# GEOTECHNICAL SITE INVESTIGATION REPORT

**PROJECT:** 495 Fourth Avenue, Austral

**CLIENT:** Fabcot Pty Limited

**DATE:** 27/10/23

**REPORT No.:** NE1784

GEOTESTA

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# 1. INTRODUCTION

Geotesta was originally engaged by The Bathla Group in October 2021 to conduct a Geotechnical Site Investigation (GSI) Report for 495 Fourth Avenue, Austral NSW 2179, Report# NE996, 02 November 2021", on the site referred to as 495 Fourth Avenue, Austral NSW 2179. Based on the original information received from the Client, it was understood that the proposed construction involved a low-density residential development subdivision. The current GSI Report further addresses that the previously assessed property has since transferred ownership to Fabcot Pty Limited. The site is now being repurposed for the construction of a supermarket with one level of basement by Fabcot Pty Limited (Woolworths Group).

The fieldwork for the geotechnical site investigation was carried out on October 14, 2021. The investigation scope included the following:

- Subsurface exploration using boreholes and test pits to assess the soil profile and geotechnical properties of the subsurface materials.
- Laboratory testing of soil samples to determine their classification, salinity, and aggressivity.
- Evaluation of footing types, founding depths, and allowable bearing capacities for strip/pad footings and piles.
- Assessment of site preparation, excavation, and earthworks requirements.
- Recommendation on temporary batters, shoring systems, and lateral earth pressures for retaining walls and excavation support in close proximity to adjoining sites.

This assessment has been carried out in accordance with the relevant Australian Standards (AS), including:

- AS 1726-2017, *Geotechnical site investigations*
- AS 2870-2011, *Residential slabs and footings*
- AS 3600-2009, *Concrete structures*
- AS 2159.2009, *Piling-Design and installation*
- AS 4678-2002, *Earth-retaining structures*
- AS 3798-1996, *Guidelines on earthworks for commercial and residential developments*



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## 2. FIELD INVESTIGATION

The site under investigation is situated at 495 Fourth Avenue, Austral NSW 2179 and is approximately 50 km west of the Sydney CBD.

The field investigation involved the drilling of three (3) boreholes; drilled to the maximum depth of 3.0m or refusal. The borehole locations were determined on-site by an Experienced Geotechnical Engineer according to the proposed development and considering site accessibility and the anticipated locations of underground services.

A site plan showing the borehole locations is presented in Figure 1. Borehole drilling was carried out with a ute-mounted drilling rig and solid flight auger. Dynamic Cone Penetrometer (DCP) testing was also undertaken at the surface adjacent to each borehole to estimate the consistency/density of the subsurface materials.

The fieldwork was performed in the presence of the Geotesta Geotechnical Engineer who positioned boreholes, collected samples, nominated testing depths, and prepared borehole logs in accordance with AS 1726. All field observations and in-situ test results are presented on the borehole logs attached in Appendix A of this report.

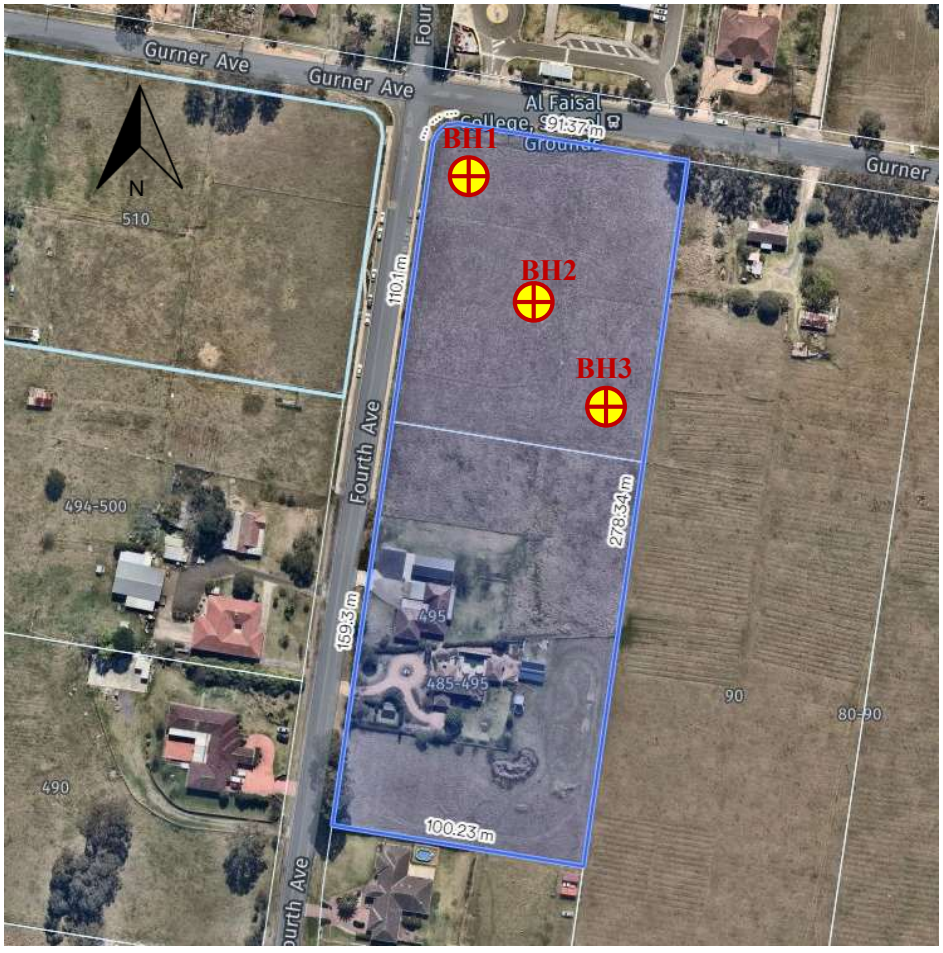


**Figure 1. Site Plan and Boreholes location**



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# 3. FINDINGS

## 3.1 Site Condition and Topography

The site of the proposed development is rectangular in shape with an area of approximately 13,000 m². At the time of investigation, the subject site was covered with tall grass and overgrown vegetation. The site area is relatively flat with an average slope of about 2.5%. It is bound by Fourth Ave on the west, and Gurner Ave on the north. The Area is surrounded by mostly vacant land with few low-rise housing units and a school north of the site. Regional topographic maps indicate that the site approximately ranges between 80 to 84 meters above sea level, referenced to the Australian Height Datum (AHD).

## 3.2 Site Geology

The geological origin of the soil profile was identified from our visual examination of the soil samples, geotechnical experience, and with reference to geological maps of the area. The geological map of the area indicates that the site is situated in Bringelly Shale of the Wianamatta Group consisting of shale, carbonaceous claystone, claystone, laminite, fine to medium-grained lithic sandstone, rare coal and tuff (Rwb). (Penrith, 1:100 000, Geological Sheet 9030). The geological map is shown in Figure 3.

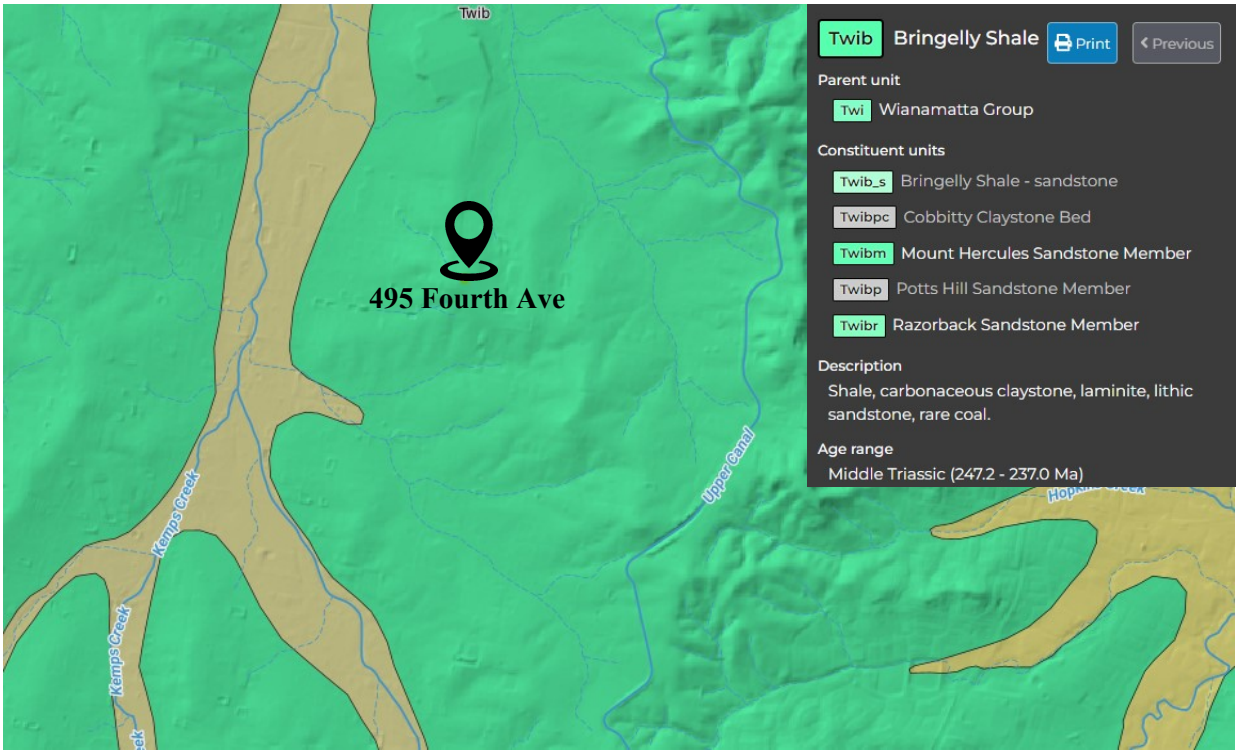


**Figure 2. Geological map of the site and surrounding area**



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### 3.3 Soil/Rock Profile

The encountered soil profiles are presented in the borehole logs in Appendix A and tabulated in summary in Table 1 below.

Topsoil was encountered in all boreholes to a maximum depth of approximately 0.2m, followed by natural silty clay to depths ranging from approximately 0.1m to 1.0m. The natural/residual Clay was underlain by extremely to highly weathered, very low-strength shale as summarised in Table 1.

**Table 1: Summary of Sub-Surface Materials**

| Approximate Depth range of Unit (mBGL*) | | | | | |
|---|---|---|---|---|---|
| Unit | Material | BH1 | BH2 | BH3 | Description |
| 1 | Topsoil | 0.0-0.1 | 0.0-0.1 | 0.0-0.2 | Silty Clay |
| 2 | Silty Clay | 0.1-0.7 | 0.1-0.7 | 0.2-0.6 | Firm |
| 3 | Silty Clay | 0.7-0.9 | 0.7-1.0 | 0.6-0.8 | Very Stiff |
| 4 | Shale (Class V) | 0.9-2.5 | 1.0-2.0 | 0.8-2.5 | XW/HW, H/VLS |

**Measured from the existing ground surface*
*XW- Extremely Weathered, HW-Highly Weathered, H-Hard, VLS-Very Low Strength*
*Higher strength shale may be encountered at lower depths.*

### 3.4 Site Classification

Two (2) soil samples were taken from the natural silty clay soil and sent to Geotesta Lab, a NATA-accredited laboratory for testing of index properties to assess the site reactivity and classification. The laboratory test results are summarised in Table 2.

**Table 2: Summary of Soil Laboratory Test Results**

| Bore No. | Depth (m) | Soil Type | LL % | PL % | PI % | LS % |
|---|---|---|---|---|---|---|
| BH1 | 0.5 | Silty Clay | 50 | 18 | 32 | 13.5 |
| BH3 | 0.7 | Silty Clay | 53 | 20 | 33 | 14.5 |

*Note: LL= Liquid Limit; PL=Plastic Limit; PI= Plasticity Index; LS= Linear Shrinkage*

Site/soil classification based on Australian Standard 2870-2011 Residential Slabs and Footings is not applicable to the proposed development with one level of basement. Atterberg limit test results indicate that the natural Silty Clay at the site is medium to high plasticity soil. After considering the area geology, the soil profiles encountered in the bores, and the presence of low bearing capacity soil, the site is classified as CLASS "H1" with respect to foundation construction (Australian Standard 2870-2011



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Residential Slabs and Footings). It has been estimated preliminarily that the Characteristic Surface Movement (ys) of the underlying natural Silty Clay soil will be in the range of 40-60 mm provided the building site is protected from "abnormal moisture conditions" and is drained as described in AS 2870.

It must be emphasised that the heave mentioned, and recommendations referred to in this report are based solely on the soil profile observed at the time of the investigation for this report, without taking into account any abnormal moisture conditions as defined in AS2870 – 2011, Clause 1.3.3 that might be created thereafter. With abnormal moisture conditions, distress will occur and may result in "non-acceptable probabilities of serviceability and safety of the building during its design life," as defined in AS2870-2011, Clause 1.3.1. If these distresses are not acceptable to the builder, owner or other relevant parties then further fieldwork and revised footing recommendations must be carried out.

### 3.5 Groundwater

Groundwater was not encountered within any of the inspected boreholes to the maximum depth of 2.5m. The data from publicly available groundwater bores closest to the site area also indicates that it is unlikely to encounter groundwater during the excavation of the basement up to a depth of approximately 5 meters. However, if any perched water is encountered during the excavation, appropriate measures as outlined in this report should be followed.

### 3.6 Earthquake Design

Australian Standard AS 1170.4-2007, Structural design actions, Part 4: Earthquake actions in Australia outlines the relevant methods used in earthquake risk classification and design requirements, enabling the assessment of an earthquake design category for the structure to be determined. Based on the results of the geotechnical investigation and the soil data gathered from the boreholes, a site sub-soil class of "Ce" – shallow soil site can be adopted as per Section 4 of the above-mentioned standard.

A hazard factor (Z) of 0.08 can be adopted for Sydney based on information obtained from Table 3.2 and Figure 3.2(A) of AS 1170.4–2007.

### 3.7 Salinity and Aggressivity Assessment

Three (3) soil samples were submitted to Eurofin MGT Laboratory, a NATA-accredited laboratory, for chemical testings for the salinity and aggressivity assessment. The testing was carried out for the aggressivity suite and to assess the exposure classification for the proposed development.



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Sampling was targeted to achieve a representative coverage of site conditions in line with assessed sub-surface profiles, proposed development, and the investigation scope. The laboratory testing certificates are presented in Appendix B.

### 3.7.1 Salinity Assessment

Laboratory test results for the salinity assessment are summarised in Table 3.

**Table 3: Soil Salinity Test Results**

| Sample ID | Conductivity (Ec) (1:5 Aqueous extract dS/m) | Ece[1] (ds/m) | Salinity assessment[2] |
|---|---|---|---|
| S1 (BH1-0.8m) | 0.018 | 0.162 | Non-Saline |
| S2 (BH2-1.0m) | 0.034 | 0.306 | Non-Saline |
| S3 (BH3-0.5m) | 0.014 | 0.126 | Non-Saline |

[1]Based on EC to ECe multiplication factors in the Department of Land and Water Conservation (2002) Guidelines (Table 6.1), a multiplication factor of 9 was applied to Clay loam.
[2]Based on Table 6.2 of the Department of Land and Water Conservation (2002) where ECe < 2dS/m = Non-saline; ECe= 2-4dS/m = slightly saline; ECe = 4-8dS/m = moderately saline; ECe = 8-16dS/m = very saline; ECe > 16dS/m = highly saline.

Referring to the above test result, the site is considered as non-saline.

### 3.7.2 Aggressivity Assessment

Sulphate and pH test results for aggressivity assessment are summarised in Table 4.

**Table 4: Aggressivity classification test results for concrete and steel piles**

| Sample ID | pH (1:5 Aqueous extract) | Sulphate (SO4) (mg/kg) | Aggressivity assessment concrete | Aggressivity assessment steel |
|---|---|---|---|---|
| S1 (BH1-0.8m) | 6.7 | <10 | Non-Aggressive | Non-Aggressive |
| S2 (BH2-1.0m) | 5.8 | 20 | Non-Aggressive | Non-Aggressive |
| S3 (BH3-0.5m) | 6 | 10 | Non-Aggressive | Non-Aggressive |

[1]In accordance with AS3600 (2009)

Referring to the above test result, the site is considered as **Non-Aggressive** to concrete pile and **Non-Aggressive** to steel pile.



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### 3.7.3 Exposure Classifications for concrete and steel in Saline and Sulfate soils

The site soil is considered non-saline, non-aggressive to concrete piles and non-aggressive to steel. An exposure classification of A1 for concrete in saline soils and an exposure classification of A1 for concrete and A1 for steel in sulphate soils should be adopted for the preliminary design of proposed concrete structures.

## 4. SUMMARY OF PRINCIPAL GEOTECHNICAL ISSUES OF THE SITE

Based on the site investigation results, our observations, and the proposed development information, we consider the following to be the principal geotechnical issues to be considered in the planning design and construction of the development:

- For excavations of the basement, retention systems are to be constructed to support the vertical excavation on all sides. Both short-term and permanent retention systems are to be designed for the basement excavation. Using a permanent retaining wall for vertical excavation near adjoining structures/assets will minimise lateral movement of the excavation face and reduce the risk imposed on the stability of the adjacent building/street and potential underground services. Excavation to the proposed basement depths, assumed here to be at a depth of RL 78.8 (assuming a basement slab thickness of 0.2m), requires the implementation of supports to a depth of up to approximately 5m to ensure stability and safety are maintained. Soldier pile walls supported by anchors/prop/strut and shotcrete infill panels may be used as the preferred shoring system. More rigid contiguous pile walls may be used if low movement is desired. The effect of the excavation on the adjacent buildings and local/state assets is to be assessed.
- The excavation in low to medium-strength bedrock if encountered, needs the use of "hard rock" excavation equipment, which may cause vibrations to transfer through the rock mass and affect adjacent structures. A vibration monitoring plan is to be provided and implemented during the excavation in low to medium-strength bedrock.
- Based on this investigation and other publicly available information the presence of groundwater, is unlikely within the proposed excavation of up to 5 meters. However, if any perched water is stored locally within fractures of the shale bedrock, it may result in seepage into the basement. Therefore, it is important to consider this when constructing the basement structure. Given the relatively low permeability of the exposed bedrock, conventional sump and pump methods should be capable of dewatering during construction if



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groundwater encountered. In the long term, a drained basement is recommended as the suitable option for this development.

- The depth of investigation was limited to 2.5m due to auger refusal on very low strength Shale bedrock. However, it is expected that higher strength Shale could be exposed at the bulk excavation level. Depending on the structural loads, shallow or deep foundations may be required as the foundation system of the proposed development. The proposed structure is to be supported on the strata of similar stiffness to minimise the total and differential settlement. No major site/slab preparation is anticipated.

## 5. SITE PREPARATION AND EARTHWORK

The depth of Topsoil/Fill materials varies across the site up to depths of 0.2 m. Any fill encountered during excavation should be treated as uncontrolled fill. The following measures should be adopted for the site preparation (Wherever required and if applicable):

- All topsoil from the construction area should be stripped to subgrade/foundation level and stockpiled on site (if applicable) for possible re-use if required. Topsoil not being reused should be disposed of offsite following a waste classification report.
- Any evidence of contamination or asbestos-containing materials found during excavation works should be notified to the Project Engineer immediately.

It is recommended that Geotesta be engaged to provide a site inspection during the various stages of construction to confirm that the ground conditions for the proposed construction are consistent with the assumptions or findings in this report.

All earthworks recommendations should be complemented by reference to the latest edition of Safe Work Australia's 'Excavation Work Code of Practice' and AS3798-2007: 'Guidelines on Earthworks for Commercial and Residential Developments'.

### 5.1 Engineered Fill

If required, the Controlled fill can be used on the subgrade in uniform layers to provide the required design level in accordance with the foundation design.

The natural clayey soils and ripped Shale bedrock are best suited for bulk filling. The material should not contain any particle sizes greater than 150 mm. It is expected that bedrock of low strength or less should readily break down beneath the weight of the



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rollers, however, bedrock of medium strength or higher may potentially need to be crushed using a rock crusher.

If required, suitable granular materials are to be imported on-site to be used as engineered fill within the site.

### 5.2 Compaction

Compaction of backfill material is required to ensure that excessive surface settlement does not occur. The required backfill density and minimum frequency of testing for compaction control as detailed in AS 3798 – 2007 are summarised below:

- 1 test per layer per 500m$^2$; or
- 1 test per 100m$^3$ distributed reasonably evenly throughout full depth and area; or
- 3 tests per visit (whichever requires the most tests)

Testing should be undertaken in accordance with AS 1289 "Methods of testing for soil engineering purposes". Tested layers that do not satisfy the outlined criteria are to be stripped, replaced, re-compacted and re-tested to achieve the minimum compaction requirement specified above. Testing of compaction density should be undertaken by a suitably qualified geotechnical testing company.

## 6. EXCAVATION

Based on the soil/bedrock profile and conditions encountered at the borehole locations, light excavation machinery should be adequate for the footing excavations into Topsoil/Fill materials and Silty Clay (down to approximately 1 m below the ground surface), should be comparable with a Soft Excavation Class as per SANS 1200D. Excavations into the Shale bedrock (below 1 m) will encounter Intermediate to Hard excavations. Table 5 describes the excavation classes as per SANS 1200D.

**Table 5: Excavation classes as per SANS 1200D**

| Excavation Class | Description |
|---|---|
| Soft | Excavation in material that can be efficiently removed by a back-acting excavator of flywheel power approximately 0.10kW per millimetre of tined-bucket width, without the use of pneumatic tools such as paving breakers |
| Intermediate | Excavation in material that requires a back-acting excavator of flywheel power exceeding 0.10 kW per millimetre of tined-bucket width or the use of pneumatic tools before removal by equipment equivalent to that specified for soft excavation. |
| Hard | Hard rock excavation shall be excavation in material (excluding boulder excavation) that cannot be efficiently removed without blasting or wedging and splitting. |



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Excavations in rock using hydraulic rock hammers will need to be controlled as there could be direct transmission of ground vibrations to nearby structures and potential buried services. The vibrations might result in discomfort to occupants of the neighbouring buildings. In case of any hard excavation condition on-site, Lower energy equipment such as small rock breakers or saw cuts is recommended to be used on the site to confirm that peak particle velocities (PPV) fall within acceptable limits. Subject to the results of the dilapidation reports, we recommend that the PPV along the eastern/northern site boundary does not exceed 10mm/sec during bedrock excavation using rock breakers. Vibration monitoring will be required to verify that this is achieved. However, if the contractor adopts methods and/or equipment in accordance with the recommendations in Table 6 for a ground vibration limit of 5 mm/sec, vibration monitoring is not required.

**Table 6: Recommendation on Maximum Peak Particle Velocity for Rock-breaking Equipment**

| Distance from adjoining structure (m) | Maximum Peak Particle Velocity 5mm/sec | | Maximum Peak Particle Velocity 10 mm/sec | |
|---|---|---|---|---|
| | Equipment | Operating Limit % of maximum capacity | Equipment | Operating Limit % of maximum capacity |
| 1.5 to 2.5 | Hand-operated jackhammer only | 100 | 300 kg rock hammer | 50 |
| 2.5 to 5 | 300 kg rock hammer | 50 | 300 kg rock hammer<br>600 kg rock hammer | 100<br>50 |

Excavation to the proposed bulk excavation depths requires the implementation of supports to the excavation faces to ensure stability and safety are maintained. The excavation support minimises lateral movement of the excavation face and reduces the risk imposed on the stability of adjacent buildings, underground services (if there are any) and council assets (Fourth Ave and Gurner Ave).

### 6.1 Temporary Cut Batters

It is assumed that the excavation will be carried out by installing shoring walls before any excavation starts so no major cut batter will be used on site. If required, the excavation in Unit 2–3 Silty Clay may be undertaken to 1.0m depth and may stand nearly vertical without the need for battering back. Temporary unsupported excavation up to 1.5m deep within the existing Unit 2 - 3 Silty Clay layer should be no

steeper than 1.5H:1V. Temporary unsupported cut batters more than 1.5m up to 3m deep within the existing Unit 2 - 3 Silty Clay should not be steeper than 2H:1V.

Temporary unsupported excavation up to 1.5m deep within the existing Unit 4 Shale layer should be no steeper than 0.75H:1V. Temporary unsupported cut batters more than 1.5m up to 3m deep within the existing Unit 4 Shale should not be steeper than 1H:1V.

It is recommended that a geotechnical engineer be engaged during the excavation stage to confirm/identify the material for the whole excavation depth.

The batter slope angles are recommended subject to the following measures:

- The batters should be protected against erosion.
- Permanent batters should be drained.
- Temporary batters shall not be left unsupported for more than 2 months without further advice. Following heavy rains (raining more than 6 hours with an intensity of greater than 15mm/day), they should be inspected by a geotechnical engineer.
- A minimum offset distance of 1.5 m from the batter crest should be maintained for surcharge loads and the offset distance should be increased to match the maximum depth of excavation.

### 6.2 Retaining Walls

The design of the basement retaining wall/retention wall for the short term (i.e., during construction) will depend on the method of construction. If the bottom-up technique is adopted, temporary cantilever walls or anchored/propped walls can be used.

For the long term, floor slabs will provide bracing to the basement retaining walls, and thus, the walls should be designed as braced structures.

Surcharge loads induced by adjacent structures, traffic, footing load, etc., need to be considered along with earth pressures in the design.

If simple support systems (e.g., cantilever walls) are adopted, retaining wall design may be based on the Earth Pressure Approach and using closed-form solutions adopting the geotechnical parameters summarised in Table 7 below.



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**Table 7: Retaining Wall Design Parameters for Earth Pressure Approach**

| Unit/ Soil Type | γ (kN/m3) | $K_0$ | $K_a$ | $K_p$/Ultimate Passive Earth Pressure |
|---|---|---|---|---|
| Unit 2 / Firm Silty Clay | 18 | 0.56 | 0.39 | 2.56 |
| Unit 3 / Very Stiff Silty Clay | 20 | 0.53 | 0.36 | 2.77 |
| Unit 4 / Shale (Class V) | 22 | 0.53 | 0.36 | 200 kPa |

For construction methods that minimise deflection and where restraint is applied via struts, bracings, or anchors, the temporary or short-term lateral earth pressure distribution should be approximated as a trapezoidal distribution behind the retaining wall. A maximum lateral earth pressure of 8H kPa is obtained at a depth of 0.25H, where H is the total depth of the excavation to be retained. For basement walls where wall deflections are not critical, the maximum lateral earth pressure may be reduced to 6H kPa.

It must be emphasised that where adjoining footings exist near the retaining walls, the "at rest" earth pressures must be maintained, and the active design condition is not appropriate.

### 6.3 Anchored Soldier Pile Retention

The use of anchored soldier piles, secant or contiguous piles can be adopted for this site in case of an increase in depth of excavation. In considering such a retention system, the following aspects should be considered in the design and construction of the proposed retaining walls:

- The anchors should be considered with earth pressure "at rest" condition as the design criteria.
- The soldier piles should be installed at a maximum spacing of three times the pile diameter prior to the commencement of the bulk excavation for the basement.
- Reinforced shotcrete should be applied to all the exposed faces of the basement excavation prior to the commencement of the next level of excavation. Shotcrete should be applied before the bulk excavation exceeds a depth of approximately 1.0 metres. However, this may require review based on the encountered soil conditions and once the levels of adjoining footings are known.
- Excavation for the basement level should not extend more than 0.5 metres



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below the level of the ground anchors if they are used to maintain "at rest" earth pressures before the anchors are installed and fully pre-stressed.

### 6.4 Ground Anchors

Ground anchors used in connection with the temporary support of any retention structures should extend into Class-V Shale. Recommended design bond stress for rock anchor design is shown in Table 8.

**Table 8: Recommended Design Bond Stress for Anchor Design**

| Unit/Material | Design Bond Stress (kPa) |
|---|---|
| Unit 4/Shale -Class V | 150 |

The free length of ground anchors should be sufficient to ensure that failure cannot occur on a sliding wedge behind the retention wall structure. As a guide, it is therefore recommended that the free length of the ground anchors should extend at least 1.5m beyond the 45° line extending from the bottom of the basement excavation.

Generally, ground anchors should be installed at an angle of approximately 15° to 20° below the horizontal and where possible the ground anchor bond length should not exceed 12.0m to ensure adequate load transfer characteristics.

### 6.5 Estimated Wall Deflection and Ground Settlement

The maximum wall deflection is estimated to lie in the range between 0.25% and 0.35% of the excavation depth. Corresponding vertical settlements of between 0.20% and 0.25% of the excavation depth can be anticipated directly behind the wall, with settlements reducing to zero at a lateral distance approximately corresponding to the depth of the basement excavation. When considering the influence of the anticipated settlements on the existing adjoining structures, the founding depths of the existing footings should be considered.

Due to the presence of the adjacent Fourth Ave and Gurner Ave, retaining wall deflections along the street boundary will need to be limited to 0.5% of the excavated height or 30mm, whichever is lower in accordance with the RMS Technical Direction, 'Excavation adjacent to RMS infrastructure', Ref: GTD 2012/001 dated 27 April 2012.

In addition to the inherent deformations that will take place within the proposed basement excavation, there may be some minor delays between excavation and the establishment of a suitable retention system, during which time additional minor lateral deflection may take place. A full dilapidation survey of any adjoining structure (if available) is therefore recommended prior to the commencement of the basement



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excavation. This should be followed by regular surveys and monitoring during construction.

### 6.6 Drainage of Retention Systems

The basement construction would include bulk excavation to an approximate depth of up to 5m. Seepage inflow and seepage infiltration from perched water may be present during the bulk excavation. It is therefore recommended that a suitable drainage system be installed and maintained behind all retaining wall structures to ensure the dissipation of any hydrostatic forces that may result from the accumulation of any seepage water behind the wall structures. Such seepage water flows should readily be able to be intercepted by the construction of a suitable sub-surface cut-off drain on the high side of the subject site. Strip drains behind the shotcrete panels are highly recommended.

### 6.7 Basement Slab

Based on the investigation results, the exposed subgrade below the basement slab will comprise class-V Shale or better. The basement slab should be underlain by a layer of durable igneous granular material such as DGB20 or other approved material to act as a separation layer between the clay/rock and the basement slab. If a drained basement is used, then drainage should be provided around the basement perimeter and below the basement slab to direct seepage into sumps with permanent and fail-safe automatic pumps to remove water from the basement. The underfloor drainage should comprise a strong, durable, single-sized washed aggregate such as 'blue metal' gravel.

## 7. FOUNDATION RECOMMENDATION

### 7.1 Geotechnical Design Parameters

The estimated geotechnical parameters of soil and rock materials encountered below the site are provided in Table 9:

**Table 9: Estimated Geotechnical Design Parameters**

| Unit/ Soil Type | γ (kN/m3) | Su (kPa) | c′ (kPa) | Φ′ | E′ (MPa) | ν' |
|---|---|---|---|---|---|---|
| Unit 2 / Firm Silty Clay | 18 | 25 | 3 | 26 | 8 | 0.3 |
| Unit 3 / Very Stiff Silty Clay | 20 | 100 | 8 | 28 | 30 | 0.3 |
| Unit 4 / Shale (Class V) | 22 | --- | 30 | 28 | 100 | 0.3 |



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### 7.2 Footing

Engineer-designed strip/pad footings founded on Class V Shale or better can be used for the proposed development. The strip/pad footings should be founded in the natural Unit 4 Shale layer or better and be founded at least 100 mm into the recommended founding material. The allowable bearing capacities presented in Table 10 can be adopted for the design of the pad/strip footings for the proposed structures at the site.

**Table 10: Allowable Bearing Capacity for Pad/Strip Footings**

| Material | Allowable Bearing Capacity (kPa) |
|---|---|
| Unit 4 / Shale (Class V) | 700 |

*Note, that higher strength materials may encounter at lower depths.*

It should be noted that the soil profile may vary across the site. The foundation depths quoted in this report are measured from the surface during our testing and may vary accordingly if any filling or excavation works are carried out. It is recommended that a geotechnical engineer be engaged during the footing excavation stage to confirm the founding depth and founding material for all units.

The settlement of a footing is dependent on the load applied to the footing and the foundation conditions below the footing. However, it can be expected that the settlement of a strip/pad footing designed using the parameters in Table 10 will be ≤ 1% of the footing width.

All footings for the same structure should be founded on strata of similar stiffness to minimize the risk of differential movements, with articulation provided where appropriate.

Bored piles can be also used to support the proposed construction. Bored piles should be founded with an embedment of at least one (1) pile diameter in the founding material for which the footing has been designed (i.e., Unit 4 Shale). The bearing capacities including end-bearing and shaft adhesion are presented in Table 11. Additional embedment of three (3) pile diameters would be necessary to utilise adhesion for the embedment in the respective Unit 3/ Unit 4 soil materials.

The pile foundations of the proposed construction are assumed to be a high redundancy system and the intrinsic test factor ($\phi_{tf}$) is assumed to be equal to the basic geotechnical strength reduction factor ($\phi_{gb}$), in accordance with AS 2159. The overall design average risk rating (ARR) is to be calculated by the designer and the corresponding geotechnical strength reduction shall be adopted.



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**Table 11: Allowable Adhesion and End Bearing Capacity for Piles**

| Material | Allowable End Bearing | Allowable Shaft Adhesion | Ultimate End Bearing | Ultimate Shaft Adhesion |
|---|---|---|---|---|
| Unit 4 / Shale (Class V) | 700 kPa | 50 kPa | 2000 kPa | 100 kPa |

**minimum embedment depths of one (1) and three (3) pile diameters into the silty clay/shale are necessary to achieve these allowable design values for end bearing and adhesion, respectively*
*Ultimate skin friction values based on the clean socket of roughness category R2 or better*

## 8. HYDROGEOLOGICAL ASSESSMENT

During the site investigation, the groundwater was not encountered in any of the boreholes during drilling. We assume the bulk excavation level at RL of 78.8. Based on data obtained from the publicly available water bores closest to the site, it is anticipated that the proposed excavations will not intercept the groundwater table. However, perched water may be encountered during the excavation.

Based on the available information, we assume that groundwater flow (if there is any) into the basement to be less than 3 ML per year. Therefore, we consider that the design and construction of a drained basement is appropriate for the proposed development. Following the measurement of groundwater inflows at the completion of excavation, an accurate estimate of long-term groundwater inflows will be made to assess long-term pumping requirements. Drainage should be provided around the basement perimeter to direct seepage into sumps with automatic pumps to remove water from the basement.

We consider the adoption of a drained basement would have negligible impact on any nearby foundations, services, assets, structures, and ecosystems.

The anticipated volume of seepage will determine if the submission of a dewatering application and a subsequent dewatering license are required for the project. Based on the existing information and results of this investigation, Geotesta believes no dewatering license is required at this stage. All site discharges should be passed through a filter material prior to release into the Council stormwater system or approved alternative. Groundwater assessment and testing are to be carried out prior to discharge of any groundwater to ensure contaminant levels (if applicable) are appropriate. Additionally, written approval from the Council (if required) should be obtained prior to the discharge of groundwater.



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# 9. ADDITIONAL GEOTECHNICAL INVESTIGATION AND ASSESSMENTS

To conduct a more comprehensive examination of the subsurface materials for the proposed development's foundations, it is necessary to perform additional geotechnical investigations. This entails increasing the number of boreholes and conducting rock coring to obtain a more thorough understanding of the bedrock shale's strength and weathering characteristics. We strongly recommend the installation of groundwater wells to facilitate continuous monitoring of groundwater levels, particularly if they are encountered during the process. In the event that groundwater is encountered above the depth of bulk excavation, it is advisable to conduct pumping tests to estimate the permeability of the subsurface materials and the rate of seepage into the basement.

Additionally, it is essential to evaluate the potential impact of the excavation on TfNSW (Transport for New South Wales) and local government assets. This assessment should employ finite-element methods to determine the structural effects. Geotesta is well-equipped to perform all the required supplementary investigations and assessments for this particular project.

***DOCUMENT CONTROL***

| Date | Version | Report Prepared By: | Report Reviewed by: |
|---|---|---|---|
| 27 October 2023 | NE1784 | **Anees Raja Siddiqui**<br>BEng, MEng<br>Geotechnical Engineer | **Dr. Mohammad Hossein Bazyar**<br>BEng MEng Ph.D MIEAust CPEng NER<br>Principal Geotechnical Engineer |



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Phone: 1300 852216 |email: info@geotesta.com.au

## 10.REFERENCES


- Australian Standard AS 1726-2017, *Geotechnical site investigations*
- Australian Standard AS 2870-2011, *Residential slabs and footings*
- Australian Standard AS 3600-2009, *Concrete structures*
- Australian Standard AS 2159.2009, *Piling-Design and installation*
- Australian Standard AS 4678-2002, *Earth-retaining structures*
- Australian Standard AS 5100.5-2004, *Bridge design Part 5: Concrete*
- Australian Standard AS 3798-1996, *Guidelines on earthworks for commercial and residential developments*
- Pells, P.J.N., Mostyn, G., Walker, B.F. (1998), *Foundations on Sandstone and Shale in the Sydney Region*
- *Western Salinity Code of Practice,* March 2003 (Amended January 2004)




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## Information about This Report

The report contains the results of a soil and water quality Assessment conducted for a specific purpose and client. The results should not be used by other parties, or for other purposes, as they may contain neither adequate nor appropriate information.

**Test Hole Logging**

The information on the test hole logs (boreholes, test pits, exposures etc.) is based on a visual and tactile assessment, except at the discrete locations where test information is available (field and/or laboratory results). The test hole logs include both factual data and inferred information.

**Groundwater**

Unless otherwise indicated, the water levels presented on the test hole logs are the levels of free water or seepage in the test hole recorded at the given time of measuring. The actual groundwater level may differ from this recorded level depending on material permeability (i.e. depending on the response time of the measuring instrument). Further, variations of this level could occur with time due to such effects as seasonal, environmental and tidal fluctuations or construction activities. Confirmation of groundwater levels, phreatic surfaces or piezometric pressures can only be made by appropriate instrumentation techniques and monitoring programmes.

**Interpretation of Results**

The discussion or recommendations contained within this report are normally based on a site evaluation from discrete test hole data. Generalised, idealised or inferred subsurface conditions (including any geotechnical cross-sections) have been assumed or prepared by interpolation and/or extrapolation of these data. As such these conditions are an interpretation and must be considered as a guide only.

**Change in Conditions**

Local variations or anomalies in the generalised ground conditions do occur in the natural environment, particularly between discrete test hole locations. Additionally, certain design or construction procedures may have been assumed in assessing the soil-structure interaction behaviour of the site. Furthermore, conditions may change at the site from those encountered at the time of the geotechnical investigation through construction activities and constantly changing natural forces.

Any change in design, construction methods, or in-ground conditions as noted during construction, from those assumed or reported should be referred to GEOTESTA for appropriate assessment and comment.



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**Reproduction of Report**

Where it is desired to reproduce the information contained in our geotechnical report or other technical information, for the inclusion in contract documents or engineering specification of the subject development, such reproductions should include at least all of the relevant test hole and test data, together with the appropriate standard description sheets and remarks made in the written report of a factual or descriptive nature. Reports are the subject of copyright and shall not be reproduced without the permission of Geotesta.



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# Appendix A

# Borehole Logs



GEOTESTA PTY LTD | ABN 9185162081| 6/20-22 Foundry Road, Seven Hills NSW 2147
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# BOREHOLE LOG

**BOREHOLE No: BH1**

**Page:** 1 **of** 1

| | | | | | |
|---|---|---|---|---|---|
| Client: | Bathla Group | Drilling Co: | Geotesta | Easting: | --- |
| Project: | 495 Fourth Avenue, Austral | Driller: | A.G | Northing: | --- |
| Job No: | NE996 | Rig Type: | Mounted Rig | Grid Ref: | See Figure 1 |
| Location: | 495 Fourth Avenue, Austral, NSW, 2179 | Inclination: | Vertical | Collar RL: | |
| Date Drilled: | 14/10/21 | Bearing: | Vertical | Logged by: | T.S Checked by: M.H.B |

*Test Method: AS 1289.6.3.2-1997 & AS 1726-2017*

| Depth (m) | Drilling Method | Graphic Log | Group Symbol | MATERIAL DESCRIPTION<br>Type, colour, particle size and shape, structure | Moisture | Consistency / Strength | DCP blows/100mm | FIELD TESTS & NOTES | Sampling / Runs | Water Levels | Depth (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | | | | **TOPSOIL**, Silty CLAY with rootlets | M | | 1 | | | | 0.00 |
| | | | CI | **Silty CLAY**, medium plasticity, dark brown<br>Grades: becoming orange-brown | M | F | 1<br>2<br>1<br>2<br>3 | | | | |
| 0.50 | | | | Grades: becoming mottled grey | | VST/H | 1<br>9<br>15 | ● Di1 at 0.15m<br>● D1 at 0.15m<br>● Att1 at 0.5m | | | 0.50 |
| 1.00 | | | | **SHALE**, with clay seam, extremely weathered, hard to very low strength, light brown<br>Grades: highly weathered, very low strength | D-M | | 12<br>14<br>13 | ● S1 at 0.8m<br>Refusal at 1.2m<br>20 blows reached | | | 1.00 |
| 1.50 | | | | | | | | | | | 1.50 |
| 2.00 | | | | | | | | | | | 2.00 |
| 2.50 | Solid Flight Auger | | | Borehole terminated at 2.5m, Refusal | | | | | | | 2.50 |
| 3.00 | | | | | | | | | | | 3.00 |
| 3.50 | | | | | | | | | | | 3.50 |
| 4.00 | | | | | | | | | | | 4.00 |
| 4.50 | | | | | | | | | | | 4.50 |
| 5.00 | | | | | | | | | | | 5.00 |

**consistency:**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| ST | stiff |
| VST | very stiff |
| H | hard |
| WC | well compacted |

**relative density:**

| | |
|---|---|
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

EL: extremly low strength

**moisture:**

| | |
|---|---|
| D | Dry |
| M | Moist |
| W | Wet |
| S | Saturated |

**water:** water level; level risen to; water inflow

**soil classification:** soil is classified in accordance with AS1726 unless otherwise noted

**Notes:**

Di - Discrete Sample
D - Duplicate Sample
No groundwater was encountered
Disturbed Sample

**sampling / testing:**

intact sample from core
T intact tube sample
Standard Penetration Test
B Bulk sample
Supp Su from Pocket Penetrometer
Suv Su from Field Vane Shear test

# BOREHOLE LOG

**BOREHOLE No: BH2**

**Page:** 1 **of** 1

| | | | | | |
|---|---|---|---|---|---|
| Client: | Bathla Group | Drilling Co: | Geotesta | Easting: | --- |
| Project: | 495 Fourth Avenue, Austral | Driller: | A.G | Northing: | --- |
| Job No: | NE996 | Rig Type: | Mounted Rig | Grid Ref: | See Figure 1 |
| Location: | 495 Fourth Avenue, Austral, NSW, 2179 | Inclination: | Vertical | Collar RL: | |
| Date Drilled: | 14/10/21 | Bearing: | Vertical | Logged by: | T.S Checked by: M.H.B |

*Test Method: AS 1289.6.3.2-1997 & AS 1726-2017*

| Depth (m) | Drilling Method | Graphic Log | Group Symbol | MATERIAL DESCRIPTION<br>Type, colour, particle size and shape, structure | Moisture | Consistency / Strength | DCP blows/100mm | FIELD TESTS & NOTES | Sampling / Runs | Water Levels | Depth (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | | | | | | | | | | | 0.00 |
| | | | | **TOPSOIL**, Silty CLAY with rootlets | M | | 1 | | | | |
| | | | CI | **Silty CLAY**, high to medium plasticity, dark brown<br>Grades: becoming orange-brown mottled grey | | | 1<br>2 | | | | |
| 0.50 | | | | | | F | 2<br>2 | ● Di10 at 0.1m<br>● S2 at 1.0m | | | 0.50 |
| | | | | | M | | 2 | | | | |
| | | | | Grades: becoming yellow-brown | | | 3 | | | | |
| | | | | | | VST | 6<br>9 | Refusal at 0.9m<br>20 blows reached | | | |
| 1.00 | | | | with shale fragments | | | | | | | 1.00 |
| | | | | **SHALE**, with clay seam, extremely weathered, very low strength, light brown<br>Grades: interbedded sandstone and shale | | | | | | | |
| 1.50 | | | | | M | | | | | | 1.50 |
| 2.00 | | | | Borehole terminated at 2.0m, Refusal | | | | | | | 2.00 |
| 2.50 | Solid Flight Auger | | | | | | | | | | 2.50 |
| 3.00 | | | | | | | | | | | 3.00 |
| 3.50 | | | | | | | | | | | 3.50 |
| 4.00 | | | | | | | | | | | 4.00 |
| 4.50 | | | | | | | | | | | 4.50 |
| 5.00 | | | | | | | | | | | 5.00 |

**consistency:**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| ST | stiff |
| VST | very stiff |
| H | hard |
| WC | well compacted |

**relative density:**

| | |
|---|---|
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

EL: extremly low strength

**moisture:**

| | |
|---|---|
| D | Dry |
| M | Moist |
| W | Wet |
| S | Saturated |

**water:**

water level

level risen to

water inflow

**Notes:**

Di - Discrete Sample

D - Duplicate Sample

No groundwater was encountered

Disturbed Sample

**sampling / testing:**

intact sample from core

T intact tube sample

Standard Penetration Test

B Bulk sample

Supp Su from Pocket Penetrometer

Suv Su from Field Vane Shear test

**soil classification:**
soil is classified in accordance with AS1726 unless otherwise noted

# BOREHOLE LOG

**BOREHOLE No: BH3**

**Page:** 1 **of** 1

| | | | | | |
|---|---|---|---|---|---|
| Client: | Bathla Group | Drilling Co: | Geotesta | Easting: | --- |
| Project: | 495 Fourth Avenue, Austral | Driller: | A.G | Northing: | --- |
| Job No: | NE996 | Rig Type: | Mounted Rig | Grid Ref: | See Figure 1 |
| Location: | 495 Fourth Avenue, Austral, NSW, 2179 | Inclination: | Vertical | Collar RL: | |
| Date Drilled: | 14/10/21 | Bearing: | Vertical | Logged by: | T.S Checked by: M.H.B |

*Test Method: AS 1289.6.3.2-1997 & AS 1726-2017*

| Depth (m) | Drilling Method | Graphic Log | Group Symbol | MATERIAL DESCRIPTION<br>Type, colour, particle size and shape, structure | Moisture | Consistency / Strength | DCP blows/100mm | FIELD TESTS & NOTES | Sampling / Runs | Water Levels | Depth (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | | | | | | | | | | | 0.00 |
| | | | | **TOPSOIL**, Silty CLAY with rootlets | M | | 1<br>1 | Di20 at 0.15m | | | |
| | | | CI | **Silty CLAY**, high to medium plasticity, dark brown | | F | 2<br>2 | D2 at 0.15m<br>S3 at 0.5m | | | |
| 0.50 | | | | Grades: becoming orange-brown | M | | 1<br>2 | Att2 at 0.7m | | | 0.50 |
| | | | | with shale fragments | | VST | 5<br>6 | Refusal at 0.8m<br>20 blows reached | | | |
| 1.00 | | | | **SHALE**, with clay seam, extremely to highly weathered, very low | | | | | | | 1.00 |
| 1.50 | | | | | M | | | | | | 1.50 |
| 2.00 | | | | | | | | | | | 2.00 |
| 2.50 | Solid Flight Auger | | | Borehole terminated at 2.5m, Refusal | | | | | | | 2.50 |
| 3.00 | | | | | | | | | | | 3.00 |
| 3.50 | | | | | | | | | | | 3.50 |
| 4.00 | | | | | | | | | | | 4.00 |
| 4.50 | | | | | | | | | | | 4.50 |
| 5.00 | | | | | | | | | | | 5.00 |

**consistency:**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| ST | stiff |
| VST | very stiff |
| H | hard |
| WC | well compacted |

**relative density:**

| | |
|---|---|
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

EL: extremly low strength

**moisture:**

| | |
|---|---|
| D | Dry |
| M | Moist |
| W | Wet |
| S | Saturated |

**water:**

water level

level risen to

water inflow

**soil classification:**

soil is classified in accordance with AS1726 unless otherwise noted

**Notes:**

Di - Discrete Sample

D - Duplicate Sample

No groundwater was encountered

Disturbed Sample

**sampling / testing:**

intact sample from core

intact tube sample

Standard Penetration Test

| | |
|---|---|
| B | Bulk sample |
| Supp | Su from Pocket Penetrometer |
| Suv | Su from Field Vane Shear test |

# Appendix B

## Laboratory Test Results



GEOTESTA PTY LTD | ABN 9185162081| 6/20-22 Foundry Road, Seven Hills NSW 2147
Phone: 1300 852216 |email: info@geotesta.com.au

# Material Test Report

**Report Number:** **A201021.1221.02-9**
**Issue Number:** 1
**Date Issued:** 22/10/2021
**Client:** Geotesta
20/01 Talavera Road, Macquarie Park NSW 2113
**Project Number:** A201021.1221.02
**Project Name:** 495 Fourth Avenue, Austral
**Project Location:** Austral, NSW
**Client Reference:** NE996
**Work Request:** 4091
**Sample Number:** 21-4091A
**Date Sampled:** 14/10/2021
**Dates Tested:** 22/10/2021 - 22/10/2021
**Sampling Method:** Sampled by Client
*The results apply to the sample as received*
**Remarks:** SLS Reference: A201021.1221.02 BH1, BH3
**Sample Location:** **BH1 , Depth: 0.50**
**Material:** Silty Clay: brown mottled orange


Sydney Laboratory Services
Construction and Material Testing Laboratory
Unit 1, 68-72 Asquith Street Silverwater NSW 2128
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Email: Ashwin.Tatikonda@ade.group


Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Ashwin Tatikonda
Laboratory Manager
NATA Accredited Laboratory Number: 14664

| Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1) | | Min | Max |
|---|---|---|---|
| Sample History | Oven Dried / Air Dried / Natural / Unknown | | |
| Preparation Method | Wet Sieve / Dry Sieve / Both Sieves / Unknown | | |
| Liquid Limit (%) | 50 | | |
| Plastic Limit (%) | 18 | | |
| **Plasticity Index (%)** | **32** | | |

| Linear Shrinkage (AS1289 3.4.1) | | Min | Max |
|---|---|---|---|
| Moisture Condition Determined By | AS 1289.3.1.1 / AS 1289.3.1.2 / AS 1289.3.9.1 / AS 1289.3.9.2 | | |
| Linear Shrinkage (%) | 13.5 | | |
| Cracking Crumbling Curling | Cracking | | |




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*Results relate only to the items tested/sampled.*

# Material Test Report

**Report Number:** **A201021.1221.02-9**
**Issue Number:** 1
**Date Issued:** 22/10/2021
**Client:** Geotesta
20/01 Talavera Road, Macquarie Park NSW 2113
**Project Number:** A201021.1221.02
**Project Name:** 495 Fourth Avenue, Austral
**Project Location:** Austral, NSW
**Client Reference:** NE996
**Work Request:** 4091
**Sample Number:** 21-4091B
**Date Sampled:** 14/10/2021
**Dates Tested:** 22/10/2021 - 22/10/2021
**Sampling Method:** Sampled by Client
*The results apply to the sample as received*
**Remarks:** SLS Reference: A201021.1221.02 BH1, BH3
**Sample Location:** **BH3 , Depth: 0.70**
**Material:** Silty Clay: brown mottled grey


Sydney Laboratory Services
Construction and Material Testing Laboratory
Unit 1, 68-72 Asquith Street Silverwater NSW 2128
Phone: (02) 9648 6669
Email: Ashwin.Tatikonda@ade.group


Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Ashwin Tatikonda
Laboratory Manager
NATA Accredited Laboratory Number: 14664

| Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1) | | Min | Max |
|---|---|---|---|
| Sample History | Oven Dried / Air Dried / Natural / Unknown | | |
| Preparation Method | Wet Sieve / Dry Sieve / Both Sieves / Unknown | | |
| Liquid Limit (%) | 53 | | |
| Plastic Limit (%) | 20 | | |
| **Plasticity Index (%)** | **33** | | |

| Linear Shrinkage (AS1289 3.4.1) | | Min | Max |
|---|---|---|---|
| Moisture Condition Determined By | AS 1289.3.1.1 / AS 1289.3.1.2 / AS 1289.3.9.1 / AS 1289.3.9.2 | | |
| Linear Shrinkage (%) | 14.5 | | |
| Cracking Crumbling Curling | Cracking | | |




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*Results relate only to the items tested/sampled.*

eurofins | Environment Testing

# Certificate of Analysis

**Geotesta Pty Ltd (NSW)**
**Unit 6, 20/22 Foundry Road**
**Seven Hills**
**NSW 2147**

**NATA Accredited**
**Accreditation Number 1261**
**Site Number 18217**

Accredited for compliance with ISO/IEC 17025 – Testing
NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates.

**Attention:** **- Mohammad Hossein Bazyar**

**Report** **834460-S**
Project name 495 FOURTH AVENUE AUSTRAL
Project ID NE996
Received Date Oct 22, 2021

| **Client Sample ID** | | | **S1(0.8M)** | **S2(1.0M)** | **S3(0.5M)** |
|---|---|---|---|---|---|
| **Sample Matrix** | | | **Soil** | **Soil** | **Soil** |
| **Eurofins Sample No.** | | | **S21-Oc35738** | **S21-Oc35739** | **S21-Oc35740** |
| **Date Sampled** | | | **Oct 14, 2021** | **Oct 14, 2021** | **Oct 14, 2021** |
| Test/Reference | LOR | Unit | | | |
| | | | | | |
| Conductivity (1:5 aqueous extract at 25°C as rec.) | 10 | uS/cm | 18 | 34 | 14 |
| pH (1:5 Aqueous extract at 25°C as rec.) | 0.1 | pH Units | 6.7 | 5.8 | 6.0 |
| Sulphate (as SO4) | 10 | mg/kg | < 10 | 20 | 10 |
| % Moisture | 1 | % | 24 | 10 | 20 |
| Chloride | 10 | mg/kg | - | - | < 10 |
| Resistivity* | 0.5 | ohm.m | - | - | 700 |

## Sample History

Where samples are submitted/analysed over several days, the last date of extraction is reported.

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 |
|---|---|---|---|
| Conductivity (1:5 aqueous extract at 25°C as rec.) | Sydney | Oct 22, 2021 | 7 Days |
| - Method: LTM-INO-4030 Conductivity | | | |
| pH (1:5 Aqueous extract at 25°C as rec.) | Sydney | Oct 22, 2021 | 7 Days |
| - Method: LTM-GEN-7090 pH by ISE | | | |
| Sulphate (as SO4) | Sydney | Oct 22, 2021 | 28 Days |
| - Method: In-house method LTM-INO-4270 Sulphate by Ion Chromatograph | | | |
| Chloride | Sydney | Oct 22, 2021 | 28 Days |
| - Method: In-house method LTM-INO-4270 Anions by Ion Chromatography | | | |
| % Moisture | Sydney | Oct 22, 2021 | 14 Days |
| - Method: LTM-GEN-7080 Moisture | | | |

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NATA # 1261 Site # 1254

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Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

**Brisbane**
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NATA # 1261 Site # 20794

**Newcastle**
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**Company Name:** Geotesta Pty Ltd (NSW)
**Address:** Unit 6, 20/22 Foundry Road
Seven Hills
NSW 2147

**Project Name:** 495 FOURTH AVENUE AUSTRAL
**Project ID:** NE996

**Order No.:**
**Report #:** 834460
**Phone:** 1300852 216
**Fax:**

**Received:** Oct 15, 2021 6:10 PM
**Due:** Oct 25, 2021
**Priority:** 5 Day
**Contact Name:** - Mohammad Hossein Bazyar

**Eurofins Analytical Services Manager : Asim Khan**

| Sample Detail | | | | | | Conductivity (1:5 aqueous extract at 25°C as rec.) | pH (1:5 Aqueous extract at 25°C as rec.) | Sulphate (as SO4) | Aggressivity Soil Set | Moisture Set |
|---|---|---|---|---|---|---|---|---|---|---|
| **Melbourne Laboratory - NATA # 1261 Site # 1254** | | | | | | | | | | |
| **Sydney Laboratory - NATA # 1261 Site # 18217** | | | | | | X | X | X | X | X |
| **Brisbane Laboratory - NATA # 1261 Site # 20794** | | | | | | | | | | |
| **Mayfield Laboratory - NATA # 1261 Site # 25079** | | | | | | | | | | |
| **Perth Laboratory - NATA # 2377 Site # 2370** | | | | | | | | | | |
| **External Laboratory** | | | | | | | | | | |
| **No** | **Sample ID** | **Sample Date** | **Sampling Time** | **Matrix** | **LAB ID** | | | | | |
| 1 | S1(0.8M) | Oct 14, 2021 | | Soil | S21-Oc35738 | X | X | X | | X |
| 2 | S2(1.0M) | Oct 14, 2021 | | Soil | S21-Oc35739 | X | X | X | | X |
| 3 | S3(0.5M) | Oct 14, 2021 | | Soil | S21-Oc35740 | | | | X | X |
| **Test Counts** | | | | | | 2 | 2 | 2 | 1 | 3 |

## 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 1999, as amended May 2013 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. Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
9. 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.

### 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 |
| **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 |
| **WA DWER** | Sum of PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA |

### QC - Acceptance Criteria

The acceptance criteria should be used as a guide only and may be different when site specific Sampling Analysis and Quality Plan (SAQP) have been implemented

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%

NOTE: pH duplicates are reported as a range not as RPD

Surrogate Recoveries: Recoveries must lie between 20-130% Phenols & 50-150% PFASs..

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

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### 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. 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.
4. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of recovery the term "INT" appears against that analyte.
5. For Matrix Spikes and LCS results a dash "-" in the report means that the specific analyte was not added to the QC sample.
6. 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** | | | | | | | |
| Conductivity (1:5 aqueous extract at 25°C as rec.) | uS/cm | < 10 | | | 10 | Pass | |
| Sulphate (as SO4) | mg/kg | < 10 | | | 10 | Pass | |
| Chloride | mg/kg | < 10 | | | 10 | Pass | |
| **LCS - % Recovery** | | | | | | | |
| Conductivity (1:5 aqueous extract at 25°C as rec.) | % | 91 | | | 70-130 | Pass | |
| Sulphate (as SO4) | % | 108 | | | 70-130 | Pass | |
| Chloride | % | 106 | | | 70-130 | Pass | |
| Resistivity* | % | 91 | | | 70-130 | Pass | |

| Test | Lab Sample ID | QA Source | Units | Result 1 | | | Acceptance Limits | Pass Limits | Qualifying Code |
|---|---|---|---|---|---|---|---|---|---|
| **Spike - % Recovery** | | | | | | | | | |
| | | | | Result 1 | | | | | |
| Sulphate (as SO4) | S21-Oc31279 | NCP | % | 112 | | | 70-130 | Pass | |
| **Spike - % Recovery** | | | | | | | | | |
| | | | | Result 1 | | | | | |
| Chloride | S21-Oc31279 | NCP | % | 110 | | | 70-130 | Pass | |

| Test | Lab Sample ID | QA Source | Units | Result 1 | Result 2 | RPD | Acceptance Limits | Pass Limits | Qualifying Code |
|---|---|---|---|---|---|---|---|---|---|
| **Duplicate** | | | | | | | | | |
| | | | | Result 1 | Result 2 | RPD | | | |
| Conductivity (1:5 aqueous extract at 25°C as rec.) | S21-Oc45636 | NCP | uS/cm | 280 | 290 | 1.7 | 30% | Pass | |
| pH (1:5 Aqueous extract at 25°C as rec.) | S21-Oc45636 | NCP | pH Units | 5.8 | 5.7 | <1 | 30% | Pass | |
| Sulphate (as SO4) | N21-Oc26313 | NCP | mg/kg | 17 | 16 | 5.0 | 30% | Pass | |
| **Duplicate** | | | | | | | | | |
| | | | | Result 1 | Result 2 | RPD | | | |
| Chloride | S21-Oc31279 | NCP | mg/kg | < 10 | < 10 | <1 | 30% | Pass | |
| Resistivity* | S21-Oc45636 | NCP | ohm.m | 35 | 35 | 1.7 | 30% | Pass | |

## Comments

### Sample Integrity

| | |
|---|---|
| Custody Seals Intact (if used) | N/A |
| Attempt to Chill was evident | Yes |
| 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:

| | |
|---|---|
| Asim Khan | Analytical Services Manager |
| Charl Du Preez | Senior Analyst-Inorganic (NSW) |

**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.

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