Preliminary Geotechnical Assessment

Precinct 1

Southern Thornlands (Confidential)

62 – 124 Springacre Road, Thornlands

Prepared for:

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Report Number: J002123-002-R-Rev4

June 2025

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1.0 INTRODUCTION

Core Consultants Pty Ltd (Core) was engaged by Empower Engineers and Project Managers (Empower) to undertake a Preliminary Geotechnical Investigation for Precinct 1 of a proposed development at Thornlands, Queensland.

Precinct 1 is located at 62 to 124 Springacre Road, Thornlands, Queensland (hereafter referred to as the 'site'). The site comprises six separate allotments, Lot 12 to 14 on RP53653 (4-6), Lot 1 & 2 on RP128089 (7& 8) and Lot 16 on RP53653 (9), covering approximately 40 ha and is shown in Image 2 below and Figure 1, attached. Image 3 shows the Precinct 1 Boundaries.

Image 1: Site Locality (Aerial image sourced from Qld Globe, Annotations by Core).

Image 2: Lot and Plan Map (Aerial image sourced from Nearmap Pty Ltd, Annotations by Core).

The investigation was carried out by Core in accordance with our proposal Q004458-001-L-Rev1, dated 24 August 2023.

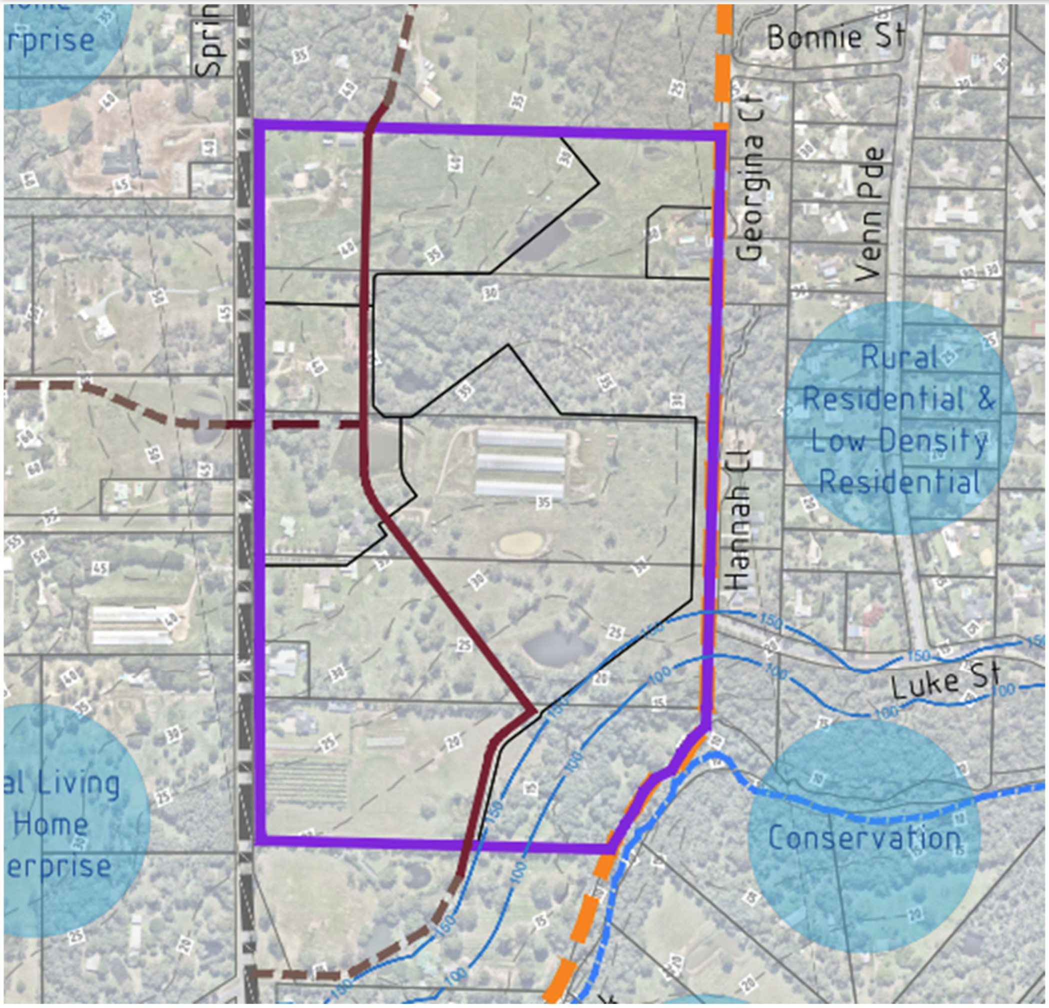


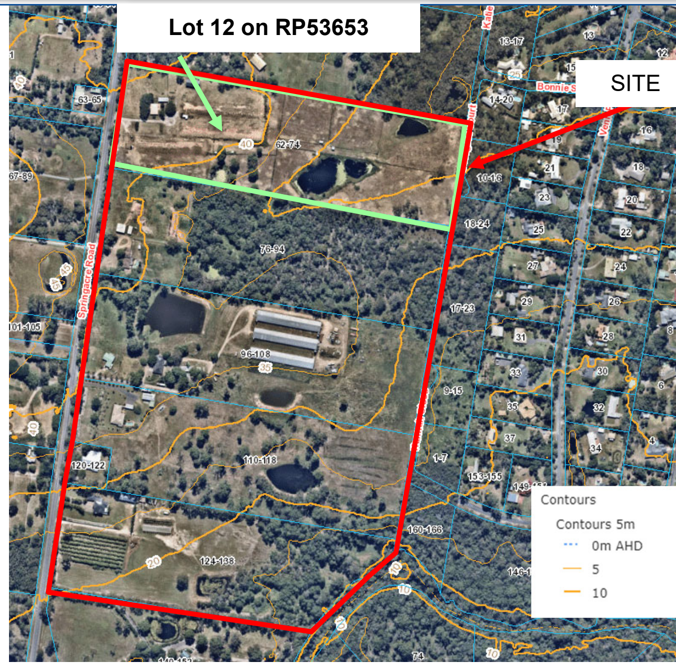
Image 3: Precinct 1 Boundaries Context Plan (Image sourced from Urbex Pty Ltd, B00702-MC-CP01)

2.0 SITE DESCRIPTION

As part of the scope of work, a site visit was undertaken by a Core representative on 11 September 2023. Characteristics of the site, based on the Core site visit and documents reviewed, are presented in the following sections.

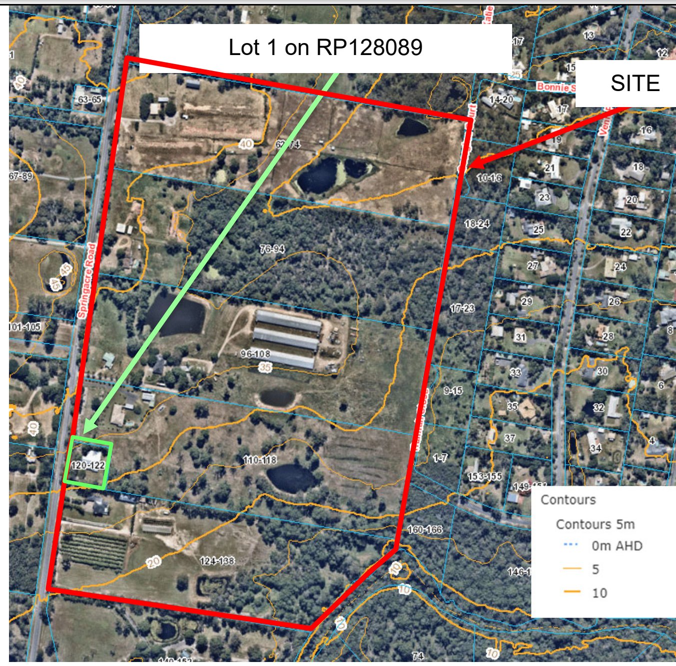
Table 1: Site Descriptions

Topic	Data
Lot 12 on RP53653	
Site Use	Rural residential dwellings.
Site Features, Buildings and Structures	The allotment consisted of two residential dwellings, a couple of sheds, a demountable building and an old above ground storage tank (AST). Three dams are situated across the site. Along with fenced adjustment areas and shelters for horses. Photographs taken during the site walkover are provided below.
Topography	The elevation of the allotment ranges between 40 m Australian Height Datum (AHD) and 30 m AHD (RCC City Plan, 2013). The site has a gradient slope of approximately 10 m toward the southeastern boundary with the lowest point at the central southern boundary.

	 Source: RCC City Plan Interactive Mapping (Not to Scale).
Drainage	Stormwater runoff across the level hard stand areas of the allotment would flow towards storm pits around the residential dwellings towards the roadways. All other runoff outside of the hard stand areas would infiltrate through the soil and follow the topography of the site towards the central portion flowing towards the southeast.
Nearest Surface Water Receptor	The nearest water body is Eprapah Creek located approximately 600 m to the southeast of the allotment. A waterway off Eprapah Creek is located across the allotment which flows towards the dams within the southern Lots.
Lot 13 on RP53653	
Site Use	Rural residential dwellings.
Site Features, Buildings and Structures	The allotment (Lot 13 on RP53653) consisted of one residential dwellings, two sheds, concrete pads and a number of compacted fill stockpiles for motor cross use. The larger portion of the allotment consists of dense vegetation with dirt tracks. One dam is situated along the central southern boundary.
Topography	The elevation of Lot 13 on RP53653 ranges between 40 m Australian Height Datum (AHD) and 30 m AHD (RCC City Plan, 2013). The site has a gradient slope of approximately 10 m toward the central southern boundary.

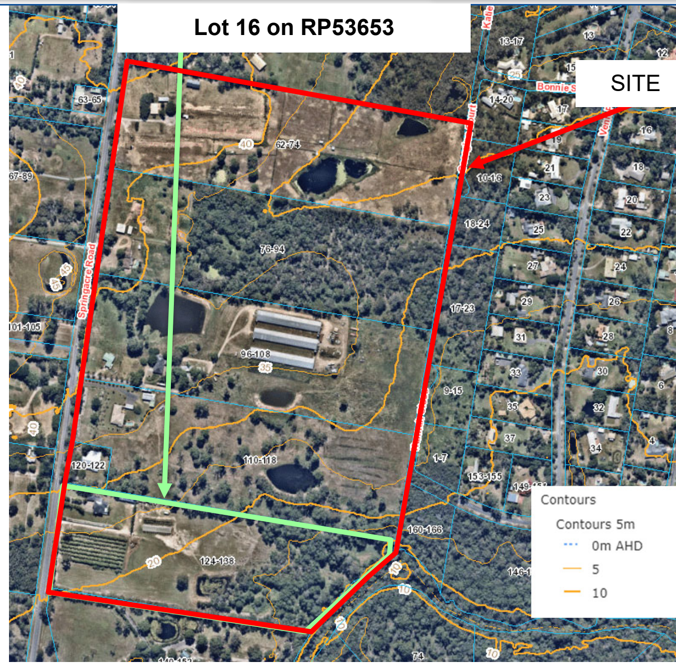
	 Source: RCC City Plan Interactive Mapping (Not to Scale).
Drainage	Stormwater runoff across the level hard stand areas of the allotment located within the western portion would flow towards storm pits along Springacre Road. All other runoff outside of the hard stand areas would infiltrate through the soil and follow the topography of the site towards the southern central portion flowing towards the south.
Nearest Surface Water Receptor	The nearest water body is Eprapah Creek located approximately 500 m to the southeast of the Lot 13 on RP53653. A waterway off Eprapah Creek is located towards the north on Lot 12 on RP53653 that appears to flow in a north east to south western direction towards the dam located on Lot 13 on RP53653.
Lot 14 on RP53653	
Site Use	Rural residential dwellings and previous Poultry Farm.
Site Features, Buildings and Structures	Lot 14 on RP53653 consisted of two residential dwellings, three sheds, three large poulty sheds, shipping containers, above ground water tanks, a gravel compacted road way, and several areas containing waste materials. Two dams are evident on this lot (Lot 14 on RP53653), one is situated along the central southern boundary and the other within the eastern portion.
Topography	The elevation of Lot 14 on RP53653 ranges between 40 m Australian Height Datum (AHD) and 30 m AHD (RCC City Plan, 2013). The site has a gradient slope of approximately 10 m toward the southeastern boundary.

	 Source: RCC City Plan Interactive Mapping (Not to Scale).
Drainage	Stormwater runoff across the western portion appears to run towards the dam within the northwest. The area towards the east appears to have a drainage line that runs along the southern most poultry shed and flow towards the dam located along the southern boundary. This southern most dam appeared to catch all runoff surrounding the poultry sheds.
Nearest Surface Water Receptor	The nearest water body is Eprapah Creek located approximately 400 m to the southeast of the allotment. The northwestern dam appears to be connected to a waterway or tributary off Eprapah Creek.
Lot 1 on RP128089	
Site Use	Residential dwellings including sheds and pool.
Site Features, Buildings and Structures	The allotment consisted of residential dwelling, five sheds and one inground pool. Allotment is fenced and appears to be in good condition. Further detailed information is provided in section 4.0. Site features are shown in Figure 4, attached.
Topography	The elevation of the allotment ranges between 36 m Australian Height Datum (AHD) and 30 m AHD (RCC City Plan, 2013). The site has a gradient slope of approx. 6 m toward the southeastern boundary.

	 Source: RCC City Plan Interactive Mapping (Not to Scale).
Drainage	Stormwater runoff across the allotment appears to run towards the neighbouring allotment in the east. Overland flow generally runs towards the east and flows towards the dam located south east of the allotment.
Nearest Surface Water Receptor	The nearest water body is Eprapah Creek located approx. 400 m to the south east of the allotment. The northwestern dam appears to be connected to a waterway or tributary off Eprapah Creek.
Lot 2 on RP128089	
Site Use	Rural residential dwellings.
Site Features, Buildings and Structures	The allotment consisted of one residential dwelling, inground pool, one shed, a shipping container, and sealed drive way. One dam is evident on this allotment situated along the central southern boundary.
Topography	The elevation of the allotment ranges between 40 m Australian Height Datum (AHD) and 20 m AHD (RCC City Plan, 2013). The site has a gradient slope of approximately 20 m toward the southeastern boundary.

Source: RCC City Plan Interactive Mapping (Not to Scale).

Drainage	Stormwater runoff across the allotment appears to run towards the dam located within the central southern portion. The dam appears to be connected to a tributary off Eprapah Creek. Any overflow is likely to run into this tributary and towards the Creek.
Nearest Surface Water Receptor	The nearest water body is Eprapah Creek located approximately 250 m to the southeast of the allotment. The dam appears to be connected to a tributary off Eprapah Creek, the northern most one located within Lot 16 on RP53653Lot 16 on RP53653.
Lot 16 on RP53653	
Site Use	Rural residential dwellings and previous agricultural orchards.
Site Features, Buildings and Structures	The allotment consisted of one residential dwelling, two sheds, a compacted gravel roadway, three separate orchards and areas containing waste materials. One dam is evident on this allotment, situated along the central southern boundary. Two tributaries are evident on the allotment within the eastern portion. Erosion was observed within the western portion of the allotment.
Topography	The elevation of the allotment ranges between 30 m Australian Height Datum (AHD) and 10 m AHD (RCC City Plan, 2013). The site has a gradient slope of approximately 20 m toward the southeastern boundary.

	 Source: RCC City Plan Interactive Mapping (Not to Scale).
Drainage	Stormwater runoff across the allotment appears to run towards the southeast. The tributaries evident across the allotment run in a northwest to southeast direction flowing towards Eprapah Creek which is located along the southeastern boundary.
Nearest Surface Water Receptor	The nearest water body is Eprapah Creek located along the southeastern boundary. Eprapah Creek flows towards Redland Bay in a northeasterly direction.

3.0 BACKGROUND INFORMATION

3.1 Geology

Published geological information[1] indicates that the site is underlain by residual soils and rock of the late Triassic Early Jurassic age Woogaroo Subgroup (RJbw) comprising '*Sublabile to quartzose sandstone, siltstone, quartz-rich granule to cobble conglomerate and coal'.* An extract of the relevant geological map is shown in Image 3 below.

[1] © State of Queensland(Department of Resources) 2023. Updated data available at QSpatial.
Licensed under CC BY 4.0.

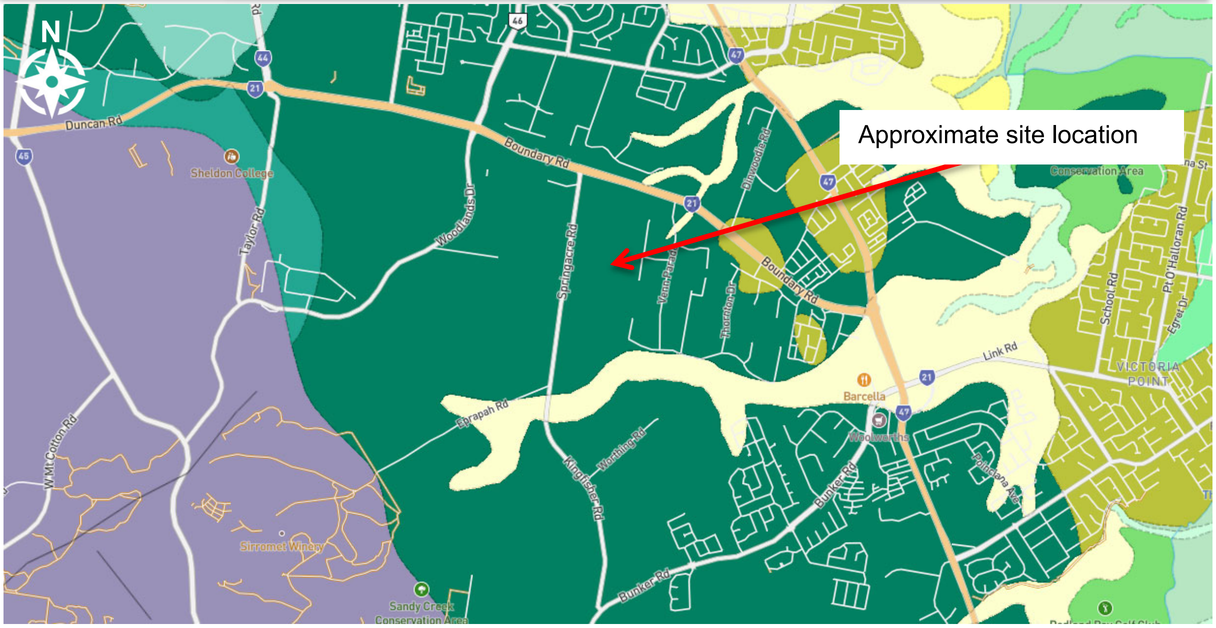


Image 4: Extract from QGD 2023 geology map (Not to scale).

3.2 Acid Sulfate Soils

Published acid sulfate soil (ASS) maps indicate that the site has been assessed as Land with an extremely low (Cq) probability of potential ASS(PASS) occurrence as mapped at this scale. An extract of the relevant ASS map is shown in Image 4 below.

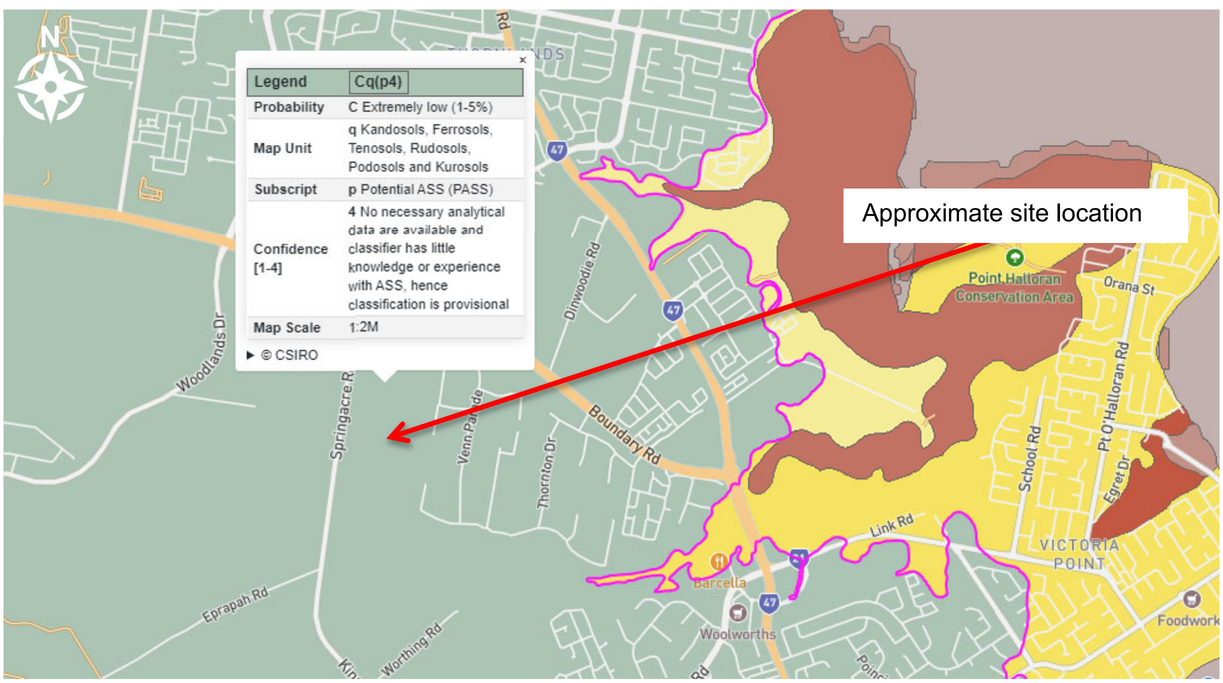


Image 4: Extract from ASS map (Not to scale).

3.3 Groundwater

A search of the Department of Natural Resources, Mines and Energy (DNRME) groundwater database was conducted on 21 April 2023. The search indicated that there are five registered groundwater bores within 500 m of the site.

The closest groundwater bore with available information was approximately 100 m south of the site (at the closest point), used as a sub-artesian water supply bore. The geology encountered consisted of sand overlying silty sand, gravel, clay (grey brown), basalt clay (very weathered), shale (grey), sandstone (extremely weathered). Groundwater level information provided indicated standing water level (SWL) at 4.85 m below ground level (BGL) flowing in a northerly direction. Water quality data provided the groundwater to consist of hard, acidic brackish quality.

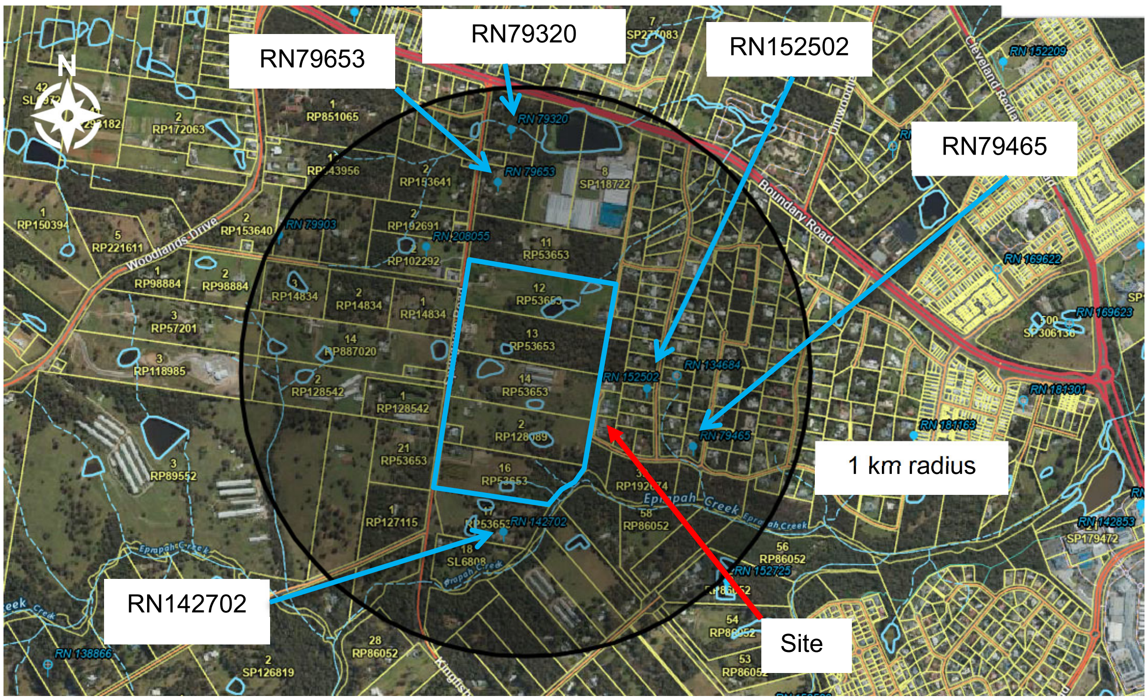


Image 5: DNRME Groundwater Bores (Aerial image sourced from State of Queensland (Queensland Globe), Copyright © State of Queensland 2023, under license. Annotations by Core Consultants Pty Ltd.)

3.4 Summary of Site History from Aerial Imagery Review

Review of aerial imagery indicates that the site consisted of dense vegetation until the 1960's with some vegetation cleared and residential dwellings built. Between the late 1960's to early 1970's, poultry sheds were constructed on Lot 12 on RP53653 and Lot 2 on RP128089, with introduction of dams to most lots. At least one residence is evident on each Lot. In the 1980's extensive vegetation clearing was evident, seemingly for agricultural purposes. Lot 12 on RP53653 demolished the poultry sheds around 1997 however, Lot 14 on RP53653 still appeared to be a functioning poultry farm in 1997. In 2009 crops appeared within Lot 16 on RP53653 and are present to now. During this time stockpiles are evident within Lot 13 on RP53653 with the beginning of motocross usage and in Lot 14 on RP53653 multiple shipping containers are evident.

4.0 INVESTIGATION METHODS

The field investigation was undertaken on 18 and 19 September 2023 and comprised the drilling of eight boreholes (designated BH1 to BH8), The borehole locations were assessed by reference to site features and a smartphone GPS and are shown on the attached Figure 1.

The boreholes were drilled to depths up to 6 m below ground level (BGL) using a 4WD-mounted auger drill rig. Disturbed samples were taken of representative strata. Standard Penetrometer Testing (SPT) were conducted at regular intervals. The boreholes were backfilled with the excavation spoil on completion.

The fieldwork was carried out by an experienced geotechnician under the direction of a geotechnical engineer from Core. Subsurface conditions were logged in accordance with AS1726-2017 *Geotechnical site investigations*.

Laboratory testing was performed at NATA-accredited laboratories on selected samples and comprised the following:

- Atterberg limit and linear shrinkage
- Emerson class
- Standard compaction and California bearing ratio (CBR) on samples remoulded to 100% (Standard) near optimum moisture content and soaked for 4 days before testing.

5.0 INVESTIGATION RESULTS

5.1 Subsurface Conditions

Reports of Boreholes are presented in Appendix A together with Explanation of Notes and Methods. In summary, the subsurface conditions observed during the investigation are provided in Table 2 below; the SPT test results are plotted in Image 6.

Table 2: Summary of Subsurface Conditions.

Unit	Description
Topsoil	Silty sand up to 0.1 m BGL, present where fill was absent
Fill	Firm to stiff Sandy Clay in BH 1 to 3.7 m BGL Soft to stiff Silty Clay to 0.4-0.6m BH 2, 3 & 6 Loose Silty Sand in BH 7 to 0.3 m BGL Possible fill of hard sandy silty and very dense silty or clayey sand in BH 8 to 4.2 m BGL
Residual Soil	Medium dense Gravelly Sand in BH 8 only to 5.0 m BGL High Plasticity, hard Silty Clay to extremely weathered, very low strength Siltstone in BH4 to 1.5 m BGL Medium to high plasticity, stiff to hard Silty Clay to 4.4 to 6 m (borehole terminations) BGL
Weathered Sandstone	Extremely to highly weathered Sandstone below 5.8 m in BH 1 and below 4.4 m BGL in BH 2.

Groundwater seepage was encountered at 4.2 m BGL in BH 8 but was not encountered in any other borehole. Groundwater conditions vary over distance and time and may vary with changes in rainfall, climate, surface and subsurface drainage conditions and human influences.

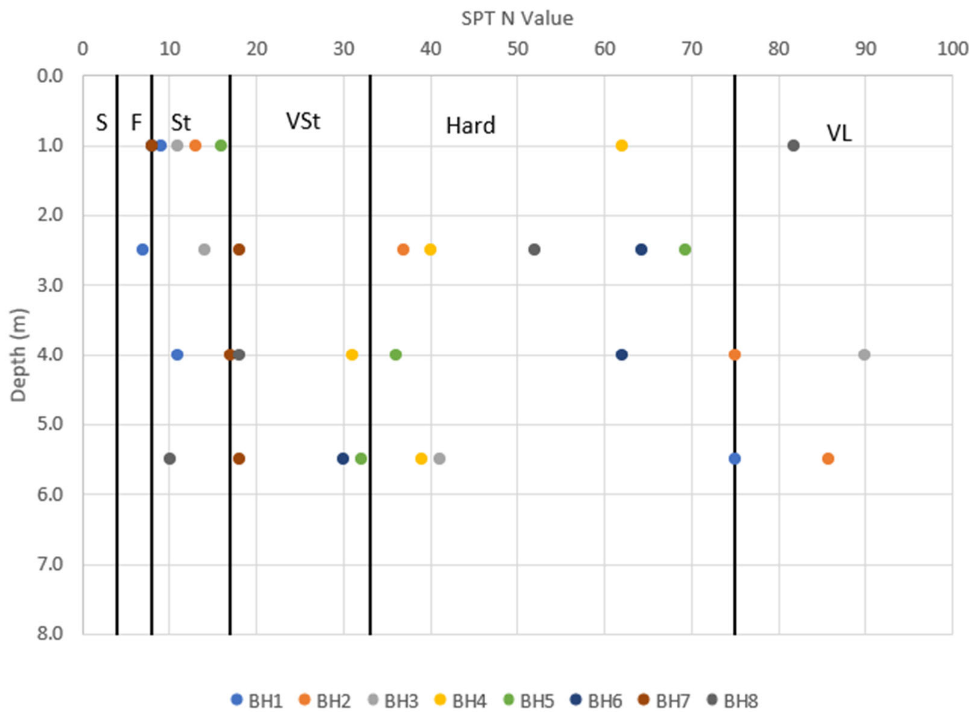


Image 6: SPT Test Results

5.2 Laboratory Testing

A summary of the laboratory results is shown in Tables 3 and 4 below. The laboratory reports are attached in Appendix B.

Table 3: Summary of Plasticity and Particle Size Test Results.

Sample	Material	LL (%)	PI (%)	% < 2.36 mm	% < 0.075 mm	WPI	Emerson Class
BH1, 1.0-1.45m	Sandy Clay	61	40	91	38	1,998	4*
BH4, 1.0-1.45m	Silty Clay	42	16	96	69	1,265	3
BH6, 0.5m	Silty Clay	66	40	96	82	3,606	-
BH7, 1.0-1.2m	Sandy Clay	92	65	100	56	4,998	4*
BH8, 0.5m	Silty Sand	-	-	-	-	-	2

Notes: w – moisture content LL – liquid limit PI – plasticity index WPI – weighted plasticity index
*Mineral (Carbonate) present

Table 4: Summary of Compaction and CBR Test Results.

Sample	Material	SMDD (t/m^3)	OMC (%)	Swell (%)	CBR (%)
BH 1, 0.2-1.0 m	Sandy Clay	1.85	15.0	0.5	6
BH5, 0.2-0.7 m	Silty Clay	1.54	25.0	1.0	5

Notes: SMDD – standard maximum dry density OMC - optimum moisture content

6.0 COMMENTS & RECOMMENDATIONS

6.1 Earthworks

Site preparation earthworks in development areas should comprise stripping of topsoil and root matter (encountered to about 0.1 m in the test locations) and removing any existing uncontrolled fill. The results indicate areas of relatively deep uncontrolled fill possibly associated with former dams and other activities by landowners. Localised areas of deeper topsoil may also be possible.

Based on the materials encountered during the investigation, small sized 8 to 15 t excavators could excavate the soils and fill encountered in the investigation although excavatability of the hard soils would be slower with the smaller machines and larger machines could be expected for productivity. Scrapers could be used for earthworks although push loading is likely to be required. Concrete, if encountered, would require a rock breaker for removal.

Following stripping, the subgrade should be proof rolled using a loaded water truck or minimum 10 t smooth drum roller to check for presence of any soft spots; these spots should be either tyned, dried and recompacted if the soft zone is thin enough or removed and replaced with controlled fill.

Based on the subsurface conditions encountered, soil from excavation areas including the existing fill should generally be suitable for reuse as structural fill provided materials are free from deleterious material, oversize particles (>75 mm size), and organic matter. Silty sands can be problematic when wet and should be blended with clay soils for reuse or removed. Handling and moisture conditioning of the high plasticity clay soils would be difficult and trafficability poor if earthworks are carried out during or following wet weather.

Filling should be undertaken in accordance with AS3798-2007 requirements including the following measures:

- Fill should have a maximum particle size of 150 mm. Imported select fill should be cohesive in nature and preferably have a plasticity index of < 15%, a maximum particle size of 150 mm, minimum fines content of 15% and a soaked CBR of > 10%.
- Fill should be compacted in layers, typically up to mot more than 300 mm thick (loose), but layer thickness will be dependent upon the type/size of compaction plant, material type and conditions
- Fill should be compacted to a dry density ratio (DDR) of at least 95% (Standard compaction) for cohesive soils. Higher density ratio of 100 % should be adopted in the pavement subgrades.
- Fill should be compacted at moisture contents within the range of +2 to -2% of optimum moisture content for Standard Compaction.
- Confirmatory compaction testing must be carried out at regular intervals. Guidance on testing frequency is provided in AS 3798-2007 Table 8.1.
- Fill embankments should be ‘over built’ then trimmed back to the well compacted material.
- It is recommended that filling in excess of 0.5 m depth be carried out with Level 1 Inspection and Testing in accordance with Australian Standard AS 3798-2007 *Guidelines on Earthworks for Commercial and Residential Developments*; shallower filling could be undertaken under Level 2 Inspection and Testing.

Temporary excavations in the clays up to 3 m high are expected to remain stable near vertical in the short term provided there are no surcharge loads, structures or services in the excavation crest area. Excavations more than 1.5 m deep will need shoring boxes if workers are to enter the excavation, or to be sloped or benched with bench heights not exceeding about 1.2 m with slopes of 1V:1H generally. Permanent batter slopes should be formed no steeper than 1V:2H for stability and be topsoiled and greased for erosion protection with swale drains at the crest to intercept surface water flows and with good drainage at the toe of the slope. Flatter slopes may be adopted for safe access for maintenance.

The results of the Emerson class tests indicate the clay soils are moderately to highly erodible, and the silty sand highly erodible. Usual good erosion and sediment control practices during construction would include use of silt fences to filter surface water flow, minimising exposed surfaces and surface water flows and concentration of those flows and sealing off surfaces with a smooth drum roller if rain is expected. The permanent unsealed surfaces should be topsoiled and grassed.

6.2 Retaining Walls

The design of retaining walls up to 3 m high (concrete sleeper walls, blockwork walls or mass gravity rock walls) may be undertaken using a triangular pressure distribution and the earth pressure coefficients given below in Table 5.

The active earth pressure coefficient can be used if some rotation of the wall is tolerable; otherwise an 'at-rest' earth pressure coefficient (K_0) should be used. Clay backfill soils in a zone equal to the wall height behind walls should be moisture conditioned (if not controlled fill) to within 2 % of optimum moisture content to avoid high swell pressures on walls, or be replaced with granular fill.

Passive pressure should be ignored where there is potential for in-ground services trenches (or similar) in front of the wall.

Table 5: Lateral Earth Pressure Coefficients.

Retained Material	Bulk Density (kN/m³)	Ø' (degrees)	c' (kPa)	Cohesion c_u (kPa)	Lateral Earth Pressure Coefficients		
					K_a	K_p	K_o
Very stiff clay and clay fill	20	22	5	100	0.4	2.5	0.55

Notes:
K_a - active; K_o - at rest; K_p – passive
Active state develops when: Deflection > 0.001H to 0.004H (granular soil), or deflection > 0.01H to 0.04H (cohesive soil)

Recommendations for retaining wall footings are provided in Section 6.4.

Walls should be fully drained to avoid water pressures developing on the wall.

The effect of surcharge pressures can be assessed by multiplying the surcharge load by the active or at rest pressure coefficient adopted for design.

6.3 Site Reactivity and Classification

Site classification derived in accordance with Australian Standard AS 2870-2011 *Residential slabs and footings* provides an indication of the likely magnitude of reactive (shrink and swell) movements associated with normal seasonal soil moisture variations (y_s). These would need to be assessed in detail once earthworks has been completed, however the following preliminary assessment is provided for planning purposes.

In this case, the in its current conditions would be *Class P* because of the presence of uncontrolled fill, requiring design by engineering principles. If the uncontrolled fill is taken up and replaced with controlled fill, then the site can be reclassified.

The estimated range of y_s is calculated in accordance with the methodology presented in AS2870-2011, by assessment of the soil suction change, factored for lateral restraint multiplied by the soil layer thickness and the instability index (estimated to range about from 1.5 to 4 % based on the plasticity testing).

For the Thornlands region of wet temperate climate zone, the depth of design suction change H_s is 1.8 m, with a crack depth of 0.9 m in natural soil profile, but with no crack depth allowance where cut or fill earthworks is carried out.

Based on the results of the testing, the estimated surface movements in response to normal seasonal moisture change ranges from about 20 to 50 mm for the site in its current conditions, but about 30 to 80 mm after cut and fill using the site clays. The relevant site classifications for the site movements are:

- 20 to 40 mm - *Class M* moderately reactive
- 40 to 60 mm – *Class H1* highly reactive
- 60 to 75 mm - *Class H2* highly reactive
- >75mm - *Class E* extremely reactive

Some care in the identification and use of the most highly reactive clays would be required to minimise the Class E conditions; as a guide, capping of these *Class E* lots with say 200 mm of relatively low plasticity granular soils would reduce the estimated movement to *Class H2* or *Class H1* range.

Because of the highly reactive soils, works should be designed for careful control of moisture with vegetation kept well back from buildings and the ground sloping away from the building to ensure good surface drainage. QBCC guidelines for homeowners are attached in this respect (Appendix C).

6.4 High Level Footings

Site conditions and the proposed development suggest that future buildings would generally be expected to be designed using high level footings with slab stiffening to suit the site classification. Allowable bearing pressures for high level footings would range from 100 kPa for stiff clay and controlled fill (minimum 95 % dry density ratio) to 200 kPa for very stiff clays and medium dense sands, and 350 kPa for hard soils.

If piles were required for larger structures (e.g. retail, commercial or education buildings), bored piles founding at least two pile diameters into the very stiff to hard clay could be designed using an allowable end bearing of 250 kPa and an allowable shaft friction of 15 kPa; the upper 1 m of pile shaft should be ignored to allow for shaft load development.

As subsurface conditions can vary, footing excavations would need to be checked at time of construction and may need to be varied if adverse conditions were encountered.

6.5 Pavement Design (CBR) Parameters

The anticipated subgrades are expected to mainly comprise natural residual clay materials and re-used site-won clay fill materials. The results of the laboratory tests indicate soaked CBR values of 5 and 6 %. Based on the soil profiles encountered (high plasticity clay), for a well drained subgrade with either subsoil drains or a well drained verge that is graded to shed water well away from the road edge, a CBR value of 5 % is recommended. Where the subgrade is not well drained then a CBR value of 3 % should be considered.

As subsurface conditions will vary, these parameters will need specific sampling and testing once earthworks is complete.

6.6 Drainage and Groundwater

The investigation encountered predominantly high plasticity clay soils of low permeability across the site, with groundwater only locally encountered in the sand fill in BH 8, which appears to be perched water. Good surface drainage will be required to ensure the clay soil do not become wet resulting in loss of strength and excessive reactive soil movements. Groundwater seems unlikely to be encountered at shallow depth extensively across the site during construction, and if encountered could likely be controlled using pumping from sumps.

6.7 Landslide Risk

A landslide risk assessment has been carried out following the Australian Geomechanics Society '*Landslide Risk Management Guidelines'* (AGS 2007). Relative levels of risk and their implications are given in Table 6 below and the *Qualitative Terminology for Use in Assessing Risk to Property* is attached (Appendix D).

The land slopes following the proposed development are shown in Empower Drawing SK-CE14 (Appendix E). the drawing indicates that following earthworks the slopes within the development lots are generally less than 5 %, with steeper slopes shown at boundaries where retaining walls will be used, or at basins and road embankments where slopes are in the 15 % (1V:7H) to 35 % (1V:3H) range. Slopes in other parts of the site are mostly in the range up to 15 %, except locally around dams and drainage lines where slopes increase to around 35 %.

Following earthworks carried out in accordance with the recommendations in this report, the subsurface conditions are expected to comprise controlled fill and stiff to hard or medium dense residual soils overlying weathered rock, with batter slopes steeper than those recommended in this report retained by engineered retaining walls and individually assessed to confirm an acceptable level of stability (i.e. safety factor of 1.5).

With reference to the qualitative measures of likelihood and consequence given in the attachment Qualitative Terminology for Use in Assessing Risk to Property, it is considered that based on the information provided by the client and the proposed construction with the recommendations in this report followed, the likelihood of a landslide instability impacting the proposed works lots is ‘Rare’ to ‘Unlikely’ and the consequential property loss could be ‘Minor’ to ‘Medium’. A combination of these measures in the risk matrix results in a property risk classification of **Very Low or Low.** This level of risk is generally acceptable to regulators.

Table 6: Stability Risk Levels

Risk Level		Example Implications
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 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 regulators’ approval) but requires investigation, planning and implementation of treatment options to reduce 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 required.
VL	VERY LOW RISK	Acceptable. Manage by normal slope maintenance procedures.
Note: 1) 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.		

7.0 CLOSURE

Should you require any further information please contact the undersigned. We draw your attention to the document, Limitations, which is included in Appendix E.

Core Consultants Pty Ltd

Yours sincerely,

Andrew Middleton
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AM/WM/am

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Appendix A
Borehole Reports and Explanation of Notes and Methods

core consultants pty ltd

REPORT OF BOREHOLE: BH1

Job No	: J002123	Easting	: 525592		
Client	: Empower Engineers and Project Managers	Northing	: 6949638	Logged	: MM
Project	: Southern Thornlands	UTM	: 56	Logged Date	: 18/09/2023
Location	: Precinct 1	Drill Rig	: 4WD Mounted Auger Rig	Checked	: CJ
Contractor	: Geo-serve	Inclination	: -90 deg	Checked Date	: 21/11/2023

Drilling Method	Penetration Resistance	Water	Depth (m)	Elevation (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Testing: SPT	Samples: U50 Tube	Samples: DS	Samples: BDS	DCP graph
ADT		no groundwater encountered	0–1			CL	FILL Sandy CLAY: trace fine to coarse sized gravel, fine to medium grained sand, low plasticity, brown, trace cobbles .	w > PL	F-St					
			1–3.1			CI	FILL Silty CLAY: with fine grained sand, trace fine to coarse sized gravel, medium plasticity, brown and grey, high plasticity clay appears in mixed colours and layers..			3, 4, 5, (N = 9); 2, 3, 4, (N = 7)				
			3.1–3.7			CI	FILL Silty CLAY: with fine grained sand, trace fine to coarse sized gravel, medium plasticity, brown and grey.							
			3.7–4			CH	Silty CLAY RESIDUAL: high plasticity, red-brown.	w > PL	St					
			4–4.8			CH	Pale grey and red.			3, 4, 7, (N = 11)				
			4.8–5.2			CH	POSSIBLY RESIDUAL SOIL.	w < PL	VSt					
			5.2–5.8			CH			H	10, 28, 30/120mm, (N = R)				
			5.8			SST	Extremelyweathered, Clayey to silty SAND ROCK: fine grained, pale grey and red, low plasticity clay.	M-D	VD					

BH1 Terminated at 5.92m

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REPORT OF BOREHOLE: BH2

Job No	: J002123	Easting	: 525642.0		
Client	: Empower Engineers and Project Managers	Northing	: 6949555.0	Logged	: MM
Project	: Southern Thornlands	UTM	:	Logged Date	: 18/09/2023
Location	: Precinct 1	Drill Rig	: 4WD Mounted Auger Rig	Checked	: CJ
Contractor	: Geo-serve	Inclination	: -90 deg	Checked Date	: 21/11/2023

Drilling Method: ADT

Water: no groundwater encountered

Depth (m)	Classification Code	Material Description	Moisture	Consistency/Density	Testing: SPT
0.1	SM	Silty SAND (TOPSOIL): trace fine to medium sized gravel, fine to medium grained, brown.	M	L	
0.5	CI-CH	FILL Silty CLAY: trace fine to medium sized gravel, medium to high plasticity, brown with red.	w > PL	St	
0.9	CI-CH	Silty CLAY RESIDUAL: trace fine to medium sized gravel, medium to high plasticity, red mottled brown and grey.			
1.8	CI-CH	Silty CLAY RESIDUAL: medium to high plasticity, pale grey mottled red.		St-VSt	3, 6, 7, (N = 13)
2.6	CI-CH	Trace fine to medium sized gravel, pale grey and red with orange-brown.	w < PL		
4.1	CI-CH			H	8, 16, 21, (N = 37)
4.4	CI	Sandy CLAY RESIDUAL: medium plasticity, pale grey with red, fine grained sand.			10, 17, 30/120mm, (N = R)
5.5	SST	Extremelyweathered, Clayey to silty SAND ROCK: medium to coarse grained, pale grey mottled red-brown, low plasticity clay.	M	VD	
	SST	SANDSTONE: coarse grained, grey with orange-brown, very low to low strength, distinctly weathered.	D	VLS-L	30/105mm, (N = R)

BH2 Terminated at 5.65m

Columns also shown: Penetration Resistance, Elevation (m), Graphic Log, Samples (U50 Tube, DS, BDS), DCP graph (0 2 4 6 8 10 12 14 16 18 20 22 24)

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REPORT OF BOREHOLE: BH3

Job No	: J002123	Easting	: 525444		
Client	: Empower Engineers and Project Managers	Northing	: 6949489	Logged	: MM
Project	: Southern Thornlands	UTM	:	Logged Date	: 18/09/2023
Location	: Precinct 1	Drill Rig	: 4WD Mounted Auger Rig	Checked	: CJ
Contractor	: Geo-serve	Inclination	: -90 deg	Checked Date	: 21/11/2023

Drilling Method: ADT

Water: no groundwater encountered

Depth (m)	Graphic Log / Classification Code	Material Description	Moisture	Consistency/Density	Testing: SPT
0.0 – 0.3	CL	FILL Silty CLAY: low plasticity, brown, grey and orange-brown.	w > PL	S-F	
0.3 – 0.6	CI-CH	FILL Silty CLAY: medium to high plasticity, brown mottled grey and orange-brown.			
0.6 – 0.9	CH	Silty CLAY RESIDUAL: high plasticity, brown, red and grey.		St	
0.9 – 2.1	CH	Red and grey.			3, 5, 6, (N = 11)
2.1 – 3.5	CH	Pale grey and red.			4, 7, 7, (N = 14)
3.5 – 3.8	CH	Becoming pale grey mottled red.	w < PL	VSt	
3.8 – 5.95	CH	Pale grey and red, ferruginous fine grained gravel, relict rock structure.		H	6, 26, 30/100mm, (N = R); 9, 18, 23, (N = 41)

BH3 Terminated at 5.95m

Columns: Drilling Method, Penetration Resistance, Water, Depth (m), Elevation (m), Graphic Log, Classification Code, Material Description, Moisture, Consistency/Density, Testing (SPT), Samples (U50 Tube, DS, BDS), DCP graph (0 2 4 6 8 10 12 14 16 18 20 22 24 26)

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REPORT OF BOREHOLE: BH4

Job No	: J002123	Easting	: 525669		
Client	: Empower Engineers and Project Managers	Northing	: 6949309	Logged	: MM
Project	: Southern Thornlands	UTM	:	Logged Date	: 18/09/2023
Location	: Precinct 1	Drill Rig	: 4WD Mounted Auger Rig	Checked	: CJ
Contractor	: Geo-serve	Inclination	: -90 deg	Checked Date	: 21/11/2023

Drilling Method	Penetration Resistance	Water	Depth (m)	Elevation (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Testing: SPT	Samples: U50 Tube	Samples: DS	Samples: BDS	DCP graph
ADT		no groundwater encountered	0.0–1.5			SLT	SILTSTONE: fine grained, grey with orange-brown, very low strength, highly weathered.	D	VLS	25, 30/145mm, (N = R)				
			1.5–2.5			CH	Silty CLAY RESIDUAL: high plasticity, grey.	w < PL	H	14, 17, 23, (N = 40)				
			2.5–5.3			CH	Pale grey, yellow-brown and black.			7, 14, 17, (N = 31)				
			5.3–5.95			CH	Pale grey with orange-brown and white, fissured clay.			11, 18, 21, (N = 39)				

BH4 Terminated at 5.95m

DCP graph scale: 0 2 4 6 8 10 12 14 16 18 20 22 24 26

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REPORT OF BOREHOLE: BH5

Job No	: J002123	Easting	: 525712		
Client	: Empower Engineers and Project Managers	Northing	: 6949145	Logged	: MM
Project	: Southern Thornlands	UTM	:	Logged Date	: 02/10/2023
Location	Precinct 1	Drill Rig	: 4WD Mounted Auger Rig	Checked	: CJ
Contractor	: Geo-serve	Inclination	: -90 deg	Checked Date	: 21/11/2023

Drilling Method	Penetration Resistance	Water	Depth (m)	Elevation (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Testing: SPT	Samples: U50 Tube	Samples: DS	Samples: BDS	DCP graph
ADT		no groundwater encountered	0.1			CI	Sandy CLAY TOPSOIL: medium plasticity, brown mottled grey, fine grained sand.	w < PL	St					
			0.2			CL	Sandy CLAY RESIDUAL: low plasticity, brown mottled grey, fine grained sand.	w ≈ PL						
						CI	Silty CLAY RESIDUAL: trace medium sized gravel, medium plasticity, grey with red.							
			0.7			CI	Red with grey.	w > PL						
			1.1			CI	Pale grey with red, trace ferruginous fine grained gravel.	w < PL	VSt	3, 7, 9, (N = 16)				
			2			CI	Becoming grey, relict rock structure.		VSt-H	12, 25, 30/130mm, (N = R)				
			3.5			CI	Trace medium sized gravel, pale grey mottled red orange-brown, band of sandy clay layer appears.		H	4, 18, 18, (N = 36)				
			5			CH	Silty CLAY RESIDUAL: high plasticity, grey, fissured clay.			10, 14, 18, (N = 32)				
							BH5 Terminated at 5.95m							

DCP graph scale: 0 2 4 6 8 10 12 14 16 18 20 22 24 26

Depth scale: 1, 2, 3, 4, 5, 6

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REPORT OF BOREHOLE: BH6

Job No	: J002123	Easting	: 525394		
Client	: Empower Engineers and Project Managers	Northing	: 6949121	Logged	: MM
Project	: Southern Thornlands	UTM	:	Logged Date	: 18/09/2023
Location	: Precinct 1	Drill Rig	: 4WD Mounted Auger Rig	Checked	: CJ
Contractor	: Geo-serve	Inclination	: -90 deg	Checked Date	: 21/11/2023

Drilling Method	Penetration Resistance	Water	Depth (m)	Elevation (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Testing: SPT	Samples: U50 Tube	Samples: DS	Samples: BDS	DCP graph
ADT		no groundwater encountered	0.3			CI	FILL Silty CLAY: trace fine to medium sized gravel, medium plasticity, brown with grey and orange-brown.	w > PL	St					
			0.4			CL	Silty CLAY RESIDUAL: low plasticity, brown.		F-St					
			0.6			CI	Silty CLAY RESIDUAL: trace fine sized gravel, medium plasticity, pale brown.							
			1			CL-CI	Low to medium plasticity.							
			1.4			CI	Medium plasticity, red with brown.			3, 4, 4, (N = 8)				
			1.6			CI	Red with grey.							
			2.3			CH	High plasticity, pale grey with red and orange-brown, trace extremely weathered very low strength siltstone fractures.		H	8, 30/140mm, (N = R)				
			2.7			CH		w < PL						
			4			CH	Red with grey, interbedded of extremely weathered siltstone .							
						CH	Trace ferruginous fine grained gravel.			4, 16, 30/145mm, (N = R)				
										9, 15, 15, (N = 30)				
							BH6 Terminated at 5.95m							

Depth scale: 1, 2, 3, 4, 5, 6

DCP graph axis: 0 2 4 6 8 10 12 14 16 18 20 22 24 26

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REPORT OF BOREHOLE: BH7

Job No	: J002123	Easting	: 525449.3		
Client	: Empower Engineers and Project Managers	Northing	: 6948910.8	Logged	: CJ
Project	: Southern Thornlands	UTM	:	Logged Date	: 18/09/2023
Location	: Precinct 1	Drill Rig	: 4WD Mounted Auger Rig	Checked	: CJ
Contractor	: Geo-serve	Inclination	: -90 deg	Checked Date	: 21/11/2023

Drilling Method	Penetration Resistance	Water	Depth (m)	Elevation (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Testing: SPT	Samples: U50 Tube	Samples: DS	Samples: BDS	DCP graph
ADT		no groundwater encountered	0.0–0.3			SM	FILL Silty SAND: fine to coarse grained, grey.	M	L					
			0.3–0.7			CI	Sandy CLAY RESIDUAL: medium plasticity, grey mottled orange-brown with red, fine to coarse grained sand.	w > PL	F					
			0.7–2.4			CL	Silty to sandy CLAY RESIDUAL: low plasticity, grey mottled red-brown, fine grained sand.	w < PL	F-St	2, 3, 5, (N = 8)				
			2.4–3.5			CL	With fine ironstone seams.	w ≈ PL	VSt	5, 8, 10, (N = 18)				
			3.5–4			CH	Sandy CLAY RESIDUAL: high plasticity, grey mottled orange-brown, fine to coarse grained sand.	w < PL						
			4–5			CH	Coarse grained sand.			5, 8, 9, (N = 17)				
			5–5.95			CH	Pale grey.			5, 7, 11, (N = 18)				

DCP graph scale: 0 2 4 6 8 10 12 14 16 18 20 22 24 26

BH7 Terminated at 5.95m

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REPORT OF BOREHOLE: BH8

Job No	: J002123	Easting	: 525630.8		
Client	: Empower Engineers and Project Managers	Northing	: 6948855.1	Logged	: CJ
Project	: Southern Thornlands	UTM	:	Logged Date	: 18/09/2023
Location	: Precinct 1	Drill Rig	: 4WD Mounted Auger Rig	Checked	: CJ
Contractor	: Geo-serve	Inclination	: -90 deg	Checked Date	: 21/11/2023

Drilling Method	Penetration Resistance	Water	Depth (m)	Elevation (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Testing: SPT	Samples: U50 Tube	Samples: DS	Samples: BDS	DCP graph
ADT			0			SM	Sandy SILT POSSIBLY FILL: low plasticity, pale grey, fine to medium grained sand.	w ≈ LL	H	9, 25, 30/110mm, (N = R)				
			1.6			SM	Silty SAND POSSIBLY FILL: fine to medium grained, pale grey and brown.	D	VD					
			2.3			SM	Silty to gravelly SAND POSSIBLY FILL: fine to coarse grained, fine to coarse sized gravel, pale grey and brown.							
			2.4			SC	Clayey to silty SAND POSSIBLY FILL: trace fine sized gravel, fine to coarse grained, grey mottled brown, low plasticity clay, fine grained angular gravel with quartz possibly quarry fill for erosion protection .	M		15, 26, 26, (N > 50)				
			3			SC	Trace coarse sized gravel, fine grained angular gravel with quartz.							
		groundwater encountered	4.2			SW	Gravelly SAND RESIDUAL SOIL: fine to coarse grained, fine to coarse sized gravel, grey mottled brown.	W-M	MD	7, 10, 8, (N = 18)				
			5			CL-CI	Sandy to gravelly CLAY RESIDUAL SOIL: low to medium plasticity, grey mottled brown, fine to coarse sized gravel, fine to coarse grained sand.	w > PL	St					
			5.5			CL-CI	Fine to medium sized gravel.			3, 4, 6, (N = 10)				

DCP graph scale: 0 2 4 6 8 10 12 14 16 18 20 22 24 26

BH8 Terminated at 5.95m

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EXPLANATION OF NOTES, ABBREVIATIONS & TERMS USED ON BOREHOLE AND TEST PIT REPORTS

DRILLING/EXCAVATION METHOD

AS	Auger Screwing	RD	Rotary blade or drag bit	NQ	Diamond Core - 47 mm
AD	Auger Drilling	RT	Rotary Tricone bit	NMLC	Diamond Core - 52 mm
*V	V - Bit	RAB	Rotary Air Blast	HQ	Diamond Core - 63 mm
T	TC - Bit, e.g. ADT	RC	Reverse Circulation	HMLC	Diamond Core – 63mm
HA	Hand Auger	PT	Push Tube	BH	Tractor Mounted Backhoe
ADH	Hollow Auger	CT	Cable Tool Rig	EX	Tracked Hydraulic Excavator
DTC	Diatubre Coring	JET	Jetting	EE	Existing Excavation
WB	Washbore or Bailer	NDD	Non-destructive digging	HAND	Excavated by Hand Methods

PENETRATION/EXCAVATION RESISTANCE

L	**Low resistance** . Rapid penetration possible with little effort from the equipment used
M	**Medium resistance.** Excavation possible at an acceptable rate with moderate effort from equipment used
H	**High resistance to penetration/excavation**. Further penetration is possible at a slow rate
R	**Refusal or Practical Refusal.** No further progress possible without the risk of damage or unacceptable wear to the digging implement or machine.

These assessments are subjective and are dependent on many factors including the equipment power, weight, condition of excavation or drilling tools, and the experience of the operator.

WATER

▽	Water level shown at date	◁	Partial water loss
▷	Water inflow	◀	Complete water loss

GROUNDWATER NOT OBSERVED	The observation of groundwater whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit.
GROUND WATER NOT ENCOUNTERED	The borehole/test pit was dry soon after excavation. However, groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/test pit been left open for a longer period.

SAMPLING AND TESTING

SPT	Standard Penetration Test to AS1289.6.3.1-2004
4,7,11 N=18	4,7,11 = Blows per 150mm N = Blows per 300mm penetration following 150mm seating
30/80mm	Where practical refusal occurs, the blows and penetration for that interval are reported
RW	Penetration occurred under the rod weight only
HW	Penetration occurred under the hammer and rod weight only
HB	Hammer double bouncing on anvil
DS	Disturbed Sample
BDS	Bulk disturbed sample
G	Gas Sample
W	Water sample
FP	Field permeability test over section noted
FV	Field vane shear test expressed as uncorrected shear strength (sv = peak value)
PID	Photoionisation Detector reading in ppm
PM	Pressuremeter test over section noted
PP	Pocket penetrometer test expressed as instrument reading in kPa
U63	Thin walled tube sample - number indicates nominal sample diameter in millimetres
WPT	Water pressure tests
DCP	Dynamic cone penetration test
CPT	Dynamic cone penetration test
CPTu	Static cone penetration test with pore pressure (u) measurement

ROCK CORE RECOVERY

TCR = Total Core Recovery (%)

$$= \frac{\text{Length of core recovered}}{\text{Length of core run}} \times 100$$

SCR = Solid Core Recovery (%)

$$= \frac{\sum \text{Length of cylindrical core recovered}}{\text{Length of core run}} \times 100$$

RQD = Rock Quantity Designation (%)

$$= \frac{\sum \text{Axial lengths of core} > 100 \text{ mm}}{\text{Length of core run}} \times 100$$

METHOD OF SOIL DESCRIPTION USED ON BOREHOLE AND TEST PIT REPORTS

FILL

GRAVEL (GP or SW)

SAND (SP or SW)

SILT (ML or MH)

CLAY (CL,CI, or CH)

ORGANIC SOILS (OL or OH or Pt)

COBBLES or BOULDERS

Combinations of these basic symbols may be used to indicate mixed materials such as sandy clay.

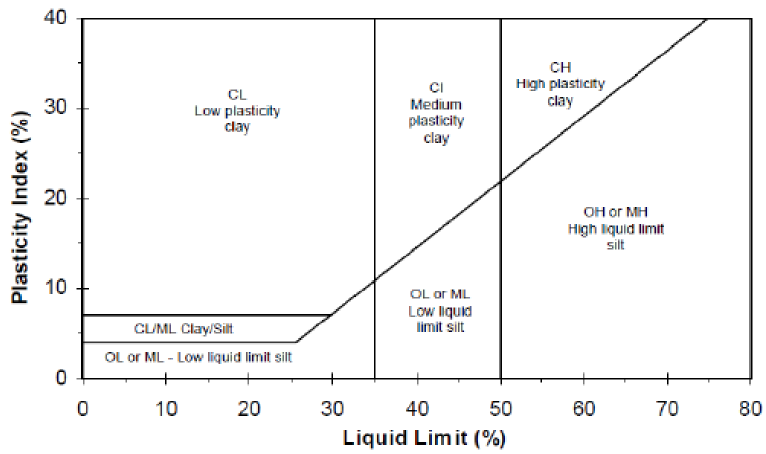
CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil and Rock is classified and described in Reports of Boreholes and Test Pits using the preferred method given in AS 1726 - 2017. The material properties are assessed in the field by visual/tactile methods.

PARTICLE SIZE

Major Division	Sub Division	Particle Size
Boulders		>200 mm
Cobbles		63 - 200 mm
Gravel	Coarse	20 - 63 mm
Gravel	Medium	6.7 - 20 mm
Gravel	Fine	2.36 - 6.7 mm
Sand	Coarse	0.6 - 2.36 mm
Sand	Medium	0.21 - 0.6 mm
Sand	Fine	0.075 - 0.21 mm
Silt		0.002 - 0.075 mm
Clay		<0.002 mm

PLASTIC PROPERTIES



MOISTURE CONDITION FOR COARSE GRAINED SOIL — AS 1726 - 2017

Symbol	Term	Description
D	Dry	Non-cohesive and free running
M	Moist	Soil feels cool, darkened in colour, tends to stick together
W	Wet	Soil feels cool, darkened in colour, soil sticks together, free water forms when handling

MOISTURE CONDITION FOR FINE GRAINED SOIL — AS1726 - 2017

Symbol	Term	Description
W<PL	Moist dry of liquid limit	Hard and friable or powdery
W = PL	Moist near plastic limit	Soils can be molded at a moisture condition approximately equal to the plastic limit
W >PL	Moist, wet of plastic limit	Soils usually weakened and free water forms on hands when handling
W = LL	Wet near plastic limit	
W > LL	Wet, wet of liquid limit	

CONSISTENCY TERMS FOR COHESIVE SOILS — AS1726—2017

Symbol	Term	Undrained Shear Strength
VS	Very Soft	0 to 12 kPa
S	Soft	12 to 25 kPa
F	Firm	25 to 50 kPa
St	Stiff	50 to 100 kPa
VSt	Very Stiff	100 to 200 kPa
H	Hard	Above 200 kPa

RELATIVE DENSITY OF COARSE GRAINED SOILS — AS1726—2017

Symbol	Term	Density Index %	SPT ‘N’ #
VL	Very Loose	Less than 15	0 to 4
L	Loose	15 to 35	4 to 10
MD	Medium Dense	35 to 65	10 to 30
D	Dense	65 to 85	30 to 50
VD	Very Dense	Above 85	Above 50

In the absence of test results, consistency and density may be assessed from correlations with the observed behaviour of the material.

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TERMS FOR ROCK MATERIAL STRENGTH & WEATHERING AND ABBREVIATIONS FOR DEFECT DESCRIPTIONS

ROCK MATERIAL STRENGTH CLASSIFICATION				AS1726—2017
Symbol	**Term**	**Uniaxial Compressive Strength (MPa)**	**Point Load Strength $I_{s\,(50)}$ (MPa)**	**Field Guide**
VL	Very Low Strength	0.6 to 2	0.03 to 0.1	Material crumbles under firm blows with sharp end of pick. Pieces up to 30 mm thick can be broken with finger pressure.
L	Low Strength	2 to 6	0.1 to 0.3	Easily scored with knife. Indentations 1 mm to 3 mm show in the specimen with firm blows of the pick point. A piece of core 150 mm by 50 mm may be broken by hand. Sharp edges of core are friable and break during handling.
M	Medium Strength	6 to 20	0.3 to 1	Readily scored with a knife. A piece of core 150 mm by 50 mm can be broken by hand with difficulty.
H	High Strength	20 to 60	1 to 3	A piece of core 150 mm by 50 mm cannot be broken by hand but can be broken by a pick with a single firm blow. Rock rings under hammer.
VH	Very High Strength	60 to 200	3 to 10	Hand specimen breaks with pick after more than one blow. Rock rings under hammer.
EH	Extremely High Strength	Above 200	Above 10	Specimen requires many blows with geological pick to break through intact material. Rock rings under hammer.

● = Diametral Point Load Test ▼ = Axial Point Load Test

CLASSIFICATION OF MATERIAL WEATHERING		AS1726—2017
Symbol	**Term**	**Field Guide**
RS	Residual Soil *(Note 1)*	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible but the soil has not been significantly transported.
XW	Extremely Weathered *(Note 1)*	Material is weathered to such an extent that is has soil properties. Mass structure and material texture and fabric of original rock are still visible.
HW	Highly Weathered *(Note 2)*	The whole rock mass is discoloured, usually by iron staining or beaching to the extent that the colour of the original rock is not recognizable. Rock strength is significantly changed by weathering. Some primary miner-als have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
MH	Moderately Weathered *(Note 2)*	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognizable, but shows little or no change in strength from fresh rock.
SW	Slightly Weathered	Pock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
FR	Fresh	Rock shows no signs of decomposition of individual minerals or colour change.
Note 1	The term 'Extremely Weathered rock' is misleading as the material has soil properties. The word 'rock' should be replaced with the name of the original rock of the word 'material', eg. Extremely Weathered granite or Extremely Weathered material.	
Note 2	Where it is not possible to distinguish between 'Highly Weathered' and 'Moderately Weathered' rock the term 'Distinctly Weathered' may be used.	

DEFECT TYPE/DESCRIPTION			
B	Bedding Parting	V	Vein
J	Joint	HB/DB	Handling/Drilling Break
EW	Extremely Weathered Seam	C	Contact
FZ	Fracture Zone	L	Cleavage
CZ/S	Crushed Zone/Seam	X	Foliation
IS	Infilled Seam	S	Schistocity
SZ/S	Sheared Zone/Seam		

DEFECT PROFILE	
Symbol	**Description**
PL	Planar
St	Stepped
Un	Undulating

DEFECT INFILL DESCRIPTION	
Symbol	**Description**
Cn	Clean: No visible coating
Sn	Stain: Coated 1 to 3 mm
Vr	Veneer: < 1 mm
Ct	Coating: 1 to 3 mm

DEFECT ROUGHNESS DESCRIPTION	
Symbol	**Description**
Sl	Slickenside
Sm	Smooth
Ro	Rough

Vertical Boreholes - The dip (inclination from horizontal) for the defect is given.

Inclined Boreholes - The inclination is measured as the acute angle to the core axis.

Appendix B
Laboratory Test Results

Material Test Report

Report Number:	**B-23-386-10**
Issue Number:	1
Date Issued:	05/10/2023
Client:	Core Consultants Pty Ltd
	Unit 3/31 Londor Close, Hemmant Qld 4174
Project Number:	B-23-386
Project Name:	Quality Assurance - 2023
Client Reference:	J2123
Work Request:	12952
Sample Number:	B-12952A
Date Sampled:	25/09/2023
Dates Tested:	25/09/2023 - 03/10/2023
Sampling Method:	Sampled by Client - Tested as Received
	The results apply to the sample as received
Preparation Method:	AS 1289.1.1 - Sampling and preparation of soils
Remarks:	Client Project Ref No: J2123 - Phase 2000
Site Selection:	Selected by Client
Sample Location:	**BH1, Depth: 0.2m-1.0m**

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AMB Geotech SQS Pty Ltd
ABN 36 631 788 620

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Email: brisbane@sqs.net.au

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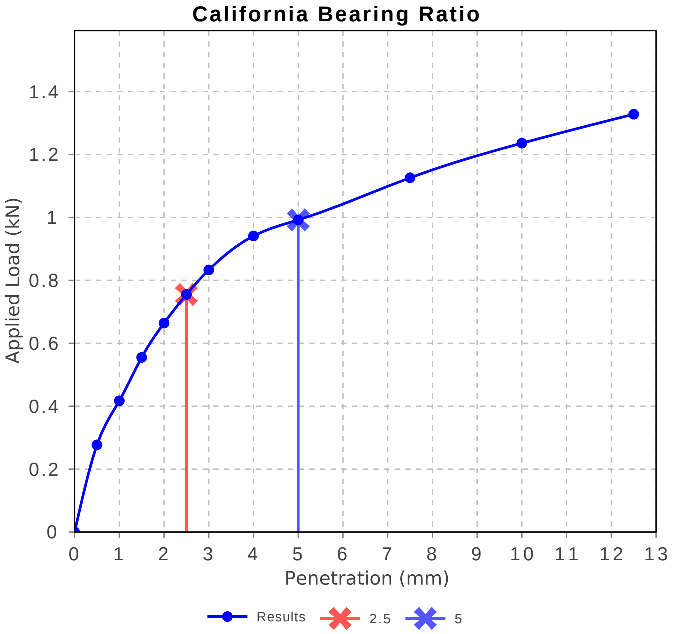
Approved Signatory: Torin Pegler
Senior Soil Technician
NATA Accredited Laboratory Number: 2911

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**6**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS1289 5.1.1		
Method used to Determine Plasticity	Visual		
Maximum Dry Density (t/m^3)	1.85		
Optimum Moisture Content (%)	15.0		
Laboratory Density Ratio (%)	98.0		
Laboratory Moisture Ratio (%)	100.5		
Dry Density after Soaking (t/m^3)	1.81		
Field Moisture Content (%)	10.6		
Moisture Content at Placement (%)	15.0		
Moisture Content Top 30mm (%)	18.5		
Moisture Content Rest of Sample (%)	16.9		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	48.7		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



Material Test Report

Report Number:	**B-23-386-10**
Issue Number:	1
Date Issued:	05/10/2023
Client:	Core Consultants Pty Ltd
	Unit 3/31 Londor Close, Hemmant Qld 4174
Project Number:	B-23-386
Project Name:	Quality Assurance - 2023
Client Reference:	J2123
Work Request:	12952
Sample Number:	B-12952B
Date Sampled:	25/09/2023
Dates Tested:	25/09/2023 - 04/10/2023
Sampling Method:	Sampled by Client - Tested as Received
	The results apply to the sample as received
Preparation Method:	AS 1289.1.1 - Sampling and preparation of soils
Remarks:	Client Project Ref No: J2123 - Phase 2000
Site Selection:	Selected by Client
Sample Location:	**BH1, Depth: 1.0-1.45m**

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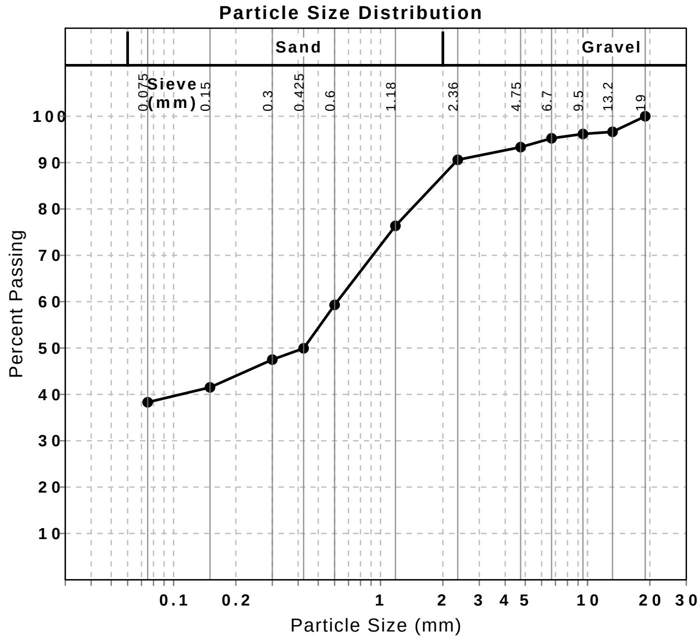
Senior Soil Technician

NATA Accredited Laboratory Number: 2911

Particle Size Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
19 mm	**100**		
13.2 mm	**97**		
9.5 mm	**96**		
6.7 mm	**95**		
4.75 mm	**93**		
2.36 mm	**91**		
1.18 mm	**76**		
0.6 mm	**59**		
0.425 mm	**50**		
0.3 mm	**48**		
0.15 mm	**42**		
0.075 mm	**38**		



Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**4 ***		
Soil Description	Sandy Clay		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	23		
* Mineral Present	Carbonate		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1 & Q252)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Passing 0.425 (%)	50		
Liquid Limit (%)	61		
Plastic Limit (%)	21		
Plasticity Index (%)	**40**		
Weighted Plasticity Index (%)	1998		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	**16.0**		
Cracking Crumbling Curling	None		

Material Test Report

Report Number: **B-23-386-10**
Issue Number: 1
Date Issued: 05/10/2023
Client: Core Consultants Pty Ltd
Unit 3/31 Londor Close, Hemmant Qld 4174
Project Number: B-23-386
Project Name: Quality Assurance - 2023
Client Reference: J2123
Work Request: 12952
Sample Number: B-12952C
Date Sampled: 25/09/2023
Dates Tested: 25/09/2023 - 05/10/2023
Sampling Method: Sampled by Client - Tested as Received
The results apply to the sample as received
Preparation Method: AS 1289.1.1 - Sampling and preparation of soils
Remarks: Client Project Ref No: J2123 - Phase 2000
Site Selection: Selected by Client
Sample Location: **BH4, Depth: 1.0-1.45m**

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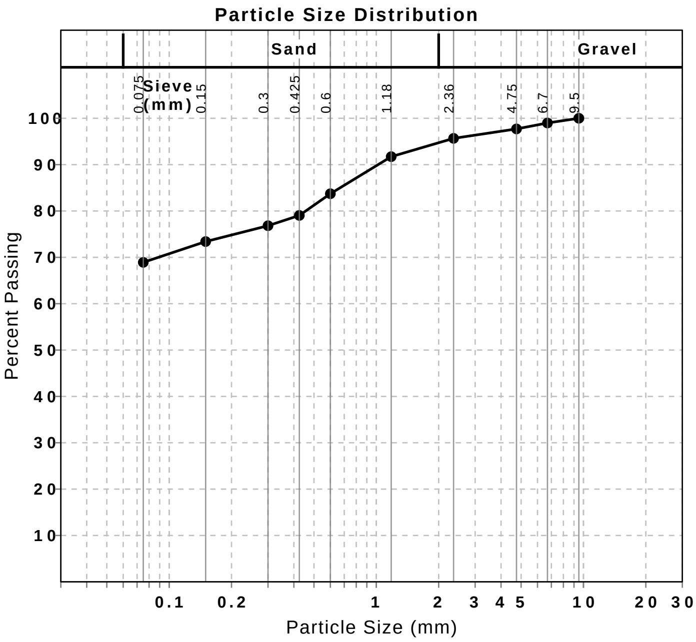
Senior Soil Technician
NATA Accredited Laboratory Number: 2911

Particle Size Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
9.5 mm	**100**		
6.7 mm	**99**		
4.75 mm	**98**		
2.36 mm	**96**		
1.18 mm	**92**		
0.6 mm	**84**		
0.425 mm	**79**		
0.3 mm	**77**		
0.15 mm	**73**		
0.075 mm	**69**		



Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1 & Q252)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Passing 0.425 (%)	79		
Liquid Limit (%)	42		
Plastic Limit (%)	26		
Plasticity Index (%)	**16**		
Weighted Plasticity Index (%)	1265		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	**7.0**		
Cracking Crumbling Curling	Curling		

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**3**		
Soil Description	Silty Clay		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	23		

Material Test Report

Report Number:	**B-23-386-10**
Issue Number:	1
Date Issued:	05/10/2023
Client:	Core Consultants Pty Ltd
	Unit 3/31 Londor Close, Hemmant Qld 4174
Project Number:	B-23-386
Project Name:	Quality Assurance - 2023
Client Reference:	J2123
Work Request:	12952
Sample Number:	B-12952D
Date Sampled:	25/09/2023
Dates Tested:	25/09/2023 - 03/10/2023
Sampling Method:	Sampled by Client - Tested as Received
	The results apply to the sample as received
Preparation Method:	AS 1289.1.1 - Sampling and preparation of soils
Remarks:	Client Project Ref No: J2123 - Phase 2000
Site Selection:	Selected by Client
Sample Location:	**BH5, Depth: 0.2-0.7m**

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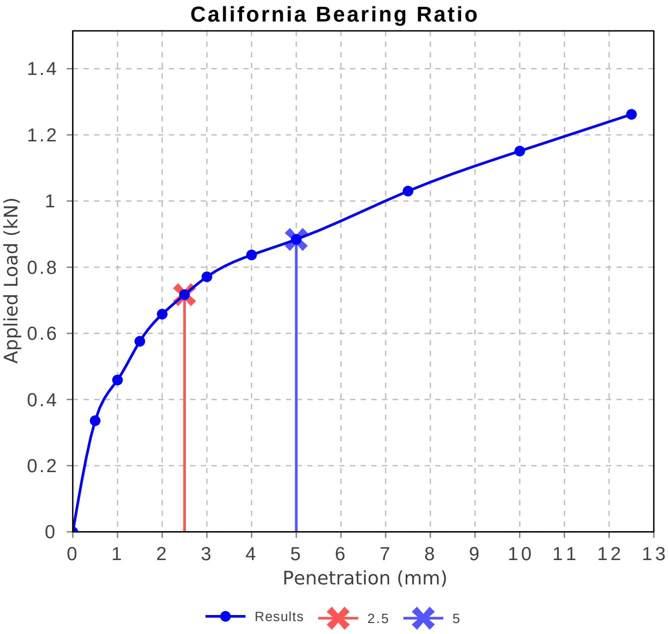
Senior Soil Technician

NATA Accredited Laboratory Number: 2911

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		
Maximum Dry Density (t/m^3)	1.54		
Optimum Moisture Content (%)	25.0		
Laboratory Density Ratio (%)	98.0		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.50		
Field Moisture Content (%)	19.9		
Moisture Content at Placement (%)	25.2		
Moisture Content Top 30mm (%)	31.0		
Moisture Content Rest of Sample (%)	28.1		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	49.0		
Swell (%)	1.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



Material Test Report

Report Number:	**B-23-386-10**
Issue Number:	1
Date Issued:	05/10/2023
Client:	Core Consultants Pty Ltd
	Unit 3/31 Londor Close, Hemmant Qld 4174
Project Number:	B-23-386
Project Name:	Quality Assurance - 2023
Client Reference:	J2123
Work Request:	12952
Sample Number:	B-12952E
Date Sampled:	25/09/2023
Dates Tested:	25/09/2023 - 05/10/2023
Sampling Method:	Sampled by Client - Tested as Received
	The results apply to the sample as received
Preparation Method:	AS 1289.1.1 - Sampling and preparation of soils
Remarks:	Client Project Ref No: J2123 - Phase 2000
Site Selection:	Selected by Client
Sample Location:	**BH6, Depth: 0.5 m**

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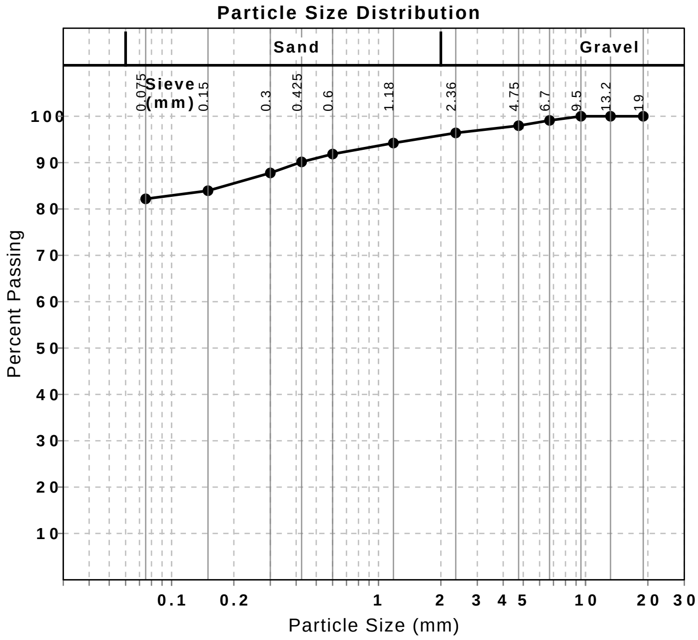
Senior Soil Technician

NATA Accredited Laboratory Number: 2911

Particle Size Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
19 mm	**100**		
13.2 mm	**100**		
9.5 mm	**100**		
6.7 mm	**99**		
4.75 mm	**98**		
2.36 mm	**96**		
1.18 mm	**94**		
0.6 mm	**92**		
0.425 mm	**90**		
0.3 mm	**88**		
0.15 mm	**84**		
0.075 mm	**82**		



Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1 & Q252)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Passing 0.425 (%)	90		
Liquid Limit (%)	66		
Plastic Limit (%)	26		
Plasticity Index (%)	**40**		
Weighted Plasticity Index (%)	3606		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	**17.0**		
Cracking Crumbling Curling	Cracking & Curling		

Material Test Report

Report Number:	**B-23-386-10**
Issue Number:	1
Date Issued:	05/10/2023
Client:	Core Consultants Pty Ltd
	Unit 3/31 Londor Close, Hemmant Qld 4174
Project Number:	B-23-386
Project Name:	Quality Assurance - 2023
Client Reference:	J2123
Work Request:	12952
Sample Number:	B-12952F
Date Sampled:	25/09/2023
Dates Tested:	25/09/2023 - 05/10/2023
Sampling Method:	Sampled by Client - Tested as Received
	The results apply to the sample as received
Preparation Method:	AS 1289.1.1 - Sampling and preparation of soils
Remarks:	Client Project Ref No: J2123 - Phase 2000
Site Selection:	Selected by Client
Sample Location:	**BH7, Depth: 1.0-1.2m**

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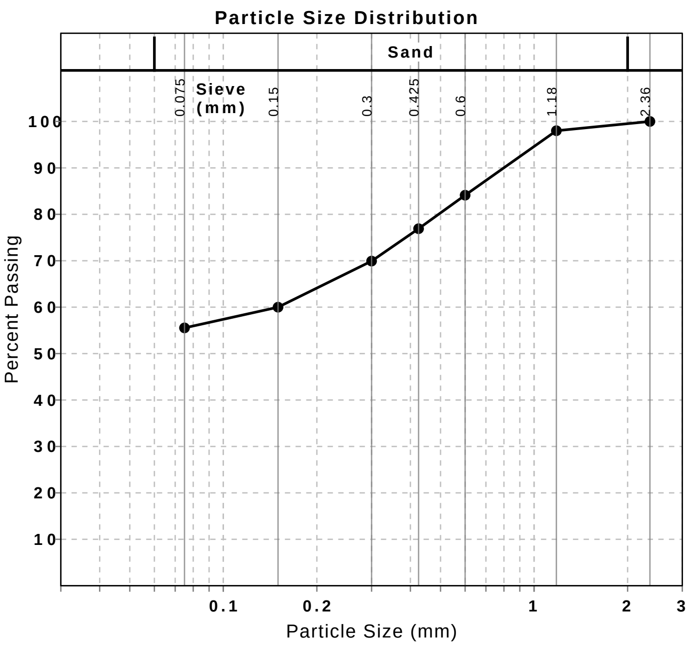
Approved Signatory: Torin Pegler
Senior Soil Technician

NATA Accredited Laboratory Number: 2911

Particle Size Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
2.36 mm	**100**		
1.18 mm	**98**		
0.6 mm	**84**		
0.425 mm	**77**		
0.3 mm	**70**		
0.15 mm	**60**		
0.075 mm	**56**		



Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1 & Q252)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Passing 0.425 (%)	77		
Liquid Limit (%)	92		
Plastic Limit (%)	27		
Plasticity Index (%)	**65**		
Weighted Plasticity Index (%)	4998		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	**20.5**		
Cracking Crumbling Curling	Curling		

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**4 ***		
Soil Description	Sandy Clay		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	23		
* Mineral Present	Carbonate		

Material Test Report

Report Number: **B-23-386-10**
Issue Number: 1
Date Issued: 05/10/2023
Client: Core Consultants Pty Ltd
Unit 3/31 Londor Close, Hemmant Qld 4174
Project Number: B-23-386
Project Name: Quality Assurance - 2023
Client Reference: J2123
Work Request: 12952
Sample Number: B-12952G
Date Sampled: 25/09/2023
Dates Tested: 25/09/2023 - 04/10/2023
Sampling Method: Sampled by Client - Tested as Received
The results apply to the sample as received
Preparation Method: AS 1289.1.1 - Sampling and preparation of soils
Remarks: Client Project Ref No: J2123 - Phase 2000
Site Selection: Selected by Client
Sample Location: **BH8, Depth: 0.5 m**

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Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**2**		
Soil Description	Silty Sand		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	23		

Certificate of Analysis

Environment Testing

NATA Accredited
Accreditation Number 1261
Site Number 20794

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NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates.

Core Consultants Pty Ltd
18 Lysaght St
Coolum Beach
QLD 4573

Attention: **Christie Johnson**

Report	**1027016-S**
Project name	SOUTHERN THORNLANDS
Project ID	J2123
Received Date	Sep 18, 2023

Client Sample ID			**BH8 0.0-0.25**	**BH8 0.25-0.5**	**BH8 0.5-0.75**	**BH8 0.75-1.0**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**B23-Se0040205**	**B23-Se0040206**	**B23-Se0040207**	**B23-Se0040208**
Date Sampled			**Sep 18, 2023**	**Sep 18, 2023**	**Sep 18, 2023**	**Sep 18, 2023**
Test/Reference	LOR	Unit				
Acid Sulfate Soils Field pH Test						
pH-F (Field pH test)*	0.1	pH Units	5.5	5.7	5.9	5.7
pH-FOX (Field pH Peroxide test)*	0.1	pH Units	3.5	3.8	3.6	4.2
Reaction Ratings*S05	0	-	4.0	4.0	4.0	4.0

Client Sample ID			**BH8 1.0-1.25**	**BH8 1.25-1.5**	**BH8 1.5-1.75**	**BH8 1.75-2.0**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**B23-Se0040209**	**B23-Se0040210**	**B23-Se0040211**	**B23-Se0040212**
Date Sampled			**Sep 18, 2023**	**Sep 18, 2023**	**Sep 18, 2023**	**Sep 18, 2023**
Test/Reference	LOR	Unit				
Acid Sulfate Soils Field pH Test						
pH-F (Field pH test)*	0.1	pH Units	5.5	5.1	5.3	5.7
pH-FOX (Field pH Peroxide test)*	0.1	pH Units	3.9	3.8	4.1	4.3
Reaction Ratings*S05	0	-	4.0	2.0	2.0	4.0

Client Sample ID			**BH8 2.0-2.25**	**BH8 2.25-2.5**	**BH8 2.5-2.75**	**BH8 2.75-3.0**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**B23-Se0040213**	**B23-Se0040214**	**B23-Se0040215**	**B23-Se0040216**
Date Sampled			**Sep 18, 2023**	**Sep 18, 2023**	**Sep 18, 2023**	**Sep 18, 2023**
Test/Reference	LOR	Unit				
Acid Sulfate Soils Field pH Test						
pH-F (Field pH test)*	0.1	pH Units	5.8	5.8	5.5	5.6
pH-FOX (Field pH Peroxide test)*	0.1	pH Units	4.1	4.1	4.0	4.2
Reaction Ratings*S05	0	-	4.0	2.0	4.0	2.0

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Sample History

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

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

Description	Testing Site	Extracted	Holding Time
Acid Sulfate Soils Field pH Test	Brisbane	Sep 21, 2023	7 Days

- Method: LTM-GEN-7060 Determination of field pH (pHF) and field pH peroxide (pHFOX) tests

Company Name:	Core Consultants Pty Ltd	**Order No.:**		**Received:**	Sep 18, 2023 2:00 PM
Address:	18 Lysaght St Coolum Beach QLD 4573	**Report #:**	1027016	**Due:**	Sep 25, 2023
		Phone:	07 5475 5900	**Priority:**	5 Day
		Fax:		**Contact Name:**	Christie Johnson
Project Name:	SOUTHERN THORNLANDS				
Project ID:	J2123				

Eurofins Analytical Services Manager : Alana Wadsworth

Sample Detail						Acid Sulfate Soils Field pH Test
Brisbane Laboratory - NATA # 1261 Site # 20794						X
External Laboratory						
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**	
1	BH8 0.0-0.25	Sep 18, 2023		Soil	B23-Se0040205	X
2	BH8 0.25-0.5	Sep 18, 2023		Soil	B23-Se0040206	X
3	BH8 0.5-0.75	Sep 18, 2023		Soil	B23-Se0040207	X
4	BH8 0.75-1.0	Sep 18, 2023		Soil	B23-Se0040208	X
5	BH8 1.0-1.25	Sep 18, 2023		Soil	B23-Se0040209	X
6	BH8 1.25-1.5	Sep 18, 2023		Soil	B23-Se0040210	X
7	BH8 1.5-1.75	Sep 18, 2023		Soil	B23-Se0040211	X
8	BH8 1.75-2.0	Sep 18, 2023		Soil	B23-Se0040212	X
9	BH8 2.0-2.25	Sep 18, 2023		Soil	B23-Se0040213	X
10	BH8 2.25-2.5	Sep 18, 2023		Soil	B23-Se0040214	X
11	BH8 2.5-2.75	Sep 18, 2023		Soil	B23-Se0040215	X
12	BH8 2.75-3.0	Sep 18, 2023		Soil	B23-Se0040216	X
Test Counts						12

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Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer that may have an impact on the results.
9. This report replaces any interim results previously issued.

Holding Times

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

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

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

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

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

Units

mg/kg: milligrams per kilogram	**mg/L:** milligrams per litre	**µg/L:** micrograms per litre
ppm: parts per million	**ppb:** parts per billion	**%:** Percentage
org/100 mL: Organisms per 100 millilitres	**NTU:** Nephelometric Turbidity Units	**MPN/100 mL:** Most Probable Number of organisms per 100 millilitres
CFU: Colony forming unit		

Terms

APHA	American Public Health Association
COC	Chain of Custody
CP	Client Parent - QC was performed on samples pertaining to this report
CRM	Certified Reference Material (ISO17034) - reported as percent recovery.
Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
LOR	Limit of Reporting.
LCS	Laboratory Control Sample - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
SRA	Sample Receipt Advice
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
TBTO	Tributyltin oxide (*bis*-tributyltin oxide) - individual tributyltin compounds cannot be identified separately in the environment however free tributyltin was measured and its values were converted stoichiometrically into tributyltin oxide for comparison with regulatory limits.
TCLP	Toxicity Characteristic Leaching Procedure
TEQ	Toxic Equivalency Quotient or Total Equivalence
QSM	US Department of Defense Quality Systems Manual Version 5.4
US EPA	United States Environmental Protection Agency
WA DWER	Sum of PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC - Acceptance Criteria

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

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

Results <10 times the LOR: No Limit

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

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

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

Surrogate Recoveries: Recoveries must lie between 20-130% for Speciated Phenols & 50-150% for PFAS. SVOCs recoveries 20 – 150%

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.4 where no positive PFAS results have been reported have been reviewed and no data was affected.

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling. Therefore, laboratory analysis is unlikely to be completed within holding time.Analysis will begin as soon as possible after sample receipt.
4. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of recovery the term "INT" appears against that analyte.
5. For Matrix Spikes and LCS results a dash "-" in the report means that the specific analyte was not added to the QC sample.
6. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Duplicate									
Acid Sulfate Soils Field pH Test				Result 1	Result 2	RPD			
pH-F (Field pH test)*	B23-Se0040206	CP	pH Units	5.7	5.7	pass	20%	Pass	

Comments

Sample Integrity

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

Qualifier Codes/Comments

Code	Description
S05	Field Screen uses the following fizz rating to classify the rate the samples reacted to the peroxide: 1.0; No reaction to slight. 2.0; Moderate reaction. 3.0; Strong reaction with persistent froth. 4.0; Extreme reaction.

Authorised by:

Paige Howarth	Analytical Services Manager
Jonathon Angell	Senior Analyst-SPOCAS

Glenn Jackson
Managing Director

Final Report – this report replaces any previously issued Report

- Indicates Not Requested

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

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

Appendix C
QBCC Guidelines for Homeowners

queensland building
and construction commission

A guide to preventing structural damage

Build better.

Home owners guide to planning landscaping and maintenance of foundations

Structural damage can result from movement in clay soils caused by varying moisture conditions around the perimeter of homes.

The majority of Queensland homes are situated on what are termed reactive clay soils. These soils are subject to expansion and contraction depending on seasonal weather and site conditions. Sandy sites and rocky terrain are usually not prone to this expansion and contraction.

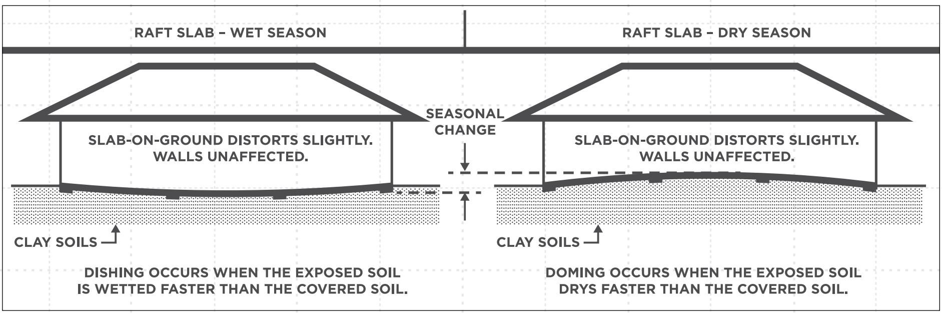
In Queensland, engineers design footings to the **Australian Standard AS2870 – 2011 Residential slabs and footings**. Footings correctly designed to this standard are intended to accommodate the expected movements caused by seasonal movements caused by seasonal volume changes in the soil (swelling when wet and shrinking when dry) - under **normal conditions**. The performance of footings under this standard requires **normal conditions** to be **maintained** around the house.

This guideline identifies **abnormal conditions** that should be avoided and/or corrected.

Dry seasons cause soils to dry out rapidly. Wet seasons cause soils to become wet quickly. This results in sudden extreme volume changes and movement in soil.

Abnormal conditions (other than seasonal changes), may include the effect of trees, poor surface drainage and/or leaking plumbing. If not allowed for in the engineer's design, these types of abnormal conditions may lead to movement and damage varying from minor to extreme.

NORMAL MOVEMENT EXPECTATIONS FOR BUILDINGS CONSTUCTED ON REACTIVE CLAY SOILS



How much can the soils under my house move?

The amount of movement that may occur depends on the site classification, which is defined under the **Australian Standard AS2870**.

The relevant classifications and expected movements under normal site conditions and seasonal influences are:

Site classification	Description of type of clay and reactivity	Expected range of movement
A	Mostly sand and rock with little or no ground movement from moisture changes.	0
S	Slightly reactive clays that do not present significant trouble. Very limited damage could be expected in the life of the building.	0 to 20mm
M	Moderately reactive clays that may cause minor movement and damage in the life of the building. Reasonable care is required in planning the site.	20 to 40mm
H (H1 & H2)	Highly reactive clays have potential to move more, and react to variable moisture change conditions. Some minor damage may occur in the life of the building under normal conditions. More significant damage may occur where site maintenance conditions are a problem e.g. influence of trees or leaking underground plumbing or poor drainage. Particular care is required in planning the site.	**H1** 40 to 60mm **H2** 60 to 75mm
E	Extremely reactive clays have the potential to react significantly to any variable moisture changes in the foundation clays and require significant attention to detail in planning the site works. Extreme movement and damage may occur if the site conditions and foundation maintenance requirements are not observed. Footing systems and site conditions on "E" sites require very detailed specification from an engineer.	>75mm (Note: Movements on **E** sites have been known to move up to and in excess of 100 to 150mm in SE Qld)

Is it normal to expect cracking to occur in brickwork, walls and ceilings?

Yes, damage in varying degrees can be expected in the life of the building depending on the relevant site classification.

If cracking becomes apparent the site maintenance conditions should be checked as noted under "key points to consider..."

Corrective action should be carried out immediately and may include regrading surface drainage, moving gardens and trees or repairing leaks in water supply, stormwater and/or sewer drainage.

A sound plan for a reactive clay site is to provide a consistent moisture regime around the building by installing paths and patios against the house. Locate lawns up against paths & patios. Garden beds, the most heavily watered parts of a garden, should be kept well away from the house.

If gardens must be placed in close proximity to the house, they should be sealed with plastic and contain only a few small plants. Take care not to trap water against the building if using garden edging.

Caution: Care should also be taken if placing filling against the house. Always ensure weep holes are not covered and that existing Termite Management Systems are not compromised.

Key points to consider when planning landscaping to avoid structural damage.

- Plan type and location of gardens, paths, driveways, lawns, filling and retaining walls
- Take care in selection of trees and shrubs. Do not over plant next to the house
- Keep trees with high water demand well away from buildings in reactive clay areas.
- Avoid variable conditions around the house and maintain adequate moisture/watering. Do not ***over*** water and avoid the use of unregulated sprinkler systems.
- Locate ponds and water features away from the house.
- Direct surface water away from the house. Do not allow water to be trapped or pond near the house.
- Repair leaking pipes and taps.

Note: these issues should be considered as part of planning and maintaining the home. Aim to provide a consistent moisture regime around the house. This will minimise soil moisture variations that may cause movement and result in structural damage.

Common sense guidelines for landscaping and gardens

1. Gardens

Important: It is quite impractical to try to prevent gardening activities from increasing the moisture content around the foundations of your home. The only practical course is to keep such activities away from the immediate vicinity of the building and so minimise their effects.

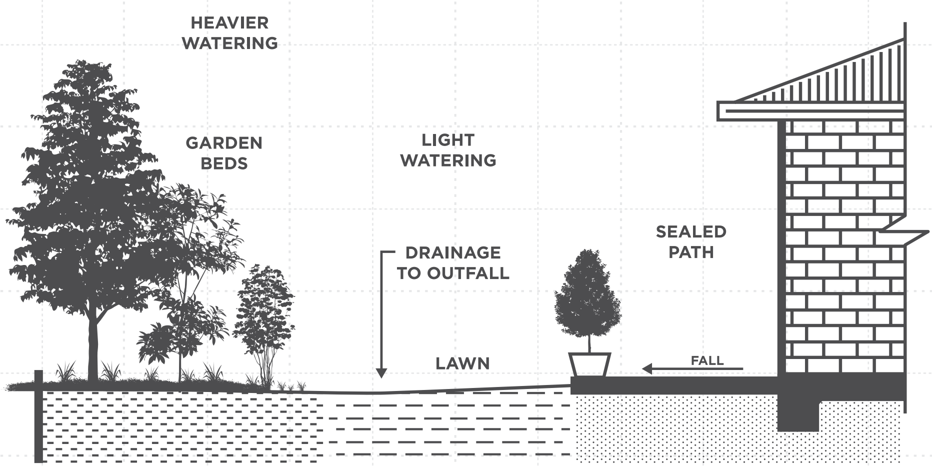
A sound plan for a reactive clay site is to provide a consistent moisture regime around the building by installing paths and patios against the house. Locate lawns up against paths & patios. Garden beds, the most heavily watered parts of a garden, should be kept well away from the house.

If gardens must be placed in close proximity to the house, they should be sealed with plastic and contain only a few small plants. Take care not to trap water against the building if using garden edging.

Caution: Care should also be taken if placing filling against the house. Always ensure weep holes are not covered and that existing Termite Management Systems are not compromised.

RECOMMENDED LAYOUT FOR GARDENS AND LANDSCAPING

Trees and garden beds requiring heavy watering should be kept well removed from the dwelling.



2. Paths, patios and driveways

Paths should be laid hard against brickwork or footings with a fall away from the house to a stormwater discharge point.

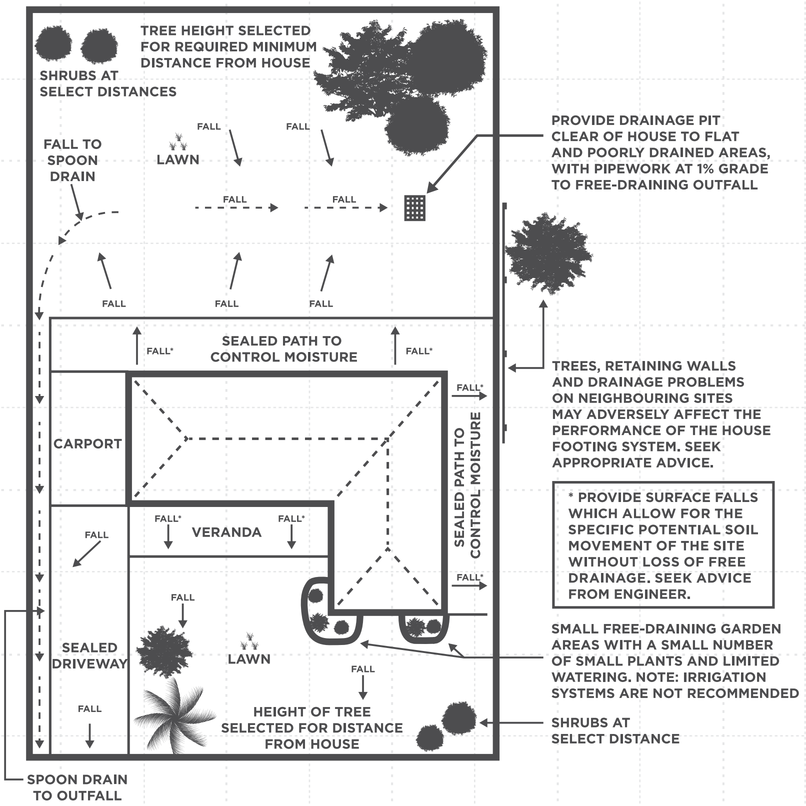
Avoid placing large expanses of concrete on one side of the house and heavily watered garden beds on the other.

The water saturated clay in the gardens will expand and swell while the soil under the concrete may not move. Structural damage can result from this unco-ordinated movement.

Concrete pavements should be constructed in a way that will not impede surface water flowing away from the building or cause water to pond adjacent to the footings causing clay foundations to swell.

On "H" & "E" site classifications, particular detail is required to prevent pavement from moving away from the building. Movement in paths could cause stress on pipes and inspection openings and/or breakages in pipes. Resulting leakages may cause movement and damage as a result of clay soils under the house swelling.

RECOMMENDED LANDSCAPING



3. Lawns

If placing lawn areas against the house, ensure that filling built up against the wall is graded away and will not allow ponding of water to occur. The filling should be impervious clay soil and not sandy loam.

REMEMBER: Do not cover weep holes.

4. Filling

Prior to preparing for gardens, lawns or filling as part of site works, care should be taken to ensure the sub-grade or ground level is graded or sloped away, especially when filling or top dressing with sandy loam. The sub-grade should consist of impervious natural site clay.

Where elevated floors exist ensure that the final finished ground level outside the house is not higher than the sub-floor area and that water cannot flow back under the house.

5. Excessive watering of gardens and lawns

The erection of a building also indirectly brings with it changes in the moisture content to the site. While it is normal to water gardens and lawns, excessive or over watering should be avoided. Consistent and adequate watering should be observed at all times.

The location of sprinkler systems next to houses should also be avoided on H and E sites.

Sprinkler systems should be as well controlled and maintained as practical, and only used in gardens and on lawns away from the building.

6. Site drainage and sloping sites

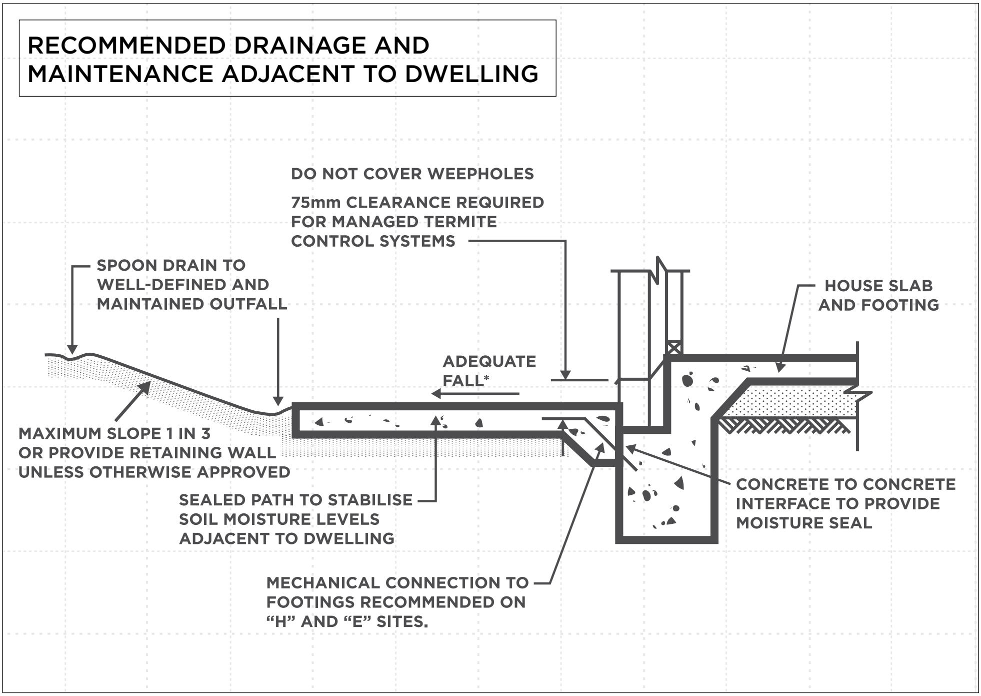
Design for site conditions, location of retaining walls, paths, swimming pools, future structures or proposed extensions etc. should all be considered when preparing the site for correct surface water flow.

If the ground slopes towards the house, paths with spoon drains should be provided.

It is also important to place drains uphill of the footings so as to direct water around the house and away from the footings. A stormwater and roof water drainage management plan should be considered and take into account water flowing from adjoining properties.

Seek advice from an engineer

1. To ascertain surface falls which allow for the specific potential soil movement of the site without loss of free drainage
2. To provide correct mechanical connection of perimeter paths of footings



7. Trees and shrubs

The roots of trees and shrubs can affect footings by removing moisture from clay soils immediately underneath the building causing subsidence as the clays shrink.

In its search for water, a tree root system can spread a lateral distance equal to the height of the tree. If in rows or grouped with other trees the roots may spread up to twice the height of the tree.

Care should be taken when selecting trees and, as a guide, the trees listed should not be planted within the distance of their mature height from the house depending on the site classification and whether they are to be planted in a line or in a group.

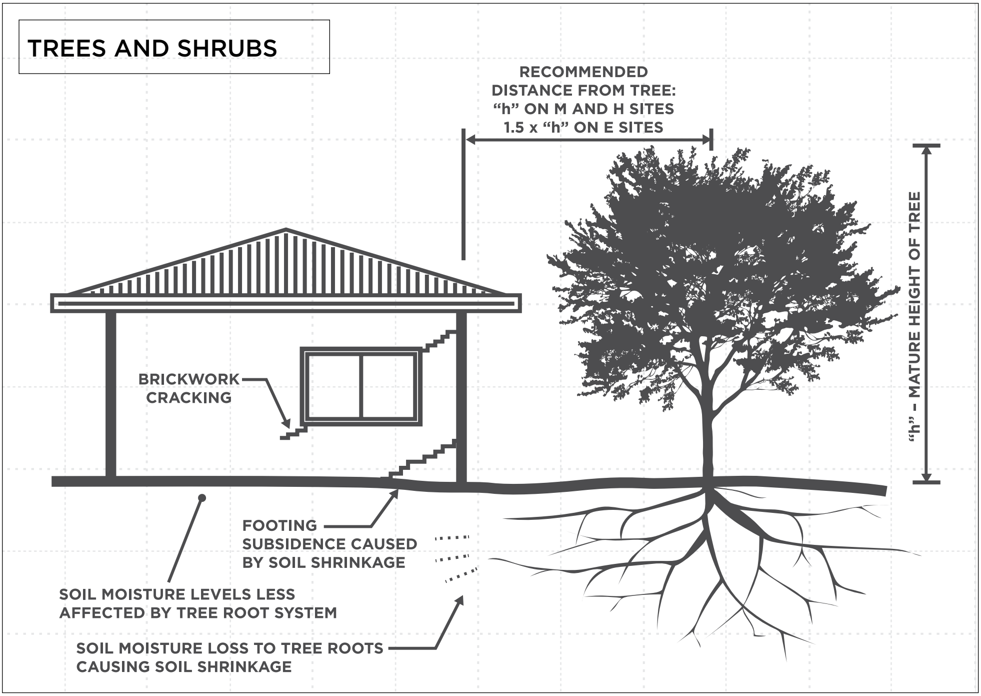
Height of Tree(h)
Distance from house (d)

d = 1 h for class **H** and **M** sites.

d = 1.5 h for class **E** sites.

d = 2 h for rows or groups of trees.

10 to 20 metres	20 to 30 metres	30 to 60 metres
Acacias	But-But	Blue Gum
Ash	Cedars	Cypress
Athel Tree	English Oak	English Elm
Candlebark	Lemon Gum	Figs
Manna Gum	Palms	Karri
Pepper tree	Planes	Pines
Willows	Sheoaks	Poplars
Yate	Silky Oak	River Gum
Yellow Gum	Spotted Gum	Sugar
	Casuarina	



Summary of owner responsibilities for houses under warranty

1. Maintain the site drainage at all times.

2. Do not alter the site drainage provided by the builder. Any changes to the site drainage should ensure that water will be directed away from the building and not pond adjacent to the footing and slab system. Care should also be taken to avoid directing water flow to adjoining properties.

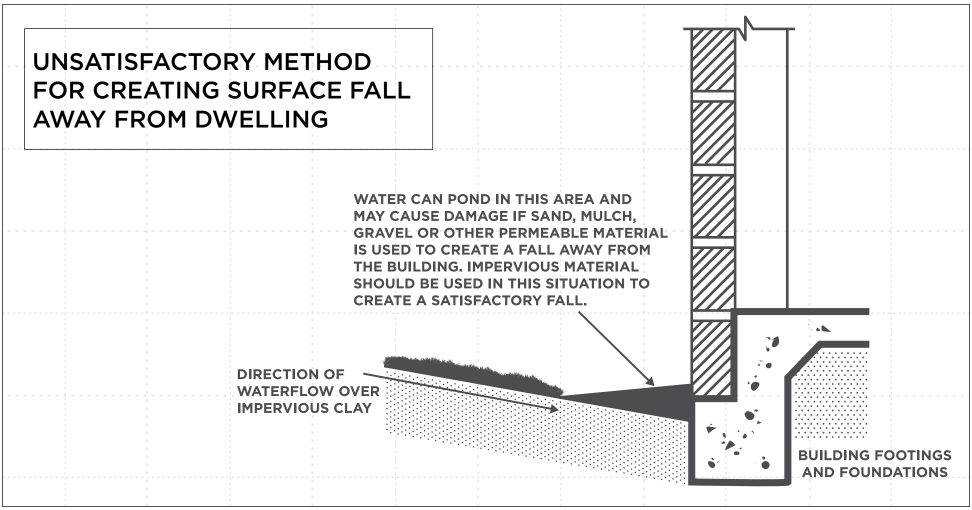
3. Where possible on reactive clay sites (Type M,H,E Classifications), avoid placing gardens or installing garden edging, gravel pavements etc next to the building. This may cause water retention and/or promote a greater variation in moisture conditions around the building.

4. Installation of sprinkler systems next to dwellings on highly and extremely reactive sites (Type H & E Classifications) should be avoided. Adequate and consistent watering only is recommended. Over watering should be avoided.

5. Do not plant trees within a distance from a building that equates to their mature height. Always plant in accordance with the requirements for the relevant site classification.

6. Regularly check and maintain plumbing, drainage and stormwater systems by immediately carrying out repairs to leakages or breakages when observed (usually displayed by seepage and/or greener lawns etc.), or when minor damage or cracking exceeding 3-5mm appears in walls or ceilings.

By observing these requirements, movement and damage which may be expected in the life of the building can be minimised and maintained within normal performance requirements.



Notes:

Note: this document has been developed to provide homeowners with general guidance on the maintenace of their homes. It does not purport to address site specific issues. Homeowners should seek professional advice from their builder or engineer when they experience movement in their home or need advice on issues which may affect their home.

Need more information?

Visit qbcc.qld.gov.au or call us on 139 333.

QBCC20150210_FCTbrstructuraldamageV3

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Appendix D
Landslide Risk Assessment Qualitative Terminology For Use In Assessing Risk To Property

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}	$5\text{x}10^{-2}$	10 years	20 years	The event is expected to occur over the design life.	ALMOST CERTAIN	A
10^{-2}	$5\text{x}10^{-3}$	100 years	200 years	The event will probably occur under adverse conditions over the design life.	LIKELY	B
10^{-3}	$5\text{x}10^{-4}$	1000 years	2000 years	The event could occur under adverse conditions over the design life.	POSSIBLE	C
10^{-4}	$5\text{x}10^{-5}$	10,000 years	20,000 years	The event might occur under very adverse circumstances over the design life.	UNLIKELY	D
10^{-5}	$5\text{x}10^{-6}$	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

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**

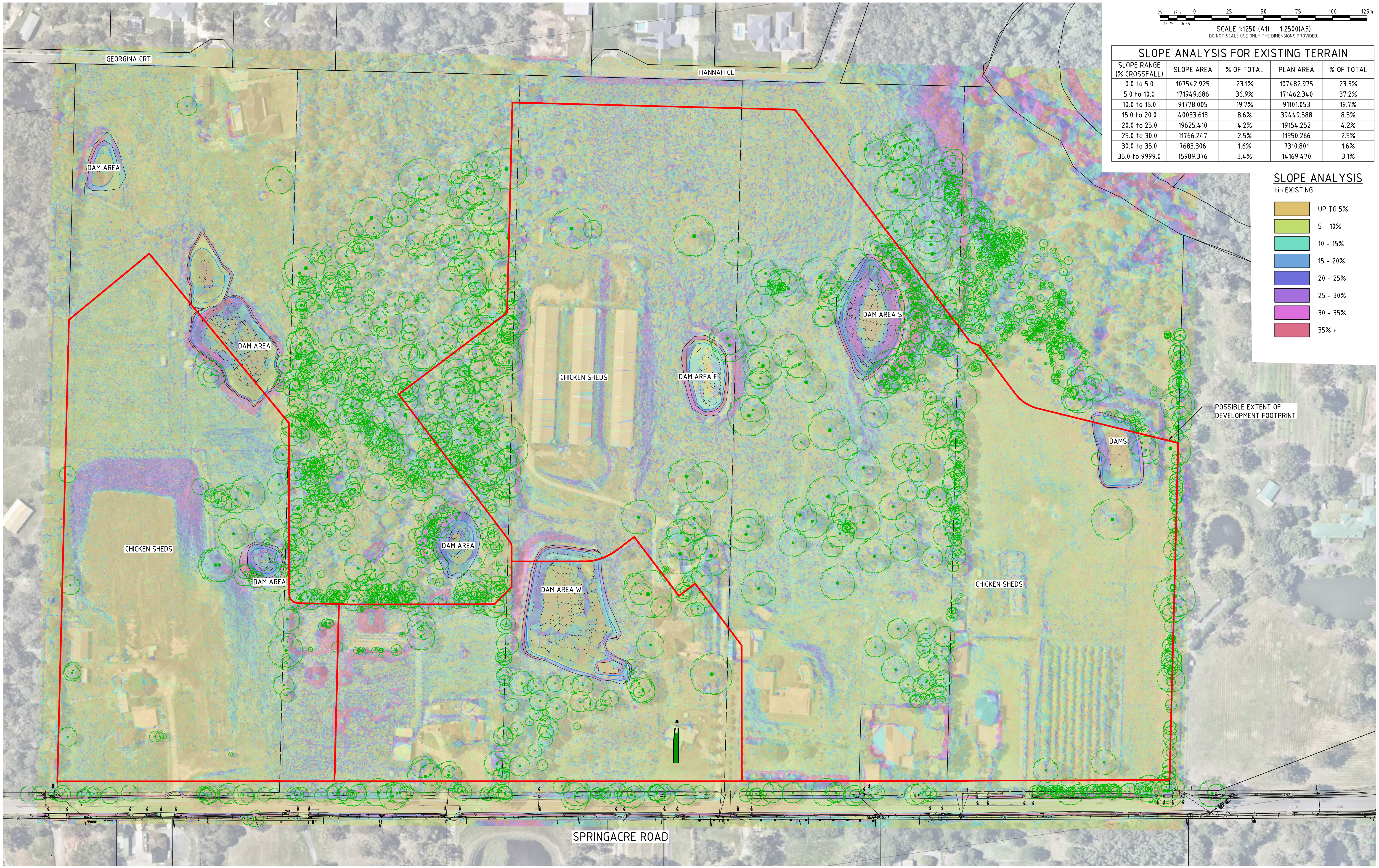
Notes: (5) For Cell A5, may be subdivided such that a consequence of less than 0.1% is Low Risk.
(6) When considering a risk assessment it must be clearly stated whether it is for existing conditions or with risk control measures which may not be implemented at the current time.

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 E
Slope Analysis



SCALE 1:1250 (A1) 1:2500(A3)

DO NOT SCALE USE ONLY THE DIMENSIONS PROVIDED.

SLOPE ANALYSIS FOR EXISTING TERRAIN

SLOPE RANGE (% CROSSFALL)	SLOPE AREA	% OF TOTAL	PLAN AREA	% OF TOTAL
0.0 to 5.0	107542.925	23.1%	107482.975	23.3%
5.0 to 10.0	171949.686	36.9%	171462.340	37.2%
10.0 to 15.0	91778.005	19.7%	91101.053	19.7%
15.0 to 20.0	40033.618	8.6%	39449.588	8.5%
20.0 to 25.0	19625.410	4.2%	19154.252	4.2%
25.0 to 30.0	11766.247	2.5%	11350.266	2.5%
30.0 to 35.0	7683.306	1.6%	7310.801	1.6%
35.0 to 9999.0	15989.376	3.4%	14169.470	3.1%

SLOPE ANALYSIS

tin EXISTING

- UP TO 5%
- 5 - 10%
- 10 - 15%
- 15 - 20%
- 20 - 25%
- 25 - 30%
- 30 - 35%
- 35% +

No.	Amendments	Drawn	Design	Design Chk	Appd	Date
B	MINOR DRAWING REVISIONS	PDW	PDW	PI	PI	26/05/25
A	ORIGINAL ISSUE	MC	PDW	PDW	PI	06/12/23

ENGINEERING CERTIFICATION

Registered Engineer

Date

Registered Accreditation

Mirabel THORNLANDS

EMPOWER

Client: URBEX (SOUTHERN THORNLANDS)

Project: SOUTHERN THORNLANDS

Title: SLOPE ANALYSIS FOR EXISTING TERRAIN (TIN EXISTING)

PRELIMINARY

Datum: AHD PSM - RL - (MGA) COORD

FOR INFORMATION

Project No.	Drawing No.	Rev
	B00702-SK-EF01	B

Plot Date: 26/05/2025 5:37:11 PM
User: PAUL DE WEGER

Appendix F
Limitations

LIMITATIONS

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Conditions may exist which were undetectable given the limited nature of the enquiry Core was retained to undertake with respect to the site. Variations in conditions may occur between investigatory locations, and there may be special conditions pertaining to the site which have not been revealed by the investigation and which have not therefore been taken into account in the Document. Accordingly, additional studies and actions may be required.

In addition, it is recognised that the passage of time affects the information and assessment provided in this Document. Core’s opinions are based upon information that existed at the time of the production of the Document. It is understood that the Services provided allowed Core to form no more than an opinion of the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings, or any laws or regulations.

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