Proposed Subdivision
Hereford Hill - Stage 3
Site Classification

Lot 11, DP 1248129,
New England Highway,
Lochinvar

NEW17P-0054B-AD
24 May 2021

LABORATORY (NSW) PTY LTD

GEOTECHNICAL I LABORATORY I EARTHWORKS I QUARRY I CONSTRUCTION MATERIAL TESTING

24 May 2021

McCloy Lochinvar Pty Ltd
Suite 1, Level 3, 426 King Street
NEWCASTLE WEST NSW 2309

Attention: Mr Rylan Gibson

Dear Sir,

RE: PROPOSED SUBDIVISION – HEREFORD HILL, STAGE 3
LOT 11, DP 1248129, NEW ENGLAND HIGHWAY, LOCHINVAR
SITE CLASSIFICATION (LOTS 301 TO 324)

Please find enclosed our geotechnical report for the proposed residential subdivision of Hereford Hill, Stage 3, to be located at Lot 11, DP 1248129 New England Highway, Lochinvar.

The report includes recommendations for Site Classification in accordance with AS2870-2011, "Residential Slabs and Footings" following the completion of site regrading earthworks.

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

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

Jason Lee

Jason Lee
Principal Geotechnical Engineer

Table of Contents:

Attachments:

Figures:	Figure AB1: Site Plan & Approximate Test Pit Locations
ADW Johnson	Drawing Ref. 239591(3)-ENG-501, Rev 1 dated 28/10/2020
Appendix A:	Results of Field Investigations
Appendix B:	Results of Laboratory Testing
Appendix C:	CSIRO Sheet BTF 18

1.0 Introduction

Qualtest Laboratory NSW Pty Ltd (Qualtest) is pleased to present this geotechnical site classification report to McCloy Lochinvar Pty Ltd (McCloy), for Stage 3 of the Hereford Hill residential subdivision located at Lot 11, DP 1248129, New England Highway, Lochinvar.

A preliminary Site Classification has previously been provided for Stages 3 to 5, (Qualtest Report Ref: NEW17P-0054B-AB, 28 October 2020). Based on the brief and drawings provided in an email from McCloy dated 13 May 2021, it is understood the extent of Stage 3 comprises subdivision into 24 residential lots (Lots 301 to 324), as shown on Figure AD1.

The scope of work included providing site classification with respect to reactive soils, in accordance with the requirements of AS2870-2011 'Residential Slabs and Footings', for Stage 3 following completion of site regrade works.

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

2.0 Desktop Study

The scope of work has included a review of the following reports by Qualtest:

- Geotechnical Assessment, 'Proposed Subdivision – Stages 3 to 5, Lot 11 DP 1248129, New England Highway, Lochinvar' (Report Reference: NEW17P-0054B-AB, 28 October 2020);
- Site Classification, 'Proposed Subdivision – Stages 1 & 2, Lot 11 DP 1248129, New England Highway, Lochinvar' (Report Reference: NEW17P-0054A-AD, 30 April 2021);
- Preliminary Geotechnical Assessment, 'Proposed Subdivision – Lots 1 to 3, DP 1218389, New England Highway, Lochinvar' (Report Reference: NEW17P-0054-AA.Rev1, 23 August 2017).

This report includes selected results from the reports referenced above, to supplement information collected during the current investigations where applicable. Reference should be made to the reports outlined above for further details of site conditions, field work and laboratory testing conducted, site supervision, and testing carried out.

Site regrade works within Stage 3 is understood to have been limited to earthworks for construction of roads, with no filling or topsoil depths of greater than 0.4m within the lots. A copy of the Site Regrade Plan prepared by ADW Johnson is attached for reference

3.0 Field Work

The field work investigations were carried out on 31 August and 4 September 2020 and comprised of:

- DBYD search and visual check of proposed test locations for the presence of underground services;
- Site walkover to make observations of surface features at the property and in the immediate surrounding area;
- Excavation of 14 test pits (TP301 to TP314) using a 2.7 tonne excavator equipped with a 450mm wide bucket. Test pits were terminated at depths of between 1.3m and 2.2m, with undisturbed samples (U50 tubes) taken for subsequent laboratory testing.
- Test pits were backfilled with the excavation spoil and compacted using the excavator bucket and tracks.

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

Approximate test pit locations are shown on the attached Figure AD1. Test pits were located in the field by handheld GPS and relative to existing site features including topographic features, lot boundaries, existing developments and trees.

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

4.0 Site Description

4.1 Surface Conditions

The site of proposed Stage 3 is located in the southern part of Lot 11, DP1248129, known as No. 853 New England Highway. The site is bounded by rural residential lots including open grass fields, with Stages 1 and 2 of the subdivision to the north, Stage 4 to the east, Stage 5 to the south and DA2 Area to the west.

The site is located within a region of gently undulating topography, on the slopes of a local northwest trending spur formation with relatively low relief.

The site is judged to generally be well drained mostly by way of downhill surface runoff following natural ground contours, generally in the west and south-west direction.

At the time of the field investigation, the site was mostly vacant with wire fencing along boundaries and separating paddocks. Other vegetation generally comprises of established grass cover on most of the site, with some scattered trees. Since that time, earthworks have commenced for construction of adjacent stages of the subdivision.

The site was judged to have good trafficability by way of 4WD vehicle on the day of the field investigation. Selected photographs of the site taken on the day of the site investigations (31 August and 4 September 2020), are shown below.

Photograph 1: Near TP313, facing southeast.

Photograph 2: Near TP313, facing southwest.

Photograph 3: Near TP311, facing east.

Photograph 4: Near TP311, facing south.

Photograph 5: Near TP309, facing southeast.

Photograph 6: Near TP309, facing southeast.

4.2 Subsurface Conditions

Reference to the 1:100,000 Cessnock Regional Geology Series Sheet 9132 indicates the site to be underlain by the Lochinvar Formation of the Dalwood Group, which is characterised by lithic feldspathic sandstone, siltstone, shale, tuff, basalt flows and erratics.

Table 1 presents a summary of the typical soil / rock types encountered at the test pit locations during the field investigations, divided into representative geotechnical units.

TABLE 1 – SUMMARY OF GEOTECHNICAL UNITS AND SOIL TYPES

Unit	Soil Type	Description
1	Fill	Not encountered in test pits at time of investigation.
2	Topsoil	Sandy CLAY – low to medium plasticity, dark brown to brown, fine to medium grained sand, root affected.
3	Colluvium / Alluvium	Not encountered in test pits at time of investigation.
4	Residual Soil	CLAY / Sandy CLAY – medium to high and high plasticity, pale brown to brown and dark brown, orange-brown to red-brown and grey to dark grey, fine to coarse grained sand, with some fine to coarse grained angular to sub-angular and sub-rounded gravel. Gravelly Sandy CLAY/ Clayey Sandy GRAVEL – medium plasticity, pale brown and pale grey-brown, fine to medium grained angular to sub-angular gravel, fine to medium grained sand.
5	Extremely Weathered (XW) Rock with soil properties	Andesite; breaks down into variable mixtures of Clayey Sandy GRAVEL / Sandy GRAVEL / Gravelly Sandy CLAY / Sandy CLAY / Gravelly CLAY /Gravelly Clayey SAND / Clayey SAND – fine to coarse grained angular to sub-angular gravel, low to high plasticity clay fines, fine to coarse grained sand, brown to dark brown, dark grey to black, with some pale brown, red-brown to orange-brown and white, with some Feldspar. Sandstone; breaks down into Gravelly Clayey SAND – fine to medium grained, fines of low to medium plasticity, fine to coarse grained angular gravel.

6	Highly Weathered (HW) Rock	ANDESITE – grey, dark grey to brown, pale grey-brown and red-brown, estimated very low to medium strength. Generally increasing strength with depth. Highly fractured in places. Possibly lithic feldspathic sandstone in places.

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

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

Location	**Unit 1 Fill**	**Unit 2 Topsoil**	**Unit 3 Colluvium / Alluvium**	**Unit 4 Residual Soil**	**Unit 5 XW Rock**	**Unit 6 HW to MW Rock**
	Depth in metres (m)					
TP301	-	0.00 - 0.10	-	0.10 - 1.00	1.00 - 2.00	-
TP302	-	0.00 - 0.15	-	0.15 - 1.30	1.30 - 2.00	-
TP303	-	0.00 - 0.25	-	0.25 - 1.30	1.30 - 2.00	-
TP304	-	0.00 - 0.20	-	0.20 - 1.70	1.70 - 2.20	-
TP305	-	0.00 - 0.20	-	0.20 - 0.55	0.55 - 1.70	1.70 - 1.80^
TP306	-	0.00 - 0.20	-	0.20 - 0.70	0.70 - 1.50	1.50 - 1.60*
TP307	-	0.00 - 0.20	-	0.20 - 1.40	1.40 - 2.00	-
TP308	-	0.00 - 0.20	-	0.20 - 0.65	0.65 - 1.20	1.20 - 1.30*
TP309	-	0.00 - 0.15	-	0.15 - 1.10	1.10 - 1.40*	1.40*
TP310	-	0.00 - 0.20	-	0.20 - 0.70	0.70 - 1.30	1.30 - 1.45*
TP311	-	0.00 - 0.20	-	0.20 - 1.20	1.20 - 1.50	1.50 - 1.80*
TP312	-	0.00 - 0.20	-	0.20 - 1.80	-	1.80 - 2.00
TP313	-	0.00 - 0.15	-	0.15 - 1.20	1.20 - 2.00	-
TP314	-	0.00 - 0.20	-	0.20 - 0.90	0.90 - 1.20	1.20 - 1.45*
Previous Investigation (Ref: NEW17P-0054.AA.Rev1, dated: 23 August 2017)						
TP05	-	0.00 - 0.20	0.20 - 0.70	0.70 - 1.50	1.50 - 2.40	-
Note:	^ = Slow to very slow progress of 2.7 tonne excavator. * = Refusal or Practical refusal of 2.7 tonne excavator met on Highly Weathered Rock.					

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

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

5.0 Laboratory Testing

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

- (13 no.) Shrink / Swell tests; and,
- (1 no.) Atterberg Limits tests.

Results of the laboratory testing are presented in Appendix B, with a summary of the Shrink/Swell and Atterberg Limits test results presented in Tables 3 and 4, respectively.

TABLE 4 – SUMMARY OF SHRINK / SWELL TESTING RESULTS

Location	Depth (m)	Material Description	I_{ss} (%)
TP301	0.80 – 1.00	(CH) Sandy CLAY	1.2
TP302	0.40 – 0.60	(CH) CLAY	4.4
TP303	0.85 – 1.10	(CI) Sandy CLAY	1.4
TP304	1.00 – 1.20	(CH) CLAY	4.8
TP305	0.30 – 0.50	(CH) CLAY	4.2
TP306	0.50 – 0.70	(CH) CLAY	2.9
TP308	0.30 – 0.60	(CH) CLAY	2.8
TP309	0.45 – 0.60	(CH) CLAY	3.2
TP310	0.50 – 0.70	(CH) CLAY	2.2
TP311	0.80 – 1.00	(CH) CLAY	4.6
TP312	0.40 – 0.60	(CH) CLAY	4.4
TP313	0.60 – 0.80	(CH) Sandy CLAY	4.4
TP314	0.40 – 0.60	(CH) CLAY	2.8

TABLE 4 – SUMMARY OF ATTERBERG LIMITS TESTING RESULTS

Location	Depth (m)	Material Description	Liquid Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)
TP307	0.65 – 0.85	(CI) Gravelly Sandy CLAY	39	14	7.5

The results of laboratory Shrink / Swell and Atterberg Limits tests indicate that the residual clays at the site are generally highly reactive.

6.0 Site Classification to AS2870-2011

Based on the results of the field work and laboratory testing, residential lots located within proposed Stage 3 of Hereford Hill residential subdivision located at Lot 11, DP 1248129, known as No. 853 New England Highway, Lochinvar, are classified in their current condition, in accordance with AS2870-2011 *'Residential Slabs and Footings'* as shown in Table 5.

TABLE 5 – SITE CLASSIFICATION TO AS2870-2011

Stage	Lot Numbers	Site Classification
3	301 to 324	**H2**

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

The effects of changes to the soil profile by additional cutting and filling and the effects of past and future trees should be considered in selection of the design value for differential movement. If site re-grading works involving cutting or filling are performed after the date of this assessment the classification may change and further advice should be sought.

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

The classification presented above assumes that:

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

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

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

7.0 Limitations

The findings presented in the report and used as the basis for recommendations presented herein were obtained using normal, industry accepted geotechnical design practices and standards. To our knowledge, they represent a reasonable interpretation of the general conditions of the site.

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

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

Data and opinions contained within the report may not be used in other contexts or for any other purposes without prior review and agreement by Qualtest. If this report is reproduced, it must be in full.

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

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

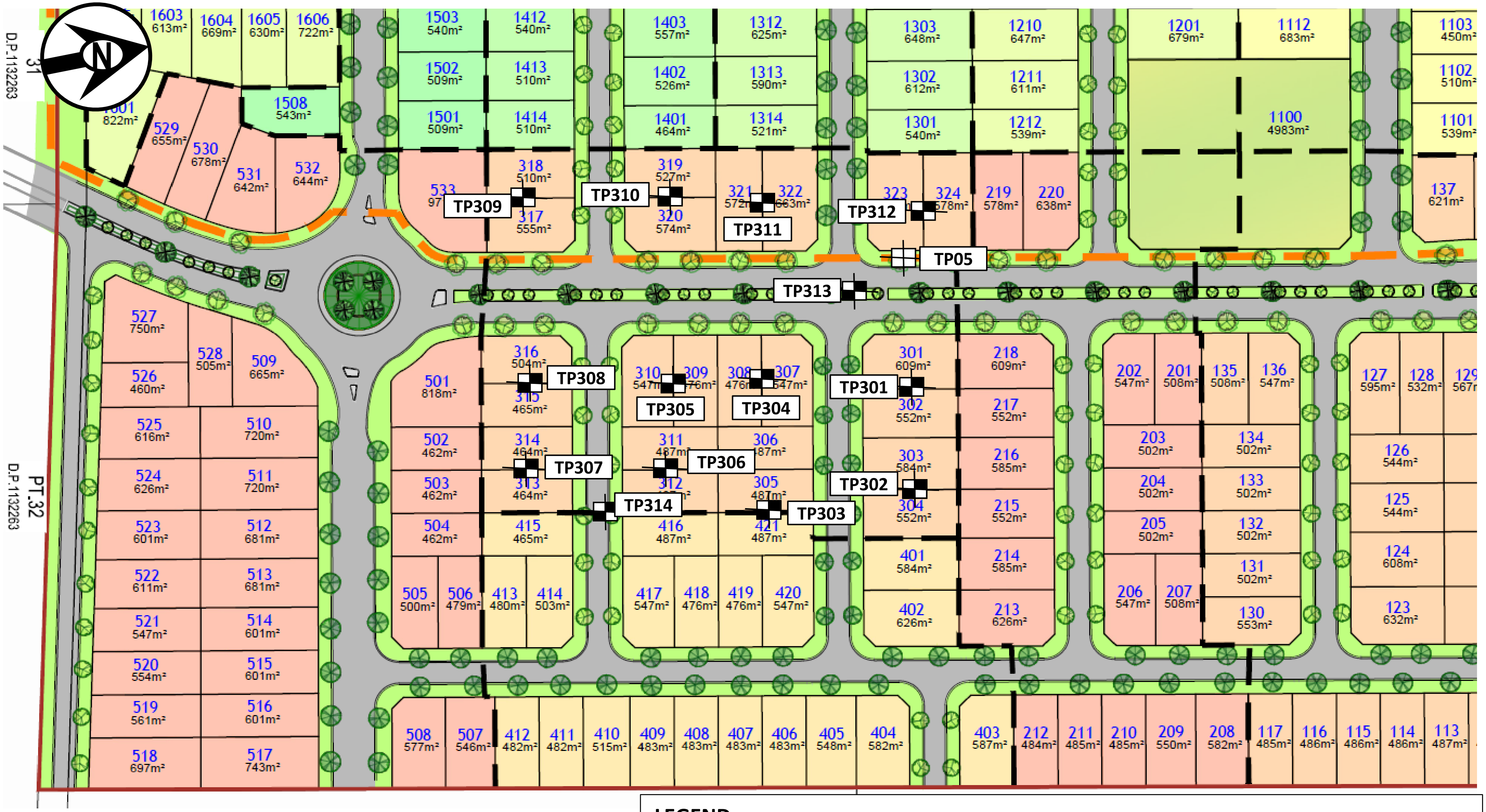
Jason Lee

Jason Lee
Principal Geotechnical Engineer

FIGURES

Figure AD1: Site Plan and Approximate Test Pit Locations

ADW Johnson Drawing Ref. 239591(3)-ENG-501, Rev 1, dated 28/10/2020



Based on Master plan provided by client
(Ref: 239591(2)-SALES-001-G MP-002, by ADW Johnson Pty Ltd).

LEGEND:

▣	Approximate test pit location (September 2020).
⊞	Approximate test pit location (Previous Investigations, April 2017).

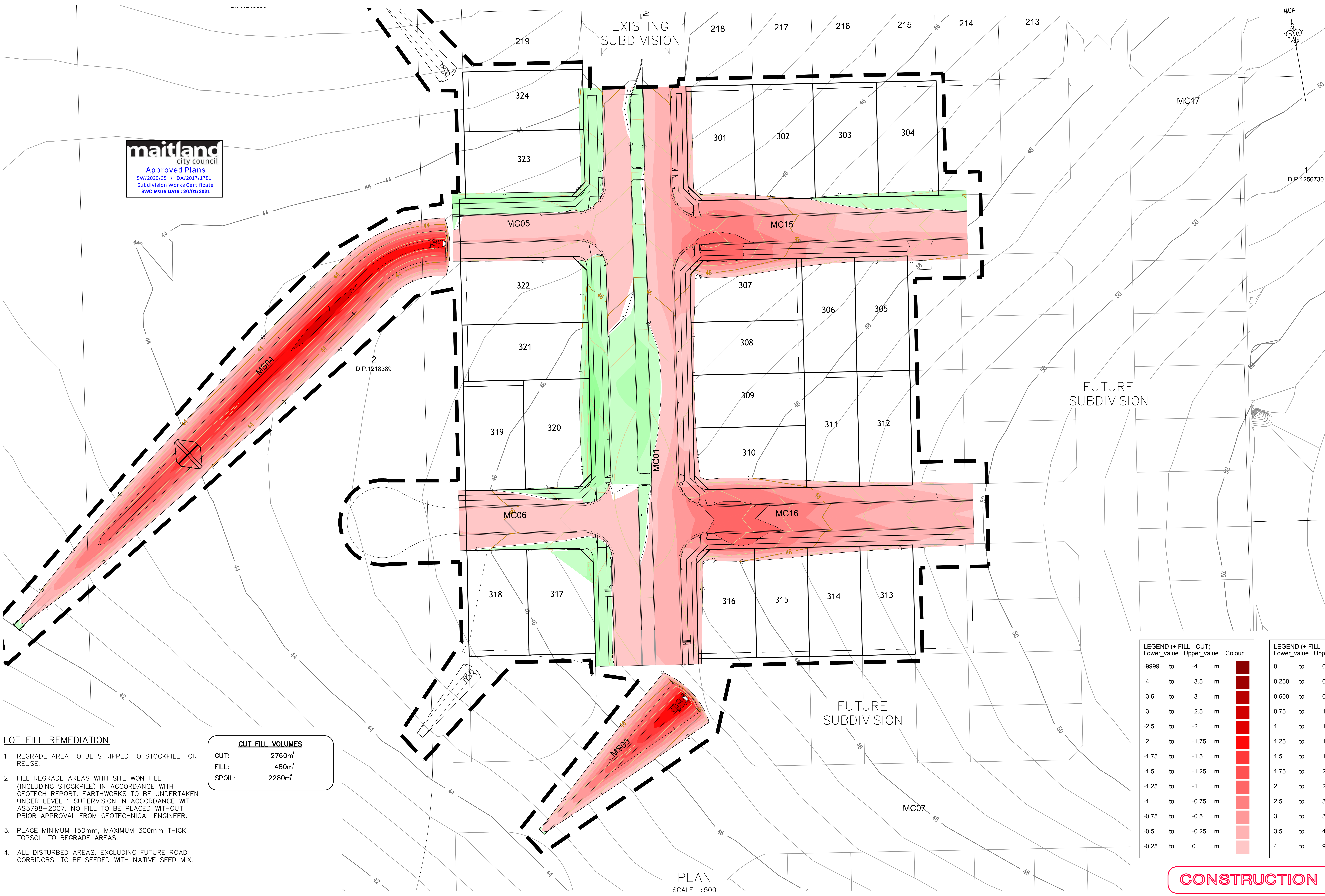
Qualtest
LABORATORY (NSW) PTY LTD

Client:	McCLOY LOCHINVAR PTY LTD	Drawing No:	FIGURE AD1
Project:	PROPOSED SUBDIVISION - STAGE 3	Project No:	NEW17P-0054B
Location:	LOT 11, DP 1248129, NEW ENGLAND HIGHWAY, LOCHINVAR	Scale:	NOT TO SCALE
Title:	SITE PLAN & APPROXIMATE TEST PIT LOCATIONS	Date:	24/05/2021

239591(3)-ENG-501(1)

maitland
city council
Approved Plans
SW/2020/35 / DA/2017/1781
Subdivision Works Certificate
SWC Issue Date : 20/01/2021

DIAL 1100
BEFORE YOU DIG



PLAN
SCALE 1:500

LOT FILL REMEDIATION

1. REGRADE AREA TO BE STRIPPED TO STOCKPILE FOR REUSE.
2. FILL REGRADE AREAS WITH SITE WON FILL (INCLUDING STOCKPILE) IN ACCORDANCE WITH GEOTECH REPORT. EARTHWORKS TO BE UNDERTAKEN UNDER LEVEL 1 SUPERVISION IN ACCORDANCE WITH AS3798–2007. NO FILL TO BE PLACED WITHOUT PRIOR APPROVAL FROM GEOTECHNICAL ENGINEER.
3. PLACE MINIMUM 150mm, MAXIMUM 300mm THICK TOPSOIL TO REGRADE AREAS.
4. ALL DISTURBED AREAS, EXCLUDING FUTURE ROAD CORRIDORS, TO BE SEEDED WITH NATIVE SEED MIX.

CUT FILL VOLUMES

CUT:	2760m^3
FILL:	480m^3
SPOIL:	2280m^3

LEGEND (+ FILL - CUT)

Lower_value		Upper_value		Colour
-9999	to	-4	m	🟥
-4	to	-3.5	m	🟥
-3.5	to	-3	m	🟥
-3	to	-2.5	m	🟥
-2.5	to	-2	m	🟥
-2	to	-1.75	m	🟥
-1.75	to	-1.5	m	🟥
-1.5	to	-1.25	m	🟥
-1.25	to	-1	m	🟥
-1	to	-0.75	m	🟥
-0.75	to	-0.5	m	🟥
-0.5	to	-0.25	m	🟥
-0.25	to	0	m	🟥

LEGEND (+ FILL - CUT)

Lower_value		Upper_value		Colour
0	to	0.250	m	🟩
0.250	to	0.5	m	🟩
0.500	to	0.75	m	🟩
0.75	to	1	m	🟩
1	to	1.25	m	🟩
1.25	to	1.5	m	🟩
1.5	to	1.75	m	🟩
1.75	to	2	m	🟩
2	to	2.5	m	🟩
2.5	to	3	m	🟩
3	to	3.5	m	🟩
3.5	to	4	m	🟩
4	to	99999	m	🟩

CONSTRUCTION ISSUE

100mm AT FULL SIZE

REV.	DATE	AMENDMENT	DRAWN	CHECK	DESIGN	VERIFY
A	23.07.2020	INITIAL ISSUE	D.W.	L.G.	M.A.	L.G.
0	21.08.2020	ISSUED FOR CONSTRUCTION	D.W.	L.G.	M.A.	L.G.
1	28.10.2020	COUNCIL COMMENTS ADDED (BERM AND LOW FLOW PIPE)	D.W.	L.G.	M.A.	L.G.

DESIGN FILE N:\239591\Design\12D\239591 CC DESIGN\239591_CC_DESIGN.project

SCALES
0 10 20 A1 / A3
1:500 / 1:1000

ALL DIMENSIONS ARE IN METRES. DO NOT SCALE

adw johnson

Hunter Office
Unit 7/335 Hillsborough Rd
Warners Bay N.S.W. 2282
Phone: (02) 4978 5100
Fax: (02) 4978 5199
email: hunter@adwjohnson.com.au
www.adwjohnson.com.au
ABN 62 129 445 398

CLIENT
McCLOYGROUP

PROPERTY DESCRIPTION
PROPOSED SUBDIVISION
STAGE 3
LOT 1 D.P.1218389
853 NEW ENGLAND HIGHWAY, LOCHINVAR

SURVEYED: ADW Johnson
DATUM: GDA94 M.G.A. ZONE 56 A.H.D.

PROJECT: LOCHINVAR STAGE 3

PLAN TITLE: SITE REGRADE PLAN

PROJECT No.		DISCIPLINE		NUMBER	REV.
239591(3)	–	ENG	–	501	1

Plotted By: deanw Plot Date: 28/10/20 – 07:23 Cad File: N:\239591\Drawings\Engineering\Civil\CC\Stage3\239591(3)–ENG–501(1).dwg

APPENDIX A:

Results of Field Investigations

ENGINEERING LOG - TEST PIT

TEST PIT NO: TP301
CLIENT: McCLOY LOCHINVAR PTY LTD
PAGE: 1 OF 1
PROJECT: HEREFORD HILL SUBDIVISION - STAGES 3 TO 5
JOB NO: NEW17P-0054B
LOCATION: 853 NEW ENGLAND HIGHWAY, LOCHINVAR
LOGGED BY: BB
DATE: 31/8/20

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR
SURFACE RL:
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.5 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered			0.10m		CI	TOPSOIL: Sandy CLAY - medium plasticity, dark brown, fine grained sand, root affected.	M ~ W_P				TOPSOIL
				0.5 0.80m		CH	CLAY - high plasticity, brown, trace fine to medium grained sand.		VSt	HP HP HP	250 250 350	RESIDUAL SOIL
		0.80m U50 1.00m		1.0 1.00m		CH	Sandy CLAY - medium to high plasticity, brown to pale brown, fine to coarse grained sand, with some fine to coarse grained angular to sub-angular gravel.			HP HP	320 550	
				1.40m		GC	Extremely weathered Andesite with soil properties: breaks down into Clayey Sandy GRAVEL - fine to coarse grained angular, dark grey to black with some brown, fine to coarse grained sand, fines of medium to high plasticity.	D	VD			EXTREMELY TO HIGHLY WEATHERED ROCK
				1.5 2.0 2.00m		GP	Extremely weathered Andesite with soil properties: breaks down into Sandy GRAVEL - fine to coarse grained angular, dark grey to black with some brown, fine to coarse grained sand With some rounded Feldspathic Xenocrysts.					EXTREMELY WEATHERED ROCK
							Hole Terminated at 2.00 m					

LEGEND:

Water

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

Strata Changes

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

Notes, Samples and Tests

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

Field Tests

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

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

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

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

Qualtest LABORATORY (NSW) PTY LTD

ENGINEERING LOG - TEST PIT

CLIENT: McCLOY LOCHINVAR PTY LTD
PROJECT: HEREFORD HILL SUBDIVISION - STAGES 3 TO 5
LOCATION: 853 NEW ENGLAND HIGHWAY, LOCHINVAR

TEST PIT NO: **TP302**
PAGE: 1 OF 1
JOB NO: NEW17P-0054B
LOGGED BY: BB
DATE: 31/8/20

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.5 m
SURFACE RL:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
E	Not Encountered					CI	TOPSOIL: Sandy CLAY - medium plasticity, dark brown, fine grained sand, root affected. 0.15m	M > w_P				TOPSOIL
		0.40m U50 0.60m		0.5 1.0		CH	CLAY - medium to high plasticity, orange-brown to brown, with some fine to medium grained sand, trace fine to medium grained sub-rounded to angular gravel. 1.15m		VSt	HP HP HP HP HP	200 250 220 300 500	RESIDUAL SOIL
						CI	Sandy CLAY - medium plasticity, pale grey-brown and pale orange-brown, fine to medium grained sand. 1.30m	M < w_P	H	HP	>600	RESIDUAL SOIL / EXTREMELY WEATHERED ROCK
				1.5 2.0		SC	Extremely Weathered Sandstone with soil properties: breaks down into Gravelly Clayey SAND- fine to medium grained, pale orange-brown, fines of low to medium plasticity, fine to coarse grained (mostly fine to medium grained) angular gravel. 2.00m	D	VD			EXTREMELY WEATHERED ROCK
							Hole Terminated at 2.00 m					

LEGEND:

Water

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

Strata Changes

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

Notes, Samples and Tests

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

Field Tests

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

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

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

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

ENGINEERING LOG - TEST PIT

CLIENT:	McCLOY LOCHINVAR PTY LTD	**TEST PIT NO:**	**TP303**
PROJECT:	HEREFORD HILL SUBDIVISION - STAGES 3 TO 5	**PAGE:**	1 OF 1
LOCATION:	853 NEW ENGLAND HIGHWAY, LOCHINVAR	**JOB NO:**	NEW17P-0054B
		LOGGED BY:	BB
		DATE:	31/8/20

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR
SURFACE RL:
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.5 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered					CI	TOPSOIL: Sandy CLAY - medium plasticity, dark brown, fine to medium grained sand, root affected.	$M \sim W_P$				TOPSOIL
							0.25m					
				0.5		CH	CLAY - high plasticity, brown to dark brown, with some fine to medium grained sand.	$M > W_P$	VSt	HP HP	280 230	RESIDUAL SOIL
							0.75m					
		0.85m U50 1.10m		1.0		CI	Sandy CLAY - medium plasticity, pale brown to brown, fine to medium grained sand. Pockets of extremely weathered andesite	$M \sim W_P$	VSt H	HP HP HP	300 420 500	
							1.30m					
				1.5		CH	Extremely Weathered Andesite with soil properties: breaks down into Sandy CLAY - medium to high plasticity, brown to dark brown, with some white, fine to medium grained sand, with some rounded Feldspathic Xenocrysts.	$M < W_P$	H	HP	>600	EXTREMELY WEATHERED ROCK / RESIDUAL SOIL
							1.70m					
				2.0		SC	Extremely Weathered Andesite with soil properties: breaks down into Clayey SAND - fine to medium grained sand, brown to dark brown, with some white, fines of medium to high plasticity, with some rounded Feldspathic Xenocrysts.	D	VD			EXTREMELY WEATHERED ROCK
							2.00m					
							Hole Terminated at 2.00 m					

LEGEND:

Water

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

Strata Changes

- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

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

Field Tests

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

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

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

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

ENGINEERING LOG - TEST PIT

CLIENT:	McCLOY LOCHINVAR PTY LTD	**TEST PIT NO:**	**TP304**
PROJECT:	HEREFORD HILL SUBDIVISION - STAGES 3 TO 5	**PAGE:**	1 OF 1
LOCATION:	853 NEW ENGLAND HIGHWAY, LOCHINVAR	**JOB NO:**	NEW17P-0054B
		LOGGED BY:	BB
		DATE:	31/8/20

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR
SURFACE RL:
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.5 m
DATUM: AHD

Drilling and Sampling					Material description and profile information				Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered			0.20m	CI	TOPSOIL: Sandy CLAY - medium plasticity, dark brown, fine grained sand, root affected.	M < W$_P$				TOPSOIL
		0.30m U50 0.45m		0.5 0.90m	CH	CLAY - high plasticity, brown, with some fine to medium grained sand.	M > W$_P$	VSt	HP HP HP	250 230 300	RESIDUAL SOIL
		1.00m U50 1.20m		1.0 1.5 1.70m	CH	CLAY - medium to high plasticity, pale brown, with some fine to medium grained sand.	M ~ W$_P$	H	HP HP HP HP HP HP	310 550 570 480 >600	
				2.0 2.20m	SC	Extremely Weathered Andesite with soil properties: breaks down into Gravelly CLAY - medium to high plasticity, pale grey with some pale orange-brown to red-brown, fine to medium grained angular gravel, with pockets of extremely weathered sandstone.	M < W$_P$		HP	550	EXTREMELY WEATHERED ROCK
						Hole Terminated at 2.20 m					

LEGEND:

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

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

Notes, Samples and Tests

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

Field Tests

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

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

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

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

Qualtest
LABORATORY (NSW) PTY LTD

ENGINEERING LOG - TEST PIT

CLIENT:	McCLOY LOCHINVAR PTY LTD	**TEST PIT NO:**	**TP305**
PROJECT:	HEREFORD HILL SUBDIVISION - STAGES 3 TO 5	**PAGE:**	1 OF 1
LOCATION:	853 NEW ENGLAND HIGHWAY, LOCHINVAR	**JOB NO:**	NEW17P-0054B
		LOGGED BY:	BB
		DATE:	31/8/20

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.5 m
SURFACE RL:
DATUM: AHD

METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered				CI	TOPSOIL: Sandy CLAY - medium plasticity, dark brown, fine to medium grained sand, root affected.	M < W_P				TOPSOIL
		0.30m U50 0.50m		0.5	CH	0.20m CLAY - high plasticity, brown, trace fine to medium grained sand.	M > W_P	VSt	HP HP	270 250	RESIDUAL SOIL
				1.0	GC	0.55m Extremely Weathered Andesite with soil properties: breaks down into Clayey Sandy GRAVEL - fine to medium grained angular, brown to red-brown, fine to coarse grained sand, fines of medium plasticity.	D - M	VD			EXTREMELY WEATHERED ROCK
				1.5	GP	1.00m Extremely Weathered Andesite with soil properties: breaks down into Sandy GRAVEL - fine to medium grained angular, brown to red-brown, fine to coarse grained sand.					
						1.70m ANDESITE - dark grey-brown, estimated low strength. 1.80m	D				HIGHLY WEATHERED ROCK / EXTREMELY WEATHERED ROCK
				2.0		Hole Terminated at 1.80 m Very slow progress					

LEGEND:

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

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

Notes, Samples and Tests

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

Field Tests

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

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

Moisture Condition

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

Density

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

Qualtest
LABORATORY (NSW) PTY LTD

ENGINEERING LOG - TEST PIT

CLIENT: McCLOY LOCHINVAR PTY LTD
PROJECT: HEREFORD HILL SUBDIVISION - STAGES 3 TO 5
LOCATION: 853 NEW ENGLAND HIGHWAY, LOCHINVAR

TEST PIT NO: TP306
PAGE: 1 OF 1
JOB NO: NEW17P-0054B
LOGGED BY: BB
DATE: 31/8/20

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.5 m
SURFACE RL:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered					CI	TOPSOIL: Sandy CLAY - medium plasticity, dark brown, fine to medium grained sand, root affected. 0.20m	M < W_P				TOPSOIL
		0.50m U50 0.70m		0.5		CH	CLAY - high plasticity, brown, trace fine to medium grained sand. 0.70m	M > W_P	VSt	HP HP HP	220 300 320	RESIDUAL SOIL
				1.0		SC	Extremely Weathered Andesite with soil properties: breaks down into Gravelly Clayey SAND - fine to coarse grained, brown to pale brown, fine to medium grained angular to sub-angular gravel, fines of low to medium plasticity. 1.30m	D - M	VD			EXTREMELY WEATHERED ROCK
				1.5		GP	Extremely Weathered Andesite with soil properties: breaks down into Sandy GRAVEL - fine to coarse grained angular to sub-angular, brown to pale brown, fine to medium grained sand. 1.50m					
							ANDESITE - brown to grey-brown, estimated low to medium strength. 1.60m	D				HIGHLY WEATHERED ROCK
				2.0			Hole Terminated at 1.60 m Practical Refusal					

LEGEND:

Water

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

Strata Changes

- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

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

Field Tests

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

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

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

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

Qualtest
LABORATORY (NSW) PTY LTD

ENGINEERING LOG - TEST PIT

CLIENT: McCLOY LOCHINVAR PTY LTD
PROJECT: HEREFORD HILL SUBDIVISION - STAGES 3 TO 5
LOCATION: 853 NEW ENGLAND HIGHWAY, LOCHINVAR

TEST PIT NO: **TP307**
PAGE: 1 OF 1
JOB NO: NEW17P-0054B
LOGGED BY: BB
DATE: 31/8/20

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.5 m
SURFACE RL:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
E	Not Encountered					CI	TOPSOIL: Sandy CLAY - medium plasticity, dark brown, fine grained sand, root affected.	M < w_P				TOPSOIL
		0.30m U50 0.60m		0.5		CH	0.20m CLAY - high plasticity, brown, trace fine to medium grained sand.	M > w_P	VSt	HP HP	250 300	RESIDUAL SOIL
		0.65m U50 0.85m		1.0		CI	0.60m Gravelly Sandy CLAY - medium plasticity, pale brown to pale grey-brown, fine to medium grained sand, fine grained angular gravel. Fine to medium grained angular gravel.	M < w_P	H / Fb	HP	550	RESIDUAL SOIL / EXTREMELY WEATHERED ROCK
				1.5 2.0		CI	1.40m Extremely Weathered Andesite with soil properties: breaks down into Gravelly Sandy CLAY - medium plasticity, pale brown to pale grey-brown, fine to medium grained sand, fine grained angular gravel.					EXTREMELY WEATHERED ROCK
							2.00m Hole Terminated at 2.00 m					

LEGEND:

Water

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

Strata Changes

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

Notes, Samples and Tests

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

Field Tests

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

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

Moisture Condition

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

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

ENGINEERING LOG - TEST PIT

CLIENT:	McCLOY LOCHINVAR PTY LTD	**TEST PIT NO:**	**TP308**
PROJECT:	HEREFORD HILL SUBDIVISION - STAGES 3 TO 5	**PAGE:**	1 OF 1
LOCATION:	853 NEW ENGLAND HIGHWAY, LOCHINVAR	**JOB NO:**	NEW17P-0054B
		LOGGED BY:	BB
		DATE:	4/9/20

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR **SURFACE RL:**
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.5 m **DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
E	Not Encountered					CI	TOPSOIL: Sandy CLAY - medium plasticity, brown, fine grained sand, root affected.	$M < w_P$				TOPSOIL
		0.30m U50 0.60m		0.5		CH	0.20m CLAY - high plasticity, brown to red-brown.	$M > w_P$	VSt	HP HP	250 280	RESIDUAL SOIL
				1.0		GP	0.65m Extremely Weathered Andesite with soil properties: breaks down into Sandy GRAVEL - fine to coarse grained, angular, brown to grey-brown, fine to medium grained sand, with some fines of low plasticity.	D	VD			EXTREMELY WEATHERED ROCK
							1.20m ANDESITE - dark grey to grey brown with some red-brown, estimated low to medium strength. 1.30m					HIGHLY WEATHERED ROCK / EXTREMELY WEATHERED ROCK
				1.5 2.0			Hole Terminated at 1.30 m Practical Refusal					

LEGEND:

Water

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

Strata Changes

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

Notes, Samples and Tests

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

Field Tests

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

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

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

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

ENGINEERING LOG - TEST PIT

Qualtest
LABORATORY (NSW) PTY LTD

CLIENT:	McCLOY LOCHINVAR PTY LTD	**TEST PIT NO:**	**TP309**
PROJECT:	HEREFORD HILL SUBDIVISION - STAGES 3 TO 5	**PAGE:**	1 OF 1
LOCATION:	853 NEW ENGLAND HIGHWAY, LOCHINVAR	**JOB NO:**	NEW17P-0054B
		LOGGED BY:	BB
		DATE:	4/9/20

EQUIPMENT TYPE:	2.7 TONNE EXCAVATOR			**SURFACE RL:**	
TEST PIT LENGTH:	2.0 m	**WIDTH:**	0.5 m	**DATUM:**	AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered					CI	TOPSOIL: CLAY - medium plasticity, dark brown, with some fine to medium grained sand, root affected.	$M < W_P$				TOPSOIL
				0.15m		CH	CLAY - high plasticity, brown, with some fine to medium grained sand.	$M > W_P$	VSt	HP	230	RESIDUAL SOIL
		0.45m U50 0.60m		0.5						HP	300	
										HP	330	
				1.0			Some pockets of extremely weathered Andesite.			HP	370	RESIDUAL SOIL / EXTREMELY WEATHERED ROCK
				1.10m		GP	Extremely Weathered Andesite with soil properties: breaks down into Sandy GRAVEL - fine to coarse grained (mostly coarse grained), angular, dark grey, fine to coarse grained (mostly medium to coarse grained) sand, trace fines of low plasticity.	D	VD			EXTREMELY WEATHERED ROCK / HIGHLY WEATHERED ROCK
				1.40m			Hole Terminated at 1.40 m Practical Refusal					
				1.5								
				2.0								

LEGEND:

Water

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

Strata Changes

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

Notes, Samples and Tests

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

Field Tests

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

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

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

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

ENGINEERING LOG - TEST PIT

TEST PIT NO: TP310
PAGE: 1 OF 1
CLIENT: McCLOY LOCHINVAR PTY LTD
JOB NO: NEW17P-0054B
PROJECT: HEREFORD HILL SUBDIVISION - STAGES 3 TO 5
LOGGED BY: BB
LOCATION: 853 NEW ENGLAND HIGHWAY, LOCHINVAR
DATE: 4/9/20

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR
SURFACE RL:
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.5 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered					CI	TOPSOIL: Sandy CLAY - medium plasticity, dark brown, fine to medium grained sand, root affected.	M ~ W_P				TOPSOIL
		0.50m U50 0.70m		0.5		CH	0.20m CLAY - high plasticity, brown, with some fine to medium grained sand.		VSt - H	HP HP	380 410	RESIDUAL SOIL
							Pockets of extremely weathered Andesite.		H	HP	550	
				1.0		GP	0.70m Extremely Weathered Andesite with soil properties: breaks down into Sandy GRAVEL - fine to coarse grained, angular, grey-brown, fine to coarse grained sand, with some fines of low plasticity.	D	VD			EXTREMELY WEATHERED ROCK
							1.30m ANDESITE - grey-brown, estimated very low to low strength.					HIGHLY WEATHERED ROCK / EXTREMELY WEATHERED ROCK
							1.45m Becoming low to medium strength.					
				1.5			Hole Terminated at 1.45 m Practical Refusal					
				2.0								

LEGEND:

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

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

Notes, Samples and Tests

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

Field Tests

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

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

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

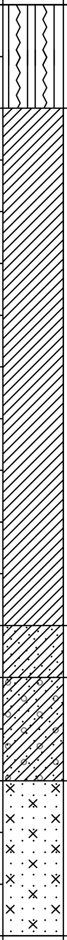
Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - TEST PIT

CLIENT:	McCLOY LOCHINVAR PTY LTD	**TEST PIT NO:**	**TP311**
PROJECT:	HEREFORD HILL SUBDIVISION - STAGES 3 TO 5	**PAGE:**	1 OF 1
LOCATION:	853 NEW ENGLAND HIGHWAY, LOCHINVAR	**JOB NO:**	NEW17P-0054B
		LOGGED BY:	BB
		DATE:	31/8/20

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

TEST PIT LENGTH: 2.0 m **WIDTH:** 0.5 m **DATUM:** AHD



Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered					CI	TOPSOIL: Sandy CLAY - medium plasticity, dark brown, fine to medium grained sand, root affected.	M ~ W$_P$				TOPSOIL
		0.80m U50 1.00m		0.20m 0.5 1.0		CH	CLAY - high plasticity, brown, with some fine to medium grained (mostly fine grained) sand.	M > W$_P$	VSt	HP HP HP HP	320 310 350 380	RESIDUAL SOIL
				1.20m		CL	Extremely Weathered Andesite with soil properties: breaks down into Sandy CLAY - low to medium plasticity, pale orange-brown to pale grey, fine grained sand.	M < W$_P$	H	HP	>600	EXTREMELY WEATHERED ROCK
				1.30m		CL	Extremely Weathered Andesite with soil properties: breaks down into Sandy Gravelly CLAY - low to medium plasticity, pale orange-brown to pale grey, fine grained sand, fine to medium grained angular gravel.					
				1.50m 1.5			ANDESITE - grey to grey-brown, estimated low to medium strength, highly fractured.	D				HIGHLY WEATHERED ROCK / EXTREMELY WEATHERED ROCK
				1.80m 2.0			Hole Terminated at 1.80 m Practical Refusal					

LEGEND:

Water

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

Strata Changes

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

Notes, Samples and Tests

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

Field Tests

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

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

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

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

ENGINEERING LOG - TEST PIT

Qualtest LABORATORY (NSW) PTY LTD

CLIENT:	McCLOY LOCHINVAR PTY LTD	**TEST PIT NO:**	**TP312**
PROJECT:	HEREFORD HILL SUBDIVISION - STAGES 3 TO 5	**PAGE:**	1 OF 1
LOCATION:	853 NEW ENGLAND HIGHWAY, LOCHINVAR	**JOB NO:**	NEW17P-0054B
		LOGGED BY:	BB
		DATE:	31/8/20

EQUIPMENT TYPE: 2.7 TONNE EXCAVATOR **SURFACE RL:**
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.5 m **DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
E	Not Encountered					CL	TOPSOIL: Sandy CLAY - low plasticity, dark brown, fine grained sand, root affected. 0.20m	M ~ w_P				TOPSOIL
		0.40m U50 0.60m		0.5		CH	CLAY - medium to high plasticity, brown to dark brown, with some fine grained sand. 0.80m	M > w_P	VSt	HP HP HP	300 320 350	RESIDUAL SOIL
				1.0		CH	CLAY - medium to high plasticity, brown to red-brown, with some fine to medium grained sand. With pockets of Sandy GRAVEL. 1.35m	M > w_P		HP HP	>600 550	
				1.5		GP	Sandy GRAVEL - fine to coarse grained angular to sub-angular, brown and dark grey, fine to coarse grained sand, with pockets of fines of low to medium plasticity. Pockets of Extremely Weathered Andesite. 1.80m	D	D			RESIDUAL SOIL / EXTREMELY WEATHERED ROCK
				2.0			ANDESITE - dark grey with some white (rounded Feldspathic Xenocrysts), estimated low to medium strength, highly fractured. 2.00m					HIGHLY WEATHERED ROCK / EXTREMELY WEATHERED ROCK
							Hole Terminated at 2.00 m					

LEGEND:

Water

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

Strata Changes

- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

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

Field Tests

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

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

Moisture Condition

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

Density

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

ENGINEERING LOG - TEST PIT

CLIENT:	McCLOY LOCHINVAR PTY LTD	**TEST PIT NO:**	**TP313**
PROJECT:	HEREFORD HILL SUBDIVISION - STAGES 3 TO 5	**PAGE:**	1 OF 1
LOCATION:	853 NEW ENGLAND HIGHWAY, LOCHINVAR	**JOB NO:**	NEW17P-0054B
		LOGGED BY:	BB
		DATE:	31/8/20

EQUIPMENT TYPE:	2.7 TONNE EXCAVATOR	**SURFACE RL:**	
TEST PIT LENGTH:	2.0 m **WIDTH:** 0.5 m	**DATUM:**	AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered			0.15m		CL	TOPSOIL: Sandy CLAY - low plasticity, dark brown, fine grained sand, root affected.	M < W$_P$				TOPSOIL
				0.5 0.50m		CH	CLAY - high plasticity, brown, with some fine to medium grained sand. With some fine grained sub-rounded to sub-angular gravel.	M > W$_P$	VSt	HP HP	250 260	RESIDUAL SOIL
		0.60m U50 0.80m		0.80m		CH	Sandy CLAY - medium to high plasticity, brown and grey, fine to coarse grained sand, with some fine to medium grained angular to sub-angular gravel.			HP HP	320 400	RESIDUAL SOIL / EXTREMELY WEATHERED ROCK
		0.90m CBR 1.10m		1.0 1.20m		GC	Clayey Sandy GRAVEL - fine to medium grained, angular to sub-angular, brown and grey, fine to coarse grained sand, fines of medium plasticity. Gravel content increasing with depth.	D - M	VD			
		1.50m D 1.60m		1.5 2.0 2.00m		GC	Extremely Weathered Andesite with soil properties: breaks down into Clayey Sandy GRAVEL - fine to coarse grained angular, brown to red-brown, fine to coarse grained sand, fines of low to medium plasticity.					EXTREMELY WEATHERED ROCK
							Hole Terminated at 2.00 m					

LEGEND:

Water

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

Strata Changes

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

Notes, Samples and Tests

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

Field Tests

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

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

Moisture Condition

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

Density

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

ENGINEERING LOG - TEST PIT

CLIENT:	McCLOY LOCHINVAR PTY LTD	**TEST PIT NO:**	**TP314**
PROJECT:	HEREFORD HILL SUBDIVISION - STAGES 3 TO 5	**PAGE:**	1 OF 1
LOCATION:	853 NEW ENGLAND HIGHWAY, LOCHINVAR	**JOB NO:**	NEW17P-0054B
		LOGGED BY:	BB
		DATE:	31/8/20

EQUIPMENT TYPE:	2.7 TONNE EXCAVATOR	**SURFACE RL:**	
TEST PIT LENGTH:	2.0 m **WIDTH:** 0.5 m	**DATUM:**	AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered					CI	TOPSOIL: Sandy CLAY - medium plasticity, dark brown, fine to medium grained sand, root affected.	M < W$_p$				TOPSOIL
		0.40m CBR & U50 0.60m		0.20m 0.5		CH	CLAY - high plasticity, brown, trace fine to medium grained sand.	M > W$_p$	VSt	HP HP HP	240 250 300	RESIDUAL SOIL
				0.80m		CI	Gravelly Sandy CLAY - medium plasticity, pale grey-brown, fine to medium grained angular gravel, fine to coarse grained sand.	M < W$_p$	H / Fb	HP	>600	RESIDUAL SOIL / EXTREMELY WEATHERED ROCK
		1.00m U50 1.20m		0.90m 1.0		GP	Extremely weathered Andesite with soil properties: breaks down into Sandy GRAVEL - fine to medium grained angular, pale grey-brown, fine to coarse grained sand.	D	VD			EXTREMELY WEATHERED ROCK
				1.20m			ANDESITE - pale grey-brown, estimated low strength.					HIGHLY WEATHERED ROCK / EXTREMELY WEATHERED ROCK
				1.45m			Estimated low to medium strength.					
				1.5 2.0			Hole Terminated at 1.45 m Practical Refusal					

LEGEND:

Water

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

Strata Changes

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

Notes, Samples and Tests

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

Field Tests

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

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

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

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

APPENDIX B:

Results of Laboratory Testing

QUALTEST Laboratory (NSW) Pty Ltd (20708)
8 Ironbark Close Warabrook NSW 2304
T: 02 4968 4468
F: 02 4960 9775
E: admin@qualtest.com.au
W: www.qualtest.com.au
ABN: 98 153 268 896

Report No: SSI:NEW20W-3182--S01
Issue No: 1

Shrink Swell Index Report

Client:	McCloy Project Management Pty Ltd PO Box 2214 Dangar NSW 2309
Principal:	
Project No.:	NEW17P-0054B
Project Name:	Proposed Subdivision - Hereford Hill - Stage 3 to 5

NATA
WORLD RECOGNISED ACCREDITATION

B. Cullen
Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 10/09/2020

Sample Details

Sample ID:	NEW20W-3182--S01	**Client Sample ID:**	-
Test Request No.:	-	**Sampling Method:**	Sampled by Engineering Department
Material:	Sandy Clay	**Date Sampled:**	1/09/2020
Source:	On Site	**Date Submitted:**	4/09/2020
Specification:	No Specification		
Project Location:	New England Highway, Lochinvar, NSW		
Sample Location:	TP301 - (0.8 - 1.0m)		
Borehole Number:	TP301		
Borehole Depth (m):	0.8 - 1.0		
Date Tested:	4/09/2020		

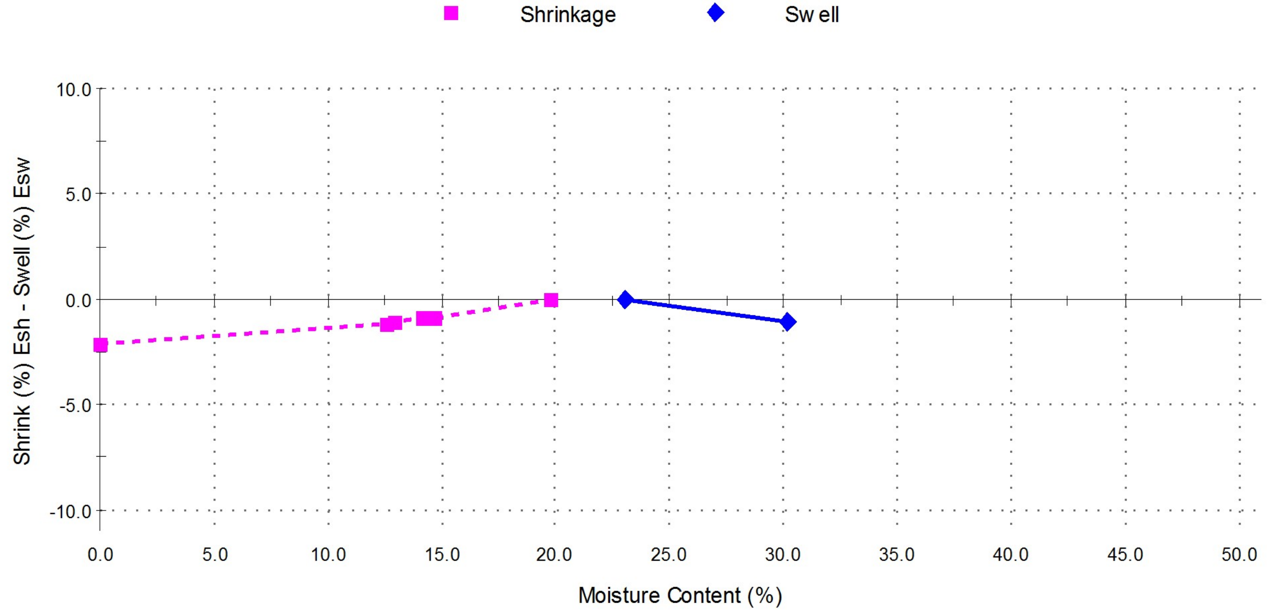
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	-1.1
Moisture Content before (%):	23.1
Moisture Content after (%):	30.1
Est. Unc. Comp. Strength before (kPa):	>600
Est. Unc. Comp. Strength after (kPa):	130

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	2.1
Shrinkage Moisture Content (%):	19.8
Est. inert material (%):	8%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Moderate

Shrink Swell



Shrink Swell Index - Iss (%): 1.2

Comments

The results outlined above apply to the sample as received

QUALTEST Laboratory (NSW) Pty Ltd (20708)
8 Ironbark Close Warabrook NSW 2304
T: 02 4968 4468
F: 02 4960 9775
E: admin@qualtest.com.au
W: www.qualtest.com.au
ABN: 98 153 268 896

Report No: SSI:NEW20W-3182--S02
Issue No: 1

Shrink Swell Index Report

Client:	McCloy Project Management Pty Ltd PO Box 2214 Dangar NSW 2309
Principal:	
Project No.:	NEW17P-0054B
Project Name:	Proposed Subdivision - Hereford Hill - Stage 3 to 5

NATA
WORLD RECOGNISED ACCREDITATION

B. Cullen
Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 9/09/2020

Sample Details

Sample ID:	NEW20W-3182--S02	**Client Sample ID:**	-
Test Request No.:	-	**Sampling Method:**	Sampled by Engineering Department
Material:	Sandy Clay	**Date Sampled:**	1/09/2020
Source:	On Site	**Date Submitted:**	4/09/2020
Specification:	No Specification		
Project Location:	New England Highway, Lochinvar, NSW		
Sample Location:	TP302 - (0.4 - 0.6m)		
Borehole Number:	TP302		
Borehole Depth (m):	0.4 - 0.6		
Date Tested:	4/09/2020		

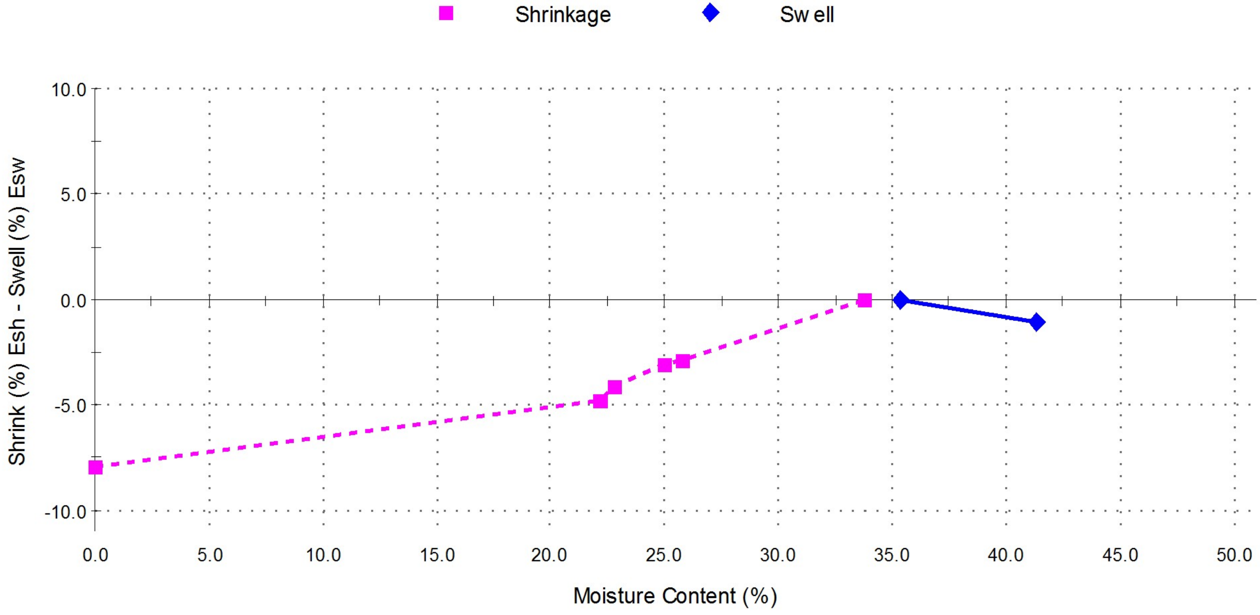
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	-1.1
Moisture Content before (%):	35.4
Moisture Content after (%):	41.3
Est. Unc. Comp. Strength before (kPa):	220
Est. Unc. Comp. Strength after (kPa):	120

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	7.9
Shrinkage Moisture Content (%):	33.8
Est. inert material (%):	3%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Nil

Shrink Swell



Shrink Swell Index - Iss (%): 4.4

Comments

The results outlined above apply to the sample as received

QUALTEST Laboratory (NSW) Pty Ltd (20708)
8 Ironbark Close Warabrook NSW 2304
T: 02 4968 4468
F: 02 4960 9775
E: admin@qualtest.com.au
W: www.qualtest.com.au
ABN: 98 153 268 896

Report No: SSI:NEW20W-3182--S03
Issue No: 1

Shrink Swell Index Report

Client:	McCloy Project Management Pty Ltd PO Box 2214 Dangar NSW 2309
Principal:	
Project No.:	NEW17P-0054B
Project Name:	Proposed Subdivision - Hereford Hill - Stage 3 to 5

Accredited for compliance with ISO/IEC 17025-Testing.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Results provided relate only to the items tested or sampled.
This report shall not be reproduced except in full.

NATA
WORLD RECOGNISED ACCREDITATION

B. Cullen
Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 9/09/2020

Sample Details

Sample ID:	NEW20W-3182--S03	**Client Sample ID:**	-
Test Request No.:	-	**Sampling Method:**	Sampled by Engineering Department
Material:	Sandy Clay	**Date Sampled:**	1/09/2020
Source:	On Site	**Date Submitted:**	4/09/2020
Specification:	No Specification		
Project Location:	New England Highway, Lochinvar, NSW		
Sample Location:	TP303 - (0.85 - 1.10m)		
Borehole Number:	TP303		
Borehole Depth (m):	0.85 - 1.1		
Date Tested:	4/09/2020		

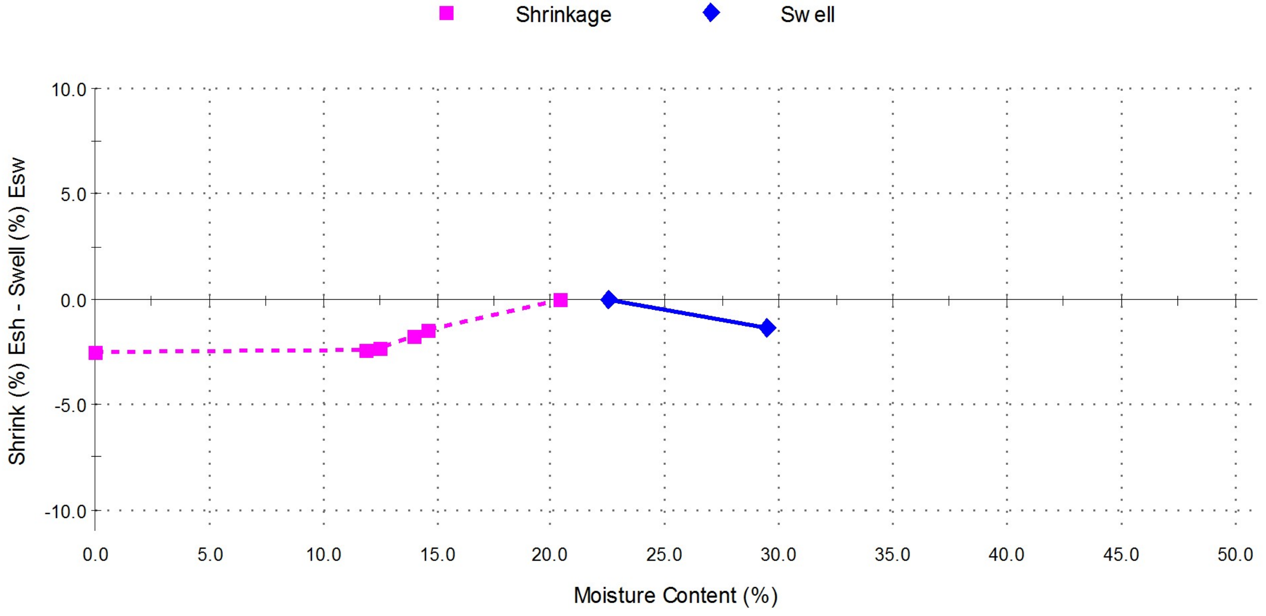
Swell Test — AS 1289.7.1.1

Swell on Saturation (%):	-1.3
Moisture Content before (%):	22.5
Moisture Content after (%):	29.5
Est. Unc. Comp. Strength before (kPa):	490
Est. Unc. Comp. Strength after (kPa):	220

Shrink Test — AS 1289.7.1.1

Shrink on drying (%):	2.5
Shrinkage Moisture Content (%):	20.4
Est. inert material (%):	<1%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Major

Shrink Swell



Shrink Swell Index - Iss (%): 1.4

Comments

The results outlined above apply to the sample as received

QUALTEST Laboratory (NSW) Pty Ltd (20708)
8 Ironbark Close Warabrook NSW 2304
T: 02 4968 4468
F: 02 4960 9775
E: admin@qualtest.com.au
W: www.qualtest.com.au
ABN: 98 153 268 896

Report No: SSI:NEW20W-3182--S04
Issue No: 1

Shrink Swell Index Report

Client:	McCloy Project Management Pty Ltd PO Box 2214 Dangar NSW 2309
Principal:	
Project No.:	NEW17P-0054B
Project Name:	Proposed Subdivision - Hereford Hill - Stage 3 to 5

NATA
WORLD RECOGNISED ACCREDITATION

B. Cullen
Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 10/09/2020

Sample Details

Sample ID:	NEW20W-3182--S04	**Client Sample ID:**	-
Test Request No.:	-	**Sampling Method:**	Sampled by Engineering Department
Material:	Sandy Clay	**Date Sampled:**	1/09/2020
Source:	On Site	**Date Submitted:**	4/09/2020
Specification:	No Specification		
Project Location:	New England Highway, Lochinvar, NSW		
Sample Location:	TP304 - (1.0 - 1.20m)		
Borehole Number:	TP304		
Borehole Depth (m):	1.0 - 1.2		
Date Tested:	4/09/2020		

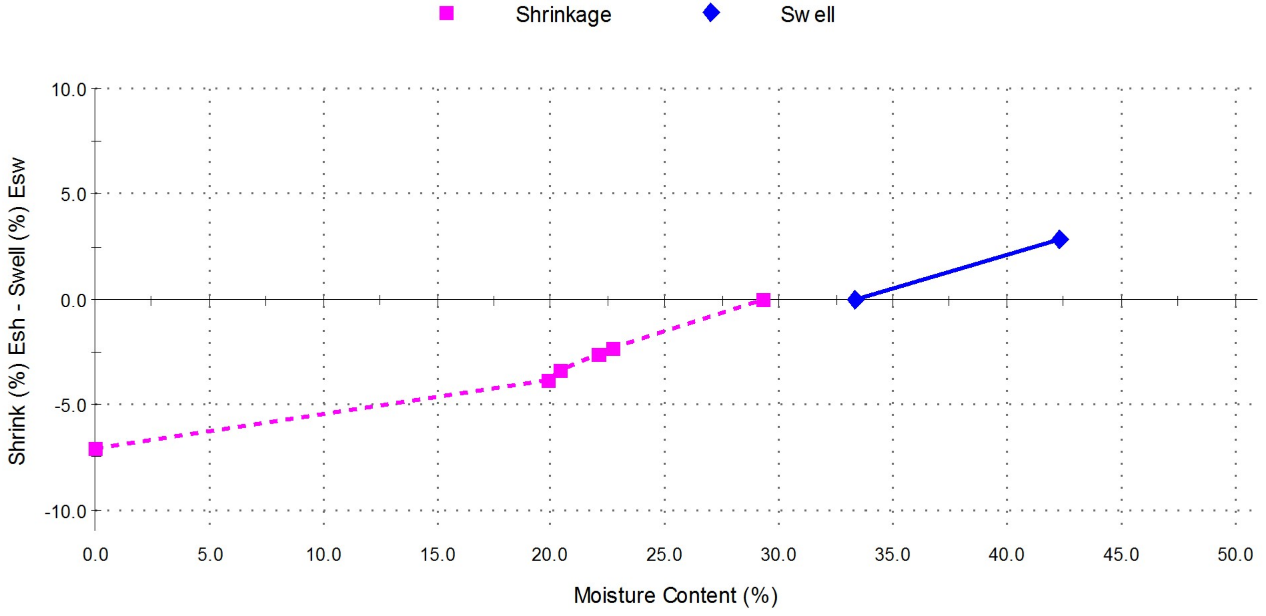
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	2.9
Moisture Content before (%):	33.3
Moisture Content after (%):	42.3
Est. Unc. Comp. Strength before (kPa):	470
Est. Unc. Comp. Strength after (kPa):	200

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	7.1
Shrinkage Moisture Content (%):	29.3
Est. inert material (%):	<1%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Nil

Shrink Swell



Shrink Swell Index - Iss (%): 4.8

Comments

The results outlined above apply to the sample as received

QUALTEST Laboratory (NSW) Pty Ltd (20708)
8 Ironbark Close Warabrook NSW 2304
T: 02 4968 4468
F: 02 4960 9775
E: admin@qualtest.com.au
W: www.qualtest.com.au
ABN: 98 153 268 896

Shrink Swell Index Report

Report No: SSI:NEW20W-3182--S05
Issue No: 1

Client: McCloy Project Management Pty Ltd
PO Box 2214
Dangar NSW 2309

Principal:
Project No.: NEW17P-0054B
Project Name: Proposed Subdivision - Hereford Hill - Stage 3 to 5

Accredited for compliance with ISO/IEC 17025-Testing.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Results provided relate only to the items tested or sampled.
This report shall not be reproduced except in full.

NATA
WORLD RECOGNISED ACCREDITATION

B. Cullen
Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 10/09/2020

Sample Details

Sample ID:	NEW20W-3182--S05	**Client Sample ID:**	-
Test Request No.:	-	**Sampling Method:**	Sampled by Engineering Department
Material:	Sandy Clay	**Date Sampled:**	1/09/2020
Source:	On Site	**Date Submitted:**	4/09/2020
Specification:	No Specification		
Project Location:	New England Highway, Lochinvar, NSW		
Sample Location:	TP305 - (0.3 - 0.5m)		
Borehole Number:	TP305		
Borehole Depth (m):	0.3 - 0.5		
Date Tested:	4/09/2020		

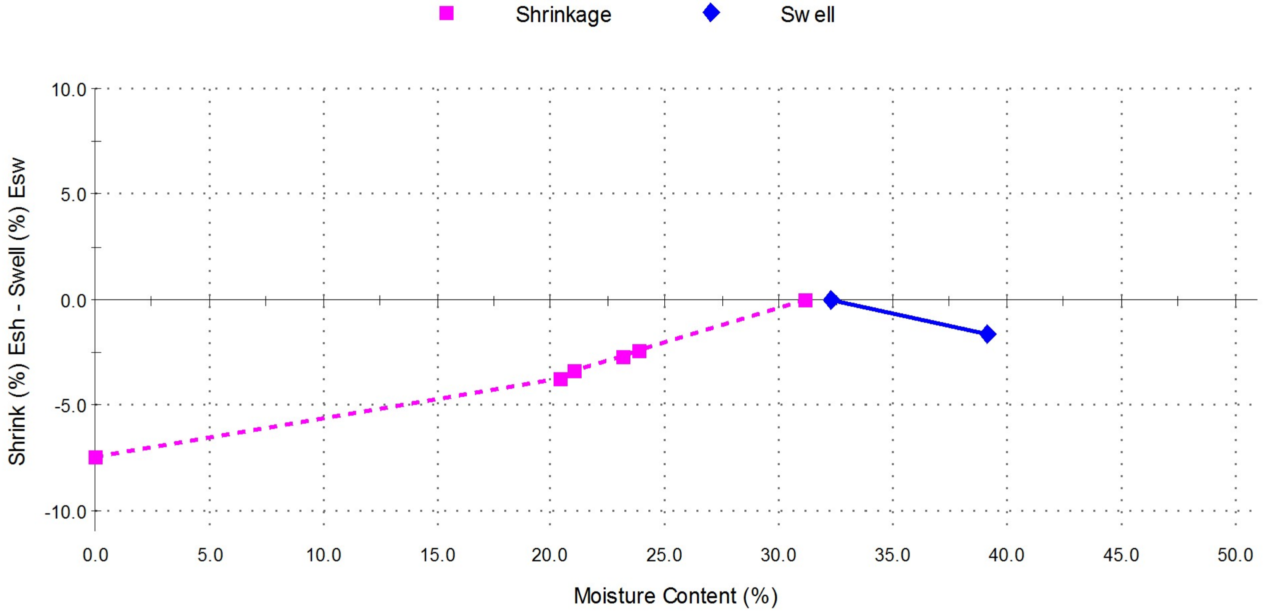
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	-1.7
Moisture Content before (%):	32.3
Moisture Content after (%):	39.1
Est. Unc. Comp. Strength before (kPa):	130
Est. Unc. Comp. Strength after (kPa):	90

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	7.5
Shrinkage Moisture Content (%):	31.1
Est. inert material (%):	<1%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Nil

Shrink Swell



Shrink Swell Index - Iss (%): 4.2

Comments

The results outlined above apply to the sample as received

QUALTEST Laboratory (NSW) Pty Ltd (20708)
8 Ironbark Close Warabrook NSW 2304
T: 02 4968 4468
F: 02 4960 9775
E: admin@qualtest.com.au
W: www.qualtest.com.au
ABN: 98 153 268 896

Report No: SSI:NEW20W-3182--S06
Issue No: 1

Shrink Swell Index Report

Client:	McCloy Project Management Pty Ltd PO Box 2214 Dangar NSW 2309
Principal:	
Project No.:	NEW17P-0054B
Project Name:	Proposed Subdivision - Hereford Hill - Stage 3 to 5

B. Cullen
Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 10/09/2020

Sample Details

Sample ID:	NEW20W-3182--S06	**Client Sample ID:**	-
Test Request No.:	-	**Sampling Method:**	Sampled by Engineering Department
Material:	Sandy Clay	**Date Sampled:**	1/09/2020
Source:	On Site	**Date Submitted:**	4/09/2020
Specification:	No Specification		
Project Location:	New England Highway, Lochinvar, NSW		
Sample Location:	TP306 - (0.5 - 0.7m)		
Borehole Number:	TP306		
Borehole Depth (m):	0.5 - 0.7		
Date Tested:	4/09/2020		

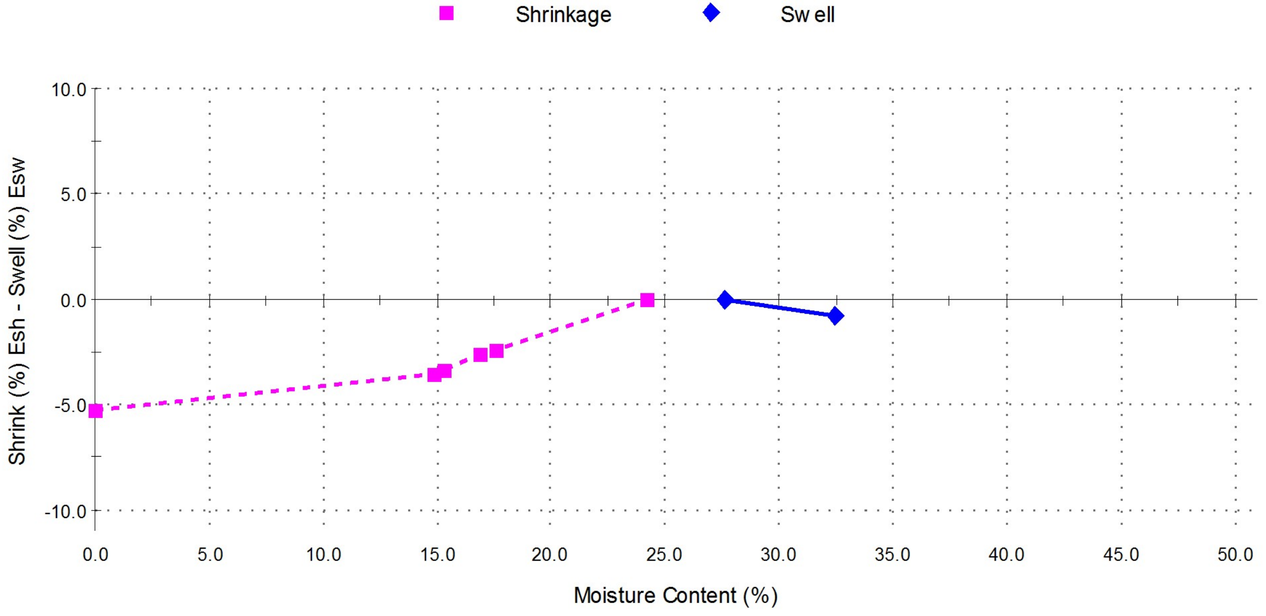
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	-0.8
Moisture Content before (%):	27.6
Moisture Content after (%):	32.4
Est. Unc. Comp. Strength before (kPa):	200
Est. Unc. Comp. Strength after (kPa):	200

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	5.3
Shrinkage Moisture Content (%):	24.2
Est. inert material (%):	<1%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Nil

Shrink Swell



Shrink Swell Index - Iss (%): 2.9

Comments

The results outlined above apply to the sample as received

QUALTEST Laboratory (NSW) Pty Ltd (20708)
8 Ironbark Close Warabrook NSW 2304
T: 02 4968 4468
F: 02 4960 9775
E: admin@qualtest.com.au
W: www.qualtest.com.au
ABN: 98 153 268 896

Material Test Report

Report No: MAT:NEW20W-3231--S01
Issue No: 1

Client: McCloy Project Management Pty Ltd
PO Box 2214
Dangar NSW 2309

Principal:
Project No.: NEW17P-0054B
Project Name: Proposed Subdivision - Hereford Hill - Stage 3 to 5

Accredited for compliance with ISO/IEC 17025-Testing.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Results provided relate only to the items tested or sampled.
This report shall not be reproduced except in full.

B. Cullen
Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 14/09/2020

Sample Details

Sample ID: NEW20W-3231--S01
Sampling Method: Sampled by Engineering Department
Date Sampled: 04/09/2020
Source: On-Site
Material: Insitu
Specification: No Specification
Project Location: New England Highway, Lochinvar, NSW
Sample Location: TP307 - (0.65 - 0.85m)

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	7.5	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		Yes	
Liquid Limit (%)	AS 1289.3.1.1	39	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	25	
Plasticity Index (%)	AS 1289.3.3.1	14	
Date Tested		11/09/2020	

Comments

The results outlined above apply to the sample as received

QUALTEST Laboratory (NSW) Pty Ltd (20708)
8 Ironbark Close Warabrook NSW 2304
T: 02 4968 4468
F: 02 4960 9775
E: admin@qualtest.com.au
W: www.qualtest.com.au
ABN: 98 153 268 896

Shrink Swell Index Report

Report No: SSI:NEW20W-3231--S02
Issue No: 1

Client: McCloy Project Management Pty Ltd
PO Box 2214
Dangar NSW 2309

Principal:
Project No.: NEW17P-0054B
Project Name: Proposed Subdivision - Hereford Hill - Stage 3 to 5

Accredited for compliance with ISO/IEC 17025-Testing.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Results provided relate only to the items tested or sampled.
This report shall not be reproduced except in full.

NATA
WORLD RECOGNISED ACCREDITATION

B. Cullen
Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 15/09/2020

Sample Details

Sample ID: NEW20W-3231--S02
Client Sample ID: -
Test Request No.: -
Sampling Method: Sampled by Engineering Department
Material: Insitu
Date Sampled: 4/09/2020
Source: On-Site
Date Submitted: 9/09/2020
Specification: No Specification
Project Location: New England Highway, Lochinvar, NSW
Sample Location: TP308 - (0.3 - 0.6m)
Borehole Number: TP308
Borehole Depth (m): 0.3 - 0.6
Date Tested: 9/09/2020

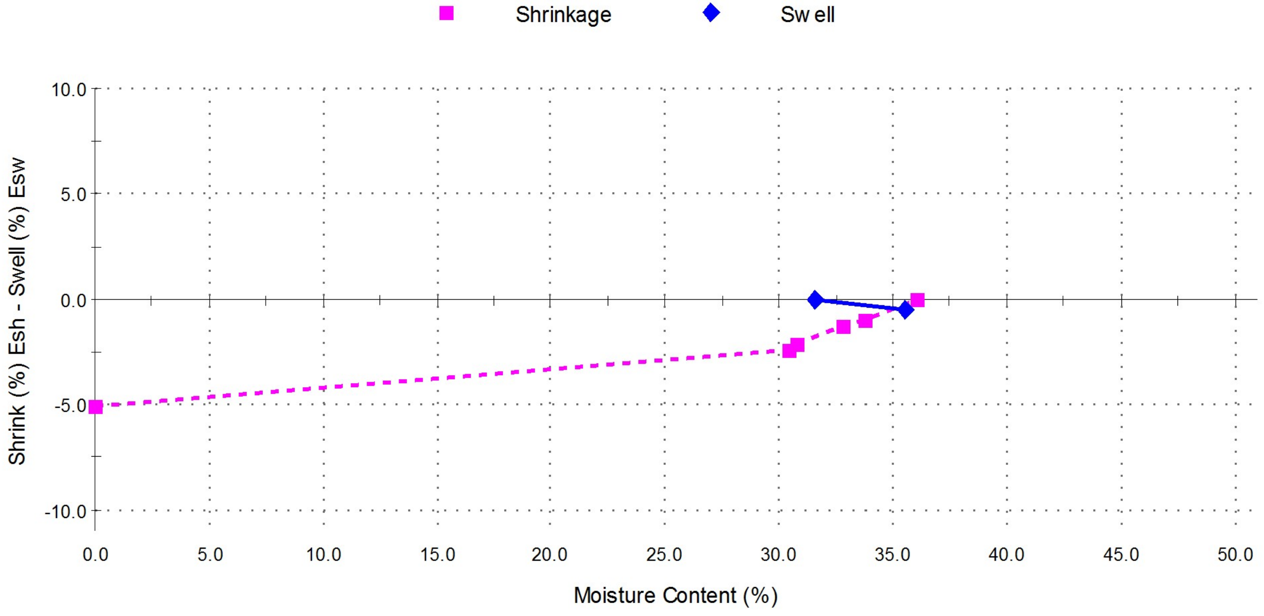
Swell Test AS 1289.7.1.1

Swell on Saturation (%): -0.5
Moisture Content before (%): 31.6
Moisture Content after (%): 35.5
Est. Unc. Comp. Strength before (kPa): 340
Est. Unc. Comp. Strength after (kPa): 200

Shrink Test AS 1289.7.1.1

Shrink on drying (%): 5.1
Shrinkage Moisture Content (%): 36.0
Est. inert material (%): 7%
Crumbling during shrinkage: Nil
Cracking during shrinkage: Nil

Shrink Swell



Shrink Swell Index - Iss (%): 2.8

Comments

The results outlined above apply to the sample as received

QUALTEST Laboratory (NSW) Pty Ltd (20708)
8 Ironbark Close Warabrook NSW 2304
T: 02 4968 4468
F: 02 4960 9775
E: admin@qualtest.com.au
W: www.qualtest.com.au
ABN: 98 153 268 896

Report No: SSI:NEW20W-3231--S03
Issue No: 1

Shrink Swell Index Report

Client:	McCloy Project Management Pty Ltd PO Box 2214 Dangar NSW 2309
Principal:	
Project No.:	NEW17P-0054B
Project Name:	Proposed Subdivision - Hereford Hill - Stage 3 to 5

Accredited for compliance with ISO/IEC 17025-Testing.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Results provided relate only to the items tested or sampled.
This report shall not be reproduced except in full.

B. Cullen
Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 15/09/2020

Sample Details

Sample ID:	NEW20W-3231--S03	**Client Sample ID:**	-
Test Request No.:	-	**Sampling Method:**	Sampled by Engineering Department
Material:	Insitu	**Date Sampled:**	4/09/2020
Source:	On-Site	**Date Submitted:**	9/09/2020
Specification:	No Specification		
Project Location:	New England Highway, Lochinvar, NSW		
Sample Location:	TP309 - (0.45 - 0.6m)		
Borehole Number:	TP309		
Borehole Depth (m):	0.45 - 0.6		
Date Tested:	9/09/2020		

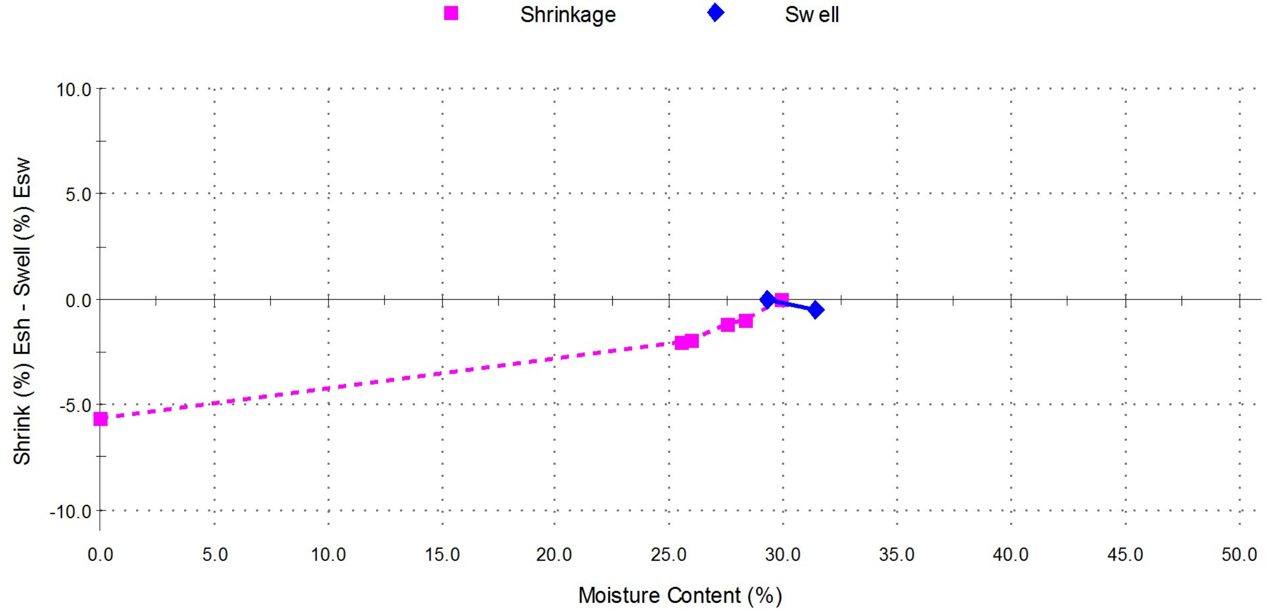
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	-0.5
Moisture Content before (%):	29.3
Moisture Content after (%):	31.4
Est. Unc. Comp. Strength before (kPa):	300
Est. Unc. Comp. Strength after (kPa):	210

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	5.7
Shrinkage Moisture Content (%):	29.9
Est. inert material (%):	7%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Minor

Shrink Swell



Shrink Swell Index - Iss (%): 3.2

Comments

The results outlined above apply to the sample as received

QUALTEST Laboratory (NSW) Pty Ltd (20708)
8 Ironbark Close Warabrook NSW 2304
T: 02 4968 4468
F: 02 4960 9775
E: admin@qualtest.com.au
W: www.qualtest.com.au
ABN: 98 153 268 896

Report No: SSI:NEW20W-3231--S04
Issue No: 1

Shrink Swell Index Report

Client:	McCloy Project Management Pty Ltd PO Box 2214 Dangar NSW 2309
Principal:	
Project No.:	NEW17P-0054B
Project Name:	Proposed Subdivision - Hereford Hill - Stage 3 to 5

Accredited for compliance with ISO/IEC 17025-Testing.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Results provided relate only to the items tested or sampled.
This report shall not be reproduced except in full.

NATA
WORLD RECOGNISED ACCREDITATION

B. Cullen
Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 15/09/2020

Sample Details

Sample ID:	NEW20W-3231--S04	**Client Sample ID:**	-
Test Request No.:	-	**Sampling Method:**	Sampled by Engineering Department
Material:	Insitu	**Date Sampled:**	4/09/2020
Source:	On-Site	**Date Submitted:**	9/09/2020
Specification:	No Specification		
Project Location:	New England Highway, Lochinvar, NSW		
Sample Location:	TP310 - (0.5 - 0.7m)		
Borehole Number:	TP310		
Borehole Depth (m):	0.5 - 0.7		
Date Tested:	9/09/2020		

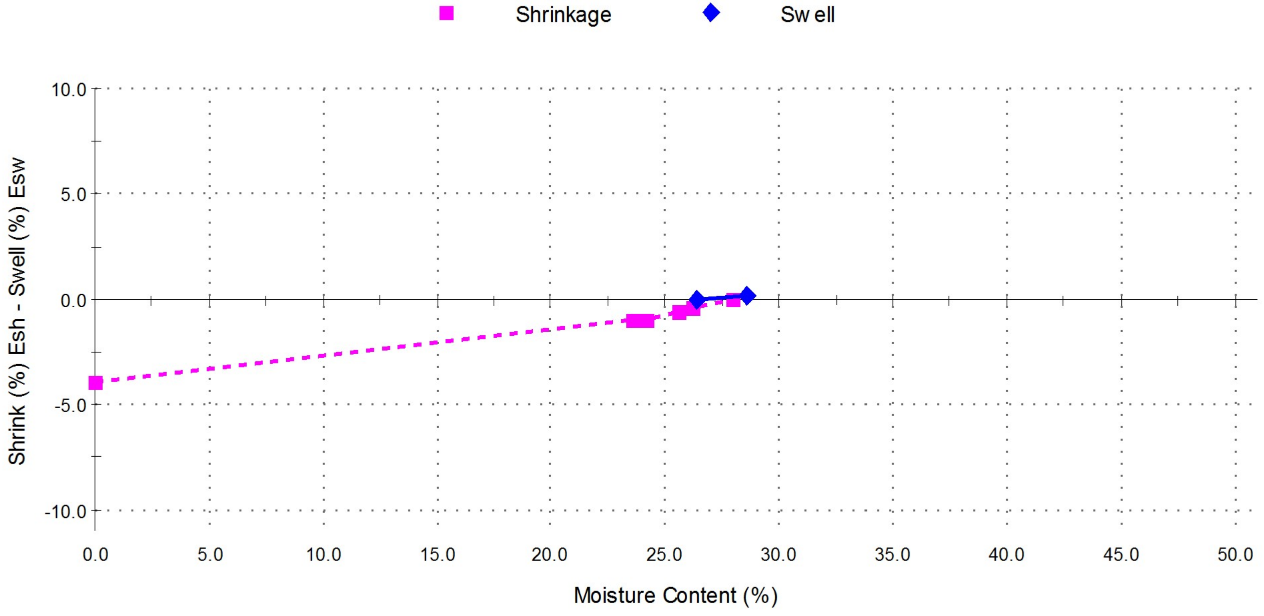
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	0.2
Moisture Content before (%):	26.4
Moisture Content after (%):	28.6
Est. Unc. Comp. Strength before (kPa):	450
Est. Unc. Comp. Strength after (kPa):	300

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	3.9
Shrinkage Moisture Content (%):	27.9
Est. inert material (%):	9%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Major

Shrink Swell



Shrink Swell Index - Iss (%): 2.2

Comments

The results outlined above apply to the sample as received

QUALTEST Laboratory (NSW) Pty Ltd (20708)
8 Ironbark Close Warabrook NSW 2304
T: 02 4968 4468
F: 02 4960 9775
E: admin@qualtest.com.au
W: www.qualtest.com.au
ABN: 98 153 268 896

Report No: SSI:NEW20W-3182--S07
Issue No: 1

Shrink Swell Index Report

Client:	McCloy Project Management Pty Ltd PO Box 2214 Dangar NSW 2309
Principal:	
Project No.:	NEW17P-0054B
Project Name:	Proposed Subdivision - Hereford Hill - Stage 3 to 5

Accredited for compliance with ISO/IEC 17025-Testing.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Results provided relate only to the items tested or sampled.
This report shall not be reproduced except in full.

WORLD RECOGNISED ACCREDITATION

B. Cullen
Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 9/09/2020

Sample Details

Sample ID:	NEW20W-3182--S07	**Client Sample ID:**	-
Test Request No.:	-	**Sampling Method:**	Sampled by Engineering Department
Material:	Sandy Clay	**Date Sampled:**	1/09/2020
Source:	On Site	**Date Submitted:**	4/09/2020
Specification:	No Specification		
Project Location:	New England Highway, Lochinvar, NSW		
Sample Location:	TP311 - (0.8 - 1.0m)		
Borehole Number:	TP311		
Borehole Depth (m):	0.8 - 1.0		
Date Tested:	4/09/2020		

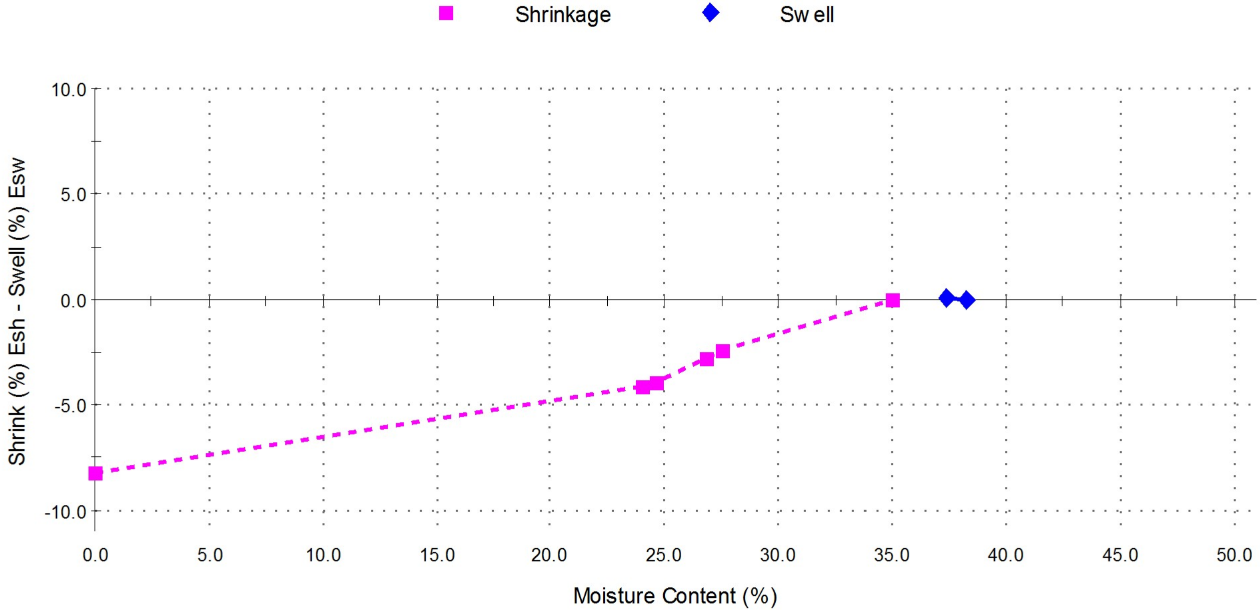
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	0.1
Moisture Content before (%):	38.3
Moisture Content after (%):	37.4
Est. Unc. Comp. Strength before (kPa):	360
Est. Unc. Comp. Strength after (kPa):	230

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	8.2
Shrinkage Moisture Content (%):	35.0
Est. inert material (%):	4%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Minor

Shrink Swell



Shrink Swell Index - Iss (%): 4.6

Comments

The results outlined above apply to the sample as received

QUALTEST Laboratory (NSW) Pty Ltd (20708)
8 Ironbark Close Warabrook NSW 2304
T: 02 4968 4468
F: 02 4960 9775
E: admin@qualtest.com.au
W: www.qualtest.com.au
ABN: 98 153 268 896

Shrink Swell Index Report

Report No: SSI:NEW20W-3182--S08
Issue No: 1

Client:	McCloy Project Management Pty Ltd PO Box 2214 Dangar NSW 2309
Principal:	
Project No.:	NEW17P-0054B
Project Name:	Proposed Subdivision - Hereford Hill - Stage 3 to 5

Accredited for compliance with ISO/IEC 17025-Testing.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Results provided relate only to the items tested or sampled.
This report shall not be reproduced except in full.

B. Cullen
Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 9/09/2020

Sample Details

Sample ID:	NEW20W-3182--S08	**Client Sample ID:**	-
Test Request No.:	-	**Sampling Method:**	Sampled by Engineering Department
Material:	Sandy Clay	**Date Sampled:**	1/09/2020
Source:	On Site	**Date Submitted:**	4/09/2020
Specification:	No Specification		
Project Location:	New England Highway, Lochinvar, NSW		
Sample Location:	TP312 - (0.4 - 0.6m)		
Borehole Number:	TP312		
Borehole Depth (m):	0.4 - 0.6		
Date Tested:	4/09/2020		

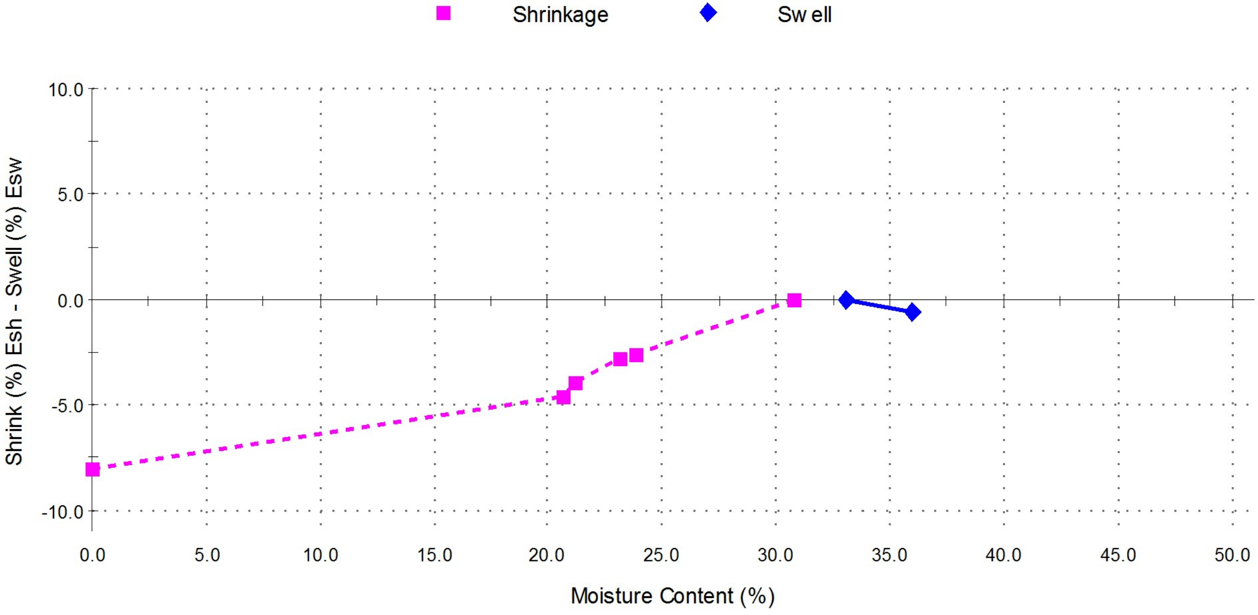
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	-0.6
Moisture Content before (%):	33.0
Moisture Content after (%):	35.9
Est. Unc. Comp. Strength before (kPa):	270
Est. Unc. Comp. Strength after (kPa):	170

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	8.0
Shrinkage Moisture Content (%):	30.8
Est. inert material (%):	<1%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Nil

Shrink Swell



Shrink Swell Index - Iss (%): 4.4

Comments

The results outlined above apply to the sample as received

QUALTEST Laboratory (NSW) Pty Ltd (20708)
8 Ironbark Close Warabrook NSW 2304
T: 02 4968 4468
F: 02 4960 9775
E: admin@qualtest.com.au
W: www.qualtest.com.au
ABN: 98 153 268 896

Shrink Swell Index Report

Report No: SSI:NEW20W-3182--S09
Issue No: 1

Client:	McCloy Project Management Pty Ltd PO Box 2214 Dangar NSW 2309
Principal:	
Project No.:	NEW17P-0054B
Project Name:	Proposed Subdivision - Hereford Hill - Stage 3 to 5

Accredited for compliance with ISO/IEC 17025-Testing.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Results provided relate only to the items tested or sampled.
This report shall not be reproduced except in full.

B. Cullen
Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 9/09/2020

Sample Details

Sample ID:	NEW20W-3182--S09	**Client Sample ID:**	-
Test Request No.:	-	**Sampling Method:**	Sampled by Engineering Department
Material:	Sandy Clay	**Date Sampled:**	1/09/2020
Source:	On Site	**Date Submitted:**	4/09/2020
Specification:	No Specification		
Project Location:	New England Highway, Lochinvar, NSW		
Sample Location:	TP313 - (0.6 - 0.8m)		
Borehole Number:	TP313		
Borehole Depth (m):	0.6 - 0.8		
Date Tested:	4/09/2020		

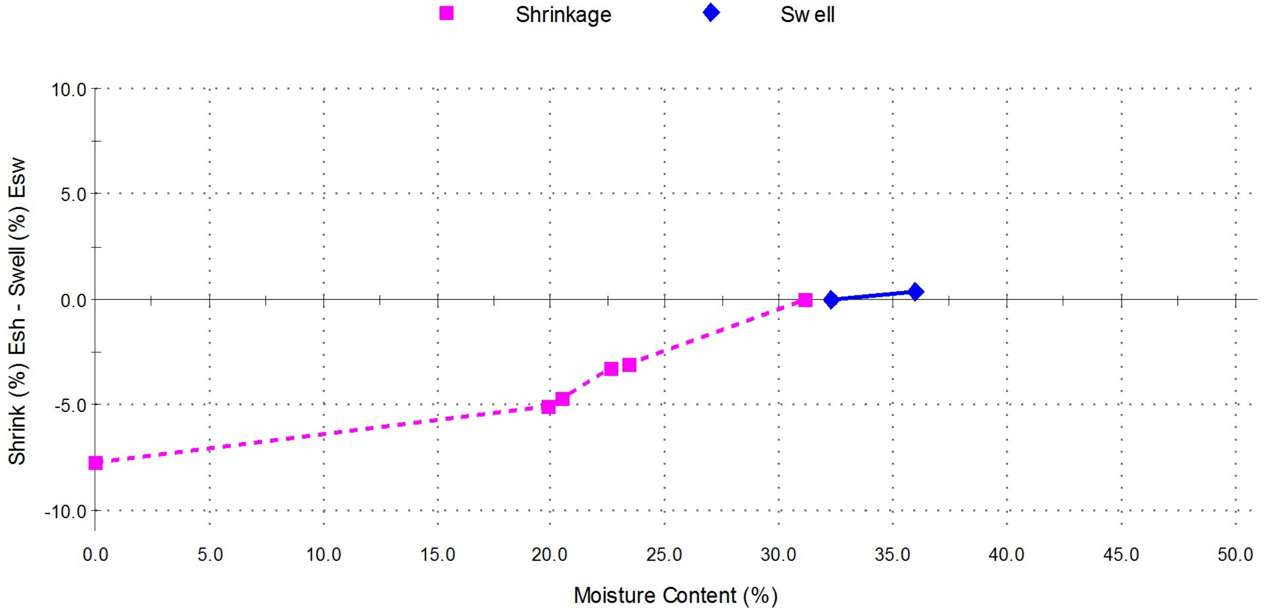
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	0.3
Moisture Content before (%):	32.3
Moisture Content after (%):	35.9
Est. Unc. Comp. Strength before (kPa):	280
Est. Unc. Comp. Strength after (kPa):	220

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	7.8
Shrinkage Moisture Content (%):	31.1
Est. inert material (%):	<1%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Nil

Shrink Swell



Shrink Swell Index - Iss (%): 4.4

Comments

The results outlined above apply to the sample as received

QUALTEST Laboratory (NSW) Pty Ltd (20708)
8 Ironbark Close Warabrook NSW 2304
T: 02 4968 4468
F: 02 4960 9775
E: admin@qualtest.com.au
W: www.qualtest.com.au
ABN: 98 153 268 896

Report No: SSI:NEW20W-3182--S10
Issue No: 1

Shrink Swell Index Report

Client:	McCloy Project Management Pty Ltd PO Box 2214 Dangar NSW 2309
Principal:	
Project No.:	NEW17P-0054B
Project Name:	Proposed Subdivision - Hereford Hill - Stage 3 to 5

B. Cullen
Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 15/09/2020

Sample Details

Sample ID:	NEW20W-3182--S10	**Client Sample ID:**	-
Test Request No.:	-	**Sampling Method:**	Sampled by Engineering Department
Material:	Sandy Clay	**Date Sampled:**	1/09/2020
Source:	On Site	**Date Submitted:**	4/09/2020
Specification:	No Specification		
Project Location:	New England Highway, Lochinvar, NSW		
Sample Location:	TP314 - (0.4 - 0.6m)		
Borehole Number:	TP314		
Borehole Depth (m):	0.4 - 0.6		
Date Tested:	4/09/2020		

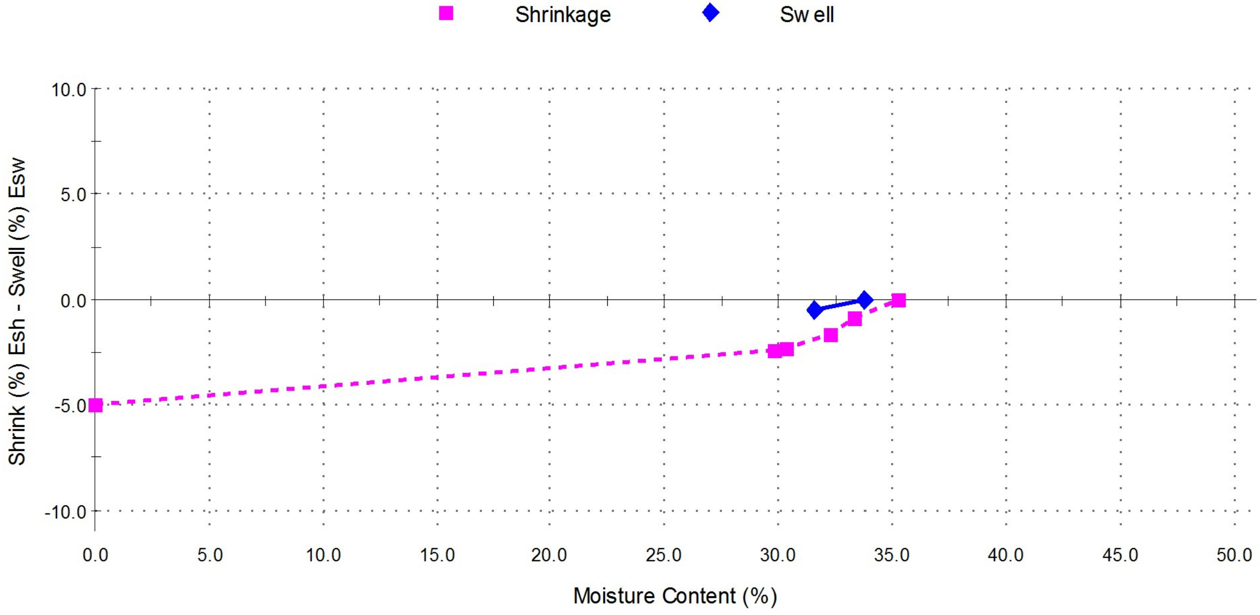
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	-0.5
Moisture Content before (%):	33.8
Moisture Content after (%):	31.5
Est. Unc. Comp. Strength before (kPa):	200
Est. Unc. Comp. Strength after (kPa):	150

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	5.0
Shrinkage Moisture Content (%):	35.3
Est. inert material (%):	5%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Major

Shrink Swell



Shrink Swell Index - Iss (%): 2.8

Comments

The results outlined above apply to the sample as received

APPENDIX C:

CSIRO Sheet BTF 18

Foundation Maintenance and Footing Performance: A Homeowner’s Guide

Foundation Maintenance and Footing Performance:

A Homeowner's Guide

CSIRO

BTF 18 replaces Information Sheet 10/91

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

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

Soil Types

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

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

Causes of Movement

Settlement due to construction

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

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

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

Erosion

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

Saturation

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

Seasonal swelling and shrinkage of soil

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

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

Shear failure

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

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

GENERAL DEFINITIONS OF SITE CLASSES

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

Tree root growth

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

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

Unevenness of Movement

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

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

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

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

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

Effects of Uneven Soil Movement on Structures

Erosion and saturation

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

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

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

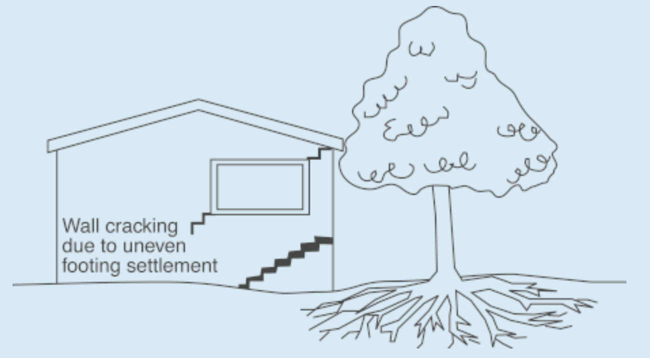
Seasonal swelling/shrinkage in clay

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

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

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

Trees can cause shrinkage and damage



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

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

Movement caused by tree roots

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

Complications caused by the structure itself

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

Effects on full masonry structures

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

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

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

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

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

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

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

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

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

Water Service and Drainage

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

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

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

Seriousness of Cracking

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

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

Prevention/Cure

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

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

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

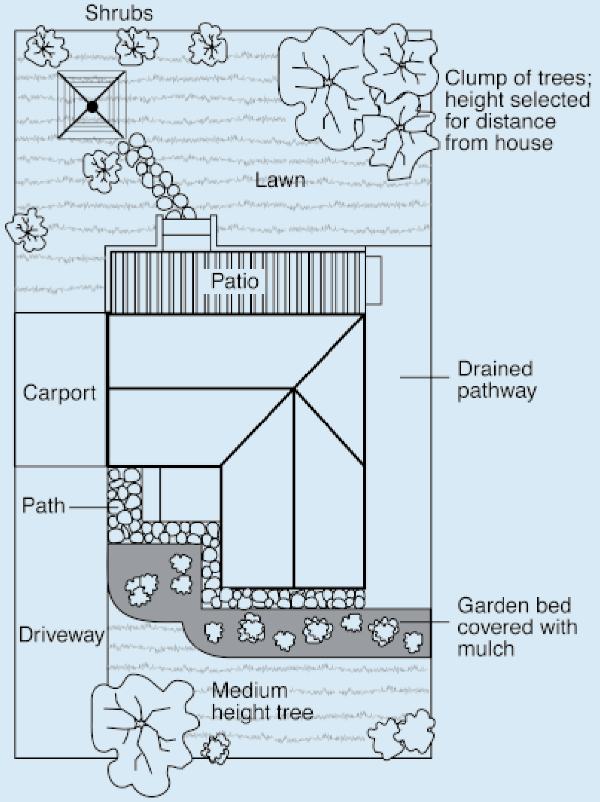
Protection of the building perimeter
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

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

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

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

Gardens for a reactive site



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

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

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

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

Condensation

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

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

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

The garden

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

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

Existing trees

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

Information on trees, plants and shrubs

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

Excavation

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

Remediation

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

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

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

Distributed by

CSIRO PUBLISHING PO Box 1139, Collingwood 3066, Australia

Freecall 1800 645 051 Tel (03) 9662 7666 Fax (03) 9662 7555 www.publish.csiro.au

Email: publishing.sales@csiro.au