 49.8 AHD
EASTING: 337144
NORTHING: 6253842
DIP/AZIMUTH: 90°/--

BORE No: A07
PROJECT No: 85537.00
DATE: 21/6/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
		FILLING - variably compacted, brown-grey medium sand filling with traces of shale and sandstone gravel										
					0.1							
				A/E								
					0.2							
	0.25	FILLING - variably compacted, grey silty sand filling with some traces of medium basalt gravel, traces of crushed glass										
					0.5							
				A/E								
	0.6	Bore discontinued at 0.6m - refusal on possible sandstone bedrock			0.6							

RIG: Bobcat

DRILLER: GM

LOGGED: AT

CASING: Uncased

TYPE OF BORING: 110mm diameter solid flight auger to 0.6m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 49.6 AHD
EASTING: 337130
NORTHING: 6253864
DIP/AZIMUTH: 90°/--

BORE No: A08
PROJECT No: 85537.00
DATE: 21/6/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)
				Type	Depth	Sample	Results & Comments		
49.6		FILLING - variably compacted, brown fine to coarse sand filling with some sandstone gravel, trace of brown clay							
				E	0.1				
					0.2				
	0.5	FILLING - loosely compacted, grey, fine to medium sand filling with traces of silt, some medium to coarse igneous gravel		E	0.5				
					0.6				
49.6					0.9				
				E					
	1.0	Bore discontinued at 1.0m - refusal on sandstone			1.0				
48									

RIG: Bobcat

DRILLER: GM

LOGGED: AT

CASING: Uncased

TYPE OF BORING: 110mm diameter solid flight auger to 1.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 49.8 AHD
EASTING: 337105
NORTHING: 6253880
DIP/AZIMUTH: 90°/--

BORE No: A09
PROJECT No: 85537.00
DATE: 22/6/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
	0.03	ASPHALTIC CONCRETE								
	0.1	CONCRETE								
		Bore discontinued at 0.1m - auger refusal on concrete								

RIG: Bobcat

DRILLER: GM

LOGGED: JS

CASING: Uncased

TYPE OF BORING: Solid flight auger (TC-bit) to 0.1m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W	Water seep
E	Environmental sample	W	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test (s(50) (MPa)
		PL(D)	Point load diametral test (s(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 50.1 AHD
EASTING: 337176
NORTHING: 6253798
DIP/AZIMUTH: 90°/--

BORE No: A10
PROJECT No: 85537.00
DATE: 21/6/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
-0.8	0.15	FILLING - moderately to well compacted, red-brown sand filling, slightly clayey, traces of fine sandstone gravel		E/A	0.1							
		FILLING - variably compacted, grey-brown medium sand filling, traces of grey silt and clay			0.15							
				E/A	0.3							
					0.4							
	0.5	Bore discontinued at 0.5m - refusal on sandstone										

RIG: Bobcat

DRILLER: GM

LOGGED: AT

CASING: Uncased

TYPE OF BORING: 110mm diameter solid flight auger to 0.5m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 60.1 AHD
EASTING: 337131
NORTHING: 6253944
DIP/AZIMUTH: 90°/--

BORE No: A11
PROJECT No: 85537.00
DATE: 21/6/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
60	0.05	ASPHALTIC CONCRETE								
		CONCRETE								
59	0.2	Bore discontinued at 0.2m - auger refusal on bedrock								

RIG: Bobcat

DRILLER: GM

LOGGED: AT

CASING: Uncased

TYPE OF BORING: 150mm diameter diacore to 0.2m

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	T	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W	Water seep
E	Environmental sample	W	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 56.3 AHD
EASTING: 337097
NORTHING: 6253925
DIP/AZIMUTH: 90°/--

BORE No: A12
PROJECT No: 85537.00
DATE: 21/6/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
		FILLING - variably compacted, dark grey silt filling, slightly sand, traces of clay and rootlets (topsoil)			0.1							
				A/E	0.2							
		0.3m: becoming sandy										
				A/E	0.5							
					0.6							
	0.7	Bore discontinued at 0.7m - refusal on sandstone										
	1											
	1.5											

RIG: Bobcat

DRILLER: GM

LOGGED: AT

CASING: Uncased

TYPE OF BORING: 110mm diameter solid flight auger to 0.7m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 55.1 AHD
EASTING: 337087
NORTHING: 6253919
DIP/AZIMUTH: 90°/--

BORE No: A13
PROJECT No: 85537.00
DATE: 21/6/2016
SHEET 1 OF 1

[illegible]

RIG: Bobcat

DRILLER: GM

LOGGED: AT

CASING: Uncased

TYPE OF BORING: 110mm diameter solid flight auger to 0.45m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W	Water seep
E	Environmental sample	W	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 54.3 AHD
EASTING: 337078
NORTHING: 6253948
DIP/AZIMUTH: 90°/--

BORE No: A14
PROJECT No: 85537.00
DATE: 21/6/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
	0.05	ASPHALTIC CONCRETE										
		ROADBASE GRAVEL			0.1							
	0.15	FILLING - apparently moderately compacted, dark grey fine sand filling with traces of igneous gravel		A/E	0.2							
					0.6							
				A/E	0.7							
	0.8	Bore discontinued at 0.8m - refusal on concrete										
	1											

RIG: Bobcat

DRILLER: GM

LOGGED: AT

CASING: Uncased

TYPE OF BORING: 110mm diameter solid flight auger to 0.8m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 52.7 AHD
EASTING: 337087
NORTHING: 6253970
DIP/AZIMUTH: 90°/--

BORE No: A15
PROJECT No: 85537.00
DATE: 22/6/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
	0.03	ASPHALTIC CONCRETE								
		FILLING - grey, sandy gravel (roadbase) filling, damp		E	0.1					
	0.25	FILLING - grey and brown sand filling with some gravel (igneous rock and sandstone), tile and ceramic pipe fragments, brick and concrete rubble, damp		E	0.5					
	1			E	1.0					
	1.2	SANDSTONE - extremely low to low strength, extremely weathered, brown sandstone								
	1.5	Bore discontinued at 1.5m - auger refusal on sandstone								

RIG: Bobcat

DRILLER: GM

LOGGED: JS

CASING: Uncased

TYPE OF BORING: Solid flight auger (TC-bit) to 1.5m

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 44.9 AHD
EASTING: 337047
NORTHING: 6253946
DIP/AZIMUTH: 90°/--

BORE No: A16
PROJECT No: 85537.00
DATE: 22/6/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
	0.05	ASPHALTIC CONCRETE								
		FILLING - grey, sandy gravel (roadbase) filling, damp		E	0.1					
	0.25	SANDSTONE - extremely low to low strength, extremely to highly weathered, orange-brown sandstone								
	0.5	Bore discontinued at 0.5m		E	0.5					
44										
1										
43										

RIG: Bobcat

DRILLER: GM

LOGGED: JS

CASING: Uncased

TYPE OF BORING: Solid flight auger (TC-bit) to 0.5m

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 50.8 AHD
EASTING: 337053
NORTHING: 6253965
DIP/AZIMUTH: 90°/--

BORE No: A17
PROJECT No: 85537.00
DATE: 22/6/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
		FILLING - loosely compacted, brown fine sand filling, traces of rootlets and silt										
				E	0.1							
					0.2							
	0.25	Bore discontinued at 0.25m - auger refusal on possible sandstone bedrock										

RIG: Bobcat

DRILLER: GM

LOGGED: JS

CASING: Uncased

TYPE OF BORING: 110mm diameter solid flight auger to 0.25m

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND					
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U _s	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W _s	Water seep	S	Standard penetration test
E	Environmental sample	W _l	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 46.2 AHD
EASTING: 337049
NORTHING: 6253934
DIP/AZIMUTH: 90°/--

BORE No: A18
PROJECT No: 85537.00
DATE: 22/6/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
46		FILLING - variably compacted, brown medium to fine sand filling, traces of rootlets, some sandstone gravel										
				E	0.1							
					0.2							
	0.35	Bore discontinued at 0.35m - auger refusal on possible sandstone bedrock										
	1											
45												

RIG: Bobcat

DRILLER: GM

LOGGED: JS

CASING: Uncased

TYPE OF BORING: 110mm diameter solid flight auger to 0.35m

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 41.8 AHD
EASTING: 337060
NORTHING: 6253880
DIP/AZIMUTH: 90°/--

BORE No: A19
PROJECT No: 85537.00
DATE: 22/6/2016
SHEET 1 OF 1

[illegible]

RIG: Bobcat

DRILLER: GM

LOGGED: JS

CASING: Uncased

TYPE OF BORING: 110mm diameter solid flight auger to 0.4m

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	T	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W	Water seep
E	Environmental sample	W	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 51.8 AHD
EASTING: 337220
NORTHING: 6253781
DIP/AZIMUTH: 90°/--

BORE No: A20
PROJECT No: 85537.00
DATE: 22/6/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
	0.2	TOPSOIL/FILLING - variably compacted, dark brown silty sand filling with traces of rootlets		E	0.1							
		FILLING - variably compacted, dark brown-grey sand filling with some sandstone cobbles			0.2							
	0.55	Bore discontinued at 0.55m - refusal on sandstone boulder or asphaltic concrete		E	0.55							

RIG: Bobcat

DRILLER: GM

LOGGED: JS

CASING: Uncased

TYPE OF BORING: 110mm diameter solid flight auger to 0.55m

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND					
A	Auger sample	G	Gas sample	PLD	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 50.2 AHD
EASTING: 337200
NORTHING: 6253772
DIP/AZIMUTH: 90°/--

BORE No: A21
PROJECT No: 85537.00
DATE: 22/6/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
8	0.2	FILLING - variably compacted, dark grey silty sand filling with traces of rootlets (topsoil)			0.1							
				E/A								
	0.55	FILLING - variably compacted, grey sand filling, traces of ceramics and rootlets			0.2							
				E/A	0.4							
					0.5							
	0.55	Bore discontinued at 0.55m - auger refusal on asphaltic concrete										

RIG: Bobcat

DRILLER: GM

LOGGED: AT

CASING: Uncased

TYPE OF BORING: 110mm diameter solid flight auger to 0.55m

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 51.0 AHD
EASTING: 337168
NORTHING: 6253829
DIP/AZIMUTH: 90°/--

BORE No: A22
PROJECT No: 85537.00
DATE: 22/6/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
5	0.4	FILLING - apparently moderately compacted, brown sand filling with some fine quartz gravel and traces of silt		E/A	0.1							
					0.2							
					0.5							
					0.6							
1	1.0	FILLING - variably compacted, dark brown silty sand filling with slightly fine brown crushed sandstone gravel		E/A	0.8m: becoming dark grey							
					1.0							
					1.1							
					1.2							
1	1.55	FILLING - variably compacted, dark grey gravelly sand filling with some igneous (basalt gravel), slightly silty		E/A	1.0							
					1.1							
					1.2							
					1.5							
	1.55	Bore discontinued at 1.55m - auger refusal on sandstone			1.55							

RIG: Bobcat

DRILLER: GM

LOGGED: AT

CASING: Uncased

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 50.6 AHD
EASTING: 337154
NORTHING: 6253853
DIP/AZIMUTH: 90°/--

BORE No: A23
PROJECT No: 85537.00
DATE: 22/6/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
		FILLING - apparently well compacted, dark brown fine to medium sand filling, traces of silt and igneous gravel										
					0.1							
				E/A								
					0.2							
		0.25m: becoming brown										
					0.45							
				E/A								
	0.5	Bore discontinued at 0.5m - refusal on sandstone			0.5							

RIG: Bobcat

DRILLER: GM

LOGGED: AT

CASING: Uncased

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 50.7 AHD
EASTING: 337146
NORTHING: 6253870
DIP/AZIMUTH: 90°/--

BORE No: A24
PROJECT No: 85537.00
DATE: 22/6/2016
SHEET 1 OF 1

[illegible]

RIG: Bobcat

DRILLER: GM

LOGGED: AT

CASING: Uncased

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W	Water seep
E	Environmental sample	W	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 50.5 AHD
EASTING: 337130
NORTHING: 6253874
DIP/AZIMUTH: 90°/--

BORE No: A25
PROJECT No: 85537.00
DATE: 22/6/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)
				Type	Depth	Sample	Results & Comments		
		FILLING - variably compacted, dark grey silty sand filling with traces of rootlets, fine igneous gravel			0.1				5
				E/A	0.2				10
					0.5				15
				E/A*	0.55				20
	0.55	Bore discontinued at 0.55m - refusal on sandstone							

RIG: Bobcat

DRILLER: GM

LOGGED: AT

CASING: Uncased

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: *BD6-200616 collected at 0.5m to 0.55m

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 51.5 AHD
EASTING: 337099
NORTHING: 6253890
DIP/AZIMUTH: 90°/--

BORE No: A26
PROJECT No: 85537.00
DATE: 22/6/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
		TOPSOIL - dark grey silt, traces of rootlets and sand										
	0.2	Bore discontinued at 0.2m - refusal on sandstone		E*	0.1							
					0.2							
	1											
	50											

RIG: Bobcat

DRILLER: GM

LOGGED: AT

CASING: Uncased

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: *BD7-200616 collected at 0.1m to 0.2m

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U _s	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 53.2 AHD
EASTING: 337205
NORTHING: 6253823
DIP/AZIMUTH: 90°/--

BORE No: A27
PROJECT No: 85537.00
DATE: 22/6/2016
SHEET 1 OF 1

[illegible]

RIG: Bobcat

DRILLER: GM

LOGGED: AT

CASING: Uncased

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	W	Tube sample (x mm dia.)
C	Core drilling	W _s	Water sample
D	Disturbed sample	W _{seep}	Water seep
E	Environmental sample	W _{level}	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 53.4 AHD
EASTING: 337179
NORTHING: 6253833
DIP/AZIMUTH: 90°/--

BORE No: A28
PROJECT No: 85537.00
DATE: 22/6/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
		FILLING - apparently moderately compacted, brown filling with fine sand filling, traces of fine ironstone and igneous gravel		E/A	0.1 0.12							
	0.35	FILLING - apparently moderately compacted, dark grey, medium sand filling with traces of ironstone sand and crushed ceramics		E/A	0.5 0.6							
	1			E/A	1.0							
	1.1	Bore discontinued at 1.1m - refusal on sandstone		E/A	1.1							

RIG: Bobcat

DRILLER: GM

LOGGED: AT

CASING: Uncased

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PLD	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Taronga Conservation Society Australia
PROJECT: African Safari
LOCATION: Bradleys Head Road, Mosman

SURFACE LEVEL: 54.0 AHD
EASTING: 337204
NORTHING: 6253838
DIP/AZIMUTH: 90°/--

BORE No: A29
PROJECT No: 85537.00
DATE: 22/6/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
		FILLING - apparently well compacted, brown, silty fine sand filling with traces of brown clay and ironstone gravel		E/A	0.1							
					0.45							
				E/A	0.5							
	0.7	Bore discontinued at 0.7m - refusal on sandstone										
	1											

RIG: Bobcat

DRILLER: GM

LOGGED: AT

CASING: Uncased

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)



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Results of Dynamic Penetrometer Tests

Client Taronga Conservation Society Australia
Project African Safari
Location Bradleys Head Road, Mosman

Project No. 85537.00
Date 17-22/06/16
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Test Locations	A02	A03	A04	A05	A06	A07	A08	A10	A12	A13
RL of Test (AHD)	55.4	56.5	49.7	49.8	49.8	49.8	49.6	50.1	56.3	55.1
Depth (m)										
0.00 – 0.15	1	2	10	15	5	15	15	15	7	1
0.15 – 0.30	0	6	10	23	25/100	20	13	20	3	4
0.30 – 0.45	3	2	9	6	3	9	6	5	4	3
0.45 – 0.60	6	3	3	6	3	25/140	4	25/100	25/150	25/100
0.60 – 0.75	25/50	7	2	20/50	6		3			
0.75 – 0.90		10	4		25/140		3			
0.90 – 1.05		10	20				R			
1.05 – 1.20		25/100	R							
1.20 – 1.35										
1.35 – 1.50										
1.50 – 1.65										
1.65 – 1.80										
1.80 – 1.95										
1.95 – 2.10										
2.10 – 2.25										
2.25 – 2.40										
2.40 – 2.55										
2.55 – 2.70										
2.70 – 2.85										
2.85 – 3.00										

Test Method AS 1289.6.3.2, Cone Penetrometer ☒
 AS 1289.6.3.3, Sand Penetrometer ☐

Tested By AT
Checked By NLE

Remarks R = REFUSAL
 25/50 = 25 BLOW COUNTS FOR 50mm PENETRATION

Results of Dynamic Penetrometer Tests

Client Taronga Zoo Conservation Society Australia
Project African Safari
Location Bradleys Head Road, Mosman

Project No. 85537.00
Date 17-22/06/16
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Test Locations	A14	A17	A18	A19	A20	A21	A22	A23	A24	A25
RL of Test (AHD)	54.3	50.8	46.16	41.8	51.8	50.2	51.0	50.6	50.7	50.5
Depth (m)										
0.00 – 0.15	-	3	7	3	5	4	10	12	8	6
0.15 – 0.30	20	25/140	3	5	6	6	6	15	12	20
0.30 – 0.45	15		25/100	7	25/100	4	18	B	13	13
0.45 – 0.60	6			25/90	R		16		11	
0.60 – 0.75	5						B		16	
0.75 – 0.90	25/100								8	
0.90 – 1.05									11	
1.05 – 1.20									11	
1.20 – 1.35									B	
1.35 – 1.50										
1.50 – 1.65										
1.65 – 1.80										
1.80 – 1.95										
1.95 – 2.10										
2.10 – 2.25										
2.25 – 2.40										
2.40 – 2.55										
2.55 – 2.70										
2.70 – 2.85										
2.85 – 3.00										

Test Method AS 1289.6.3.2, Cone Penetrometer ☒
 AS 1289.6.3.3, Sand Penetrometer ☐

Tested By AT
Checked By NLE

Remarks B = BOUNCING
 R = REFUSAL
 25/100 = 25 BLOW COUNTS FOR 100mm PENETRATION

Results of Dynamic Penetrometer Tests

Client Taronga Zoo Conservation Society Australia
Project African Safari
Location Bradleys Head Road, Mosman

Project No. 85537.00
Date 17-22/06/16
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Test Locations	A26	A27	A28	A29						
RL of Test (AHD)	51.5	53.2	53.4	54.0						
Depth (m)										
0.00 – 0.15	5	7	10	18						
0.15 – 0.30	25/50	15	10	12						
0.30 – 0.45		25/100	8	8						
0.45 – 0.60		R	6	8/75						
0.60 – 0.75			8	B						
0.75 – 0.90			8							
0.90 – 1.05			12							
1.05 – 1.20			6							
1.20 – 1.35			10							
1.35 – 1.50			B							
1.50 – 1.65										
1.65 – 1.80										
1.80 – 1.95										
1.95 – 2.10										
2.10 – 2.25										
2.25 – 2.40										
2.40 – 2.55										
2.55 – 2.70										
2.70 – 2.85										
2.85 – 3.00										

Test Method AS 1289.6.3.2, Cone Penetrometer ☒
 AS 1289.6.3.3, Sand Penetrometer ☐

Tested By AT
Checked By NLE

Remarks B = BOUNCING
 R = REFUSAL
 25/50 = 25 BLOW COUNTS FOR 50mm PENETRATION