

10 December 2024

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YLess4U

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Proposed Monopole Tower – 45 Perry Lane, Boxers Creek NSW, 2580

Geotechnical Investigation Report

1 Introduction

At the request of YLess4U (the Client), Fortify Geotech Pty Ltd (Fortify) carried out a geotechnical investigation for the proposed monopole tower at 45 Perry Lane, Boxers Creek NSW, 2580 (Figure 1). It is understood that the development consists of the construction of a 12 m high monopole tower which is planned to be constructed approximately 1.5 km away from Hume Highway co-ordinates 32°32'18.5"S 151°57'26.1"E.

To establish the site subsurface conditions, a handheld hydraulic push-tube was used to excavate one borehole, designated BH1. Dynamic Cone Penetrometer (DCP) testing was also conducted at the location of the borehole. Figure 2 demonstrates an aerial photograph showing the approximate borehole and DCP location. The subsurface profile was logged in accordance with the Unified Soil Classification System (USCS) and the borehole logs are attached.

2 Investigation Results

2.1 SUBSURFACE CONDITIONS

The geological information provided by the Department of Regional NSW (Reference 1) indicates the area to be underlain by Eocene Age Crookwell Basalt, which consists of dark grey to black, mostly fine-grained, alkali olivine basalt and dolerite with minor trachyte and lithic welded ignimbrite (Figure 3). A layer of residual soil is expected to overlie the bedrock. Table 1 summarizes the subsurface conditions encountered in BH1.

Table 1: Subsurface Conditions

Geological Profile	Depth Interval	Description
TOPSOIL/ FILL	0m to 0.2m	SILT ; low plasticity, fine grained, orangish brown, trace sand, grass rootlets, dry, stiff.
XW BEDROCK	0.2m to >0.4m	Extremely Weathered (XW) BASALT; recovered as SILT with basalt cobbles and gravels ; dark brown to dark grey and white specs, extremely weathered, fine to coarse gravels, dry, very low strength.

2.2 DYNAMIC CONE PENETROMETER (DCP) TESTING

To determine the relative density/consistency of the subsurface profile, a Dynamic Cone Penetrometer (DCP) test was conducted on 25th November 2024 in accordance with AS1289.6.3.2 "Determination of the penetration resistance of a soil – 9kg dynamic cone penetrometer test". The DCP results are summarized in Table 2 below.

TABLE 2 - DCP Testing Results

Depth below existing ground surface (m)	Blows per 100 mm penetration DCP 1
0.1	10
0.2	15
0.3	17
0.4	21
0.5	25* (refusal)

The results for the DCP tests indicate the subsurface profile to comprise stiff soil to 0.2m depth, underlain by hard material until the termination depth of ~0.5m depth at which the DCP reached refusal.

2.3 GROUNDWATER

Groundwater was not encountered within the 0.4m investigation depth. However, temporary perched seepages may be encountered at shallow depths following rainfall events within the more previous near-surface soils.

3 DISCUSSION & RECOMMENDATIONS

3.1 STRUCTURE FOOTINGS

Footings including thickened sections of slabs forming footings should be taken below the topsoil material and any loose or moisture affected soil and founded in the medium dense or denser residual soils, or into the extremely weathered bedrock. A footing depth of at least ~0.2m depth below existing surface levels is expected.

Recommended allowable end-bearing pressures and shaft adhesion values for various footing systems and likely foundation materials are provided in Table 3.

TABLE 3 – Recommended Allowable End-Bearing Pressures for Footings

Foundation Material Type	Depth Below Existing Surface Level	Allowable End-Bearing Pressure			Allowable Shaft Adhesion on Piles	
		Strips	Pads	Piles	Downward Loading	Uplift
Newly Placed Controlled Fill	-	90kPa`	120kPa	N/A	N/A	N/A
XW Basalt Bedrock	~0.2 m	800kPa	640kPa	N/A	N/A	N/A
HW or Less Weathered Basalt Bedrock	~0.4 m	1,500kPa	1,500kPa	3,000kPa	140kPa	110kPa

It is recommended that footings are inspected by a geotechnical engineer prior to the pouring of concrete to ensure that footings are founded in adequate material.

Ground slabs can be constructed on natural soils or newly placed controlled fill. Following excavation to the required level, slab areas on soil should be proof rolled by a pad foot roller to check for any weak, wet, or deforming soils that may require replacement.

If required for design of ground slabs, a modulus of subgrade reaction of 50kPa/mm can be assumed for a natural soil or controlled fill foundation.

3.2 EXCAVATION CONDITIONS & USE OF EXCAVATED MATERIAL

It is understood that only shallow excavations are required for the proposed development. The excavations are expected to be through existing topsoil and weathered bedrock. The topsoil and extremely weathered bedrock are readily diggable by backhoe and medium sized excavator to at least ~0.5m. Moderately weathered and less weathered bedrock may be encountered below ~0.5m depth and would require heavy excavator, bulldozer ripping and rock hammering.

Any low/medium plasticity natural soils can be used in controlled fill construction of building platforms, provided any rock particles are broken down to <75mm size and the fill is environmentally suitable for re-use on site. Topsoil and existing uncontrolled fill material should not be used in controlled fill construction; however, it can be used for landscaping.

If imported fill is required, a suitable select fill material would include a low or medium plasticity soil such as clayey sand or gravelly clayey sand, containing between 25% and 50% fines less than 0.075mm size (silt and clay), and no particles greater than 75mm size.

3.3 SITE DRAINAGE

Permanent groundwater was not encountered within the investigation depth; the under layer soils was dry. The permanent groundwater table is expected to be below the proposed excavations, although temporary perched seepages may be present following rain.

Suitable surface drainage should be provided to ensure rainfall run-off or other surface water cannot pond against buildings or pavements. Drainage should be provided behind all retaining walls, and subsoil drains should be installed along the upslope sides of access roads and carparks.

Should you require any further information, please contact our office.

Yours faithfully,
Fortify Geotech Pty Ltd

Written by;

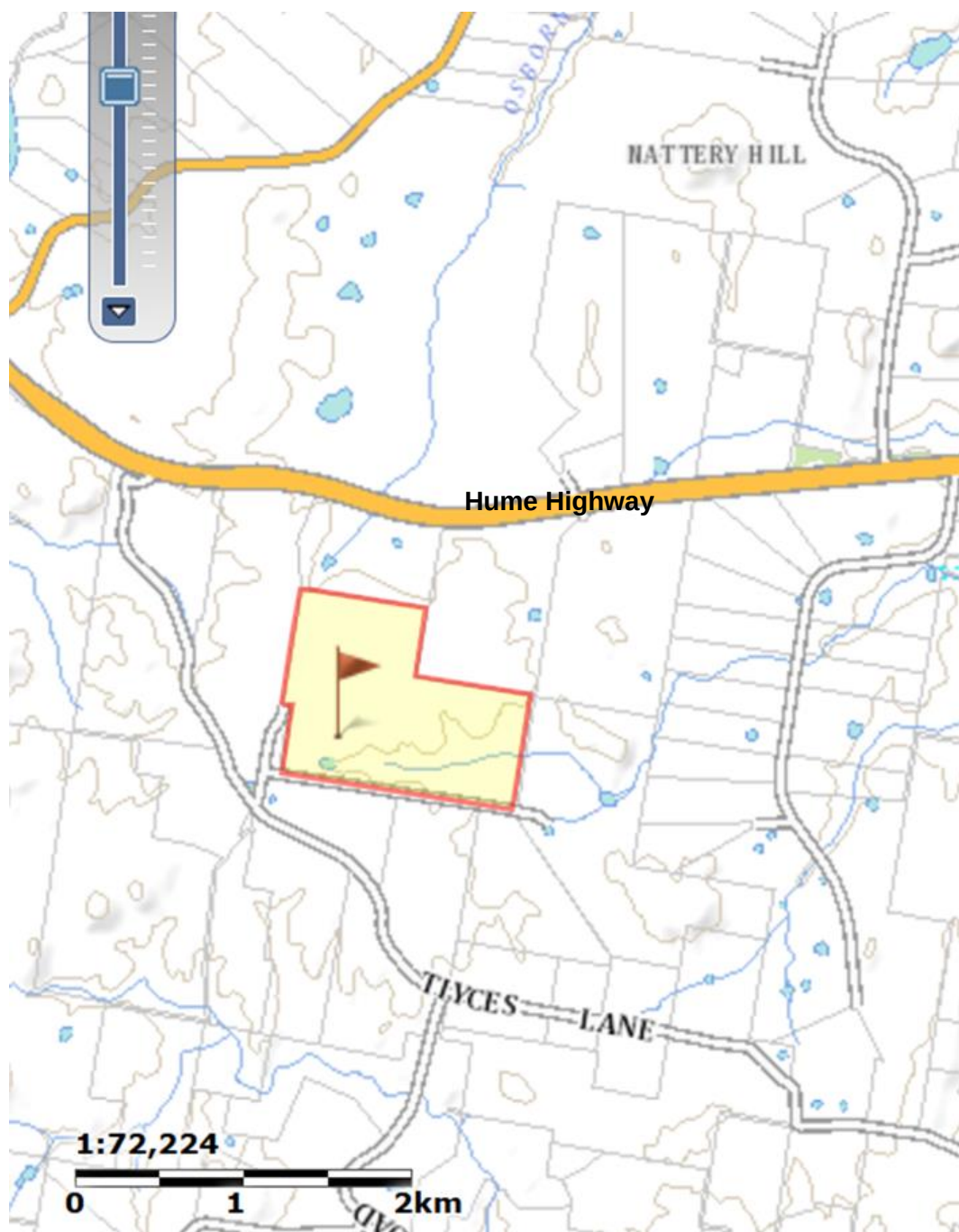


Ellie Mousavi
Geotechnical Engineer
MEngSc (Geotechnical and Civil Engineering)

Reviewed by;



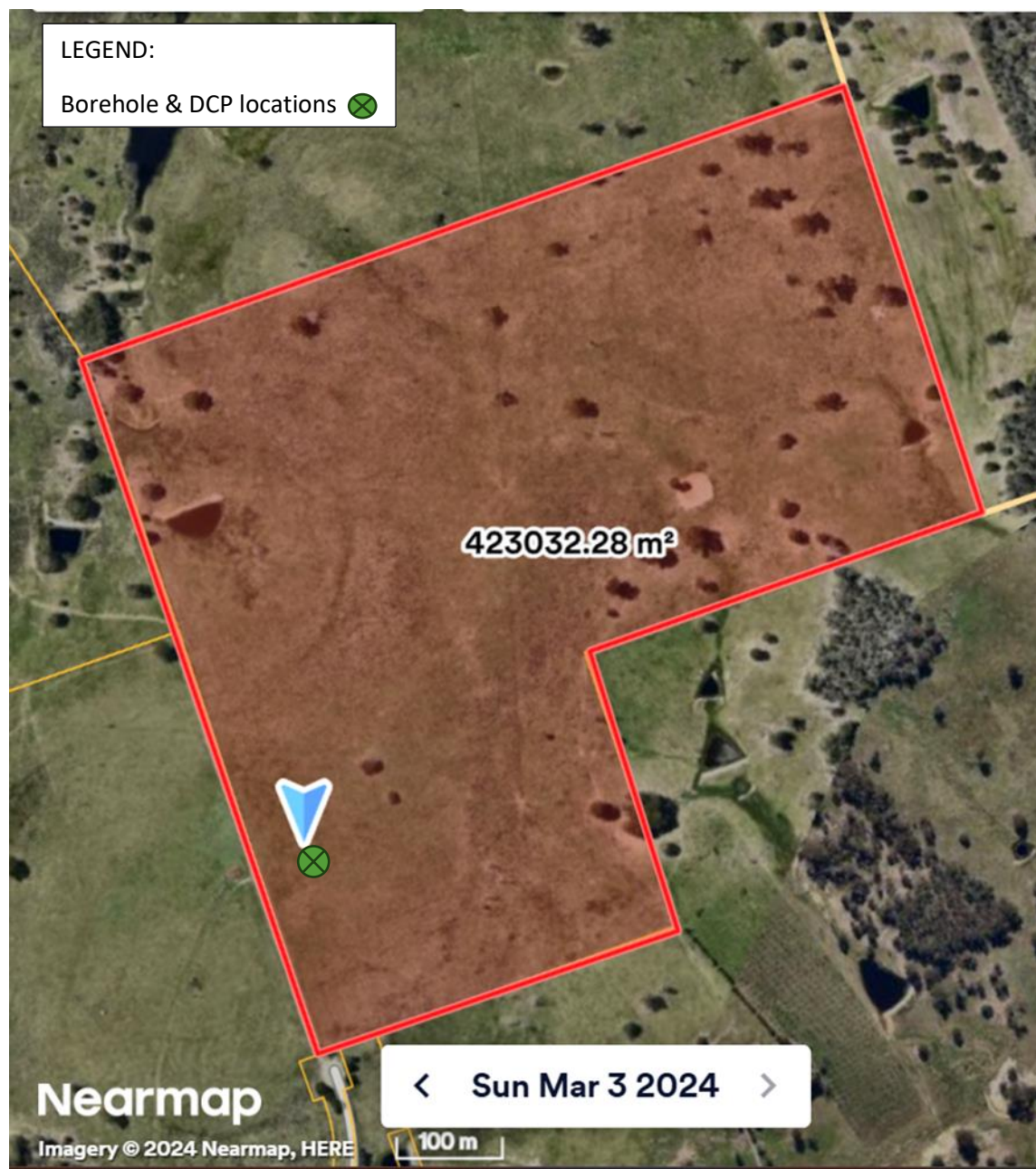
Manuel Neves
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NSW PE Registration # PRE0002314



SITE LOCALITY

S2439.1

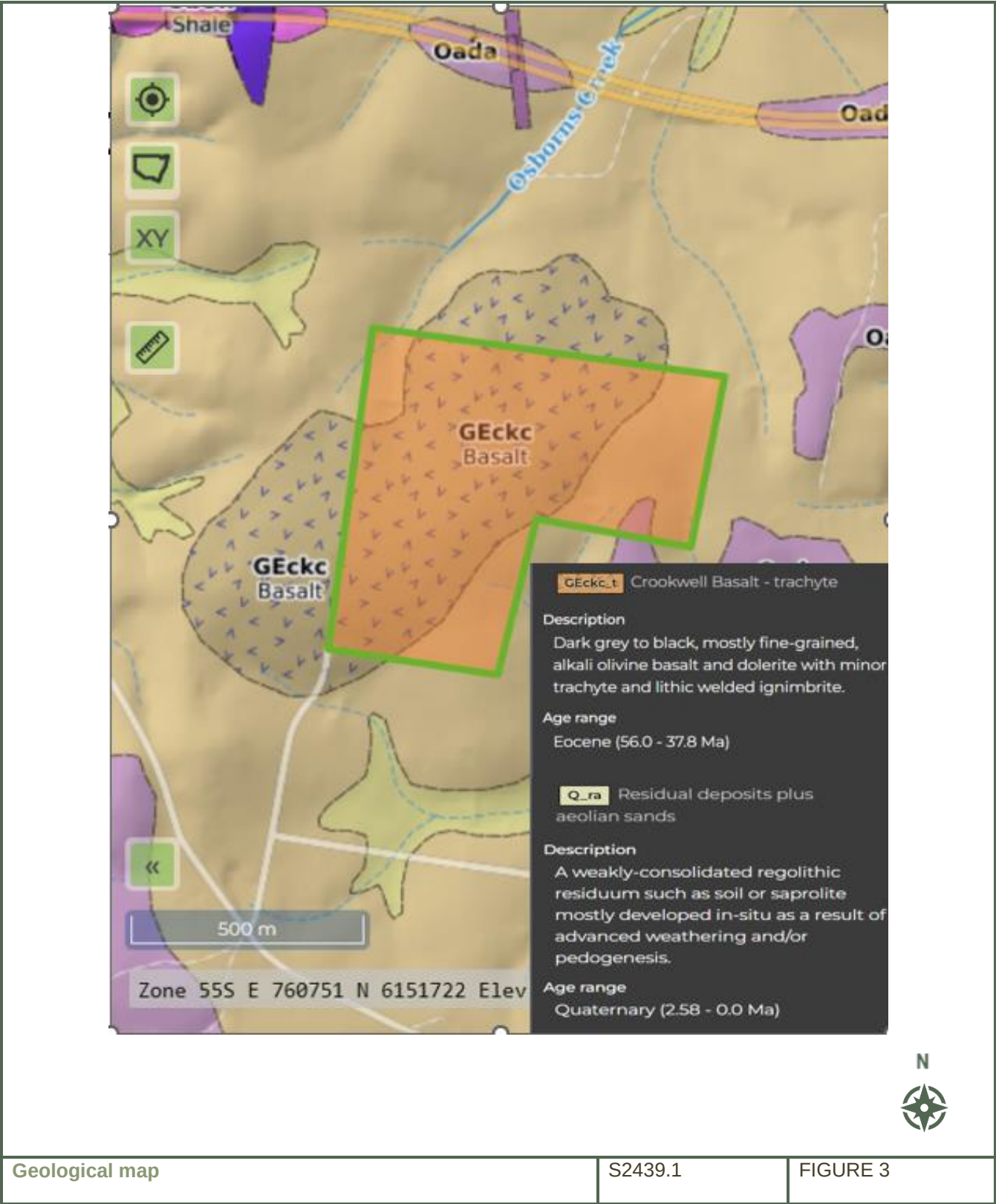
FIGURE 1



AERIAL PHOTOGRAPH AND BOREHOLE/DCP LOCATIONS

S2439.1

FIGURE 2



REFERENCES

- Reference 1 MinView – geological map - <https://minview.geoscience.nsw.gov.au> – Accessed 29/11/2024
- Reference 2 Standards Australia, “AS2870 – Residential Slabs & Footings”, 2011.
- Reference 3 AS3798 - 2007, “Guidelines on earthworks for commercial and residential developments”.

Borehole Log

Borehole No.	BH1
Sheet	1 of 1
Job No.	S2439.4
Location :	Collar Level : Not Known Angle From Vertical : 0° Bearing : N.A.

CLIENT:	YLess4U
PROJECT	Proposed Monopole Tower 139 Towrang Rd, Towrang, NSW, 2425
Equipment Type : Handheld pushtube Hole Diameter : 50mm	

Sample No.	Water	Method/ Casing	RL (m)	Depth (m)	Graphic Log	U.S.C.S.	Material Description, Structure Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure	Moisture Condition	Consistency or Relative Density	Field Test Results	Geological Profile
	None Encountered			0.2	GP-GM		GRAVELLY SILT: very low plasticity, brown with orange spots, with cobbles, grass rootlets.	D	H	DCP 16	TOP SOIL
										13	
					SP-SM		SILT : low plasticity, brownish red with orange, with sand, medium to coarse grained, trace clay.		L	2	
				0.5					H	10	
					SW		SAND: fine to coarse grained sand, brown, grey with dark orange red mottled.		H	25	
				0.8	SC		CLAYEY SAND: fine to coarse grained, light grey with orange and red mottled, low plasticity, trace gravel.	D-M			
				1.0							
				1.1			EXTREMELY WEATHERED SANDSTONE: recovered as CLAYEY SAND, fine to coarse grained, light grey with orange mottled and black specs.	M			EXTREMELY WEATHERED BEDROCK
				1.3			BOREHOLE TERMINATED AT 1.3m Refusal				
				1.5							

Logged By : EM

Date : 25/11/24

Checked By :

Date :

BOREHOLE/EXCAVATION LOG S2439.4-LOGS.GPJ EXC.GDT 9/12/24

Borehole Log

Borehole No.	DCP2
Sheet	1 of 1
Job No.	S2439.4
Location :	
Collar Level : Not Known	
Angle From Vertical : 0°	
Bearing : N.A.	

[illegible]

Logged By : EM

Date : 25/11/24

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Date :

DESCRIPTION AND CLASSIFICATION OF SOIL

The methods of description and classification of soils used in this report are based on the Australian Standard 1726 – 2017, Geotechnical site investigations. In general, soils are described along the following characteristics: soil name, plasticity or behavioural or particle characteristics of the primary soil component, colour, secondary soil components' plasticity or behavioural or particle characteristics, condition, structure, inclusions, strength or density and origin.

GENERAL DEFINITION - SOIL

SOIL In engineering usage, soil is a natural aggregate of mineral grains which can be separated by gentle mechanical means as agitation in water, can be remoulded and can be classified according to the Unified Soil Classification System.

SOIL ORIGIN

Soil origins fall into the following categories:

- Residual soil:** Soils which have been formed in-situ by the chemical weathering of parent rock. These soils no longer retain any visible structure or fabric of the parent soil or rock material.
- Extremely weathered material:** Formed directly from in situ weathering of geological formations. Although this material of soil strength it retains the structure and/or fabric of the parent rock material.
- Alluvial soil:** Deposited by streams and rivers.
- Estuarine soil:** Deposited in coastal estuaries, and including sediments carried by inflowing rivers and streams, and tidal currents.
- Marine soil:** Deposited in a marine environment.
- Lacustrine soil:** Deposited in freshwater lakes.
- Aeolian soil:** Carried and deposited by wind.
- Colluvial soil:** Soil and rock debris transported down slopes by gravity, with or without the assistance of flowing water.
- Topsoil:** Mantle of surface and/or near-surface soil often but not always defined by high levels of organic material, both dead and living.
- Fill:** Any material which has been placed by anthropogenic processes.

SOIL CLASSIFICATION

PARTICLE SIZE DEFINITIONS

Soil components are described according to the predominating particle size, qualified by the grading of other particles present (e.g. sandy clay) on the following basis:

Classification	Components	Subdivision	Particle Size (mm)
Oversize	Boulders		>200
	Cobbles		63 to 200
Coarse grained soil	Gravel	Coarse	19 to 63
		Medium	6.7 to 19
		Fine	2.36 to 6.7
	Sand	Coarse	0.6 to 2.36
		Medium	0.21 to 0.6
		Fine	0.075 to 0.21
Fine grained soil	Silt		0.002 to 0.075
	Clay		<0.002

MOISTURE CONDITION

Coarse Grained Soil		Fine Grained Soil	
Dry (D)	Non-cohesive and free-running.	Moist, dry of plastic limit ($w < W_p$)	Hard and friable or powdery.
Moist (M)	Soil feels cool, darkened in colour. Soil tends to stick together.	Moist, near plastic limit ($w \approx W_p$)	Soils can be moulded at a moisture content approximately equal to the plastic limit.
Wet (W)	As for moist, with free water forming when handled.	Moist, wet of plastic limit ($w > W_p$)	Soils usually weakened and free water forms on hands when handling.
		Wet, near liquid limit ($w \approx W_L$)	Near liquid limit.
		Wet, wet of liquid limit ($w > W_L$)	Wet of liquid limit.

CONSISTENCY/RELATIVE DENSITY

Cohesive soils are classified on the ease by which the soil can be remoulded and can be either assessed in the field by tactile means, by laboratory testing or through mechanical determination methods. Non-cohesive soils are classified on the basis of relative density, generally from the results of in-situ penetration tests and terms for both are defined as below:

Cohesive Soils			Non-cohesive Soils	
Consistency	Indicative Undrained Shear Strength s_u (kPa)	Field Guide to Consistency	Term	Relative Density (%)
Very soft (VS)	≤ 12	Exudes between the fingers when squeezed in hand.	Very Loose (VL)	≤ 15
Soft (S)	$> 12 - \leq 25$	Can be moulded by light finger pressure.	Loose (L)	$> 15 - \leq 35$
Firm (F)	$> 25 - \leq 50$	Can be moulded by strong finger pressure.	Medium Dense (MD)	$> 35 - \leq 65$
Stiff (St)	$> 50 - \leq 100$	Cannot be moulded by fingers.	Dense (D)	$> 65 - \leq 85$
Very Stiff (VSt)	$> 100 - \leq 200$	Can be indented by thumb nail.	Very Dense (VD)	> 85
Hard (H)	> 200	Can be indented with difficulty by thumb nail.		
Friable (Fr)	-	Can be easily crumbled or broken into small pieces by hand.		

MINOR COMPONENTS

Descriptive Term	Assessment Guide	Proportion of minor component in:
With	Easily detectable by visual or tactile means and little difference between general properties and properties of primary component.	Coarse grained soils: Fines – 5 to 12% Accessory coarse component – 15 to 30% Fine grained soils: Coarse component - 15 to 30%
Trace	Detectable by visual or tactile means but little or no difference between general properties and properties of primary component.	Coarse grained soils: Fines – <5% Accessory coarse component – <15% Fine grained soils: Coarse component - <15%

CEMENTATION

Where cementation is present in soils, they can be either weakly cemented where they are easily disaggregated by hand in air or water or moderately cemented where effort is required to disaggregate the soil by hand in air or water.

SAMPLING

Sampling is carried out during drilling to allow engineering examination (and laboratory testing where required) of soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are generally taken by one of two methods:

1. Driving or pushing a thin walled sample tube into the soil and withdrawing with a sample of soil in a relatively undisturbed state.
2. Core drilling using a retractable inner tube (R.I.T.) core barrel.

Such samples yield information on structure and strength in additions to that obtained from disturbed samples and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling are given in the report.

PENETRATION TESTING

The relative density of non-cohesive soils is generally assessed by in-situ penetration tests, the most common of which is the standard penetration test. The test procedure is described in Australian Standard 1289 "Testing Soils for Engineering Purposes" – Test No. F3.1.

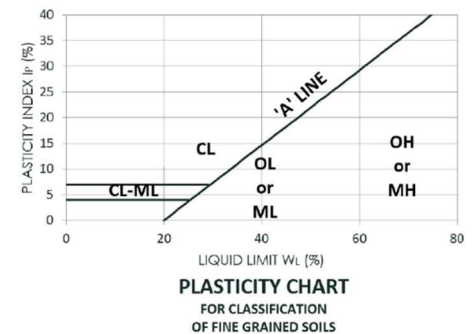
The standard penetration test is carried out by driving a 50mm diameter split tube penetrometer of standard dimensions under the impact of a 63kg hammer having a free fall of 750mm.

The "N" value is determined as the number of blows to achieve 300mm of penetration (generally after disregarding the first 150mm penetration through possibly disturbed material). The results of these tests can be related empirically to the engineering properties of the soil.

The test is also used to provide useful information in cohesive soils under certain conditions, a good quality disturbed sample being recovered with each test. Other forms of in situ testing are used under certain conditions and where this occurs, details are given in the report.

Unified Soil Classification System (Metricated)
Data for Description Identification and Classification of Soils

MAJOR DIVISIONS				DESCRIPTION				FIELD IDENTIFICATION				LABORATORY CLASSIFICATION													
				Group Symbol	Graphic Symbol	TYPICAL NAME	DESCRIPTIVE DATA	GRAVELS AND SANDS			Group Symbol	% < 0.075 mm	PLASTICITY OF FINE FRACTION	Coefficient of Uniformity C_u	Coefficient of Curvature C_c	Notes									
COARSE GRAINED SOILS	More than 65% by dry mass, less than 63mm is greater than 0.075mm.	GRAVELS	More than 50% of coarse grains are greater than 2.36mm.	GW		Well graded gravels and gravel-sand mixtures, little or no fines	Give soil name, indicate approximate percentages of sand and gravel, particle characteristics including particle size subdivision, particle shape, colour, secondary component characteristics and other pertinent descriptive information, symbols in parenthesis.	COARSE GRAINED SOILS	More than 65% of material less than 63mm is greater than 0.075mm.	A 0.075mm particle is about the smallest particle visible to the naked eye.	GOOD	Wide range in grain size	"Clean" materials (not enough fines to bond coarse grains)	None	GW	0-5	-	>4	Between 1 and 3	1. Identify fines by the method given for fine grained soils. 2. For fines contents between 5% and 12%, the soil shall be given a dual classification comprising the two group symbols separated by a dash, e.g. for a gravel with between 5% and 12% silt fines, the classification is GP-GM. 3. Soils that are dominated by boulders, cobbles or peat (Pt) are described separately and are not classified.					
		GP			Poorly graded gravels and gravel-sand mixtures, little or no fines	POOR					Predominantly one size or range of sizes	GP			0-5	-	Fails to comply with above								
		GRAVELLY SOILS		GM		Silty gravels, gravel-sand-silt mixtures					GOOD TO FAIR	"Dirty" materials (Excess of fines)	Fines are silty (1)	None to medium	GM	12-50	Below 'A' line and $I_p > 7$	-	-						
				GC		Clayey gravels gravel-sand-clay mixtures							Fines are clayey (1)	Medium to high	GC	12-50	Above 'A' line and $I_p > 7$	-	-						
		SANDS		SW		Well graded sands and gravelly sands, little or no fines					GOOD	Wide range in grain size	"Clean" materials (not enough fines to bond coarse grains)	None	SW	0-5	-	>6	Between 1 and 3						
				SP		Poorly graded sands, little or no fines										POOR	Predominantly one size or range of sizes	SP	0-5		-	Fails to comply with above			
		SANDY SOILS		SM		Silty sand, sand-silt mixtures					GOOD TO FAIR	"Dirty" materials (Excess of fines)	Fines are silty (1)	None to medium	SM	12-50	Below 'A' line or $I_p < 4$	-	-						
				SC		Clayey sands, sand-clay mixtures							Fines are clayey (1)	Medium to high	SC	12-50	Above 'A' line and $I_p > 7$	-	-						
	FINE GRAINED SOILS	More than 35% by dry mass, less than 63mm is less than 0.075mm.	Liquid Limit less than 50%.	Liquid Limit more than 50%.	ML						Inorganic silts, very fine sands, rock flour, silty or clayey fine sands.	Give soil name, indicate degree and character of plasticity, colour, secondary component characteristics other pertinent descriptive information, symbols in parenthesis. For undisturbed soil add information on structure including zoning, defects and cementing, moisture condition, and consistency. Example: (CI) CLAY, with gravel, red-brown, medium plasticity, very stiff; gravel 20%, fine to medium, sub-rounded; moist, with desiccation cracks; residual.	FINE GRAINED SOILS	More than 35% of material less than 63mm is smaller than 0.075mm.	SILT AND CLAY FRACTION			Use the gradation curve of material passing 63mm for classification of fractions according to criteria for major component.	More than 35% of material is less than 63mm passing 0.075mm.		Below 'A' line	CL	OH or ML	Below 'A' line	PLASTICITY CHART FOR CLASSIFICATION OF FINE GRAINED SOILS
					Fraction smaller than 0.2 mm AS sieve size																				
DRY STRENGTH					DILATANCY	TOUGHNESS																			
None to low					Slow to rapid	Low	ML																		
Medium to high					None to slow	Medium	CL, CI																		
Low to medium					Slow	Low	OL																		
Low to medium					None to slow	Low to medium	MH																		
High to very high		None	High		CH																				
High to high		None to very slow	Low to medium		OH																				
					Pt		Peat muck and other highly organic soils	Readily identified by colour, odour, spongy feel and generally fibrous texture			PT				* Effervescence with H ₂ O ₂										



DESCRIPTION AND CLASSIFICATION OF ROCK

The methods of description and classification of rock used in this report are based on the Australian Standard 1726 – 2017, Geotechnical site investigations. In general, descriptions cover the following properties for rock – rock name, grain size, colour, fabric and texture, inclusions or minor components, moisture content, durability, rock material condition including strength and weathering and/or alteration, defects and geological description.

GENERAL DEFINITIONS – ROCK

ROCK In engineering usage, rock is a natural aggregate of minerals connected by strong and permanent cohesive forces. Since “strong” and “permanent” are subject to different interpretations, the boundary between rock and soil is necessarily an arbitrary one. Rock material is intact rock that is bounded by defects.

DEFECT Discontinuity, fracture, break or void in the material or materials across which there is little or no tensile strength.

STRUCTURE The nature and configuration of the different defects within the rock mass and their relationship to each other.

ROCK MASS The entirety of the system formed by all of the rock material and all the defects that are present.

DESCRIPTIVE TERMS

ROCK NAME Simple rock names are used rather than precise geological classification. Rock names fall into category types of sedimentary rocks, igneous rocks, metamorphic rocks and duricrust rocks.

PARTICLE SIZE

Grain size terms for sedimentary rocks with predominantly sand sized grains are:

Coarse grained – mainly 0.6mm to 2mm.

Medium grained – mainly 0.2mm to 0.6mm.

Fine grained – mainly 0.06mm (just visible) to 0.2mm.

In igneous and metamorphic rock types, where significant, the following terms are used to describe the dominant or average grain size and/or the grain size may be recorded in millimetres:

Coarse grained – mainly greater than 2mm.

Medium grained – mainly 0.06mm to 2mm.

Fine grained – mainly less than 0.06mm (just visible).

If readily identifiable, the minerals should be described.

FABRIC

When the arrangement of grains shows an alignment, a preferred orientation or a layering that is visible, descriptive terms for sedimentary rocks are bedding and lamination. Bedding is layering produced by changes in sedimentation. Lamination is similar to bedding but developed in layer thicknesses of less than 20mm. Fabric descriptive terms for metamorphic rocks are foliation, which is the parallel arrangement of minerals due to metamorphic processes and cleavage, which is a type of foliation developed in fine grained metamorphic rocks such as slates. For igneous rocks, flow banding is a layering produced during flow of a partially solidified igneous rock that causes crystals to become oriented.

INDISTINCT FABRIC

Where layering or fabric is just visible. There is little effect on strength properties.

DISTINCT FABRIC

Where layering or fabric is easily visible. The rock may break more easily parallel to the fabric.

ROCK WEATHERING DEFINITIONS

Extremely Weathered (XW)	Rock substance affected by weathering to the extent that the rock exhibits soil properties, i.e. it can be remoulded and can be classified according to the Unified Soil Classification System, but the texture of the original rock is still evident.
Highly Weathered (HW)	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and other signs of the chemical or physical decomposition are evident. Porosity and strength may be increased or decreased compared to the fresh rock usually as a result of iron leaching or deposition. The colour and strength of the original fresh rock substance is no longer recognisable.
Moderately Weathered (MW)	Rock substance affected by weathering to the extent that staining extends throughout the whole of the rock substance and the original colour of the fresh rock is no longer recognisable.
Slightly Weathered (SW)	Rock substance affected by weathering to the extent that partial staining or discolouration of the rock substance, usually limonite, has taken place. The colour and texture of fresh rock is recognisable.
Fresh (FR)	Rock substance unaffected by weathering.

The degrees of rock weathering may be gradational. Intermediate stages are described by dual symbols with the prominent degree of weathering first (e.g. EW-HW).

The various degrees of weathering do not necessarily define strength parameters as some rocks are of low strength, even when fresh, to the extent that they can be broken by hand across the fabric, and some rocks may increase in strength during the weathering process.

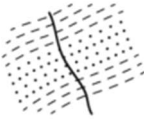
ROCK STRENGTH

Rock strength is defined by the Point Load Strength Index ($I_{s(50)}$) and refers to the strength of the rock substance in the direction normal to the bedding. The test procedure is described by the International Society of Rock Mechanics.

Term	Point Load Strength Index $I_{s(50)}$ MPa	Field Guide	Approx Unconfined Compressive Strength MPa*
Very Low Strength (VL)	0.03 to 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30mm thick can be broken by finger pressure.	0.6 to 2
Low Strength (L)	0.1 to 0.3	Easily scored with a knife; indentations 1mm to 3mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150 mm long by 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.	2 to 6
Medium Strength (M)	0.3 to 1	Readily scored with a knife; a piece of core 150mm long x 50mm dia. can be broken by hand with difficulty.	6 to 20
High Strength (H)	1 to 3	A piece of core 150mm long x 50mm dia. cannot be broken by hand but can be broken by a pick with a single firm blow, rock rings under hammer.	20 to 60
Very High Strength (VH)	3 to 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.	60 to 200
Extremely High Strength (EH)	more than 10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.	more than 200

ROCK DEFECT TYPES

This classification applies to the range of possible rock defect types that are types of natural fractures along which the core is discontinuous. These include bedding plane partings, joints and other rock defects, but exclude known artificial fractures such as drilling breaks.

Term		Description	Diagram
Parting		A surface or crack across which the rock has little or no tensile strength. Parallel or sub-parallel to layering (e.g. bedding) or a planar anisotropy in the rock material (e.g. cleavage). May be open or closed.	
Joint		A surface or crack with no apparent shear displacement across which the rock has little or no tensile strength, but which is not parallel to layering or to planar anisotropy in the rock material. May be open or closed.	
Sheared Surface		A near planar, curved or undulating surface which is usually smooth, polished or slickensided and which shows evidence of shear displacement.	
Sheared Zone		Zone of rock material with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge-shaped blocks.	
Seams	Sheared Seam	Seam of soil material with roughly parallel almost planar boundaries, composed of soil materials with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge-shaped blocks.	
	Crushed Seam	Seam of soil material with roughly parallel almost planar boundaries, composed of disoriented, usually angular fragments of the host rock material which may be more weathered than the host rock. The seam has soil properties.	
	Infilled Seam	Seam of soil material usually with distinct roughly parallel boundaries formed by the migration of soil into an open cavity or joint, infilled seams less than 1mm thick may be described as a veneer or coating on a joint surface.	
	Extremely Weathered Seam	Seam of soil material, often with gradational boundaries. Formed by weathering of the rock material in place.	

The spacing, length (sometimes called persistence), aperture (openness), and seam thickness should generally be described directly in millimetres or metres.

ROCK DEFECT DESCRIPTIONS

DEFECT ROUGHNESS TERMS		DEFECT SHAPE TERMS		DEFECT COATING TERMS	
Term	Description	Term	Description	Term	Description
Very Rough	Many large surface irregularities (amplitude generally more than 1mm). Feels like, or coarser than very coarse sand paper.	Planar	The defect does not vary in orientation.	Clean	No visible coating.
Rough	Many small surface irregularities (amplitude generally less than 1mm). Feels like fine to coarse sand paper.	Curved	The defect has a gradual change in orientation.	Stained	No visible coating but surfaces are discoloured.
Smooth	Smooth to touch. Few or no surface irregularities.	Undulating	The defect has a wavy surface.	Veneer	A visible coating or soil or mineral, too thin to measure; may be patchy.
Polished	Shiny smooth surface.	Stepped	The defect has one or more well defined steps.	Coating	A visible coating up to 1mm thick. Thicker soil material should be described using appropriate defect terms (e.g. infilled seam). Thicker rock strength material should be described as a vein.
Slickensided	Grooved or striated surface, usually polished.	Irregular	The defect has many sharp changes of orientation.		

Limitations in the Use and Interpretation of this Geotechnical Report

Our Professional services were performed, our findings obtained, and our recommendations prepared in accordance with generally accepted engineering principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

The geotechnical report was prepared for the use of the Owner in the design of the subject facility and should be made available to potential contractors/purchasers of the site and/or for information on factual data only. This report should not be used for contractual purposes as a warranty of interpreted subsurface conditions such as those indicated by the interpretive boring and test pit logs, cross- sections, or discussion of subsurface conditions contained herein.

The analyses, conclusions and recommendations contained in the report are based on site conditions as they presently exist and assume that the exploratory borings, test pits, and/or probes are representative of the subsurface conditions of the site. If, during construction, subsurface conditions are found which are significantly different from those observed in the exploratory borings and test pits, or assumed to exist in the excavations, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. If there is a substantial lapse of time between the submission of this report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, this report should be reviewed to determine the applicability of the conclusions and the recommendations considering the changed conditions and time lapse.

The Summary Boring Logs are our opinion of the subsurface conditions revealed by periodic sampling of the ground as the borings progressed. The soil descriptions and interfaces between strata are interpretive and actual changes may be gradual. Groundwater levels often vary seasonally. Groundwater levels reported on the boring logs or in the body of the report are factual data only for the dates shown.

The boring logs and related information depict subsurface conditions only at the specific locations and at the particular time designated on the logs. Soil conditions at the other locations may differ from conditions occurring at these boring locations. Also, the passage of time may result in a change in the soil conditions at these boring locations. In making an assessment of a site from a limited number of boreholes or test pits there is the possibility that variations may occur between test locations.

The data derived from the site investigation program and subsequent laboratory testing are extrapolated across the site to form an inferred geological model and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour with regard to the proposed development. Despite investigation the actual conditions at the site might differ from those inferred to exist, since no subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies. It is recommended that the Owner consider providing a contingency fund to accommodate such potential extra costs.

This firm cannot be responsible for any deviation from the intent of this report including, but not restricted to, any changes to the scheduled time of construction, the nature of the project or the specific construction methods or means indicated in this report: nor can our firm be responsible for any construction activity on sites other than the specific site referred to in this report.