GEOTECHNICAL INVESTIGATION REPORT

263-267 CANTERBURY ROAD, CANTERBURY, NSW

PREPARED FOR MING LI
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1 PROJECT INFORMATION

1.1 INTRODUCTION AND OBJECTIVE

Geo-Environmental Engineering Pty Ltd (GEE) was commissioned by Ming Li to complete a geotechnical investigation at 263 - 267 Canterbury Road, Canterbury New South Wales (herein referred to as the 'site').

The investigation relates to the proposed construction of a multi-storey, residential development with a three level basement, and was required to support a Development Application (DA) with Council and to assist with the preliminary design of the development.

The report presents the factual 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.

1.2 PROPOSED DEVELOPMENT

As previously mentioned, the proposed development will comprise the construction of a residential development consisting of six levels above ground and three basement levels. Architectural plans are provided for reference in **Appendix A**.

The finished floor level for the lowest basement level (basement 03) is expected to be -3.37m above Australian Height Datum (AHD) at the northern end and -1.8m AHD at the southern end. Taking into account the necessary over excavation to accommodate the basement floor slab, GEE anticipates that a maximum excavation depth of between approximately 9.0m and 10.5m. The basement excavation will extend to within close proximity of each of the site boundaries.

1.3 SCOPE OF WORK

The scope of work undertaken by GEE, to satisfy the above objectives, was as follows:

- ◊ Dial Before You Dig (DBYD) desktop search for underground services,
- ◊ Visual appraisal of the site conditions and locality,
- ◊ Review of published geological, soils and acid sulphate maps for the area,
- ◊ The drilling of boreholes and the performance of Standard Penetrometer Tests (SPTs) to assess the subsurface conditions including the strength and consistency of the bedrock formation,

- Installation of a groundwater monitoring well within borehole BH3 to measure water level and assess the rate of inflow of any water present,
- Collection of representative soil from each borehole and rock samples from borehole BH3,
- Analysis of selected soil samples for the preliminary analysis of soil salinity and aggressivity,
- Analysis of selected rock samples for strength testing, and
- Engineering assessment and reporting.

2 SITE INFORMATION

2.1 SITE DESCRIPTION

The site is located on the northern side of Canterbury Road and is bounded by Phillips Avenue to the west, Clunes Lane to the north and other commercial dwellings to the east. The site covers an area of 779.5m^2 (by survey) and is legally referred to as Lot 18 in Deposited Plan 703437.

At the time of investigation, a two storey commercial building occupied the south western corner of the site. A concrete driveway was situated along the western boundary and was linked to a concrete car parking area at the rear of the site.

2.2 TOPOGRAPHY

During the field investigation, it was noted that the site was relatively flat, while a review of the survey plan (**Appendix A**) indicates that the surface elevation is between approximately 6.8m and 5.9m AHD.

2.3 REGIONAL GEOLOGY AND SOILS

A review of the Sydney 1:100,000 geological map (reference 1), indicated that the site is located over the Triassic aged Ashfield Shale formation of the Wianamatta Group, which comprises "*black to dark-grey shale and laminite".* The map also indicates that the geological contact with the Hawkesbury sandstone formation, comprising "*medium to coarse-grained quartz sandstone, very minor shale and laminite lenses",* is less than 200m east of the site.

A review of the regional soils map indicates that the site is located within the Blacktown Soil Landscape Group (reference 2). Soils of the Blacktown group are typically heavy clays derived from the weathering process of shale bedrock, and have low fertility and are often strongly acidic.

2.4 HYDROGEOLOGY

Based on the regional geological and soils information, the groundwater beneath the site is likely to be confined or partly confined, discrete, water-bearing zones within the bedrock formation. However, intermittent water seepage may also occur at the soil / bedrock and from defects within the bedrock formation.

2.5 ACID SULFATE SOIL RISK

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 '*Botany Bay'* 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 within an area defined as "Class 5". In accordance with Clause 6.1 of Council's Local Environment Plan (LEP) 2012, a preliminary assessment of acid sulfate soil and potentially a management plan is recommended for any "*Works within 500 metres of adjacent Class 1, 2, 3 or 4 land that is below 5 metres Australian Height Datum and by which the watertable is likely to be lowered below 1 metre Australian Height Datum on adjacent Class 1, 2, 3 or 4 land*".

The surface elevation is significantly greater than 5m AHD and the maximum depth of excavation is not extending below 1m AHD. In this regard dewatering to below 1m AHD is not required and there is no need for an acid sulphate soil assessment or management plan.

3 METHOD OF INVESTIGATION AND RESULTS

3.1 FIELDWORK METHODOLOGY

Fieldwork was undertaken on the 13th June 2018 by Ruairi Carroll, a geotechnical engineer from GEE, and the work 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 SPTs within each borehole to assess the consistency and/or relative density of the soil profile,
- ◊ The collection of representative soil samples for the preliminary assessment of soil salinity and aggressivity,
- ◊ Collection and analysis of rock samples from borehole BH3 for the preliminary assessment of rock strength, and
- ◊ The installation of a groundwater monitoring well within borehole BH3 to assess the depth to groundwater and rate of inflow.

The boreholes were drilled using track mounted, Hanjin D&B drilling rig that was owned and operated by Geosense Pty Ltd using a combination of solid flight augers (SFA) and NMLC diamond coring. The boreholes were advanced through surface fill material (i.e. either imported soil or soil which has previously been disturbed) and natural (i.e. previously undisturbed) soil profile, before terminating within the underlying fine grained sandstone bedrock at depths of between 2.45m and 9.64m below ground surface (bgs).

The SPTs were performed within the soil profile of each borehole in accordance with Australian Standard 1289.6.3.1 (reference 4).

The monitoring well was installed within BH3 in accordance with the Land and Water Biodiversity Committee (2012) Minimum Construction Requirements for Water Bores in Australia (reference 5), using 50 mm diameter uPVC pipe, with a machine slotted screen section, 2 mm sand pack and a bentonite seal. The depth of the screened interval of the well was between 3.1m and 6.1m bgs. The purpose of the groundwater monitoring well was to assess the presence and depth of stabilised groundwater at the site and to monitor the rate of groundwater inflow. Construction details of the well are provided in the borehole logs (**Appendix B**). GEE notes that the well was not installed to a depth commensurate with the proposed basement excavation because at the time of our fieldwork it was understood that the basement only comprised two levels.

Notwithstanding this, the well is considered to be suitable for providing a preliminary assessment of water seepage rates.

The location of the boreholes was estimated using measurements from existing features and is shown on **Figure 1**. A copy of the borehole is provided in **Appendix B**.

3.2 GEOLOGICAL MODEL

The site stratigraphy, as observed in the boreholes, typically comprised surface fill material, underlain by natural Sandy CLAY and Clayey SAND soil, which graded into weathered sandstone bedrock which was consistent with the Hawkesbury sandstone formation. Detailed descriptions of the subsurface conditions on site are provided in the borehole logs provided in **Appendix B**, while the soil profile is also summarised in **Table 1**.

Table 1: Summary of Subsurface Conditions

Layer / Unit	Description	Depth to Base of Layer (m)[1]			Consistency / Relative Density[1]
		BH1	BH2	BH3	
	CONCRETE	0.1	0.2	0.1	--
FILL	SAND/ Sandy SILT with some clay: dark brown/ light brown with grey inclusions, fine to coarse grained sand, moist.	0.8	0.75	0.9	Very soft to firm
NATURAL SOIL	Sandy CLAY / Clayey SAND: orange brown / reddish brown / grey, low to medium plasticity, fine to coarse grained sand, moist.	1.75	1.9	2.5	Very Stiff to Hard
BEDROCK	SANDSTONE: grey/red, fine to coarse grained, extremely to distinctly weathered and estimated to be extremely low to low strength.	ND	ND	6.8	--
	SANDSTONE: grey with orange staining, slightly weathered, fine to coarse grained, medium to high strength.	ND	ND	>9.64	--

Note 1: Determined from the borehole and DCP observations
ND – Not Determined

3.2.1 *Groundwater*

Permanent groundwater (i.e. the water table) was not encountered during the drilling of the boreholes. However, seepage water was noted during the drilling of boreholes BH2 and BH3 at depths of 4.6m and 5.5m, respectively. The seepage water within the monitoring well installed within BH3 stabilised at 2.2 m bgs when measured 5 weeks after installation.

3.3 LABORATORY TESTING

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

- ◊ Electrical Conductivity (EC) to provide a detailed assessment of the salinity potential of the soil profile,
- ◊ Sulphate, chloride, resistivity and pH to determine the exposure classification of the soil with respect to buried structural concrete and unprotected steel, and
- ◊ Point load strength index testing to characterise the strength of the bedrock formation.

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

3.3.1 *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 6). 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**.

[1] EC_e results are EC data multiplied by a conversion factor which depends upon the soil texture / type (Reference 6)

Table 2: Electrical Conductivity Results

Sample Location / Depth	Sample Description	EC (dS/m)	Multiplication Factor[1]	EC_e (dS/m)
BH1 / 1.0 – 1.5	Sandy CLAY	0.0097	9	0.873
BH1 / 2.5 – 2.95	SANDSTONE: Weathered	0.015	10	0.150
BH2 / 4.8 – 4.9	SANDSTONE: Weathered	0.038	10	0.380
BH3 / 0.0 – 0.5	FILL: Sandy SILT	0.063	14	0.532
BH3 / 1.5 – 1.95	Sandy CLAY	0.055	9	0.495
BH3 / 5.1 – 5.6	SANDSTONE: Weathered	0.023	10	0.230
BH3 / 6.0 – 6.5	SANDSTONE: Weathered	0.029	10	0.290

According to the Department Land and Water Conservation NSW (reference 6), 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 natural soil profile is considered to be non-saline.

3.3.2 *Aggressivity Testing*

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 6.1 and 6.3 from Section 6 of the Australian Standard AS 2159 (reference 7). 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 / 1.0 – 1.5	B	6.0	--	--	--
BH1 / 2.5 – 2.95	B	5.0	10	<10	66,000
BH4 / 4.8 – 4.9	B	5.2	--	--	--
BH3 / 0.0 – 0.5	B	7.5	10	<10	16,000
BH3 / 1.5 – 1.95	B	5.1	36	<10	18,000
BH3 / 5.1 – 5.6	B	5.2	25	<10	43,000
BH3 / 6.0 – 6.5	B	5.7	33	<10	34,000

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 mildly-aggressive towards concrete. According to Australian Standard AS 3600-2009 (reference 8), specifically Table 4.8.1, this equates to an exposure classification of 'A2'.

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-aggressive / non-corrosive towards any unprotected steel.

3.3.3 *Rock Strength Testing*

To assess the strength of the encountered bedrock, representative samples of recovered rock core were collected from borehole BH3 and tested by MHK Geotechnical Pty Ltd for NATA accredited point load index (I_{s50}) testing.

Point load tests are a simple and economical test for estimating the strength of a rock and the tests results are routinely multiplied by a factor of 15 - 20 to estimate a UCS value, although the correlation is known to vary significantly. For the purpose of this investigation a multiplication factor of 15 was adopted for estimating the UCS value from the point load tests.

For point load testing, the recovered rock core samples were loaded diametrally and axially until failure and the failure loads for each test recorded. The results for core

samples loaded axially ranged from 0.68MPa to 2.42MPa with an average of 1.34MPa, while the diametrally loaded samples ranged from 0.16MPa to 1.92MPa with an average of 1.04MPa. Considering that future foundations load the bedrock in a similar direction as the axial loaded point load tests, more emphasis is placed on these results.

Assuming a UCS/Is50 correlation factor of 15, the inferred UCS values for all the point load test results, when loaded axially, are estimated to be approximately 10.2MPa to 36.4MPa with an average of approximately 20.0MPa.

A copy of the laboratory test reports is provided in **Appendix C**.

4 DISCUSSION

4.1 SITE PREPARATION

Following demolition of the existing structures and prior to bulk excavation works, 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 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 9) 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.

Finally, considering the proximity of adjoining buildings, care must be taken during demolition works to ensure that the adjoining footings, or the zone of influence of these footings, are not disturbed. Also, a dilapidation report is recommended prior to commencing demolition works. The purpose of a dilapidation report is to confirm that demolition and construction 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.

4.2 EARTHWORKS

As mentioned in Section 1.2, earthworks at the site are expected to comprise excavation to a depth of approximately 9.0m to 10.5m bgs to facilitate construction of the basement. The basement will extend to within close proximity to each of the site boundaries.

4.2.1 *Excavation*

Based on the fieldwork undertaken as part of this investigation, the excavation will encounter fill material and natural soil before grading into weathered sandstone bedrock below approximately 1.8m to 2.5m bgs. Based on the site investigation details, the strength of bedrock is initially likely to be very low to low strength, becoming medium to high strength within the depth of the basement 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 4.2.3.

4.2.2 *Groundwater Inflow*

Permanent groundwater was not encountered during the drilling of the boreholes. However seepage slow seepage is expected to occur over time along the soil-bedrock interface and through defects within the bedrock formation. This is supported by the fact that seepage water was noted while drilling boreholes BH2 and BH3 and seepage also continued to seep into the monitoring well installed within BH3.

GEE notes that the basement is expected to extend beyond the depth of the monitoring well and therefore an additional investigation is recommended (preferably following demolition work) to more accurately define the depth of groundwater and to assess the rate of groundwater inflow.

Notwithstanding this, based on local knowledge, GEE expects that seepage water will 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.

4.2.3 *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 close 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 a number of 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 10).
- 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 11).
- DIN 4150 – Part 3 – 1999. Effects if Vibration on Structures (reference 12).
- Department of Environment and Conservation NSW, 2006. Assessing Vibration: a technical guideline (reference 13).
- 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 14).
- British Standard BS 7385-2:1993. Evaluation and measurement for vibration in buildings. Guide to damage levels from groundborne vibration (reference 15).

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 13). 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 manufactures 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.

4.2.4 Excavation Support

Based on the proposed development plans (**Appendix A**), the excavation for the basement is expected to extend to all site boundaries. In this regard, the use of temporary shoring or the early construction of permanent walls designed to shore up the boundaries (and protect adjoining structures and regional services) will be required. Additionally, considering the excavation will encroach on the zone of influence of foundations for the adjoining structures to the east, it will be necessary to ensure that the design of the walls do not allow any significant movement that could de-stabilise adjacent infrastructure.

The fill material, natural soil and upper portion of the sandstone bedrock formation (i.e. very low to low strength rock that may normally be excavated with mechanical equipment and without rock breaking equipment) will require full support during excavation. Higher strength bedrock is likely to be self-supporting provided adverse jointing is not present within the excavation faces and disturbance during excavation is minimal. However, this will require regular inspections by an experienced engineering geologist during bulk excavation works.

At this preliminary stage, options for shoring include the use of closely spaced soldier piles or contiguous piling combined with a pile cap. If soldier piles are adopted, it will be important to protect any soil that is exposed at the boundary during excavation works to prevent the soil from drying out, shrinking and potentially impacting on shallow footings of adjoining structures.

Where piles have been included within the retaining wall design and are to provide support to adjacent structures, anchoring will be required near the surface, as a cantilever system will unlikely prove to be sufficiently rigid to avoid surface (lateral) deflections. In order to achieve the required embedment within the rock, it may be necessary to employ an appropriate high-torque boring rig. GEE recommends that the piling contractor complete any investigation necessary to determine the drillability of the rock and if a suitable socket cannot be achieved, and if the piles are founded above the depth of excavation, anchors will need to be installed in the toe of each pile to provide lateral restraint. Where blockwork walling is to be constructed, a bench with a minimum width of 400 mm could be cut within the top of the sandstone formation to facilitate construction.

The retention system adopted should be designed by a suitably experienced structural engineer in accordance with AS 4678-2002 *Earth Retaining Structures* (reference 16)

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 on the basis of 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 (rigid wall), 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 will 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, so as 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 and bedrock profile encountered at the site are provided in **Table 5** however, it is recommended that further investigation, including the coring of the bedrock throughout the full depth and extent of the proposed basement level be undertaken to confirm these parameters and the depth of the various soil / bedrock units. Preferably this is completed following demolition of the existing structures to enable access to the entire site.

Table 5: Geotechnical Design Parameters – Retaining Walls

Units	Depth to Top of Layer (m)	Unit Weight (kN/m³)	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)
Fill / Natural Soil	Surface	18	0.35	0.5	--	5	25
Sandstone: EL to L Strength	~2	22	0.3	0.35	3.5	10	30
Sandstone: M to H strength	~6.8	24	0.10	0.25	4.0	30	40

4.2.5 *Temporary Anchors*

Temporary ground anchors are likely to be required for the lateral restraint of boundary shoring walls until such time that the walls are permanently strutted by the building floor slabs. The suggested allowable bond stresses for the design of temporary ground anchors in the upper bedrock formation is 150kPa, however, additional investigations are warranted.

Ground anchors should be designed to have a free length that extends beyond an imaginary line drawn upwards at an angle of 45° from the toe of the wall, to cater for possible 45° faults or joints behind the wall. The minimum free length should be 3 m. After installation, each anchor should be proof loaded to 125% of the design working load and locked-off at about 80% of the working load. Periodic checks should be carried out during the construction phase to ensure that the lock-off load is maintained and not lost due to creep effects or other causes. The above parameters are based on the assumption that the anchor holes are clean and thoroughly flushed, with grouting and other installation procedures carried out carefully and in accordance with normal good anchoring practice. The successful anchoring contractor should be required to demonstrate that the above bond values are achievable with the proposed anchor construction method.

4.3 FOUNDATIONS

Following excavation of the basement, the bulk excavation level will comprise sandstone bedrock, which (at this preliminary stage) is expected to be high in strength and consistent with high end Class III and low end Class II sandstone (Pells et al - reference 17). This equates to a serviceability end bearing pressure of 6MPa, however

GEE recommends that additional investigations are completed to confirm this quality and strength of bedrock is consistent across the entire site.

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.

4.3.1 *Aggressivity / Exposure Classification*

Based on the limited exposure classification test results (Section 3.3.2), and in accordance with AS 2159-2009 (reference 7), the subsurface concrete structures (*e.g.* footings) should be designed based on mildly-aggressive soil conditions for concrete. According to Australian Standard AS 3600-2009 (reference 8), the equivalent exposure classification is 'A2'.

With respect to unprotected steel, the natural soil profile is considered to be non-aggressive / non-corrosive.

4.4 SALINITY

The lab testing completed herein indicates that the soil profile is non-saline and therefore no specific salinity management plan is warranted.

5 CONCLUSION AND RECOMMENDATIONS

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

Based on the results of the investigation, the proposed development is considered feasible. Additionally, GEE concludes that the existing rock formation is capable of withstanding 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 the 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. This is also likely to be required by RMS due to the proximity of the development to Canterbury Road which has state significance.

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

6 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.

7 REFERENCES

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11. 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)*.
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15. British Standard BS 7385-2:1993. *Evaluation and measurement for vibration in buildings. Guide to damage levels from groundborne vibration.*
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FIGURE

1 – Site Plan

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

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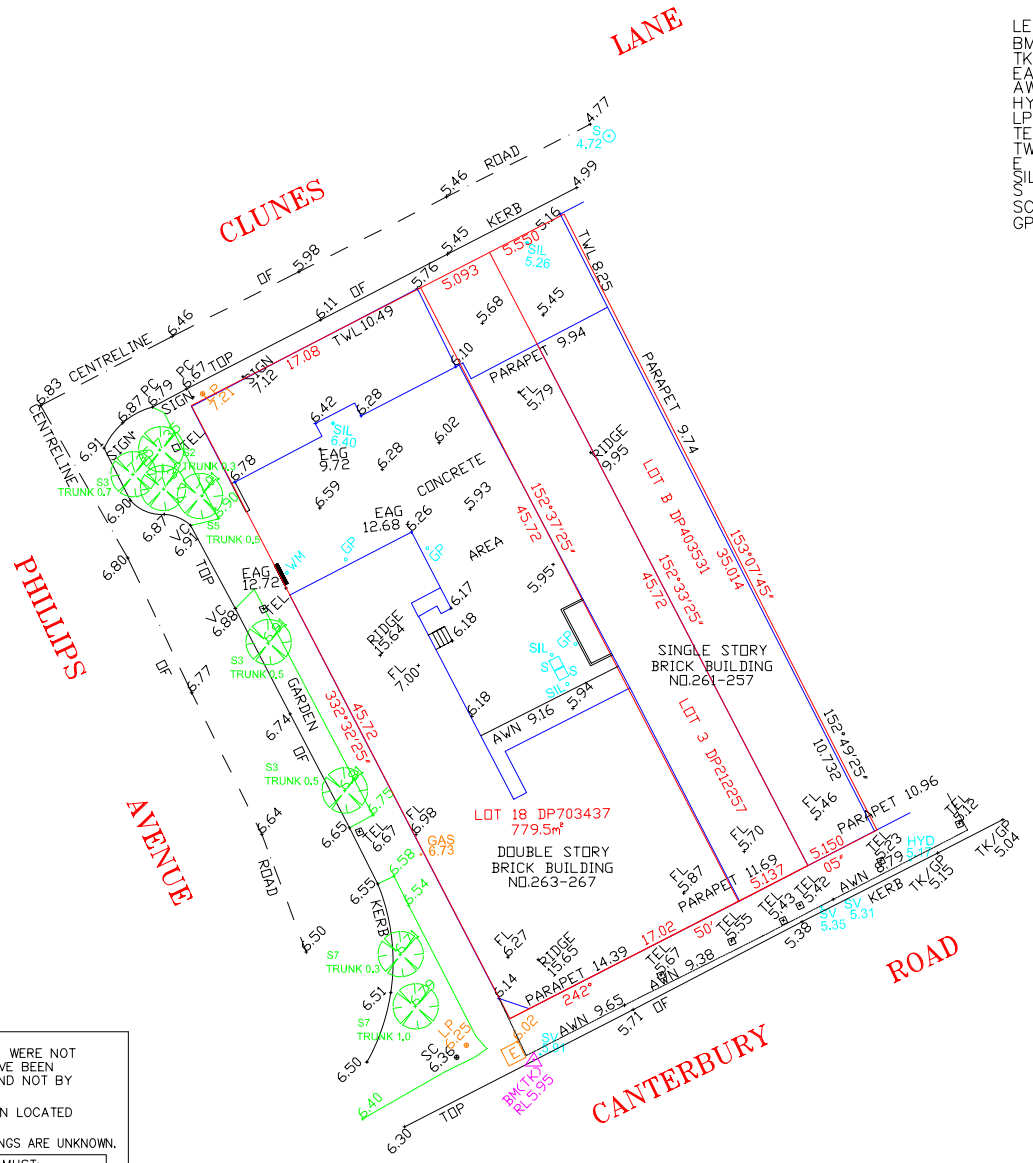
E - info@geoenvironmental.com.au
www.geoenvironmental.com.au

TITLE: SITE PLAN 263-267 Canterbury Road, Canterbury NSW	SCALE: **N.T.S**	DATE: **20 June 2018**	FIGURE No. **1**
	DRAWN: **R. Carroll**	JOB No.: **G18042CAN**	REVISION: **A**

APPENDIX A

SURVEY AND ARCHITECTURAL PLANS (11 SHEETS)



LEGEND:
BM DENOTES BENCHMARK
TK DENOTES TOP OF KERB
EAG DENOTES EAVE AND GUTTER
AWN DENOTES AWNING
HYD DENOTES HYDRANT
LP DENOTES LIGHT POLE
TEL DENOTES TELSTRA PIT
TWL DENOTES TOP OF WALL
E DENOTES ELECTRICITY PIT
SIL DENOTES SEWER INSPECTION LID
S DENOTES SEWER
SC DENOTES SPEED CAMERA
GP DENOTES GULLY PIT

THE TITLE BOUNDARIES AS SHOWN HEREON WERE NOT MARKED AT THE TIME OF SURVEY AND HAVE BEEN DETERMINED BY PLAN DIMENSIONS ONLY AND NOT BY FIELD SURVEY.

SOME SERVICES SHOWN HEREON HAVE BEEN LOCATED BY FIELD SURVEY.

NOTE: LOCATIONS OF DOMESTIC SERVICE CROSSINGS ARE UNKNOWN.

PRIOR TO EXCAVATION THE CONTRACTOR MUST:
* NOTIFY A.G.L. ON 0419527919
* OBTAIN TELSTRA'S "DUTY OF CARE" DOCUMENT REGARDING WORKING IN THE VICINITY OF TELSTRA PLANT.
* VERIFY CO-AXIAL/OPTIC FIBRE CABLE LOCATION

PRIOR TO ANY DEMOLITION, EXCAVATION OR CONSTRUCTION ON THE SITE, THE RELEVANT AUTHORITY SHOULD BE CONTACTED FOR LOCATION OF FURTHER UNDERGROUND SERVICES AND DETAILED LOCATIONS OF ALL SERVICES.

DIAL 1100 BEFORE YOU DIG

EAST coast POSITIONING

SURVEYORS

NORTHWEST
P.O. BOX 7388, BAULKHAM HILLS
N.S.W. 2153, Australia
Mob: 0408556914 or 0418416285
Email: ms@ecpsurveyors.com.au

CLIENT/PROJECT

GHAZI AL ALI
ARCHITECT

263-267 CANTERBURY RD, CANTERBURY

SURVEYOR:	TH
CHECK:	TH
AUTHORISED:	MS

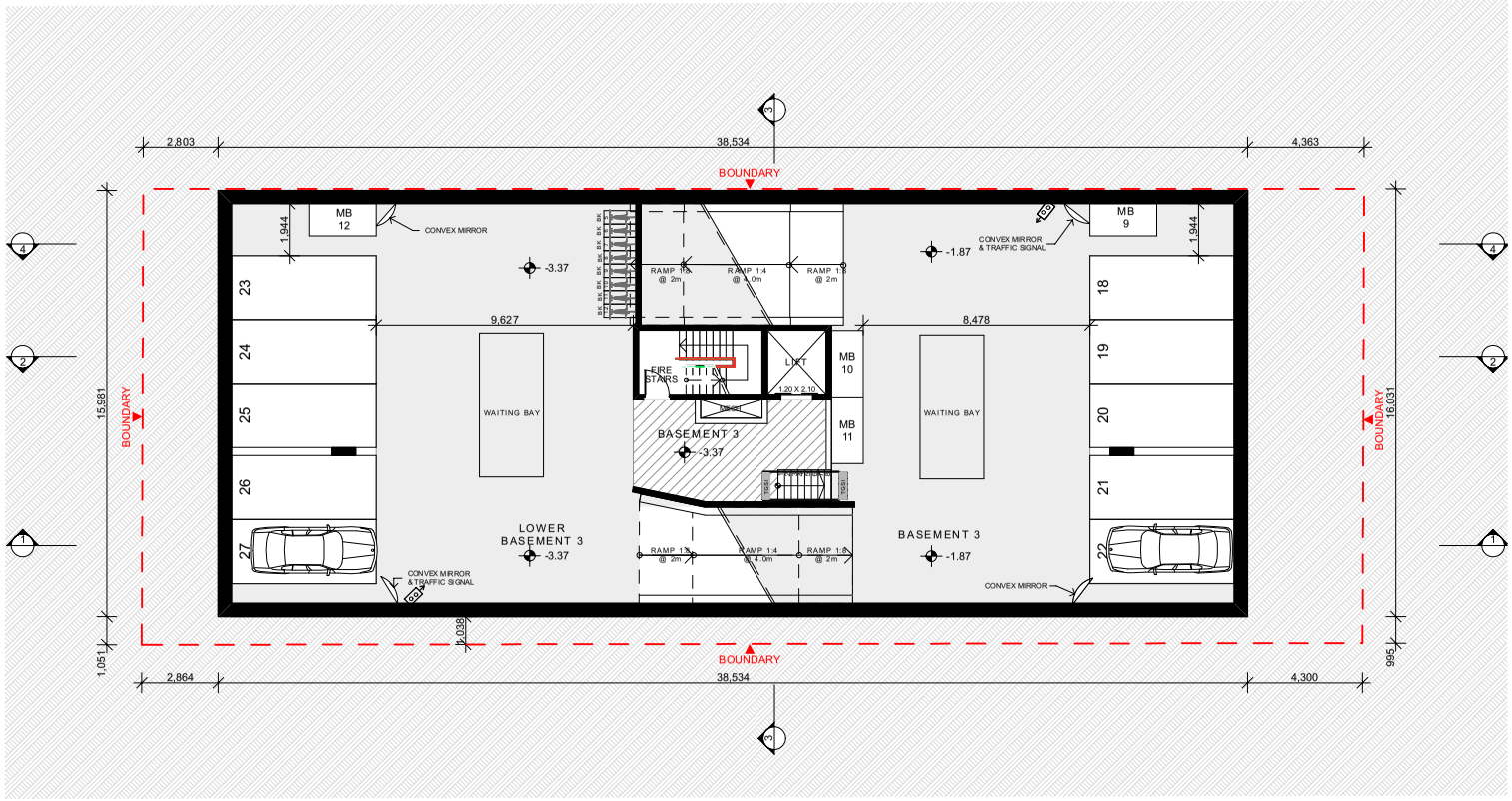
DETAIL SURVEY

AUTHORITY	CANTERBURY
PROPERTY	LOT 18 DP 703437
LOCALITY	CANTERBURY
ORIGIN OF LEVELS	SSM 130919
DATUM	AHD
DATE	19/04/2018
DRAWN BY	AH/TH
SHEET	1 OF 1
DRAWING No.	ECP675.D.02
AMENDMENT	

1:250 SCALE

No.	AMENDMENTS	DRAWN	DATE:

FILE NAME: ECP675.D.02



1 BASEMENT 03
1:200

BASEMENT 03

CARSPACE:	**10**
MOTORBIKE:	**4**
BICYCLE:	**8**

SCALE 1:200 @ A3

0 1 2 5 10M

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DA

Drawing Original Size A3

Issue	Date	Description
P2	18.09.18	COORDINATION
P1	13.09.18	TRAFFIC COORDINATION
P	06.03.18	PRELIMINARY

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SCALE	DATE
1:200	8/20/2018

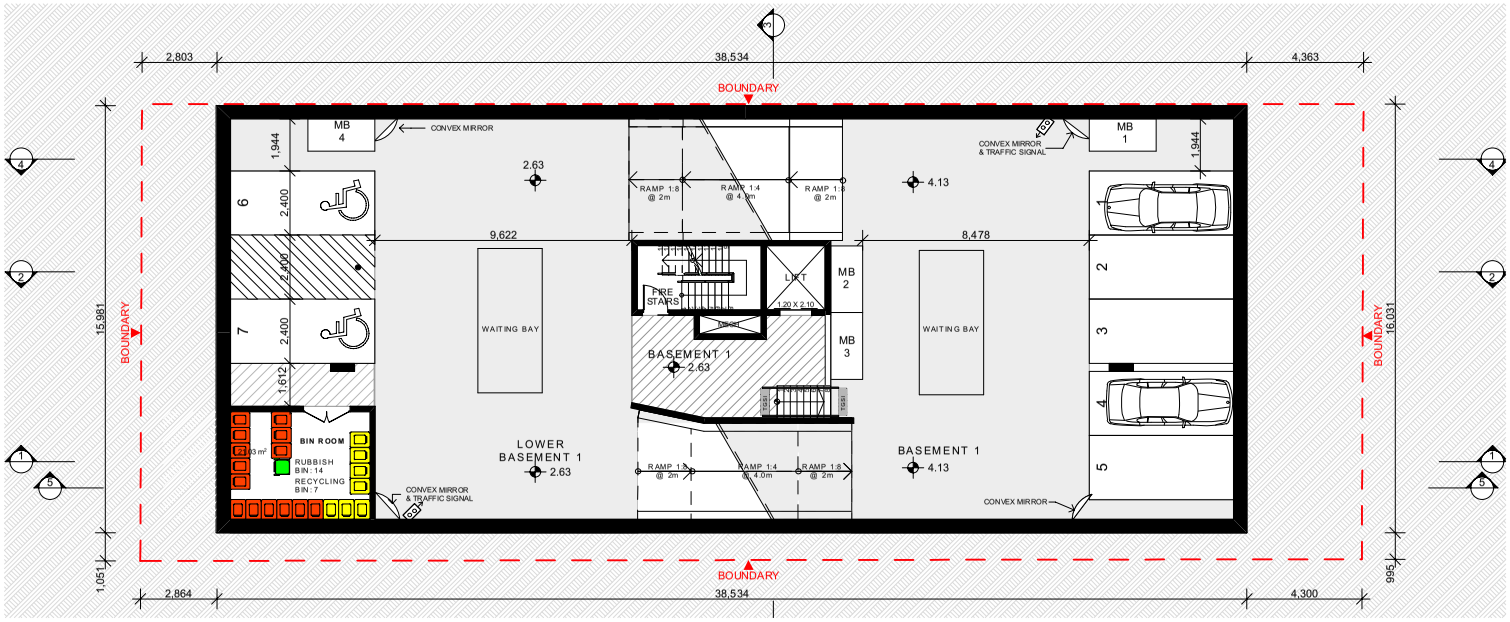
DRAWN	PROJECT ARCHITECT	PROJECT DIRECTOR
OI	TZ	GA

DRAWING NAME
BASEMENT 03

PROJECT NUMBER
P18-014

DRAWING NUMBER
DA A-1200

REV.
P



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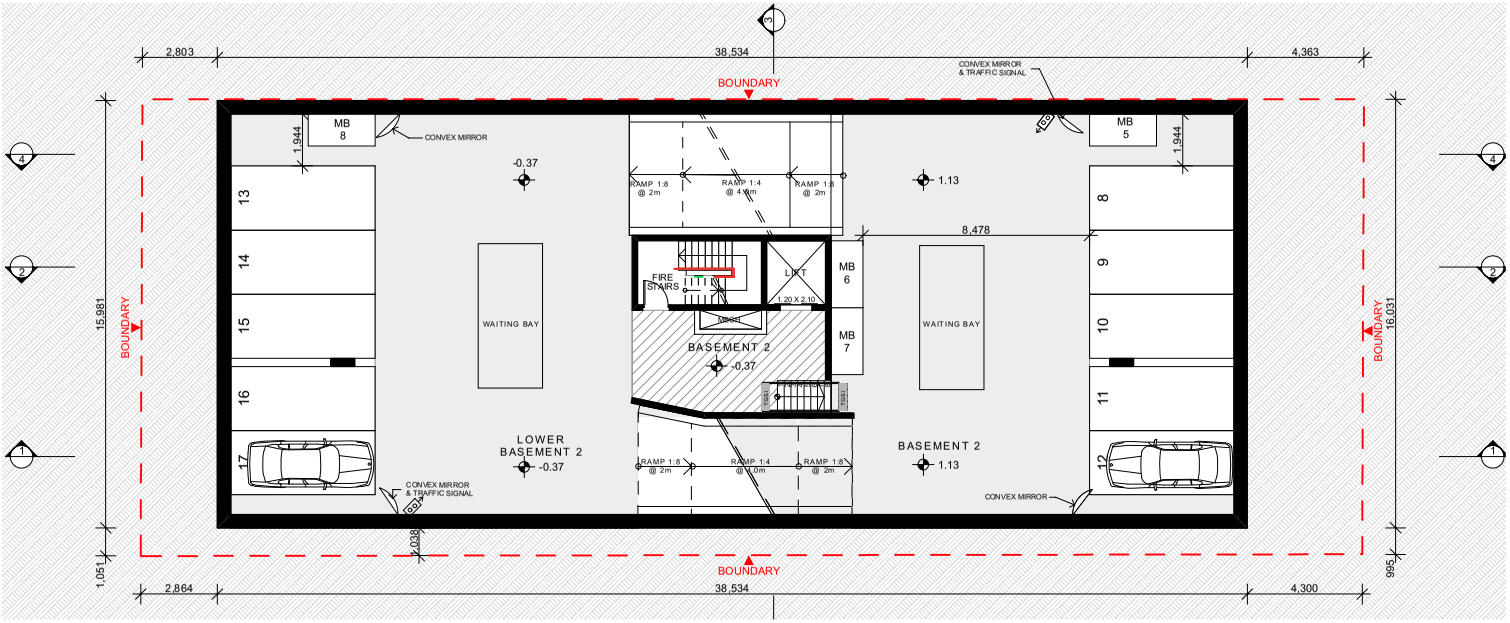
BASEMENT 01

CARSPACE: **7**

MOTORBIKE: **4**



2 BASEMENT 02
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BASEMENT 02

CARSPACE: **10**

MOTORBIKE: **4**

SCALE 1:200 @ A3

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Issue	Date	Description
P2	15/08/18	COORDINATION
P1	15/08/18	STRUCTURAL COORDINATION
P	15/03/18	TRAFFIC REVIEW

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CLIENT: **MING LI**

SCALE	DATE
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DRAWN	PROJECT ARCHITECT	PROJECT DIRECTOR
OI	TZ	GA

DRAWING NAME: **BASEMENT 01 & 02**

PROJECT NUMBER: **P18-014**

DRAWING NUMBER: **DA A-1201**

REV: **P**

GROUND FLOOR PLAN
SCALE: 1:200

SCALE 1:200 @ A3

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A3 Drawing Original Size

Issue	Date	Description
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P		

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SCALE	DATE
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DRAWN	PROJECT ARCHITECT	PROJECT DIRECTOR
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DRAWING NAME
GROUND FLOOR PLAN

PROJECT NUMBER
P18-014

DRAWING NUMBER
DA A-1202

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2 LEVEL 02
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SCALE 1:200 @ A3

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P1		ISSUED FOR COORDINATION
P		ISSUED FOR PRELIMINARY

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DRAWN	PROJECT ARCHITECT	PROJECT DIRECTOR
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DRAWING NAME
LEVEL 01 & 02 PLAN

PROJECT NUMBER
P18-014

DRAWING NUMBER
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REV.
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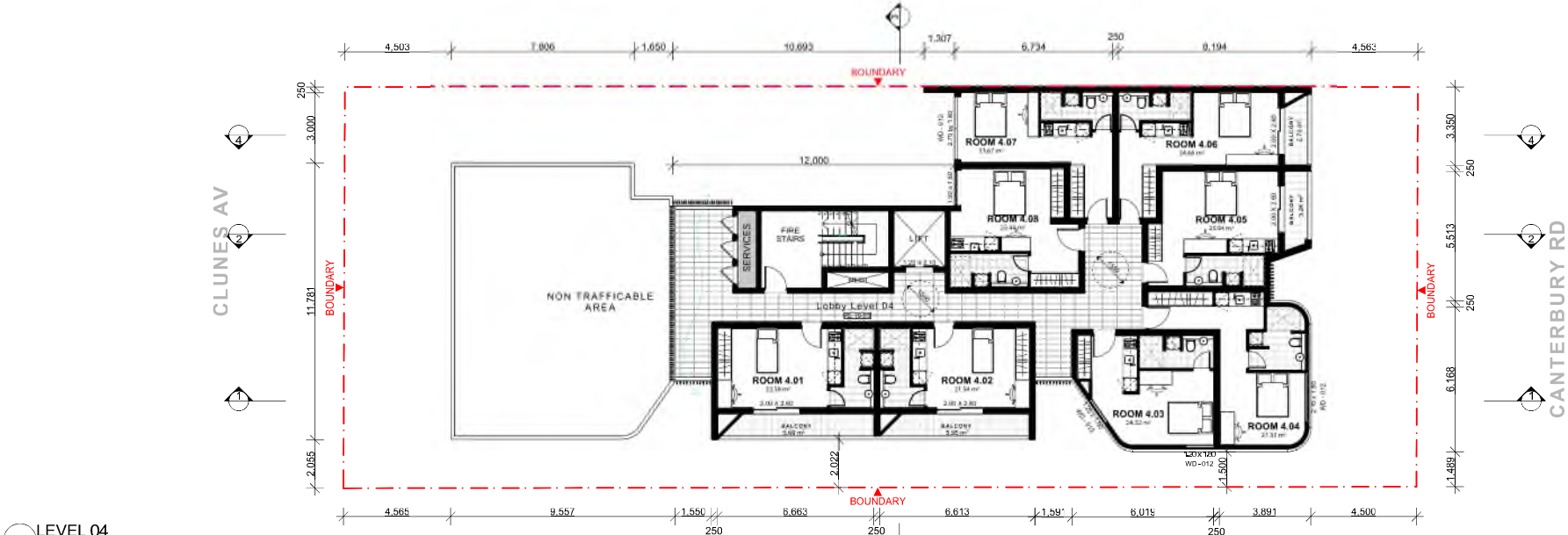

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SCALE 1:200 @ A3

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P1		ISSUED FOR COORDINATION
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PROJECT DIRECTOR GA

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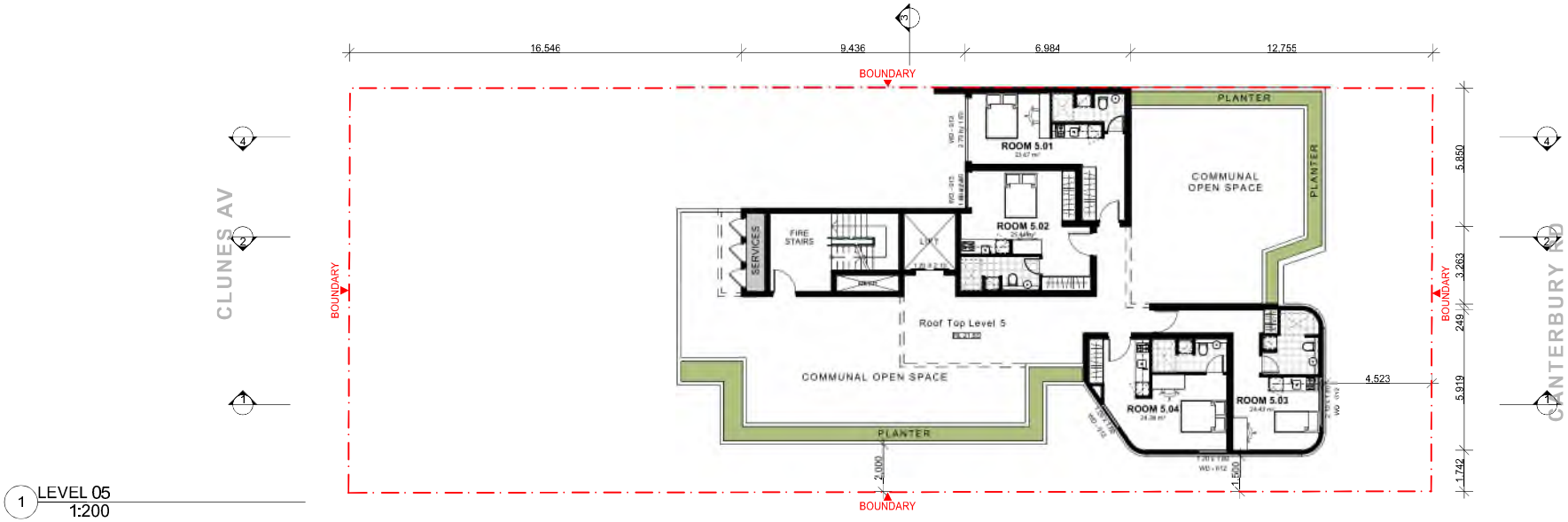

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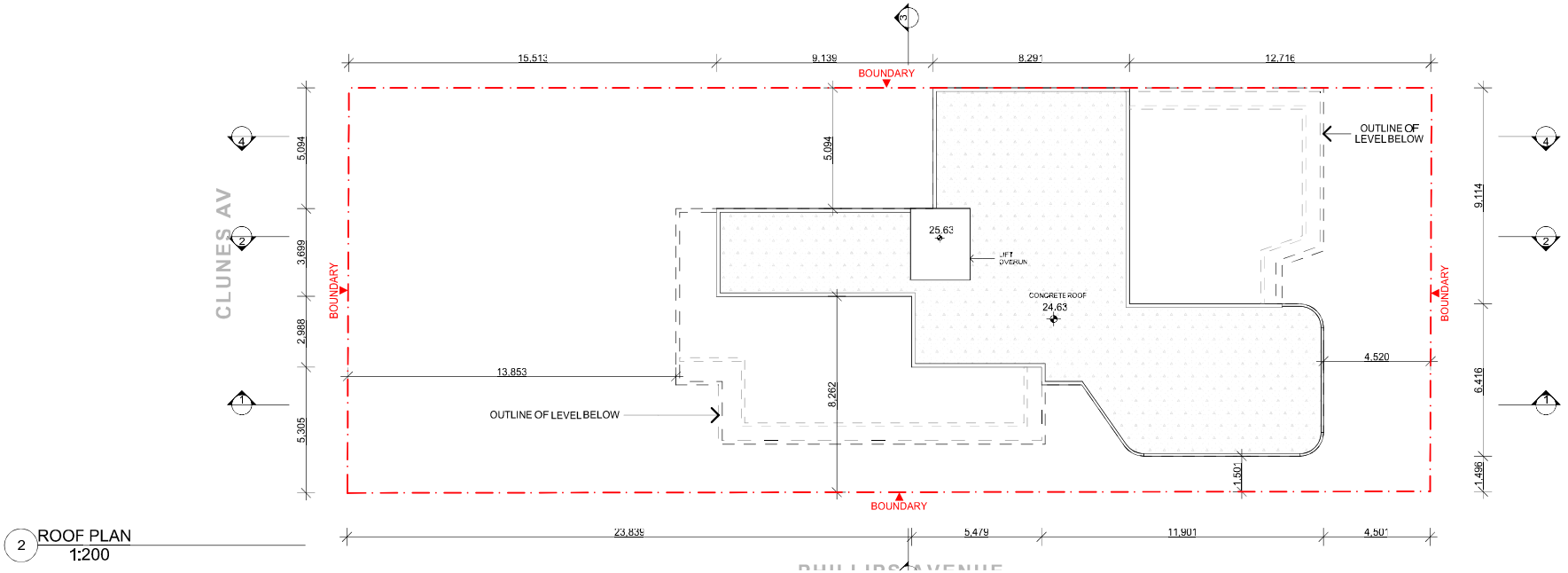

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P2		TOWN PLANNING
P1		TOWN PLANNING
P		COUNCIL PRELIMINARY

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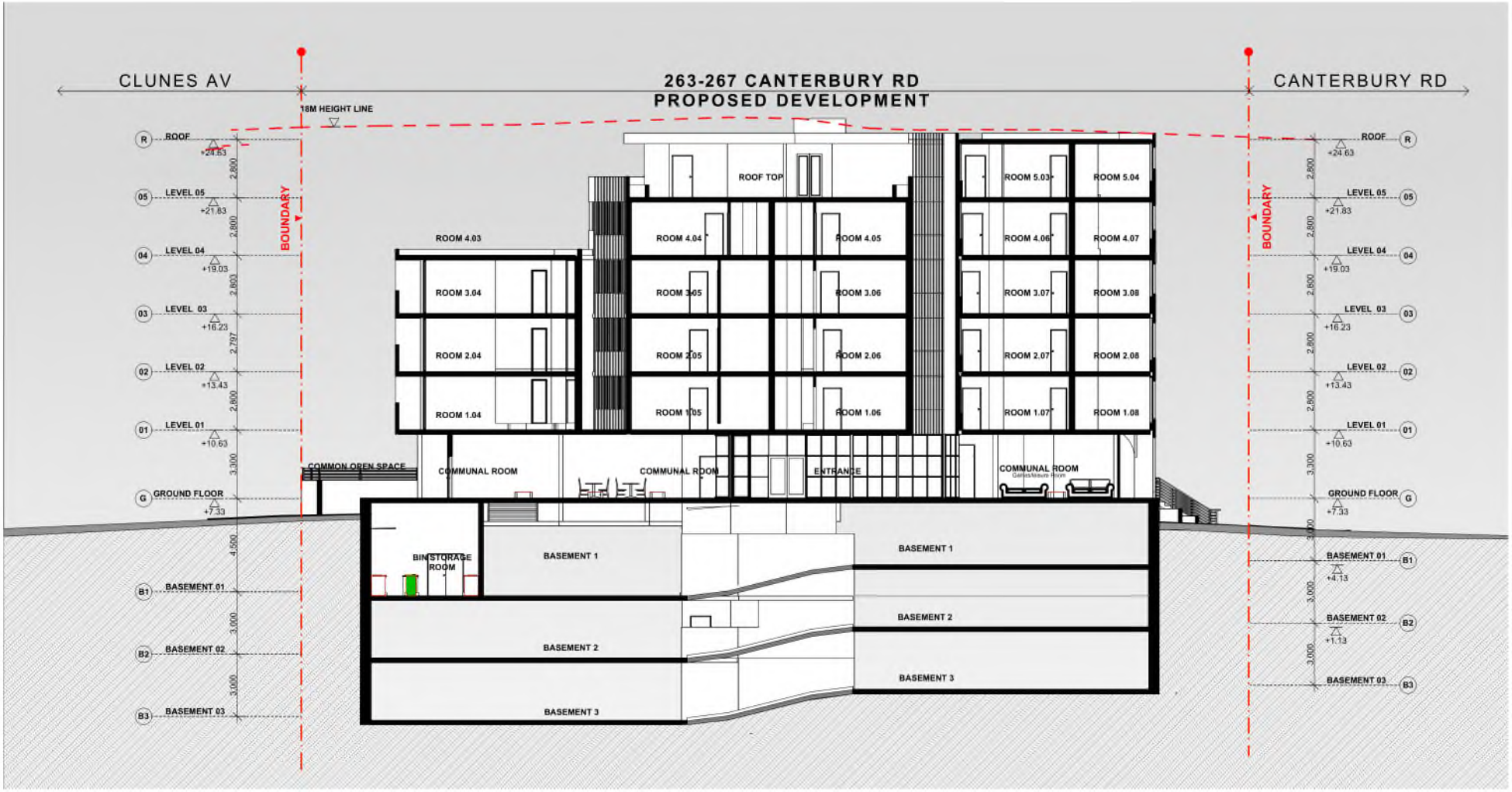
SCALE 1:200
DATE 0/20/2018
DRAWN OI
PROJECT ARCHITECT TZ
PROJECT DIRECTOR GA

DRAWING NAME
LEVEL 05 & ROOF PLAN
DRAWING NUMBER DA A 1205
PROJECT NUMBER P18-014
REV. P



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A3 Drawing Original Size

Issue	Date	Description
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P1		TOWN PLANNING
P		COUNCIL PRELIMINARY

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PROJECT DIRECTOR GA

DRAWING NAME
SECTION 1

PROJECT NUMBER
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DRAWING NUMBER
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REV.
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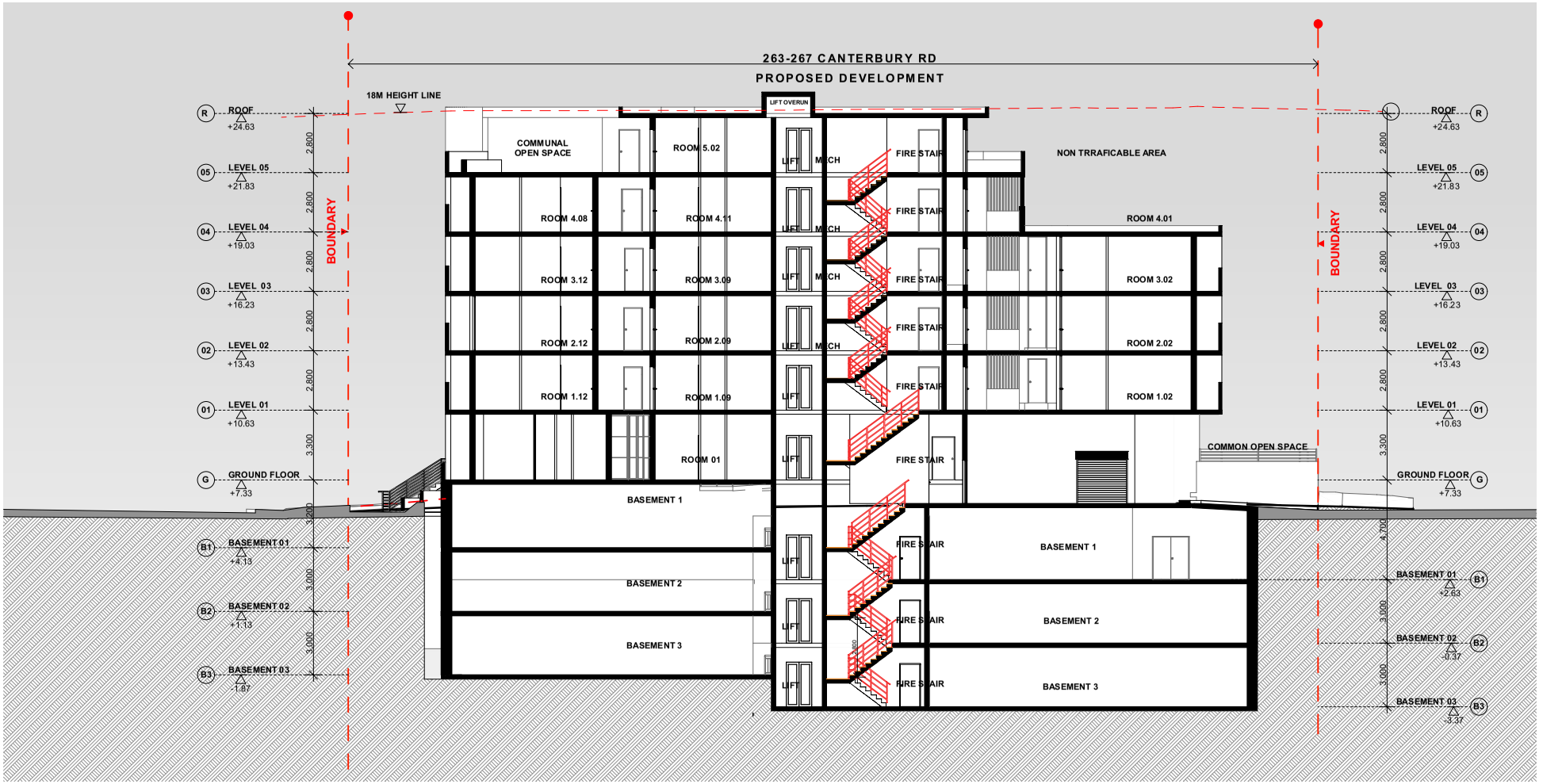

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P1	15/08/18	ISSUE FOR COORDINATION
P	8/03/18	PRELIMINARY

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SCALE	DATE
1:200	8/20/2018

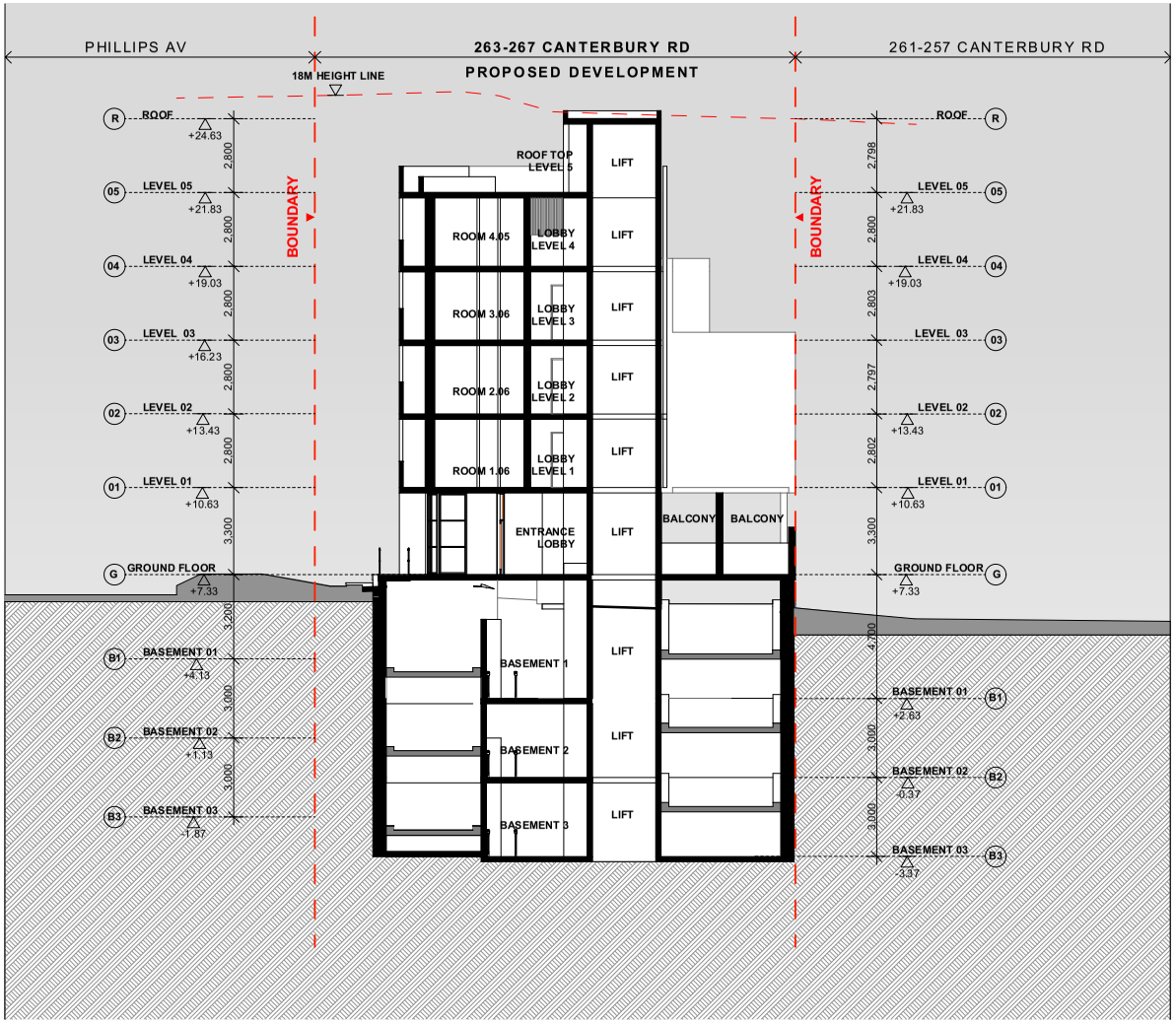
DRAWN	PROJECT ARCHITECT	PROJECT DIRECTOR
OI	TZ	GA

DRAWING NAME
SECTION 2

PROJECT NUMBER
P18-014

DRAWING NUMBER
DA A-1402

REV.
P



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Drawing Original Size A3

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P1	15/08/18	PRELIMINARY COORDINATION
P	8/03/18	PRELIMINARY

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SCALE	DATE
1:200	8/20/2018

DRAWN	PROJECT ARCHITECT	PROJECT DIRECTOR
OI	TZ	GA

DRAWING NAME
SECTION 3

PROJECT NUMBER
P18-014

DRAWING NUMBER
DA A-1403

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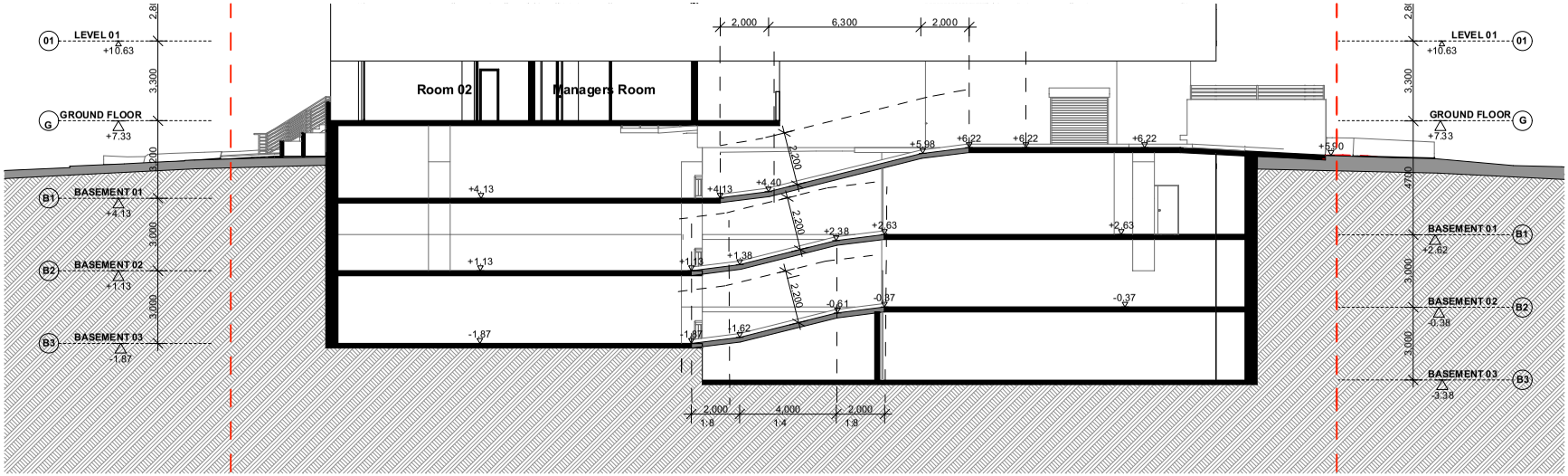

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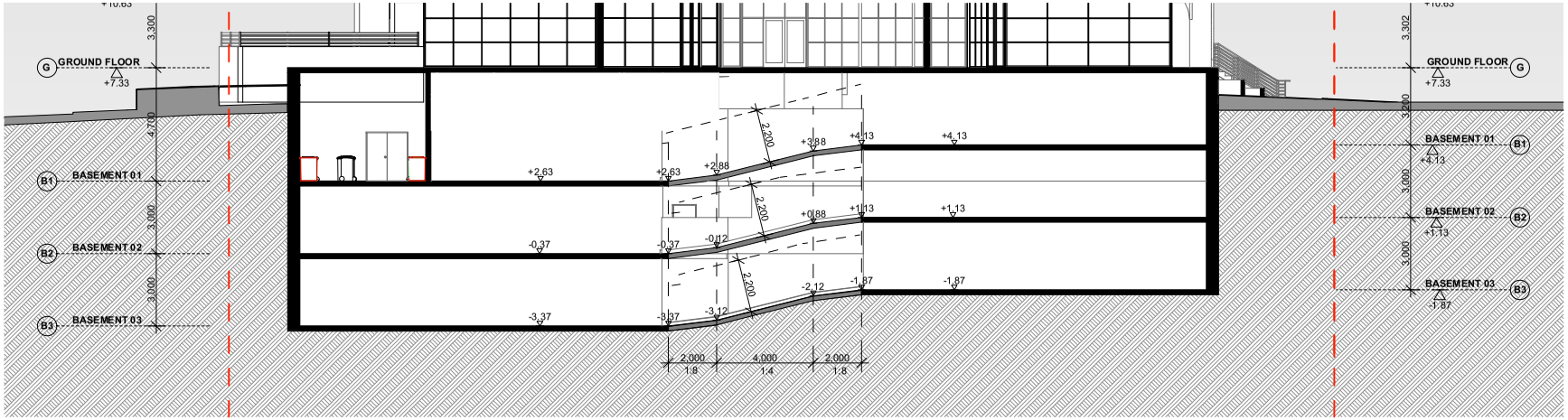

RAMP SECTION 2
1:200

SCALE 1:200 @ A3

0 1 2 5 10M

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Drawing Original Size A3

Issue	Date	Description
P2	18/08/18	COORDINATION
P1	15/08/18	BASIC COORDINATION
P	8/03/18	PRELIMINARY

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82 Bridge St, Lane Cove NSW 2066
02 9420 3361

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+61 2 8883 4239

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a: Suite 101, 506 Miller St,
Cammeray NSW 2062
t: +61 2 9922 03 12

BCA
DESIGN RC
6/80/9A Glen st,
Milsons Point 2061
0405 295 978
aleks@designrc.com.au

PLANNING
NEXUS ENVIRONMENTAL PLANNING PTY LTD
29/103 Majors Bay Road, Concord 2137
02 9736 1313
kennan@ozemail.com.au

ARCHITECT
GHAZI AL ALI ARCHITECT
NSW reg. no. 7542
T. +612 9744 7035 | E. office@ghazia.com
ACN: 67167131848
LEVEL 2,UNIT 2, 14 RAILWAY PARADE
BURWOOD NSW 2134

PROJECT
263-267 CANTERBURY ROAD

CLIENT
MING LI

SCALE	DATE
	8/20/2018

DRAWN	PROJECT ARCHITECT	PROJECT DIRECTOR
OI	TZ	GA

DRAWING NAME
RAMP SECTIONS

PROJECT NUMBER
P18-014

DRAWING NUMBER
DA A-1404

REV.
P

APPENDIX B

BOREHOLE LOGS (5 SHEETS)

Borehole Log Report

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

Hole ID. **BH1**
Hole Depth: **2.45 m**
Sheet: **1 of 1**

Project Name: **Geotechnical Investigation** Project Number: **G18042CAN**
Location / Site: **263-267 Canterbury Road, Canterbury NSW** Client: **Ming Li**

Drilling Company: **Geo Environmental Engineering** Date Started: **13-JUN-18** Ground Level: **RL6.6m** (approx)
Drill Method: **Solid Flight Auger** Date Completed: **13-JUN-18** Easting: ----------
Equipment: **Track mounted drilling rig** 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 SPT	Observations / Comments
							Surface: Concrete					
Solid Flight Auger / SPT		0.0	6.0			Fill	**FILL**- Concrete, grey.	loose	dry/ moist	BH1 0.11-0.50m		
		0.5				Fill	**FILL**- Silty Sand, dark brown, fine grained, fine to medium Gravel (ironstone). colour change to light brown. becoming white/grey.			BH1 0.50-0.95m	3 4 3 N=7	
		1.0				Residual Soil	**Sandy SILT/ Silty SAND**- light brown, fine to medium grained, trace clay.	loose	dry/ moist			
		1.5	5.0			Residual Soil	**Sandy CLAY/ Clayey SAND**- orange brown/light brown, low to medium plasticity, fine to medium grained.	medium dense / stiff	dry/ moist	BH1 1.00-1.50m		
		2.0				Bedrock	**SANDSTONE**- red/grey, fine to medium grained, estimated to be extremely to disctinctly weathered and very low to low strength.		dry	BH1 1.50-1.74m	18 16 SPT bouncing	
										BH1 2.10-2.30m		Borehole Remained Dry
							Hole Terminated at 2.45m Due to Refusal					

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

Additional Comments

Logged By: **Ruairi Carroll** Date: **13-Jun-18** Checked By: **Stephen McCormack** Date: **22-JUN-18**

GEE DAVIES BH LOG G18042CAN(UPDATED).GPJ GEE.GDT 26-7-18 10:30:27 AM

Borehole Log Report

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

Hole ID. **BH2**
Hole Depth: **5.00 m**
Sheet: **1 of 1**

Project Name: **Geotechnical Investigation** Project Number: **G18042CAN**
Location / Site: **263-267 Canterbury Road, Canterbury NSW** Client: **Ming Li**

Drilling Company: **Geo Environmental Engineering** Date Started: **13-JUN-18** Ground Level: **RL6m** (approx)
Drill Method: **Solid Flight Auger** Date Completed: **13-JUN-18** Easting: ----------
Equipment: **Track mounted drilling rig** 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 SPT	Observations / Comments
							Surface: Concrete					
Solid Flight Auger / SPT						Fill	**FILL**- Concrete, grey.					
							FILL- Concrete, grey.	very loose	moist	BH2 0.19-0.50m		
							FILL- Sand, dark brown with grey inclusions, fine to coarse grained, with some clay and gravel.			BH2 0.50-0.95m	1 1 1 N=2	
		1.0	5.0			Residual Soil	**Sandy CLAY/ Clayey SAND**- light brown/orange brown with red inclusions, low to medium plasticity.	soft to firm	moist			
							Silty CLAY- grey /red, low to medium plasticity, fine to medium grained, with some sand.	stiff	moist	BH2 1.30-1.40m		
		2.0	4.0			Bedrock	**SANDSTONE**- light grey/ red, fine to medium grained, estimated to be extremely to distinctly weathered and extremely low to very low strength.		dry/ moist	BH2 1.50-1.95m	6 6 7 N=13	
										BH2 1.95-2.50m		
		3.0	3.0				**SANDSTONE**- light grey/ red, fine to medium grained, estimated to be very low to low strength.		dry/ moist	BH2 2.50-2.95m	6 7 26 N=33	
	▽	4.0	2.0				200mm clay seam noted at 4.7m.					
		5.0	1.0							BH2 4.80-4.90m		
							Hole Terminated at 5.00m Due to Refusal					
		6.0	0.0									
		7.0	-1.0									

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

Additional Comments

Logged By: **Ruairi Carroll** Date: **13-Jun-18** Checked By: **Stephen McCormack** Date: **22-JUN-18**

GEE DAVIES BH LOG G18042CAN(UPDATED).GPJ GEE.GDT 26-7-18 10:30:28 AM

Borehole Log Report

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

geo-environmental ENGINEERING

Hole ID. **BH3**
Hole Depth: **9.64 m**
Sheet: **1 of 2**

Project Name: **Geotechnical Investigation** Project Number: **G18042CAN**
Location / Site: **263-267 Canterbury Road, Canterbury NSW** Client: **Ming Li**

Drilling Company: **Geo Environmental Engineering** Date Started: **13-JUN-18** Ground Level: **RL6m** (approx)
Drill Method: **SFA/NLMC** Date Completed: **13-JUN-18** Easting: ----------
Equipment: **Track mounted drilling rig** 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 SPT	Observations / Comments	Well Details	Well Construction
							Surface: Concrete							
Solid Flight Auger / SPT	2.2m 20-Jul-18	0.0	6.0			Fill	**FILL**- Concrete, grey.						0.00 0.10	
							FILL- Sandy Silt, dark brown, fine to coarse grained, with some clay.	very soft	moist	BH3 0.00-0.50m				Bentonite
		1.0	5.0			Residual Soil	**Sandy CLAY**- grey with orange and red staining, low to medium plasticity, fine to coarse grained.	stiff	moist	BH3 0.85-0.95m	0 0 1 N=1			
										BH3 0.95-1.50m				
		2.0	4.0								4 4 6 N=10			2mm Sand
										BH3 2.00-2.50m			2.50	
							SAND- grey with red staining, fine to coarse grained, with some clay.	medium dense	moist					
		3.0	3.0			Bedrock	**SANDSTONE**- grey/ red, fine to coarse grained, estimated to be extremely/distictly weathered and extremely low to very low strength.		moist	BH3 2.50-2.95m	24 18 SPT Refusal		3.00 3.10	
										BH3 7.00-0.95m				
NLMC Coring		4.0	2.0											50mm Ø Screen
		5.0	1.0				**Sandy CLAY**- grey, medium to high plasticty, (500mm Seam).			BH3 5.10-5.60m		Seepage Water at 5.5m		
		6.0	0.0				**SANDSTONE**- light brown/ red, fine to coarse grained, estimated to be low to medium strength.							
										BH3 6.00-6.50m			6.10 6.15	2mm Sand
		7.0	-1.0				*BH3 continued as cored hole from 6.5m*							

GEE DAVIES BH LOG G18042CAN(UPDATED).GPJ GEE.GDT 26-7-18 10:30:29 AM

Moisture

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

Additional Comments

Logged By: **Ruairi Carroll** Date: **13-Jun-18**
Checked By: **Stephen McCormack** Date: **22-JUN-18**

Borehole Log Report

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

Hole ID. **BH3**
Hole Depth: **9.64 m**
Sheet: **2 of 2**

Project Name: **Geotechnical Investigation** Project Number: **G18042CAN**
Location / Site: **263-267 Canterbury Road, Canterbury NSW** Client: **Ming Li**

Drilling Company: **Geo Environmental Engineering** Date Started: **13-JUN-18** Ground Level: **RL6m** (approx)
Drill Method: **SFA/NLMC** Date Completed: **13-JUN-18** Easting: ----------
Equipment: **Track mounted drilling rig** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	Material Type	Material Description	Weathering	Estimated Strength (MPa) EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	$Is_{(50)}$ MPa D=diametral A=axial	U.C.S. (Mpa)	Rock Mass Defects: RQD %	Core Photo	Defect Spacing (mm) 20 60 200 600 2000	Defect Description type, inclination, thickness, shape, roughness, coating: Specific / General	Well Details	Depth (m)	Casing & Core Lifts
						Continued from non-cored borehole from 6.5m											
		7.0	-1.0		Bedrock	**SANDSTONE** - grey with orange staining, fine to coarse grained.	SW		A=0.79 D=0.16		97			6.50 SM, 0, CLAY		7.0	
		7.5	-1.5						A=0.68 D=0.45 A=0.8					SM, 0, CLAY		7.5	
		8.0	-2.0						A=2.01 D=1.64							8.0	
		8.5	-2.5													8.5	
		9.0	-3.0											SM, 0, CLAY SM, 0, CLAY SM, 0, CLAY		9.0	
		9.5	-3.5						A=2.42 D=1.92							9.5	9.64
		10.0	-4.0			**Hole Terminated at 9.64 m** Target Depth reached										10.0	
		10.5	-4.5													10.5	
		11.0	-5.0													11.0	
		11.5	-5.5													11.5	
		12.0	-6.0													12.0	
		12.5	-6.5													12.5	
		13.0	-7.0													13.0	
		13.5	-7.5													13.5	

Additional Comments

Logged By: **Ruairi Carroll** Date: **13-Jun-18** Checked By: **Stephen McCormack** Date: **22-JUN-18**

GEE DAVIES CH LOG G18042CAN(UPDATED).GPJ GEE.GDT 26-7-18 10:34:18 AM

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

LABORATORY REPORTS (8 SHEETS)

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

CERTIFICATE OF ANALYSIS 194450

Client Details

Client	Geo-Environmental Engineering
Attention	R Carroll, Stephen McCormack
Address	82 Bridge St, Lane Cove, NSW, 2066

Sample Details

Your Reference	**G18042CAN**
Number of Samples	7 SOIL
Date samples received	21/06/2018
Date completed instructions received	21/06/2018

Analysis Details

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

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

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

Report Details

Date results requested by	28/06/2018
Date of Issue	25/06/2018

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

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

Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By

Jacinta Hurst, Laboratory Manager

Misc Inorg - Soil						
Our Reference		194450-1	194450-2	194450-3	194450-4	194450-5
Your Reference	UNITS	BH3	BH3	BH3	BH3	BH1
Depth		0.0-0.5	1.5-1.95	5.1-5.6	6.0-6.5	2.5-2.95
Date Sampled		13/06/2018	13/06/2018	13/06/2018	13/06/2018	13/06/2018
Type of sample		SOIL	SOIL	SOIL	SOIL	SOIL
Date prepared	-	22/06/2018	22/06/2018	22/06/2018	22/06/2018	22/06/2018
Date analysed	-	22/06/2018	22/06/2018	22/06/2018	22/06/2018	22/06/2018
pH 1:5 soil:water	pH Units	7.5	5.1	5.2	5.7	5.0
Electrical Conductivity 1:5 soil:water	µS/cm	63	55	23	29	15
Chloride, Cl 1:5 soil:water	mg/kg	<10	<10	<10	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	10	36	25	33	10
Resistivity in soil*	ohm m	160	180	430	340	660

Misc Inorg - Soil			
Our Reference		194450-6	194450-7
Your Reference	UNITS	BH1	BH2
Depth		1.0-1.5	4.8-4.9
Date Sampled		13/06/2018	13/06/2018
Type of sample		SOIL	SOIL
Date prepared	-	22/06/2018	22/06/2018
Date analysed	-	22/06/2018	22/06/2018
pH 1:5 soil:water	pH Units	6.0	5.2
Electrical Conductivity 1:5 soil:water	µS/cm	97	38

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Alternatively determined by colourimetry/turbidity using Discrete Analyer.

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			22/06/2018	1	22/06/2018	22/06/2018		22/06/2018	[NT]
Date analysed	-			22/06/2018	1	22/06/2018	22/06/2018		22/06/2018	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	7.5	7.8	4	102	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	1	63	62	2	105	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	<10	<10	0	96	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	10	20	67	102	[NT]
Resistivity in soil*	ohm m	1	Inorg-002	<1	1	160	160	0	[NT]	[NT]

Result Definitions

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

Quality Control Definitions

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

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

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

CHAIN OF CUSTODY - Client

ENVIROLAB SERVICES

Client:	Geo-Environmental Engineering Pty Ltd	**Client Project Name and Number:** G18042CAN	**Envirolab Services** **12 Ashley St, Chatswood, NSW, 2067**
Project Mgr:	McCormack	**PO No.:**	
Sampler:	Carroll	**Envirolab Services Quote No. :**	**Phone: 02 9910 6200**
Address:	82 Bridge Street Lane Cove NSW 2066	**Date results required:**	**Fax: 02 9910 6201**
Email:	stephen@geoenvironmental.com.au rcarroll@geoenvironmental.com.au	**Or choose: standard / 1 day / 2 day / 3 day** 5 days *Note: Inform lab in advance if urgent turnaround is required - surcharge applies*	**E-mail: ahie@envirolabservices.com.au**
Phone:	0431 480 980		**Contact: Aileen Hie**

Sample information				Tests Required														Comments
Envirolab Sample ID	**Client Sample ID**	**Date sampled**	**Type of sample**	**EC**	**pH**	**Chloride**	**Sulfate**	**Sodocity**	**Resistivity (Calc)**	**combination 5a**	**Combination 3**	**8 metals**	**CEC**						**Provide as much information about the sample as you can**
1	BH3 / 0.0 - 0.5	13-06-18	Soil	1	1	1	1		1										
2	BH3 / 1.5 - 1.95	13-06-18	Soil	1	1	1	1		1										
3	BH3 / 5.1 - 5.6	13-06-18	Soil	1	1	1	1		1										
4	BH3 / 6.0 - 6.5	13-06-18	Soil	1	1	1	1		1										
5	BH1/2.5 - 2.95	13-06-18	Soil	1	1	1	1		1										
6	BH1/1.0 - 1.5	13-06-18	Soil	1	1														
7	BH4/4.8 - 4.9	13-06-18	Soil	1	1														

Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200

Job No: 194450
Date Received: 21/6
Time Received: 1100
Received by: PH
Temp: Cool/Ambient
Cooling: Ice/Icepack
Security: Intact/Broken/None

Relinquished by (company):	Geo-Environmental Engineering	**Received by (company):** ES	**Samples Received: Cool or Ambient (circle one)**
Print Name:	R. Carroll	**Print Name:** PH	**Temperature Recieved at:** (if applicable)
Date & Time:	20-Jun-18 9AM	**Date & Time:** 21/6 1100	**Transported by: Hand delivered / courier**
Signature:		**Signature:**	**Page No: 1 of 1**

POINT LOAD STRENGTH INDEX

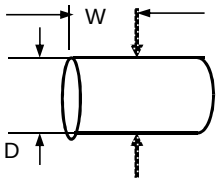
Project No.	G18042CAN

Client:	Ming Li	Date:	13-Jun-18
Project:	Geotechnical Investigation	Tested by:	RC
Location:	263-267 Canterbury Road, Canterbury	Data checked:	SM

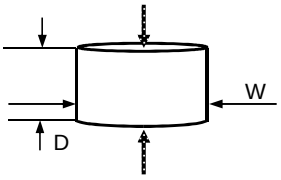
Test Machine:	GSA	Test Locality:	MHK	Core Size:	52 mm

Bore/TP	Depth (m)	Rock Type	Moisture Condition	Test Type	W (mm)	D (mm)	Load kN (P)	Failure Type	Point Load Strength Index $I_{S(50)}$ (MPa)	Strength Classification
BH3	6.79	SANDSTONE	F	D	50.0	50.0	0.40	2	0.16	L
BH3	6.79	SANDSTONE	F	A	52.0	46.0	2.30	1	0.79	M
BH3	7.40	SANDSTONE	F	A	52.0	42.0	1.84	1	0.68	M
BH3	7.40	SANDSTONE	F	D	50.0	51.0	1.15	2	0.45	M
BH3	7.45	SANDSTONE	F	A	52.0	46.0	2.32	4	0.80	
BH3	8.09	SANDSTONE	F	D	50.0	49.0	3.97	2	1.64	H
BH3	8.09	SANDSTONE	F	A	52.0	44.0	5.65	1	2.01	H
BH3	9.56	SANDSTONE	F	D	50.0	47.0	4.36	2	1.92	H
BH3	9.56	SANDSTONE	F	A	52.0	45.0	6.94	1	2.42	H

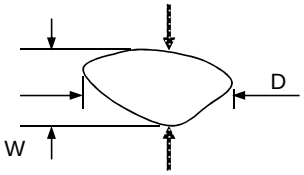
TEST TYPE :



W/D > 0.5
DIAMETRAL (D)



D/W = 0.3 - 1.0
AXIAL (A)



D/W = 0.3 - 1.0
IRREGULAR LUMP (I)

MOISTURE CONDITION :
Field (F), Saturated (S), Dry (D)

FAILURE TYPE :
1. Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.
2. Fracture along bedding.
3. Fracture influenced by pre-existing joint plane (J), microfracture (M), vein (V), chemical alteration (C).
4. Chip or partial fracture.

NOTES For specimens tested parallel to plane of weakness $D_e^2 = D^2$
For specimens tested perpendicular to plane of weakness $D_e^2 = 4WD/\pi$