GEOTECHNICAL INVESTIGATION REPORT

68A QUEENSCLIFF ROAD, QUEENSCLIFF NSW

PREPARED FOR CLASSIC PLANS
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1 PROJECT INFORMATION

1.1 INTRODUCTION AND OBJECTIVES

Geo-Environmental Engineering Pty Ltd (GEE) was commissioned by Mr Erol Ozdirik from Classic Plans to complete a geotechnical investigation at 68A Queenscliff Road, Queenscliff New South Wales (herein referred to as 'the site'). A survey plan of the site is provided in **Appendix A**.

GEE understands that the investigation is required to support a Development Application with Council which relates to the proposed construction of a mixed use (commercial and residential) development which will include three levels over a single level basement. A three-storey building comprising a lower level shop with residential apartments above currently occupies the site.

The report presents the factual and interpreted results of the field investigations and provides interpretation and recommendations regarding the ground conditions at the site, in accordance with client requirements and the agreed scope of work. Furthermore, the report addresses slope instability risk concerns in response to requirements specified by Council.

1.2 NORTHERN BEACHES COUNCIL DCP

The Northern Beaches Council DCP/E10-Landslide Risk for Warringah requires a geotechnical assessment for land subject to Hazard Mapping (Landslide Risk). Council's mapping shows the land at this site is within Area B (Flanking Slopes from 5 to 25 Degrees).

For land in Area B, a Checklist (refer to Section 5.3.2) is used to determine whether a geotechnical report is required.

The following report provides an assessment of landslide risk in accordance with Council's DCP.

1.3 PROPOSED DEVELOPMENT

The proposed development will comprise three levels above ground and a single level basement. The ground floor will comprise a commercial development while the upper floors will comprise residential apartments. According to the development plans (**Appendix A**) the basement excavation will extend to the boundaries of the site with vehicle access from Queenscliff Road.

The basement level is expected to have a finished floor level of 24.415m above Australian Height Datum (AHD). Considering the existing site elevations shown on the survey, and the over-excavation required to facilitate construction of the basement slab, an excavation depth of approximately 3.0m to 3.5m below ground surface (bgs) is expected with the deepest excavation adjacent to the northern boundary which runs parallel with Queenscliff Road.

1.4 SCOPE OF WORK

To satisfy the above objective, GEE completed the following scope of work:

- A dial-before-you-dig (DBYD) desktop search for buried services,
- A geotechnical investigation conducted on 28 May 2019, with drilling of 3 boreholes in accessible areas of the site to assess the nature and consistency of subsurface soils and the depth of the underlying bedrock,
- Collection of soil and rock from the boreholes for selective laboratory testing to assist with characterisation of the soil profile,
- Performance of Dynamic Cone Penetrometer Tests (DCPs) to assess the consistency and/or relative density of the soil profile, and to assist with determining the depth to bedrock,
- Site mapping by an experienced engineering geologist and review of the site slope stability,
- Engineering assessment and reporting.

2 SITE INFORMATION

2.1 SITE DESCRIPTION

The site is bounded by Queenscliff Road to the north, Bridge Road to the east and a low-density residential dwelling and apartments to the south and west. The site covers an area of 315.3m^2 (by survey) and is legally described as Lot A in Deposited Plan DP 961049.

At the time of the field investigation, the site was occupied by a three-storey brick commercial and residential dwelling, with an associated carport with driveway access to Queenscliff Road. The remaining area of the site was predominantly covered by concrete with a small section of lawn along the northern boundary.

The exterior of the existing dwelling appeared to be in a sound condition with minor cracking noted in the southwest corner of the structure. The concrete balcony at the rear (southern) side of the dwelling has partially separated from the main structure due to settlement of its foundation.

Sandstone outcrop was observed in the front garden of the property located across Queenscliff Road to the north.

Existing site features are shown on the site survey provided in **Appendix A** and **Figure 1**. Photographs of the site, which were taken at the time of the site investigation are provided for reference in Plates 1 to 8 below.

Plate 1 – View to the west showing the existing dwelling.

Plate 2 – View to the west showing the southern boundary with No.21 Bridge Street.

Plate 3 – View to the north showing eastern site boundary.

Plate 4 – View to the east showing existing dwelling.

Plate 5 – View to the south showing western boundary with adjacent development.

Plate 6 – View to the northeast showing existing dwelling.

Plate 7 – Cracking and settlement of rear concrete veranda viewed east.

Plate 8 – Sandstone outcrop in front yard of property to the north of the site.

2.2 TOPOGRAPHY

The site is located on a southerly dipping hillslope with a moderate grade of about 15**%**. According to the survey plan (**Appendix A**) the surface elevation falls from approximately 27.62m above Australian Height Datum (AHD) in the northwest corner of the site to 26.50m AHD at the southwest corner.

2.3 GEOLOGY AND SOIL

A review of the regional geological map (reference 1) indicates that the site is underlain by the Triassic aged Hawkesbury Sandstone formation, consisting of "*…medium to coarse-grained quartz sandstone, very minor shale and laminite lenses"*.

A review of the regional soils map indicates that the site is located within the (Colluvial) Hawkesbury Soil Landscape. (reference 2). The Hawkesbury Soil Landscape comprises rugged rolling to steep hills on Hawkesbury Sandstone, narrow crests and ridges, incised valleys, steep sided slopes and rocky benches, broken scarps and boulders. Limitations of the Hawkesbury Group Soils include extreme soil erosion hazard, mass movement (rockfall hazard), steep slopes, rock outcrops, highly permeable and of low fertility. Soils of the Hawkesbury group are characterised by shallow to moderately deep (30-100cm) yellow earth and earthy sands. These soils typically are very permeable, have low fertility and form a high soil erosion hazard.

Rock outcrop and sub-surface soils identified during the fieldwork were consistent with the published mapping.

2.4 HYDROGEOLOGY

The regional and permanent groundwater in the vicinity of the site is expected to be confined or partly confined, discrete, water-bearing zones within the bedrock formation. However, GEE notes that intermittent 'perched' water seepage is likely to occur through the identified colluvial soils, and at the residual soil / bedrock interface following rainfall events.

2.5 ACID SULFATE SOIL POTENTIAL

Acid Sulfate Soil is naturally occurring sediments and soils containing iron sulfides (principally iron sulfide, iron disulfide or their precursors). Oxidation of these soils through exposure to the atmosphere or through lowering of groundwater levels results in the generation of sulfuric acid.

Land that may contain potential acid sulfate soils was mapped by the NSW Department of Land and Water Conservation (DLWC) and based on these maps local Councils produced their own acid sulfate soil maps to be used for planning purposes.

The DLWC '*Sydney Heads'* Acid Sulfate Soil Risk Map (reference 3), indicates that the site lies within an area with no known occurrences of acid sulphate soil and land activities within this area are "...*not likely to be affected by acid sulphate soil materials*".

The Acid Sulfate Soils Map produced by the NSW Department of Planning and Environment, via interactive online mapping, indicates that the site lies outside of areas defined as '*Class 1*' to '*Class 5*'. In this regard, there is no need for an acid sulphate soil assessment or management plan.

3 FIELD INVESTIGATIONS

Fieldwork was undertaken on the 30th May 2018 by Matthew Kilham, an engineering geologist working on behalf of GEE. The fieldwork comprised:

- ◊ The drilling and logging of three boreholes (BH1 to BH3) in accessible areas of the site to assess the soil conditions and depth to bedrock,
- ◊ The performance of DCP tests at each borehole location (DCP1 and DCP2) to assess the consistency and/or relative density of the soil profile and to assist with determining the depth to bedrock, and
- ◊ The collection of representative soil samples for the preliminary assessment of soil salinity and aggressivity.

The boreholes were drilled using an 85mm diameter, hand operated auger, while the DCP tests were performed in accordance with Australian Standard Test Method AS1289.6.3.2-1997 (reference 4). During drilling, the encountered fill and natural soils were geologically logged by an experienced engineering geologist, taking care to describe the presence and depth of any fill material / previously disturbed ground, the natural stratum, moisture, seeps or water bearing zones, and the elevation of the water level/hydraulic head.

Boreholes BH1 to BH3 were advanced through surface fill and the natural soil profile before terminating due to practical refusal on weathered sandstone bedrock which occurred at depths of 0.35m to 1.65m below ground surface (bgs).

The DCP tests at BH1 and BH2 were terminated due to practical refusal which occurred at similar depths to the boreholes and this supported the conclusion that bedrock was encountered.

The location of the boreholes and DCP tests were estimated using measurements from existing site features and are shown on **Figure 1**. A copy of the borehole logs, including DCP test results, are provided in **Appendix B**.

4 INVESTIGATION RESULTS

4.1 SUBSURFACE CONDITIONS

The subsurface conditions, as observed in the boreholes, typically comprised fill and topsoil overlying residual sandy soils before refusing on weathered sandstone bedrock which occurred at depths of between 0.35m and 1.65m (bgs).

Detailed descriptions of the subsurface conditions on site are provided in the borehole logs (including DCP test data) in **Appendix B**, while a summary of the subsurface conditions encountered across the site are provided in **Table 1**.

Table 1: Summary of Subsurface Conditions

Layer / Unit	Description	Depth to Base of Layer (m)[1]	Consistency / Relative Density[1]
TOPSOIL/FILL	Silty SAND and SAND: brown and grey, fine to coarse grained, trace Gravel and Cobbles	0.10 – 1.00	Loose to medium dense, soft to firm
RESIDUAL SOIL	SAND trace Silt and Clay: grey mottled orange, trace bands extremely weathered Sandstone.	0.35 – 1.65	Loose to medium dense
BEDROCK	SANDSTONE: grey white, fine to medium grained, extremely weathered	>0.35 – 1.65	Estimated very low strength

Note 1: Estimated from DCP tests and borehole observations

Adverse aesthetics, specifically odours associated with potential contamination, were not noted during the fieldwork. Additionally, no potentially Asbestos Containing Materials (ACM) was observed in the bores during the drilling.

4.1.1 GROUNDWATER

Permanent groundwater was not encountered in the boreholes during drilling. However, slight seepage was observed in boreholes BH1 and BH3 and this occurred near the fill and residual soil interface.

4.2 LABORATORY TEST RESULTS

Representative samples of soil were collected from the boreholes and submitted to Envirolab Services Pty Ltd (Envirolab) for selective testing which included:

- ◊ Electrical Conductivity (EC) to provide a detailed assessment of the salinity potential of the soil profile, and
- ◊ Sulphate, Chloride, resistivity and pH to determine the exposure classification of the soil with respect to buried structural concrete and unprotected steel.

The laboratory test results are presented in **Appendix C,** while a summary of the results is provided in the following sub-sections.

4.2.1 SOIL SALINITY TESTING

An assessment of soil salinity conditions has been undertaken with reference to guidance published by the Department Land and Water Conservation NSW (reference 5). In this regard, selected samples of natural soil were submitted to Envirolab for NATA accredited testing of Electrical Conductivity (EC), which is the primary indicator of salinity,

The raw EC results and the EC_e results[1], are provided in **Table 2**.

Table 2: Electrical Conductivity Results

Sample Location / Depth (m)	Sample Description	EC (dS/m)	Multiplication Factor[1]	EC_e (dS/m)
BH1 / 0.1 – 0.5	FILL – Sand	0.059	17	1.00
BH1 / 0.55 – 0.85	FILL – Sand	0.089	17	1.51
BH1 / 1.0 – 1.1	Sand	0.032	17	0.54
BH1 / 1.5 – 1.6	Sand	0.057	17	0.97

According to the Department Land and Water Conservation NSW (reference 8), ECe results less than 2dS/m are considered to be non-saline, ECe results between 2dS/m to 4dS/m are slightly saline, and results between 4dS/m and 8dS/m are considered to be moderately saline. The above test data indicate that the fill/natural soil profile is non-saline.

[1] EC_e results are EC lab data that is multiplied by a conversion factor which depends upon the soil texture / type (reference 5)

4.2.2 EXPOSURE CLASSIFICATION TESTS

Selected soil samples were submitted to Envirolab for NATA accredited testing of pH, sulfate, chloride and resistivity to provide a preliminary assessment of the exposure classification (or aggressiveness/corrosiveness potential) of the soil with respect to future buried steel and/or concrete (e.g. footings).

To determine the aggressiveness of the soil and water environment on concrete or steel, the chemical test results are compared to Tables 6.4.2(C) and 6.5.2(C) from Section 6 of the Australian Standard AS 2159 (reference 6). This section provides assessment criteria to assess the 'exposure classification' for a concrete or steel pile. The Standard has two classes of soil conditions:

(A) high permeability soils below groundwater; and
(B) low permeability soils and all soils above groundwater.

For this site, all the soil samples are considered to be condition 'B'. Based on the chemical testing results, the standard provides a range of 'exposure classifications' from non-aggressive to very severe. For the range of chemical conditions in the soil surrounding the structure, the condition leading to the most severe aggressive conditions is adopted.

A summary of the soil results is provided in **Table 3**.

Table 3: Exposure classification (aggressivity) test results

Sample Location / Depth	Soil Condition	pH	Sulphate (SO_4) mg/kg	Chloride (Cl) mg/kg	Resistivity Ohm.cm
BH1 / 0.1 – 0.5	B	8.1	140	54	17,000
BH1 / 0.55 – 0.85	B	7.7	<30	21	11,000
BH1 / 1.0 – 1.1	B	8.0	<30	24	31,000
BH1 / 1.5 – 1.6	B	7.2	49	67	18,000

The aggressivity potential of an environment on concrete is dependent on the sulphate and pH levels of the soil. Based on the limited number of test results above and taking into account the 'worst-case' sample, the subsurface profile is non-aggressive towards

concrete. According to Australian Standard AS 3600-2009 (reference 7), specifically Table 4.8.1, this equates to an exposure classification of 'A1'.

The corrosive potential of an environment on unprotected steel is normally dependent on pH, chloride, and resistivity levels of the soil. Based on the limited number of test results above and taking into account the 'worst-case' sample, the subsurface profile is considered to be non-corrosive towards any unprotected steel.

5 DISCUSSION

5.1 SITE PREPARATION

Following demolition of the existing structures and prior to bulk excavation works and construction of the new development, all topsoil with organic matter and any pavement materials, should be removed from the proposed building and pavement areas. Stripped topsoil should be stockpiled for re-use as landscape material or disposed of off-site.

Material removed from site will need to be managed in accordance with the provisions of current legislation and may include segregation by material type classification in accordance with NSW EPA (2014) *Waste Classification Guidelines* (reference 8) and disposal at facilities appropriately licensed to receive the particular materials. GEE notes that the natural soil and bedrock may be classified as Virgin Excavated Natural Material (VENM) and re-used on other sites rather than disposed at a landfill, although it must be proven to be free of contamination.

5.2 EARTHWORKS

Based on the development plans provided in **Appendix A**, the basement excavation will extend to a depth of between 3.0m and 3.5m bgs and will extend up to the site boundaries and the deepest excavation will be adjacent to the northern boundary which runs parallel with Queenscliff Road.

5.2.1 EXCAVATION

Based on the fieldwork undertaken as part of this investigation, the excavation will encounter fill material and residual sandy soils before grading into weathered sandstone bedrock below approximately 1.20 and 1.65m bgs. GEE notes that the bedrock profile was not exposed during the investigation due to hand auger refusals at the bedrock level. In this regard the composition and strength of the bedrock has not been accurately assessed as part of this investigation. Notwithstanding this, GEE anticipates that the sandstone within the depth of the excavation will initially be very low to low strength becoming medium to high strength with depth. More detailed investigations are recommended following demolition of the existing structures to confirm the composition and strength of the bedrock profile within the depth of the proposed excavation.

The fill and natural soil profile is expected to be readily excavated using standard equipment such as excavators. However, the use of an impact hammer will be

required upon encountering the bedrock formation, especially when combined with unfavourable rock-defect geometry. When using an impact hammer the effects of vibration should be considered and are discussed further in Section 5.2.3.

5.2.2 GROUNDWATER

Permanent groundwater was not encountered during the drilling of the boreholes. However, slight to moderate seepage was observed in boreholes BH1 and BH2 during the investigation and further seepage is expected to occur over time along the soil-bedrock interface and through defects within the bedrock formation.

The seepage is expected to be sufficiently managed during the earthworks phase by pumping from a sump at the base of the excavation. In the long term, conventional techniques such as strip drains behind basement walls and ag-lines will need to be incorporated into the design of the basement to ensure that any seepage is directed to a sump where it can be pumped into the regional stormwater system.

5.2.3 CONSTRUCTION / EXCAVATION INDUCED VIBRATION

When using a hydraulic hammer, vibrations will be transmitted through the ground and potentially impact on adjoining structures. Where possible, the use of other techniques not involving impact (*e.g.* rock saws), should be adopted as they would reduce or possibly eliminate risks of damage due to vibrations.

The structures on the adjacent properties (and nearby services) are sensitive to vibrations above certain threshold levels (regarding potential for cracking). Given that the proposed basement excavation will extend to within proximity of the boundaries and adjoining development, close controls by the excavation contractor over the rock excavation are necessary, and are recommended, so that excessive vibration effects are not generated.

Peak Particle Velocity (PPV) is usually the adopted measure of ground vibration and the safe limits depend on the sensitivity of the adjoining structures and services. There is several Australian and overseas publications which provide vibration velocity guideline levels (or safe limits) including:

- Australian Standard AS2187.2-2006 Explosives - Storage and use - Use of explosives - Appendix J: Ground Vibrations and Airblast Overpressure (reference 9).

- Australian Standard AS2670.2-1990 Evaluation of human exposure to whole-body vibration - Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz) (reference 10).
- DIN 4150 – Part 3 – 1999. Effects if Vibration on Structures (reference 11).
- Department of Environment and Conservation NSW, 2006. Assessing Vibration: a technical guideline (reference 12).
- British Standard BS 7385-1:1990. Evaluation and measurement for vibration in buildings. Guide for measurement of vibrations and evaluation of their effects on buildings (reference 13).
- British Standard BS 7385-2:1993. Evaluation and measurement for vibration in buildings. Guide to damage levels from groundborne vibration (reference 14).

The most appropriate guidelines levels for the proposed excavation work are provided in AS2187.2-2006, which refers to guideline values from BS7385-2 for the prevention of minor or cosmetic damage occurring in structures from ground vibration. Additionally, the guideline levels provided in DIN 4150 Part 3 is considered an appropriate source for guideline levels.

Ideally, safe limits should be determined by a specialist vibration consultant. However, as a preliminary and conservative guide, and considering the above guidelines and the type of adjoining structures present, GEE recommend that excavation methods should be adopted which limit ground vibrations at the adjoining developments to not more than 5mm/sec.

The PPV limit of 5mm/sec is expected to be achievable if rock breaker equipment or other excavation methods are restricted as indicated in **Table 4**.

Table 4: Recommendations for Rock Hammer Equipment

Distance from adjoining structure (m)	Maximum Peak Particle Velocity 5mm/sec	
	Equipment	Operating Limit (% of Maximum Capacity)
1.0 to 2.0	Hand operated jackhammer only	100
2.0 to 5.0	300 kg rock hammer	50
5.0 to 10.0	300 kg rock hammer or 600 kg rock hammer	100 50

GEE notes human discomfort levels caused by vibration are typically less than the levels that are likely to cause cosmetic or structural damage to structures. Therefore, complaints may be lodged by neighbours before any cosmetic or structural damage occurs. In this regard, consideration may be given to adopting more stringent vibration limits recommended for human amenity or, as a minimum, ensuring that vibration monitoring is undertaken as reassurance to confirm that vibrations are within safe limits. Acceptable vibration limits for human comfort caused by construction and excavation equipment are provided in DEC (2006) (reference 12). Specifically, maximum acceleration limits as specified in Table 2.2 of the guideline should be adopted.

Finally, at all times, the excavation equipment should be operated by experienced personnel, according to the manufacture's instructions, and in a manner consistent with minimising vibration effects. Measures which may be used to minimise vibration include:

- ◊ Progressive breakage from open excavated faces,
- ◊ Selective breakage along open joints, where present,
- ◊ Use of rock hammers in short bursts to prevent generation of resonant frequencies,
- ◊ Orientation of the rock hammer pick away from property boundaries and into the existing open excavation,
- ◊ Commencement of excavation as far away from other structures as possible, and
- ◊ The use of a rock sawing or grinder adjacent to the site boundaries. GEE notes that this equipment also reduces the possibility of overbreak and loosening of the rock mass.

5.2.4 *EXCAVATION SUPPORT*

Based on the architectural plans (**Appendix A**), the basement excavation will extend up to the site boundaries. In this regard, temporary support or the early construction of permanent walls will be required along all faces of the basement excavation.

Considering the subsurface conditions encountered during the field investigations, options for shoring include the use of contiguous piling combined with a pile cap. For piles, open bored piles or Continuous Flight Auger (CFA) piles, are both considered to be feasible and should be designed by a suitably experienced structural engineer in accordance with AS 4678-2002 *Earth Retaining Structures* (reference 15) and should consider the short and long term configurations. In the short term, should the shoring walls be cantilevered or supported by a single row of anchors and some wall movements can be tolerated (flexible wall), the pressure acting on the wall can be estimated based on a triangular earth pressure distribution.

When internal props, such as the ground floor slab, restrain retaining wall movement, or where significant movements cannot be tolerated, such as immediately adjacent to adjoining buildings, an 'at-rest' earth pressure coefficient (Ko) should be adopted with either a uniform or trapezoidal pressure distribution. This may also include the lengths of wall immediately adjacent to adjoining structures that bound the site. It should be noted that shoring which is designed for this 'at rest' coefficient may still undergo some lateral movements, depending on the final configuration of the wall and construction sequence.

The design of any retaining structures should make allowance for all applicable surcharge loadings including construction activities around the perimeter of the excavation and adjacent buildings. Consideration should be given to the possibility of a hydrostatic pressure due to build-up of water behind the wall (*e.g.* from broken services), unless permanent subsurface drainage can be provided.

Finally, computer aided analysis may be carried out to assess potential ground movements based on different wall designs and construction sequence, to control deflections to within tolerable limits. It is also considered prudent to carry out surveys before and after installation to measure the actual movement of the wall or soil.

Preliminary geotechnical parameters for the soil profile encountered at the site are provided in **Table 5**. Parameters for the expected sandstone bedrock profile have been provided however GEE notes that the composition and strength of the bedrock

profile were not determined during the preliminary investigation. Further investigation using a mechanical drilling rig are recommended prior to undertaking the design for the proposed structures.

Table 5: Geotechnical Design Parameters – Retaining Structures

Units	Depth to Top of Layer (m)	Unit Weight (kN / m^3)	Active Lateral Earth Pressure (Ka)	Lateral Earth Pressure at Rest (Ko)	Passive Lateral Earth Pressure (Kp)	Effective Cohesion (c') (kPa)	Effective Friction Angle (φ') (degree)
1 - Fill / Natural Soil	Surface	18	0.35	0.5	--	0	25
2 – Sandstone	1.2 – 1.65	22	0.2	0.35	3.5	25	40

5.2.5 DILAPIDATION REPORT

GEE suggests that a dilapidation report be carried out on neighboring buildings prior to commencing excavation. The purpose of a dilapidation report is to confirm that construction works, in particular the excavation works, are not causing damage and therefore may prevent future claims of damage arising from the works. Preferably these surveys should be agreed to, and the report signed, by the owners of the adjacent building prior to work commencing.

5.3 LANDSLIP RISK ISSUES

5.3.1 WARRINGAH DCP

The Northern Beaches Council DCP/E10-Landslide Risk for Warringah requires a geotechnical assessment for land subject to Hazard Mapping (Landslide Risk). Council's mapping shows the land at this site is within Area B (Flanking Slopes from 5 to 25 Degrees).

For land in Area B, a Checklist and Flow Chart (below) are used to determine whether or not a geotechnical report is required, addressing geotechnical risk in accordance with AGS 2007 Guidelines (reference 16).

The site and slope features within and affecting the property were assessed at the time of the geotechnical site visit undertaken on 28 May 2019, to determine requirements under the Warringah DCP in connection with the proposed development.

Our assessment and opinions on slope instability risk for the site and proposed development, presented in the following sections, are determined in accordance with the Australian Geomechanics Society's Landslide Risk Management Concepts and Guidelines (2007) (reference 16), as required by the DCP.

It should be noted that the Warringah DCP (*Objectives – to ensure development is "**geotechnically stable**"*) does not define the level of "acceptable risk". In accordance with usual practice (refer Table 1 in AGS 2007), we have adopted Low Risk as the threshold for acceptable risk level for property damage/economic consequence, and 10^{-6} per annum for loss of life.

5.3.2 ASSESSMENT REQUIREMENTS

Reference to the checklist and flowchart confirm a landslide risk assessment is required by virtue of the proposed basement excavation depth of up to approximately 3.5m.

Our assessment is discussed in Sections 5.3.3 – 5.3.5 below.

CHECKLIST

1.0	LANDSLIP RISK CLASS (Landslip Risk Class in which site is located)
	A Geotechnical report not normally required
	B Council officers to decide if geotechnical report required
	C Geotechnical report required
	D Council officers to decide if geotechnical report required
	E Geotechnical report required

2.0	SITE LOCATION
No.68A (Lot A DP961049) Queenscliff Rd Queenscliff NSW. Located downhill of street, side boundary also on Bridge Rd.	

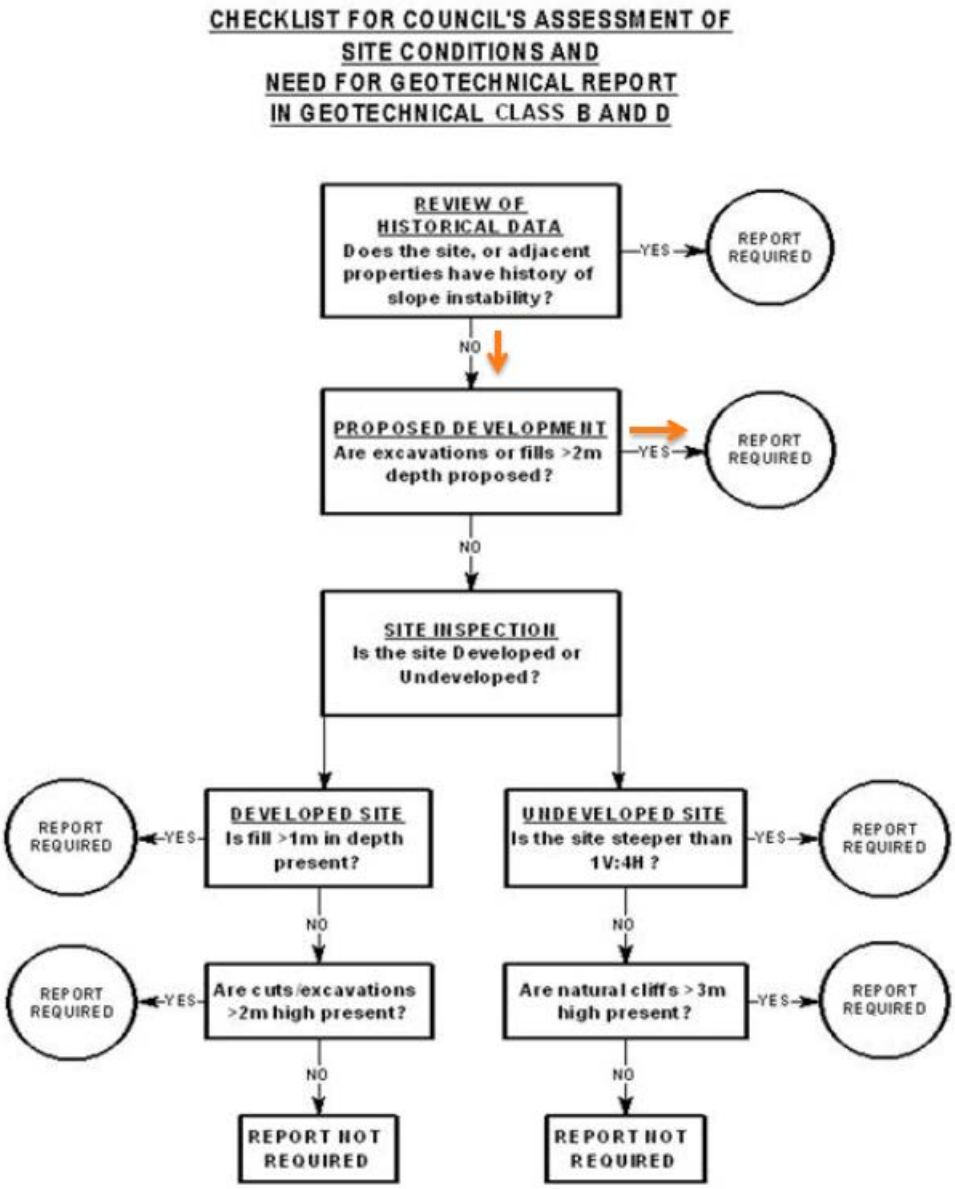
3.0	PROPOSED DEVELOPMENT
Three-storey commercial and residential units with single level basement. Excavation depth approx. 3.5m.	

4.0	EXISTING SITE DESCRIPTION
Moderate slope gradient, 8^{o} – 10^{o} falling from front to rear (photographs attached). Current development two storey commercial and residential units, no basement. Sandstone hillslope, rock ledge outcrops nearby. No evidence of instability of natural slope.	

5.0	RECOMMENDATIONS
Geotechnical landslide risk assessment required by virtue of proposed excavation depth in excess of 2m. Engineering design required at CC stage for excavation and footings.	

6.0	DATE OF ASSESSMENT:	28 May 2019
7.0	ASSESSMENT BY:	Matthew Kilham

(Refer Flowchart below)



5.3.3 PRESENT SLOPE CONDITIONS

The existing slope above and through the site has been altered by filling to form Queenscliff Road. The underlying natural slope has been interpreted as comprising shallow colluvial and residual soils overlying a stepped or gently sloping sandstone bedrock profile.

The present slope conditions comprise a natural/fill slope falling to the south at a general gradient of 8^{o} – 10^{o}. The established residential/commercial development is in excess of 30 years of age. The nature of the dwelling footings was not determined

as part of this investigation but given the condition of the exterior walls of the dwelling it is likely that the foundations have been extended to the bedrock level.

There is no evidence the slope in this locality and within or adjacent to the site at No.68A has experienced landsliding since its early settlement and residential development.

In the absence of any direct or presumed evidence of recent slope instability (last several hundred years and more), the likelihood of landslide activity initiating on or adjacent to (but influencing) the site over a notional design life for the continuing existence of the present developments on these properties of 100 years, is considered 'UNLIKELY'.

For the assessed slope conditions at this site, namely shallow sand soils over sandstone bedrock, possible hazards to be considered are limited to shallow translational soil failure, at a scale which could affect the development with up to 'MEDIUM' consequence for property damage, the assessed risk would be LOW (refer attached risk matrix and other extracts from AGS 2007).

For potential loss of life in such a landslide event, the risk to persons is assessed using the risk equation 4 in AGS 2007. The input variables for the calculation are estimated as follows:

Probability of the event $P_{(H)}$	10^{-4} per annum
Probability of spatial impact $P_{(S:H)}$	0.1
Temporal spatial probability $P_{(T:S)}$	0.3
Vulnerability of the person $V_{(D:T)}$	0.1

The calculated risk level is 3×10^{-7} per annum

The above estimates for risk to life and risk for property for the present slope conditions are both below the acceptable risk level noted in 5.3.1 above.

5.3.4 CONSTRUCTION STAGE

Risk of instability during construction needs to be considered in regard to the excavations necessary for basement construction.

Excavation in sandy soils above the bedrock will be limited to a depth less than 2m. Control is necessary over batter slope or temporary support. The latter is

recommended. The underlying sandstone bedrock could be excavated as a self-supporting face, subject to geotechnical inspection to confirm the rock quality.

It is recommended that mapping of excavated faces be carried out by a geotechnical engineer or engineering geologist during the excavation phase to verify the ground conditions.

In our opinion, with the above controls properly detailed as part of the engineering design for the Construction Certificate, and implemented, the stability of the construction-stage excavations can be maintained at appropriate levels by suitable engineering design for temporary support systems and staging, backed up by a robust Excavation Methodology Statement prepared for the work as part of the usual documentation for a Construction Certificate.

5.3.5 COMPLETED DEVELOPMENT

It is our opinion that the proposed development can be completed so that the slope conditions and structural elements will have a low risk or lower in regard to slope instability, when assessed in accordance with the guidelines in AGS 2007.

This is contingent on the following:

- ◊ all recommendations of this report being faithfully implemented, and
- ◊ the engineering design, construction controls and monitoring, and final engineering verifications as appropriate, being properly undertaken in accordance with the normally accepted practice and regulation for this type of development.

5.4 FOUNDATIONS

Following excavation of the basement, the bulk excavation level is likely to comprise sandstone bedrock which is capable of providing a minimum serviceability bearing capacity of 1,000kPa (reference 17). However, further geotechnical investigation will be required to confirm the strength and quality of the bedrock formation.

Footing systems should be designed by a suitably qualified and experienced structural engineer and GEE recommends that inspection by a geotechnical engineer is undertaken during the footing excavation stage, to confirm that the design founding conditions have been achieved.

5.4.1 AGGRESSIVITY / EXPOSURE CLASSIFICATION

Based on the preliminary exposure classification test results (Section 4.2.2), and in accordance with AS 2159-2009 (reference 6), the subsurface concrete structures (*e.g.* footings) may be designed based on non-aggressive soil conditions for concrete. According to Australian Standard AS 3600-2009 (reference 7) the exposure classification is 'A1'. For buried steel that is unprotected, the sub-surface profile is considered to be non-aggressive/corrosive.

6 CONCLUSION AND RECOMMENDATIONS

GEE considers that sufficient information has been gained to be confident of the subsurface conditions across the site, to allow final design of the proposed development and to provide Council with assurances regarding the geotechnical feasibility of the proposed development and the risk of instability.

Based on the results of the investigation, it is concluded that the development can be undertaken with appropriate engineering design and construction controls, such that the risks of slope instability associated with the works and the completed development will be acceptable, i.e. low risk, in accordance with AGS Guidelines.

Additionally, GEE concludes that the existing rock formation can withstand the proposed loads to be imposed, and standard shoring works (provided they are designed by a structural engineer), will ensure the stability of the excavation and provide protection and support of adjoining properties. However, further investigation (preferably post demolition) is recommended to more accurately define the strength and quality of the bedrock formation which will minimise the uncertainty for earthworks contractors and structural design engineers when planning and designing the proposed excavation and foundations. Additionally, inspections are recommended during the excavation phase of the development to confirm the geological model and design founding conditions have been achieved.

The geotechnical issues associated with the proposed development have been addressed by the investigation and are discussed in this report. If, during construction, any conditions are encountered that vary significantly from those described or inferred in the above report, it is a condition of the report that we be advised so that those conditions, and the conclusions discussed in the report, can be reviewed and alternative recommendations assessed, if appropriate.

GEE will be pleased to assist with any further advice or geotechnical services required in regard to the proposed development.

7 GENERAL LIMITATIONS

Soil and rock formations are variable. The logs or other information presented as part of this report indicate the approximate subsurface conditions only at the specific test locations. Boundaries between zones on the logs or stratigraphic sections are often not distinct, but rather are transitional and have been interpreted.

The precision with which subsurface conditions are indicated depends largely on the frequency and method of sampling, and on the uniformity of subsurface conditions. The spacing of test sites also usually reflects budget and schedule constraints. Groundwater conditions described in this report refer only to those observed at the place and under circumstances noted in the report. The conditions may vary seasonally or as a consequence of construction activities on the site or adjacent sites.

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

The comments given in this report are intended only for the guidance of the design engineer, or for other purposes specifically noted in the report. The number of boreholes or test excavations necessary to determine all relevant underground conditions which may affect construction costs, techniques and equipment choice, scheduling, and sequence of operations would normally be greater than has been carried out for design purposes. Contractors should therefore rely on their own additional investigations, as well as their own interpretations of the borehole data in this report, as to how subsurface conditions may affect their work.

8 REFERENCES

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11. DIN 4150 – Part 3 – 1999. *Effects if Vibration on Structures.*
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15. Australian Standard AS4678-2002: Australian Standard, 2002: *Earth Retaining Structures*.
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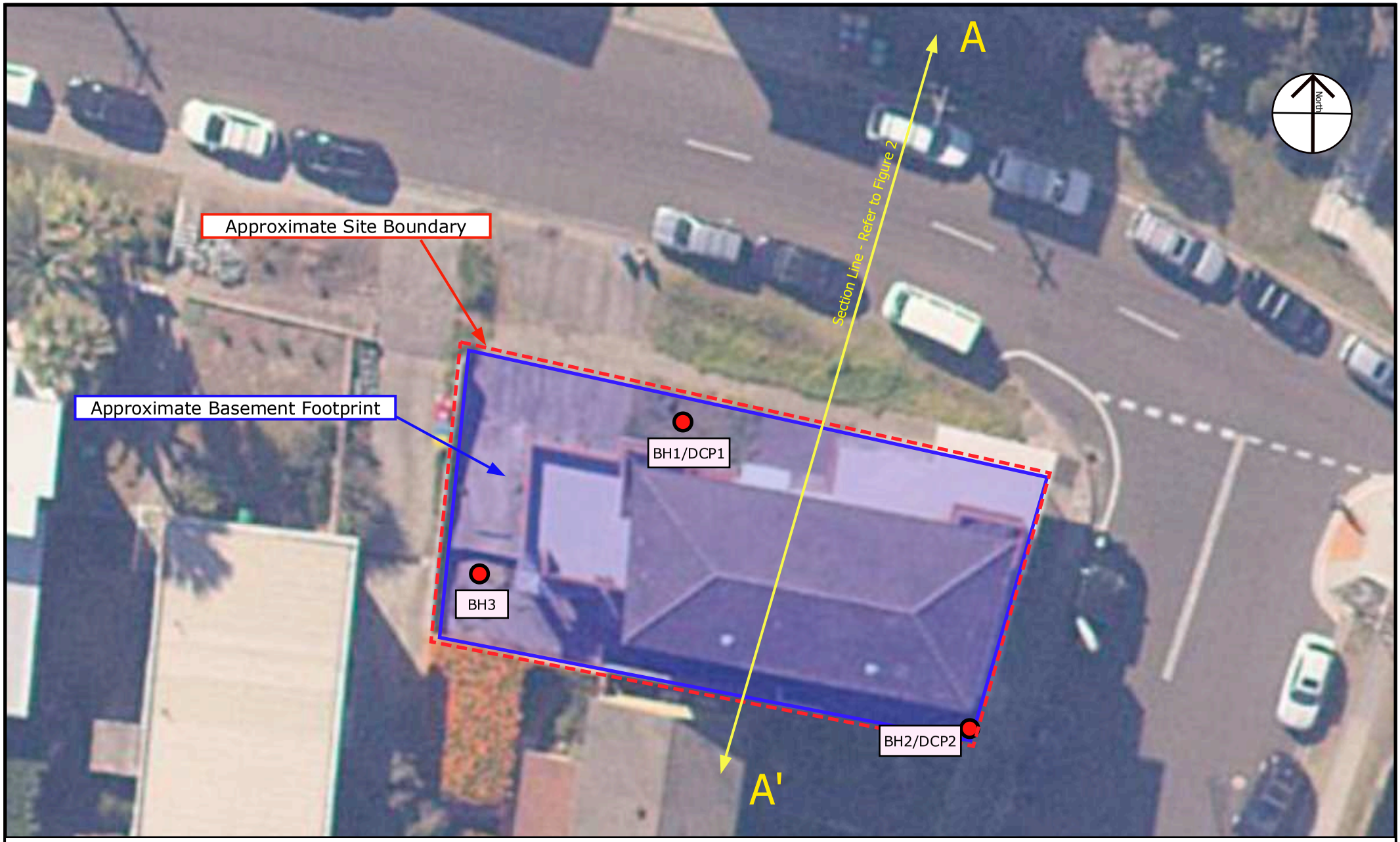
FIGURES

1 – Site Plan

2 – Site Section A - A’



Aerial image: provided by SIXmaps (NSW LPI)- Image dated 06/04/2016

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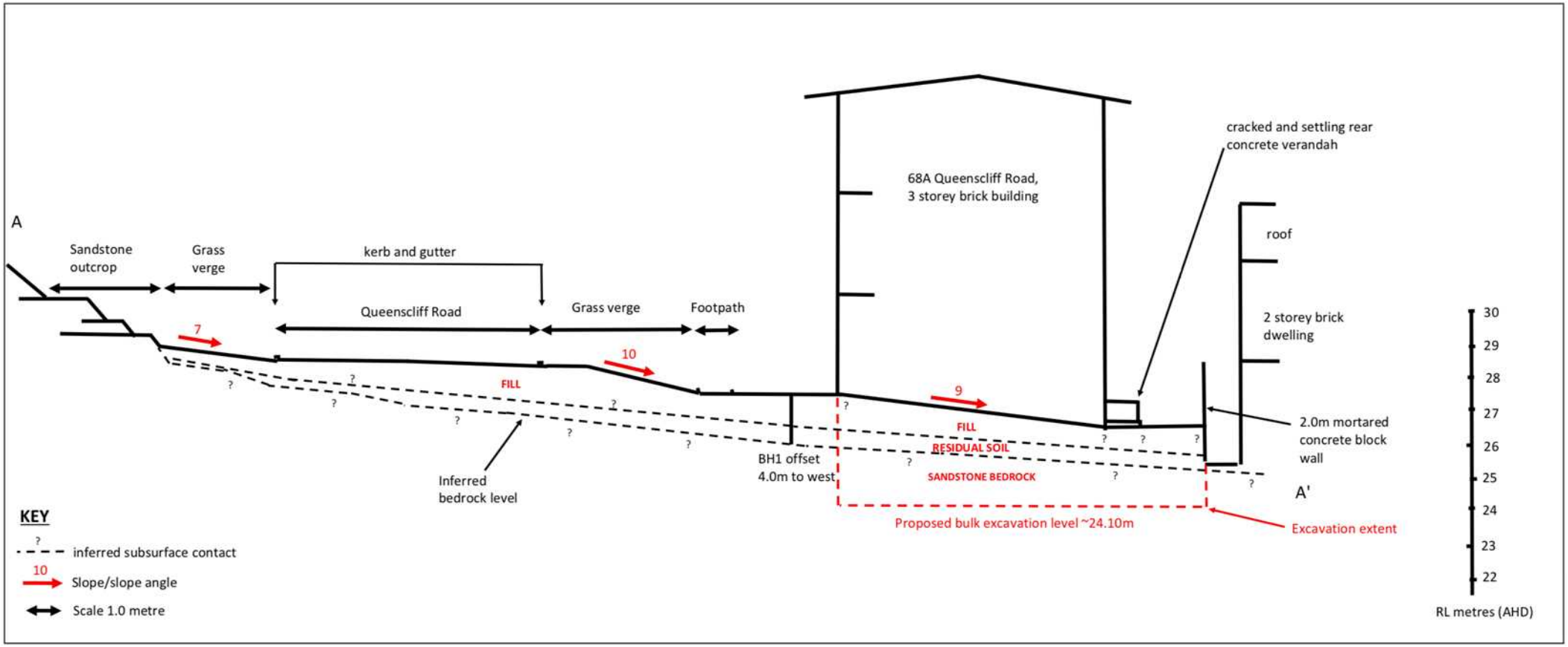
TITLE: SITE PLAN 68A Queenscliff Road, Queenscliff NSW	SCALE: **N.T.S**	DATE: **5 June 2019**	FIGURE No. **1**
	DRAWN: **M.Kilham**	JOB No.: **G19024QUE**	REVISION: **A**



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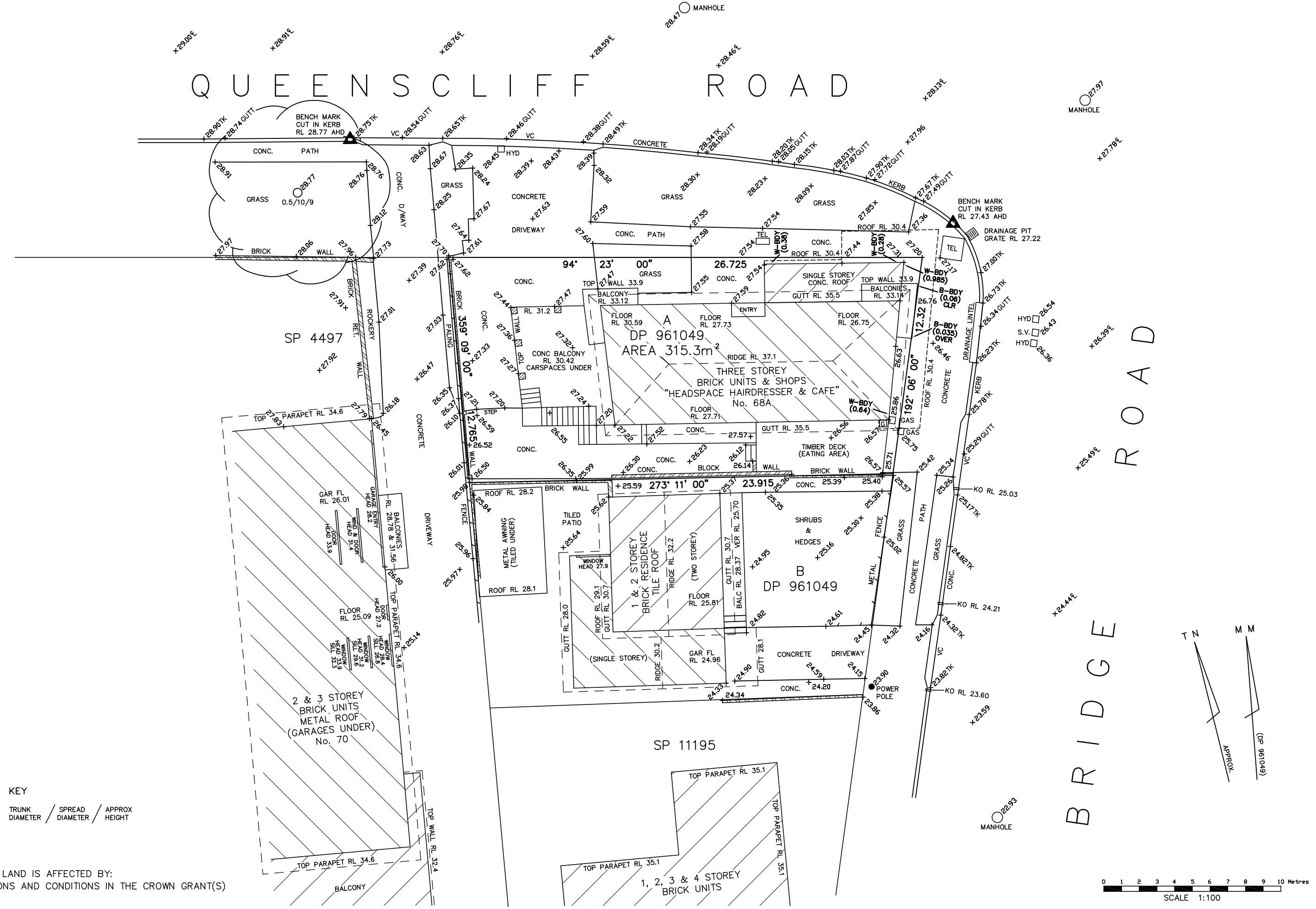
www.geoenvironmental.com.au

TITLE: SITE SECTION A - A' 68A Queenscliff Road, Queenscliff NSW	SCALE: **N.T.S**	DATE: **5 June 2019**	FIGURE No. **2**
	DRAWN: **M.Kilham**	JOB No.: **G19024QUE**	REVISION: **A**

APPENDIX A

Survey and Architectural Plans (12 Sheets)



KEY

TRUNK DIAMETER / SPREAD DIAMETER / APPROX HEIGHT

THE SUBJECT LAND IS AFFECTED BY:
1. RESERVATIONS AND CONDITIONS IN THE CROWN GRANT(S)

NOTES:-
- Bearings and distances are by Title and/or Deed only. No boundary investigation has been carried out.
- Relationship of improvements to boundaries is diagrammatic only. Where offsets are critical they should be confirmed by further survey
- Services shown hereon have been determined from visual evidence only. Prior to any demolition, excavation or construction on the site the relevant authority should be contacted to establish detailed location and depth. be confirmed by further survey.
- The bearings on these plan boundaries are from Land Title Office plans. They are on Magnetic Meridian. If True North is required a further survey would be necessary.

SYMBOLS & ABBREVIATIONS:

D	DOOR	PP	POWER POLE
DH&R	DRILL HOLE & WING	SMH	SEWER MANHOLE
E	ELECTRICITY LINE	SV	SEWER VENT
FL	FLOOR LEVEL	TEL	TELECOM PIT
G	GAS METER	TK	TOP OF KERB
HYD	HYDRANT	WM	WATER METER
VC	VEHICLE CROSSING	W	WINDOW
PC	PRAM CROSSING	D	DOOR
		KO	KERB OUTLET

SURVEY NOTES

DATUM :	AUSTRALIAN HEIGHT DATUM
ORIGIN OF LEVELS:	SSM 763 RL 31.090 AHD
SURVEYORS:	GK & RD
SURVEY DATE :	26/03/2013
LOCAL GOVT AREA:	WARRINGAH
AutoCAD 2002:	20130113.DWG
PLOTFILE:	(A1 - 1:100) 20130113

CAUTION

THIS SURVEY HAS BEEN CARRIED OUT FOR THE PRODUCTION OF PLANS AT A REDUCTION RATIO OF 1 : 100 . ENLARGEMENT BEYOND THIS IS NEITHER INTENDED NOR SUPPORTED

BALLENDEN SURVEYORS
C1/102-106 BOYCE RD,
MAROUBRA JUNCTION, N.S.W. 2035
PHONE (02) 9344 5506 FAX (02) 9344 5506
E-mail: ballenden@ozemail.com.au

No. 68A QUEENSCLIFF ROAD, QUEENSCLIFF
DETAIL & BOUNDARY SURVEY

CLIENT: Christine Coulits

DRAWN: DS	SCALE : 1:100(A1) 1:200(A3)		LOT A IN DP 961049
CHKD: -	REF: 30113	ISSUED: 02/04/13	SHEET 1 OF 2

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Ⓒ No.55
Balcony Balcony

Ⓓ No.53
Balcony Balcony

Ⓒ No.12
Balcony Balcony Balcony

BRIDGE ROAD

Ⓑ No.47

WINTER SUN PATH
SUNRISE

SUMMER PREVALING NORTH-EASTERLY WINDS MORNING & AFTERNOON

TN

WINTER SUN PATH
SUNSET

QUEENSCLIFF ROAD

path
new
path

② ② ②

BOUNDARY 26.725

BOUNDARY 12.765

3000 min

DRIVEWAY TO BASEMENT PARKING

9580

3110

Lot A
DP 961049
AREA 315.3m

BOUNDARY 12.32

Remove redundant crossing

DRIVEWAY

BOUNDARY 23.915

3035 min. wall

SHOP TERRACE

1865 min. balcony

WINTER PREVALING WESTERLY WINDS (MORNING)

SUMMER SUN PATH
SUNSET

METAL AWNING

①

No.21 A
1 & 2 STOREY
BRICK DWELLING

WINTER PREVALING WINDS (AFTERNOON)

SUMMER PREVALING WINDS (AFTERNOON SOUTHERLY BUSTERS)

BRIDGE ROAD

SUMMER SUN PATH
SUNRISE

Ⓒ No.68

No.70
2 & 3 STOREY
BRICK FLAT BUILDING

TN

0 2 4 6 8 10
1:100 @ A3

LEGEND

- PROPOSED NEW BUILDING
- PREVALING WINDS
- VIEWS
- NOISE
- VEHICULAR SITE ENTRY
- NEIGHBOURING WINDOWS FACING SITE
- VIEW CORRIDOR
- EXISTING TREES TO BE RETAINED
- EXISTING TREES TO BE REMOVED – N/A
- Ⓐ 2 STOREY DWELLINGS
- Ⓑ 2 STOREY RESIDENTIAL FLAT BUILDINGS
- Ⓒ 3 STOREY RESIDENTIAL FLAT BUILDINGS
- Ⓓ 4 STOREY RESIDENTIAL FLAT BUILDINGS
- ① SECLUDED PRIVATE OPEN SPACE
- ② EXISTING DRIVEWAY

SITE PLAN & SITE ANALYSIS PLAN

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68A QUEENSCLIFF ROAD, QUEENSCLIFF
LOT A DP 961049

client:
COULITS FAMILY

scale – 1:200
date – 07/02/19
DA – issue A
dwg. no. – 040/19

sheet 1 of 11

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QUEENSCLIFF ROAD

BENCH MARK
CUT IN KERB
RL 28.77 AHD

BENCH MARK
CUT IN KERB
RL 27.43 AHD

BOUNDARY 26.725

BOUNDARY 12.765

BOUNDARY 12.32

Tel

RL 23.99

COMMON
BULK STORES
min. 4m³

BICYCLE RACKS

EXIT
STAIR 1
UP

RL 23.99

RL 24.09

1100

6780

2746

LIFT

RL 24.14

5550

METERS

3 STORE

2 STORE

1 STORE

RL 24.09

RL 24.09

2

5500

STORE

750

1000

5

5 STORE

4 STORE

2700

2590

2880

2400

300

3

5400

RAMPED FLOOR DOWN @ 1:20

6

STORE

5400

7260

2400

5770

1000

750

CAR PARKING

RL 24.415

4

RL.24.415

RL 25.865

27.52

RL 24.67

RL 24.415

UP

3000

tilta-door

2700

5380

soft
l'scaping

4750

2000

1135

EXIT
STAIR 2

UP

RL 25.665

RL 25.58

Driveway

No.70
2 & 3 STOREY
BRICK FLAT BUILDING

Balcony

No.21 A
2 STOREY
BRICK DWELLING

BRIDGE ROAD

TN

0 1 2 3 4 5

1:100 @ A3

Legend

Denotes footprint of existing structure

Denotes footprint of previous approval DA2015/1079

BASEMENT FLOOR PLAN

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scale – 1:100 @ A3
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QUEENSCLIFF ROAD

BRIDGE ROAD

path

BENCH MARK
CUT IN KERB
RL 28.77 AHD

BENCH MARK
CUT IN KERB
RL 27.43 AHD

WASTE PICK-UP AREA

Driveway sight line

Regrade & returf council nature strip to council requirements

New RC crossing to council requirements

Regrade & returf council nature strip to council req.

GRADE UP TO UPPER PATH

Regrade & returf council nature strip to council req.

BOUNDARY 26.725

RL 27.907

2.0m @ 1:20.0

3600

RL 27.807

DRIVEWAY

3.47m @ 5.5

RL 27.170

Driveway

9295

BOUNDARY 12.765

WASTE RM (Commercial)
3.0x1.8

RL.27.80

WASTE RM (Residential)
2.8x2.4

COMMERCIAL 2
(26m2)
8.6x3.0
RL.27.60

stairs up from basement

RESIDENTIAL ENTRY
RL 27.60

LIFT

ENTRY LOBBY
RL.27.60

UP to units

KITCHEN
4.3x2.4

UNISEX DIS WC
2.6x1.9

UNISEX WC

COOL RM
4.3x1.6

COMMERCIAL 1
(85.8m2)
8.0/6.3x9.0
RL.27.00

COMMERCIAL ENTRY
RL 27.00

TERRACE
9330
2400

Line of building over

RL 25.865

3075

1800 high privacy screen to edge of terrace & planter

TERRACE
Louvred awing over

3000 minimum

planter

BOUNDARY 26.725

BOUNDARY 12.332

soft l'scaping

Line of building over

230

No.70
2 & 3 STOREY
BRICK FLAT BUILDING

Balcony

METAL AWNING

5855

11085

No.21 A
2 STOREY
BRICK DWELLING

Note:
ALL STORMWATER LINES TO BE DIRECTED TO BRIDGE ROAD KERB & GUTTER

Legend

Denotes footprint of existing structure

Denotes footprint of previous approval DA2015/1079

0 1 2 3 4 5
1:100 @ A3

SITE & GROUND FLOOR PLAN

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QUEENSCLIFF ROAD

BENCH MARK
CUT IN KERB
RL 28.77 AHD

BENCH MARK
CUT IN KERB
RL 27.43 AHD

23715

BOUNDARY 26.725

3000 minimum

Driveway

BOUNDARY 12.765

8560

BED 1
3.6x3.0

LIVING
4.0x3.6

b/in

BATH
2.3x1.8

st
(2m3)

LDY

KITCHEN
2.7x2.3

DINING
3.1x3.0

UNIT 3 (50m2)

LIFT

UP

LOBBY

1000 min.

b/in

BED 1
3.6x3.0

BATH
2.2x1.8

st
(2m3)

LDY

KITCHEN
2.1x2.0

DINING
3.2x2.7

UNIT 1 (54m2)

UNIT 2 (50m2)

b/in

st
(2m3)

LDY

DINING
2.7x2.4

LIVING
3.8x3.5

KITCHEN
3.1x2.1

BED 1
3.9x3.0

BATH
2.3x1.8

Line of wall over

BALC
8 m²

Louvred awning below

Line of balcony over

Planter below

min. wall

Terrace below

LIVING
4.6x3.4

Line of wall over

BALC
8 m²

BALC
8 m²

min. balcony

BOUNDARY 12.32

7625

2810

1885

4130

1990

3090

3035

1865

BOUNDARY 26.725

6060

8535

7330

21510

No.70
2 & 3 STOREY
BRICK FLAT BUILDING

Balcony

METAL AWNING

No.21 A
2 STOREY
BRICK DWELLING

BRIDGE ROAD

N

0 1 2 3 4 5
1:100 @ A3

Legend

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FIRST FLOOR PLAN

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sheet 4 of 11

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QUEENSCLIFF ROAD

BENCH MARK
CUT IN KERB
RL 28.77 AHD

BENCH MARK
CUT IN KERB
RL 27.43 AHD

BRIDGE ROAD

Driveway

3000 minimum

BOUNDARY 12.765

BOUNDARY 12.32

BOUNDARY 26.725

23715

9580

8280

UNIT 5 (72m2)

BED 1
3.2x3.0

LIVING
5.0x3.9/3.5

b/in

BATH
2.2x1.8

b/in

BED 1
3.6x3.0

TILT Roof access skylight over

UP

DINING
4.0x3.0

pull down stair to roof terrace

LIFT

42 41 45 50 51 52

UP to roof terrace

LOBBY

1000 min.

UNIT 4 (90m2)

st (2m3)

LDY

KITCHEN
2.8x2.25

ENS
2.8x.9

BED 1
3.8x2.95

b/in

BED 1
3.7x3.0

BATH
2.0x1.8

BED 1
3.6x2.4

b/in

st (2m3)

UP

TILT Roof access skylight over

LDY

KITCHEN
3.9x2.7

DINING
4.2x3.0

LIVING
4.6x3.3

BALC
10 m²
4560

BALC
14 m²
4860

6180

6150

6030

15550

3110

min. wall 3000

mim. balcony 1865

2150

1885

No.70
2 & 3 STOREY
BRICK FLAT BUILDING

Balcony

METAL AWNING

No.21 A
2 STOREY
BRICK DWELLING

TN

0 1 2 3 4 5

1:100 @ A3

Legend

Denotes footprint of existing structure

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SECOND FLOOR PLAN

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project:
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68A QUEENSCLIFF ROAD, QUEENSCLIFF
LOT A DP 961049

client:
COULITS FAMILY

scale – 1:100 @ A3
date – 07/02/19
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dwg. no. – 040/19

sheet 5 of 11

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QUEENSCLIFF ROAD

BENCH MARK
CUT IN KERB
RL 28.77 AHD

BENCH MARK
CUT IN KERB
RL 27.43 AHD

BRIDGE ROAD

Driveway

BOUNDARY 12.765

BOUNDARY 12.32

BOUNDARY 26.725

'Tilt' pop-up glazed roof over stair to roof terrace covering Helix Monorail stair lift, or similar

1000 high ss wire + handrail balustrade

PRIVATE ROOF TERRACE Unit 6
28.6m2

PRIVATE ROOF TERRACE Unit 5
40.5m2

concrete lift roof

COMMON ROOF TERRACE (70m2)

1800mm privacy screen between landscaped planters

600mm high landscaped planters

'Tilt' pop-up glazed roof over stair to roof terrace

'Tilt' pop-up glazed roof over stair to roof terrace

1000mm high ss wire & handrail balustrade to edge of terraces

waterproof membrane over concrete roof slab laid to falls covered by pavers on polypads to all trafficable roof terraces

waterproof membrane over concrete roof slab with pebble ballast over to all non-trafficable areas

A

B

No.70
2 & 3 STOREY
BRICK FLAT BUILDING

Balcony

No.21 A
2 STOREY
BRICK DWELLING

TN

0 1 2 3 4 5
1:100 @ A3

Legend

Denotes footprint of existing structure

Denotes footprint of previous approval DA2015/1079

ROOF PLAN

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LOT A DP 961049

client:
COULITS FAMILY

scale – 1:100 @ A3
date – 07/02/19
DA – issue A
dwg. no. – 040/19

sheet 6 of 11

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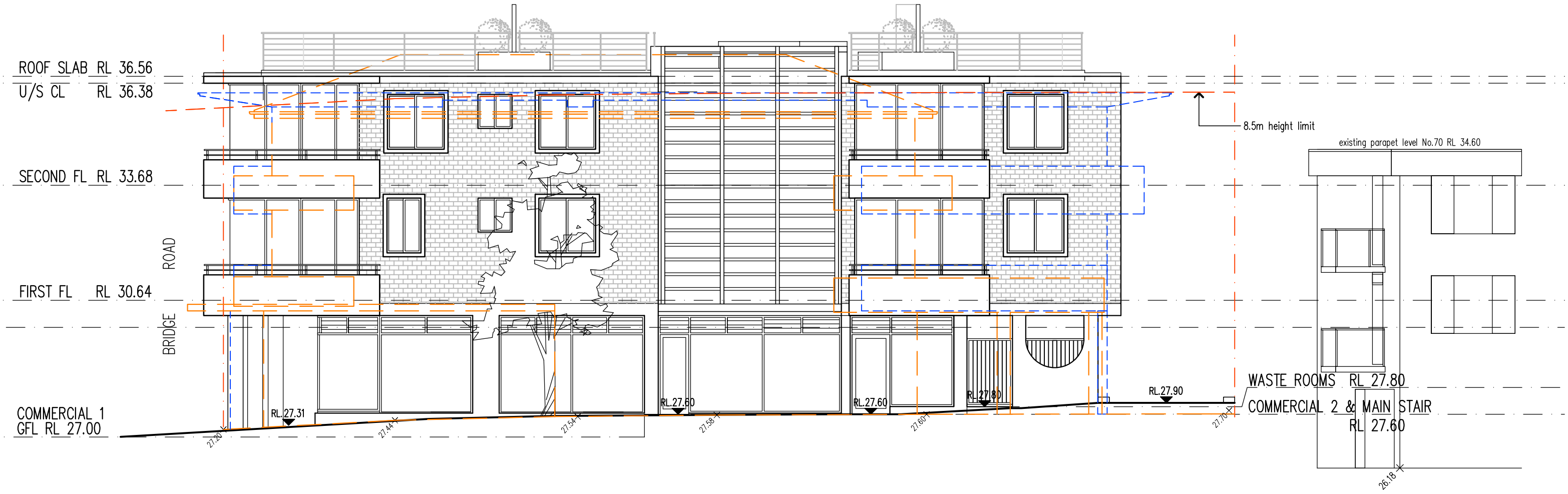
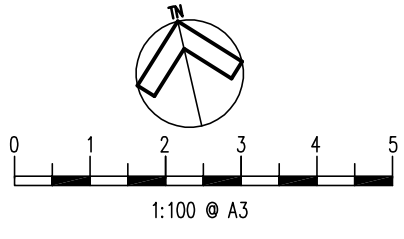


NORTH ELEVATION



Legend

Denotes footprint of existing structure

Denotes footprint of previous approval DA2015/1079

classic plans in collaboration with
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Ph. 9349 3656 or 0425 208 897
Email: classicplans@optusnet.com.au

project:
PROPOSED NEW RESIDENTIAL/COMMERCIAL DEVELOPMENT
68A QUEENSCLIFF ROAD, QUEENSCLIFF
LOT A DP 961049

client:
COULITS FAMILY

scale – 1:100 @ A3
date – 07/02/19
DA – issue A
dwg. no. – 040/19

GENERAL NOTES:

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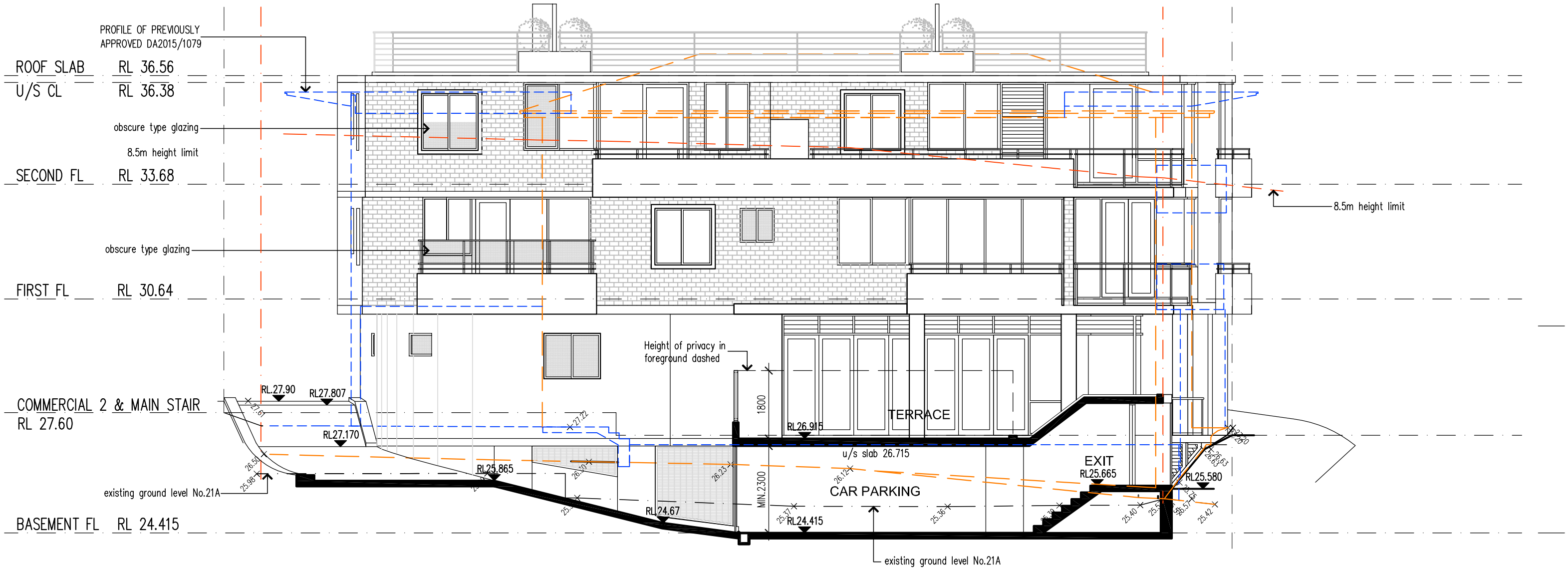

SOUTH ELEVATION

TN

0 1 2 3 4 5

1:100 @ A3

Legend

Denotes footprint of existing structure

Denotes footprint of previous approval DA2015/1079

classic plans in collaboration with
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project:
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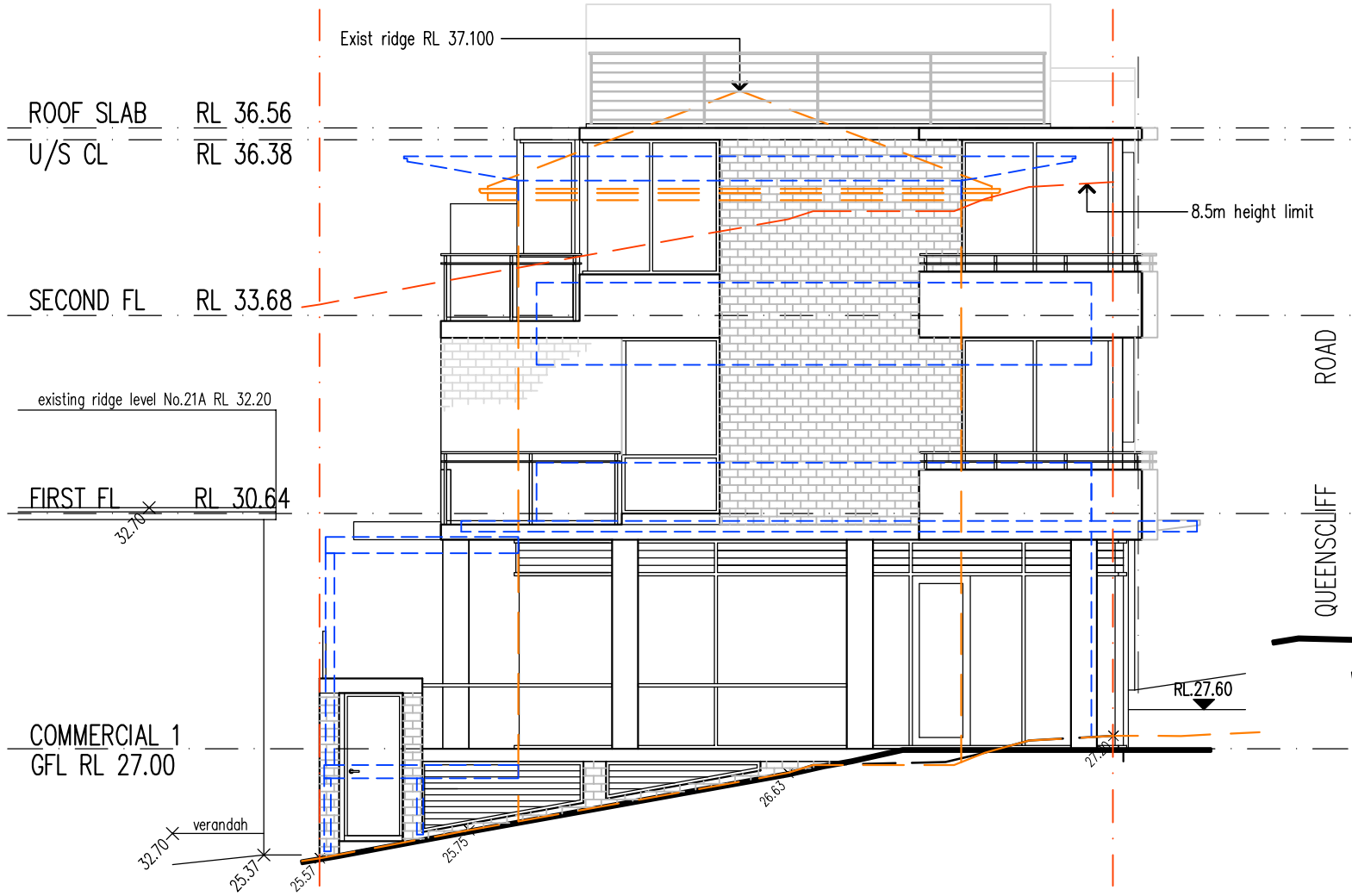
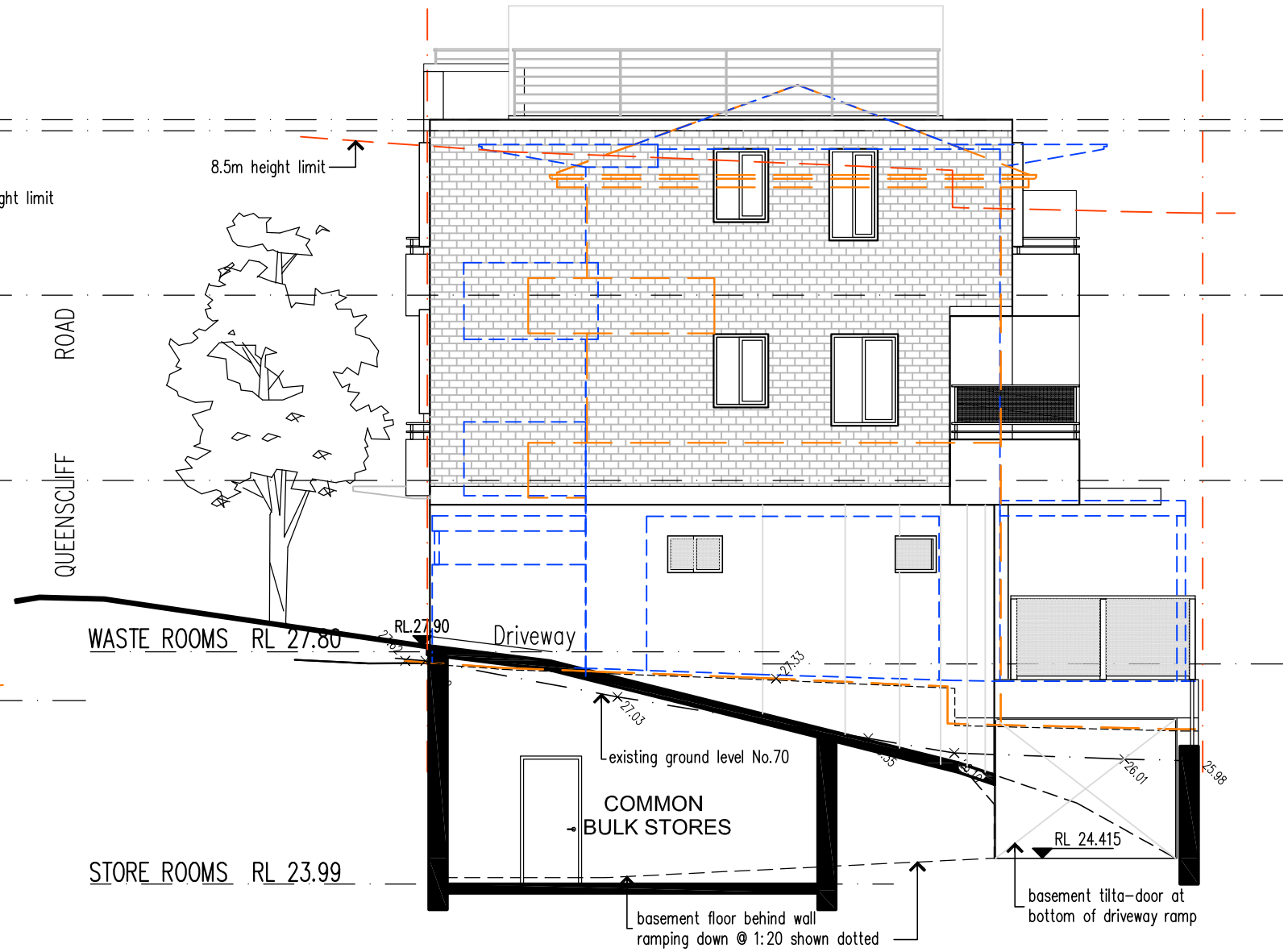
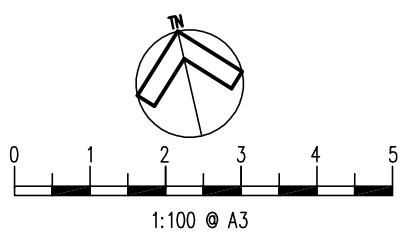


EAST ELEVATION



WEST ELEVATION



Legend

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Denotes footprint of previous approval DA2015/1079

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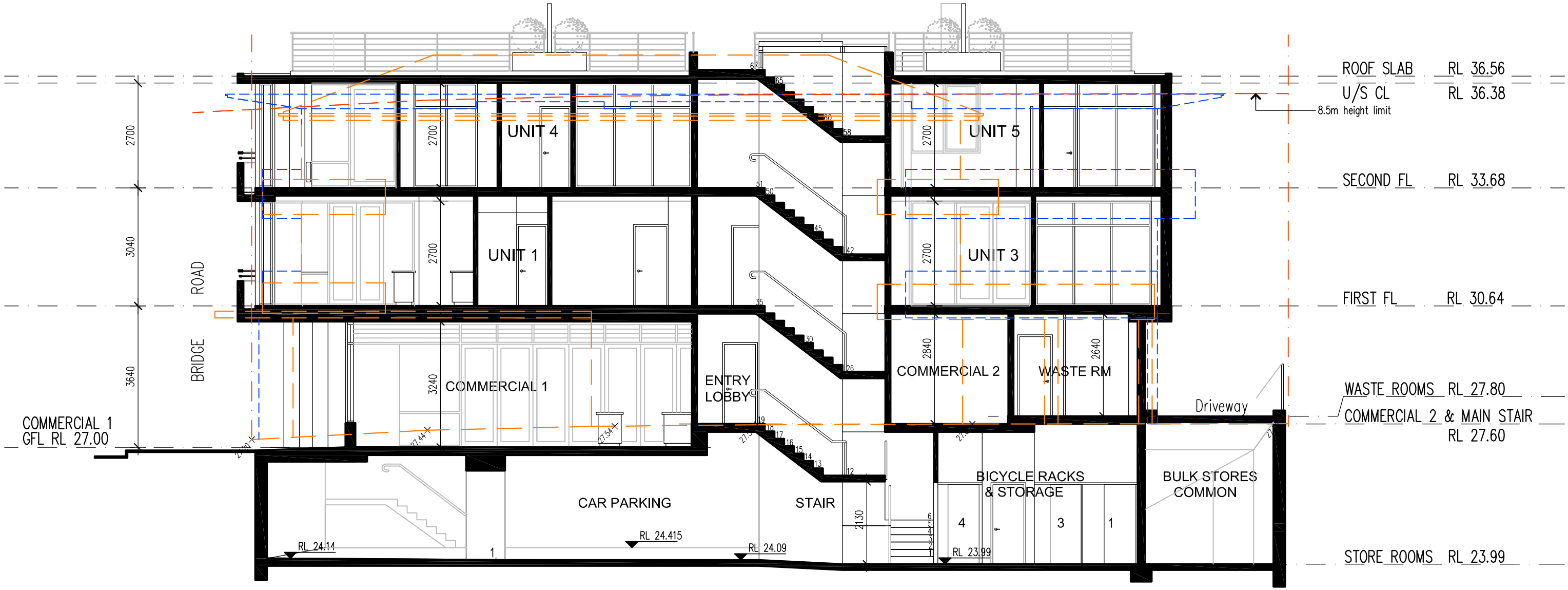
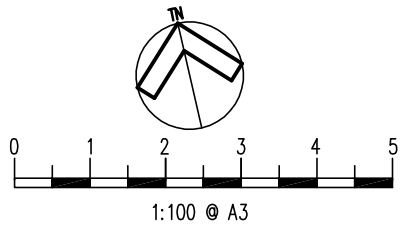


SECTION A-A



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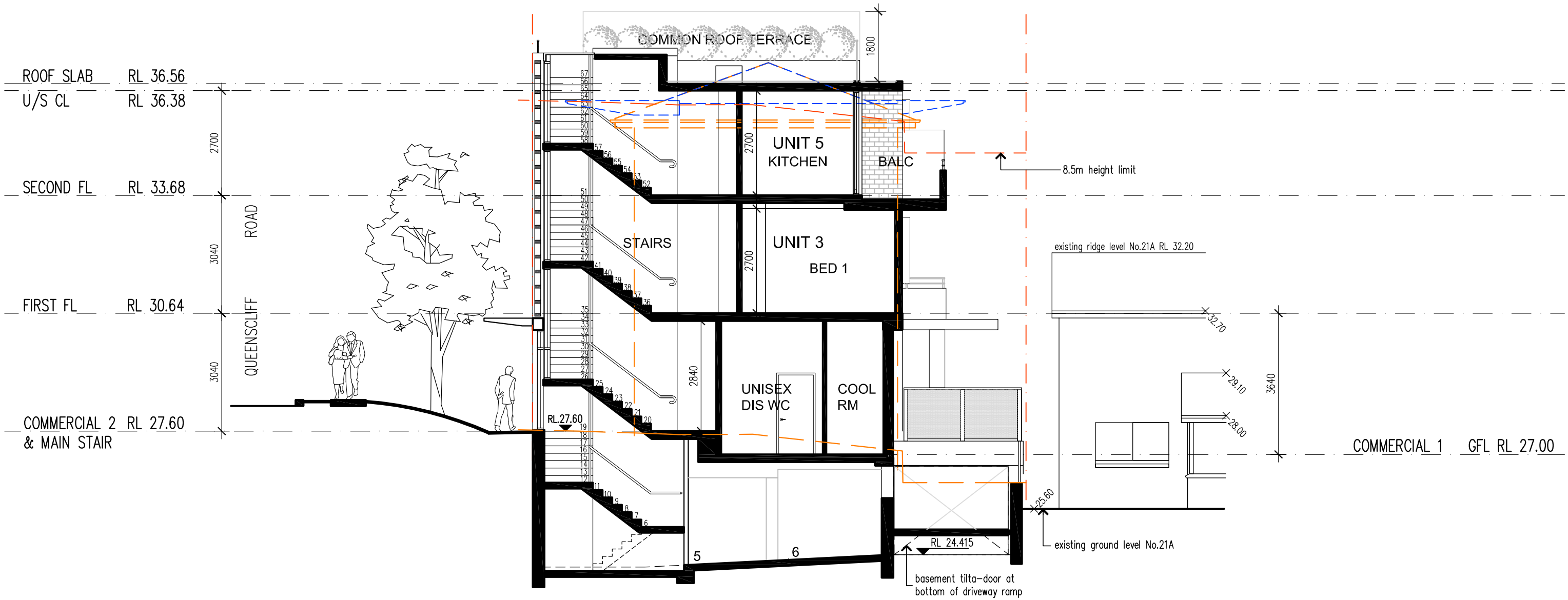

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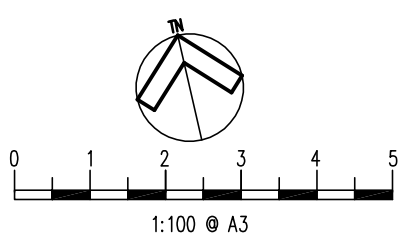

Legend

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Denotes footprint of previous approval DA2015/1079

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68A QUEENSCLIFF ROAD, QUEENSCLIFF
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client:
COULITS FAMILY

scale – 1:100 @ A3
date – 07/02/19
DA – issue A
dwg. no. – 040/19

sheet 11 of 11

APPENDIX B

Borehole Logs (4 Sheets)

Borehole Log Report

Geo Environmental Engineering Pty Ltd
82 Bridge Street
Lane Cove NSW 2066
T 02 9420 3361

geo-environmental ENGINEERING

Hole ID. **BH1**
Hole Depth: **1.65 m**
Sheet: **1 of 1**

Project Name: **Geotechnical Investigation** Project Number: **G19024QUE**
Location / Site: **68A Queenscliff Road, Queenscliff NSW** Client: **Classic Plans**

Drilling Company: **Geo Environmental Engineering** Date Started: **28-MAY-19** Ground Level: **RL27.5m** (approx)
Drill Method: **Manual** Date Completed: **28-MAY-19** Easting: ----------
Equipment: **Hand Auger** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Consistency / Density	Moisture	Samples / Tests: ID No.	Samples / Tests: DCP blows/100mm	Observations / Comments
							Surface: Grass				5 10 15	
Hand Auger	1m Seepage				SM	Fill	**TOPSOIL / FILL**- Silty Sand, brown, fine to medium grained, with roots.	loose to medium dense	d			
					SP	Fill	**FILL**- Sand, pink, fine to medium grained, Trace fine to coarse gravel (Sandstone).	loose to medium dense	sm	BH 1 0.10-0.55m		
			27.0									
					SM	Fill	**FILL**- Sand Trace Silt, dark brown, fine to medium grained, Trace fine gravel (sandstone) trace cobbles or boulders, Glass.	very loose to loose	m	BH 1 0.55-0.85m		
		1.0			SP	Natural	**SAND**- dark grey, fine to coarse grained, Trace fine gravel rounded (Quarts).	very loose to loose	vm	BH 1 1.00-1.10m		
					SP	Natural	**SAND**- Trace Silt And Clay, grey mottled orange, fine to medium grained, Trace extremely weathered sandstone.	medium dense to dense	vm	BH 1 1.50-1.60m	>>	
			26.0									
		2.0					**Refusal at 1.65m** Terminated on sandstone bedrock					

Moisture	
D	Dry
Dp	Damp
SM	Slightly Moist
M	Moist
VM	Very Moist
W	Wet
Sd	Saturated

Additional Comments

Logged By: **Matt Kilham** Date: **28-May-19** Checked By: **Stephen McCormack** Date: **05-JUN-19**

GEE DAVIES BH LOG G19024QUE LOGS.GPJ GEE.GDT 6-6-19 12:32:06 PM

Borehole Log Report

Geo Environmental Engineering Pty Ltd
82 Bridge Street
Lane Cove NSW 2066
T 02 9420 3361

Hole ID. **BH2**
Hole Depth: **0.35 m**
Sheet: **1 of 1**

Project Name: **Geotechnical Investigation** Project Number: **G19024QUE**
Location / Site: **68A Queenscliff Road, Queenscliff NSW** Client: **Classic Plans**

Drilling Company: **Geo Environmental Engineering** Date Started: **28-MAY-19** Ground Level: **RL25.7m** (approx)
Drill Method: **Manual** Date Completed: **28-MAY-19** Easting: ----------
Equipment: **Hand Auger** Northing: ----------

Depth (m)	RL (m)	USCS Symbol	Material Type	Material Description	Consistency / Density	Moisture	DCP blows/100mm	Observations / Comments
				Surface: Concrete			5 10 15	
				CONCRETE.				
		SM	Fill	**SAND**- Trace Silt, brown, fine to medium grained, Fill / Disturbed.	very loose	m		
					very loose	vm		
		SM	Natural	**SAND**- Trace Silt, black, fine to medium grained, Topsoil (Insitu).				
				SAND- grey and orange, fine to medium grained, Residual.	loose	m		Bore dry upon completion
	25.0			**Refusal at 0.35m** Terminated on sandstone bedrock				
1.0								
	24.0							
2.0								

Moisture

D	Dry
Dp	Damp
SM	Slightly Moist
M	Moist
VM	Very Moist
W	Wet
Sd	Saturated

Additional Comments

Logged By: **Matt Kilham** Date: **28-May-19** Checked By: **Stephen McCormack** Date: **05-JUN-19**

GEE DAVIES BH LOG G19024QUE LOGS.GPJ GEE.GDT 6-6-19 12:32:33 PM

Borehole Log Report

Geo Environmental Engineering Pty Ltd
82 Bridge Street
Lane Cove NSW 2066
T 02 9420 3361

Hole ID. **BH3**
Hole Depth: **1.25 m**
Sheet: **1 of 1**

Project Name: **Geotechnical Investigation** Project Number: **G19024QUE**
Location / Site: **68A Queenscliff Road, Queenscliff NSW** Client: **Classic Plans**

Drilling Company: **Geo Environmental Engineering** Date Started: **28-MAY-19** Ground Level: **RL26.5m** (approx)
Drill Method: **Manual** Date Completed: **28-MAY-19** Easting: ----------
Equipment: **Hand Auger** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Consistency / Density	Moisture	Observations / Comments
							Surface: Concrete			
Hand Auger	0.45m Seepage					Fill	**VOID**- Material Adjacent Hole In Concrete.			
							SAND- grey / brown, fine to coarse grained, brick and concrete.	very loose to loose	slightly moist	
			26.0				**SAND**- dark grey, fine to medium grained.	loose	vm	
							SAND- grey brown, fine to medium grained, with fine rounded gravel (Quartz).	loose	vm	
		1.0					**SANDSTONE- (Possible boulder or residual crust)** - brown, fine to medium grained, highly weathered.	loose	vm	
						Bedrock Natural	**SAND**- grey mottled orange, fine to medium grained.	loose to medium dense	m	
							SANDSTONE- grey white, fine to medium grained, highly weathered estimated very low to low strength.	loose to medium dense	m	
			25.0				**Refusal at 1.25m** Terminated on sandstone bedrock			
		2.0								

Moisture	
D	Dry
Dp	Damp
SM	Slightly Moist
M	Moist
VM	Very Moist
W	Wet
Sd	Saturated

Additional Comments

Logged By: **Matt Kilham** Date: **28-May-19** Checked By: **Stephen McCormack** Date: **05-JUN-19**

GEE DAVIES BH LOG G19024QUE LOGS.GPJ GEE.GDT 6-6-19 12:33:02 PM

Geo Environmental Engineering
82 Bridge Street
Lane Cove NSW 2066
E info@geoenvironmental.com.au

Log Report Legend

MATERIAL SYMBOL

FILL	CONCRETE	ASPHALT	TOPSOIL
ORGANICS	ESTUARINE MUD		

CLAY	SAND	SILT	GRAVEL
Sandy CLAY	Clayey SAND	Clayey SILT	Clayey GRAVEL
Silty CLAY	Silty SAND	Sandy SILT	Sandy GRAVEL
Gravelly CLAY	Gravelly SAND	Gravelly SILT	Silty GRAVEL
CLAY & SAND	SAND & CLAY	SILT & CLAY	GRAVEL & CLAY
CLAY & SILT	SAND & SILT	SILT & SAND	GRAVEL & SAND
CLAY & GRAVEL	SAND & GRAVEL	SILT & GRAVEL	GRAVEL & SILT
Sandy Silty CLAY	Clayey Silty SAND	Sandy Clayey SILT	Sandy Clayey GRAVEL
Silty Sandy CLAY	Silty Clayey SAND	Clayey Sandy SILT	Clayey Sandy GRAVEL
Sandy Gravelly CLAY	Clayey Gravelly SAND	Sandy Gravelly SILT	Silty Clayey GRAVEL
Silty Gravelly CLAY	Silty Gravelly SAND	Clayey Gravelly SILT	Clayey Silty GRAVEL
Gravelly Silty CLAY	Gravelly Silty SAND	Gravelly Clayey SILT	Sandy Silty GRAVEL
Gravelly Sandy CLAY	Gravelly Clayey SAND	Gravelly Sandy SILT	Silty Sandy GRAVEL

SANDSTONE	SHALE	GRANITE	BASALT	SHALE / SANDSTONE
PORCELLANITE	GNEISS	SHALE / CLAYSTONE	MUDSTONE	
CLAYSTONE	MUDSTONE / CLAYSTONE	SHALE / SILTSTONE	IRONSTONE	

WATER LEVELS

Encountered Water

Standing Water

ABBREVIATIONS

PT	Pushtube
SFA	Solid Flight Auger
PWS	Percussion Window Sampler
HA	Hand Auger
HFA	Hollow Flight Auger

WELL GRAPHICS

Cuttings	Bentonite	Screen
Gravel Pack	Grout	Cave-in

GEE LEGEND * * 29/10/09 5:04:07 PM

APPENDIX C

Lab Testing Results (6 Sheets)

Geo-Environmental Engineering Pty Ltd
82 Bridge St
Lane Cove
NSW 2066

Attention: **Stephen McCormack**

Report **658952-S**
Project name
Project ID G19024QVE
Received Date May 31, 2019

Client Sample ID			**BH1/0.1-0.55M**	**BH1/0.55-0.85M**	**BH1/1-1.1M**	**BH1/1.5-1.6M**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins | mgt Sample No.			**M19-Jn01300**	**M19-Jn01301**	**M19-Jn01302**	**M19-Jn01303**
Date Sampled			**Not Provided**	**Not Provided**	**Not Provided**	**Not Provided**
Test/Reference	LOR	Unit				
Chloride	5	mg/kg	54	21	24	67
Conductivity (1:5 aqueous extract at 25°C as rec.)	10	uS/cm	59	89	32	57
pH (1:5 Aqueous extract at 25°C as rec.)	0.1	pH Units	8.1	7.7	8.0	7.2
Resistivity*	0.5	ohm.m	170	110	310	180
Sulphate (as SO4)	30	mg/kg	140	< 30	< 30	49
% Moisture	1	%	4.7	9.0	10	14

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results (regarding both quality and NATA accreditation).

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Chloride	Melbourne	Jun 06, 2019	28 Day
- Method: LTM-INO-4090 Chloride by Discrete Analyser			
Conductivity (1:5 aqueous extract at 25°C as rec.)	Melbourne	Jun 06, 2019	7 Day
- Method: LTM-INO-4030 Conductivity			
pH (1:5 Aqueous extract at 25°C as rec.)	Melbourne	Jun 06, 2019	7 Day
- Method: LTM-GEN-7090 pH in soil by ISE			
Sulphate (as SO4)	Melbourne	Jun 06, 2019	28 Day
- Method: LTM-INO-4110 Sulfate by Discrete Analyser			
% Moisture	Melbourne	Jun 01, 2019	14 Day
- Method: LTM-GEN-7080 Moisture			

eurofins | mgt

ABN – 50 005 085 521
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Dandenong South VIC 3175
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

Sydney
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16 Mars Road
Lane Cove West NSW 2066
Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Perth
2/91 Leach Highway
Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

Company Name: Geo-Environmental Engineering P/L
Address: 82 Bridge St
Lane Cove
NSW 2066

Project Name:
Project ID: G19024QVE

Order No.:
Report #: 658952
Phone: 02 9592 0218
Fax: 02 9519 9140

Received: May 31, 2019 2:33 PM
Due: Jun 7, 2019
Priority: 5 Day
Contact Name: Stephen McCormack

Eurofins | mgt Analytical Services Manager : Andrew Black

Sample Detail						Aggressivity Soil Set	Moisture Set
Melbourne Laboratory - NATA Site # 1254 & 14271						X	X
Sydney Laboratory - NATA Site # 18217							
Brisbane Laboratory - NATA Site # 20794							
Perth Laboratory - NATA Site # 23736							
External Laboratory							
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**		
1	BH1/0.1-0.55M	Not Provided		Soil	M19-Jn01300	X	X
2	BH1/0.55-0.85M	Not Provided		Soil	M19-Jn01301	X	X
3	BH1/1-1.1M	Not Provided		Soil	M19-Jn01302	X	X
4	BH1/1.5-1.6M	Not Provided		Soil	M19-Jn01303	X	X
Test Counts						4	4

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure, April 2011 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram

mg/L: milligrams per litre

ug/L: micrograms per litre

ppm: Parts per million

ppb: Parts per billion

%: Percentage

org/100mL: Organisms per 100 millilitres

NTU: Nephelometric Turbidity Units

MPN/100mL: Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	US Department of Defense Quality Systems Manual Version 5.2 2018
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 50-150%-Phenols & PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.2 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test			Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank									
Chloride			mg/kg	< 5			5	Pass	
Sulphate (as SO4)			mg/kg	< 30			30	Pass	
LCS - % Recovery									
Chloride			%	92			70-130	Pass	
Sulphate (as SO4)			%	125			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
				Result 1	Result 2	RPD			
Chloride	M19-Jn01177	NCP	mg/kg	100	100	2.0	30%	Pass	
Conductivity (1:5 aqueous extract at 25°C as rec.)	M19-Jn11074	NCP	uS/cm	44	40	9.0	30%	Pass	
pH (1:5 Aqueous extract at 25°C as rec.)	M19-Jn01144	NCP	pH Units	5.9	5.8	2.0	30%	Pass	
Sulphate (as SO4)	M19-Jn01177	NCP	mg/kg	< 30	< 30	<1	30%	Pass	
% Moisture	M19-Ap31757	NCP	%	5.1	5.1	<1	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	No
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Authorised By

Andrew Black	Analytical Services Manager
Julie Kay	Senior Analyst-Inorganic (VIC)

Glenn Jackson
General Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.