Proposed Subdivision - Preliminary Geotechnical Assessment

20 & 20A Cantwell Road, Lochinvar

NEW24P-0120-AB
29 July 2024

Qualtest
LABORATORY (NSW) PTY LTD

GEOTECHNICAL I LABORATORY I EARTHWORKS I QUARRY I CONSTRUCTION MATERIAL TESTING

29 July 2024

Trustee of the Roman Catholic Church for the Diocese of Maitland Newcastle
c/- Monteath & Powys
Suite 13 - 125 Bull St
Newcastle West NSW 2302

Attention: Chad Beecham

Dear Chad

RE: PROPOSED SUBDIVISION
20 & 20A CANTWELL ROAD, LOCHINVAR
PRELIMINARY GEOTECHNICAL ASSESSMENT

Please find enclosed our Geotechnical Assessment report for the proposed subdivision, to be located at 20 & 20A Cantwell Road, Lochinvar.

The report includes recommendations for preliminary Site Classification in accordance with AS2870-2011, "*Residential Slabs and Footings*", pavement design and construction for proposed half road widening of Cantwell Road pavement (including kerb and gutter) and for internal subdivision roads, recommendations for detention basin construction, excavation conditions and site earthworks.

If you have any questions regarding this report, please do not hesitate to contact Ben Edwards, Shannon Kelly or the undersigned.

For and on behalf of Qualtest Laboratory (NSW) Pty Ltd

Jason Lee

Jason Lee
Principal Geotechnical Engineer

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1.0 Introduction

Qualtest Laboratory NSW Pty Ltd (Qualtest) is pleased to present this report to Trustee of the Roman Catholic Church for the Diocese of Maitland Newcastle, c/- Monteath & Powys (M&P), for the proposed residential subdivision, to be located at Lots 1 & 2 DP 1299958, known as No. 20 & 20A Cantwell Road, Lochinvar.

Based on the information provided in an email from M&P on 12 October 2023, and information obtained by Qualtest, it is understood that the site is about 14.57ha in area, and is proposed to be subdivided into 138 residential lots, with associated roads, services, and water quality detention basins.

The scope of work for the geotechnical assessment included providing discussion and recommendations on the following:

- Site capability assessment - Assessing the suitability of the site for development from a geotechnical perspective, including risk of slope instability and associated geotechnical constraints;
- Preliminary site classification to AS2870-2011, '*Residential Slabs and Footings*';
- Pavement design and construction in accordance with the requirements of Maitland City Council (MCC) for:
    - Internal subdivision roads;
    - Construction of half road widening of Cantwell Road along the full frontage of the development site, and 200m connection to the New England Highway;
- Excavation conditions and depth to rock (where encountered);
- Site preparation;
- The suitability of the site soils for use as fill and fill construction procedures;
- How settlement for fill over 2m will be addressed;
- Detention Basin design and construction recommendations, including excavation and foundation conditions, key in details, embankment construction and batter slopes. Understood to include two detention basins, locations to be confirmed;
- Special requirements for construction procedures and site drainage.

This report presents the results of the field work investigations and laboratory testing, and provides recommendations for the scope outlined above.

2.0 Desktop study

2.1 Previous Reports

No previous geotechnical information for the subject site has been provided to Qualtest during this assessment. Qualtest has undertaken assessment and reporting for an adjoining site located to the east of the subject site, and a number of nearby subdivision developments to the south of the New England Highway, with results of those assessments given consideration during this assessment.

A Preliminary and Detailed Site Investigation (PDSI) (contamination assessment) has been prepared concurrently to this preliminary geotechnical assessment by Qualtest (ref. NEW24P-0120-AA, July 2024). Selected information from the PDSI is included in this report. Reference should be made to the PDSI report for further details.

2.2 Acid Sulfate Soil Risk Map

The 1:25,000 Greta Acid Sulfate Soil Risk Map shows the site is located in an area of no known occurrence of Acid Sulfate Soils.

2.3 Geology Map

Reference to the 1:100,000 Newcastle Coalfield Regional Geology Sheet indicates the site to be underlain by the Lochinvar Formation of the Dalwood Group, which is characterised by Basalt, Siltstone, and Sandstone rock types.

2.4 Soil Landscape Map

The soil landscape map published on the Department of Planning, Industry and Environment (DPIE) eSPADE version 2.1 is shown below.

Figure 1: Soil Landscape Map Overlay: Soil landscape units are labelled in yellow text. Approximate site boundary shown in white.

The south-western and north-eastern areas (majority of the site) are mapped as the North Eelah Landscape (nex), and typical qualities and limitations include the following: localised shallow soils, localised rock outcrop hazard, widespread foundation hazard, widespread productive arable land, widespread recharge zone, localised gully erosion hazard, widespread sheet erosion hazard, localised high run-on, localised seasonal waterlogging.

The middle area is mapped as the Lovedale Landscape (lvv), and typical qualities and limitations include the following: localised non-cohesive soils, widespread foundation hazard, localised discharge zone, localised salinity hazard, localised gully erosion hazard, widespread sheet erosion hazard, localised streambank erosion hazard, widespread high run-on, widespread poor drainage, localised permanent waterlogging, localised seasonal waterlogging, localised flood hazard.

3.0 Field Work

The field work investigations were carried out between 12 & 13 June 2024 and comprised of:

- DBYD search and scanning of proposed test locations using an accredited professional cable locator to check for the presence of underground services;
- Site walkover to make observations of surface features at the property and in the immediate surrounding area;
- Drilling of 5 boreholes (BHQ01 to BHQ05) using a 2.7 tonne excavator equipped with a 300mm diameter auger attachment, to depths between 0.71m and 1.50m;
- Excavation of 18 test pits (TPQ06 to TPQ23) using a 2.7 tonne excavator equipped with a 300mm wide bucket. Test pits were terminated at depths of between 0.50m and 2.50m;
- Undisturbed samples (U50 tubes) and bulk disturbed samples were taken for subsequent laboratory testing;
- Test pits and boreholes were backfilled with the excavation spoil and compacted using the excavator bucket/auger and tracks.

Investigations were carried out by an experienced Geotechnical Engineer from Qualtest who located the test pits and boreholes, carried out the testing and sampling, produced field logs of the test pits and boreholes, and made observations of the site surface conditions.

Approximate test pit and borehole locations are shown on the attached Figure AB1. Test pits and boreholes were located in the field by handheld GPS and relative to existing site features including topographic features, lot boundaries, existing developments and trees.

Engineering logs of the test pits and boreholes are presented in Appendix A.

4.0 Site Description

4.1 Surface Conditions

The site comprises Lot 1 and Lot 2 DP1299958, known as 20 & 20A Cantwell Road, Lochinvar. The site comprises an irregular shape with a total plan area of about 14.6 hectares, with the site location and area shown in Figure AB1 attached.

The site is bounded by vacant land to the north and east, by St Joseph's College (school) and vacant land to the south, and by Cantwell Road to the west, with rural residential properties to the west of Cantwell Road.

The site is located within a region of gently undulating topography, on undulating local hills / spurs intersected by a tributary of Lochinvar Creek, which generally drains through the middle of the site towards the north. The creek tributary turns towards the northwest in the northern part of the site, and crosses the western side of the northern boundary. The creek was observed to contain stagnant water, to a maximum depth of about 0.5m.

The eastern half of the site was observed to slope at angles of about 4° to 5° towards the west and southwest, towards the tributary of Lochinvar Creek. The western half of the site was observed to be near flat, generally sloping at angles of about 2° or less towards the north and northeast, towards the tributary of Lochinvar Creek. Slopes in the south-western area are generally about 2° or less towards the west. Locally steeper slopes are present along the creek banks.

Based on the provided detail survey drawing (Ref No: 22/0064, Sheet No: 1 / 15, Revision: 1, dated: 07/03/2024, prepared by Monteath & Powys), ground levels are understood to be in the order of RL28.6m (AHD) and RL24.5m (AHD) on the southwest and northwest corners of the site, respectively; and, up to about RL32m to RL42m along the eastern side of the site on the mid slopes of a northwest trending spur.

Observed development was generally limited to wire fencing generally located around the lot boundary. Some concrete and bricks were observed in the central portion of Lochinvar Creek (in the vicinity of TPQ14), likely used for a former stock crossing. A ballast rock crossing was observed in southern portion of Lochinvar Creek, likely used for erosion protection and vehicle crossing.

Vegetation generally comprises of established grass cover on most of the site, with some scattered trees generally located adjacent to the creek in the middle portion of the site, and in the north-eastern area.

During the site investigation which was carried out following significant rainfall, the majority of the site appeared to generally be poorly to moderately drained primarily by way of downhill surface runoff following natural ground contours, generally towards the lower lying areas (creek) in the middle portion of the site.

The majority of the site was judged to have fair to poor trafficability by way of 4WD vehicle on the day of the field investigation. Much of the site was observed to have wet boggy / moisture affected ground surface, with multiple small areas of ponded water, (noting the fieldwork was conducted following a recent period of wet weather / rainfall in the month prior).

Selected photographs of the site taken during days of the site investigations are shown below.

Photograph 1: Facing northeast from near the northwestern corner of site (near BHQ01).

Photograph 2: Facing southwest from near the northwestern corner of site (near BHQ01).

Photograph 3: Facing northeast from approximately 12m southwest of BHQ02. BHQ02 on other side of Cantwell Road.

Photograph 4: Facing south, along Cantwell Road from approximately 12m southwest of BHQ02.

Photograph 5: Facing northeast from approximately 6m northwest of BHQ05, showing Cantwell Road.

Photograph 6: Facing south from approximately 6m northwest of BHQ05. Excavator at borehole location (BHQ05). New England Highway in background.

Photograph 7: Facing southwest from near TPQ12. Showing Excavator tracks formed within area of soft / moisture affected ground surface, localised ponded water.

Photograph 8: Facing northwest from near TPQ12. Showing excavation spoil from TPQ12.

Photograph 9: Facing southeast from near TPQ06 in the northwestern part of site.

Photograph 10: Facing south from near TPQ06 in the northwestern part of site.

Photograph 11: Facing north from near TPQ10 in the central part of the site.

Photograph 12: Facing northeast towards Lochinvar Creek from near TPQ10 in the central part of the site.

Photograph 13: Facing west from near TPQ18, towards existing Lochinvar Creek.

Photograph 14: Facing northwest from near TPQ18, towards existing Lochinvar Creek in left of photograph.

Photograph 15: Facing southwest from near TPQ17.

Photograph 16: Facing northwest from near TPQ17.

Photograph 17: Facing southwest from beside southern boundary of the site. Showing ballast crossing area within Lochinvar Creek.

Photograph 18: Facing west from near TPQ14, within central part of site. Showing a localised area with existing building rubble, generally comprising of concrete blocks within the base of Lochinvar Creek.

4.2 Subsurface Conditions

Table 1 provides a summary of the typical soil types encountered at the test pit and borehole locations during the field investigation, divided into representative geotechnical units.

Table 2 contains a summary of the distribution of the above geotechnical units at the test pit and borehole locations.

TABLE 1 – SUMMARY OF GEOTECHNICAL UNITS AND SOIL TYPES

Unit	Soil Type	Description
1A	Fill – Topsoil / root affected.	Sandy Clayey GRAVEL / Sandy Gravelly CLAY - fine to medium grained angular, pale brown to grey-brown, fines of low to medium plasticity, fine to coarse grained sand, root affected. Sandy CLAY - medium to high plasticity, grey-brown, with brown, fine to coarse (mostly fine to medium) grained sand, with fine to medium grained angular gravel in places, root affected.

Unit	Soil Type	Description
1B	Uncontrolled Fill	Sandy CLAY, CLAY - medium to high plasticity, brown to dark brown, trace dark grey, fine to coarse grained sand, trace fine grained angular gravel. MIXTURE OF SOIL AND CONCRETE BLOCKS: About 40% concrete blocks up to approximately 0.5m in size in matrix of Clayey GRAVEL - fine to coarse grained (mostly fine to medium) angular, dark brown, fines of medium to high plasticity, with some gravel coal chitter, trace steel and brick fragments. (TPQ14 only).
2	Topsoil	Sandy CLAY, CLAY - medium to high plasticity, colour variations of dark grey-brown, grey, pale grey to pale brown, brown, sand generally fine grained, root affected.
3	Slopewash / Alluvium	Not encountered within test pits during current investigation.
4	Residual Soil	CLAY, Silty CLAY - medium to high plasticity, colour variations of grey-brown, grey to pale grey, pale brown, pale grey to white, with some pale orange, red-brown, with some silt / fine grained sand, trace fine to medium grained, rounded gravel in places, with some extremely weathered / highly weathered pockets/bands in places. Silty CLAY - Low to medium plasticity, pale grey to white and pale orange to orange, with some extremely weathered pockets. Sandy CLAY - medium plasticity, pale grey to white and pale brown, with some pale orange to orange, fine to coarse grained (mostly fine to medium) grained sand. Sandy Gravelly CLAY / Clayey GRAVEL - medium plasticity, grey-brown and red-brown, fine to medium grained angular gravel, fine to coarse grained sand.
5	Extremely Weathered (XW) Rock with soil properties	Extremely Weathered Sandy Siltstone with soil properties: breaks down into Sandy CLAY – medium plasticity, orange-brown and pale grey to pale brown, fine grained sand, trace fine to medium grained, rounded gravel. Extremely Weathered Sandy Siltstone with soil properties: breaks down into Silty CLAY - low to medium plasticity, orange-brown and pale grey to white with some highly weathered pockets/bands.
6	Highly Weathered (HW) to Moderately Weathered (MW) Rock	Sandy SILTSTONE - orange-brown and grey to white, variable estimated strength ranging from low to medium, to high strength, fractured in places, with extremely weathered pockets in places. ANDESITE - pale grey to pale brown, with some white and dark grey, estimated low to medium strength.

TABLE 2 – SUMMARY OF GEOTECHNICAL UNITS ENCOUNTERED AT EACH TEST LOCATION

Location	Unit 1A Fill – Topsoil	Unit 1B Uncontrolled Fill	Unit 2 Topsoil	Unit 3 Slopewash, Alluvium	Unit 4 Residual Soil	Unit 5 XW Rock	Unit 6 HW to MW Rock
	Depth in metres (m)						
Cantwell Road							
BHQ01	0.00 - 0.10	0.10 - 0.25	-	-	0.25 - 1.50	-	-
BHQ02	0.00 - 0.05	0.05 - 0.35	-	-	0.35 - 0.70	-	0.70 - 0.71*
BHQ03	0.00 - 0.10	0.10 - 0.30	-	-	0.30 - 0.90	-	0.90 - 0.92*
BHQ04	-	-	0.00 - 0.10	-	0.10 - 1.50	-	-
BHQ05	-	-	0.00 - 0.20	-	0.20 - 1.50	-	-
Internal Subdivision Area							
TPQ06	-	-	0.00 - 0.10	-	0.10 - 2.30	-	-
TPQ07	-	-	0.00 - 0.10	-	0.10 - 2.40	-	-
TPQ08	-	-	0.00 - 0.15	-	0.15 - 2.00^	-	-
TPQ09	-	-	0.00 - 0.10	-	0.10 - 2.30^	-	-
TPQ10	-	-	0.00 - 0.10	-	0.10 - 2.40*	-	-
TPQ11	-	-	0.00 - 0.10	-	0.10 - 2.30^	-	-
TPQ12	-	-	0.00 - 0.10	-	0.10 - 2.50	-	-
TPQ13	-	-	0.00 - 0.10	-	0.10 - 1.80	-	1.80 - 1.90*
TPQ14	-	0.00 - 0.20	-	-	0.20 - 0.50	-	-
TPQ15	-	-	0.00 - 0.35	-	0.35 - 1.60	1.60 - 1.70	-

Location	Unit 1A Fill – Topsoil	Unit 1B Uncontrolled Fill	Unit 2 Topsoil	Unit 3 Slopewash, Alluvium	Unit 4 Residual Soil	Unit 5 XW Rock	Unit 6 HW to MW Rock
	Depth in metres (m)						
TPQ16	-	-	0.00 - 015	-	0.15 - 1.00	1.00 - 1.40	1.40 - 1.42*
TPQ17	-	-	0.00 - 0.10	-	0.10 - 0.90	0.90 - 1.30	1.30 - 1.40^
TPQ18	-	-	0.00 - 0.10	-	0.10 - 2.20	-	-
TPQ19	-	-	0.00 - 0.10	-	0.10 - 2.00^	-	-
TPQ20	-	-	0.00 - 0.15	-	0.15 - 2.00	-	-
TPQ21	-	-	0.00 - 0.15	-	0.15 - 2.10	-	-
TPQ22	0.00 - 0.20	-	-	-	0.20 - 0.60	-	-
TPQ23	0.00 - 0.20	-	-	-	0.20 - 0.60	-	-

Notes:

^ = Slow to very slow progress of 2.7 tonne excavator.

* = Refusal or Practical refusal of 2.7 tonne excavator met on Highly Weathered Rock.

No groundwater levels or inflows were encountered in the boreholes or test pits during the limited time that they remained open on the day of the field investigations.

It should be noted that groundwater conditions can vary due to rainfall and other influences including regional groundwater flow, temperature, permeability, recharge areas, surface condition, and subsoil drainage.

5.0 Laboratory Testing

Samples collected during the current field investigations were returned to our NATA accredited Newcastle Laboratory for testing which comprised of:

- (12 no.) California Bearing Ratio (CBR, 10 day soaked) & Standard Compaction;
- (12 no.) Shrink / Swell tests;
- (5 no.) Particle Size Distribution;
- (5 no.) Atterberg Limits; and
- (5 no.) Emerson Crumb.

Results of the laboratory testing are presented in Appendix B, with a summary of the CBR, Shrink/Swell test, Particle Size Distribution, Atterberg Limits, and Emerson Crumb test results presented in Tables 3, 4 and 5.

TABLE 3 – SUMMARY OF CBR TESTING RESULTS

Location	Sample Depth (m)	Field Moisture Content (%)	Optimum Moisture Content (%)	Relationship of Field MC to OMC (%)	Swell (%)	CBR (%)
BHQ01	0.30 – 0.50	23.5	23.5	OMC	2.0	2.5
BHQ02	0.35 – 0.55	18.3	19.5	1.2 DRY	2.0	3.0
BHQ03	0.30 – 0.50	27.0	27.0	OMC	2.0	4.5
BHQ05	0.30 – 0.50	27.1	29.0	1.9 DRY	0.5	5
TPQ08	0.30 – 0.50	22.5	22.0	0.5 WET	2.0	5
TPQ09	0.30 – 0.50	22.7	23.5	0.8 DRY	2.0	2.5
TPQ12	0.30 – 0.50	19.5	25.0	5.5 DRY	**2.5**	2.5
TPQ13	0.30 – 0.50	22.9	23.5	0.6 DRY	2.0	2.5
TPQ15	0.30 – 0.50	16.1	17.5	1.4 DRY	0.5	3.5
TPQ16	0.30 – 0.50	23.4	22.5	0.9 WET	**2.5**	2.5
TPQ18	0.30 – 0.50	19.6	19.5	0.1 WET	0.5	4.5
TPQ19	0.30 – 0.50	17.3	17.0	0.3 WET	0.5	3.5

TABLE 4 – SUMMARY OF SHRINK / SWELL TESTING RESULTS

Location	**Depth (m)**	**Material Description**	**I_{ss} (%)**
TPQ06	0.50 – 0.65	(CH) CLAY	5.2
TPQ08	0.50 – 0.70	(CH) CLAY	3.6
TPQ09	0.60 – 0.75	(CH) CLAY	5.2
TPQ10	0.50 – 0.70	(CH) CLAY	2.7
TPQ11	1.00 – 1.20	(CH) CLAY	3.2
TPQ12	0.70 – 0.85	(CH) CLAY	4.3
TPQ13	0.50 – 0.65	(CH) CLAY	2.9
TPQ15	0.50 – 0.70	(CH) CLAY	2.0
TPQ16	0.50 – 0.65	(CH) CLAY	1.9
TPQ17	0.30 – 0.50	(CH) CLAY	4.0
TPQ18	0.50 – 0.70	(CH) CLAY	3.9
TPQ19	0.50 – 0.80	(CH) CLAY	1.8

The results of laboratory shrink / swell tests indicate that the colluvial and residual clays at the site are generally highly reactive.

TABLE 5 – SUMMARY OF PARTICLE SIZE DISTRIBUTION, ATTERBERG LIMITS AND EMERSON CRUMB TESTING RESULTS

Location and Depth (m)	Material Description	Grading		Atterberg Limits			Emerson Class
		Sieve (mm)	% Pass	Liquid Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)	
TPQ06 0.30 – 0.50	(CH) CLAY	37.5	100	88	66	17.5	2
		19.0	100				
		2.36	100				
		0.075	71				
TPQ20 0.50 – 0.80	(CH) CLAY	37.5	100	59	43	18.5	3
		19.0	100				
		2.36	100				
		0.075	71				
TPQ20 1.50 – 1.80	(CI/CH) CLAY / Sandy CLAY	37.5	100	43	29	12.0	2
		19.0	100				
		2.36	98				
		0.075	63				
TPQ21 0.50 – 0.80	(CH) Sandy CLAY	37.5	100	51	37	16.0	5
		19.0	100				
		2.36	98				
		0.075	45				
TPQ21 1.50 – 1.80	(CH) CLAY	37.5	100	58	42	18.0	4
		19.0	100				
		2.36	99				
		0.075	74				

6.0 Discussion and Recommendations

6.1 General

The site is considered suitable for development from a geotechnical viewpoint provided that development is carried out in accordance with sound engineering principles and good hillside practice (as set out in Appendix C), and with respect to the constraints and recommendations of this report, including geotechnical input during the design and construction phases.

Based upon the site testing and observations carried out during this preliminary assessment, geotechnical issues affecting capability for urban development identified at the site include:

- The presence of wet / boggy areas in parts of the site, as well as a watercourse, drainage depressions, and areas of ponded water. Although the wet/boggy areas appeared to be generally related to recent wet weather, and the residual soils logged at the test locations were generally of stiff or better consistency, these may include areas or layers of inadequate bearing capacity for support of footings / earthworks and construction plant. There is also potential for abnormal moisture conditions associated with prolonged wet conditions. Measures such as drainage improvements and localised over-excavation, deepened footings, subgrade treatment or bridging layers may be required.
- The presence or possible presence of localised areas of uncontrolled fill. Residential footings and pavements should be founded in suitable material beneath all uncontrolled fill, or the fill should be removed and replaced under engineering supervision.

Further geotechnical investigation and/or advice should be carried out during detailed design phase including for site classification, creek crossings, and footing/retention design where required.

6.2 Slope Stability and Recommended Geotechnical Constraints

6.2.1 Basis of Assessment

The risk of slope instability has been assessed from the observed site conditions using methods consistent with those presented in the Australian Geomechanics Society (AGS) publication "*Practice Note Guidelines for Landslide Risk Management, 2007*". Based on those methods, the risks to property associated with slope instability on the subject area have been assessed using the terms presented in AGS 2007, *Landslide Risk Assessment Qualitative Terminology for Use in Assessing Risk to Property*, extracts of which are attached in Appendix C.

The report provides an assessment of the risk of slope instability on the proposed development area. The report also recommends some geotechnical constraints for the site development in light of the slope instability assessment. The assessed risk to the proposed development is based on the geotechnical constraints and recommendations provided in this report being implemented.

The onus is on the owner, potential owner, or interested party to decide whether the assessed level of risk is acceptable taking into account the likely consequences of the risk and the recommended geotechnical constraints.

6.2.2 Principal Site Features and Evidence of Instability

The assessment of the risk of slope instability has been based on the site observations recorded in Section 3 and the principal site features summarised below:

- The site is located within a region of gently undulating topography, on undulating local hills / spurs intersected by a tributary of Lochinvar Creek, which generally drains through the middle of the site towards the north. The eastern half of the site was observed to slope at angles of about 4° to 5° towards the west and southwest, towards the tributary of Lochinvar Creek. The western half of the site was observed to be near flat, generally sloping at angles of about 2° or less towards the north and northeast, towards the tributary of Lochinvar Creek. Slopes in the south-western area are generally about 2° or less towards the west. Locally steeper slopes are present along the creek banks.
- Soil depths are assessed to generally range from about 0.7m to greater than 2.5m;
- Some wet / boggy areas and areas of ponded water were observed. These areas appeared to be generally related to recent wet weather. Water inflow was not encountered within test pits or boreholes on the lower lying parts of the site or within the vicinity of existing watercourse;
- No evidence of deep soil erosion at the site at the time of the field work; and,
- No obvious evidence of overall slope instability or significant damage attributable to slope related ground movement was observed on or in the vicinity of the site.

6.2.3 Hazard Identification

Elements at risk for the identified hazards are the proposed subdivision developments, which may include proposed residences, sheds, swimming pools, roads and driveways and / or other site infrastructure.

The following hazards that could potentially impact on this site are assessed as follows:

H1. Potential broad deep seated instability;

H2. Potential shallow instability such as overloading of slopes by excessive loads, unsuitable batters/support or unsuitable founding depths, or failure of fill not placed in a proper manner or subject to erosion by concentrated surface flows;

H3. Potential shallow ground ‘creep’ movements or slumping.

6.2.4 Risk Evaluation for the Proposed Development

The matrix below evaluates the hazards outlined above and their likelihood of occurring based on the proposed development of the site, and assuming the geotechnical constraints and recommendations of this report are implemented. If these recommendations are not followed, the likelihood of hazards occurring may increase and the level of risk may change. Further advice should be sought where necessary.

Hazard	Location	Consequence	Likelihood	Risk
H1	Overall Site	Major	Barely Credible	Very Low
H2	Overall Site	Major	Unlikely	Low
H3	Overall Site	Minor	Unlikely	Low

Based on the above, the proposed development area is assessed as having a **"Low"** risk of slope instability.

It would be normal practice in the Maitland City Council local government area for development to proceed on a site with a risk level classification of Low.

Development should be carried out in accordance with sound engineering principles and good hillside practice (as set out in Appendix C), and the geotechnical constraints outlined in this report.

6.2.5 Recommended Geotechnical Constraints for Development

Type of Structure:

There are no particular geotechnical constraints on the type of structures provided they are founded on footings designed and constructed in accordance with sound engineering principles such as AS2870, '*Residential Slabs and Footings*'.

Area for Development:

The site is considered feasible for development from a slope stability viewpoint; however, suitability for development is conditional upon the geotechnical constraints and recommendations provided in this report being implemented.

Specific advice should be followed for potentially problematic areas such as areas with potential wet/boggy ground and/or inadequate bearing capacity if encountered.

Development of the site should be undertaken in accordance with good hillside construction practice and sound engineering principles as presented in the excerpts from AGS 2007 provided in Appendix C.

Care should be taken in the design of any developments in the vicinity of any existing excavations, fill platforms, embankments and dams, particularly if they involve surcharge loads or excavations.

Foundation Type:

Strip / pad footings, pier and beam systems or raft slabs would be feasible from a slope stability viewpoint (split level raft slabs may be more suited to some sloping areas of the site to limit the slope modifications required).

Footings should not be founded within any existing uncontrolled fill. If uncontrolled fill is encountered, this will require piered foundations founded beneath the fill, removal of the fill, or removal and replacement of the fill to engineering specification.

Foundations should be designed and constructed in accordance with sound engineering principles such as the recommendations and advice of AS2870, '*Residential Slabs and Footings*'.

Foundations near the crest of excavations should be taken to rock or founded behind or below a 1V:2H projection from the toe of the excavation.

Footings are to be founded outside of or below all zones of influence resulting from existing or future service trenches.

Additional foundation recommendations including Preliminary Site Classification to AS2870-2011 are provided in Section 6.3.

Excavations:

Excavations should be supported by properly designed and constructed retaining walls or else battered at 1V:2H or flatter and protected from erosion. Excavations in competent bedrock (below the level of backhoe refusal, if encountered) may be battered at 1V:1H.

Excavations should be designed for surcharge loading from slopes, retaining walls, structures and other improvements in the vicinity of the excavation.

Care should be taken not to disturb or destabilise existing underground services or structures. Excavations should remain outside a 1V:2H projection from the base of any structural footings.

Drainage measures should be implemented above and behind all temporary and permanent excavations to avoid concentrated water flows on the face of the cut or infiltration into the soil/rock profile behind the cut. Surface water flows from upslope areas should be diverted away from the cut face.

Filling:

The depth of unsupported fill on the site should preferably not exceed 1.5m and should be battered at 1V:2H or flatter and protected against erosion. All fill greater than 1.5m deep should preferably be supported by engineer designed retaining walls.

If fill is to be placed on slopes in excess of 1V:8H (7°), a prepared surface should be benched or stepped into the slope.

Care should be taken during backfilling of any gully areas or drainage depressions to reduce the risk of leaving a preferential underground drainage path which could result in softening of the surrounding area, piping erosion and/or localised seepage.

If backfilling depressions within the lower lying areas, it may be necessary to divert drainage flows and/or provide dedicated sump and pump areas to prevent water ponding in areas of proposed fill placement. It is likely that excavation of over-wet material will be required prior to placement of fill in drainage depressions and low lying wet areas.

Earthworks should be carried out in accordance with the recommendations outlined in AS3798-2007 '*Guidelines for Earthworks for Commercial and Residential Developments*'.

The placement of fill in areas of proposed settlement sensitive development should be witnessed and documented by a geotechnical authority, carried out to 'Level 1' criteria as defined in Clause 8.2 – Section 8, of AS3798-2007.

Recommendations for earthworks procedures are provided in the following sections of this report. Further geotechnical advice should be sought with regards to site preparation and fill construction procedures at the time of detailed geotechnical investigations and design.

Retaining Walls

All structural retaining walls and all landscaping walls in excess of 1.0m should be designed by an experienced engineer familiar with the site conditions.

All retaining walls should be designed for surcharge loading from slopes, structures and other existing/future improvements in the vicinity of the wall. Adequate subsurface and surface drainage should be provided behind all retaining walls.

Excavations for the construction of retaining walls result in a temporary reduction in the stability of the adjacent area particularly during wet weather until the wall is complete. This increased risk can be managed or reduced by appropriate construction planning, using temporary support, staged excavation and control of drainage.

Drainage and Sewage Disposal:

Adequate surface and storm water drainage should be installed and maintained on the site in accordance with local government requirements.

All collected stormwater run-off should be piped into the street / inter-allotment drainage system or discharged into existing storm water drains or watercourses in a controlled manner that limits erosion. Surface and sub-soil drains may be required to improve drainage.

Potential effects of site modifications on surface runoff and groundwater flowing from upslope should also be considered, with provision of subsurface drainage to intercept and redirect groundwater where assessed to be necessary.

Septic wastes should be connected to the reticulated disposal system.

Other:

Inspection should be carried out by a geotechnical authority during construction to confirm the conditions assumed in this report and in the design.

Further recommendations are provided in following sections of this report. Additional recommendations may be provided during further stages of the project.

6.3 Preliminary Site Classification to AS2870-2011

Based on the results of the field work and laboratory testing carried out, the subject site located at 20 & 20A Cantwell Road, Lochinvar, as shown on Figure AA1, is preliminarily classified in the current condition in accordance with AS2870-2011 '*Residential Slabs and Footings*', as shown in Table 6.

TABLE 6 – SITE CLASSIFICATION TO AS2870-2011

Indicative Site Conditions	Location / Test Pit Numbers	Site Classification
>2.3m depth to Rock, highly reactive subsoil	Generally encountered in majority of the test pit locations across the site	**H2**
>2.3m depth to Rock, Extremely reactive subsoil	TPQ06 and TPQ09 Indicative based on I_{ss} results from these pits	**E**
Rock depths of about 1.4m or less, moderately to highly reactive subsoil	TPQ17 and TPQ16 Subject to confirmation by further testing	**H1**
Uncontrolled Filling to depths > 0.40m Watercourses, over-wet or soft subsoils of inadequate bearing capacity	TBC Subject to confirmation by further testing	**P**

The classifications in Table 6 are preliminary, based on broadly spaced investigations and limited surface observations, and should be confirmed prior to design of foundations.

As a preliminary guide based upon the results of field investigations and laboratory testing:

- The majority of the site areas proposed for residential lots which have Residual Soil profile are likely to classify as **Class 'H2'**.
- Localised areas with deep Residual Soil profile and extremely reactive clay will classify as **Class 'E'** in their existing condition.
- Some areas may be classified as **Class 'H1'** in their existing condition if sufficient test pits and laboratory testing are carried out to delineate areas with shallower rock and/or other lower reactivity material at depths of about 1.4m or less.
- **Lots filled using fill comprising site won residual soil** or similar material placed to 'Level 1' criteria as defined in Clause 8.2 – Section 8, of AS3798-2007, are likely to result in a site classification of **Class 'E'** in most cases.

A characteristic free surface movement of 40mm to 60mm is estimated for lots classified as **Class 'H1'** in their existing condition.

A characteristic free surface movement of 60mm to 75mm is estimated for lots classified as **Class 'H2'** in their existing condition.

A characteristic free surface movement of greater than 75mm is estimated for lots classified as **Class 'E'** in their existing condition.

The effects of changes to the soil profile by additional cutting and filling and the effects of past and future trees should be considered in selection of the design value for differential movement.

If site re-grading works involving cutting or filling are performed after the date of this assessment the classification may change and further advice should be sought.

As a preliminary guide, lots filled using fill comprising site won colluvium/alluvium and residual soil or similar material placed to 'Level 1' criteria as defined in Clause 8.2 – Section 8, of AS3798-2007, are likely to result in a site classification of **Class 'E'** in most cases.

Where cutting is carried out Lots may be re-classified as **Class 'H1', Class 'H2'** or **Class 'E'**, largely dependent upon the resultant depth to underlying lower reactivity soil and rock, plus depth and reactivity of any topsoil layers.

With engineering input and specific measures utilising approved imported fill, it may be possible to achieve a site classification of **Class 'H2'** on filled lots, if fill is placed to an approved depth across the full building envelope / lot. Measures may include placing an upper layer/layers of imported controlled fill of low reactivity and/or providing a sufficiently thick (about 0.3m depth) layer of imported topsoil layer of very low to non-reactive soil.

If measures targeting site classification of Class 'H2' are proposed, then further engineering advice should be sought. Due to anticipated variability in reactivity of site won materials, it is recommended that Shrink/Swell testing of lower layers of controlled fill is undertaken during construction so that the suitability and required thickness of the proposed overlying lower reactivity fill can be reassessed.

Final site classification will be dependent on a number of factors, including depth of topsoil, depth of cut / fill, reactivity of the natural soil and any fill material placed, depth to rock, and the level of supervision carried out.

Re-classification of lots should be confirmed by the geotechnical authority at the time of construction following any site re-grade works. If measures targeting site classification of Class 'H2' are proposed, then it is recommended that testing is carried out on each lot prior to final classification of lots.

Footings for the proposed development should be designed and constructed in accordance with the requirements of AS2870-2011.

The classification presented above assumes that:

- All footings are founded in controlled fill (if applicable) or in the residual clayey soils or rock below all non-controlled fill, topsoil material and root zones, and fill under slab panels meets the requirements of AS2870-2011, in particular, the root zone must be removed prior to the placement of fill materials beneath slabs.
- The performance expectations set out in Appendix B of AS2870-2011 are acceptable, and that site foundation maintenance is undertaken to avoid extremes of wetting and drying.
- Footings are to be founded outside of or below all zones of influence resulting from existing or future service trenches.
- The constructional and architectural requirements for reactive clay sites set out in AS2870-2011 are followed.
- Adherence to the detailing requirement outlined in Section 5 of AS2870-2011 '*Residential Slabs and Footings'* is essential, in particular Section 5.6, '*Additional requirements for Classes M, H1, H2 and E sites'* including architectural restrictions, plumbing and drainage requirements.
- Site maintenance complies with the provisions of CSIRO Sheet BTF 18, *"Foundation Maintenance and Footing Performance: A Homeowner's Guide"*, a copy of which is attached in Appendix D.

All structural elements on all lots should be supported on footings founded beneath all uncontrolled fill, layers of inadequate bearing capacity, soft/loose, wet or other potentially deleterious material.

If any localised areas of uncontrolled fill of depths greater than 0.4m are encountered during construction, footings should be designed in accordance with engineering principles for Class 'P' sites.

6.4 Pavement Design

6.4.1 Design Subgrade CBR Values

Subgrade CBR test results from the investigations at the site ranged from 2.5% to 5%, with five of the twelve tests having CBR of 2.5%.

Based on the results of the field work, laboratory testing, and previous experience in the surrounding area, the following design California Bearing Ratio (CBR) values have been adopted for pavement thickness design for the proposed subdivision roads.

TABLE 7 – DESIGN SUBGRADE CBR VALUES

Road Section	Design Subgrade	Design CBR (%)
To Be Confirmed	Residual Clay, Controlled Fill	**2.5**
To Be Confirmed	Residual Clay, Controlled Fill	3.5
To Be Confirmed	Weathered Rock	8

Notes:

1) Design subgrade CBR values should be confirmed at the time of construction by the geotechnical authority for each relevant road section.
2) Fill placed at road subgrade level should be assessed by the geotechnical authority. If the fill is assessed to have CBR different to that of the design CBR, then a revised pavement design will be required for that section.

Based upon the test results from the site, it is anticipated that:

- **Design subgrade CBR of 2.5% is likely to apply to the majority of road sections;**
- Design subgrade CBR of 3.5% may apply to some road sections such as in the vicinity of test locations (BHQ03, BHQ05, TPQ08, TPQ15, TPQ18 and TPQ19), and possibly limited sections of other roads, if assessed to be applicable, or where filling with material of CBR of 3.5% or greater is carried out.
- Design subgrade CBR of 8% may apply if some road sections are in deeper cuts which expose weathered rock, provided that the ripped and re-compacted weathered rock is confirmed to have a design CBR $\geq$ 8%.

The design subgrade CBR may change for some proposed roads following additional investigations and laboratory testing.

Subgrade should be prepared in accordance with the site preparation requirements presented in Section 6.6.

If rock subgrade materials are encountered, the rock should be ripped and re-compacted for a minimum depth of 300mm to break-up any preferential drainage paths and provide a dense homogenous surface on which to construct the pavement.

6.4.2 Design Traffic Loadings

The design traffic loadings adopted for various classifications of internal subdivision roads and Cantwell Road in accordance with Maitland City Council (MCC) Manual of Engineering Standards, in terms of equivalent standard axles (ESA's), are presented in Table 8.

TABLE 8 – DESIGN TRAFFIC LOADING

Classification	Maximum Number of Lots	Design Traffic (ESA's)
Local – Access or Place	20	1×10^5
Local - Secondary	50	2×10^5
Local - Primary	100	5×10^5
Collector - Secondary	200	1×10^6
School Bus Route / Distributor - Secondary	400	2×10^6
Public Bus Route / Distributor - Primary	500	5×10^6
Sub Arterial	3500	1×10^7

Confirmation should be obtained from MCC with respect to the road classifications to be adopted. In the event that different design traffic design loadings are applicable, then the pavement thickness designs presented in this report should be reviewed.

6.4.3 Flexible Pavement Thickness Design

Flexible pavement thickness design has been based on the procedures outlined in:

- MCC – Manual of Engineering Standards 2014 – Pavement Design;
- Austroads, "Guide to Pavement Technology, Part 2: Pavement Structural Design";
- ARRB Special Report No 41;
- APRG Report No 21.

Flexible Pavement Thickness Designs are presented in Table 9 to Table 15.

Pavement Material Specification and Compaction Requirements are presented in Table 16.

A bridging layer should be allowed for beneath the pavement where road pavement crosses any areas where poor, wet or saturated subgrade conditions are encountered. The requirement (if any) for bridging layers is likely to be dependent on the prevailing weather conditions at the time of construction.

For areas where poor or wet subgrade conditions are encountered, pavement design may require a select layer prior to design pavement thickness construction.

If stabilised subgrade is adopted, then the suitability of proposed liming rates should be confirmed by laboratory testing prior to construction.

If the select layer is required for the purpose of providing additional cover over expansive soils, the select layer should comprise Select Fill rather than lime stabilised subgrade. The Select Fill should meet MCC Specifications(e.g. sub-base quarry product material) where required.

If rock subgrade materials are encountered, the rock should be ripped and re-compacted for a minimum depth of 300mm to break-up preferential drainage paths and provide a dense homogenous surface on which to construct the pavement.

Any areas of uncontrolled fill should be replaced as controlled fill in accordance with AS3798-2007 prior to pavement construction.

It is recommended that each construction length be boxed out to the minimum subgrade level required by the relevant pavement thickness design. Prior to pavement construction, the exposed subgrade should be assessed by the geotechnical authority to confirm the pavement thickness requirement for that section.

Design / Construction Consideration – Expansive Soils:

Expansive Nature:

With reference to the laboratory CBR test results during the current investigations, swells for the twelve samples tested varied from 0.5% to 2.5%. Noting that the swells of 2.5% correspond to CBR results of 2.5% encountered at TPQ12 and TPQ16.

With reference to Table 5.2 in Austroads 2017 – Guide to Pavement Technology Part 2: Pavement Design (Austroads 2017), this indicates that the subgrade soils at the discrete test locations and depths are generally in the range of:

- Moderate 'Expansive Nature' – majority of test locations;
- Moderate to High 'Expansive Nature' – TPQ12 on the western side of the site, and TPQ16 on the eastern side of the site.

Council Select Workshop – 4 April 2024:

With reference to the discussion points as agreed to at the recent Select Workshop with the UDIA (4 April 2024), Council provided an email to UDIA on 24 April 2024 stating that:

> *'As discussed during the meeting, Council will be amending the standard consent condition regarding shrink swell and poor CBR to make it clearer on when it needs to be applied. For new applications, the condition will be as follows:*
>
> 1. *Where a Geotechnical engineer determines high expansive soils with a ≥ 2.5% swell (10 day soak) or poor CBR (< 2%) are present within 1 metre below design subgrade, a capping layer of homogeneous select material shall be added to the pavement design and construction plans. The swell, pavement design and the select material specification shall be considered and justified against Austroads Guide to Pavement Technology Part 2, 4I, 8 and the RMS Supplement, including a 10 day soak. The adjusted pavement design shall be based on the CBR of the selected subgrade material at 'in-service moisture and density conditions' to stop premature pavement distress and to achieve the design life of the pavement. Note: A minimum, but not limited to, 300mm select material shall be added to the minimum pavement thickness for either swell and/or poor CBR.*
>
> *For existing developments, the existing consent condition is to only be applicable when swell is >2.5% and / or CBR <2%. It is only applied to the areas where that geotechnical testing result is applicable.'*

Therefore, based on the above amended draft Council Condition, it is assessed that with regard to the potential of encountering highly expansive soils at design subgrade level:

- There is likely to be a requirement for an additional 300mm select layer within parts of the proposed subdivision, including in the vicinity of TPQ12 and TPQ16 due to swells of ≥ 2.5%;
- The extents of the requirement for an additional 300mm select layer will need to be determined following additional investigations and laboratory testing carried out following bulk earthworks and box-out of proposed pavements to design subgrade level at the time of construction.
- **The extent of the High 'Expansive Nature' subgrade soils and requirement for additional select layer should be confirmed at the time of construction by the Geotechnical Testing Authority in consultation with Council. This will include visual assessment and laboratory testing of the subgrade to confirm the extents of any affected areas**.

Austroads and Council Requirements:

Austroads states that volume changes in highly expansive soils can be minimised by several options, one of which includes:

  - '*Provide a low-permeability lower subbase or a select fill capping layer above the expansive soil. The minimum thickness of this layer should be the greater of 150mm or two-and-a-half times the maximum particle size. This capping layer should extend at least 500mm past the edge of pavement, and if provided, past the kerb and channel, to reduce edge movement*'.

Based on recent experience for similar projects, MCC representatives have typically been directing the placement of a 300mm select layer in addition to the minimum pavement thickness design provided where clay subgrade soils are considered to be expansive soils.

A copy of MCC Notice of Determination has been previously provided to Qualtest for a nearby development, which included the following Condition:

  - '*37. **Prior to the issue of Subdivision Works Certificate** a minimum 300mm select layer of subbase quarry product material shall be added to the pavement design due to the presence of high swell clays.*'

Therefore, based on the above information, and with specific reference to the discussion points as agreed to at the recent Select Workshop with the UDIA and Council (4 April 2024), and proposed amendments to the standard consent condition by Council as provided in an email to UDIA on 24 April 2024, it is assessed that:

- **There is likely to be a requirement for an additional 300mm select layer within localised areas of the proposed subdivision based on testing during the current investigations, which returned two results with Swell ≥ 2.5% and CBR of 2.5%, (i.e. possibly near TPQ12 and TPQ16);**
- **The extent of the High 'Expansive Nature' and requirement for additional select layer should be confirmed at the time of construction, following box out to design subgrade level, and include CBR testing by the Geotechnical Testing Authority in consultation with Council.**
- **It may be prudent that for tendering / pricing of works, that any Contractors allow for an additional 300mm Select Layer of '*subbase quarry product material*' as per previous MCC Conditions, in addition to the pavement thickness designs provided in accordance with Austroads and MCC design standards, as a Contingency Item.**

Based upon experience with nearby subdivision developments, it is expected that MCC will require wearing course to be asphaltic concrete.

Qualtest could provide designs based upon a two-coat seal if required in accordance with MCC specification; however, the pavement subbase and total thickness specified would generally be increased by the asphalt depths specified in Table 9 to Table 15.

MCC states, *'Asphaltic concrete thickness shall be a minimum of 30mm and may be included as pavement "depth" in determining the pavement thickness. Two coat flush bitumen seals shall not be considered part of the pavement thickness'*.

TABLE 9 – FLEXIBLE PAVEMENT THICKNESS DESIGN SUMMARY – LOCAL - ACCESS OR PLACE

Road Classification	Local – Access or Place		
Design Traffic Loading (ESA's)	1 x 10^5		
Design Subgrade CBR (%)	**2.5**	3.5	8.0
Wearing Course (mm)	**30 AC10**	30 AC10	30 AC10
Base Course (mm)	**120**	120	120
Subbase (mm)	**280**	210	150
Select Fill (mm) *	**-**	-	-
Total Thickness (mm)	**430**	360	300

Notes:

1) A 10mm primer seal should be placed over the base course prior to placement of the asphaltic concrete wearing course.
2) * Select Fill comprising approved material meeting requirements of Table 16, or Stabilised Subgrade – Lime stabilised with either 3% quicklime or 4% hydrated lime.
3) An allowance for additional subgrade replacement should be anticipated in any areas where poor, wet or saturated subgrade conditions are encountered. The requirement for, and depth and extent of any subgrade replacement / select filling, should be confirmed by the geotechnical authority at the time of construction.
4) Prior to pavement construction, the exposed subgrade should be assessed by the geotechnical authority to confirm the pavement thickness requirement for that section.
5) MCC may direct the placement of a 300mm select layer in addition to minimum pavement thickness designs provided above, where clay subgrade soils are considered to be expansive soils.
6) Note MCC Notice of Determination on nearby projects. '*Prior to the issue of Subdivision Works Certificate a minimum 300mm select layer of subbase quarry product material shall be added to the pavement design due to the presence of high swell clays*'.
7) Due to construction practicalities when tying in with depth of kerb and gutter construction, the basecourse layer depth may be increased from 120mm to 150mm. The subbase thickness may be reduced accordingly, by up to 30mm, provided that this does not result in a minimum subbase thickness of less than 125mm.

TABLE 10 – FLEXIBLE PAVEMENT THICKNESS DESIGN SUMMARY – LOCAL – SECONDARY

Road Classification	Local – Secondary		
Design Traffic Loading (ESA's)	2×10^5		
Design Subgrade CBR (%)	**2.5**	3.5	8.0
Wearing Course (mm)	**30 AC10**	30 AC10	30 AC10
Base Course (mm)	**120**	120	120
Subbase (mm)	**320**	250	150
Select Fill (mm) *	**-**	-	-
Total Thickness (mm)	**470**	400	300

Notes:

1) A 10mm primer seal should be placed over the base course prior to placement of the asphaltic concrete wearing course.
2) * Select Fill comprising approved material meeting requirements of Table 16, or Stabilised Subgrade – Lime stabilised with either 3% quicklime or 4% hydrated lime.
3) An allowance for additional subgrade replacement should be anticipated in any areas where poor, wet or saturated subgrade conditions are encountered. The requirement for, and depth and extent of any subgrade replacement / select filling, should be confirmed by the geotechnical authority at the time of construction.
4) Prior to pavement construction, the exposed subgrade should be assessed by the geotechnical authority to confirm the pavement thickness requirement for that section.
5) MCC may direct the placement of a 300mm select layer in addition to minimum pavement thickness designs provided above, where clay subgrade soils are considered to be expansive soils.
6) Note MCC Notice of Determination on nearby projects. '*Prior to the issue of Subdivision Works Certificate a minimum 300mm select layer of subbase quarry product material shall be added to the pavement design due to the presence of high swell clays*'.
7) Due to construction practicalities when tying in with depth of kerb and gutter construction, the basecourse layer depth may be increased from 120mm to 150mm. The subbase thickness may be reduced accordingly, by up to 30mm, provided that this does not result in a minimum subbase thickness of less than 125mm.

TABLE 11 – FLEXIBLE PAVEMENT THICKNESS DESIGN SUMMARY – LOCAL - PRIMARY

Road Classification	Local – Primary		
Design Traffic Loading (ESA's)	5 x 10^5		
Design Subgrade CBR (%)	**2.5**	**3.5**	8.0
Wearing Course (mm)	**30 AC10**	**30 AC10**	30 AC10
Base Course (mm)	**120**	**120**	120
Subbase (mm)	**380**	**290**	150
Select Fill (mm) *	**-**	**-**	-
Total Thickness (mm)	**530**	**440**	300

Notes:

1) A 10mm primer seal should be placed over the base course prior to placement of the asphaltic concrete wearing course.
2) * Select Fill comprising approved material meeting requirements of Table 16, or Stabilised Subgrade – Lime stabilised with either 3% quicklime or 4% hydrated lime.
3) An allowance for additional subgrade replacement should be anticipated in any areas where poor, wet or saturated subgrade conditions are encountered. The requirement for, and depth and extent of any subgrade replacement / select filling, should be confirmed by the geotechnical authority at the time of construction.
4) Prior to pavement construction, the exposed subgrade should be assessed by the geotechnical authority to confirm the pavement thickness requirement for that section.
5) MCC may direct the placement of a 300mm select layer in addition to minimum pavement thickness designs provided above, where clay subgrade soils are considered to be expansive soils.
6) Note MCC Notice of Determination on nearby projects. '*Prior to the issue of Subdivision Works Certificate a minimum 300mm select layer of subbase quarry product material shall be added to the pavement design due to the presence of high swell clays*'.
7) Due to construction practicalities when tying in with depth of kerb and gutter construction, the basecourse layer depth may be increased from 120mm to 150mm. The subbase thickness may be reduced accordingly, by up to 30mm, provided that this does not result in a minimum subbase thickness of less than 125mm.

TABLE 12 – FLEXIBLE PAVEMENT THICKNESS DESIGN SUMMARY – COLLECTOR - SECONDARY

Road Classification	Collector – Secondary		
Design Traffic Loading (ESA's)	1 x 10^6		
Design Subgrade CBR (%)	**2.5**	3.5	8.0
Wearing Course (mm)	**40 AC10**	40 AC10	40 AC10
Base Course (mm)	**150**	150	150
Subbase (mm)	**380**	290	150
Select Fill (mm) *	**-**	-	-
Total Thickness (mm)	**570**	480	340

Notes:

1) A 10mm primer seal should be placed over the base course prior to placement of the asphaltic concrete wearing course.
2) * Select Fill comprising approved material meeting requirements of Table 16, or Stabilised Subgrade – Lime stabilised with either 3% quicklime or 4% hydrated lime.
3) An allowance for additional subgrade replacement should be anticipated in any areas where poor, wet or saturated subgrade conditions are encountered. The requirement for, and depth and extent of any subgrade replacement / select filling, should be confirmed by the geotechnical authority at the time of construction.
4) Prior to pavement construction, the exposed subgrade should be assessed by the geotechnical authority to confirm the pavement thickness requirement for that section.
5) MCC may direct the placement of a 300mm select layer in addition to minimum pavement thickness designs provided above, where clay subgrade soils are considered to be expansive soils.
6) Note MCC Notice of Determination on nearby projects. '*Prior to the issue of Subdivision Works Certificate a minimum 300mm select layer of subbase quarry product material shall be added to the pavement design due to the presence of high swell clays*'.

TABLE 13 – FLEXIBLE PAVEMENT THICKNESS DESIGN SUMMARY – SCHOOL BUS ROUTE / DISTRIBUTOR SECONDARY

Road Classification	School Bus Route / Distributor Secondary		
Design Traffic Loading (ESA's)	2 x 10^6		
Design Subgrade CBR (%)	**2.5**	3.5	8.0
Wearing Course (mm)	**40 AC10**	40 AC10	40 AC10
Base Course (mm)	**150**	150	150
Subbase (mm)	**430**	330	150
Select Fill (mm) *	**-**	-	-
Total Thickness (mm)	**620**	520	340

Notes:

1) A 10mm primer seal should be placed over the base course prior to placement of the asphaltic concrete wearing course.
2) * Select Fill comprising approved material meeting requirements of Table 16, or Stabilised Subgrade – Lime stabilised with either 3% quicklime or 4% hydrated lime.
3) An allowance for additional subgrade replacement should be anticipated in any areas where poor, wet or saturated subgrade conditions are encountered. The requirement for, and depth and extent of any subgrade replacement / select filling, should be confirmed by the geotechnical authority at the time of construction.
4) Prior to pavement construction, the exposed subgrade should be assessed by the geotechnical authority to confirm the pavement thickness requirement for that section.
5) MCC may direct the placement of a 300mm select layer in addition to minimum pavement thickness designs provided above, where clay subgrade soils are considered to be expansive soils.
6) Note MCC Notice of Determination on nearby projects. '*Prior to the issue of Subdivision Works Certificate a minimum 300mm select layer of subbase quarry product material shall be added to the pavement design due to the presence of high swell clays*'.

TABLE 14 – FLEXIBLE PAVEMENT THICKNESS DESIGN SUMMARY – PUBLIC BUS ROUTE / DISTRIBUTOR PRIMARY

Road Classification	Public Bus Route / Distributor Primary		
Design Traffic Loading (ESA's)	5 x 10^6		
Design Subgrade CBR (%)	**2.5**	3.5	8.0
Wearing Course (mm)	**40 AC10**	40 AC10	40 AC10
Base Course (mm)	**150**	150	150
Subbase (mm)	**480**	380	160
Select Fill (mm) *	**-**	-	-
Total Thickness (mm)	**670**	570	350

Notes:

1) A 10mm primer seal should be placed over the base course prior to placement of the asphaltic concrete wearing course.
2) * Select Fill comprising approved material meeting requirements of Table 16, or Stabilised Subgrade – Lime stabilised with either 3% quicklime or 4% hydrated lime.
3) An allowance for additional subgrade replacement should be anticipated in any areas where poor, wet or saturated subgrade conditions are encountered. The requirement for, and depth and extent of any subgrade replacement / select filling, should be confirmed by the geotechnical authority at the time of construction.
4) Prior to pavement construction, the exposed subgrade should be assessed by the geotechnical authority to confirm the pavement thickness requirement for that section.
5) MCC may direct the placement of a 300mm select layer in addition to minimum pavement thickness designs provided above, where clay subgrade soils are considered to be expansive soils.
6) Note MCC Notice of Determination on nearby projects. '*Prior to the issue of Subdivision Works Certificate a minimum 300mm select layer of subbase quarry product material shall be added to the pavement design due to the presence of high swell clays*'.

TABLE 15 – FLEXIBLE PAVEMENT THICKNESS DESIGN SUMMARY – SUB ARTERIAL

Road Classification	Sub Arterial		
Design Traffic Loading (ESA's)	1×10^7		
Design Subgrade CBR (%)	**2.5**	**3.5**	8.0
Wearing Course (mm)	**50 AC14**	**50 AC14**	50 AC10
Base Course (mm)	**160**	**160**	160
Subbase (mm)	**510**	**390**	170
Select Fill (mm) *	**-**	**-**	-
Total Thickness (mm)	**720**	**600**	380

Notes:

1) A 10mm primer seal should be placed over the base course prior to placement of the asphaltic concrete wearing course.
2) * Select Fill comprising approved material meeting requirements of Table 16, or Stabilised Subgrade – Lime stabilised with either 3% quicklime or 4% hydrated lime.
3) An allowance for additional subgrade replacement should be anticipated in any areas where poor, wet or saturated subgrade conditions are encountered. The requirement for, and depth and extent of any subgrade replacement / select filling, should be confirmed by the geotechnical authority at the time of construction.
4) Prior to pavement construction, the exposed subgrade should be assessed by the geotechnical authority to confirm the pavement thickness requirement for that section.
5) MCC may direct the placement of a 300mm select layer in addition to minimum pavement thickness designs provided above, where clay subgrade soils are considered to be expansive soils.
6) Note MCC Notice of Determination on nearby projects. '*Prior to the issue of Subdivision Works Certificate a minimum 300mm select layer of subbase quarry product material shall be added to the pavement design due to the presence of high swell clays*'.

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TABLE 16 – PAVEMENT MATERIAL SPECIFICATION AND COMPACTION REQUIREMENTS

Pavement Course	Material Specification	Compaction Requirements
Wearing Course (AC)	Maitland City Council Spec.	Maitland City Council Spec.
Base Course	CBR ≥ 80%, PI ≤ 6%	98% Modified (AS1289 5.2.1)
Subbase	CBR ≥ 30%, PI ≤ 12%	95% Modified (AS1289 5.2.1)
Select Fill / Stabilised Subgrade	Select Fill, CBR ≥ 15%, PI ≤ 15%, max particle size 75mm Or Subbase material (2% cement stabilised where required) Or Stabilised Subgrade - lime stabilised with either 3% quicklime or 4% hydrated lime to achieve CBR ≥ 10%	95% Modified (AS1289 5.2.1)
Subgrade (top 300mm)	Minimum CBR = Design CBR	100% Standard (AS1289 5.1.1)
Subgrade / Fill Below	Minimum CBR = Design CBR	95% Standard (AS1289 5.1.1)

Notes:

1) Pavement materials for base course and subbase shall also comply with Maitland City Council (MCC) Manual of Engineering Standards Appendix D – Pavement Material Properties
2) CBR = California Bearing Ratio, PI = Plasticity Index.
3) Select Fill / Stabilised Subgrade option adopted will be dependent on subgrade moisture conditions. If the select layer is required for the purpose of providing additional cover over expansive soils, the select layer should comprise Select Fill rather than lime stabilised subgrade. The Select Fill should meet MCC Specifications (i.e. sub-base quarry product material) where required.

6.4.4 Construction Considerations

Care should also be taken to follow recommended construction practices when constructing new pavement adjacent to existing, including:

- A clean, vertical perpendicular surface at full depth should be cut for both transverse and longitudinal jointing. This will reduce the risk of plating and heaving effects on the pavement;
- Ensuring joints are not in wheel paths;
- Ensuring joints in sub-base / select layers are offset to joints in the base layer;
- Ramping between layers, and at the entry and exit points to the pavement, must be removed at all times. During construction, any temporary access ramps to properties or driveways must also be removed.

A bridging layer should be allowed for beneath the pavement where road pavements cross gullies and in any areas where poor, wet or saturated subgrade conditions are encountered. The requirement (if any) for bridging layers is likely to be dependent on the prevailing weather conditions at the time of construction.

Inspection should be carried out by a geotechnical authority during construction to confirm the conditions assumed in this report and in the design.

6.5 Excavation Conditions

The depths of fill, topsoil, colluvium, residual soils and weathered rock, together with depths of slow progress or refusal of the excavator where encountered, are summarised in Section 4.2.

Based upon the results of the investigation, rock depths and properties are expected to be variable; though, depths of highly weathered or better rock are mostly in the order of 2m or deeper except near the western boundary of the site, where rock depths were found to be at depths of 0.70m in BHQ02 and 0.90m in BHQ03, and in the north-eastern area of the site, where rock depths were found to be at depths of 1.40m in TPQ16 and 1.30m in TPQ17.

In terms of excavation conditions, site materials can generally be divided into:

- Clayey and Granular Soils (Units 1, 2, 3, and 4). It is anticipated that these materials could be excavated by a conventional excavator or backhoe bucket;
- Extremely to Highly Weathered Rock or better (Units 5 & 6). Rippability is dependent on rock strength, degree of weathering and number of defects within the rock mass which can vary significantly.

It is anticipated that the Weathered Rock (Units 5 & 6) material encountered could be excavated by conventional excavator or backhoe bucket at least to the depths indicated on the appended test pit logs.

Material below the depth of excavator auger or bucket slow progress or refusal encountered during the investigations may be excavatable by ripping to some greater depth, although this has not been assessed as part of the current investigation.

The use of toothed buckets, ripping tines, and/or hydraulic rock hammers may be required if hard bands of weathered rock are encountered for deeper or confined excavations such as for service trenches. Higher strength rock or randomly occurring hard bands within the rock mass if encountered, are likely to occur towards the base of deeper cuts. Methods including rotary heads, sawing, hydraulic breaking and/or pre-splitting may be considered to improve excavatability and geometry if higher strength Rock is encountered.

It is recommended that targeted investigations (e.g. cored boreholes and/or excavation trials) are carried out if significant excavations are proposed where bedrock depth or excavatability is important to design or construction.

There is potential for groundwater to exist at localised areas of the site such as from water perched above the clay / bedrock profile. It is possible that slow water inflow may be encountered from such layers, particularly if earthworks are carried out during or following periods of wet weather, or in the vicinity of farm dams and gullies when water is present. If groundwater is encountered, it is generally expected to be manageable by de-watering by sump and pump methods.

Excavations should be supported by properly designed and constructed retaining walls or else battered at 1V:2H or flatter and protected from erosion.

Temporary excavations should be battered at 1V:1H or flatter in cohesive soils, or 1V:1.5H or flatter in granular soils, and protected from erosion. Steeper excavations may be supported by means of temporary shoring.

Temporary excavations to depths of up to 1.2m in competent compact material with sufficient cohesion, such as clay of stiff consistency or better may be battered vertically, subject to inspection during excavation by the geotechnical authority.

The safe working procedures of Work Cover NSW *Excavation work code of practice*, dated January 2020 should be followed.

Care should be taken not to disturb or destabilise existing underground services or structures.

6.6 Site Preparation

Site preparation and earthworks suitable for pavement support and site re-grading should consist of:

- Following any bulk excavation to proposed subgrade level, all areas of proposed pavement construction or site re-grading should be stripped to remove all existing uncontrolled fill, vegetation, topsoil, root affected or other potentially deleterious materials;
- Stripping depths are generally expected to be in the order of 0.10m to 0.20m to remove existing topsoil and root affected material;
- Additional stripping may be required in any areas where uncontrolled fill or poor, wet or saturated subgrade conditions are encountered, for example in the vicinity of gullies and drainage depressions, or following wet weather, in areas of the site which were observed to be wet/boggy during the investigation;
- Following stripping, the exposed subgrade should be proof rolled (minimum 10 tonne static roller), to identify any wet or excessively deflecting material. Any such areas should be over excavated and backfilled with an approved select material;
- The moisture content of the subgrade materials and therefore the need for moisture conditioning or over-excavation and replacement, will be largely dependent on pre-existing and prevailing weather conditions at the time of construction;
- Subgrade preparation should be carried out using a tracked excavator equipped with a smooth sided (‘gummy’) bucket to minimise the risk of over-disturbance of soils;
- Protect the area after subgrade preparation to maintain moisture content as far as practicable. The placement of subbase gravel would normally provide adequate protection;

- Site preparation should include provision of drainage and erosion control as required, as well as sedimentation control measures.

At the time of the field investigations, moisture content for the clay subgrade material tested varied from 5.5% dry to 0.9% wet of standard Optimum Moisture Content (OMC). It should be anticipated that moisture conditioning of the subgrade is likely to be necessary prior to compaction and placement of pavement materials.

The required time period to prepare the subgrade is likely to be dependent on the prevailing weather conditions at the time of construction.

If over-wet subgrades exist at the time of construction or deleterious materials are encountered at subgrade level, these materials should be over-excavated and be replaced with well graded granular select material with CBR of 15% or greater, or other material approved by the geotechnical authority as appropriate to the site conditions. The requirement for, and extent of subgrade replacement, should be confirmed by the geotechnical authority at the time of construction.

If the Lime Stabilisation option was to be considered, further testing would be required to confirm percentage of lime required and that adequate increase in CBR could be achieved following mixing. If the select layer is required for the purpose of providing additional cover over expansive soils, the select layer should comprise Select Fill rather than lime stabilised subgrade. The Select Fill should meet MCC Specifications (i.e. sub-base quarry product material) where required.

6.7 Fill Construction Procedures

Earthworks for pavement construction or support of foundations should consist of the following measures:

- Approved fill beneath pavements should be compacted in layers not exceeding 300mm loose thickness to the compaction requirements provided in Table 16;
- The top 300mm of natural subgrade below pavements or the final 300mm of road subgrade fill should be compacted to provide a subgrade that is within the moisture range of 60% to 90% of Optimum Moisture Content (OMC);
- Site fill beneath structures should be compacted to a minimum density ratio of 98% Standard Compaction within ±2% of OMC in cohesive soils;
- All fill should be supported by properly designed and constructed retaining walls or else battered at 1V:2H or flatter and protected against erosion;
- If fill is to be placed on slopes in excess of 1V:8H (7°), a prepared surface should be benched or stepped into the slope; and,
- Earthworks should be carried out in accordance with the recommendations outlined in AS3798-2007 *'Guidelines for Earthworks for Commercial and Residential Developments'*.

6.8 Suitability of Site Materials for Re-Use as Fill

The following comments are made with respect to suitability of site materials for re-use as fill:

- Unit 1A Fill-Topsoil and Unit 2 Topsoil materials are expected to be suitable for landscaping purposes only;
- Unit 1B Fill materials may be variable. Some fill material may be suitable for landscaping purposes only due to the presence of roots and organics. If fill material is not affected by roots or other deleterious material, it is generally expected to be suitable for re-use as

general fill for engineering purposes. These materials may require some moisture conditioning sorting and/or blending. Suitability for re-use should be confirmed prior to, or at the time of construction;

- Unit 3 Alluvium, Unit 4 Residual Soils and Unit 5 Extremely Weathered Rock are generally expected to be suitable for re-use as general fill for engineering purposes;
- Unit 6 Highly to Moderately Weathered Rock is generally expected to be suitable for re-use as general fill for engineering purposes. These materials may require sorting or processing by crushing / screening depending upon excavation methods, source material characteristics and proposed uses.

Final selection of fill materials should consider properties such as reactivity which typically judged to be from potentially high to extremely high for site won Unit 4 (CH) CLAY Residual Soils. The deeper sandy and gravelly Residual Soils and the Weathered Rock are expected to be less reactive and likely to be preferred for use as the upper layers of lot filling to reduce calculated surface movements and subsequent site classifications to AS2870-2001.

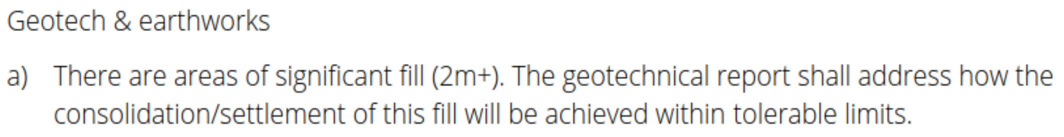
If fill is used to construct the basins, it should be approved by the geotechnical authority and placed under Level 1 supervision in accordance with AS3798-2007.

The suitability of material for re-use should be assessed and confirmed by the geotechnical authority at the time of construction. The materials may require some moisture conditioning.

Comments regarding suitability for basin dam construction are provided in Section 6.10.

6.9 Settlement of Fill of Deep Fill

On an adjacent site Council issued an RFI in relation to the geotechnical report, copied below.



Geotech & earthworks

a) There are areas of significant fill (2m+). The geotechnical report shall address how the consolidation/settlement of this fill will be achieved within tolerable limits.

To provide background information, settlement of engineered fill may be characterised as having four potential components:

1. **Short-Term Settlement** – which occurs due to self-weight as the fill is placed and for a relatively short time after fill has reached full height.
2. **Elastic Settlement** – which occurs in the fill when subjected to loads from footings and floor slabs.
3. **Long-Term or Creep Settlement** – which occurs over a period of years. In the case of deep fills with light building loads, the creep due to the self-weight of the fill will be the major component of the long-term settlement.
4. **Hydroconsolidation (Collapse) Settlement** – which can occur and is due to saturation of the fill.

Historical data and published reference papers (Ref. 'Settlement Characteristics of Deep Engineered Fills', Peter J. Waddell & Patrick K. Wong, Australian Geomechanics Vol 40, No. 4, Dec 2005) indicate that for various fill materials of thickness up to 10m, predicted creep settlement may be in the range of 5mm to 30mm.

With regards to this site:

- Site regrade plans have not been provided to Qualtest at the time of this preliminary assessment, but it is generally anticipated that maximum depth of fill (if greater than 2.0m) will most likely be in the order of 3m to 4m, or shallower;
- Based upon soil profiles and investigations to date, together with experience on nearby projects, a preliminary indication is that lots may potentially be mostly classified Class 'H2' or Class 'E' in accordance with AS2870-2011 '*Residential Slabs and Footings*'.
- A characteristic free surface movement of 60mm to 75mm is estimated for lots classified as Class 'H2', and a characteristic free surface movement of greater than 75mm is estimated for lots classified as Class 'E'.
- Where fill depths are to be in the order of 2.0m or greater, an increased compaction specification is covered in the requirements of AS3798-2007 "*Guidelines on Earthworks for Commercial and Residential Developments*", which states that – '*A minimum dry density ratio of 98% or higher may need to be considered if collapse on saturation or excessive settlement is likely to occur*'.
- It is recommended that all site regrade filling should be compacted to a minimum of 98% Standard Maximum Dry Density.

It is anticipated that predicted creep settlements may potentially be in the order of about 10mm over 20 years based on up to 4m depth of compacted fill. For a potential site classification of Class 'H2' or Class 'E' (TBC), footings would be designed in accordance with AS2870-2011 based on estimated free surface movement in the range of 60mm to 75mm or greater. This allows for significantly more movement than any potential long-term or creep settlement movements.

Where carrying out filling to relevant Australian Standards and design specifications, possible settlement based on the 4 potential settlement components outlined above can be suitably managed. With adequate control on fill placement to ensure uniform distribution of material types, compaction level and moisture conditioning, it should be possible to adopt shallow foundations on deep fills to meet the footing performance expectations similar to natural sites, and any potential consolidation / settlement of the fill should be within tolerable limits.

In addition to the above, the following points are made with respect to general site specific development conditions at this site:

- This is not a soft soils site. (i.e. Filling is not required to be carried out as part of a Pre-Load Design, to minimise post construction settlements).
- Following stripping, underlying natural soil profile comprises of stiff or better Residual clays and Weathered Rock.
- In the absence of site regrade plans, it is currently anticipated that maximum depth of filling is likely to be less than 4m. This is not significant deep fill, (i.e. in the order of 10m or greater) where settlement of poorly compacted fill may occur and impact on design requirements.
- The filling performed for site regrade, is to be carried out to Level 1 criteria as defined in Clause 8.2 – Section 8, of AS3798-2007, "Guidelines on Earthworks for Commercial and Residential Developments".
- Subsequent Site Classification for lots is to be conducted in accordance with the requirements of AS2870-2011 'Residential Slabs and Footings'.

6.10 Proposed Detention Basins

6.10.1 Site Materials and Suitability

Test pits TPQ06, TPQ20 and TPQ21 were excavated at the indicative locations of water quality detention basins advised by Monteath & Powys, to depths of 2.00m, and 2.10m, respectively.

The profile encountered in test pits generally includes Topsoil to depths of 0.15m, overlying Residual CLAY soils of medium to high plasticity to greater than the depths of investigation (greater than 2.00m).

Weathered rock was not encountered in the test pits TPQ20 and TPQ21 to depths of 2m below existing ground surface during current investigation.

Detention Basin embankments should be excavated into and/or constructed using approved impervious materials. As a guide, material should have:

- Greater than 30% clay content;
- Plasticity index of between about 10% and 50%;
- Permeability of less than 1 x 10^{-8} metres per second;
- Emerson Class Number of 4 or greater;
- Maximum particle size of 100mm.

Emerson testing on the Residual CLAY (Unit 4) indicated that the material is generally likely to have low susceptibility to dispersion. It is recommended that any soil with Emerson Class ≤ 3 should be blended with other materials, or alternatively be stabilised with addition of 1% to 2% gypsum added to the soil and blended prior to usage in embankments. It is recommended that any blended or gypsum treated material be tested to confirm suitable Emerson Class prior to placement.

Results of laboratory testing of the Residual Soil from the proposed basin footprints indicated that the material is likely to have relatively high plasticity index, and in some cases borderline or exceeding the guidance provided above. These soils may be susceptible to swelling and softening when wet, and shrinking and block cracking when dry.

Where lower plasticity material is recommended, suitable imported materials may be used, or treatment of the Residual Soil may be carried out with gypsum and/or lime, and/or blending with lower plasticity material such as Extremely to Highly Weathered Rock (possibly won from adjacent subdivision areas) or Clayey SAND if available / suitable.

The Residual CLAY (Unit 4) materials are likely to be of relatively low permeability and suited for dam wall construction on the basis of permeability. Previous experience and literature indicates similar materials may have permeability of order of magnitude ranging from about 10^{-7} to about 10^{-10} metres per second (about 0.01 millimetres to about 100mm per day). More sandy or gravelly material (if encountered) is likely to be of higher permeability, and may be more suitable if blended with Sandy CLAY material.

These materials are likely to require some moisture conditioning prior to dam embankment construction.

If fill is used to construct the basin, it should be approved by the geotechnical authority and placed under Level 1 supervision in accordance with AS3798-2007, and the general procedures outlined in Sections 6.6, 6.7 and 6.10.

6.10.2 Construction Recommendations

Earthworks for embankment construction should be in general accordance with Section 6.6 and 6.7 above, with the additional measures recommended below:

- Earthworks should be carried out in general accordance with the recommendations outlined in AS3798-2007 'Guidelines for Earthworks for Commercial and Residential Developments', and the general procedures outlined in Sections 6.6 and 6.7;
- Where fill is placed on slopes in excess of 1V:8H (7°), a prepared surface should be benched or stepped into the natural slope;
- Detention Basin embankments should be constructed using approved impervious materials, with material specification as outlined in Section 6.10.1;
- Fill should be compacted in layers not exceeding 300mm loose thickness to a minimum density ratio of 98% Standard Compaction within ±2% of OMC. As a guide, this is likely to require at least 10 passes of a 10 tonne pad foot roller for each layer of fill placed;
- Embankment materials shall be uniformly watered, tined and rolled to produce homogenous layers over the full width of the embankment. Embankments shall be overfilled and trimmed back to design grades to expose materials compacted to the minimum standards specified above;
- Detention basin embankments should include a clay cut-off trench, 'keyed' a minimum depth of 0.5m into the underlying relatively impervious Residual CLAY (Unit 4), with a minimum undrained shear strength S_U of 50kPa. The base of the cut off trench should be at least 3m in width to allow compaction by a pad foot roller;
- Material and key in requirements for the cut-off trench should be confirmed by the geotechnical authority at the time of construction.
- Fill may require treatment by gypsum, which can be done by mixing either in the stockpile area, or by adding and mixing through each layer following placing and prior to compaction. A pulvi mixer or rotary hoe should be used to achieve thorough mixing. Mixing by use of ripper tines is not recommended.
- All fill should be supported by properly designed and constructed retaining walls or else battered as recommended in Section 6.10.3 and protected against erosion;
- Fill material placed alongside pipes or other structures should be compacted using hand operated equipment or small compaction equipment to avoid damage to the structure, with care taken to ensure compaction is achieved;
- The embankment surface must be overlain by geofabric prior to placement of any rockfill such as rip rap.

Care should be taken to use materials and methods, which do not create a significant risk of leaving preferential underground drainage paths, which could result in softening of the surrounding areas, piping erosion and/or localised seepage.

The floor should be inspected for the presence of sand lenses, joints/fissures, or other potential conduits for water passage through the foundation. The geotechnical authority should provide advice on specific additional treatment requirements if such features are exposed, (considered unlikely based on site conditions).

At site locations within existing drainage depressions and lower lying areas, it is likely to be necessary to divert drainage flows to prevent water ponding in areas of proposed fill placement, particularly if works are carried out during wet weather.

6.10.3 Batter Slopes & Erosion Control

Excavations for the basins in site materials should be battered at 1V:3H or flatter, and protected from erosion.

Where the dam embankments are constructed of approved homogeneous earth fill, the embankments should be battered at maximum slopes of 1V:3.5H or flatter on the upstream side, and 1V:3H or flatter on the downstream side, and protected from erosion.

Selection of batter slopes should consider future maintenance activities such as operation of mowing equipment where necessary, typically requiring batters of 1V:4H or flatter.

Slopes should be designed for surcharge loading from slopes, retaining walls, structures, plant, and other anticipated loading in the vicinity of the slope.

Drainage measures should be implemented above and behind all temporary and permanent batter slopes to avoid concentrated water flows on the face or infiltration into the soil/rock profile behind the face. Surface water flows from upslope areas should be diverted away from the face.

Results of Emerson testing provide an indication into potential susceptibility to erosion. Where the results indicate that site materials are likely to be susceptible to dispersion, special care should be taken to prevent erosion by rainfall etc. The addition of gypsum may provide improved performance in some cases.

Erosion protection may include such measures as the addition of a topsoil horizon (minimum thickness of 200mm) and vegetation, or alternatively support by geosynthetic and nails, rock spall, gabion / terramesh walls or concrete lining.

The need for and selection of erosion protection will depend upon performance expectations (e.g. whether slumping is acceptable), and on operational factors (e.g. areas which may experience higher water velocities will require more robust protection).

A suitably designed spillway should be constructed to handle flood flows and prevent water overtopping the embankment, with scour protection of the downstream outlet channel comprising of a suitable riprap, rock fill, gabions or equivalent.

Ongoing monitoring of the performance and condition of the completed detention basin and earthworks should be carried out, particularly during and after large rainfall events. Maintenance or repair of aspects such as erosion protection measures may be required based on these observations.

Levels of soil erosion during construction should be able to be maintained within normally acceptable levels by adopting good soil erosion and sedimentation control practices, including:

- Minimise the area and duration of soil exposure by staged development and controlled clearing;
- Stockpile stripped soil for reuse and protect from erosion;
- Control storm water run-off by diverting clean run-off from denuded areas, minimising slope gradient, length and run-off velocities;
- Trap soil and water pollutants using silt traps, sediment basins, perimeter banks, silt fences and nutrient traps as appropriate;
- Re-vegetate as soon as is practicable, including the application of topsoil / hydromulch where necessary.

6.11 Special Requirements for Construction Procedures and Drainage

Care should be taken during backfilling of any dams or drainage depressions to reduce the risk of leaving a preferential underground drainage path which could result in softening of the surrounding area, piping erosion and/or localised seepage.

Potential effects of slope modifications on groundwater flowing from upslope should also be considered, with provision of subsurface drainage to intercept and redirect groundwater where assessed to be necessary.

The enclosed pavement thickness designs assume the provision of adequate surface and subsurface drainage of the pavement and adjacent areas to prevent moisture ingress into the pavement materials and subgrade. As a minimum, it is recommended that subsoil drains be installed:

- Along the high side of roads aligned across site slopes;
- Along both sides of roads aligned down slope.

It is recommended that surface and subsoil drainage be installed in line with the above advice, and in accordance with Maitland City Council specifications.

Adequate surface and subsurface drainage should be installed and connected to the stormwater disposal system.

Inspection should be carried out by a geotechnical authority during construction to confirm the conditions assumed in this report and in the design.

7.0 Limitations

This report comprises the results of an investigation carried out for a specific purpose and client as defined in the document. The report should not be used by other parties or for purposes or projects other than those assumed and stated within the report, as it may not contain adequate or appropriate information for applications other than those assumed or advised at the time of its preparation. The contents of the report are for the sole use of the client and no responsibility or liability will be accepted to any third party. The report should not be reproduced either in part or in full, without the express permission of Qualtest.

Geotechnical site investigation is based on data collection, judgment, experience, and opinion. By its nature, it is less exact than other engineering disciplines. The findings presented in the report and used as the basis for recommendations presented herein were obtained using normal, industry accepted geotechnical design practices and standards. To our knowledge, they represent a reasonable interpretation of the general conditions of the site. Under no circumstances, however, can it be considered that these findings represent the actual state of the site at all points.

The recommended depth and properties of any soil, rock, groundwater, or other material referred to in this report is an engineering estimate based on the information available at the time of its writing. The estimate is influenced and limited by the fieldwork method and testing carried out in the site investigation, and other relevant information as has been made available. In cases where information has been provided to Qualtest for the purposes of preparing this report, it has been assumed that the information is accurate and appropriate for such use. No responsibility is accepted by Qualtest for inaccuracies within any data supplied by others.

The extent of testing associated with this assessment is limited to discrete test locations. It should be noted that subsurface conditions between and away from the test locations may be different to those observed during the field work and used as the basis of the recommendations contained in this report.

If site conditions encountered during construction differ from those given in this report, further advice should be sought without delay.

This report alone should not be used by contractors as the basis for preparation of tender documents or project estimates. Contractors using this report as a basis for preparation of tender documents should avail themselves of all relevant background information regarding the site before deciding on selection of construction materials and equipment.

If you have any further questions regarding this report, please do not hesitate to contact Ben Edwards, Shannon Kelly, or the undersigned.

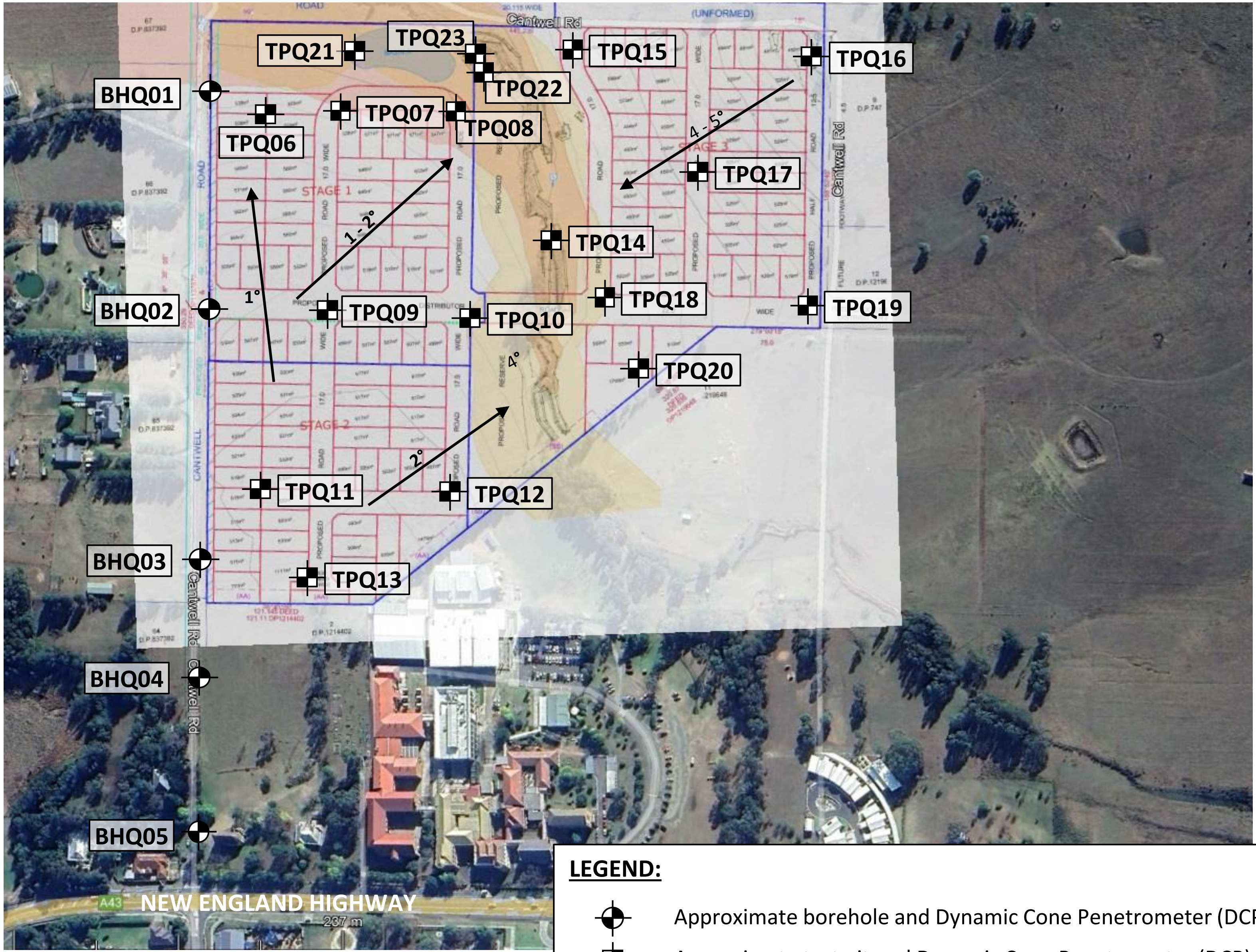
For and on behalf of Qualtest Laboratory (NSW) Pty Ltd.

Jason Lee

Jason Lee
Principal Geotechnical Engineer

FIGURE AB1

Site Plan and Approximate Test Locations



Based on drawing by Land Development Solutions (Ref. Job No: 6829, Drawing No: 1, Edition: B, dated: 14/10/2021), overlaid on Google Earth Pro Image by Qualtest.

LEGEND:

⊕	Approximate borehole and Dynamic Cone Penetrometer (DCP) test location.
⊞	Approximate test pit and Dynamic Cone Penetrometer (DCP) test location.
↘ 6°	Approximate slope angle and direction

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Client:	TRUSTEE OF THE ROMAN CATHOLIC CHURCH FOR THE DOMN	Drawing No:	FIGURE AB1
Project:	PROPOSED SUBDIVISION	Project No:	NEW24P-0120
Location:	20 & 20A CANTWELL ROAD	Scale:	N.T.S.
Title:	SITE PLAN AND APPROXIMATE TEST LOCATIONS	Date:	26/07/2024

APPENDIX A:

Results of Field Investigations

ENGINEERING LOG - BOREHOLE

Qualtest LABORATORY (NSW) PTY LTD

CLIENT:	CATHOLIC DIOCESE C/- MONTEATH & POWYS	**BOREHOLE NO:**	**BHQ01**
PROJECT:	PROPOSED SUBDIVISION	**PAGE:**	1 OF 1
LOCATION:	20 & 20A CANTWELL ROAD, LOCHINVAR	**JOB NO:**	NEW24P-0120
		LOGGED BY:	BE
		DATE:	12/6/24

DRILL TYPE: 2.7 TONNE EXCAVATOR

BOREHOLE DIAMETER: 300 mm

SURFACE RL:

DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Encountered			0.10m	☒	GC	FILL-TOPSOIL: Sandy Clayey GRAVEL / Sandy Gravelly CLAY - fine to medium grained angular, pale brown to grey-brown, fines of low to medium palsticity, fine to coarse grained sand, root affected.	M				FILL - TOPSOIL
				0.25m	☒	CH	FILL: Sandy CLAY - medium to high plasticity, brown to dark brown, trace dark grey, fine to coarse grained sand, trace fine grained angular gravel.	M > W_P	St	HP HP	180 200	FILL
		0.30m CBR 0.50m U50 0.65m		0.5 1.0	▨	CH	CLAY - medium to high plasticity, pale brown and pale grey, trace fine grained sand.			HP HP HP HP HP	150 150 150 130 150	RESIDUAL SOIL
				1.5 1.50m	▨		Pale grey to white and pale orange, with silt.		VSt	HP HP	220 250	
				2.0 2.5			Hole Terminated at 1.50 m					

LEGEND:

Water

- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes

- — — Gradational or transitional strata
- —— Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		**UCS (kPa)**
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - BOREHOLE

CLIENT:	CATHOLIC DIOCESE C/- MONTEATH & POWYS	**BOREHOLE NO:**	**BHQ02**
PROJECT:	PROPOSED SUBDIVISION	**PAGE:**	1 OF 1
LOCATION:	20 & 20A CANTWELL ROAD, LOCHINVAR	**JOB NO:**	NEW24P-0120
		LOGGED BY:	BE
		DATE:	12/6/24

DRILL TYPE: 2.7 TONNE EXCAVATOR

BOREHOLE DIAMETER: 300 mm

SURFACE RL:

DATUM:

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
AD/T	Not Encountered					CH	0.05m FILL-TOPSOIL: Sandy CLAY - medium to high plasticity, grey-brown, with brown, fine to coarse (mostly fine to medium) grained sand, with fine to medium grained angular gravel, root affected.	M > W_P				FILL-TOPSOIL
						CH	0.35m FILL: CLAY - medium to high plasticity, grey-brown, with brown, with fine grained sand, trace coarse grained angular gravel (approximately up to 60mm in size).		St	HP HP	150 150	FILL
		0.35m CBR 0.55m		0.5		CH	CLAY - medium to high plasticity, pale grey to pale brown, with brown, with fine grained sand.			HP HP	150 150	RESIDUAL SOIL
							0.70m 0.71m Sandy SILTSTONE - pale grey to grey, fine grained sand in rock matrix, estimated high strength.	D				HIGHLY WEATHERED ROCK
							Hole Terminated at 0.71 m Refusal					
				1.0								
				1.5								
				2.0								
				2.5								

LEGEND:

Water

- ▼ Water Level (Date and time shown)
- ► Water Inflow
- ◄ Water Outflow

Strata Changes

- — — Gradational or transitional strata
- ——— Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		**UCS (kPa)**
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density			
	V	Very Loose	Density Index <15%
	L	Loose	Density Index 15 - 35%
	MD	Medium Dense	Density Index 35 - 65%
	D	Dense	Density Index 65 - 85%
	VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - BOREHOLE

Qualtest LABORATORY (NSW) PTY LTD

CLIENT: CATHOLIC DIOCESE C/- MONTEATH & POWYS
PROJECT: PROPOSED SUBDIVISION
LOCATION: 20 & 20A CANTWELL ROAD, LOCHINVAR

BOREHOLE NO: **BHQ03**
PAGE: 1 OF 1
JOB NO: NEW24P-0120
LOGGED BY: BE
DATE: 12/6/24

DRILL TYPE: 2.7 TONNE EXCAVATOR
BOREHOLE DIAMETER: 300 mm
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Encountered			0.10m	▩	CH	FILL-TOPSOIL: Sandy CLAY - medium to high plasticity, grey-brown, with brown, fine to coarse (mostly fine to medium) grained sand, with fine to medium grained angular gravel, root affected.	M > W$_P$				FILL-TOPSOIL
		0.30m		0.30m	▩	CH	FILL: Sandy CLAY - medium to high plasticity, brown to dark brown, with grey, fine to coarse (mostly fine) grained sand, with fine grained angular gravel, trace brick fragments.		St	HP	180	FILL
		CBR 0.50m		0.5 0.90m	▨	CH	CLAY - medium to high plasticity, brown, trace fine to medium grained sand. With pale brown and pale grey, with Gravelly SAND pockets.		St VSt	HP HP HP HP	200 210 210 210	RESIDUAL SOIL
				0.92m			ANDESITE - grey, with pale brown and pale grey to white, estimated low to medium strength.	D				HIGHLY WEATHERED ROCK
				1.0			Hole Terminated at 0.92 m Refusal					
				1.5								
				2.0								
				2.5								

LEGEND:

Water

- Water Level (Date and time shown)
- ▶— Water Inflow
- —◀ Water Outflow

Strata Changes

- — — Gradational or transitional strata
- —— Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		**UCS (kPa)**
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - BOREHOLE

CLIENT:	CATHOLIC DIOCESE C/- MONTEATH & POWYS	**BOREHOLE NO:**	**BHQ04**
PROJECT:	PROPOSED SUBDIVISION	**PAGE:**	1 OF 1
LOCATION:	20 & 20A CANTWELL ROAD, LOCHINVAR	**JOB NO:**	NEW24P-0120
		LOGGED BY:	BE
		DATE:	12/6/24

DRILL TYPE:	2.7 TONNE EXCAVATOR	**SURFACE RL:**	
BOREHOLE DIAMETER:	300 mm	**DATUM:**	

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Encountered			0.10m		CH	TOPSOIL: CLAY - medium to high plasticity, dark grey-brown, root affected.					TOPSOIL
		0.30m CBR 0.50m		0.5 0.90m		CH	CLAY - medium to high plasticity, dark grey-brown, trace fine grained sand.		St	HP HP HP	120 110 140	RESIDUAL SOIL / COLLUVIUM
				1.0 1.50m		CI	Gravelly Sandy CLAY - medium plasticity, pale brown, with pale grey, fine to coarse grained sand, fine grained angular gravel.		VSt	HP HP	210 250	RESIDUAL SOIL
				1.5			Hole Terminated at 1.50 m					
				2.0								
				2.5								

LEGEND:

Water

- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes

- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - BOREHOLE

CLIENT: CATHOLIC DIOCESE C/- MONTEATH & POWYS
PROJECT: PROPOSED SUBDIVISION
LOCATION: 20 & 20A CANTWELL ROAD, LOCHINVAR

BOREHOLE NO: BHQ05
PAGE: 1 OF 1
JOB NO: NEW24P-0120
LOGGED BY: BE
DATE: 12/6/24

DRILL TYPE: 2.7 TONNE EXCAVATOR
BOREHOLE DIAMETER: 300 mm
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Encountered					CH	TOPSOIL: Sandy CLAY - medium to high plasticity, grey-brown, fine grained sand, root affected.	M > w_P				TOPSOIL
		0.30m CBR 0.50m		0.5		CH	0.20m CLAY - medium to high plasticity, grey-brown and red-brown, With pale grey and pale orange, with Gravelly SAND pockets.		VSt	HP HP HP	220 220 210	RESIDUAL SOIL
				1.0		CI	1.00m Sandy Gravelly CLAY / Clayey GRAVEL - medium plasticity, grey-brown and red-brown, fine to medium grained angular gravel, fine to coarse grained sand.	M < w_P	H / Fb			
				1.5 2.0 2.5			1.50m Hole Terminated at 1.50 m					

LEGEND:

Water

- Water Level (Date and time shown)
- ▶— Water Inflow
- —◀ Water Outflow

Strata Changes

- — — Gradational or transitional strata
- —— Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - TEST PIT

CLIENT: CATHOLIC DIOCESE C/- MONTEATH & POWYS
PROJECT: PROPOSED SUBDIVISION
LOCATION: 20 & 20A CANTWELL ROAD, LOCHINVAR

TEST PIT NO: TPQ06
PAGE: 1 OF 1
JOB NO: NEW24P-0120
LOGGED BY: BS / BE
DATE: 12/6/24

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR
TEST PIT LENGTH: 2.5 m **WIDTH:** 0.5 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				CH	TOPSOIL: Sandy CLAY - medium to high plasticity, pale grey to pale brown, fine grained sand, root affected.	M > W$_P$				TOPSOIL
		0.20m E 0.30m 0.30m		0.10m			CLAY - medium to high plasticity, pale grey and pale brown, with fine grained sand.		St	HP	150	RESIDUAL SOIL
		CBR 0.50m		0.5						HP	150	
		U50 0.65m								HP	120	
										HP	150	
				1.0		CH						
							Pale grey to pale brown, with pale orange, with some silt.		VSt	HP	250	
				1.5						HP	280	
										HP	250	
				1.90m		CH	Silty CLAY - medium to high plasticity, pale grey to white and pale orange.					
				2.0						HP	380	
				2.30m			Hole Terminated at 2.30 m					
				2.5								

LEGEND:

Water

- Water Level (Date and time shown)
- ▶— Water Inflow
- —◀ Water Outflow

Strata Changes

- — — — Gradational or transitional strata
- ——— Definitive or distict strata change

Notes, Samples and Tests

U$_{50}$	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W$_p$	Plastic Limit
W$_L$	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Qualtest LABORATORY (NSW) PTY LTD

ENGINEERING LOG - TEST PIT

CLIENT:	CATHOLIC DIOCESE C/- MONTEATH & POWYS	**TEST PIT NO:**	**TPQ07**
PROJECT:	PROPOSED SUBDIVISION	**PAGE:**	1 OF 1
LOCATION:	20 & 20A CANTWELL ROAD, LOCHINVAR	**JOB NO:**	NEW24P-0120
		LOGGED BY:	BS / BE
		DATE:	13/6/24

EQUIPMENT TYPE:	2.7 TONNE EXCAVATOR			**SURFACE RL:**
TEST PIT LENGTH:	2.5 m	**WIDTH:**	0.5 m	**DATUM:**

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered					CH	TOPSOIL: Sandy CLAY - medium to high plasticity, dark grey-brown, fine grained sand, root affected.	M > w_P				TOPSOIL
				0.10m		CH	CLAY - medium to high plasticity, grey-brown, with some brown, trace fine to medium grained rounded gravel.		VSt	HP HP	180 230	RESIDUAL SOIL
				0.5			Pale grey to pale brown, with some brown, trace white.			HP HP	250 250	
				1.0								
				1.10m		CI	Silty CLAY - medium plasticity, pale grey to white and pale orange, with some extremely weathered pockets.			HP	390	
				1.5						HP	300	
				2.0								
				2.40m			Hole Terminated at 2.40 m					
				2.5								

LEGEND:

Water

- ▼ Water Level (Date and time shown)
- ▶— Water Inflow
- —◀ Water Outflow

Strata Changes

- — — Gradational or transitional strata
- —— Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		**UCS (kPa)**
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density			
	V	Very Loose	Density Index <15%
	L	Loose	Density Index 15 - 35%
	MD	Medium Dense	Density Index 35 - 65%
	D	Dense	Density Index 65 - 85%
	VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - TEST PIT

Qualtest
LABORATORY (NSW) PTY LTD

CLIENT: CATHOLIC DIOCESE C/- MONTEATH & POWYS
PROJECT: PROPOSED SUBDIVISION
LOCATION: 20 & 20A CANTWELL ROAD, LOCHINVAR

TEST PIT NO: TPQ08
PAGE: 1 OF 1
JOB NO: NEW24P-0120
LOGGED BY: BS / BE
DATE: 13/6/24

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR
TEST PIT LENGTH: 2.5 m **WIDTH:** 0.5 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m			≀≀≀	CH	TOPSOIL: Sandy CLAY - medium to high plasticity, dark grey-brown, fine grained sand, root affected.	M > W_P				TOPSOIL
		0.20m 0.30m E 0.30m			▨	CH	0.15m CLAY - medium to high plasticity, pale brown with some pale grey.		St	HP	180	RESIDUAL SOIL
		CBR 0.50m								HP	180	
				0.5					VSt	HP	200	
		U50 0.70m								HP	230	
										HP	230	
				1.0						HP	300	
				1.5						HP	350	
							With extremely weathered rock pockets, trace white.					
				2.0			2.00m					
				2.5			Hole Terminated at 2.00 m Slow progress					

LEGEND:

Water
▼ Water Level (Date and time shown)
▶— Water Inflow
—◀ Water Outflow

Strata Changes
— — Gradational or transitional strata
—— Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		**UCS (kPa)**
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - TEST PIT

CLIENT: CATHOLIC DIOCESE C/- MONTEATH & POWYS
PROJECT: PROPOSED SUBDIVISION
LOCATION: 20 & 20A CANTWELL ROAD, LOCHINVAR

TEST PIT NO: TPQ09
PAGE: 1 OF 1
JOB NO: NEW24P-0120
LOGGED BY: BS / BE
DATE: 13/6/24

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR
TEST PIT LENGTH: 2.5 m **WIDTH:** 0.5 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				CH	TOPSOIL: Sandy CLAY - medium to high plasticity, pale grey to pale brown, fine grained sand, root affected.	M > W_P				TOPSOIL
		0.20m E 0.30m		0.10m			CLAY - medium to high plasticity, pale grey and pale brown.		St	HP HP HP	120 130 150	RESIDUAL SOIL
		0.60m U50 0.75m		0.5						HP HP	130 170	
				1.0		CH				HP	200	
							Pale grey to white with some orange and pale brown, trace fine to medium grained sand.					
				1.5					VSt	HP HP HP	220 230 280	
				2.0			With some extremely to highly weathered pockets/bands.					
				2.30m			Hole Terminated at 2.30 m Slow progress					
				2.5								

LEGEND:

Water

- Water Level (Date and time shown)
- ▶— Water Inflow
- —◀ Water Outflow

Strata Changes

- — — Gradational or transitional strata
- —— Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		**UCS (kPa)**
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - TEST PIT

CLIENT: CATHOLIC DIOCESE C/- MONTEATH & POWYS
PROJECT: PROPOSED SUBDIVISION
LOCATION: 20 & 20A CANTWELL ROAD, LOCHINVAR

TEST PIT NO: TPQ10
PAGE: 1 OF 1
JOB NO: NEW24P-0120
LOGGED BY: BS / BE
DATE: 12/6/24

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR
TEST PIT LENGTH: 2.5 m **WIDTH:** 0.5 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered					CI	TOPSOIL: Sandy CLAY - medium plasticity, dark grey to brown, fine grained sand, root affected.	M > Wp				TOPSOIL
				0.10m		CH	CLAY - medium to high plasticity, grey-brown and pale brown.		St	HP	150	RESIDUAL SOIL
		0.30m CBR 0.50m		0.5						HP	180	
		U50 0.70m								HP	180	
									VSt	HP	310	
							Trace fine to medium grained angular gravel, trace white.					
				1.0						HP	310	
				1.20m		CH	CLAY - medium to high plasticity, pale grey to pale brown, with orange to brown, trace silt, trace white.			HP	300	
				1.5			Trace extremely weathered / highly weathered rock pockets.			HP	320	
										HP	340	
							With extremely weathered / highly weathered rock pockets.	M < Wp	H - Fb			
				2.0								
				2.40m								
				2.5			Hole Terminated at 2.40 m Practical Refusal					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - TEST PIT

Qualtest LABORATORY (NSW) PTY LTD

CLIENT:	CATHOLIC DIOCESE C/- MONTEATH & POWYS	**TEST PIT NO:**	**TPQ11**
PROJECT:	PROPOSED SUBDIVISION	**PAGE:**	1 OF 1
LOCATION:	20 & 20A CANTWELL ROAD, LOCHINVAR	**JOB NO:**	NEW24P-0120
		LOGGED BY:	BS / BE
		DATE:	13/6/24

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR **SURFACE RL:**
TEST PIT LENGTH: 2.5 m **WIDTH:** 0.5 m **DATUM:**

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered					CH	TOPSOIL: Sandy CLAY - medium to high plasticity, dark grey-brown, fine grained sand, root affected.					TOPSOIL
				0.10m		CH	CLAY - medium to high plasticity, pale grey to pale brown.	M > W_P	St	HP	120	RESIDUAL SOIL
		0.30m										
		CBR 0.50m		0.5						HP	150	
		U50 0.70m								HP	150	
										HP	150	
		1.00m		1.0			Pale grey to grey, with some white and pale orange, trace silt, trace extremely weathered pockets.			HP	200	
		U50 1.20m							VSt	HP	300	
										HP	350	
				1.5 / 1.50m		CI	Sandy CLAY - medium plasticity, pale grey to white and pale brown, with some pale orange to orange, fine to coarse grained (mostly fine to medium) grained sand.	M ~ W_P	VSt - Fb	HP	380	
							With Gravelly SAND pockets.					
				2.0								
				2.30m			Hole Terminated at 2.30 m Slow progress					
				2.5								

LEGEND:

Water

▼ Water Level (Date and time shown)
► Water Inflow
◄ Water Outflow

Strata Changes

— — Gradational or transitional strata
—— Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		**UCS (kPa)**
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - TEST PIT

Qualtest LABORATORY (NSW) PTY LTD

CLIENT: CATHOLIC DIOCESE C/- MONTEATH & POWYS
PROJECT: PROPOSED SUBDIVISION
LOCATION: 20 & 20A CANTWELL ROAD, LOCHINVAR

TEST PIT NO: TPQ12
PAGE: 1 OF 1
JOB NO: NEW24P-0120
LOGGED BY: BS / BE
DATE: 12/6/24

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR
TEST PIT LENGTH: 2.5 m **WIDTH:** 0.5 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered					CI	TOPSOIL: Sandy CLAY - medium plasticity, dark grey to brown, fine grained sand, root affected.	$M > W_P$				TOPSOIL
				0.10m		CH	CLAY - medium to high plasticity, pale grey, with orange to red-brown.		St	HP	120	RESIDUAL SOIL
		0.30m CBR 0.50m								HP	140	
				0.5						HP	140	
										HP	180	
		0.70m U50 0.85m								HP	180	
				1.0						HP	180	
				1.5						HP	180	
										HP	180	
							With some fine to coarse grained sand, with some fine to medium grained angular ironstone gravel.		VSt	HP	210	
										HP	250	
				2.0						HP	300	
										HP	350	
							Trace fine to medium grained rounded gravel.			HP	320	
										HP	350	
				2.5			2.50m Hole Terminated at 2.50 m					

LEGEND:

Water
- Water Level (Date and time shown)
- ▶ Water Inflow
- ◀ Water Outflow

Strata Changes
- — — Gradational or transitional strata
- —— Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		**UCS (kPa)**
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - TEST PIT

Qualtest LABORATORY (NSW) PTY LTD

CLIENT:	CATHOLIC DIOCESE C/- MONTEATH & POWYS	**TEST PIT NO:**	**TPQ13**
PROJECT:	PROPOSED SUBDIVISION	**PAGE:**	1 OF 1
LOCATION:	20 & 20A CANTWELL ROAD, LOCHINVAR	**JOB NO:**	NEW24P-0120
		LOGGED BY:	BS / BE
		DATE:	13/6/24

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR

TEST PIT LENGTH: 2.5 m **WIDTH:** 0.5 m

SURFACE RL:

DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m			⌇	CH	TOPSOIL: CLAY - medium to high plasticity, grey with brown, trace fine to medium grained sand, root affected.	M > W$_p$				TOPSOIL
		0.20m E 0.30m			▨		0.10m CLAY - medium to high plasticity, pale brown to pale grey, with some brown.			HP	180	RESIDUAL SOIL
					▨					HP	160	
		0.50m U50 0.65m		0.5	▨	CH			St	HP	180	
					▨					HP	150	
				1.0	▨							
					▨		1.20m CLAY - medium to high plasticity, pale grey to pale brown, with brown and pale orange, with some silt.			HP	300	
				1.5	▨	CH	Trace extremely weathered rock pockets.		VSt	HP	300	
					⁘		1.80m ANDESITE - pale grey to pale brown, with some white and dark grey, estimated low to medium strength.	D				HIGHLY WEATHERED ROCK
				2.0			1.90m Hole Terminated at 1.90 m Practical Refusal					
				2.5								

LEGEND:

Water

▼	Water Level (Date and time shown)
▶	Water Inflow
◀	Water Outflow

Strata Changes

— — —	Gradational or transitional strata
———	Definitive or distict strata change

Notes, Samples and Tests

U$_{50}$	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		**UCS (kPa)**
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition

D	Dry
M	Moist
W	Wet
W$_p$	Plastic Limit
W$_L$	Liquid Limit

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Qualtest
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ENGINEERING LOG - TEST PIT

TEST PIT NO: TPQ14
CLIENT: CATHOLIC DIOCESE C/- MONTEATH & POWYS
PAGE: 1 OF 1
PROJECT: PROPOSED SUBDIVISION
JOB NO: NEW24P-0120
LOCATION: 20 & 20A CANTWELL ROAD, LOCHINVAR
LOGGED BY: BS / BE
DATE: 13/6/24

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR
SURFACE RL:
TEST PIT LENGTH: 2.5 m **WIDTH:** 0.5 m
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m 0.20m			▦	GC	0.20m FILL: MIXTURE OF SOIL & CONCRETE BLOCKS: About 40% of Concrete Blocks (up to approximately 0.5m in size) in matrix of Clayey GRAVEL - fine to coarse (mostly fine to medium) grained angular, dark brown, fines of medium to high plasticity, with some fine to medium grained angular coal chitter, trace steel and brick fragments.	W				FILL
		E 0.30m		0.5	▨	CH	0.50m CLAY - medium to high plasticity, pale grey and pale orange.	M > w_P	St	HP HP	100 120	RESIDUAL SOIL
				1.0 1.5 2.0 2.5			Hole Terminated at 0.50 m					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		**UCS (kPa)**
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

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ENGINEERING LOG - TEST PIT

CLIENT: CATHOLIC DIOCESE C/- MONTEATH & POWYS
PROJECT: PROPOSED SUBDIVISION
LOCATION: 20 & 20A CANTWELL ROAD, LOCHINVAR

TEST PIT NO: **TPQ15**
PAGE: 1 OF 1
JOB NO: NEW24P-0120
LOGGED BY: BS / BE
DATE: 13/6/24

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR
TEST PIT LENGTH: 2.5 m **WIDTH:** 0.5 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
E	Not Encountered					CL	TOPSOIL: Sandy CLAY - low to medium plasticity, dark grey, fine to coarse (mostly fine) grained sand, with some fine to medium grained rounded gravel, root affected in top 0.1m.	$M > W_P$				TOPSOIL
				0.35m		CH	CLAY - medium to high plasticity, grey-brown, with some orange-brown.		St	HP	120	RESIDUAL SOIL
		0.50m		0.5						HP	160	
		U50					Pale brown to orange and grey.					
		0.70m								HP	180	
										HP	180	
				1.0								
										HP	200	
									VSt	HP	250	
				1.5								
				1.60m		CI	Extremely Weathered Sandy Siltstone with soil properties: breaks down into Sandy CLAY - medium plasticity, orange-brown and pale grey to pale brown, fine grained sand, trace fine to medium grained rounded gravel.	$M < W_P$	H / Fb	HP	280	EXTREMELY WEATHERED ROCK
				1.70m			Hole Terminated at 1.70 m					
				2.0								
				2.5								

LEGEND:

Water

- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes

- — — Gradational or transitional strata
- —— Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		**UCS (kPa)**
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Qualtest LABORATORY (NSW) PTY LTD

ENGINEERING LOG - TEST PIT

CLIENT: CATHOLIC DIOCESE C/- MONTEATH & POWYS
PROJECT: PROPOSED SUBDIVISION
LOCATION: 20 & 20A CANTWELL ROAD, LOCHINVAR

TEST PIT NO: TPQ16
PAGE: 1 OF 1
JOB NO: NEW24P-0120
LOGGED BY: BS / BE
DATE: 13/6/24

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR
TEST PIT LENGTH: 2.5 m **WIDTH:** 0.5 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m 0.20m 0.30m E 0.30m		0.15m		CH	TOPSOIL: Sandy CLAY - medium to high plasticity, dark grey-brown, fine to coarse grained (mostly fine) grained sand, with some silt, trace fine to medium grained, rounded to sub-rounded gravel, root affected.	M > W$_P$				TOPSOIL
		CBR 0.50m U50 0.65m		0.5 0.80m		CH	CLAY - medium to high plasticity, grey, with some pale brown, trace fine to medium grained, rounded to sub-rounded gravel.		F - St VSt	HP HP HP HP HP HP	120 80 - 100 120 150 130 150	RESIDUAL SOIL
				1.0 1.00m		CL	Silty CLAY - low to medium plasticity, pale grey to white and pale orange to orange, with some extremely weathered pockets.			HP HP	220 220	
				1.40m		CL	Extremely Weathered Sandy Siltstone with soil properties: breaks down into Silty CLAY - low to medium plasticity, orange-brown and pale grey to white, with some highly weathered pockets/bands.	M < W$_P$	H / Fb			EXTREMELY WEATHERED ROCK
				1.42m			Sandy SILTSTONE - orange-brown and pale grey to white, fine grained sand in rock matrix, estimated low to medium strength, fractured, with extremely weathered pockets. (Breaks up into 60mm thick blocks).	D				HIGHLY WEATHERED ROCK
				1.5 2.0 2.5			Hole Terminated at 1.42 m Refusal					

LEGEND:

Water

- Water Level (Date and time shown)
- ▶— Water Inflow
- —◀ Water Outflow

Strata Changes

- — — Gradational or transitional strata
- —— Definitive or distict strata change

Notes, Samples and Tests

U$_{50}$	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		**UCS (kPa)**
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W$_p$	Plastic Limit
W$_L$	Liquid Limit

Density			
	V	Very Loose	Density Index <15%
	L	Loose	Density Index 15 - 35%
	MD	Medium Dense	Density Index 35 - 65%
	D	Dense	Density Index 65 - 85%
	VD	Very Dense	Density Index 85 - 100%

Qualtest
LABORATORY (NSW) PTY LTD

ENGINEERING LOG - TEST PIT

CLIENT: CATHOLIC DIOCESE C/- MONTEATH & POWYS
PROJECT: PROPOSED SUBDIVISION
LOCATION: 20 & 20A CANTWELL ROAD, LOCHINVAR

TEST PIT NO: **TPQ17**
PAGE: 1 OF 1
JOB NO: NEW24P-0120
LOGGED BY: BS / BE
DATE: 13/6/24

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR
TEST PIT LENGTH: 2.5 m **WIDTH:** 0.5 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered					CL	TOPSOIL: Sandy CLAY - low to medium plasticity, grey-brown, fine to medium grained sand, with some silt, root affected.					TOPSOIL
		0.30m CBR & U50 0.50m		0.5	0.10m	CH	CLAY - medium to high plasticity, grey.	M > W_P	St	HP HP HP HP HP HP	100 110 110 120 150 150	RESIDUAL SOIL
				1.0	0.90m	CI	Extremely Weathered Sandy Siltstone with soil properties: breaks down into Silty CLAY - medium plasticity, pale grey to white and orange-brown, with highly weathered pockets/bands.	M < W_P	H / Fb			EXTREMELY WEATHERED ROCK
					1.30m 1.40m		Sandy SILTSTONE - pale grey to white, fine grained sand in rock matrix, estimated low to medium strength, fractured, trace extremely weathered rock pockets.	D				HIGHLY WEATHERED ROCK
				1.5 2.0 2.5			Hole Terminated at 1.40 m Slow progress					

LEGEND:

Water

- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes

- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		**UCS (kPa)**
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - TEST PIT

CLIENT:	CATHOLIC DIOCESE C/- MONTEATH & POWYS	**TEST PIT NO:**	**TPQ18**
PROJECT:	PROPOSED SUBDIVISION	**PAGE:**	1 OF 1
LOCATION:	20 & 20A CANTWELL ROAD, LOCHINVAR	**JOB NO:**	NEW24P-0120
		LOGGED BY:	BS / BE
		DATE:	13/6/24

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR **SURFACE RL:**

TEST PIT LENGTH: 2.5 m **WIDTH:** 0.5 m **DATUM:**

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered					CH	TOPSOIL: CLAY - medium to high plasticity, grey, with some brown, trace fine grained sand, root affected.	$M > W_p$				TOPSOIL
				0.10m		CH	CLAY - medium to high plasticity, pale brown and grey-brown.		St	HP	180	RESIDUAL SOIL
		0.30m CBR 0.50m								HP	180	
				0.5						HP	200	
		U50 0.70m							VSt	HP	230	
				1.0								
				1.5						HP	230	
										HP	280	
				2.0						HP	350	
				2.20m			Hole Terminated at 2.20 m					
				2.5								

LEGEND:

Water

- Water Level (Date and time shown)
- ▶ Water Inflow
- ◀ Water Outflow

Strata Changes

- — — Gradational or transitional strata
- —— Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		**UCS (kPa)**
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - TEST PIT

Qualtest LABORATORY (NSW) PTY LTD

CLIENT: CATHOLIC DIOCESE C/- MONTEATH & POWYS
PROJECT: PROPOSED SUBDIVISION
LOCATION: 20 & 20A CANTWELL ROAD, LOCHINVAR

TEST PIT NO: TPQ19
PAGE: 1 OF 1
JOB NO: NEW24P-0120
LOGGED BY: BS / BE
DATE: 13/6/24

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR
TEST PIT LENGTH: 2.5 m **WIDTH:** 0.5 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information				Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m		0.10m	CI	TOPSOIL: Sandy CLAY - medium plasticity, pale grey to pale brown, fine grained sand, with some silt, root affected.	M > W$_P$				TOPSOIL
		0.20m E 0.30m			CH	CLAY - medium to high plasticity, pale grey and pale brown, trace fine grained sand.		St	HP	120	RESIDUAL SOIL
						Pale grey and pale orange.		VSt	HP HP	120 210	
		0.50m U50 0.80m		0.5					HP	210	
									HP	350	
				1.0					HP	380	
							M < W$_P$	H / Fb	HP	450	
				1.5					HP HP	>600 >600	
									HP	>600	
				2.00m		Hole Terminated at 2.00 m Very slow progress					
				2.5							

LEGEND:

Water

- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes

- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U$_{50}$	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W$_p$	Plastic Limit
W$_L$	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - TEST PIT

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CLIENT:	CATHOLIC DIOCESE C/- MONTEATH & POWYS	**TEST PIT NO:**	**TPQ20**
PROJECT:	PROPOSED SUBDIVISION	**PAGE:**	1 OF 1
LOCATION:	20 & 20A CANTWELL ROAD, LOCHINVAR	**JOB NO:**	NEW24P-0120
		LOGGED BY:	BS / BE
		DATE:	13/6/24

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR

SURFACE RL:

TEST PIT LENGTH: 2.5 m **WIDTH:** 0.5 m

DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				CL	TOPSOIL: Sandy CLAY - low to medium plasticity, grey and dark brown, fine grained sand, root affected.	M > w$_P$				TOPSOIL
		0.20m E 0.30m		0.15m		CH	CLAY - medium to high plasticity, grey and brown, with fine grained sand.		St	HP HP HP	180 180 180	RESIDUAL SOIL
		0.50m B & U50 0.80m		0.5			Pale brown and pale grey, trace orange.		VSt	HP HP	220 200	
				1.0					St	HP	180	
		1.50m B 1.80m		1.5						HP HP	180 250	
									VSt	HP	240	
				2.0			2.00m Hole Terminated at 2.00 m					
				2.5								

LEGEND:

Water

- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes

- — — Gradational or transitional strata
- ——— Definitive or distict strata change

Notes, Samples and Tests

U$_{50}$	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		**UCS (kPa)**
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W$_p$	Plastic Limit
W$_L$	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

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ENGINEERING LOG - TEST PIT

CLIENT: CATHOLIC DIOCESE C/- MONTEATH & POWYS
PROJECT: PROPOSED SUBDIVISION
LOCATION: 20 & 20A CANTWELL ROAD, LOCHINVAR

TEST PIT NO: TPQ21
PAGE: 1 OF 1
JOB NO: NEW24P-0120
LOGGED BY: BS / BE
DATE: 13/6/24

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR
TEST PIT LENGTH: 2.5 m **WIDTH:** 0.5 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered					CH	TOPSOIL: CLAY - medium to high plasticity, dark grey-brown.	M > W$_P$				TOPSOIL
				0.15m			CLAY - medium to high plasticity, pale brown, with some pale grey, with fine grained sand.		VSt	HP HP	220 210	RESIDUAL SOIL
		0.50m B 0.80m		0.5					St	HP HP HP HP	200 150 180 200	
				1.0		CH	Trace coarse grained angular gravel.		St - VSt	HP	200	
		1.50m B 1.80m		1.5					VSt	HP HP HP	200 220 220	
				2.0			Brown, with grey.			HP HP	300 300	
				2.10m			Hole Terminated at 2.10 m					
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- – – Gradational or transitional strata
- —— Definitive or distict strata change

Notes, Samples and Tests

U$_{50}$	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W$_p$	Plastic Limit
W$_L$	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - TEST PIT

CLIENT: CATHOLIC DIOCESE C/- MONTEATH & POWYS
PROJECT: PROPOSED SUBDIVISION
LOCATION: 20 & 20A CANTWELL ROAD, LOCHINVAR

TEST PIT NO: TPQ22
PAGE: 1 OF 1
JOB NO: NEW24P-0120
LOGGED BY: BS / BE
DATE: 13/6/24

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR
TEST PIT LENGTH: 2.5 m **WIDTH:** 0.5 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m			▩	CH	FILL-TOPSOIL: CLAY - medium to high plasticity, brown, trace fine grained sand, root affected. 0.20m	M > W_P				FILL - TOPSOIL
		0.40m			▨	CH	CLAY - medium to high plasticity, grey, with dark brown. 0.40m		VSt	HP	250	RESIDUAL SOIL - POSSIBLE FILL
										HP	250	
		E 0.50m		0.5	▨	CH	CLAY - medium to high plasticity, pale brown, with pale grey. 0.60m			HP	200	RESIDUAL SOIL
				1.0 1.5 2.0 2.5			Hole Terminated at 0.60 m					

LEGEND:

Water

- Water Level (Date and time shown)
- ▶— Water Inflow
- —◀ Water Outflow

Strata Changes

- — — Gradational or transitional strata
- —— Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

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ENGINEERING LOG - TEST PIT

CLIENT: CATHOLIC DIOCESE C/- MONTEATH & POWYS
PROJECT: PROPOSED SUBDIVISION
LOCATION: 20 & 20A CANTWELL ROAD, LOCHINVAR

TEST PIT NO: **TPQ23**
PAGE: 1 OF 1
JOB NO: NEW24P-0120
LOGGED BY: BS / BE
DATE: 13/6/24

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR
TEST PIT LENGTH: 2.5 m **WIDTH:** 0.5 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m			☒	CH	FILL-TOPSOIL: CLAY - medium to high plasticity, brown, trace fine grained sand, root affected.	M > W_p				FILL - TOPSOIL
		0.40m			▨	CH	0.20m CLAY - medium to high plasticity, grey, with dark brown.			HP	250	RESIDUAL SOIL - POSSIBLE FILL
		E 0.50m		0.5	▨	CH	0.40m CLAY - medium to high plasticity, pale brown, with pale grey. 0.60m		VSt	HP HP	250 200	RESIDUAL SOIL
							Hole Terminated at 0.60 m					
				1.0								
				1.5								
				2.0								
				2.5								

LEGEND:

Water

- Water Level (Date and time shown)
- ▶ Water Inflow
- ◀ Water Outflow

Strata Changes

- — — Gradational or transitional strata
- —— Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

LABORATORY (NSW) PTY LTD

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ABN: 98 153 268 896

DYNAMIC CONE PENETROMETER - TEST REPORT

Client: CATHOLIC DIOCESE C/- MONTEATH & POWYS
Principal:
Project: PROPOSED SUBDIVISION
Location: 20 & 20A CANTWELL ROAD, LOCHINVAR

Project Number: *NEW24P-0120*
Sheet No: *1 of 2*
Test Date: 12 & 13/06/24
Tested By: BE

Test Method: AS1289 6.3.2 ☑ Cone Tip
Drop Height: 510 ± 5mm ☐ Blunt Tip

Depth Below Surface (mm)	Test Number								Test Location / Comments
	BHQ01	BHQ02	BHQ03	BHQ04	BHQ05	TPQ06	TPQ08	TPQ09	
150						1	2	1	DCP locations as shown on attached Figure AB1.
300						2	2	1	
450		2	3	2	3	3	3	2	
600	2	3	4	2	4	2	4	3	DCP test (BHQ01) was undertaken at 0.45m from existing ground surface, within borehole.
750	3	5*/100mm	5	3	5	3	7	3	
900	3		6*	3	5	6	7	3	
1050	4			5	7*/100mm	7	16	6	
1200	4			6		11	15	6	
1350	6			5		14	17	7	DCP tests (BHQ02 to BHQ05) were undertaken at 0.3m from existing ground surface, within boreholes.
1500	7			7					
1650									
1800									
1950									
2100									DCP tests (TPQ06, TPQ08 & TPQ09) were undertaken from existing site surface levels, adjacent to corresponding test pits.
2250									
2400									
2550									
2700									
2850									
3000									
3150									
3300									
3450									
3600									
3750									
3900									
4050									
4200									
4350									
4500									

Comments: Readings recorded in blows per 150mm increments.

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ABN: 98 153 268 896

DYNAMIC CONE PENETROMETER - TEST REPORT

Client: CATHOLIC DIOCESE C/- MONTEATH & POWYS
Principal:
Project: PROPOSED SUBDIVISION
Location: 20 & 20A CANTWELL ROAD, LOCHINVAR

Project Number: *NEW24P-0120*
Sheet No: *2 of 2*
Test Date: 12 & 13/06/24
Tested By: BE

Test Method: AS1289 6.3.2 ☑ Cone Tip
Drop Height: 510 ± 5mm ☐ Blunt Tip

Depth Below Surface (mm)	Test Number								Test Location / Comments
	TPQ13	TPQ15	TPQ16	TPQ17	TPQ18	TPQ19			
150	2	1	1	1	1	1			DCP locations as shown on attached Figure AB1.
300	3	1	2	1	2	1			
450	2	2	4	1	4	2			
600	2	3	2	2	3	5			DCP tests were undertaken from existing site surface levels, adjacent to corresponding test pit.
750	3	6	2	3	5	10			
900	5	9	3	7*/100mm	11	21			
1050	6	21	8		18				
1200	12		18						
1350	18		15*/50mm						
1500									
1650									
1800									
1950									
2100									
2250									
2400									
2550									
2700									
2850									
3000									
3150									
3300									
3450									
3600									
3750									
3900									
4050									
4200									
4350									
4500									

Comments: Readings recorded in blows per 150mm increments.
* = DCP refusal / bouncing on weathered rock.

APPENDIX B:

Results of Laboratory Testing

Material Test Report

Qualtest
LABORATORY (NSW) PTY LTD
Newcastle Laboratory
2 Murray Dwyer Circuit Mayfield West NSW 2304
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Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

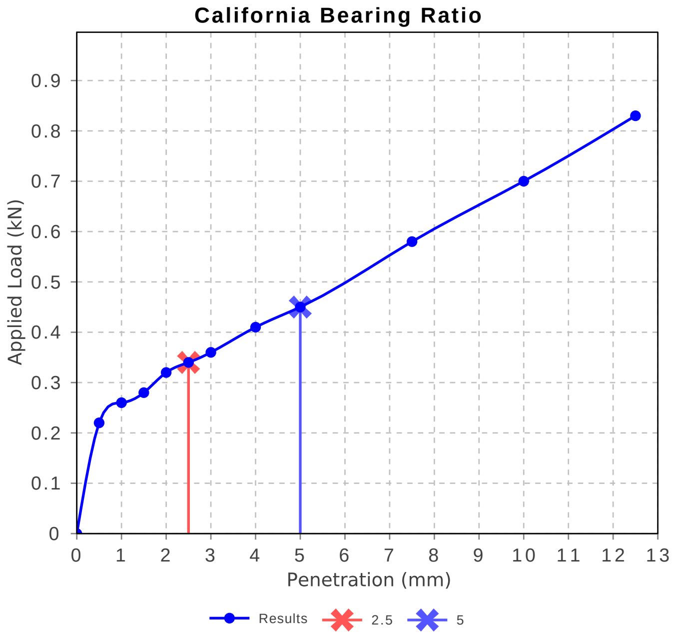
B. Cullen

Approved Signatory: Brent Cullen
Engineering Geologist

NATA Accredited Laboratory Number: 18686

Report Number: **NEW24P-0120-3**
Issue Number: 1
Date Issued: 09/07/2024
Client: The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle
841 Hunter Street, Newcastle West NSW 2321
Project Number: NEW24P-0120
Project Name: Proposed Subdivision
Project Location: 20 & 20A Cantwell Road, Lochinvar
Work Request: 4724
Sample Number: NEW24S-4724A
Date Sampled: 13/06/2024
Dates Tested: 21/06/2024 - 08/07/2024
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **BHQ01 - (0.3 - 0.5m)**
Material: CLAY
Material Source: On-Site Insitu

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**2.5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual / Tactile		
Maximum Dry Density (t/m^3)	1.58		
Optimum Moisture Content (%)	23.5		
Laboratory Density Ratio (%)	101.0		
Laboratory Moisture Ratio (%)	99.0		
Dry Density after Soaking (t/m^3)	1.57		
Field Moisture Content (%)	23.5		
Moisture Content at Placement (%)	23.1		
Moisture Content Top 30mm (%)	26.5		
Moisture Content Rest of Sample (%)	27.1		
Mass Surcharge (kg)	9		
Soaking Period (days)	10		
Curing Hours (h)	29.6		
Swell (%)	2.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



Material Test Report

Qualtest
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NATA
WORLD RECOGNISED ACCREDITATION

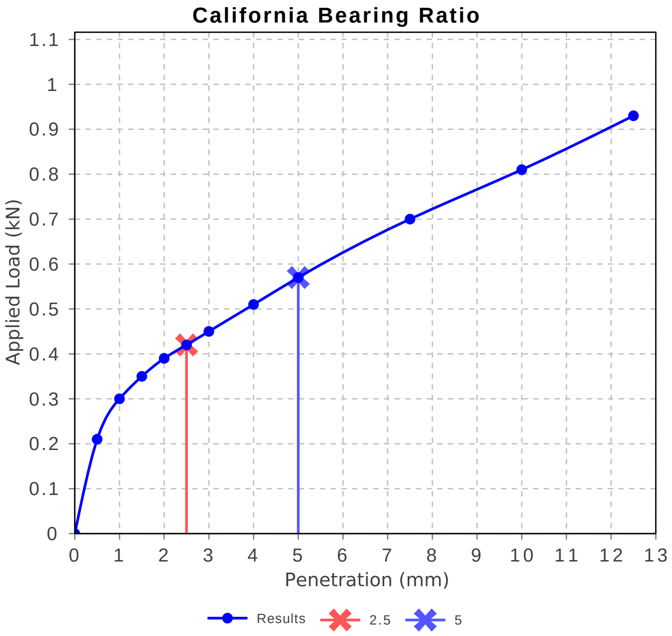
B. Cullen

Approved Signatory: Brent Cullen
Engineering Geologist

NATA Accredited Laboratory Number: 18686

Report Number: **NEW24P-0120-3**
Issue Number: 1
Date Issued: 09/07/2024
Client: The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle
841 Hunter Street, Newcastle West NSW 2321
Project Number: NEW24P-0120
Project Name: Proposed Subdivision
Project Location: 20 & 20A Cantwell Road, Lochinvar
Work Request: 4724
Sample Number: NEW24S-4724B
Date Sampled: 13/06/2024
Dates Tested: 21/06/2024 - 08/07/2024
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **BHQ02 - (0.35 - 0.55m)**
Material: CLAY
Material Source: On-Site Insitu

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**3.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual / Tactile		
Maximum Dry Density (t/m^3)	1.68		
Optimum Moisture Content (%)	19.5		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	101.0		
Dry Density after Soaking (t/m^3)	1.64		
Field Moisture Content (%)	18.3		
Moisture Content at Placement (%)	19.7		
Moisture Content Top 30mm (%)	25.3		
Moisture Content Rest of Sample (%)	25.2		
Mass Surcharge (kg)	9		
Soaking Period (days)	10		
Curing Hours (h)	29.8		
Swell (%)	2.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



Material Test Report

Report Number: **NEW24P-0120-3**
Issue Number: 1
Date Issued: 09/07/2024
Client: The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle
841 Hunter Street, Newcastle West NSW 2321
Project Number: NEW24P-0120
Project Name: Proposed Subdivision
Project Location: 20 & 20A Cantwell Road, Lochinvar
Work Request: 4724
Sample Number: NEW24S-4724C
Date Sampled: 13/06/2024
Dates Tested: 21/06/2024 - 08/07/2024
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **BHQ03 - (0.30 - 0.50m)**
Material: CLAY
Material Source: On-Site Insitu

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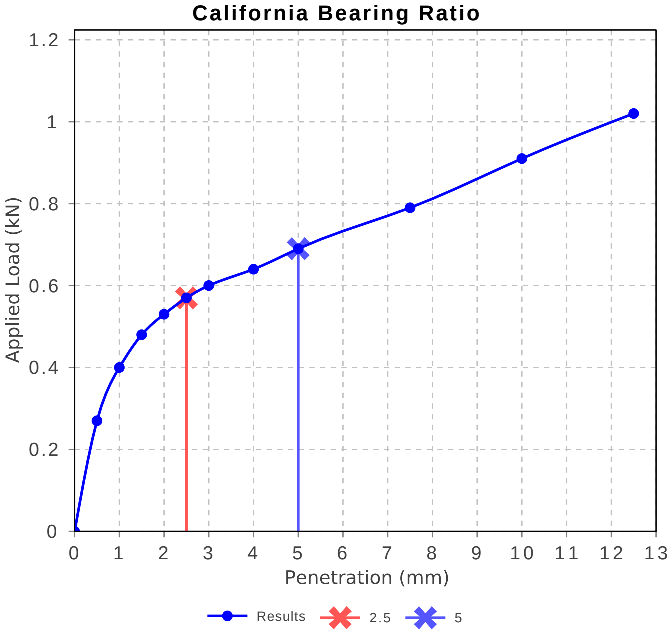
B. Cullen
Approved Signatory: Brent Cullen
Engineering Geologist
NATA Accredited Laboratory Number: 18686

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**4.5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual / Tactile		
Maximum Dry Density (t/m^3)	1.50		
Optimum Moisture Content (%)	27.0		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.46		
Field Moisture Content (%)	27.0		
Moisture Content at Placement (%)	27.2		
Moisture Content Top 30mm (%)	33.4		
Moisture Content Rest of Sample (%)	33.3		
Mass Surcharge (kg)	9		
Soaking Period (days)	10		
Curing Hours (h)	28.4		
Swell (%)	2.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



Material Test Report

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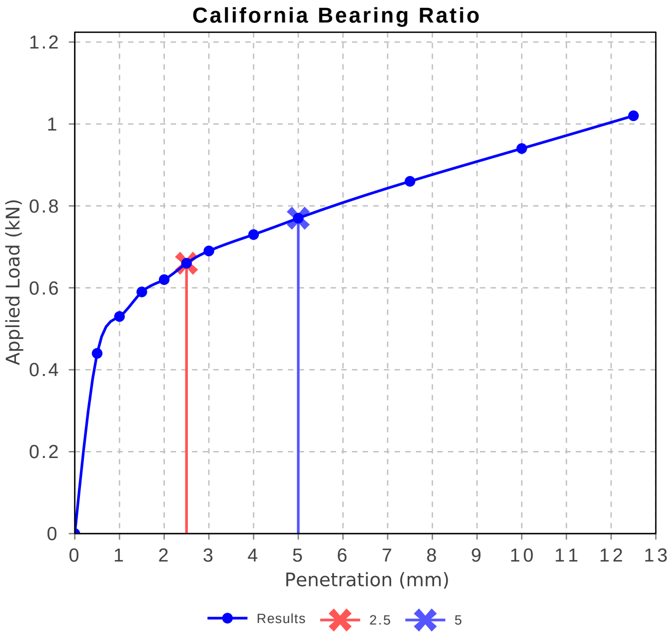
B. Cullen

Approved Signatory: Brent Cullen
Engineering Geologist

NATA Accredited Laboratory Number: 18686

Report Number:	**NEW24P-0120-3**
Issue Number:	1
Date Issued:	09/07/2024
Client:	The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle 841 Hunter Street, Newcastle West NSW 2321
Project Number:	NEW24P-0120
Project Name:	Proposed Subdivision
Project Location:	20 & 20A Cantwell Road, Lochinvar
Work Request:	4724
Sample Number:	NEW24S-4724D
Date Sampled:	13/06/2024
Dates Tested:	21/06/2024 - 08/07/2024
Sampling Method:	Sampled by Engineering Department *The results apply to the sample as received*
Sample Location:	**BHQ05 - (0.30 - 0.50m)**
Material:	CLAY
Material Source:	On-Site Insitu

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**5.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual / Tactile		
Maximum Dry Density (t/m^3)	1.45		
Optimum Moisture Content (%)	29.0		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	100.5		
Dry Density after Soaking (t/m^3)	1.44		
Field Moisture Content (%)	27.1		
Moisture Content at Placement (%)	29.0		
Moisture Content Top 30mm (%)	35.4		
Moisture Content Rest of Sample (%)	37.3		
Mass Surcharge (kg)	9		
Soaking Period (days)	10		
Curing Hours (h)	30.9		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



Material Test Report

Report Number: **NEW24P-0120-3**
Issue Number: 1
Date Issued: 09/07/2024
Client: The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle
841 Hunter Street, Newcastle West NSW 2321
Project Number: NEW24P-0120
Project Name: Proposed Subdivision
Project Location: 20 & 20A Cantwell Road, Lochinvar
Work Request: 4724
Sample Number: NEW24S-4724E
Date Sampled: 13/06/2024
Dates Tested: 21/06/2024 - 08/07/2024
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TPQ08 - (0.30 - 0.50m)**
Material: CLAY
Material Source: On-Site Insitu

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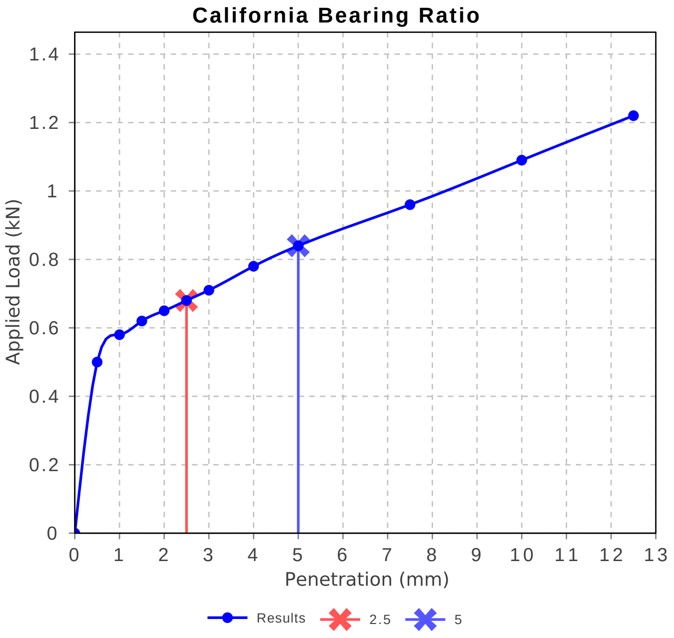
Approved Signatory: Brent Cullen
Engineering Geologist

NATA Accredited Laboratory Number: 18686

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual / Tactile		
Maximum Dry Density (t/m^3)	1.61		
Optimum Moisture Content (%)	22.0		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	101.5		
Dry Density after Soaking (t/m^3)	1.58		
Field Moisture Content (%)	22.5		
Moisture Content at Placement (%)	22.1		
Moisture Content Top 30mm (%)	27.4		
Moisture Content Rest of Sample (%)	26.8		
Mass Surcharge (kg)	9		
Soaking Period (days)	10		
Curing Hours (h)	26.2		
Swell (%)	2.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



Material Test Report

Report Number: **NEW24P-0120-3**
Issue Number: 1
Date Issued: 09/07/2024
Client: The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle
841 Hunter Street, Newcastle West NSW 2321
Project Number: NEW24P-0120
Project Name: Proposed Subdivision
Project Location: 20 & 20A Cantwell Road, Lochinvar
Work Request: 4724
Sample Number: NEW24S-4724F
Date Sampled: 13/06/2024
Dates Tested: 21/06/2024 - 08/07/2024
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TPQ09 - (0.30 - 0.50m)**
Material: CLAY
Material Source: On-Site Insitu

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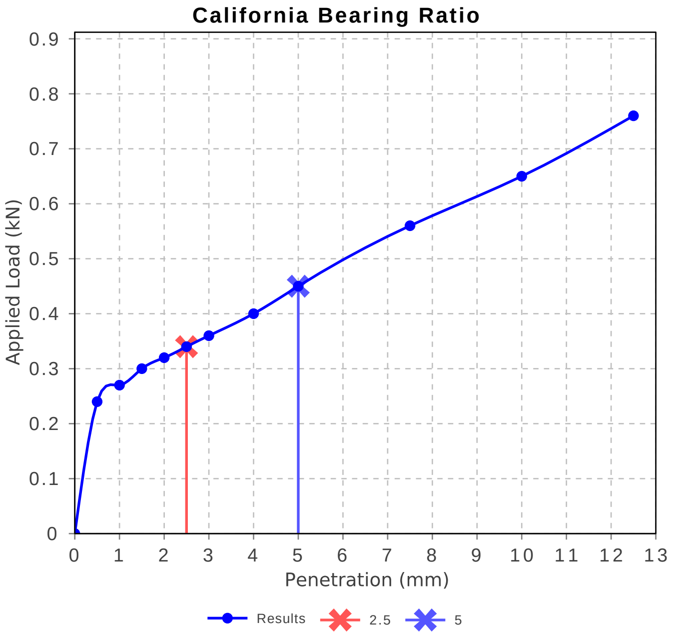
Approved Signatory: Brent Cullen
Engineering Geologist
NATA Accredited Laboratory Number: 18686

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**2.5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual / Tactile		
Maximum Dry Density (t/m^3)	1.56		
Optimum Moisture Content (%)	23.5		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	102.0		
Dry Density after Soaking (t/m^3)	1.52		
Field Moisture Content (%)	22.7		
Moisture Content at Placement (%)	24.2		
Moisture Content Top 30mm (%)	28.6		
Moisture Content Rest of Sample (%)	29.0		
Mass Surcharge (kg)	9		
Soaking Period (days)	10		
Curing Hours (h)	28.3		
Swell (%)	2.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



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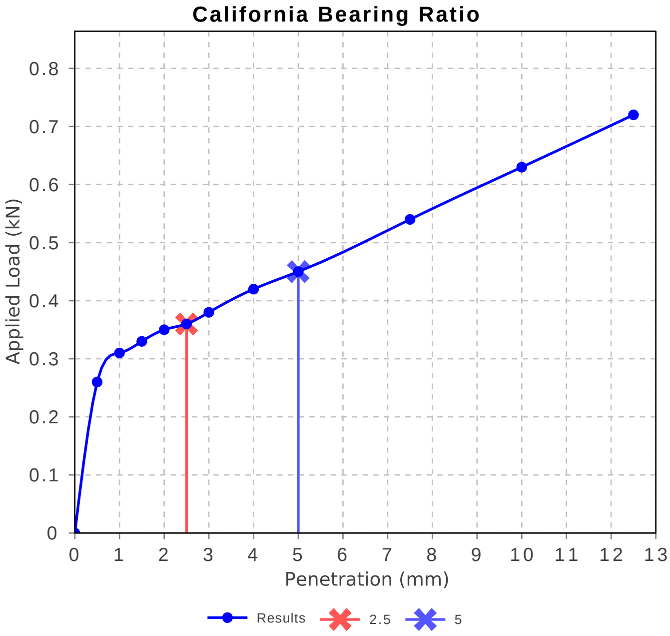
NATA Accredited Laboratory Number: 18686

Report Number:	**NEW24P-0120-3**
Issue Number:	1
Date Issued:	09/07/2024
Client:	The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle 841 Hunter Street, Newcastle West NSW 2321
Project Number:	NEW24P-0120
Project Name:	Proposed Subdivision
Project Location:	20 & 20A Cantwell Road, Lochinvar
Work Request:	4724
Sample Number:	NEW24S-4724G
Date Sampled:	13/06/2024
Dates Tested:	21/06/2024 - 08/07/2024
Sampling Method:	Sampled by Engineering Department *The results apply to the sample as received*
Sample Location:	**TPQ12 - (0.30 - 0.50m)**
Material:	CLAY
Material Source:	On-Site Insitu

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**2.5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual / Tactile		
Maximum Dry Density (t/m^3)	1.57		
Optimum Moisture Content (%)	25.0		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	99.0		
Dry Density after Soaking (t/m^3)	1.52		
Field Moisture Content (%)	19.5		
Moisture Content at Placement (%)	24.8		
Moisture Content Top 30mm (%)	28.6		
Moisture Content Rest of Sample (%)	28.0		
Mass Surcharge (kg)	9		
Soaking Period (days)	10		
Curing Hours (h)	29.5		
Swell (%)	2.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



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NATA Accredited Laboratory Number: 18686

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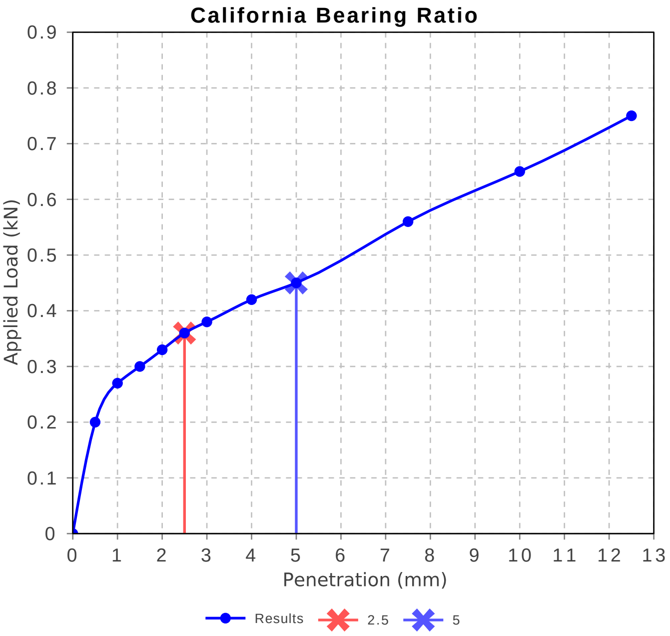
Report Number: **NEW24P-0120-3**
Issue Number: 1
Date Issued: 09/07/2024
Client: The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle
841 Hunter Street, Newcastle West NSW 2321
Project Number: NEW24P-0120
Project Name: Proposed Subdivision
Project Location: 20 & 20A Cantwell Road, Lochinvar
Work Request: 4724
Sample Number: NEW24S-4724H
Date Sampled: 13/06/2024
Dates Tested: 21/06/2024 - 08/07/2024
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **13 - (0.30 - 0.50m)**
Material: CLAY
Material Source: On-Site Insitu

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**2.5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual / Tactile		
Maximum Dry Density (t/m^3)	1.56		
Optimum Moisture Content (%)	23.5		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	100.5		
Dry Density after Soaking (t/m^3)	1.53		
Field Moisture Content (%)	22.9		
Moisture Content at Placement (%)	23.6		
Moisture Content Top 30mm (%)	28.7		
Moisture Content Rest of Sample (%)	28.6		
Mass Surcharge (kg)	9		
Soaking Period (days)	10		
Curing Hours (h)	26.6		
Swell (%)	2.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



Material Test Report

Report Number: **NEW24P-0120-3**
Issue Number: 1
Date Issued: 09/07/2024
Client: The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle
841 Hunter Street, Newcastle West NSW 2□2□
Project Number: NEW24P-0120
Project Name: Proposed Subdivision
Project Location: 20 & 20A Cantwell Road, Lochinvar
Work Request: 4724
Sample Number: NEW24S-4724I
Date Sampled: 13/06/2024
Dates Tested: 21/06/2024 - 08/07/2024
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **Q15 - (0.30 - 0.50m)**
Material: CLAY
Material Source: On-Site Insitu

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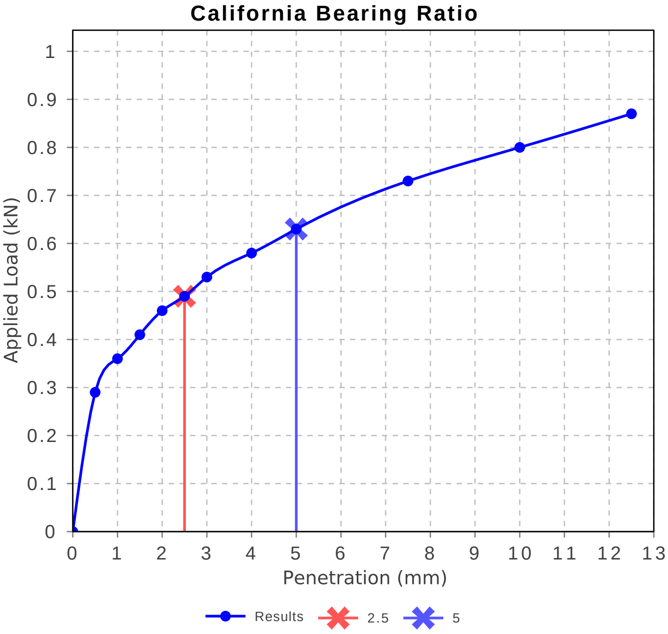
Engineering Geologist
NATA Accredited Laboratory Number: 18686

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**3.5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual / Tactile		
Maximum Dry Density (t/m^3)	1.75		
Optimum Moisture Content (%)	17.5		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	101.0		
Dry Density after Soaking (t/m^3)	1.73		
Field Moisture Content (%)	16.1		
Moisture Content at Placement (%)	17.8		
Moisture Content Top 30mm (%)	21.1		
Moisture Content Rest of Sample (%)	20.4		
Mass Surcharge (kg)	9		
Soaking Period (days)	10		
Curing Hours (h)	30.8		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



Material Test Report

Report Number: **NEW24P-0120-3**
Issue Number: 1
Date Issued: 09/07/2024
Client: The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle
841 Hunter Street, Newcastle West NSW 2321
Project Number: NEW24P-0120
Project Name: Proposed Subdivision
Project Location: 20 & 20A Cantwell Road, Lochinvar
Work Request: 4724
Sample Number: NEW24S-4724J
Date Sampled: 13/06/2024
Dates Tested: 21/06/2024 - 08/07/2024
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **Q16 - (0.30 - 0.50m)**
Material: CLAY
Material Source: On-Site Insitu

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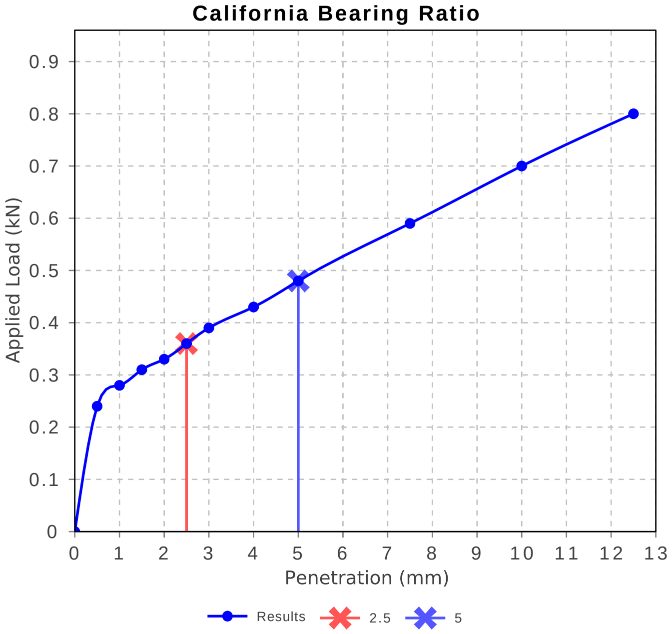
Engineering Geologist

NATA Accredited Laboratory Number: 18686

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**2.5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual / Tactile		
Maximum Dry Density (t/m^3)	1.61		
Optimum Moisture Content (%)	22.5		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	101.0		
Dry Density after Soaking (t/m^3)	1.57		
Field Moisture Content (%)	23.4		
Moisture Content at Placement (%)	22.7		
Moisture Content Top 30mm (%)	26.1		
Moisture Content Rest of Sample (%)	23.9		
Mass Surcharge (kg)	9		
Soaking Period (days)	10		
Curing Hours (h)	27.4		
Swell (%)	2.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



Material Test Report

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B. Cullen

Approved Signatory: Brent Cullen
Engineering Geologist

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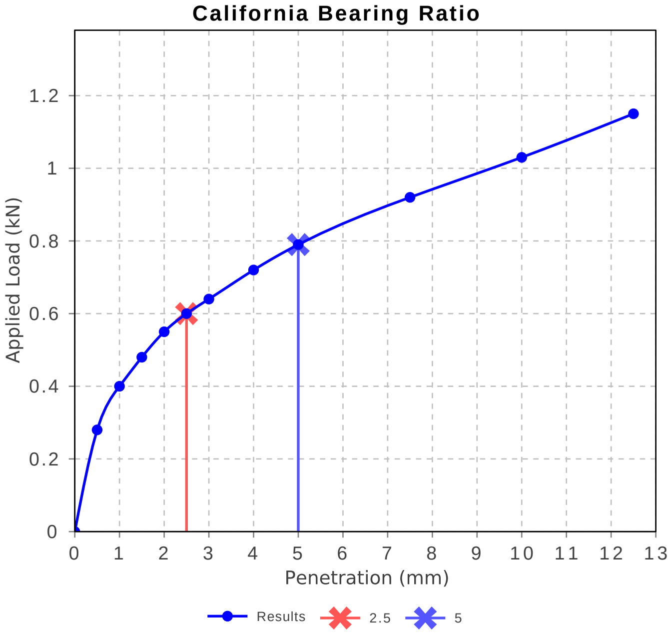
Report Number: **NEW24P-0120-3**
Issue Number: 1
Date Issued: 09/07/2024
Client: The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle
841 Hunter Street, Newcastle West NSW 2321
Project Number: NEW24P-0120
Project Name: Proposed Subdivision
Project Location: 20 & 20A Cantwell Road, Lochinvar
Work Request: 4724
Sample Number: NEW24S-4724K
Date Sampled: 13/06/2024
Dates Tested: 21/06/2024 - 08/07/2024
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **Q18 - (0.30 - 0.50m)**
Material: CLAY
Material Source: On-Site Insitu

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**4.5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual / Tactile		
Maximum Dry Density (t/m^3)	1.68		
Optimum Moisture Content (%)	19.5		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.67		
Field Moisture Content (%)	19.6		
Moisture Content at Placement (%)	19.6		
Moisture Content Top 30mm (%)	25.1		
Moisture Content Rest of Sample (%)	24.1		
Mass Surcharge (kg)	9		
Soaking Period (days)	10		
Curing Hours (h)	27.5		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



Material Test Report

Report Number:	**NEW24P-0120-3**
Issue Number:	1
Date Issued:	09/07/2024
Client:	The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle 841 Hunter Street, Newcastle West NSW 2321
Project Number:	NEW24P-0120
Project Name:	Proposed Subdivision
Project Location:	20 & 20A Cantwell Road, Lochinvar
Work Request:	4724
Sample Number:	NEW24S-4724L
Date Sampled:	13/06/2024
Dates Tested:	21/06/2024 - 08/07/2024
Sampling Method:	Sampled by Engineering Department *The results apply to the sample as received*
Sample Location:	**Q19 - (0.30 - 0.50m)**
Material:	CLAY
Material Source:	On-Site Insitu

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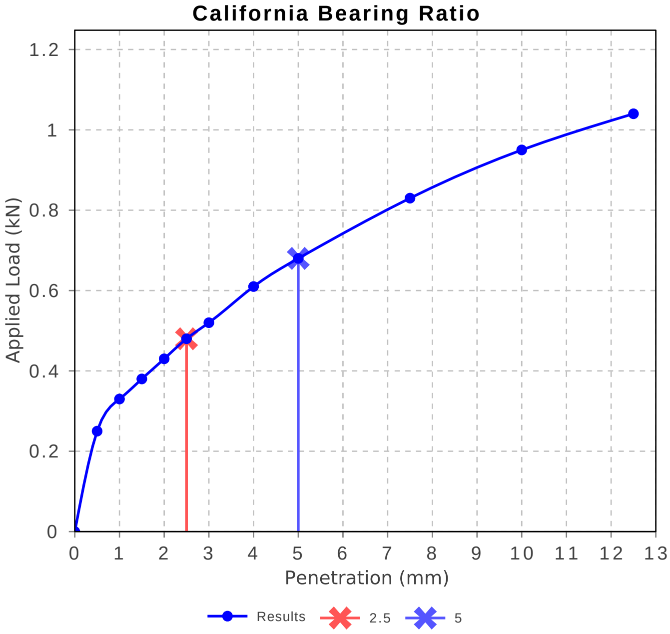
B. Cullen

Approved Signatory: Brent Cullen
Engineering Geologist

NATA Accredited Laboratory Number: 18686

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**3.5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual / Tactile		
Maximum Dry Density (t/m^3)	1.79		
Optimum Moisture Content (%)	17.0		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	102.0		
Dry Density after Soaking (t/m^3)	1.77		
Field Moisture Content (%)	17.3		
Moisture Content at Placement (%)	17.6		
Moisture Content Top 30mm (%)	19.1		
Moisture Content Rest of Sample (%)	19.6		
Mass Surcharge (kg)	9		
Soaking Period (days)	10		
Curing Hours (h)	30.8		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



Material Test Report

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Approved Signatory: Brent Cullen
Engineering Geologist

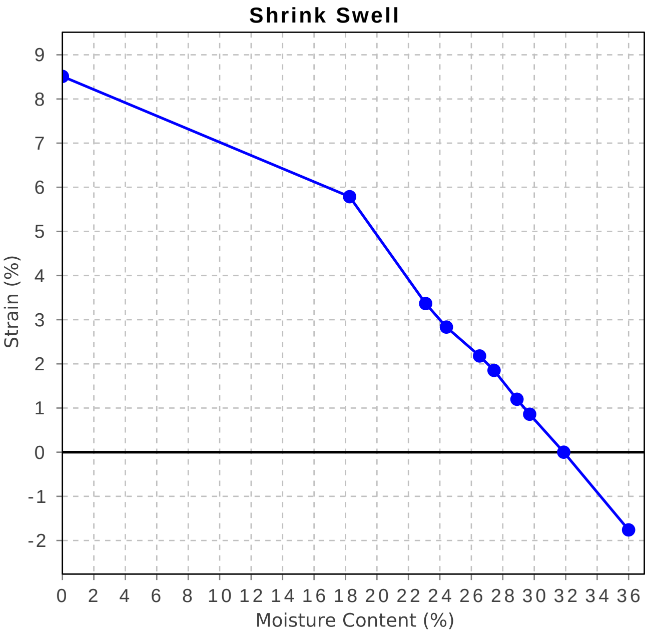
NATA Accredited Laboratory Number: 18686

Report Number: **NEW24P-0120-2**
Issue Number: 1
Date Issued: 09/07/2024
Client: The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle
841 Hunter Street, Newcastle West NSW 2321
Project Number: NEW24P-0120
Project Name: Proposed Subdivision
Project Location: 20 & 20A Cantwell Road, Lochinvar
Work Request: 4726
Sample Number: NEW24S-4726A
Date Sampled: 13/06/2024
Dates Tested: 21/06/2024 - 25/06/2024
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TPQ06 - (0.5 - 0.65m)**
Material: CLAY
Material Source: On-Site Insitu

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**5.2**
Visual Description	Clay
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**8.5**
Estimated % by volume of significant inert inclusions	1
Cracking	Slightly Cracked
Crumbling	No
Moisture Content (%)	31.9

Swell Test	
Initial Pocket Penetrometer (kPa)	150
Final Pocket Penetrometer (kPa)	100
Initial Moisture Content (%)	33.3
Final Moisture Content (%)	36.0
Swell (%)	**1.8**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	



Material Test Report

Report Number:	**NEW24P-0120-2**
Issue Number:	1
Date Issued:	09/07/2024
Client:	The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle 841 Hunter Street, Newcastle West NSW 2321
Project Number:	NEW24P-0120
Project Name:	Proposed Subdivision
Project Location:	20 & 20A Cantwell Road, Lochinvar
Work Request:	4726
Sample Number:	NEW24S-4726B
Date Sampled:	13/06/2024
Dates Tested:	21/06/2024 - 25/06/2024
Sampling Method:	Sampled by Engineering Department *The results apply to the sample as received*
Sample Location:	**TPQ08 - (0.5 - 0.70m)**
Material:	CLAY
Material Source:	On-Site Insitu

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Engineering Geologist
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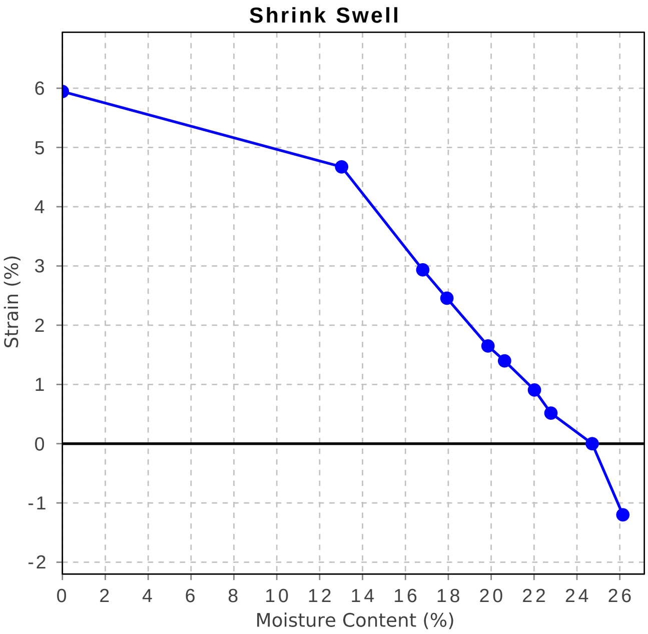
Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**3.6**
Visual Description	Clay
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**5.9**
Estimated % by volume of significant inert inclusions	2
Cracking	Uncracked
Crumbling	No
Moisture Content (%)	24.7

Swell Test	
Initial Pocket Penetrometer (kPa)	250
Final Pocket Penetrometer (kPa)	160
Initial Moisture Content (%)	23.5
Final Moisture Content (%)	26.1
Swell (%)	**1.2**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	



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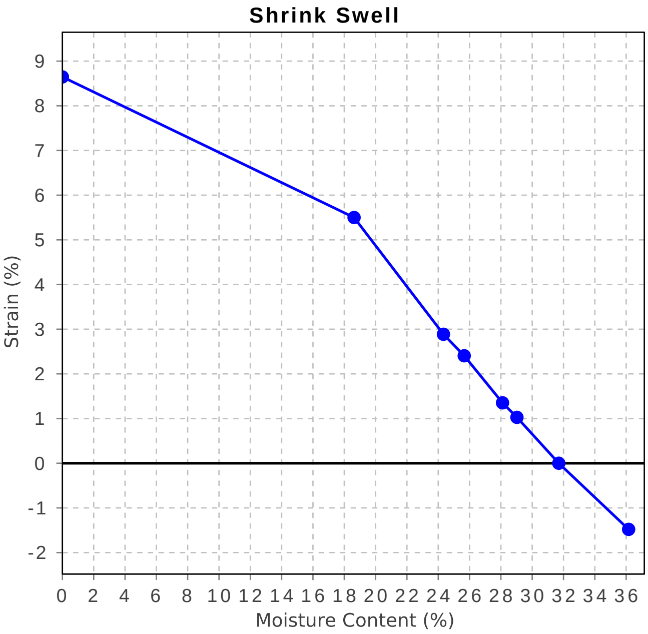
Issue Number: 1
Date Issued: 09/07/2024
Client: The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle
841 Hunter Street, Newcastle West NSW 2321
Project Number: NEW24P-0120
Project Name: Proposed Subdivision
Project Location: 20 & 20A Cantwell Road, Lochinvar
Work Request: 4726
Sample Number: NEW24S-4726C
Date Sampled: 13/06/2024
Dates Tested: 21/06/2024 - 26/06/2024
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TPQ09 - (0.6 - 0.75m)**
Material: CLAY
Material Source: On-Site Insitu

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**5.2**
Visual Description	Clay
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**8.6**
Estimated % by volume of significant inert inclusions	0
Cracking	Moderately Cracked
Crumbling	No
Moisture Content (%)	31.7

Swell Test	
Initial Pocket Penetrometer (kPa)	150
Final Pocket Penetrometer (kPa)	90
Initial Moisture Content (%)	32.7
Final Moisture Content (%)	36.2
Swell (%)	**1.5**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	



Material Test Report

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Newcastle Laboratory
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Phone: (02) 4968 4468
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Report Number:	**NEW24P-0120-2**
Issue Number:	1
Date Issued:	09/07/2024
Client:	The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle 841 Hunter Street, Newcastle West NSW 2321
Project Number:	NEW24P-0120
Project Name:	Proposed Subdivision
Project Location:	20 & 20A Cantwell Road, Lochinvar
Work Request:	4726
Sample Number:	NEW24S-4726D
Date Sampled:	13/06/2024
Dates Tested:	21/06/2024 - 26/06/2024
Sampling Method:	Sampled by Engineering Department *The results apply to the sample as received*
Sample Location:	**TPQ10 - (0.5 - 0.70m)**
Material:	CLAY
Material Source:	On-Site Insitu

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Engineering Geologist

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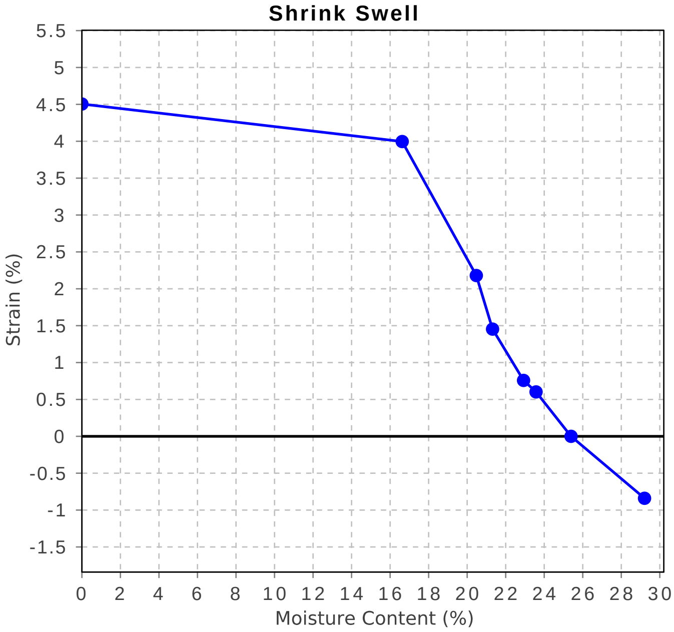
Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**2.7**
Visual Description	Clay
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**4.5**
Estimated % by volume of significant inert inclusions	
Cracking	Slightly Cracked
Crumbling	No
Moisture Content (%)	25.4

Swell Test	
Initial Pocket Penetrometer (kPa)	200
Final Pocket Penetrometer (kPa)	120
Initial Moisture Content (%)	23.0
Final Moisture Content (%)	29.2
Swell (%)	**0.8**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	



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B. Cullen

Approved Signatory: Brent Cullen
Engineering Geologist

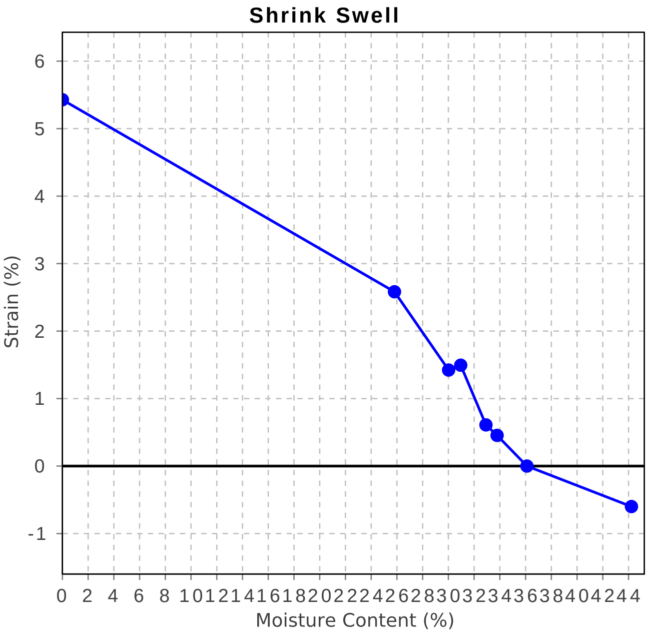
NATA Accredited Laboratory Number: 18686

Report Number: **NEW24P-0120-2**
Issue Number: 1
Date Issued: 09/07/2024
Client: The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle
841 Hunter Street, Newcastle West NSW 2321
Project Number: NEW24P-0120
Project Name: Proposed Subdivision
Project Location: 20 & 20A Cantwell Road, Lochinvar
Work Request: 4726
Sample Number: NEW24S-4726E
Date Sampled: 13/06/2024
Dates Tested: 21/06/2024 - 26/06/2024
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TPQ11 - (1.0 - 1.20m)**
Material: CLAY
Material Source: On-Site Insitu

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**3.2**
Visual Description	Clay
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**5.4**
Estimated % by volume of significant inert inclusions	1
Cracking	Moderately Cracked
Crumbling	Yes
Moisture Content (%)	36.1

Swell Test	
Initial Pocket Penetrometer (kPa)	200
Final Pocket Penetrometer (kPa)	80
Initial Moisture Content (%)	36.9
Final Moisture Content (%)	44.2
Swell (%)	**0.6**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	



Material Test Report

Report Number: **NEW24P-0120-2**
Issue Number: 1
Date Issued: 09/07/2024
Client: The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle
841 Hunter Street, Newcastle West NSW 2321
Project Number: NEW24P-0120
Project Name: Proposed Subdivision
Project Location: 20 & 20A Cantwell Road, Lochinvar
Work Request: 4726
Sample Number: NEW24S-4726F
Date Sampled: 13/06/2024
Dates Tested: 21/06/2024 - 26/06/2024
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TPQ12 - (0.7 - 0.85m)**
Material: CLAY
Material Source: On-Site Insitu

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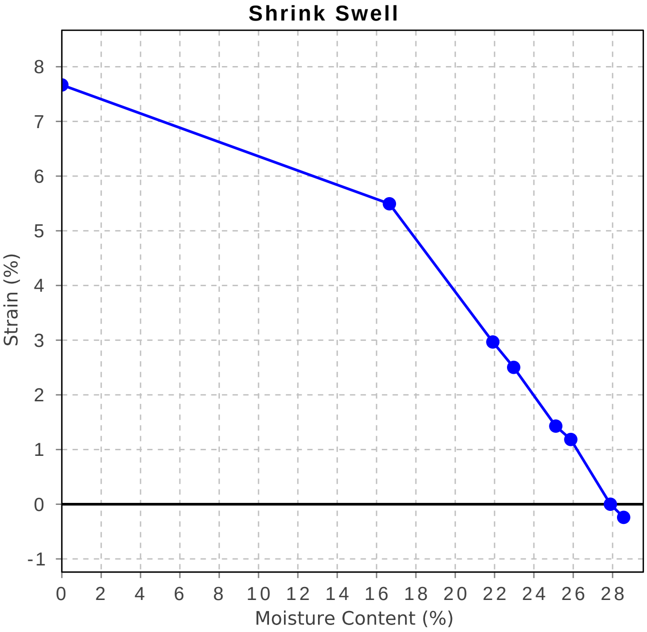
Engineering Geologist
NATA Accredited Laboratory Number: 18686

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**4.3**
Visual Description	Clay
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**7.7**
Estimated % by volume of significant inert inclusions	1
Cracking	Slightly Cracked
Crumbling	No
Moisture Content (%)	27.9

Swell Test	
Initial Pocket Penetrometer (kPa)	280
Final Pocket Penetrometer (kPa)	150
Initial Moisture Content (%)	27.0
Final Moisture Content (%)	28.6
Swell (%)	**0.2**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	



Material Test Report

Report Number:	**NEW24P-0120-2**
Issue Number:	1
Date Issued:	09/07/2024
Client:	The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle 841 Hunter Street, Newcastle West NSW 2321
Project Number:	NEW24P-0120
Project Name:	Proposed Subdivision
Project Location:	20 & 20A Cantwell Road, Lochinvar
Work Request:	4726
Sample Number:	NEW24S-4726G
Date Sampled:	13/06/2024
Dates Tested:	21/06/2024 - 26/06/2024
Sampling Method:	Sampled by Engineering Department
	The results apply to the sample as received **Sample**
Location:	**Q13 - (0.5 - 0.65m)**
Material:	CLAY
Material Source:	On-Site Insitu

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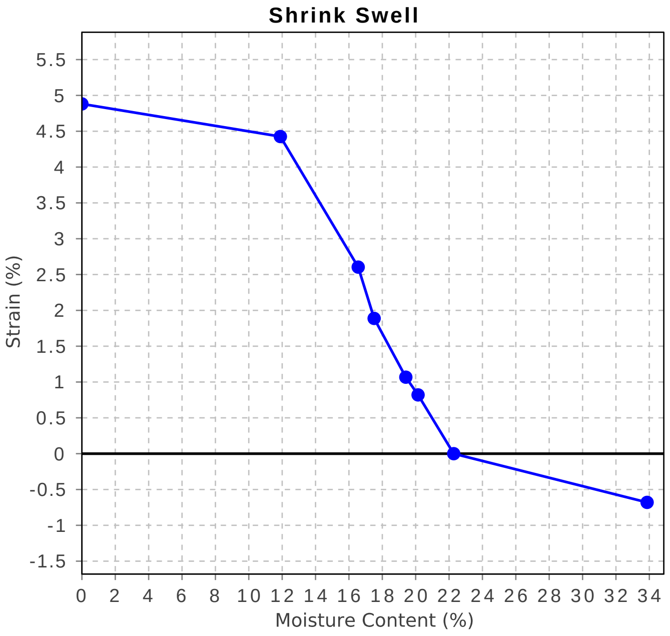
NATA Accredited Laboratory Number: 18686

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**2.9**
Visual Description	Clay
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**4.9**
Estimated % by volume of significant inert inclusions	1
Cracking	Slightly Cracked
Crumbling	No
Moisture Content (%)	22.3

Swell Test	
Initial Pocket Penetrometer (kPa)	150
Final Pocket Penetrometer (kPa)	110
Initial Moisture Content (%)	24.7
Final Moisture Content (%)	33.9
Swell (%)	**0.7**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	



Material Test Report

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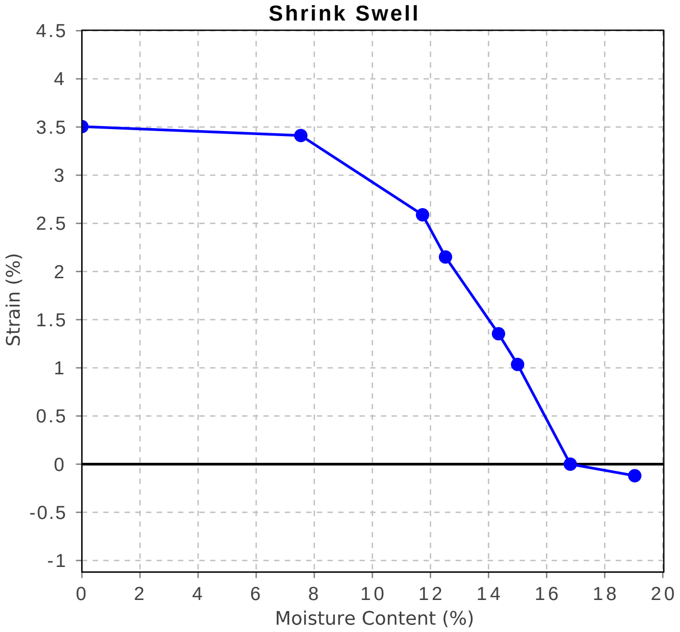
Report Number:	**NEW24P-0120-2**
Issue Number:	1
Date Issued:	09/07/2024
Client:	The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle 841 Hunter Street, Newcastle West NSW 2321
Project Number:	NEW24P-0120
Project Name:	Proposed Subdivision
Project Location:	20 & 20A Cantwell Road, Lochinvar
Work Request:	4726
Sample Number:	NEW24S-4726H
Date Sampled:	13/06/2024
Dates Tested:	21/06/2024 - 26/06/2024
Sampling Method:	Sampled by Engineering Department *The results apply to the sample as received*
Sample Location:	**Q15 - (0.5 - 0.70m)**
Material:	CLAY
Material Source:	On-Site Insitu

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**2.0**
Visual Description	Clay
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**3.5**
Estimated % by volume of significant inert inclusions	2
Cracking	Slightly Cracked
Crumbling	No
Moisture Content (%)	16.8

Swell Test	
Initial Pocket Penetrometer (kPa)	360
Final Pocket Penetrometer (kPa)	280
Initial Moisture Content (%)	15.4
Final Moisture Content (%)	19.0
Swell (%)	**0.1**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	



Material Test Report

Report Number: **NEW24P-0120-2**
Issue Number: 1
Date Issued: 09/07/2024
Client: The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle
841 Hunter Street, Newcastle West NSW 2321
Project Number: NEW24P-0120
Project Name: Proposed Subdivision
Project Location: 20 & 20A Cantwell Road, Lochinvar
Work Request: 4726
Sample Number: NEW24S-4726I
Date Sampled: 13/06/2024
Dates Tested: 21/06/2024 - 26/06/2024
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **Q16 - (0.5 - 0.65m)**
Material: CLAY
Material Source: On-Site Insitu

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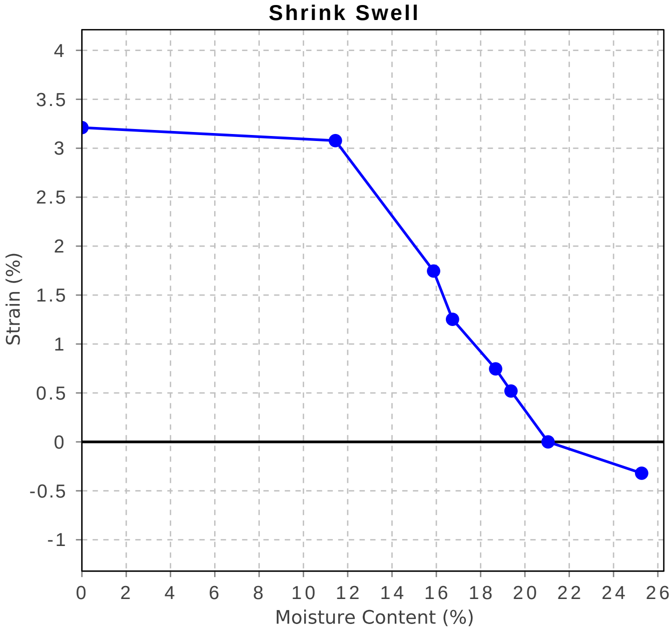
NATA Accredited Laboratory Number: 18686

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**1.9**
Visual Description	Clay
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**3.2**
Estimated % by volume of significant inert inclusions	1
Cracking	Slightly Cracked
Crumbling	No
Moisture Content (%)	21.0

Swell Test	
Initial Pocket Penetrometer (kPa)	200
Final Pocket Penetrometer (kPa)	160
Initial Moisture Content (%)	21.7
Final Moisture Content (%)	25.3
Swell (%)	**0.3**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	



Material Test Report

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Approved Signatory: Brent Cullen
Engineering Geologist
NATA Accredited Laboratory Number: 18686

Report Number: **NEW24P-0120-2**
Issue Number: 1
Date Issued: 09/07/2024
Client: The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle
841 Hunter Street, Newcastle West NSW 2321
Project Number: NEW24P-0120
Project Name: Proposed Subdivision
Project Location: 20 & 20A Cantwell Road, Lochinvar
Work Request: 4726
Sample Number: NEW24S-4726J
Date Sampled: 13/06/2024
Dates Tested: 21/06/2024 - 27/06/2024
Sampling Method: Sampled by Engineering Department

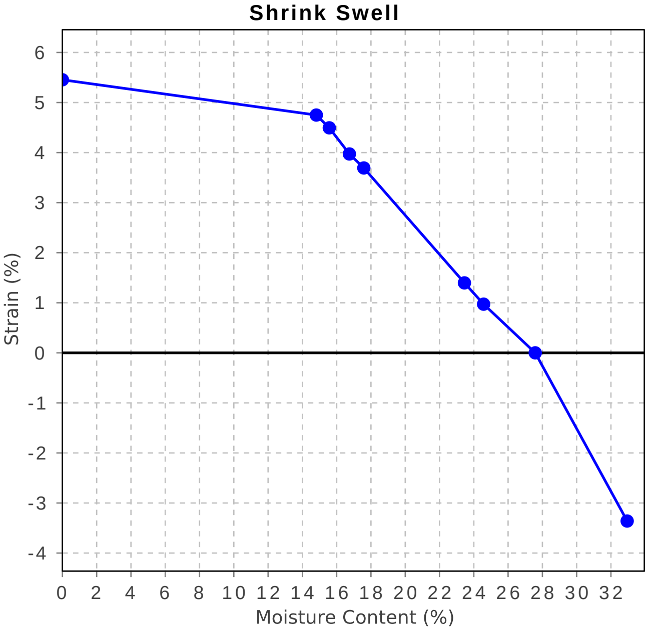
The results apply to the sample as received

Sample Location: **Q17 - (0.3 - 0.50m)**
Material: CLAY
Material Source: On-Site Insitu

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**4.0**
Visual Description	Clay
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**5.5**
Estimated % by volume of significant inert inclusions	1
Cracking	Slightly Cracked
Crumbling	No
Moisture Content (%)	27.6

Swell Test	
Initial Pocket Penetrometer (kPa)	180
Final Pocket Penetrometer (kPa)	90
Initial Moisture Content (%)	26.9
Final Moisture Content (%)	32.9
Swell (%)	**3.4**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	



Material Test Report

Report Number: **NEW24P-0120-2**
Issue Number: 1
Date Issued: 09/07/2024
Client: The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle
841 Hunter Street, Newcastle West NSW 2321
Project Number: NEW24P-0120
Project Name: Proposed Subdivision
Project Location: 20 & 20A Cantwell Road, Lochinvar
Work Request: 4726
Sample Number: NEW24S-4726K
Date Sampled: 13/06/2024
Dates Tested: 21/06/2024 - 27/06/2024
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **Q18 - (0.5 - 0.70m)**
Material: CLAY
Material Source: On-Site Insitu

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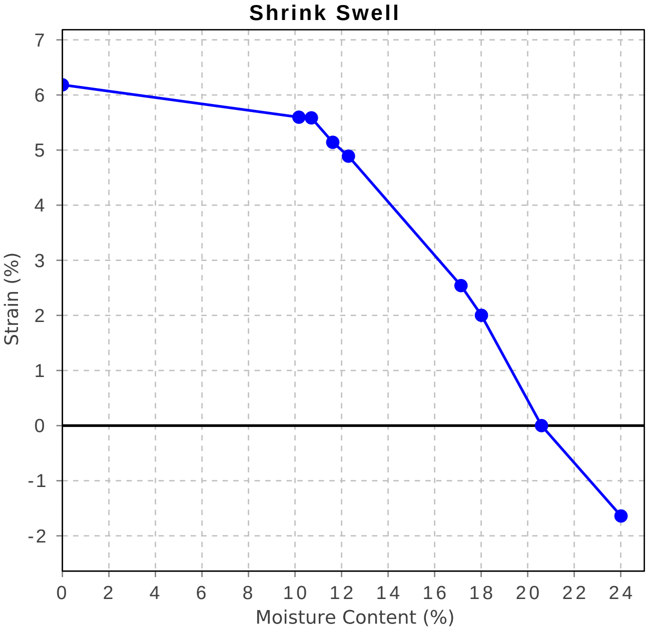
Approved Signatory: Brent Cullen
Engineering Geologist

NATA Accredited Laboratory Number: 18686

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**3.9**
Visual Description	Clay
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**6.2**
Estimated % by volume of significant inert inclusions	1
Cracking	Slightly Cracked
Crumbling	Yes / No
Moisture Content (%)	20.6

Swell Test	
Initial Pocket Penetrometer (kPa)	320
Final Pocket Penetrometer (kPa)	180
Initial Moisture Content (%)	21.3
Final Moisture Content (%)	24.0
Swell (%)	**1.6**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	



Material Test Report

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B. Cullen

Approved Signatory: Brent Cullen
Engineering Geologist

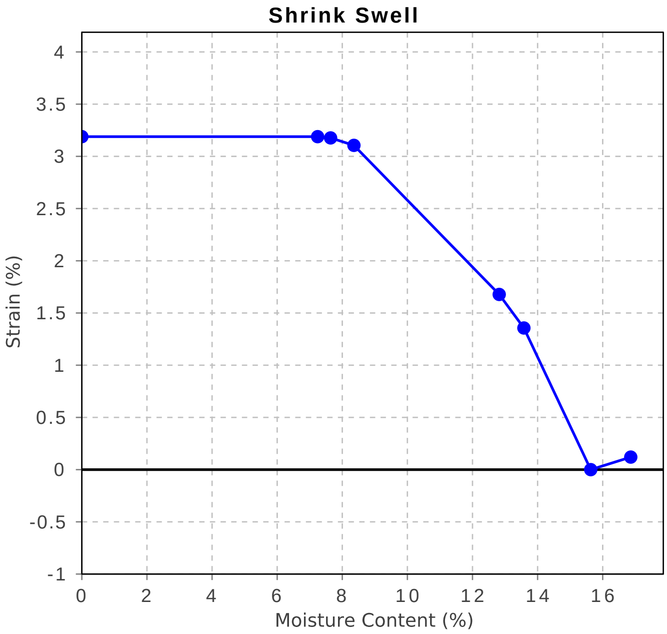
NATA Accredited Laboratory Number: 18686

Report Number: **NEW24P-0120-2**
Issue Number: 1
Date Issued: 09/07/2024
Client: The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle
841 Hunter Street, Newcastle West NSW 2321
Project Number: NEW24P-0120
Project Name: Proposed Subdivision
Project Location: 20 & 20A Cantwell Road, Lochinvar
Work Request: 4726
Sample Number: NEW24S-4726L
Date Sampled: 13/06/2024
Dates Tested: 21/06/2024 - 27/06/2024
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **Q19 - (0.5 - 0.80m)**
Material: CLAY
Material Source: On-Site Insitu

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**1.8**
Visual Description	Clay
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**3.2**
Estimated % by volume of significant inert inclusions	1
Cracking	Uncracked
Crumbling	No
Moisture Content (%)	15.6

Swell Test	
Initial Pocket Penetrometer (kPa)	410
Final Pocket Penetrometer (kPa)	460
Initial Moisture Content (%)	15.1
Final Moisture Content (%)	16.9
Swell (%)	**-0.1**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	



Material Test Report

Report Number:	**NEW24P-0120-2**
Issue Number:	1
Date Issued:	09/07/2024
Client:	The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle 841 Hunter Street, Newcastle West NSW 2321
Project Number:	NEW24P-0120
Project Name:	Proposed Subdivision
Project Location:	20 & 20A Cantwell Road, Lochinvar
Work Request:	4726
Dates Tested:	21/06/2024 - 27/06/2024
Location:	20 & 20A Cantwell Road, Lochinvar

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Engineering Geologist

NATA Accredited Laboratory Number: 18686

Shrink Swell Index AS 1289 7.1.1 & 2.1.1					
Sample Number	NEW24S-4726A	NEW24S-4726B	NEW24S-4726C	NEW24S-4726D	NEW24S-4726E
Date Sampled	13/06/2024	13/06/2024	13/06/2024	13/06/2024	13/06/2024
Date Tested	25/06/2024	25/06/2024	26/06/2024	26/06/2024	26/06/2024
Material Source	On-Site Insitu	On-Site Insitu	On-Site Insitu	On-Site Insitu	On-Site Insitu
Sample Location	TPQ06 - (0.6 - 0.65m)	TPQ08 - (0.5 - 0.70m)	TPQ09 - (0.6 - 0.75m)	TPQ10 - (0.5 - 0.70m)	TPQ11 - (1.0 - 1.20m)
Inert Material Estimate (%)	1	2	0	**	1
Pocket Penetrometer before (kPa)	150	250	150	200	200
Pocket Penetrometer after (kPa)	100	160	90	120	80
Shrinkage Moisture Content (%)	31.9	24.7	31.7	25.4	36.1
Shrinkage (%)	**8.5**	**5.9**	**8.6**	**4.5**	**5.4**
Swell Moisture Content Before (%)	33.3	23.5	32.7	23.0	36.9
Swell Moisture Content After (%)	36.0	26.1	36.2	29.2	44.2
Swell (%)	**1.8**	**1.2**	**1.5**	**0.8**	**0.6**
Shrink Swell Index Iss (%)	**5.2**	**3.6**	**5.2**	**2.7**	**3.2**
Visual Description	Clay	Clay	Clay	Clay	Clay
Cracking	SC	UC	MC	SC	MC
Crumbling	No	No	No	No	Yes
Remarks	**	**	**	**	**

Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.

Cracking Terminology: UC Uncracked, SC Slightly Cracked, MC Moderately Cracked, HC Highly Cracked, FR Fragmented.

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Material Test Report

Report Number: **NEW24P-0120-2**
Issue Number: 1
Date Issued: 09/07/2024
Client: The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle
841 Hunter Street, Newcastle West NSW 2321
Project Number: NEW24P-0120
Project Name: Proposed Subdivision
Project Location: 60 New England Highway, Lochinvar
Work Request: 4726
Dates Tested: 21/06/2024 - 27/06/2024
Location: 20 & 20A Cantwell Road, Lochinvar

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B. Cullen

Approved Signatory: Brent Cullen
Engineering Geologist
NATA Accredited Laboratory Number: 18686

Shrink Swell Index AS 1289 7.1.1 & 2.1.1					
Sample Number	NEW24S-4726F	NEW24S-4726G	NEW24S-4726H	NEW24S-4726I	NEW24S-4726J
Date Sampled	13/06/2024	13/06/2024	13/06/2024	13/06/2024	13/06/2024
Date Tested	26/06/2024	26/06/2024	26/06/2024	26/06/2024	27/06/2024
Material Source	On-Site Insitu	On-Site Insitu	On-Site Insitu	On-Site Insitu	On-Site Insitu
Sample Location	TPQ12 - (0.7 - 0.85m)	TPQ13 - (0.5 - 0.65m)	TPQ15 - (0.5 - 0.70m)	TPQ16 - (0.5 - 0.65m)	TPQ17 - (0.3 - 0.50m)
Inert Material Estimate (%)	1	1	2	1	1
Pocket Penetrometer before (kPa)	280	150	360	200	180
Pocket Penetrometer after (kPa)	150	110	280	160	90
Shrinkage Moisture Content (%)	27.9	22.3	16.8	21.0	27.6
Shrinkage (%)	**7.7**	**4.9**	**3.5**	**3.2**	**5.5**
Swell Moisture Content Before (%)	27.0	24.7	15.4	21.7	26.9
Swell Moisture Content After (%)	28.6	33.9	19.0	25.3	32.9
Swell (%)	**0.2**	**0.7**	**0.1**	**0.3**	**3.4**
Shrink Swell Index Iss (%)	**4.3**	**2.9**	**2.0**	**1.9**	**4.0**
Visual Description	Clay	Clay	Clay	Clay	Clay
Cracking	SC	SC	SC	SC	SC
Crumbling	No	No	No	No	No
Remarks	**	**	**	**	**

Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.

Cracking Terminology: UC Uncracked, SC Slightly Cracked, MC Moderately Cracked, HC Highly Cracked, FR Fragmented.

NATA Accreditation does not cover the performance of pocket penetrometer readings.

Material Test Report

Report Number: **NEW24P-0120-2**
Issue Number: 1
Date Issued: 09/07/2024
Client: The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle
841 Hunter Street, Newcastle West NSW 2321
Project Number: NEW24P-0120
Project Name: Proposed Subdivision
Project Location: 60 New England Highway, Lochinvar
Work Request: 4726
Dates Tested: 21/06/2024 - 27/06/2024
Location: 20 & 20A Cantwell Road, Lochinvar

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B. Cullen

Approved Signatory: Brent Cullen
Engineering Geologist

NATA Accredited Laboratory Number: 18686

Shrink Swell Index AS 1289 7.1.1 & 2.1.1					
Sample Number	NEW24S-4726K	NEW24S-4726L			
Date Sampled	13/06/2024	13/06/2024			
Date Tested	27/06/2024	27/06/2024			
Material Source	On-Site Insitu	On-Site Insitu			
Sample Location	TPQ18 - (0.5 0.70m)	TPQ19 - (0.5 - 0.80m)			
Inert Material Estimate (%)	1	1			
Pocket Penetrometer before (kPa)	320	410			
Pocket Penetrometer after (kPa)	180	460			
Shrinkage Moisture Content (%)	20.6	15.6			
Shrinkage (%)	**6.2**	**3.2**			
Swell Moisture Content Before (%)	21.3	15.1			
Swell Moisture Content After (%)	24.0	16.9			
Swell (%)	**1.6**	**-0.1**			
Shrink Swell Index Iss (%)	**3.9**	**1.8**			
Visual Description	Clay	Clay			
Cracking	SC	UC			
Crumbling	**	No			
Remarks	**	**			

Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.

Cracking Terminology: UC Uncracked, SC Slightly Cracked, MC Moderately Cracked, HC Highly Cracked, FR Fragmented.

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Material Test Report

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NATA Accredited Laboratory Number: 18686

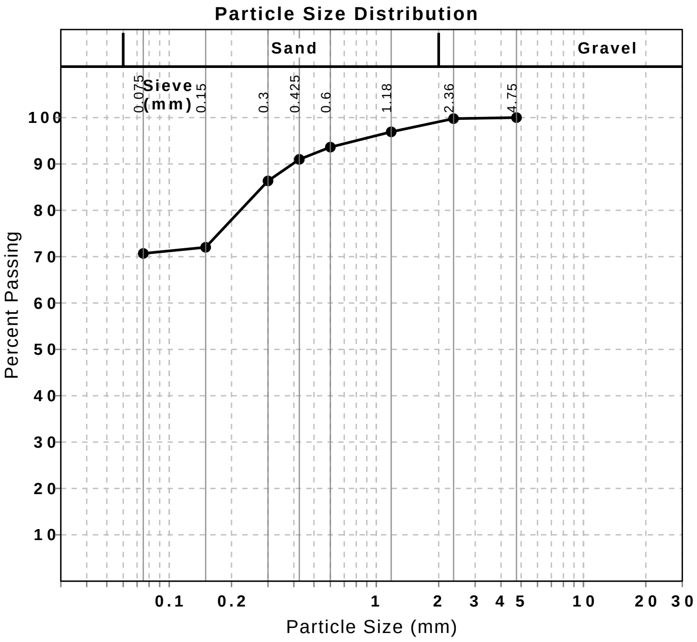
Report Number: **NEW24P-0120-1**
Issue Number: 1
Date Issued: 08/07/2024
Client: The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle
841 Hunter Street, Newcastle West NSW 2321
Project Number: NEW24P-0120
Project Name: Proposed Subdivision
Project Location: 60 New England Highway, Lochinvar
Work Request: 4725
Sample Number: NEW24S-4725A
Date Sampled: 21/06/2024
Dates Tested: 21/06/2024 - 05/07/2024
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TPQ06 - (0.3 - 0.5m)**
Material: CLAY
Material Source: On-Site Insitu

Particle Size Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
4.75 mm	**100**		
2.36 mm	**100**		
1.18 mm	**97**		
0.6 mm	**94**		
0.425 mm	**91**		
0.3 mm	**86**		
0.15 mm	**72**		
0.075 mm	**71**		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	88		
Plastic Limit (%)	22		
Plasticity Index (%)	**66**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	**17.5**		
Cracking Crumbling Curling	Curling		

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**2**		
Soil Description	Clay		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	15		



Material Test Report

Report Number: **NEW24P-0120-1**
Issue Number: 1
Date Issued: 08/07/2024
Client: The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle
841 Hunter Street, Newcastle West NSW 2321
Project Number: NEW24P-0120
Project Name: Proposed Subdivision
Project Location: 60 New England Highway, Lochinvar
Work Request: 4725
Sample Number: NEW24S-4725B
Date Sampled: 21/06/2024
Dates Tested: 21/06/2024 - 05/07/2024
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TPQ20 - (0.5 - 0.8m)**
Material: CLAY
Material Source: On-Site Insitu

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Approved Signatory: Brent Cullen
Engineering Geologist

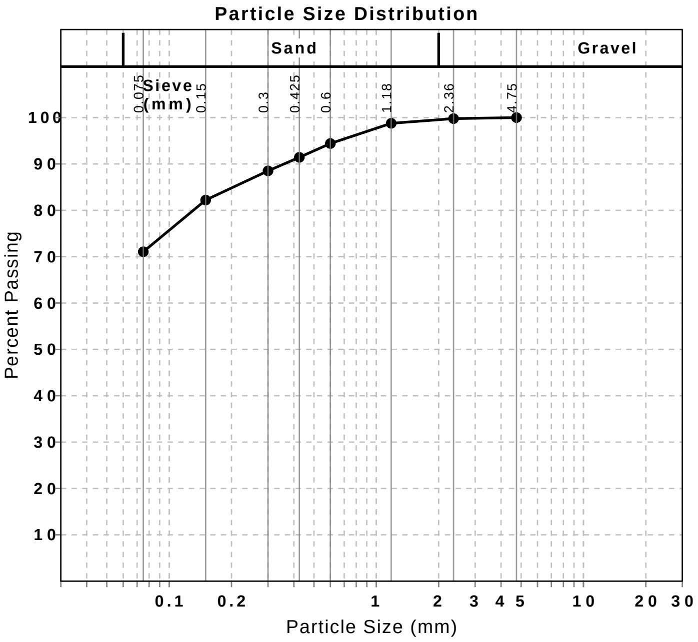
NATA Accredited Laboratory Number: 18686

Particle Size Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
4.75 mm	**100**		
2.36 mm	**100**		
1.18 mm	**99**		
0.6 mm	**94**		
0.425 mm	**91**		
0.3 mm	**89**		
0.15 mm	**82**		
0.075 mm	**71**		

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	59		
Plastic Limit (%)	16		
Plasticity Index (%)	**43**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	**18.5**		
Cracking Crumbling Curling	Cracking & Curling		

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**3**		
Soil Description	Clay		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	15		



Material Test Report

Report Number: **NEW24P-0120-1**
Issue Number: 1
Date Issued: 08/07/2024
Client: The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle
841 Hunter Street, Newcastle West NSW 2321
Project Number: NEW24P-0120
Project Name: Proposed Subdivision
Project Location: 60 New England Highway, Lochinvar
Work Request: 4725
Sample Number: NEW24S-4725C
Date Sampled: 21/06/2024
Dates Tested: 21/06/2024 - 04/07/2024
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TPQ20 - (1.5 - 1.8m)**
Material: CLAY
Material Source: On-Site Insitu

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NATA WORLD RECOGNISED ACCREDITATION

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Approved Signatory: Brent Cullen
Engineering Geologist

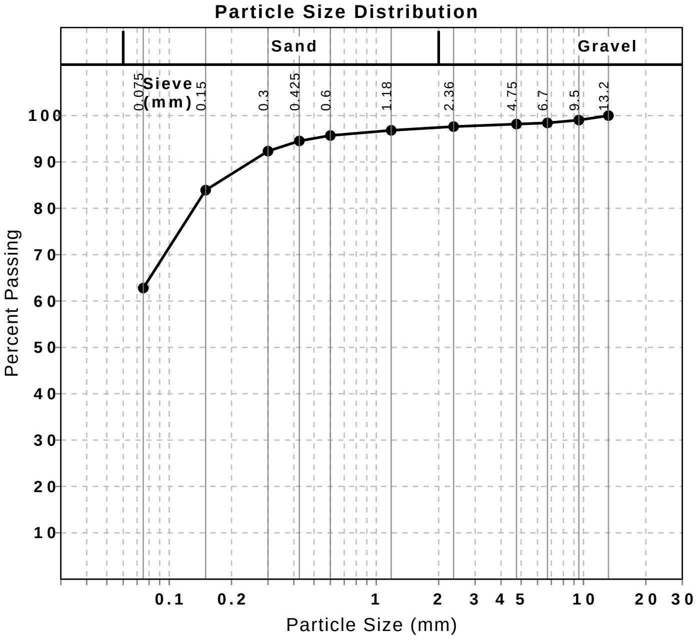
NATA Accredited Laboratory Number: 18686

Particle Size Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
13.2 mm	**100**		
9.5 mm	**99**		
6.7 mm	**98**		
4.75 mm	**98**		
2.36 mm	**98**		
1.18 mm	**97**		
0.6 mm	**96**		
0.425 mm	**95**		
0.3 mm	**92**		
0.15 mm	**84**		
0.075 mm	**63**		

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	43		
Plastic Limit (%)	14		
Plasticity Index (%)	**29**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	**12.0**		
Cracking Crumbling Curling	Cracking & Curling		

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**2**		
Soil Description	Clay		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	15		



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NATA Accredited Laboratory Number: 18686

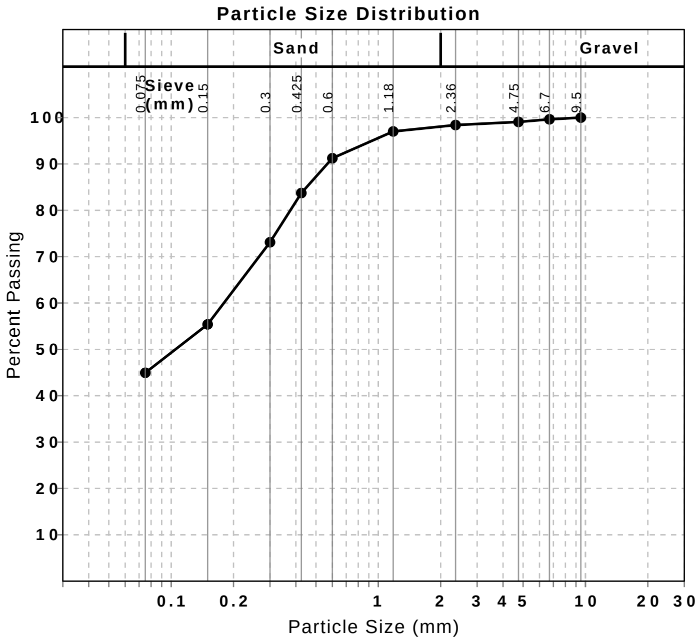
Report Number: **NEW24P-0120-1**
Issue Number: 1
Date Issued: 08/07/2024
Client: The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle
841 Hunter Street, Newcastle West NSW 2321
Project Number: NEW24P-0120
Project Name: Proposed Subdivision
Project Location: 60 New England Highway, Lochinvar
Work Request: 4725
Sample Number: NEW24S-4725D
Date Sampled: 21/06/2024
Dates Tested: 21/06/2024 - 05/07/2024
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TPQ21 - (0.5 - 0.8m)**
Material: CLAY
Material Source: On-Site Insitu

Particle Size Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
9.5 mm	**100**		
6.7 mm	**100**		
4.75 mm	**99**		
2.36 mm	**98**		
1.18 mm	**97**		
0.6 mm	**91**		
0.425 mm	**84**		
0.3 mm	**73**		
0.15 mm	**55**		
0.075 mm	**45**		

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	51		
Plastic Limit (%)	14		
Plasticity Index (%)	**37**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	**16.0**		
Cracking Crumbling Curling	Curling		

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**5**		
Soil Description	Clay		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	15		



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NATA Accredited Laboratory Number: 18686

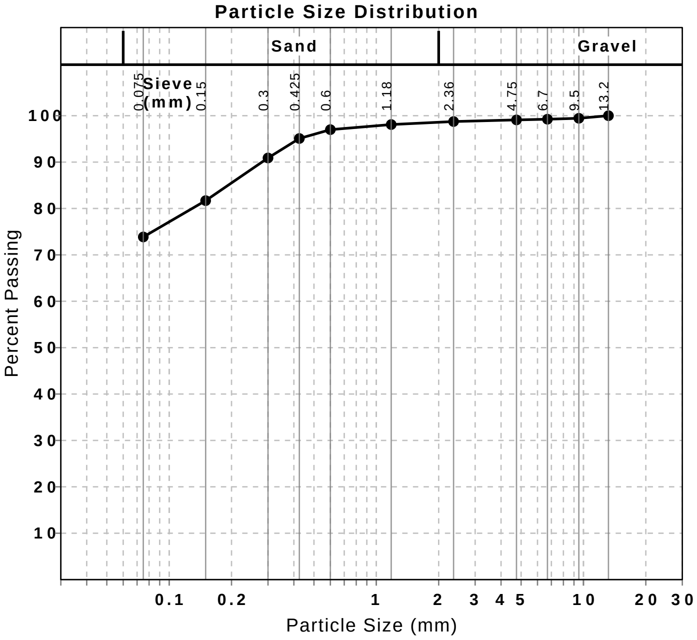
Report Number: **NEW24P-0120-1**
Issue Number: 1
Date Issued: 08/07/2024
Client: The Trustees of the Roman Catholic Church for The Diocese of Maitland-Newcastle
841 Hunter Street, Newcastle West NSW 2321
Project Number: NEW24P-0120
Project Name: Proposed Subdivision
Project Location: 60 New England Highway, Lochinvar
Work Request: 4725
Sample Number: NEW24S-4725E
Date Sampled: 21/06/2024
Dates Tested: 21/06/2024 - 05/07/2024
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TPQ21 - (1.5 - 1.8m)**
Material: CLAY
Material Source: On-Site Insitu

Particle Size Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
13.2 mm	**100**		
9.5 mm	**99**		
6.7 mm	**99**		
4.75 mm	**99**		
2.36 mm	**99**		
1.18 mm	**98**		
0.6 mm	**97**		
0.425 mm	**95**		
0.3 mm	**91**		
0.15 mm	**82**		
0.075 mm	**74**		

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	58		
Plastic Limit (%)	16		
Plasticity Index (%)	**42**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	**18.0**		
Cracking Crumbling Curling	Cracking & Curling		

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**4 ***		
Soil Description	Clay		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	15		
* Mineral Present	Carbonate		



APPENDIX C:

Selected Excerpts from AGS 2007 - Practice Note Guidelines for Landslide Risk Management

PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007

APPENDIX C: LANDSLIDE RISK ASSESSMENT

QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

QUALITATIVE MEASURES OF LIKELIHOOD

Approximate Annual Probability		Implied Indicative Landslide Recurrence Interval		Description	Descriptor	Level
Indicative Value	**Notional Boundary**					
10^{-1}	5x10^{-2}	10 years	20 years	The event is expected to occur over the design life.	ALMOST CERTAIN	A
10^{-2}	5x10^{-3}	100 years	200 years	The event will probably occur under adverse conditions over the design life.	LIKELY	B
10^{-3}	5x10^{-4}	1000 years	2000 years	The event could occur under adverse conditions over the design life.	POSSIBLE	C
10^{-4}	5x10^{-5}	10,000 years	20,000 years	The event might occur under very adverse circumstances over the design life.	UNLIKELY	D
10^{-5}	5x10^{-6}	100,000 years	200,000 years	The event is conceivable but only under exceptional circumstances over the design life.	RARE	E
10^{-6}		1,000,000 years		The event is inconceivable or fanciful over the design life.	BARELY CREDIBLE	F

Note: (1) The table should be used from left to right; use Approximate Annual Probability or Description to assign Descriptor, not *vice versa*.

QUALITATIVE MEASURES OF CONSEQUENCES TO PROPERTY

Approximate Cost of Damage		Description	Descriptor	Level
Indicative Value	**Notional Boundary**			
200%	100%	Structure(s) completely destroyed and/or large scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage.	CATASTROPHIC	1
60%	40%	Extensive damage to most of structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage.	MAJOR	2
20%	10%	Moderate damage to some of structure, and/or significant part of site requiring large stabilisation works. Could cause at least one adjacent property minor consequence damage.	MEDIUM	3
5%	1%	Limited damage to part of structure, and/or part of site requiring some reinstatement stabilisation works.	MINOR	4
0.5%		Little damage. (Note for high probability event (Almost Certain), this category may be subdivided at a notional boundary of 0.1%. See Risk Matrix.)	INSIGNIFICANT	5

Notes: (2) The Approximate Cost of Damage is expressed as a percentage of market value, being the cost of the improved value of the unaffected property which includes the land plus the unaffected structures.

(3) The Approximate Cost is to be an estimate of the direct cost of the damage, such as the cost of reinstatement of the damaged portion of the property (land plus structures), stabilisation works required to render the site to tolerable risk level for the landslide which has occurred and professional design fees, and consequential costs such as legal fees, temporary accommodation. It does not include additional stabilisation works to address other landslides which may affect the property.

(4) The table should be used from left to right; use Approximate Cost of Damage or Description to assign Descriptor, not vice versa

PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007

APPENDIX C: – QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY (CONTINUED)

QUALITATIVE RISK ANALYSIS MATRIX – LEVEL OF RISK TO PROPERTY

LIKELIHOOD		CONSEQUENCES TO PROPERTY **(With Indicative Approximate Cost of Damage)**				
	Indicative Value of Approximate Annual Probability	**1: CATASTROPHIC 200%**	**2: MAJOR 60%**	**3: MEDIUM 20%**	**4: MINOR 5%**	**5: INSIGNIFICANT 0.5%**
A – ALMOST CERTAIN	10^{-1}	VH	VH	VH	H	M or **L** (5)
B - LIKELY	10^{-2}	VH	VH	H	M	**L**
C - POSSIBLE	10^{-3}	VH	H	M	M	**VL**
D - UNLIKELY	10^{-4}	H	M	**L**	**L**	**VL**
E - RARE	10^{-5}	M	**L**	**L**	**VL**	**VL**
F - BARELY CREDIBLE	10^{-6}	**L**	**VL**	**VL**	**VL**	**VL**

Notes: (5) For Cell A5, may be subdivided such that a consequence of less than 0.1% is Low Risk.

(6) When considering a risk assessment it must be clearly stated whether it is for existing conditions or with risk control measures which may not be implemented at the current time.

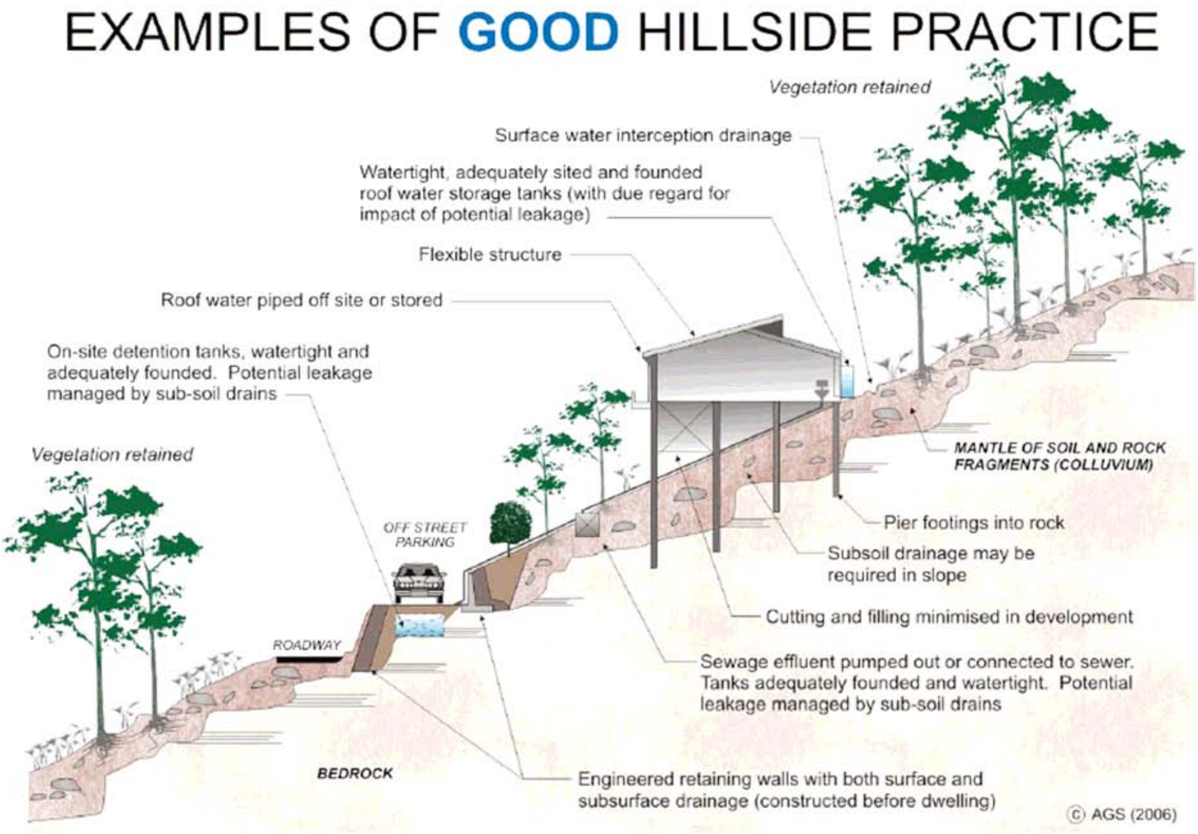
RISK LEVEL IMPLICATIONS

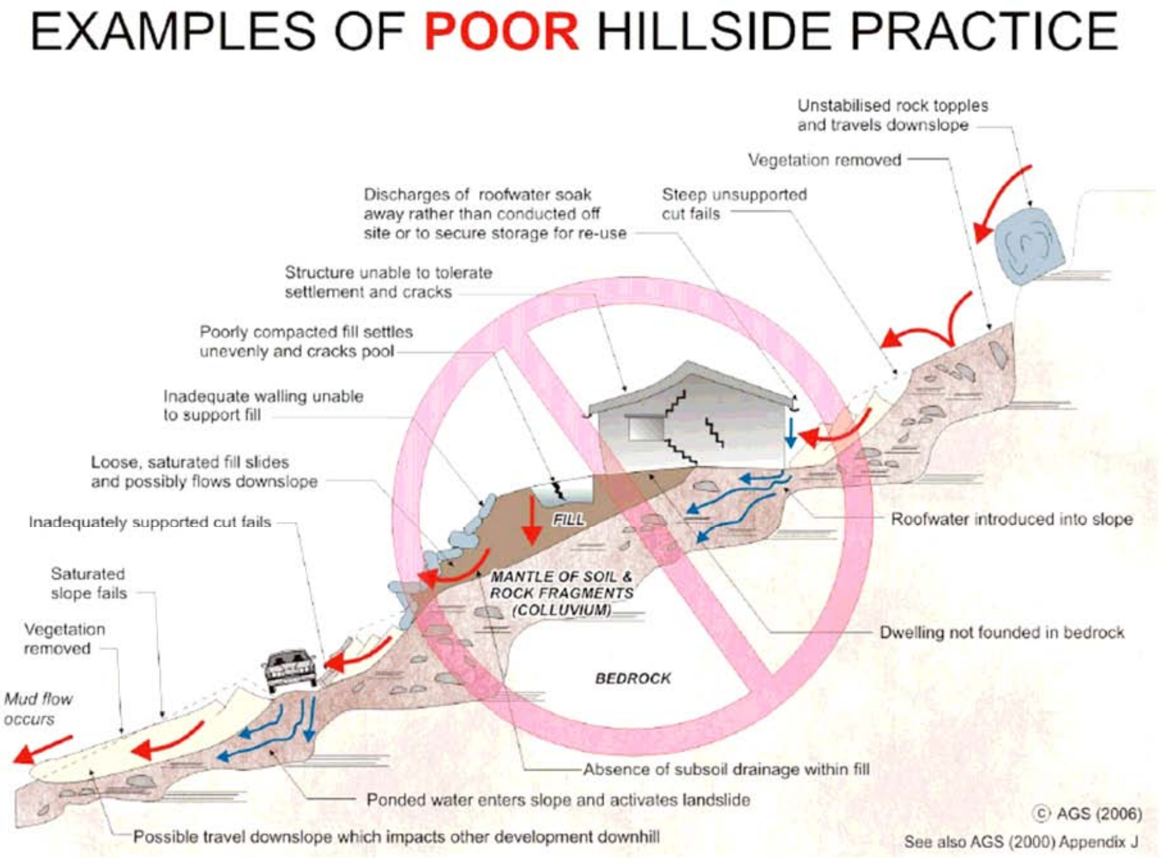
Risk Level		**Example Implications** (7)
VH	VERY HIGH RISK	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical. Work likely to cost more than value of the property.
H	HIGH RISK	Unacceptable without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to Low. Work would cost a substantial sum in relation to the value of the property.
M	MODERATE RISK	May be tolerated in certain circumstances (subject to regulator's approval) but requires investigation, planning and implementation of treatment options to reduce the risk to Low. Treatment options to reduce to Low risk should be implemented as soon as practicable.
L	LOW RISK	Usually acceptable to regulators. Where treatment has been required to reduce the risk to this level, ongoing maintenance is required.
VL	VERY LOW RISK	Acceptable. Manage by normal slope maintenance procedures.

Note: (7) The implications for a particular situation are to be determined by all parties to the risk assessment and may depend on the nature of the property at risk; these are only given as a general guide.

APPENDIX G - SOME GUIDELINES FOR HILLSIDE CONSTRUCTION

	GOOD ENGINEERING PRACTICE	*POOR ENGINEERING PRACTICE*
ADVICE		
GEOTECHNICAL ASSESSMENT	Obtain advice from a qualified, experienced geotechnical practitioner at early stage of planning and before site works.	Prepare detailed plan and start site works before geotechnical advice.
PLANNING		
SITE PLANNING	Having obtained geotechnical advice, plan the development with the risk arising from the identified hazards and consequences in mind.	Plan development without regard for the Risk.
DESIGN AND CONSTRUCTION		
HOUSE DESIGN	Use flexible structures which incorporate properly designed brickwork, timber or steel frames, timber or panel cladding. Consider use of split levels. Use decks for recreational areas where appropriate.	Floor plans which require extensive cutting and filling. Movement intolerant structures.
SITE CLEARING	Retain natural vegetation wherever practicable.	Indiscriminately clear the site.
ACCESS & DRIVEWAYS	Satisfy requirements below for cuts, fills, retaining walls and drainage. Council specifications for grades may need to be modified. Driveways and parking areas may need to be fully supported on piers.	Excavate and fill for site access before geotechnical advice.
EARTHWORKS	Retain natural contours wherever possible.	Indiscriminatory bulk earthworks.
CUTS	Minimise depth. Support with engineered retaining walls or batter to appropriate slope. Provide drainage measures and erosion control.	Large scale cuts and benching. Unsupported cuts. Ignore drainage requirements
FILLS	Minimise height. Strip vegetation and topsoil and key into natural slopes prior to filling. Use clean fill materials and compact to engineering standards. Batter to appropriate slope or support with engineered retaining wall. Provide surface drainage and appropriate subsurface drainage.	Loose or poorly compacted fill, which if it fails, may flow a considerable distance including onto property below. Block natural drainage lines. Fill over existing vegetation and topsoil. Include stumps, trees, vegetation, topsoil, boulders, building rubble etc in fill.
ROCK OUTCROPS & BOULDERS	Remove or stabilise boulders which may have unacceptable risk. Support rock faces where necessary.	Disturb or undercut detached blocks or boulders.
RETAINING WALLS	Engineer design to resist applied soil and water forces. Found on rock where practicable. Provide subsurface drainage within wall backfill and surface drainage on slope above. Construct wall as soon as possible after cut/fill operation.	Construct a structurally inadequate wall such as sandstone flagging, brick or unreinforced blockwork. Lack of subsurface drains and weepholes.
FOOTINGS	Found within rock where practicable. Use rows of piers or strip footings oriented up and down slope. Design for lateral creep pressures if necessary. Backfill footing excavations to exclude ingress of surface water.	Found on topsoil, loose fill, detached boulders or undercut cliffs.
SWIMMING POOLS	Engineer designed. Support on piers to rock where practicable. Provide with under-drainage and gravity drain outlet where practicable. Design for high soil pressures which may develop on uphill side whilst there may be little or no lateral support on downhill side.	
DRAINAGE		
SURFACE	Provide at tops of cut and fill slopes. Discharge to street drainage or natural water courses. Provide general falls to prevent blockage by siltation and incorporate silt traps. Line to minimise infiltration and make flexible where possible. Special structures to dissipate energy at changes of slope and/or direction.	Discharge at top of fills and cuts. Allow water to pond on bench areas.
SUBSURFACE	Provide filter around subsurface drain. Provide drain behind retaining walls. Use flexible pipelines with access for maintenance. Prevent inflow of surface water.	Discharge roof runoff into absorption trenches.
SEPTIC & SULLAGE	Usually requires pump-out or mains sewer systems; absorption trenches may be possible in some areas if risk is acceptable. Storage tanks should be water-tight and adequately founded.	Discharge sullage directly onto and into slopes. Use absorption trenches without consideration of landslide risk.
EROSION CONTROL & LANDSCAPING	Control erosion as this may lead to instability. Revegetate cleared area.	Failure to observe earthworks and drainage recommendations when landscaping.
DRAWINGS AND SITE VISITS DURING CONSTRUCTION		
DRAWINGS	Building Application drawings should be viewed by geotechnical consultant	
SITE VISITS	Site Visits by consultant may be appropriate during construction/	
INSPECTION AND MAINTENANCE BY OWNER		
OWNER'S RESPONSIBILITY	Clean drainage systems; repair broken joints in drains and leaks in supply pipes. Where structural distress is evident see advice. If seepage observed, determine causes or seek advice on consequences.	


EXAMPLES OF GOOD HILLSIDE PRACTICE
Vegetation retained
Surface water interception drainage
Watertight, adequately sited and founded roof water storage tanks (with due regard for impact of potential leakage)
Flexible structure
Roof water piped off site or stored
On-site detention tanks, watertight and adequately founded. Potential leakage managed by sub-soil drains
Vegetation retained
MANTLE OF SOIL AND ROCK FRAGMENTS (COLLUVIUM)
OFF STREET PARKING
Pier footings into rock
Subsoil drainage may be required in slope
Cutting and filling minimised in development
ROADWAY
Sewage effluent pumped out or connected to sewer. Tanks adequately founded and watertight. Potential leakage managed by sub-soil drains
BEDROCK
Engineered retaining walls with both surface and subsurface drainage (constructed before dwelling)
© AGS (2006)


EXAMPLES OF POOR HILLSIDE PRACTICE
Unstabilised rock topples and travels downslope
Vegetation removed
Discharges of roofwater soak away rather than conducted off site or to secure storage for re-use
Steep unsupported cut fails
Structure unable to tolerate settlement and cracks
Poorly compacted fill settles unevenly and cracks pool
Inadequate walling unable to support fill
Loose, saturated fill slides and possibly flows downslope
FILL
Roofwater introduced into slope
Inadequately supported cut fails
MANTLE OF SOIL & ROCK FRAGMENTS (COLLUVIUM)
Saturated slope fails
Dwelling not founded in bedrock
Vegetation removed
BEDROCK
Mud flow occurs
Absence of subsoil drainage within fill
Ponded water enters slope and activates landslide
Possible travel downslope which impacts other development downhill
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See also AGS (2000) Appendix J

APPENDIX D:

CSIRO Sheet BTF 18

Foundation Maintenance and Footing Performance: A Homeowner’s Guide

Foundation Maintenance and Footing Performance:

A Homeowner's Guide

BTF 18
replaces
Information
Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870, the Residential Slab and Footing Code.

Causes of Movement

Settlement due to construction

There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

Erosion

All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

Saturation

This is particularly a problem in clay soils. Saturation creates a bog-like suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume – particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

Seasonal swelling and shrinkage of soil

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

Shear failure

This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.
- In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

GENERAL DEFINITIONS OF SITE CLASSES

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites with only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes
H	Highly reactive clay sites, which can experience high ground movement from moisture changes
E	Extremely reactive sites, which can experience extreme ground movement from moisture changes
A to P	Filled sites
P	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise

Tree root growth
Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

Effects of Uneven Soil Movement on Structures

Erosion and saturation
Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpends).

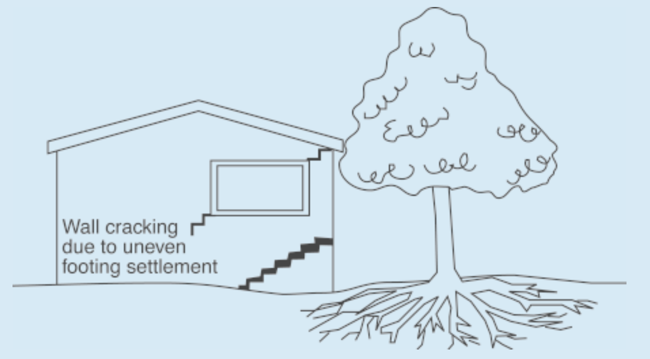
Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

Seasonal swelling/shrinkage in clay
Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.

Trees can cause shrinkage and damage



As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

Movement caused by tree roots
In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

Complications caused by the structure itself
Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

Effects on full masonry structures
Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

Effects on framed structures
Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation cause a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

Effects on brick veneer structures
Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem.
Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.
- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table C1 of AS 2870.

AS 2870 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

Prevention/Cure

Plumbing
Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

Ground drainage
In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

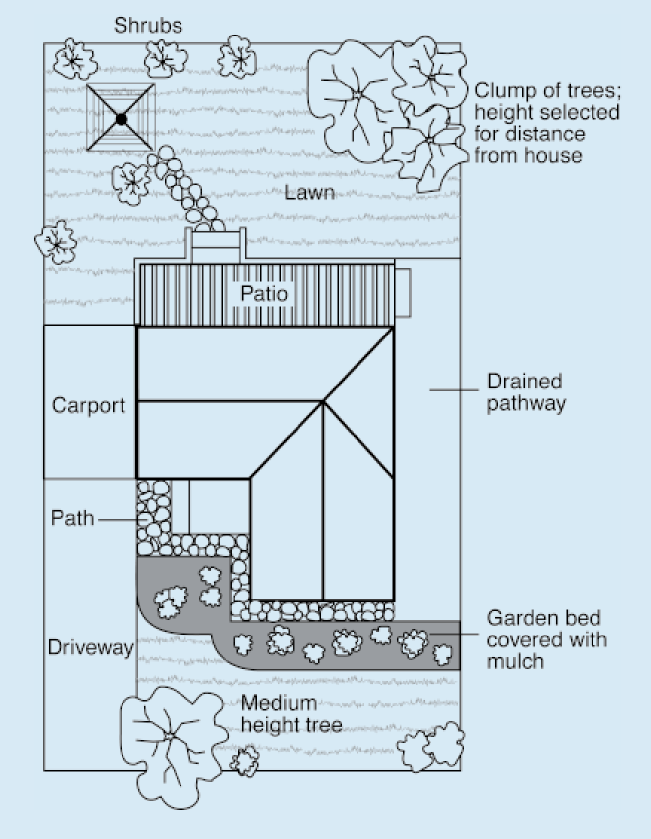
Protection of the building perimeter
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

Description of typical damage and required repair	Approximate crack width limit (see Note 3)	Damage category
Hairline cracks	<0.1 mm	0
Fine cracks which do not need repair	<1 mm	1
Cracks noticeable but easily filled. Doors and windows stick slightly	<5 mm	2
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired	5–15 mm (or a number of cracks 3 mm or more in one group)	3
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted	15–25 mm but also depend on number of cracks	4

Gardens for a reactive site



should extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

Condensation

In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

Warning: Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

The garden

The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

Existing trees

Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

Information on trees, plants and shrubs

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information. For information on plant roots and drains, see Building Technology File 17.

Excavation

Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

This BTF was prepared by John Lewer FAIB, MIAMA, Partner, Construction Diagnosis.

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