Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
15 Callistemon Close
Warabrook NSW 2304
PO Box 324
Hunter Region Mail Centre NSW 2310
Phone (02) 4960 9600

Memorandum

To	Andrew Fletcher afletcher@surveyorsnorthcoast.com.au	A Fletcher & Associates	
From	Dana Wilson	**Date**	24 Aug 2022
Subject	Interim Results of Groundwater level monitoring Proposed redevelopment of West Yamba Miles and Cox Street, Yamba	**Project No.**	89980.02
		Memo Ref	R.003.Rev0

Monitoring Period	March to July 2022
Monitoring Event	Round 1 interim datalogger download Monitoring to continue three-monthly
Monitoring Locations	Monitoring wells 301, 303, 305, 306 Loggers installed in 302 and 304 in July 2022 and will be downloaded at next quarterly monitoring event Well locations shown on Drawing 1 Bore logs attached
Water Level and Rainfall Plots	Refer Figure 1 (Rev0) It should be noted that groundwater levels are affected by factors such climatic conditions and soil permeability and will therefore vary with time.
Comments	Groundwater levels recorded slightly above ground level for Bores 301, 303, 305 and 306 on 30 March 2022 following/during 162 mm rainfall event. Further trend analysis to be conducted as part of future detailed studies

Douglas Partners Pty Ltd

Dana Wilson

Dana Wilson
Senior Associate

Reviewed by

Scott McFarlane
Principal

Limitations

The above interim advice is provided for the exclusive use of A Fletcher & Associates, agent for Dougherty Bros Pty Ltd. Further details and limitations associated with the work will be provided in our report to follow.

Attachments:
About this Report
Sampling Methods
Soil Descriptions
Symbols and Abbreviations
Borehole Logs (Bores 301 to 306)
Figure 1: Groundwater Level vs Rainfall (March 2022 to July 2022)
Drawing 1 – Test Location Plan

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Sampling Methods

Douglas Partners

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the 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 taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 – 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 – 30%	Clay with sand
Trace	0 - 15%	Clay with trace sand

In coarse grained soils (>65% coarse)
- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)
- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with ‘Mix of Soil and Cobbles/Boulders’ with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	St	50 - 100
Very stiff	VSt	100 - 200
Hard	H	>200
Friable	Fr	-

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;
- Estuarine soil – deposited in coastal estuaries;
- 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;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.
  Soil tends to stick together.
  Sand forms weak ball but breaks easily.
- Wet (W) Soil feels cool, darkened in colour.
  Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- ‘Moist, dry of plastic limit’ or ‘w <PL’ (i.e. hard and friable or powdery).
- ‘Moist, near plastic limit’ or ‘w ≈ PL (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- ‘Moist, wet of plastic limit’ or ‘w >PL’ (i.e. soils usually weakened and free water forms on the hands when handling).
- ‘Wet’ or ‘w ≈LL’ (i.e. near the liquid limit).
- ‘Wet’ or ‘w >LL’ (i.e. wet of the liquid limit).

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

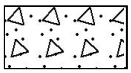
Symbols & Abbreviations

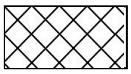
Graphic Symbols for Soil and Rock

General

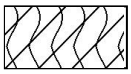

Asphalt

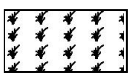

Road base

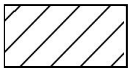

Concrete

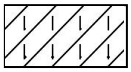

Filling

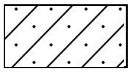
Soils


Topsoil

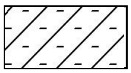

Peat

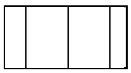

Clay

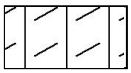

Silty clay

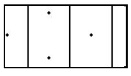

Sandy clay

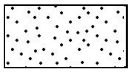

Gravelly clay

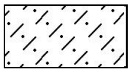

Shaly clay

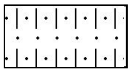

Silt


Clayey silt


Sandy silt

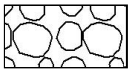

Sand

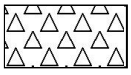

Clayey sand


Silty sand


Gravel

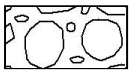

Sandy gravel


Cobbles, boulders

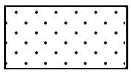

Talus

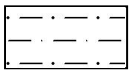
Sedimentary Rocks

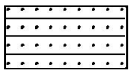

Boulder conglomerate

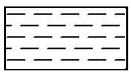

Conglomerate


Conglomeratic sandstone

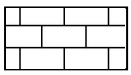

Sandstone


Siltstone

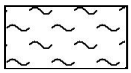

Laminite

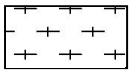

Mudstone, claystone, shale

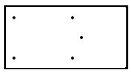

Coal


Limestone

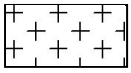
Metamorphic Rocks

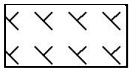

Slate, phyllite, schist

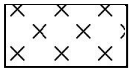

Gneiss

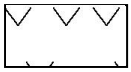

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.46 AHD
EASTING: 532341.2
NORTHING: 6743904.6
DIP/AZIMUTH: 90°/--

BORE No: 301
PROJECT No: 89980.02
DATE: 16/2/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	FILL - Silty sand, moist		D	0.1	E			Stickup = 0.78m From 0m to 0.2m, concrete From 0m to 0.4m, 50mm Diameter Class 18 PVC blank From 0.2m to 0.4m, bentonite
	0.6	CLAY - Orange-brown, possible fill, M>Wp		D	0.5	E		▼	
	1	SAND - Light grey, fine to medium grained, saturated		D	1.0	E			From 0.4m to 2.9m, gravel From 0.4m to 2.9m, 50mm Diameter Class 18 PVC Screen
	2			D	1.5	E			
	2.5	Trace silt from 2.5m SILTY SAND - Brown, fine to medium (possibly indurated), saturated		D	2.0	E			
	3			D	2.5	E			End Cap
	3.0	Bore discontinued at 3.0m, limit of investigation		D	3.0	E			

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 3.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.6m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.24 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.38 AHD
EASTING: 532870
NORTHING: 6743768
DIP/AZIMUTH: 90°/--

BORE No: 302
PROJECT No: 89980.02
DATE: 1/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	TOPSOIL - Dark grey clayey silt, M=Wp		D	0.1	E			Stickup = 0.96m From 0m to 0.2m, concrete
		SILTY SAND - Brown, fine to medium, wet		D	0.5	E			From 0.2m to 0.5m, bentonite
								▼	From 0m to 1.45m, 50mm Diameter Class 18 PVC blank
	1.5	SAND - Light grey, fine to medium, saturated		D	1.0	E			From 0.5m to 2.95m, gravel
				D	2.0	E			From 1.45m to 2.95m, Class 18 PVC Screen with stainless steel exterior mesh (pre-packed screen)
	3.0	Bore discontinued at 3.0m, limit of investigation		D	3.0	E			End Cap

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 3.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.8m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.33 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.60 AHD
EASTING: 533071.8
NORTHING: 6743343.9
DIP/AZIMUTH: 90°/--

BORE No: 303
PROJECT No: 89980.02
DATE: 20/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		TOPSOIL - Dark brown sandy silt grass covered, moist		D	0.1	E			Stickup = 0.73m From 0m to 0.2m, concrete
	0.2	SAND - Light grey fine to medium grained sand, moist		D	0.5	E		▼	From 0.2m to 1m, bentonite
	1			D	1.0	E			From 0m to 2.0m, 50mm Diameter Class 18 PVC blank
				D	1.5	E			
	2								From 1.0m to 4.0m, gravel
	3								From 2.0m to 4.0m, 50mm Diameter Class 18 PVC Screen
	3.5	SILTY SAND - Brown, fine to medium indurated							
	4				4.0				End Cap
				S			4,6,8 N = 14		
	4.45	Bore discontinued at 4.45m, limit of investigation			4.45				

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 4.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.6m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.32 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.12 AHD
EASTING: 532978
NORTHING: 6742887
DIP/AZIMUTH: 90°/--

BORE No: 304
PROJECT No: 89980.02
DATE: 30/6/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
1		CLAYEY SILT - Dark grey, M>Wp		D	0.1	E			Stickup = 0.71m From 0m to 0.2m, concrete
	0.2	SAND - Fine to medium, grey, wet							
		From 0.5m, becoming red brown, saturated		D	0.5	E		▼	From 0.2m to 0.8m, bentonite
0	1			D	1.0	E			From 0m to 1.5m, 50mm Diameter Class 18 PVC blank
				D	1.5	E			
-1	2			D	2.0	E			From 0.8m to 3.0m, gravel
									From 1.5m to 3.0m, Class 18 PVC Screen with stainless steel exterior mesh (pre-packed screen)
	3			D	3.0	E			End Cap
-2	3.0	Bore discontinued at 3.0m, limit of investigation							
	4								
-3									

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 3.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.7m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 1.83 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.43 AHD
EASTING: 532668.1
NORTHING: 6743414.3
DIP/AZIMUTH: 90°/--

BORE No: 305
PROJECT No: 89980.02
DATE: 20/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	TOPSOIL / Silty Sand - Dark brown sandy silt, grass covered, moist		D	0.1	E			Stickup = 0.78m From 0m to 0.2m, concrete
		SAND - Light grey fine to medium grained sand, trace silt, wet							From 0.2m to 0.5m, bentonite
		From 0.4m, saturated		D	0.5	E		▼	From 0m to 1.0m, 50mm Diameter Class 18 PVC blank
	1			D	1.0	E			
				D	1.5	E			
	2								From 0.5m to 4.0m, gravel
									From 1.0m to 4.0m, 50mm Diameter Class 18 PVC Screen
	3								
	4				4.0				End Cap
				S			5,7,9 N = 16		
	4.45	Bore discontinued at 4.45m, limit of investigation			4.45				

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 4.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.4m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.21 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.23 AHD
EASTING: 532176.6
NORTHING: 6742969.9
DIP/AZIMUTH: 90°/--

BORE No: 306
PROJECT No: 89980.02
DATE: 16/2/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.3	TOPSOIL - Sandy silt, dark grey, saturated		D	0.1	E		▼	Stickup = 0.89m From 0m to 0.2m, concrete
		SAND - Grey, fine to medium grained, trace silt, saturated		D	0.5	E			From 0m to 0.5m, 50mm Diameter Class 18 PVC blank From 0m to 0.5m, bentonite
	1			D	1.0	E			1
				D	1.5	E			
	2			D	2.0	E			2 From 0.5m to 3.0m, gravel From 0.5m to 3.0m, 50mm Diameter Class 18 PVC Screen
				D	2.5	E			
	3								3 End Cap
	3.0	Bore discontinued at 3.0m, limit of investigation		D	3.0	E			
	4								4

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 3.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

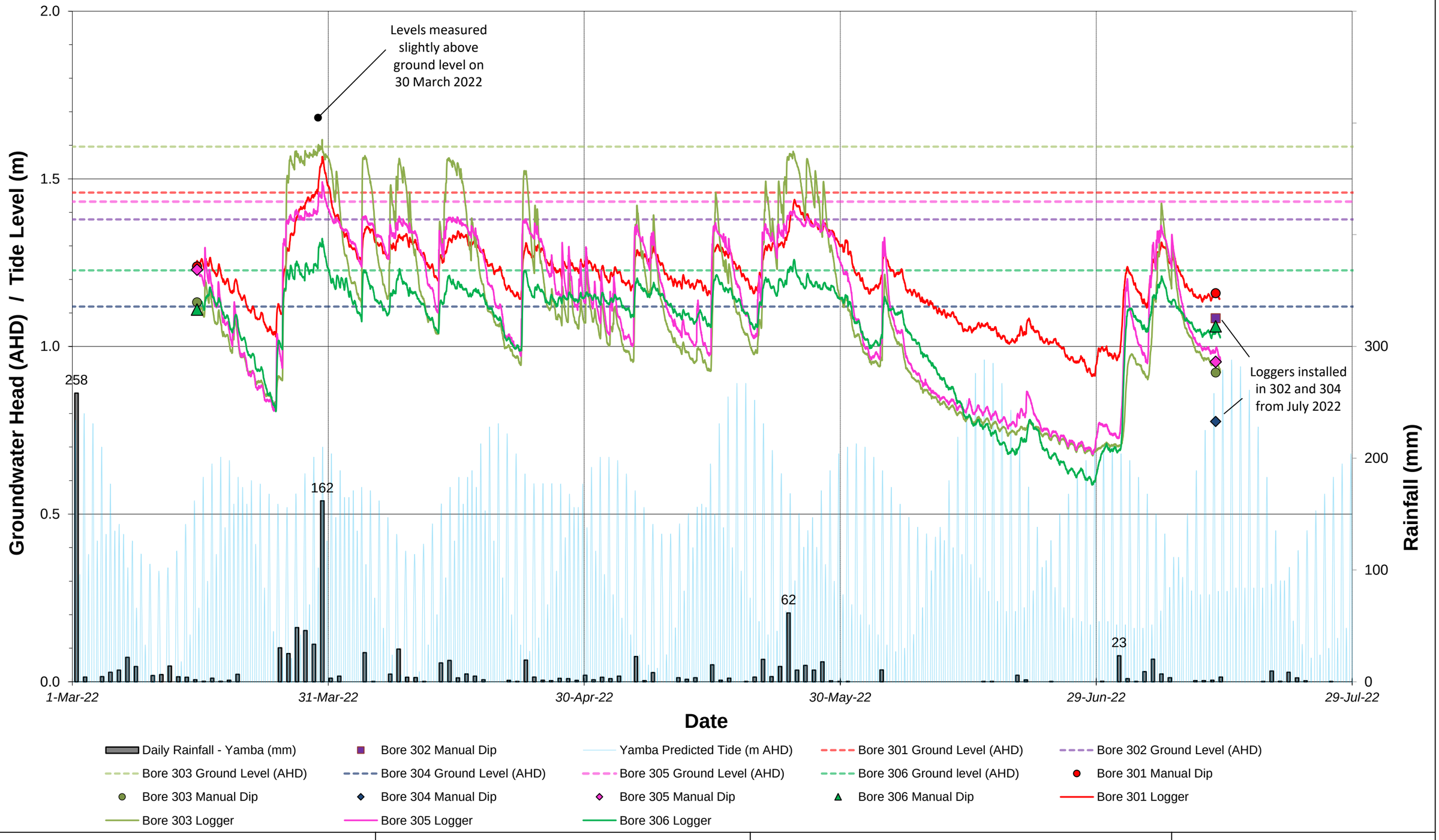
WATER OBSERVATIONS: Free groundwater observed from about 0.2m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.12 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater



Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Dougherty Bros C/- A Fletcher and Associates		**Groundwater Level vs Rainfall (March 2022 to July 2022)** **Proposed Redevelopment of West Yamba** **Miles and Cox Street, Yamba**	PROJECT NO: 89980.02
OFFICE: Newcastle	DRAWN BY: DEW		FIGURE NO: 1
SCALE: N/A	DATE: 24 August 2022		REVISION: 0

Drawing adapted from Metromap Aerial dated 24/04/2020.
Monitoring well locations were located using dGPS.

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Dougherty Bros c/o A Fletcher & Associates	
OFFICE: Newcastle	DRAWN BY: JCL
SCALE: 1:10000 @ A3	DATE: 24.August.2022

TITLE: **Test Location Plan**
Proposed Development of West Yamba
Miles and Cox Street, Yamba

PROJECT:	89980.02
DRAWING No:	1
REVISION:	0

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
15 Callistemon Close
Warabrook NSW 2304
PO Box 324
Hunter Region Mail Centre NSW 2310
Phone (02) 4960 9600

Memorandum

To	Andrew Fletcher afletcher@surveyorsnorthcoast.com.au	A Fletcher & Associates	
From	Dana Wilson	**Date**	19 Jan 2023
Subject	Interim Results of Groundwater Level Monitoring Proposed redevelopment of West Yamba Miles and Cox Street, Yamba	**Project No.**	89980.02
		Memo Ref	R.004.Rev0

Monitoring Period	March 2022 to November 2022
Monitoring Event	Round 2 interim datalogger download Monitoring to continue three-monthly (next event scheduled early Feb 2023)
Monitoring Locations	Monitoring wells 301 to 306 Well locations shown on Drawing 1 Bore logs attached
Water Level and Rainfall Plots	Refer Figure 1 (Rev1) It should be noted that groundwater levels are affected by factors such climatic conditions and soil permeability and will therefore vary with time.
Comments	All loggers operational and seem in good condition. Bore 306 was observed protruding from well monument on 4 November 2022, higher than the initial installation depth (Photo 1). It is possible that the well has been damaged / vandalised between July 2022 (Round 1) and November 2022 (Round 2). The well will be re-inspected / assessed at next monitoring event (Feb 2023) to confirm suitability for continued use or need to re-install if damaged.  **Photo 1: Well 306 protruding from well monument (4 November 2022)**
Next Monitoring Event	February 2023

Please contact the undersigned if you have any questions on this matter.

Douglas Partners Pty Ltd

Reviewed by

Dana Wilson
Senior Associate

Scott McFarlane
Principal

Limitations

The above interim advice is provided for the exclusive use of A Fletcher & Associates, agent for Dougherty Bros Pty Ltd. Further details and limitations associated with the work will be provided in our report to follow.

Attachments:

About this Report
Sampling Methods
Soil Descriptions
Symbols and Abbreviations
Borehole Logs (Bores 301 to 306)
Figure 1: Groundwater Level vs Rainfall (March 2022 to November 2022)
Drawing 1 – Test Location Plan

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Sampling Methods

Douglas Partners

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the 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 taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 – 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 – 30%	Clay with sand
Trace	0 - 15%	Clay with trace sand

In coarse grained soils (>65% coarse)
- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)
- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with ‘Mix of Soil and Cobbles/Boulders’ with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	St	50 - 100
Very stiff	VSt	100 - 200
Hard	H	>200
Friable	Fr	-

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;
- Estuarine soil – deposited in coastal estuaries;
- 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;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.
  Soil tends to stick together.
  Sand forms weak ball but breaks easily.
- Wet (W) Soil feels cool, darkened in colour.
  Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- ‘Moist, dry of plastic limit’ or ‘w <PL’ (i.e. hard and friable or powdery).
- ‘Moist, near plastic limit’ or ‘w ≈ PL (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- ‘Moist, wet of plastic limit’ or ‘w >PL’ (i.e. soils usually weakened and free water forms on the hands when handling).
- ‘Wet’ or ‘w ≈LL’ (i.e. near the liquid limit).
- ‘Wet’ or ‘w >LL’ (i.e. wet of the liquid limit).

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

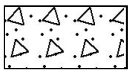
Symbols & Abbreviations

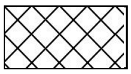
Graphic Symbols for Soil and Rock

General

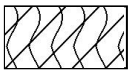

Asphalt

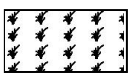

Road base

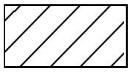

Concrete

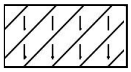

Filling

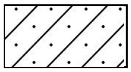
Soils


Topsoil

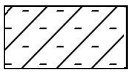

Peat

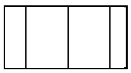

Clay

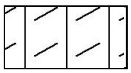

Silty clay

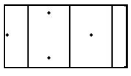

Sandy clay

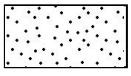

Gravelly clay

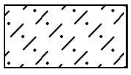

Shaly clay

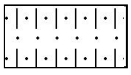

Silt


Clayey silt


Sandy silt

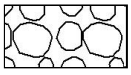

Sand

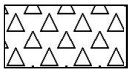

Clayey sand


Silty sand


Gravel

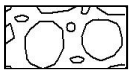

Sandy gravel


Cobbles, boulders

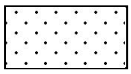

Talus

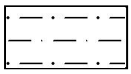
Sedimentary Rocks

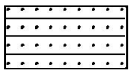

Boulder conglomerate

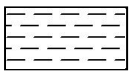

Conglomerate


Conglomeratic sandstone

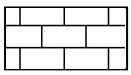

Sandstone


Siltstone

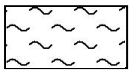

Laminite

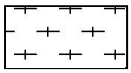

Mudstone, claystone, shale

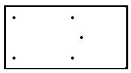

Coal


Limestone

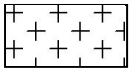
Metamorphic Rocks

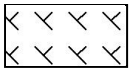

Slate, phyllite, schist

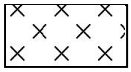

Gneiss

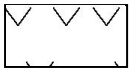

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.46 AHD
EASTING: 532341.2
NORTHING: 6743904.6
DIP/AZIMUTH: 90°/--

BORE No: 301
PROJECT No: 89980.02
DATE: 16/2/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	FILL - Silty sand, moist		D	0.1	E			Stickup = 0.78m From 0m to 0.2m, concrete From 0m to 0.4m, 50mm Diameter Class 18 PVC blank From 0.2m to 0.4m, bentonite
	0.6	CLAY - Orange-brown, possible fill, M>Wp		D	0.5	E		▼	
	1	SAND - Light grey, fine to medium grained, saturated		D	1.0	E			From 0.4m to 2.9m, gravel From 0.4m to 2.9m, 50mm Diameter Class 18 PVC Screen
	2			D	1.5	E			
	2.5	Trace silt from 2.5m SILTY SAND - Brown, fine to medium (possibly indurated), saturated		D	2.0	E			
	3			D	2.5	E			End Cap
	3.0	Bore discontinued at 3.0m, limit of investigation		D	3.0	E			

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 3.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.6m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.24 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.38 AHD
EASTING: 532870
NORTHING: 6743768
DIP/AZIMUTH: 90°/--

BORE No: 302
PROJECT No: 89980.02
DATE: 1/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	TOPSOIL - Dark grey clayey silt, M=Wp		D	0.1	E			Stickup = 0.96m From 0m to 0.2m, concrete
		SILTY SAND - Brown, fine to medium, wet		D	0.5	E			From 0.2m to 0.5m, bentonite
								▼	From 0m to 1.45m, 50mm Diameter Class 18 PVC blank
	1.5	SAND - Light grey, fine to medium, saturated		D	1.0	E			From 0.5m to 2.95m, gravel
				D	2.0	E			From 1.45m to 2.95m, Class 18 PVC Screen with stainless steel exterior mesh (pre-packed screen)
	3.0	Bore discontinued at 3.0m, limit of investigation		D	3.0	E			End Cap

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 3.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.8m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.33 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.60 AHD
EASTING: 533071.8
NORTHING: 6743343.9
DIP/AZIMUTH: 90°/--

BORE No: 303
PROJECT No: 89980.02
DATE: 20/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		TOPSOIL - Dark brown sandy silt grass covered, moist		D	0.1	E			Stickup = 0.73m From 0m to 0.2m, concrete
	0.2	SAND - Light grey fine to medium grained sand, moist		D	0.5	E		▼	From 0.2m to 1m, bentonite
	1			D	1.0	E			From 0m to 2.0m, 50mm Diameter Class 18 PVC blank
				D	1.5	E			
	2								From 1.0m to 4.0m, gravel
	3								From 2.0m to 4.0m, 50mm Diameter Class 18 PVC Screen
	3.5	SILTY SAND - Brown, fine to medium indurated							
	4				4.0				End Cap
				S			4,6,8 N = 14		
	4.45	Bore discontinued at 4.45m, limit of investigation			4.45				

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 4.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.6m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.32 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.12 AHD
EASTING: 532978
NORTHING: 6742887
DIP/AZIMUTH: 90°/--

BORE No: 304
PROJECT No: 89980.02
DATE: 30/6/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
1		CLAYEY SILT - Dark grey, M>Wp		D	0.1	E			Stickup = 0.71m From 0m to 0.2m, concrete
	0.2	SAND - Fine to medium, grey, wet							
		From 0.5m, becoming red brown, saturated		D	0.5	E		▼	From 0.2m to 0.8m, bentonite
0	1			D	1.0	E			From 0m to 1.5m, 50mm Diameter Class 18 PVC blank
				D	1.5	E			
-1	2			D	2.0	E			From 0.8m to 3.0m, gravel
									From 1.5m to 3.0m, Class 18 PVC Screen with stainless steel exterior mesh (pre-packed screen)
	3			D	3.0	E			End Cap
-2	3.0	Bore discontinued at 3.0m, limit of investigation							
	4								
-3									

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 3.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.7m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 1.83 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.43 AHD
EASTING: 532668.1
NORTHING: 6743414.3
DIP/AZIMUTH: 90°/--

BORE No: 305
PROJECT No: 89980.02
DATE: 20/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	TOPSOIL / Silty Sand - Dark brown sandy silt, grass covered, moist		D	0.1	E			Stickup = 0.78m From 0m to 0.2m, concrete
		SAND - Light grey fine to medium grained sand, trace silt, wet							From 0.2m to 0.5m, bentonite
		From 0.4m, saturated		D	0.5	E		▼	From 0m to 1.0m, 50mm Diameter Class 18 PVC blank
	1			D	1.0	E			
				D	1.5	E			
	2								From 0.5m to 4.0m, gravel
									From 1.0m to 4.0m, 50mm Diameter Class 18 PVC Screen
	3								
	4				4.0				End Cap
				S			5,7,9 N = 16		
	4.45	Bore discontinued at 4.45m, limit of investigation			4.45				

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 4.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.4m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.21 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.23 AHD
EASTING: 532176.6
NORTHING: 6742969.9
DIP/AZIMUTH: 90°/--

BORE No: 306
PROJECT No: 89980.02
DATE: 16/2/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.3	TOPSOIL - Sandy silt, dark grey, saturated		D	0.1	E		▼	Stickup = 0.89m From 0m to 0.2m, concrete
		SAND - Grey, fine to medium grained, trace silt, saturated		D	0.5	E			From 0m to 0.5m, 50mm Diameter Class 18 PVC blank From 0m to 0.5m, bentonite
	1			D	1.0	E			1
				D	1.5	E			
	2			D	2.0	E			2 From 0.5m to 3.0m, gravel From 0.5m to 3.0m, 50mm Diameter Class 18 PVC Screen
				D	2.5	E			
	3								3 End Cap
	3.0	Bore discontinued at 3.0m, limit of investigation		D	3.0	E			
	4								4

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 3.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

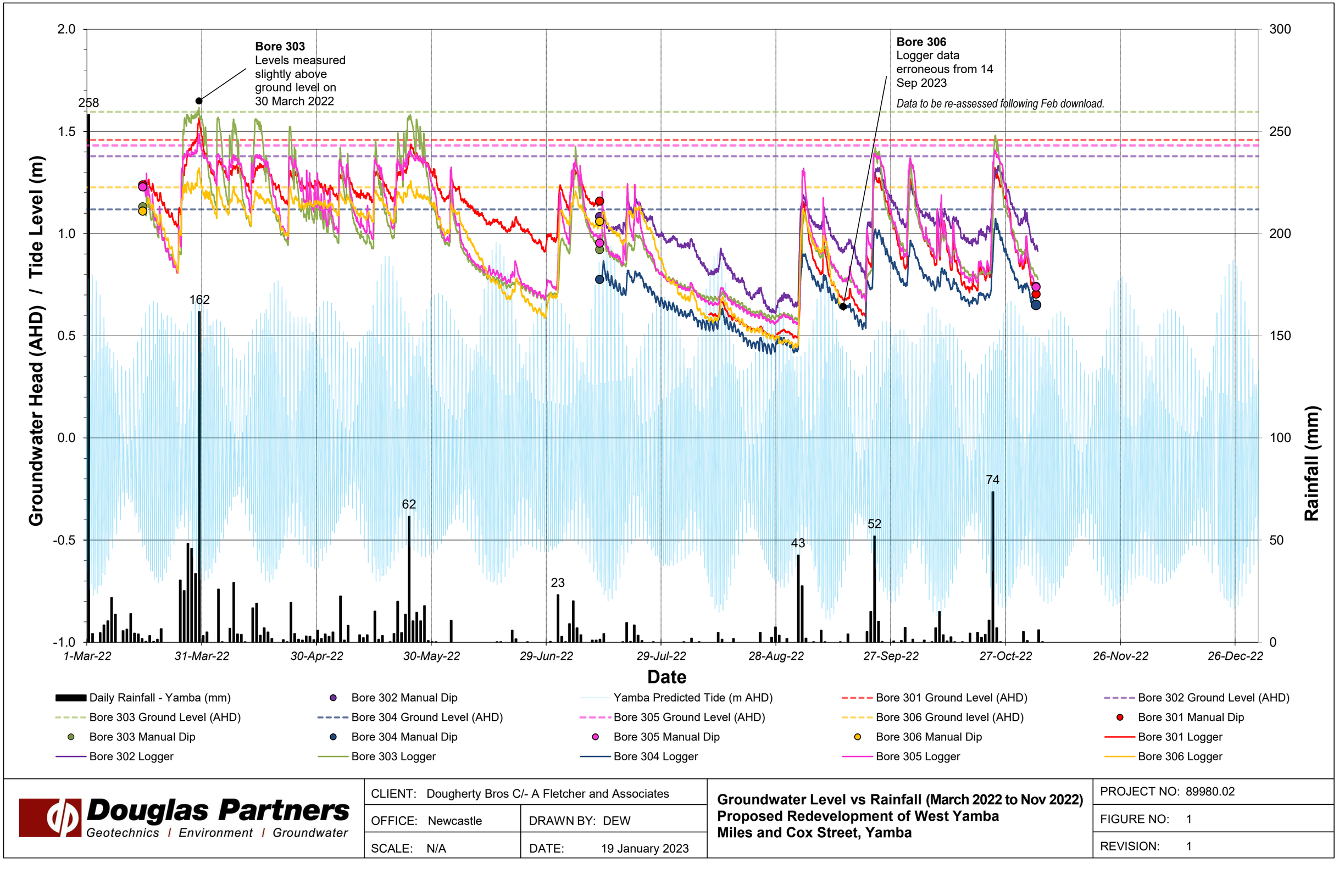
WATER OBSERVATIONS: Free groundwater observed from about 0.2m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.12 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater



Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Dougherty Bros C/- A Fletcher and Associates	**Groundwater Level vs Rainfall (March 2022 to Nov 2022)** **Proposed Redevelopment of West Yamba** **Miles and Cox Street, Yamba**	PROJECT NO: 89980.02
	OFFICE: Newcastle / DRAWN BY: DEW		FIGURE NO: 1
	SCALE: N/A / DATE: 19 January 2023		REVISION: 1

Drawing adapted from Metromap Aerial dated 24/04/2020.
Monitoring well locations were located using dGPS.

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Dougherty Bros c/o A Fletcher & Associates	
OFFICE: Newcastle	DRAWN BY: JCL
SCALE: 1:10000 @ A3	DATE: 24.August.2022

TITLE: **Test Location Plan**
Proposed Development of West Yamba
Miles and Cox Street, Yamba

PROJECT:	89980.02
DRAWING No:	1
REVISION:	0

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
15 Callistemon Close
Warabrook NSW 2304
PO Box 324
Hunter Region Mail Centre NSW 2310
Phone (02) 4960 9600

Memorandum

To	Darryll Smidt	dsmidt@cvsurveys.com.au	CV Surveys	
	Andrew Fletcher	afletcher@cvsurveys.com.au	CV Surveys	
From	Jason Lambert Dana Wilson		**Date**	14 September 2023
Subject	Interim Results of Groundwater Level Monitoring Proposed redevelopment of West Yamba Miles and Cox Street, Yamba		**Project No.**	89980.02
			Memo Ref	R.006.Rev0

Current Monitoring Period	February 2023 to September 2023. (Total monitoring period to date: March 2022 to September 2023 – 18 months)
Monitoring Event	Round 4 interim datalogger download. Monitoring to continue approximately every four months.
Monitoring Locations	Monitoring wells 301 to 306. Well locations shown on Drawing 1. Bore logs attached, including revised Bore 306.
Water Level and Rainfall Plots	Refer Figure 1 (Revision 3) It should be noted that groundwater levels are affected by factors such climatic conditions and soil permeability and will therefore vary with time.
Comments	All loggers operational and seem in good condition. Bore 301 was observed protruding from well monument on 11 September 2023, higher than the installation depth (see Photo 1). The logger data does not indicate any obvious disturbance over the monitoring period. Subsequently, casing of 301 was cut to fit within the monument and surveyed with dGPS. Based on review of data from the recent monitoring event, it considered that the well is suitable for continued monitoring. Bore 306 was observed to be damaged on 11 September 2023, i.e. monument toppled and PVC casing broken (see Photo 2). This may have been from farm machinery and/or cattle. The logger data suggests that this damage occurred on 16 August 2023. DP has repaired the well PVC, re-set the monument in concrete, installed perimeter fencing (see Photo 3) and resurveyed the top of casing level with dGPS. It considered that the well is suitable for continued monitoring.

Site Photos (11/9/2023)	 **Photo 1: Well 301 protruding from monument and cut**  **Photo 2: Well 306 knocked over**  **Photo 3: Well 306 repaired**
Next Monitoring Event	We recommend that monitoring / download events are undertaken approximately every four months with the next event to occur January 2024. Site personnel should inspect monitoring wells monthly to ensure they remain in good condition. Additional barricading / fencing may be required for long term serviceability of wells given the presence of cattle.

Please contact the undersigned if you have any questions on this matter.

Douglas Partners Pty Ltd

Jason Lambert
Geotechnical Engineer

Reviewed by

Scott McFarlane
Principal

Limitations

The above interim advice is provided for the exclusive use of CV Surveys, agent for Dougherty Bros Pty Ltd. Further details and limitations associated with the work will be provided in our report to follow.

Attachments:

About this Report
Sampling Methods
Soil Descriptions
Symbols and Abbreviations
Borehole Logs (Bores 301 to 306)
Figure 1: Groundwater Level vs Rainfall (March 2022 to September 2023)
Drawing 1 – Test Location Plan

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Sampling Methods

Douglas Partners

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the 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 taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 – 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 – 30%	Clay with sand
Trace	0 - 15%	Clay with trace sand

In coarse grained soils (>65% coarse)
- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)
- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with ‘Mix of Soil and Cobbles/Boulders’ with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	St	50 - 100
Very stiff	VSt	100 - 200
Hard	H	>200
Friable	Fr	-

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;
- Estuarine soil – deposited in coastal estuaries;
- 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;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.
  Soil tends to stick together.
  Sand forms weak ball but breaks easily.
- Wet (W) Soil feels cool, darkened in colour.
  Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- ‘Moist, dry of plastic limit’ or ‘w <PL’ (i.e. hard and friable or powdery).
- ‘Moist, near plastic limit’ or ‘w ≈ PL (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- ‘Moist, wet of plastic limit’ or ‘w >PL’ (i.e. soils usually weakened and free water forms on the hands when handling).
- ‘Wet’ or ‘w ≈LL’ (i.e. near the liquid limit).
- ‘Wet’ or ‘w >LL’ (i.e. wet of the liquid limit).

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

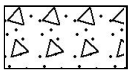
Symbols & Abbreviations

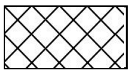
Graphic Symbols for Soil and Rock

General

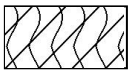

Asphalt

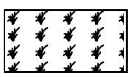

Road base

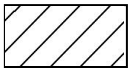

Concrete

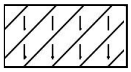

Filling

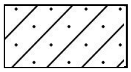
Soils


Topsoil

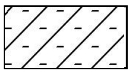

Peat

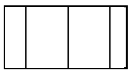

Clay

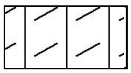

Silty clay

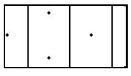

Sandy clay

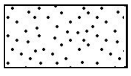

Gravelly clay

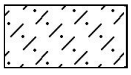

Shaly clay

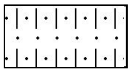

Silt


Clayey silt


Sandy silt

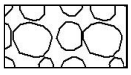

Sand

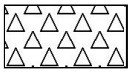

Clayey sand


Silty sand


Gravel

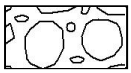

Sandy gravel


Cobbles, boulders

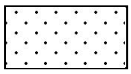

Talus

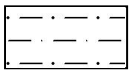
Sedimentary Rocks

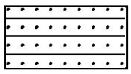

Boulder conglomerate

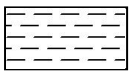

Conglomerate


Conglomeratic sandstone

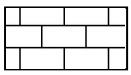

Sandstone


Siltstone

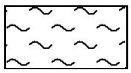

Laminite

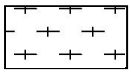

Mudstone, claystone, shale

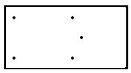

Coal


Limestone

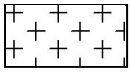
Metamorphic Rocks

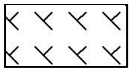

Slate, phyllite, schist

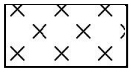

Gneiss

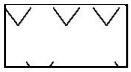

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.46 AHD
EASTING: 532341.2
NORTHING: 6743904.6
DIP/AZIMUTH: 90°/--

BORE No: 301
PROJECT No: 89980.02
DATE: 16/2/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	FILL - Silty sand, moist		D	0.1	E			From 0m to 0.1m, concrete Stickup = 0.64m From 0m to 0.2m, 50mm Diameter Class 18 PVC blank From 0.1m to 0.2m, bentonite
	0.6	CLAY - Orange-brown, possible fill, M>Wp		D	0.5	E		▼	
	1	SAND - Light grey, fine to medium grained, saturated		D	1.0	E			
				D	1.5	E			From 0.2m to 2.7m, gravel From 0.2m to 2.7m, 50mm Diameter Class 18 PVC Screen
	2			D	2.0	E			
	2.5	Trace silt from 2.5m SILTY SAND - Brown, fine to medium (possibly indurated), saturated		D	2.5	E			End Cap
	3								
	3.0	Bore discontinued at 3.0m, limit of investigation		D	3.0	E			
	4								

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 3.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.6m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.21 AHD. Well completed with above ground monument. Levels and well detailed adjusted September 2023 (well lifted above initial installation depth)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.38 AHD
EASTING: 532870
NORTHING: 6743768
DIP/AZIMUTH: 90°/--

BORE No: 302
PROJECT No: 89980.02
DATE: 1/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	TOPSOIL - Dark grey clayey silt, M=Wp		D	0.1	E			Stickup = 0.96m From 0m to 0.2m, concrete
		SILTY SAND - Brown, fine to medium, wet		D	0.5	E			From 0.2m to 0.5m, bentonite
								▼	From 0m to 1.45m, 50mm Diameter Class 18 PVC blank
	1.5	SAND - Light grey, fine to medium, saturated		D	1.0	E			From 0.5m to 2.95m, gravel
				D	2.0	E			From 1.45m to 2.95m, Class 18 PVC Screen with stainless steel exterior mesh (pre-packed screen)
	3.0	Bore discontinued at 3.0m, limit of investigation		D	3.0	E			End Cap

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 3.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.8m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.33 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.60 AHD
EASTING: 533071.8
NORTHING: 6743343.9
DIP/AZIMUTH: 90°/--

BORE No: 303
PROJECT No: 89980.02
DATE: 20/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		TOPSOIL - Dark brown sandy silt grass covered, moist		D	0.1	E			Stickup = 0.73m From 0m to 0.2m, concrete
	0.2	SAND - Light grey fine to medium grained sand, moist		D	0.5	E		▼	From 0.2m to 1m, bentonite
	1			D	1.0	E			From 0m to 2.0m, 50mm Diameter Class 18 PVC blank
				D	1.5	E			
	2								From 1.0m to 4.0m, gravel
	3								From 2.0m to 4.0m, 50mm Diameter Class 18 PVC Screen
	3.5	SILTY SAND - Brown, fine to medium indurated							
	4				4.0				End Cap
				S			4,6,8 N = 14		
	4.45	Bore discontinued at 4.45m, limit of investigation			4.45				

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 4.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.6m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.32 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.12 AHD
EASTING: 532978
NORTHING: 6742887
DIP/AZIMUTH: 90°/--

BORE No: 304
PROJECT No: 89980.02
DATE: 30/6/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
1		CLAYEY SILT - Dark grey, M>Wp		D	0.1	E			Stickup = 0.71m From 0m to 0.2m, concrete
	0.2	SAND - Fine to medium, grey, wet							
		From 0.5m, becoming red brown, saturated		D	0.5	E		▼	From 0.2m to 0.8m, bentonite
0	1			D	1.0	E			From 0m to 1.5m, 50mm Diameter Class 18 PVC blank
				D	1.5	E			
-1	2			D	2.0	E			From 0.8m to 3.0m, gravel
									From 1.5m to 3.0m, Class 18 PVC Screen with stainless steel exterior mesh (pre-packed screen)
	3			D	3.0	E			End Cap
-2	3.0	Bore discontinued at 3.0m, limit of investigation							
	4								
-3									

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 3.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.7m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 1.83 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.43 AHD
EASTING: 532668.1
NORTHING: 6743414.3
DIP/AZIMUTH: 90°/--

BORE No: 305
PROJECT No: 89980.02
DATE: 20/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	TOPSOIL / Silty Sand - Dark brown sandy silt, grass covered, moist		D	0.1	E			Stickup = 0.78m From 0m to 0.2m, concrete
		SAND - Light grey fine to medium grained sand, trace silt, wet							From 0.2m to 0.5m, bentonite
		From 0.4m, saturated		D	0.5	E		▼	From 0m to 1.0m, 50mm Diameter Class 18 PVC blank
	1			D	1.0	E			
				D	1.5	E			
	2								From 0.5m to 4.0m, gravel
									From 1.0m to 4.0m, 50mm Diameter Class 18 PVC Screen
	3								
	4				4.0				End Cap
				S			5,7,9 N = 16		
	4.45	Bore discontinued at 4.45m, limit of investigation			4.45				

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 4.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.4m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.21 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.23 AHD
EASTING: 532176.6
NORTHING: 6742969.9
DIP/AZIMUTH: 90°/--

BORE No: 306
PROJECT No: 89980.02
DATE: 16/2/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
1	0.3	TOPSOIL - Sandy silt, dark grey, saturated		D	0.1	E		▼	From 0m to 0.1m, 50mm Diameter Class 18 PVC blank Stickup = 0.91m From 0m to 0.2m, concrete From 0m to 0.5m, bentonite
		SAND - Grey, fine to medium grained, trace silt, saturated		D	0.5	E			
0	1			D	1.0	E			1
				D	1.5	E			From 0.1m to 2.6m, 50mm Diameter Class 18 PVC Screen From 0.1m to 3.0m, gravel
-1	2			D	2.0	E			2
				D	2.5	E			End Cap
-2	3	3.0 Bore discontinued at 3.0m, limit of investigation		D	3.0	E			3
-3	4								4

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 3.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

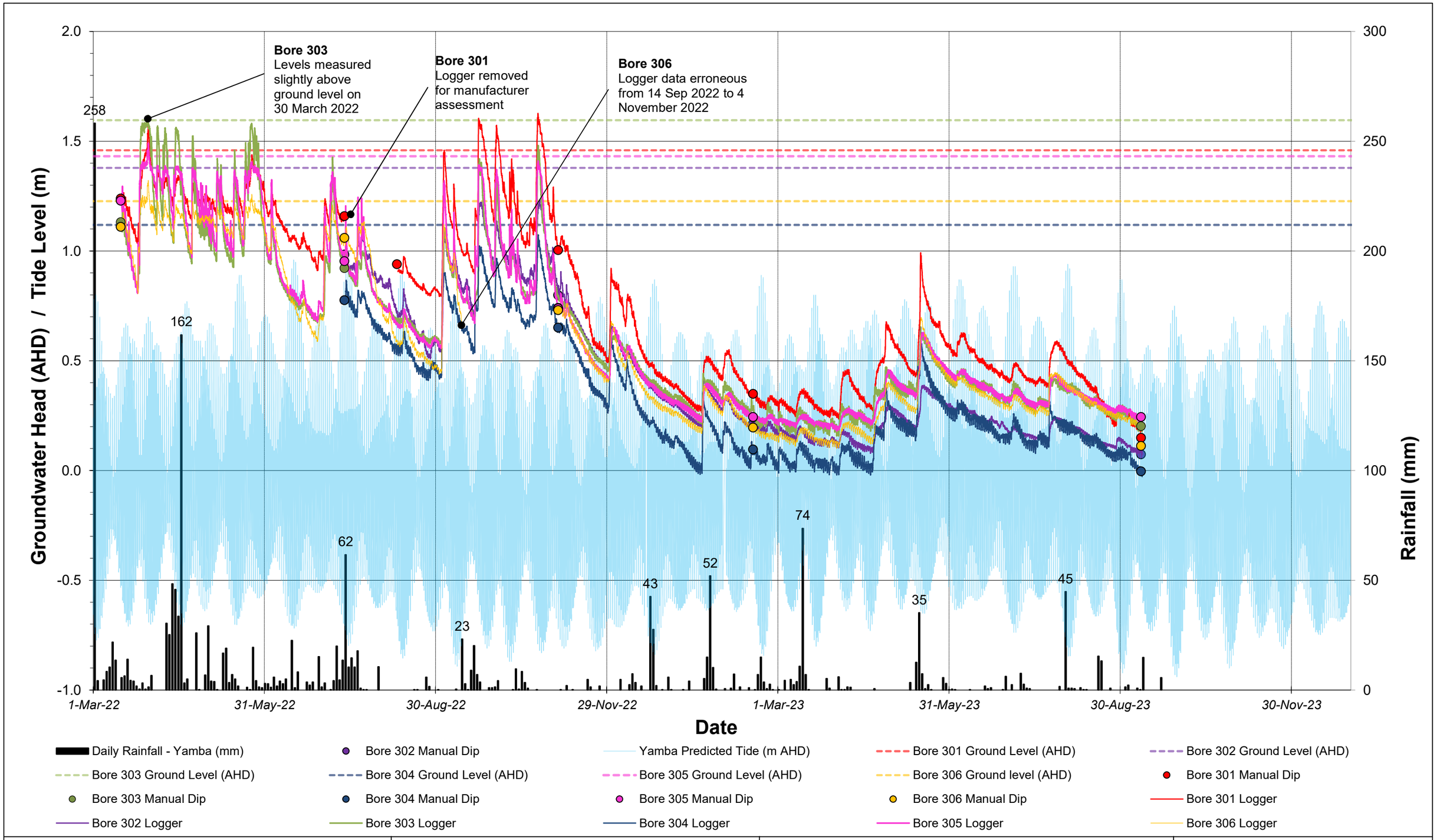
WATER OBSERVATIONS: Free groundwater observed from about 0.2m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.06 AHD. Well completed with above ground monument. Levels and well detailed adjusted September 2023 (well damaged)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater



Douglas Partners *Geotechnics / Environment / Groundwater*	CLIENT: Dougherty Bros C/- A Fletcher and Associates	**Groundwater Level vs Rainfall (Mar 2022 to Sep 2023) Proposed Redevelopment of West Yamba Miles and Cox Street, Yamba**	PROJECT NO: 89980.02
	OFFICE: Newcastle / DRAWN BY: JCL		FIGURE NO: 1
	SCALE: N/A / DATE: 14 September 2023		REVISION: 3

Drawing adapted from Metromap Aerial dated 24/04/2020.
Monitoring well locations were located using dGPS.

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Dougherty Bros c/o A Fletcher & Associates	
OFFICE: Newcastle	DRAWN BY: JCL
SCALE: 1:10000 @ A3	DATE: 24.August.2022

TITLE: **Test Location Plan**
Proposed Development of West Yamba
Miles and Cox Street, Yamba

PROJECT:	89980.02
DRAWING No:	1
REVISION:	0

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
15 Callistemon Close
Warabrook NSW 2304
PO Box 324
Hunter Region Mail Centre NSW 2310
Phone (02) 4960 9600

Memorandum

To	Andrew Fletcher afletcher@surveyorsnorthcoast.com.au	A Fletcher & Associates	
From	Dana Wilson	**Date**	19 Jan 2023
Subject	Interim Results of Groundwater Level Monitoring Proposed redevelopment of West Yamba Miles and Cox Street, Yamba	**Project No.**	89980.02
		Memo Ref	R.004.Rev0

Monitoring Period	March 2022 to November 2022
Monitoring Event	Round 2 interim datalogger download Monitoring to continue three-monthly (next event scheduled early Feb 2023)
Monitoring Locations	Monitoring wells 301 to 306 Well locations shown on Drawing 1 Bore logs attached
Water Level and Rainfall Plots	Refer Figure 1 (Rev1) It should be noted that groundwater levels are affected by factors such climatic conditions and soil permeability and will therefore vary with time.
Comments	All loggers operational and seem in good condition. Bore 306 was observed protruding from well monument on 4 November 2022, higher than the initial installation depth (Photo 1). It is possible that the well has been damaged / vandalised between July 2022 (Round 1) and November 2022 (Round 2). The well will be re-inspected / assessed at next monitoring event (Feb 2023) to confirm suitability for continued use or need to re-install if damaged.  **Photo 1: Well 306 protruding from well monument (4 November 2022)**
Next Monitoring Event	February 2023

Please contact the undersigned if you have any questions on this matter.

Douglas Partners Pty Ltd

Reviewed by

Dana Wilson
Senior Associate

Scott McFarlane
Principal

Limitations

The above interim advice is provided for the exclusive use of A Fletcher & Associates, agent for Dougherty Bros Pty Ltd. Further details and limitations associated with the work will be provided in our report to follow.

Attachments:

About this Report
Sampling Methods
Soil Descriptions
Symbols and Abbreviations
Borehole Logs (Bores 301 to 306)
Figure 1: Groundwater Level vs Rainfall (March 2022 to November 2022)
Drawing 1 – Test Location Plan

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Sampling Methods

Douglas Partners

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the 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 taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 – 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 – 30%	Clay with sand
Trace	0 - 15%	Clay with trace sand

In coarse grained soils (>65% coarse)
- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)
- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with ‘Mix of Soil and Cobbles/Boulders’ with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	St	50 - 100
Very stiff	VSt	100 - 200
Hard	H	>200
Friable	Fr	-

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;
- Estuarine soil – deposited in coastal estuaries;
- 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;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.
  Soil tends to stick together.
  Sand forms weak ball but breaks easily.
- Wet (W) Soil feels cool, darkened in colour.
  Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- ‘Moist, dry of plastic limit’ or ‘w <PL’ (i.e. hard and friable or powdery).
- ‘Moist, near plastic limit’ or ‘w ≈ PL (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- ‘Moist, wet of plastic limit’ or ‘w >PL’ (i.e. soils usually weakened and free water forms on the hands when handling).
- ‘Wet’ or ‘w ≈LL’ (i.e. near the liquid limit).
- ‘Wet’ or ‘w >LL’ (i.e. wet of the liquid limit).

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

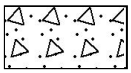
Symbols & Abbreviations

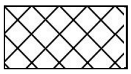
Graphic Symbols for Soil and Rock

General

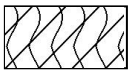

Asphalt

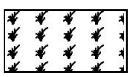

Road base

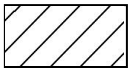

Concrete

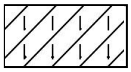

Filling

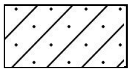
Soils


Topsoil

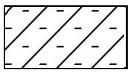

Peat

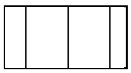

Clay

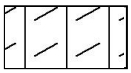

Silty clay

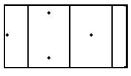

Sandy clay

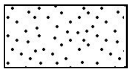

Gravelly clay

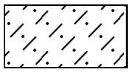

Shaly clay

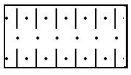

Silt


Clayey silt


Sandy silt

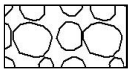

Sand

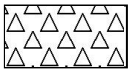

Clayey sand


Silty sand


Gravel

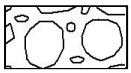

Sandy gravel


Cobbles, boulders

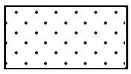

Talus

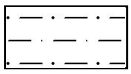
Sedimentary Rocks

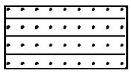

Boulder conglomerate

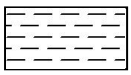

Conglomerate


Conglomeratic sandstone

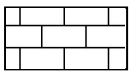

Sandstone


Siltstone

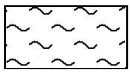

Laminite

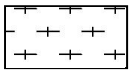

Mudstone, claystone, shale

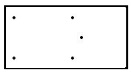

Coal


Limestone

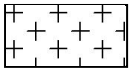
Metamorphic Rocks

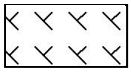

Slate, phyllite, schist

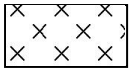

Gneiss

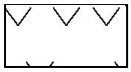

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.46 AHD
EASTING: 532341.2
NORTHING: 6743904.6
DIP/AZIMUTH: 90°/--

BORE No: 301
PROJECT No: 89980.02
DATE: 16/2/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	FILL - Silty sand, moist		D	0.1	E			Stickup = 0.78m From 0m to 0.2m, concrete From 0m to 0.4m, 50mm Diameter Class 18 PVC blank From 0.2m to 0.4m, bentonite
	0.6	CLAY - Orange-brown, possible fill, M>Wp		D	0.5	E		▼	
	1	SAND - Light grey, fine to medium grained, saturated		D	1.0	E			From 0.4m to 2.9m, gravel From 0.4m to 2.9m, 50mm Diameter Class 18 PVC Screen
	2			D	1.5	E			
	2.5	Trace silt from 2.5m SILTY SAND - Brown, fine to medium (possibly indurated), saturated		D	2.0	E			
	3			D	2.5	E			End Cap
	3.0	Bore discontinued at 3.0m, limit of investigation		D	3.0	E			

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 3.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.6m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.24 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.38 AHD
EASTING: 532870
NORTHING: 6743768
DIP/AZIMUTH: 90°/--

BORE No: 302
PROJECT No: 89980.02
DATE: 1/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	TOPSOIL - Dark grey clayey silt, M=Wp		D	0.1	E			Stickup = 0.96m From 0m to 0.2m, concrete
		SILTY SAND - Brown, fine to medium, wet		D	0.5	E			From 0.2m to 0.5m, bentonite
								▼	From 0m to 1.45m, 50mm Diameter Class 18 PVC blank
	1.5	SAND - Light grey, fine to medium, saturated		D	1.0	E			From 0.5m to 2.95m, gravel
				D	2.0	E			From 1.45m to 2.95m, Class 18 PVC Screen with stainless steel exterior mesh (pre-packed screen)
	3.0	Bore discontinued at 3.0m, limit of investigation		D	3.0	E			End Cap

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 3.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.8m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.33 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.60 AHD
EASTING: 533071.8
NORTHING: 6743343.9
DIP/AZIMUTH: 90°/--

BORE No: 303
PROJECT No: 89980.02
DATE: 20/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		TOPSOIL - Dark brown sandy silt grass covered, moist		D	0.1	E			Stickup = 0.73m From 0m to 0.2m, concrete
	0.2	SAND - Light grey fine to medium grained sand, moist		D	0.5	E		▼	From 0.2m to 1m, bentonite
	1			D	1.0	E			From 0m to 2.0m, 50mm Diameter Class 18 PVC blank
				D	1.5	E			
	2								From 1.0m to 4.0m, gravel
	3								From 2.0m to 4.0m, 50mm Diameter Class 18 PVC Screen
	3.5	SILTY SAND - Brown, fine to medium indurated							
	4				4.0				End Cap
				S			4,6,8 N = 14		
	4.45	Bore discontinued at 4.45m, limit of investigation			4.45				

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 4.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.6m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.32 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.12 AHD
EASTING: 532978
NORTHING: 6742887
DIP/AZIMUTH: 90°/--

BORE No: 304
PROJECT No: 89980.02
DATE: 30/6/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
1		CLAYEY SILT - Dark grey, M>Wp		D	0.1	E			Stickup = 0.71m From 0m to 0.2m, concrete
	0.2	SAND - Fine to medium, grey, wet							
		From 0.5m, becoming red brown, saturated		D	0.5	E		▼	From 0.2m to 0.8m, bentonite
0	1			D	1.0	E			From 0m to 1.5m, 50mm Diameter Class 18 PVC blank
				D	1.5	E			
-1	2			D	2.0	E			From 0.8m to 3.0m, gravel
									From 1.5m to 3.0m, Class 18 PVC Screen with stainless steel exterior mesh (pre-packed screen)
	3			D	3.0	E			End Cap
-2	3.0	Bore discontinued at 3.0m, limit of investigation							
	4								
-3									

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 3.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.7m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 1.83 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.43 AHD
EASTING: 532668.1
NORTHING: 6743414.3
DIP/AZIMUTH: 90°/--

BORE No: 305
PROJECT No: 89980.02
DATE: 20/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	TOPSOIL / Silty Sand - Dark brown sandy silt, grass covered, moist		D	0.1	E			Stickup = 0.78m From 0m to 0.2m, concrete
		SAND - Light grey fine to medium grained sand, trace silt, wet							From 0.2m to 0.5m, bentonite
		From 0.4m, saturated		D	0.5	E		▼	From 0m to 1.0m, 50mm Diameter Class 18 PVC blank
	1			D	1.0	E			
				D	1.5	E			
	2								From 0.5m to 4.0m, gravel
									From 1.0m to 4.0m, 50mm Diameter Class 18 PVC Screen
	3								
	4				4.0				End Cap
				S			5,7,9 N = 16		
	4.45	Bore discontinued at 4.45m, limit of investigation			4.45				

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 4.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.4m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.21 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.23 AHD
EASTING: 532176.6
NORTHING: 6742969.9
DIP/AZIMUTH: 90°/--

BORE No: 306
PROJECT No: 89980.02
DATE: 16/2/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.3	TOPSOIL - Sandy silt, dark grey, saturated		D	0.1	E		▼	Stickup = 0.89m From 0m to 0.2m, concrete
		SAND - Grey, fine to medium grained, trace silt, saturated		D	0.5	E			From 0m to 0.5m, 50mm Diameter Class 18 PVC blank From 0m to 0.5m, bentonite
	1			D	1.0	E			1
				D	1.5	E			
	2			D	2.0	E			2 From 0.5m to 3.0m, gravel From 0.5m to 3.0m, 50mm Diameter Class 18 PVC Screen
				D	2.5	E			
	3								3 End Cap
	3.0	Bore discontinued at 3.0m, limit of investigation		D	3.0	E			
	4								4

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 3.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

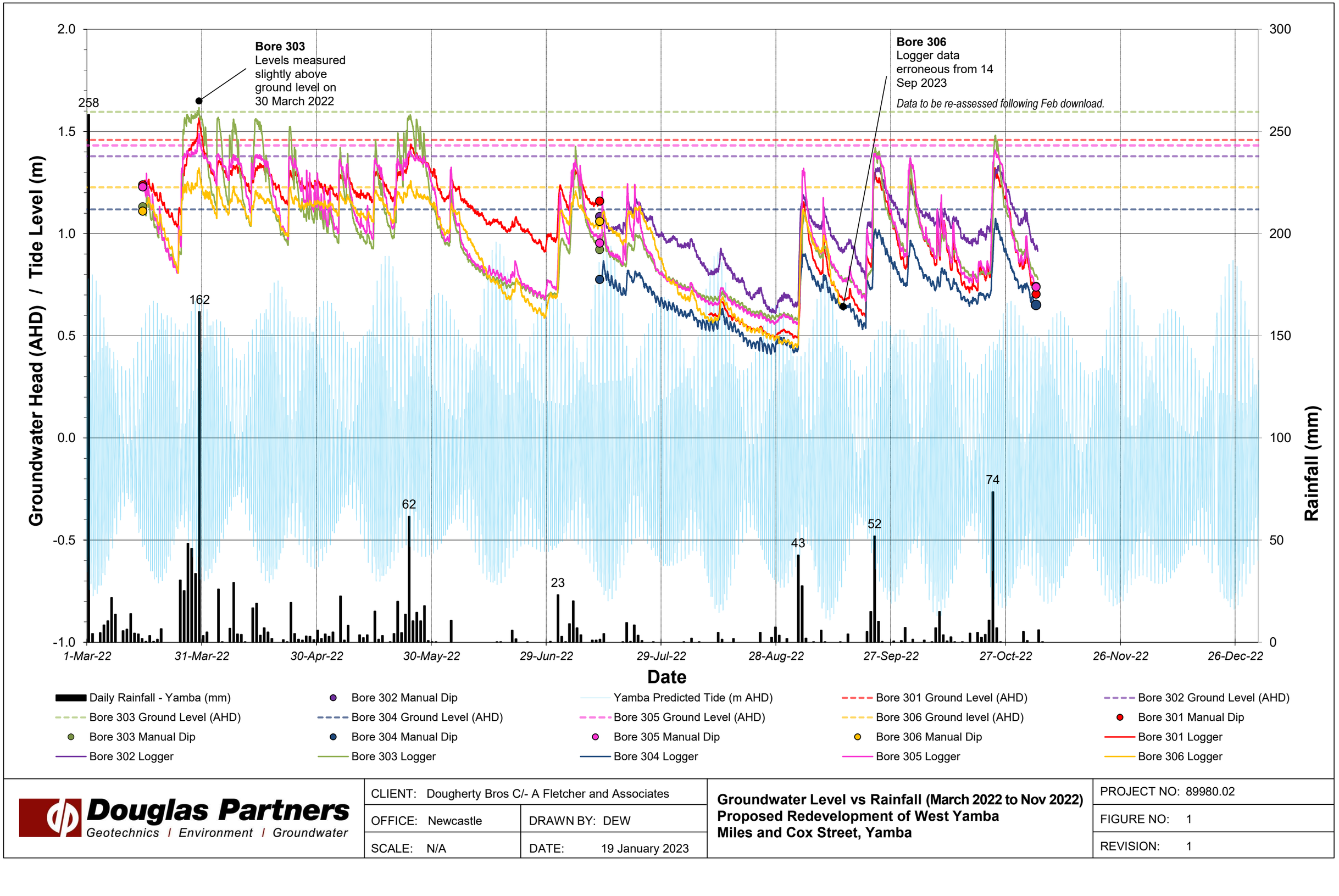
WATER OBSERVATIONS: Free groundwater observed from about 0.2m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.12 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater



Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Dougherty Bros C/- A Fletcher and Associates	**Groundwater Level vs Rainfall (March 2022 to Nov 2022)** **Proposed Redevelopment of West Yamba** **Miles and Cox Street, Yamba**	PROJECT NO: 89980.02
	OFFICE: Newcastle / DRAWN BY: DEW		FIGURE NO: 1
	SCALE: N/A / DATE: 19 January 2023		REVISION: 1

Drawing adapted from Metromap Aerial dated 24/04/2020.
Monitoring well locations were located using dGPS.

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Dougherty Bros c/o A Fletcher & Associates	
OFFICE: Newcastle	DRAWN BY: JCL
SCALE: 1:10000 @ A3	DATE: 24.August.2022

TITLE: **Test Location Plan**
Proposed Development of West Yamba
Miles and Cox Street, Yamba

PROJECT:	89980.02
DRAWING No:	1
REVISION:	0

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
15 Callistemon Close
Warabrook NSW 2304
PO Box 324
Hunter Region Mail Centre NSW 2310
Phone (02) 4960 9600

Memorandum

To	Darryll Smidt	dsmidt@cvsurveys.com.au	CV Surveys	
	Andrew Fletcher	afletcher@cvsurveys.com.au	CV Surveys	
From	Jason Lambert Dana Wilson		**Date**	14 September 2023
Subject	Interim Results of Groundwater Level Monitoring Proposed redevelopment of West Yamba Miles and Cox Street, Yamba		**Project No.**	89980.02
			Memo Ref	R.006.Rev0

Current Monitoring Period	February 2023 to September 2023. (Total monitoring period to date: March 2022 to September 2023 – 18 months)
Monitoring Event	Round 4 interim datalogger download. Monitoring to continue approximately every four months.
Monitoring Locations	Monitoring wells 301 to 306. Well locations shown on Drawing 1. Bore logs attached, including revised Bore 306.
Water Level and Rainfall Plots	Refer Figure 1 (Revision 3) It should be noted that groundwater levels are affected by factors such climatic conditions and soil permeability and will therefore vary with time.
Comments	All loggers operational and seem in good condition. Bore 301 was observed protruding from well monument on 11 September 2023, higher than the installation depth (see Photo 1). The logger data does not indicate any obvious disturbance over the monitoring period. Subsequently, casing of 301 was cut to fit within the monument and surveyed with dGPS. Based on review of data from the recent monitoring event, it considered that the well is suitable for continued monitoring. Bore 306 was observed to be damaged on 11 September 2023, i.e. monument toppled and PVC casing broken (see Photo 2). This may have been from farm machinery and/or cattle. The logger data suggests that this damage occurred on 16 August 2023. DP has repaired the well PVC, re-set the monument in concrete, installed perimeter fencing (see Photo 3) and resurveyed the top of casing level with dGPS. It considered that the well is suitable for continued monitoring.

Site Photos (11/9/2023)	 **Photo 1: Well 301 protruding from monument and cut**  **Photo 2: Well 306 knocked over**  **Photo 3: Well 306 repaired**
Next Monitoring Event	We recommend that monitoring / download events are undertaken approximately every four months with the next event to occur January 2024. Site personnel should inspect monitoring wells monthly to ensure they remain in good condition. Additional barricading / fencing may be required for long term serviceability of wells given the presence of cattle.

Please contact the undersigned if you have any questions on this matter.

Douglas Partners Pty Ltd

Jason Lambert
Geotechnical Engineer

Reviewed by

Scott McFarlane
Principal

Limitations

The above interim advice is provided for the exclusive use of CV Surveys, agent for Dougherty Bros Pty Ltd. Further details and limitations associated with the work will be provided in our report to follow.

Attachments:

About this Report
Sampling Methods
Soil Descriptions
Symbols and Abbreviations
Borehole Logs (Bores 301 to 306)
Figure 1: Groundwater Level vs Rainfall (March 2022 to September 2023)
Drawing 1 – Test Location Plan

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Sampling Methods

Douglas Partners

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the 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 taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 – 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 – 30%	Clay with sand
Trace	0 - 15%	Clay with trace sand

In coarse grained soils (>65% coarse)
- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)
- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with ‘Mix of Soil and Cobbles/Boulders’ with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	St	50 - 100
Very stiff	VSt	100 - 200
Hard	H	>200
Friable	Fr	-

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;
- Estuarine soil – deposited in coastal estuaries;
- 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;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.
  Soil tends to stick together.
  Sand forms weak ball but breaks easily.
- Wet (W) Soil feels cool, darkened in colour.
  Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- ‘Moist, dry of plastic limit’ or ‘w <PL’ (i.e. hard and friable or powdery).
- ‘Moist, near plastic limit’ or ‘w ≈ PL (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- ‘Moist, wet of plastic limit’ or ‘w >PL’ (i.e. soils usually weakened and free water forms on the hands when handling).
- ‘Wet’ or ‘w ≈LL’ (i.e. near the liquid limit).
- ‘Wet’ or ‘w >LL’ (i.e. wet of the liquid limit).

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

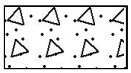
Symbols & Abbreviations

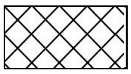
Graphic Symbols for Soil and Rock

General

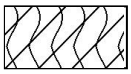

Asphalt

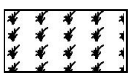

Road base

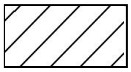

Concrete

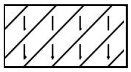

Filling

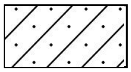
Soils


Topsoil

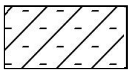

Peat

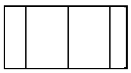

Clay

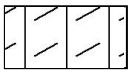

Silty clay

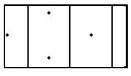

Sandy clay

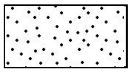

Gravelly clay

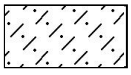

Shaly clay

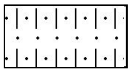

Silt


Clayey silt


Sandy silt

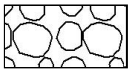

Sand

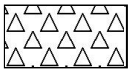

Clayey sand


Silty sand


Gravel

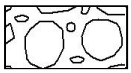

Sandy gravel


Cobbles, boulders

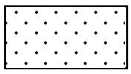

Talus

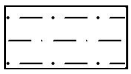
Sedimentary Rocks

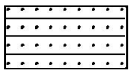

Boulder conglomerate

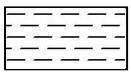

Conglomerate


Conglomeratic sandstone

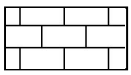

Sandstone


Siltstone

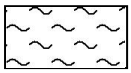

Laminite

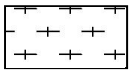

Mudstone, claystone, shale

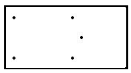

Coal


Limestone

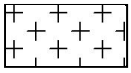
Metamorphic Rocks

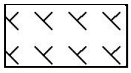

Slate, phyllite, schist

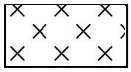

Gneiss

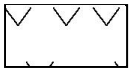

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.46 AHD
EASTING: 532341.2
NORTHING: 6743904.6
DIP/AZIMUTH: 90°/--

BORE No: 301
PROJECT No: 89980.02
DATE: 16/2/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	FILL - Silty sand, moist		D	0.1	E			From 0m to 0.1m, concrete Stickup = 0.64m From 0m to 0.2m, 50mm Diameter Class 18 PVC blank From 0.1m to 0.2m, bentonite
	0.6	CLAY - Orange-brown, possible fill, M>Wp		D	0.5	E		▼	
	1	SAND - Light grey, fine to medium grained, saturated		D	1.0	E			
				D	1.5	E			From 0.2m to 2.7m, gravel From 0.2m to 2.7m, 50mm Diameter Class 18 PVC Screen
	2			D	2.0	E			
	2.5	Trace silt from 2.5m SILTY SAND - Brown, fine to medium (possibly indurated), saturated		D	2.5	E			End Cap
	3								
	3.0	Bore discontinued at 3.0m, limit of investigation		D	3.0	E			
	4								

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 3.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.6m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.21 AHD. Well completed with above ground monument. Levels and well detailed adjusted September 2023 (well lifted above initial installation depth)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.38 AHD
EASTING: 532870
NORTHING: 6743768
DIP/AZIMUTH: 90°/--

BORE No: 302
PROJECT No: 89980.02
DATE: 1/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	TOPSOIL - Dark grey clayey silt, M=Wp		D	0.1	E			Stickup = 0.96m From 0m to 0.2m, concrete
		SILTY SAND - Brown, fine to medium, wet		D	0.5	E			From 0.2m to 0.5m, bentonite
								▼	From 0m to 1.45m, 50mm Diameter Class 18 PVC blank
	1.5	SAND - Light grey, fine to medium, saturated		D	1.0	E			From 0.5m to 2.95m, gravel
				D	2.0	E			From 1.45m to 2.95m, Class 18 PVC Screen with stainless steel exterior mesh (pre-packed screen)
	3.0	Bore discontinued at 3.0m, limit of investigation		D	3.0	E			End Cap

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 3.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.8m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.33 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.60 AHD
EASTING: 533071.8
NORTHING: 6743343.9
DIP/AZIMUTH: 90°/--

BORE No: 303
PROJECT No: 89980.02
DATE: 20/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		TOPSOIL - Dark brown sandy silt grass covered, moist		D	0.1	E			Stickup = 0.73m From 0m to 0.2m, concrete
	0.2	SAND - Light grey fine to medium grained sand, moist		D	0.5	E		▼	From 0.2m to 1m, bentonite
	1			D	1.0	E			From 0m to 2.0m, 50mm Diameter Class 18 PVC blank
				D	1.5	E			
	2								From 1.0m to 4.0m, gravel
	3								From 2.0m to 4.0m, 50mm Diameter Class 18 PVC Screen
	3.5	SILTY SAND - Brown, fine to medium indurated							
	4				4.0				End Cap
				S			4,6,8 N = 14		
	4.45	Bore discontinued at 4.45m, limit of investigation			4.45				

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 4.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.6m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.32 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.12 AHD
EASTING: 532978
NORTHING: 6742887
DIP/AZIMUTH: 90°/--

BORE No: 304
PROJECT No: 89980.02
DATE: 30/6/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
1		CLAYEY SILT - Dark grey, M>Wp		D	0.1	E			Stickup = 0.71m From 0m to 0.2m, concrete
	0.2	SAND - Fine to medium, grey, wet							
		From 0.5m, becoming red brown, saturated		D	0.5	E		▼	From 0.2m to 0.8m, bentonite
0	1			D	1.0	E			From 0m to 1.5m, 50mm Diameter Class 18 PVC blank
				D	1.5	E			
-1	2			D	2.0	E			From 0.8m to 3.0m, gravel
									From 1.5m to 3.0m, Class 18 PVC Screen with stainless steel exterior mesh (pre-packed screen)
	3			D	3.0	E			End Cap
-2	3.0	Bore discontinued at 3.0m, limit of investigation							
	4								
-3									

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 3.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.7m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 1.83 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.43 AHD
EASTING: 532668.1
NORTHING: 6743414.3
DIP/AZIMUTH: 90°/--

BORE No: 305
PROJECT No: 89980.02
DATE: 20/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	TOPSOIL / Silty Sand - Dark brown sandy silt, grass covered, moist		D	0.1	E			Stickup = 0.78m From 0m to 0.2m, concrete
		SAND - Light grey fine to medium grained sand, trace silt, wet							From 0.2m to 0.5m, bentonite
		From 0.4m, saturated		D	0.5	E		▼	From 0m to 1.0m, 50mm Diameter Class 18 PVC blank
	1			D	1.0	E			
				D	1.5	E			
	2								From 0.5m to 4.0m, gravel
									From 1.0m to 4.0m, 50mm Diameter Class 18 PVC Screen
	3								
	4				4.0				End Cap
				S			5,7,9 N = 16		
	4.45	Bore discontinued at 4.45m, limit of investigation			4.45				

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 4.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

WATER OBSERVATIONS: Free groundwater observed from about 0.4m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.21 AHD. Well completed with above ground monument.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Dougherty Bros Pty Ltd c/- A Fletcher
PROJECT: Proposed Development of West Yamba
LOCATION: Miles and Cox Street, Yamba

SURFACE LEVEL: 1.23 AHD
EASTING: 532176.6
NORTHING: 6742969.9
DIP/AZIMUTH: 90°/--

BORE No: 306
PROJECT No: 89980.02
DATE: 16/2/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
1	0.3	TOPSOIL - Sandy silt, dark grey, saturated		D	0.1	E		▼	From 0m to 0.1m, 50mm Diameter Class 18 PVC blank Stickup = 0.91m From 0m to 0.2m, concrete From 0m to 0.5m, bentonite
		SAND - Grey, fine to medium grained, trace silt, saturated		D	0.5	E			
0	1			D	1.0	E			1
				D	1.5	E			From 0.1m to 2.6m, 50mm Diameter Class 18 PVC Screen From 0.1m to 3.0m, gravel
-1	2			D	2.0	E			2
				D	2.5	E			End Cap
-2	3	3.0 Bore discontinued at 3.0m, limit of investigation		D	3.0	E			3
-3	4								4

RIG: Ground Test 100 **DRILLER:** Hickman **LOGGED:** Hickman **CASING:** HW to 3.0m

TYPE OF BORING: Solid flight auger with TC-bit, rotary with mud to termination

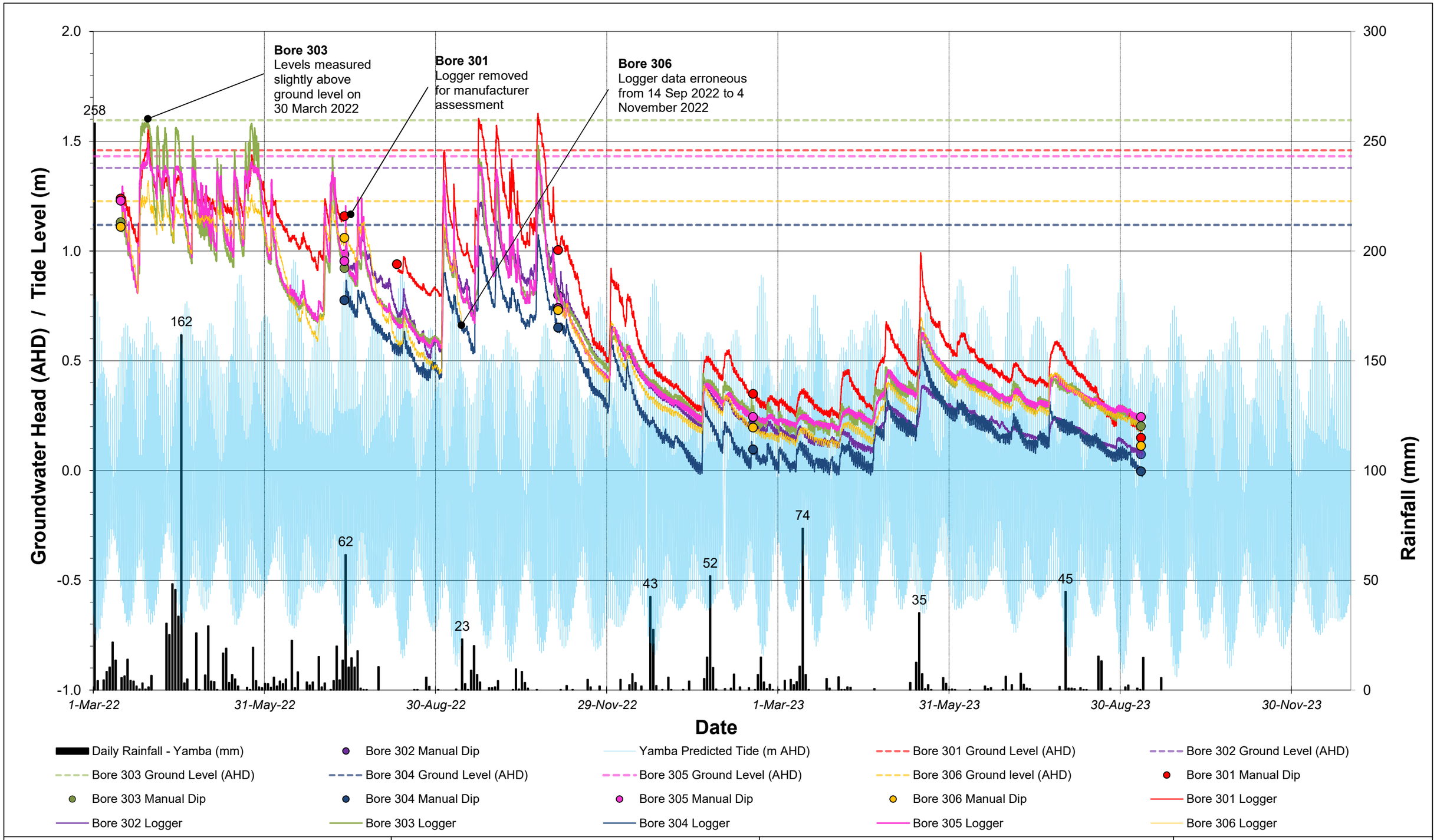
WATER OBSERVATIONS: Free groundwater observed from about 0.2m

REMARKS: Bore flushed following piezometer installation. Top of PVC casing level 2.06 AHD. Well completed with above ground monument. Levels and well detailed adjusted September 2023 (well damaged)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater



Douglas Partners *Geotechnics / Environment / Groundwater*	CLIENT: Dougherty Bros C/- A Fletcher and Associates	**Groundwater Level vs Rainfall (Mar 2022 to Sep 2023) Proposed Redevelopment of West Yamba Miles and Cox Street, Yamba**	PROJECT NO: 89980.02
	OFFICE: Newcastle / DRAWN BY: JCL		FIGURE NO: 1
	SCALE: N/A / DATE: 14 September 2023		REVISION: 3

Drawing adapted from Metromap Aerial dated 24/04/2020.
Monitoring well locations were located using dGPS.

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Dougherty Bros c/o A Fletcher & Associates	
OFFICE: Newcastle	DRAWN BY: JCL
SCALE: 1:10000 @ A3	DATE: 24.August.2022

TITLE: **Test Location Plan**
Proposed Development of West Yamba
Miles and Cox Street, Yamba

PROJECT:	89980.02
DRAWING No:	1
REVISION:	0