aurecon

Project: Stonebrook Subdivision

Geotechnical Completion Report Stage 19

Reference: 224926

Prepared for: CDL Land New Zealand Ltd.

Revision: 1

7 April 2015

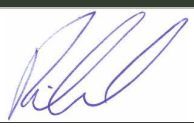
Document Control Record

Document prepared by:

Aurecon New Zealand Limited
Unit 1, 150 Cavendish Road
Casebrook Christchurch 8051
PO Box 1061
Christchurch 8140
New Zealand

T +64 3 366 0821
F +64 3 379 6955
E christchurch@aurecongroup.com
W aurecongroup.com

Document control						
Report Title	Geotechnical Completion Report Stage 19					
Document ID		**Project Number**	224926			
File Path	P:\224926\Geotech\Geotech Completion Report\Stage 19\224926 - Stage 19 - Geotech Completion Report .docx					
Client	CDL Land New Zealand Ltd.	**Client Contact**	Jason Adams			
Rev	**Date**	**Revision Details/Status**	**Prepared by**	**Author**	**Verifier**	**Approver**
0	30 March 2015	Draft for review	T. Mitchell	T. Mitchell	R. Heritage	
1	7 April 2015	For Issue	T. Mitchell	T. Mitchell	R. Heritage	I. McPherson
Current Revision	**1**					

Approval					
Author Signature		Verifier Signature		Approver Signature	
Name	T. Mitchell	Name	R. Heritage	Name	I. McPherson
Title	Geotechnical Engineer	Title	Senior Geotechnical Engineer CPEng No. 1000332	Title	Technical Director CPEng No. 49903

Contents

Appendices

1. Executive Summary

CDL New Zealand Limited is developing Stage 19 of the Stonebrook Subdivision, located between Main South Road and Burnham School Road in Rolleston, south west Christchurch. As part of this work, a geotechnical completion report is required to certify that the site works have been carried out to the required standard. This report describes earthworks involved with Stage 19 of the Stonebrook Subdivision comprising Lots 358 to 370.

Geotechnical testing carried out as part of the subdivision consent stage indicated that the Stonebrook Subdivision is classified as Technical Category 1 (TC1) with a deep groundwater table and competent gravels at shallow depths.

Earthworks to form the subdivision including cutting and filling have occurred on the site. The quality assurance (QA) testing of the earthfill indicates that 95% of Maximum Dry Density or greater compaction levels were consistently achieved and we believe that earthfill placed within the Stage 19 has achieved the required compaction levels as per intent and definition of NZS4431:1989.

From the testing undertaken as part of the development of the Stage 19 area the following is concluded:

- Bulk earthworks meet the earthworks specifications, including NZS4431:1989.
- In line with our subdivision consent assessment, the site is likely to perform to the level of TC1 equivalent.
- As the land is likely to perform to a level of TC1, and the lots are underlain by earthfill that has achieved the required compaction, we consider NZS 3604:2011 type foundations will be suitable for light weight timber frame buildings.
- The usual investigations and site observations will be required for the building consent and construction phases.

This report shall be read as a whole. Our limitations are presented in Section 7.

2. Introduction

2.1 Geotechnical Completion

CDL Land New Zealand Limited is developing Stage 19 of the Stonebrook Subdivision, located on Burnham School Road, Rolleston (See Figure 1 in Appendix A). The site works on Stage 19 have included bulk earthworks. As part of the work, a geotechnical completion report is required to certify the site works have been carried out to the required standard and to provide recommendations for building development.

This report has been prepared for CDL Land New Zealand Limited and Selwyn District Council. It describes earthworks within Stage 19 of the Stonebrook Subdivision (See Figure 2 in Appendix A).

The purpose of the geotechnical completion report is to present the following:

- A summary of previous investigation information prepared as part of subdivision consent investigations and detailed design;
- A summary of the ground conditions;
- The extent of earthworks on the lots and compliance testing of bulk earthworks;
- A summary of the findings and recommendations for residential building development.

This report has been prepared based upon known geotechnical data and compaction testing undertaken during and after earthworks construction. All references to cut/fill depths are based on the early 2012 ground levels.

This report shall be read as a whole. Our limitations are presented in Section 7.

2.2 Site Description

The Stonebrook subdivision is located south west of the Rolleston town centre and covers an area of approximately 42ha. The site has been divided into 23 stages between Main South Road to the north and Burnham School Road to the south. This report relates to Stage 19 which is essentially flat and currently vegetated with grass.

3. Pre-Development Geotechnical Work

3.1 Geotechnical Investigations

The subdivision consent and detailed geotechnical design for the subdivision included a series of geotechnical investigations comprising a desktop study, test pits and boreholes. The details of these investigations are presented in the Aurecon report *"Brookside Road Subdivision, Geotechnical Report"* for Subdivision Consent, Revision 1 dated 1 November 2011.

The type and number of investigations is presented in Table 1 below.

Table 1: Subdivision Consent Investigations

Type of Investigation	Number of Investigations
Test Pits	64
Borehole with SPT at 1.5m centres	2

3.2 Ground Conditions

From the geotechnical investigations the ground conditions within Stage 19 are summarised in Table 2.

Table 2: Typical ground conditions within the Stage 19

Depth to Top of Unit (m)	Depth to Base of Unit (m)	Soil Unit
0	0.15 to 0.35	TOPSOIL: dark brown, SILT.
0.15 to 0.35	>60	Alluvium: brownish grey GRAVEL and Sandy GRAVEL with occasional silt, clay and sand lenses.

Groundwater levels ranged from 10.3m to 13.1m below ground level. During the site earthworks the ground conditions summarised in Table 2 were typically encountered and groundwater was not encountered within the depth of interest.

3.3 Liquefaction Potential

No evidence of liquefaction such as sand boils or other surface manifestations were encountered following earthquakes in the Canterbury region since September 2010 based on observations on site during investigations and inspection of the Selwyn District Council Liquefaction Map (Selwyn District Council, 2011). This lack of evidence is consistent with a deep water table and the dense nature of the sand and gravel underlying the site.

4. Subdivision Earthworks

4.1 General

Bulk earthworks for Stage 19 of Stonebrook Subdivision were carried out in accordance with the Selwyn District Council requirements outlined in the engineering approval letter dated 29 August 2012 and NZS4431:1989 "*Code of Practice for Earthfill for Residential Development*". The works comprised regrading of the site contours for the residential lots by predominantly engineered filling with minor areas of cutting.

4.2 Areas of Cut and Fill

Site earthworks within the Stage 19 comprised filling on all lots with no cutting. The engineered fill comprises onsite natural gravel and has been compacted with a double drum roller. A layer of topsoil has been spread over the engineered fill.

We understand that the gravel fill placed across Stage 19 was sourced from a gravel stockpile in Stage 15 north west of Stage 19. The extent of filling is shown on Figure 3 in Appendix A.

4.3 Compaction Quality Control Testing

Independent testing of earthfill compaction was carried out by City Care Limited Laboratory (City Care) using a Nuclear Densometer (NDM). The acceptance criteria was based on the Selwyn District Council earthworks specification as follows:

- Compaction of fill is to be in accordance with NZS 4431: 1989 *"Code of Practice for Earthfill for Residential Development"*.
- Compaction standard is 95% Maximum Dry Density (MDD) for all areas in accordance with NZS4402:1986 "*Methods of Testing Soils for Civil Engineering Purposes*".

The locations of the soil samples obtained for laboratory compaction testing (Test Site E located in Stage 15 where the gravel used as fill on Stage 19 was stockpiled) are shown on Figure 2 and the results of the nuclear density tests were compared to the compaction tests to confirm the adequacy of the site compaction.

City Care carried out forty four nuclear density tests on lots within Stage 19. The fill was generally placed in a single lift with exception to Lots 262 and 263 where fill was placed in three and two lifts, respectively, with NDM testing carried out following each lift. The compaction test results and the compaction curve for Test Site E is presented in Appendix B.

4.4 Compaction Results

The results presented in Appendix C indicate that 95% MDD or greater compaction has been consistently achieved. We consider that all the earthfill placed within Stages 19 has achieved the required compaction.

4.5 Certification

A statement of suitability of earth fill for residential development indicating the standard of bulk earthworks generally meet our earthworks specification and the applicable codes, including NZS4431:1989 is included in Appendix D.

5. Building Development

5.1 Technical Category

Geotechnical investigations including 64 test pits and two boreholes have been carried out by Aurecon as part of the wider subdivision development and encountered no potentially liquefiable material. The ECan/GNS report *"Review of liquefaction hazard information in eastern Canterbury and parts of Selwyn, Waimakariri and Hurunui Districts" dated December 2012*, identifies the site to be non-liquefiable. Therefore the lots within the Stage 19 are likely to perform to the level of TC1 equivalent.

5.2 Earthworks on Building Lots

The extent of earthfill on Lots within Stage 19 is shown on Figure 3 in Appendix A.

The fill areas have been constructed using materials and processes that have been measured by independent testing. The testing shows that the placement of filling is generally in accordance with the specification.

5.3 Soil Suitability Criteria

Section 3 of New Zealand Standard NZS 3604:2011 "*Timber Framed Buildings not requiring specific Engineering Design*" provides several criteria for defining foundation soil suitability for lightweight timber framed residential buildings.

Clauses 3.1.3 and 3.3 provide criteria for determining strength and suitability of founding soils.

Clauses 3.4.1 and 3.4.2 discuss depths to founding. For purposes of this report, we have interpreted these clauses as meaning that for sound bearing at depths of 200mm to 600mm, standard shallow type foundations can be utilised. For depths greater than this, the use of 10MPa concrete or special foundations such as driven timber piles is to be used or alternatively excavations to "good" ground.

5.4 Building Considerations

As the land is likely to perform to a level of TC1 equivalent and all of the lots are underlain by earthfill that has achieved the required compaction, we consider NZS 3604:2011 type foundations are likely to be suitable provided they are founded below the topsoil.

We note that at the time of writing this report the location and structural form of the future dwelling on the lots are unknown, but we infer that a NZS3604:2011 type lightweight timber framed houses will be constructed.

5.5 Future Earthworks

We do not anticipate that future earthworks will be required on the majority of the lots however should such work be required the following should be noted.

- All earthworks should be carried out in accordance with the Health and Safety and Employment Act 1992 and the Ministry of Building, Innovation and Employment (MBIE) approved Code of Practice for Safety in Excavations and Shafts for Foundations, 1995.
- Cuts that exceed 0.6m high around any of the house sites that support any loads must be retained by a suitable retaining wall designed by a Chartered Professional Engineer.
- We recommend that no more than 450mm of fill is placed on the allotment without detailed engineering design.

- Any retaining walls are constructed across the site should be designed for loading from compaction equipment.

Any development where excavations greater than 1.5m in depth are proposed, must be subject to specific investigation and design to confirm these works will have no adverse effect on land stability and/or structures on adjacent lots.

5.6 Stormwater

All stormwater collected by impermeable surfaces (dwelling and pavement) and grassed areas shall be collected by lined channel drains and sumps etc. and be piped away from the lots to discharge into the Council vested infrastructure.

5.7 Construction Observations

The suitability of foundation conditions must be verified at the time of construction (refer Requirements of NZS 3604:2011). Foundation inspections by a Building Inspector who is familiar with this report or a Chartered Professional Engineer is needed and must be carried out to ensure the adequacy of the foundation subgrade prior to the placement of granular hardfill or the construction of foundations.

6. References

NZS 3604:2011. *Timber Framed Buildings*. Standards New Zealand, Wellington, New Zealand.

NZS 4402:1986. *Methods of Testing Soils for Civil Engineering Purposes*. Standards New Zealand, Wellington, New Zealand.

NZS 4431:1989. *Code of practice for earth fill for residential development*. Standards New Zealand, Wellington, New Zealand.

Brackley, H. L. (compiler). 2012; *Review of liquefaction hazard information in eastern Canterbury including Christchurch City and parts of Selwyn, Waimakariri and Hurunui Districts.* GNS Science Consultancy Report 2012/218. 99 p.

7. Limitations

We have prepared this report in accordance with the brief as provided. The contents of the report are for the sole use of the Client and no responsibility or liability will be accepted to any third party. Data or opinions contained within the report may not be used in other contexts or for any other purposes without our prior review and agreement.

This report has been prepared as part of the development of the Stonebrook Stage 19 Subdivision. It has been prepared to report on the management of the earthworks during construction, including compaction standards of fills.

This report does not remove the responsibility of the Owner / Builder / Building Certifier to satisfy themselves of foundation depth and suitability at the finally selected house location.

Subsurface conditions relevant to construction works should be assessed by experienced contractors and designers who can make their own interpretation of the factual data provided. They should perform any additional tests as necessary for their own purposes. Subsurface conditions, such as groundwater levels, can change over time. This should be borne in mind, particularly if the report is used after a protracted delay or in wet weather.

It is strongly recommended that any plans and specifications prepared by others and relating to the content of this report, or amendments to the original plans and specifications, are reviewed by Aurecon to verify that the intent of our recommendations is properly reflected in the design. During construction we request the opportunity to review our interpretations if the exposed site conditions are significantly different from those inferred in this report.

This report is not to be reproduced either wholly or in part without our prior written permission.

Appendix A

Figures

CLIENT	PRELIMINARY NOT FOR CONSTRUCTION	ALL DIMENSIONS APPROXIMATE ONLY	SCALE	SIZE	TITLE	REGIONAL SITE LOCATION PLAN	
			NTS	A4			
FIGURE	FIGURE 1		BY				
			T. MITCHELL				
			APPROVED		REFERENCE	BACKGROUND IMAGE SOURCED FROM LINZ CROWN COPYRIGHT RESERVED	
PROJECT	STONEBROOK SUBDIVISION STAGE 19		R. HERITAGE				
			DATE		FIGURE No.	PROJECT / WBS / TYPE / DISC / NUMBER / REV	
			1 APRIL 2015			224926 / 003 / FIG / TRA / 01 / 0	

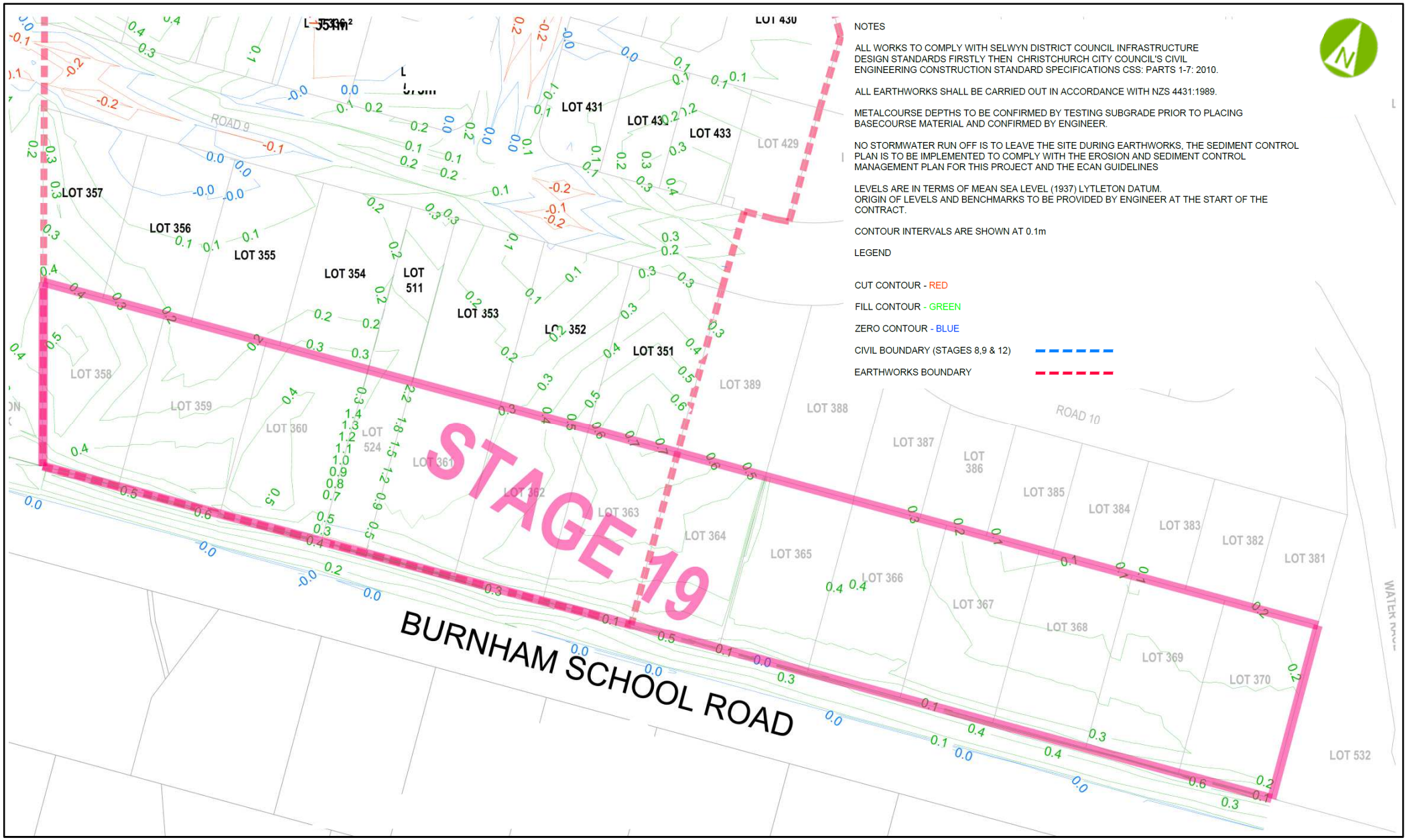
aurecon
www.aurecongroup.com

CDL LAND
NEW ZEALAND LIMITED

aurecon
www.aurecongroup.com

CDL LAND
NEW ZEALAND LIMITED

CLIENT	PRELIMINARY NOT FOR CONSTRUCTION	ALL DIMENSIONS APPROXIMATE ONLY	SCALE	SIZE	TITLE	STONEBROOK SUBDIVISION LAYOUT				
			NTS	A4						
FIGURE	FIGURE 2		BY		REFERENCE	BACKGROUND IMAGE SOURCED FROM AURECON DRAWING NO. LD-S2-CE-01				
			T. MITCHELL							
			APPROVED							
PROJECT	STONEBROOK SUBDIVISION STAGE 19		R. HERITAGE							
			DATE		FIGURE No.	PROJECT	WBS	TYPE	DISC	NUMBER	REV
			1 APRIL 2015			224926	003	FIG	TRA	02	0



CLIENT	PRELIMINARY NOT FOR CONSTRUCTION	ALL DIMENSIONS APPROXIMATE ONLY	SCALE	SIZE	TITLE	EARTHWORKS STAGE 19 AND CUT/FILL CONTOURS				
aurecon www.aurecongroup.com			NTS	A4						
CDL LAND NEW ZEALAND LIMITED	FIGURE	FIGURE 3	BY T. MITCHELL		REFERENCE	BACKGROUND IMAGE SOURCED FROM AURECON DRAWING NO.				
	PROJECT	STONEBROOK SUBDIVISION STAGE 19	APPROVED R. HERITAGE		FIGURE No.	PROJECT	WBS	TYPE	DISC	NUMBER	REV
			DATE 1 APRIL 2015			224926	003	FIG	TRA	03	0

Appendix B

Compaction Test Results

City Care Ltd Laboratory, 205 Springs Road, Christchurch 8042
T: 03 941 7616 F: 03 941 7618 www.citycare.co.nz

DETERMINATION OF THE DRY DENSITY / WATER CONTENT RELATIONSHIP
New Zealand Standard Compaction Test

Client: K B Contracting & Quarries Limited
Contact Name: Mr A. Hodgson

Sample Type: Sand and aggregate
Sample Source: Rolleston CDL, Test Site E

Sampled By: L. Sim, J. Bennett
Date Sampled: 20 January 2014
Tested By: L. Sim
Date of Test: 4 February 2014

Sample Method: Dug from hole at site specified by Client (sampling is not IANZ Accredited)
Test Method: NZS 4402:1986 Test 4.1.1(Standard Compaction)

Results:

Moisture Content (% by dry mass)	Wet Density (kg/m3)	Dry Density (kg/m3)
4.0	2010	1930
4.9	2060	1960
6.1	2130	2010
7.0	2180	2040
8.6	2300	2120
9.1	2340	2140
10.0	2330	2120
10.2	2320	2110

Maximum Dry Density = 2140 kg/m3
Optimum Water Content = 9 %
Note: Natural Water Content = 4.9 %

Sample History: Natural. Test performed on fraction <19.0mm

This report relates only to the sample tested and may only be reproduced in full.

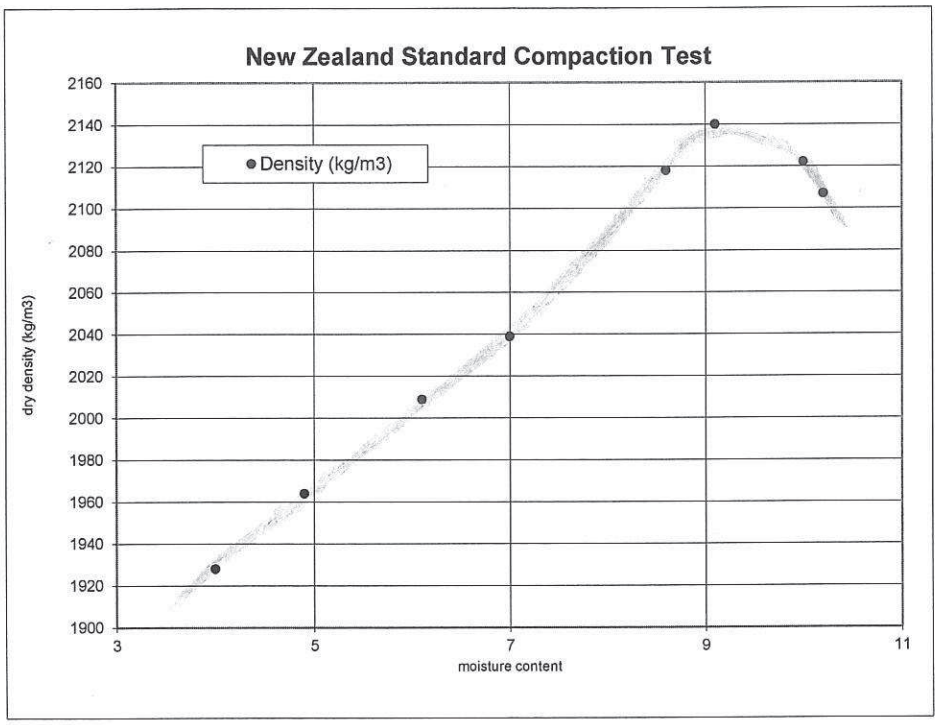
Date of Issue: 18 February 2014

Approved Signatory: _____
(T. O'Regan, Laboratory Manager)

Checked By: _____

DETERMINATION OF THE DRY DENSITY / WATER CONTENT RELATIONSHIP
New Zealand Standard Compaction Test

e Type: Sand and aggregate
e Source: Rolleston CDL, Test Site E



Appendix C

Nuclear Density Test Results

Test results supplied by City Care for K B Construction and Quarries Ltd and reproduced by Aurecon for the Stonebrook Subdivision Stages 19 Geotechnical Completion Report.

The material comprising onsite gravel was tested in accordance with NZS 4407:1991 Test 4.2.2 (backscatter mode).

Table 1 Stonebrook Subdivision Stage 9 Nuclear Densometer Re-Test Results (9 August 2013)

Lot Number	Dry Density (kg/m^3)	Wet Density (kg/m^3)	Moisture (%)	Compaction (%)
Lift 1 of 3				
362	2080	2170	4.5	97.2
362	2130	2250	5.5	99.5
Lift 1 of 2				
363	2130	2210	4.0	99.5
363	2100	2210	5.0	98.1
Lift 1 of 1				
366	2110	2220	5.5	98.6
367	2160	2260	4.5	100.9
368	2080	2200	5.5	97.2

Table 2 Stonebrook Subdivision Stage 19 Nuclear Densometer Test Results (21 August 2013)

Lot Number	Dry Density (kg/m^3)	Wet Density (kg/m^3)	Moisture (%)	Compaction (%)
Lift 2 of 3				
361/362*	2140	2250	5.5	100.0
361/362*	2190	2320	6.0	102.3
361/362*	2170	2320	7.0	101.4
361/362*	2120	2240	5.5	99.1
362/363*	2200	2330	5.5	102.8
362/363*	2190	2330	6.5	102.3
362/363*	2130	2230	5.0	99.5
362/363*	2120	2240	6.0	99.1
Lift 2 of 2				
363/364*	2150	2260	5.5	100.5
363/364*	2240	2390	6.5	104.7
363/364*	2230	2360	5.5	104.2
363/364*	2200	2350	7.0	102.8
364/365*	2040	2150	5.5	95.3

Table 2 Continued

Lot Number	Dry Density (kg/m^3)	Wet Density (kg/m^3)	Moisture (%)	Compaction (%)
364/365*	2070	2190	6.0	96.7
364/365*	2110	2270	7.5	98.6
364/365*	2130	2250	5.5	99.5

* = NDM test carried out on the boundary between two lots.

Table 3 Stonebrook Subdivision Stage 19 Nuclear Densometer Test Results (22 August 2013)

Lot Number	Dry Density (kg/m^3)	Wet Density (kg/m^3)	Moisture (%)	Compaction (%)
Lift 2 of 2				
363	2110	2240	6.5	98.6
363	2100	2240	7.0	98.1
363	2180	2230	6.0	101.9
363	2050	2180	6.0	95.8
364	2040	2170	6.5	95.3
364	2080	2210	6.5	97.2
364	2040	2170	6.0	95.3
364	2090	2230	7.0	97.7
365	2060	2170	5.5	96.3
365	2070	2180	6.5	96.7
365	2040	2160	6.0	95.3
Lift 3 of 3				
362	2040	2160	5.5	95.3
362	2050	2200	7.5	95.8

Table 4 Stonebrook Subdivision Stage 10 Nuclear Densometer Test Results (19 March 2014)

Lot Number	Dry Density (kg/m^3)	Wet Density (kg/m^3)	Moisture (%)	Compaction (%)
Lift 1 of 1				
369	2090	2190	4.5	97.7
370	2070	2170	5.0	96.7

Table 5 Stonebrook Subdivision Stage 19 Nuclear Densometer Test Results (5 June 2014)

Lot Number	Dry Density (kg/m^3)	Wet Density (kg/m^3)	Moisture (%)	Compaction (%)
Lift 1 of 1				
358	2180	2290	5.0	101.9
358	2090	2200	5.0	97.7
359	2140	2270	6.0	100.0
359	2150	2280	6.0	100.5
360	2060	2200	6.5	96.3
360	2190	2310	5.5	102.3

Notes: The NDM test results are calculated using a maximum dry density of 2140 kg/m^3 as determined by New Zealand Standard Compaction (NZS 4402:1986, Test 4.1.1) completed on 4 February 2014 by City Care from an onsite samples (Test Site E). Test Site E is located to the north west of Stage 19 but we understand that the fill placed across Lot 19 was sourced from this area and is relatively consistent with the material placed on Stage 19. The locations of the test site E are shown on Figure 2 and the compaction curve provided by City Care for the material from Test Sites E is included in Appendix B.

Appendix D

Certification

NZS 4431 : 1989

STATEMENT OF SUITABILITY OF EARTH FILL FOR RESIDENTIAL DEVELOPMENT

To *Selwyn District Council*
PO Box 90
Rolleston 7643

STATEMENT OF SUITABILITY OF EARTH FILL FOR RESIDENTIAL DEVELOPMENT

Subdivision *CDL – Stonebrook, Rolleston – Stage 19*

Owner / Developer *CDL Land New Zealand Ltd*

Location *Stonebrook Drive, Rolleston*

The earth filling, with depths of fill are shown on the attached plan 224926-DW-LD-S19-AB-CF-01 [A], have been place in compliance with the terms of NZS 4431:1989.

While work was in progress I, Ian McPherson c/- Aurecon NZ Ltd, P O Box 1061, Christchurch, acted as consulting Geotechnical Engineer.

During the work, the inspecting engineer and his staff made periodic visits of inspection to the site. Details of the soil testing carried out to check the quality of the fill by the inspecting engineer can be made available upon request.

The attached plan, 224926-DW-LD-S19-AB-CF-01 [A], shows those lots affected by filling and the extent of the fill as part of the development works.

In the opinion of the inspecting engineer the following special limitations should be observed:

Nil

This certification, that the earth fills have been placed in compliance with the terms of NZS 4431:1989 does not remove the necessity for the normal inspection and design of foundations as would be made in natural ground.

..... (signature)

Technical Director (position)

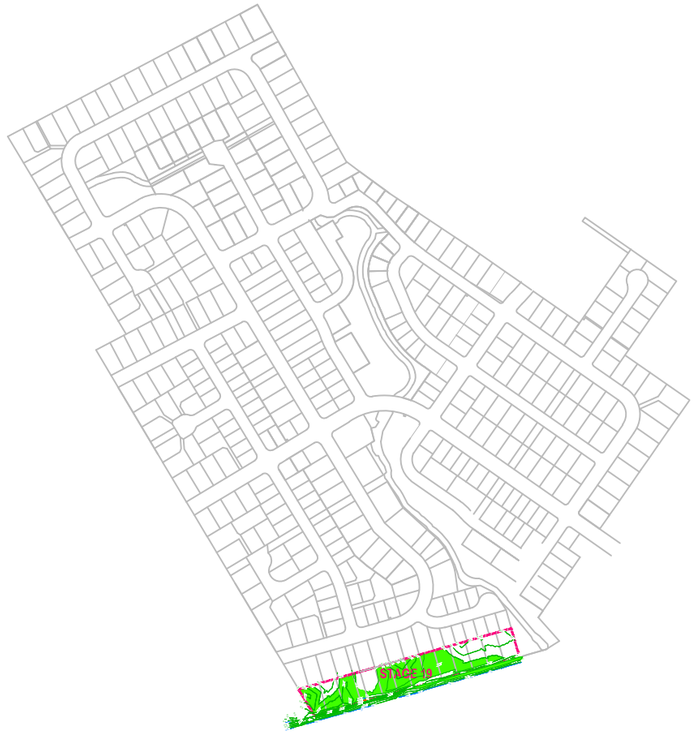
7/4/15 (date)

On behalf of *CDL Land New Zealand Ltd*

NOTES:

AS BUILT INFORMATION HAS BEEN SUPPLIED BY KBs CONTRACTING & QUARRIES LTD - DECEMBER 2014.
HEIGHTS ARE IN TERMS OF MEAN SEA LEVEL

RS = ROAD SUMP IN SDC LOW PROFILE KERB AND CHANNEL



LOCATION PLAN

80 0 160 320m
SCALE 1:8000

10 0 20 40m
SCALE 1:1000

00/00/00

aurecon
www.aurecongroup.com

CLIENT

REV	DATE	REVISION DETAILS	APPROVED
A	05.12.14	AS BUILTS ISSUED	B.TOMS

DRAWN	DESIGNED
A.COLUMBUS	M.CROWE

CHECKED: D.WATSON
APPROVED: DATE: B.TOMS

PROJECT: STONEBROOK ROLLESTON

TITLE: STAGE 19 FILL AS BUILT

AS BUILT

PROJECT No.: 224926

SCALE	SIZE
AS SHOWN	A3

DRAWING No.	REV
DW-LD-S19-AB-CF-01	A

Aurecon New Zealand Limited
Unit 1, 150 Cavendish Road
Casebrook Christchurch 8051
PO Box 1061
Christchurch 8140
New Zealand

T +64 3 366 0821
F +64 3 379 6955
E christchurch@aurecongroup.com
W aurecongroup.com