aurecon

Project: Stonebrook Subdivision

Geotechnical Completion Report Stages 8 and 12

Reference: 224926

Prepared for: CDL Land New Zealand Ltd.

Revision: 0

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Approval			
Author Signature		Approver Signature	
Name	T. Mitchell	Name	J. Kupec
Title	Geotechnical Engineer	Title	Technical Director

Contents

Appendices

1. Executive Summary

CDL New Zealand Limited is developing Stages 8 and 12 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 Stages 8 and 12 of the Stonebrook Subdivision comprising the following lots.

- Stage 8 comprises Lots 164 to 177;
- Stage 12 comprises Lots 143, 144 and 229 to 240.

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. Thus we believe that earthfill placed within the Stages 8 and 12 has achieved the required compaction levels as per intent and definition of NZS4431:1989.

From the monitoring and testing undertaken as part of the development of the Stages 8 and 12 areas the following is concluded:

- Bulk earthworks meet our 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 Stages 8 and 12 of the Stonebrook Subdivision, located on Stonebrook Drive, Rolleston (See Figure 1 in Appendix A). The site works on Stages 8 and 12 have included bulk earthworks. As part of the this 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 Stages 8 and 12 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 carried out as part of subdivision consent investigations and detailed design;
- A summary the ground conditions;
- 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 Stages 8 and 12. The site 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 Investigation Locations
Test Pits (TP)	64
Borehole with SPT at 1.5m centres (BH)	2

3.2 Ground Conditions

From the geotechnical investigations the ground conditions within Stages 8 and 12 are summarised in Table 1.

Table 2: Typical ground conditions within the Stages 8 and 12

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 1 were typically encountered and groundwater was not encountered within the area 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.

4. Subdivision Earthworks

4.1 General

Bulk earthworks for Stages 8 and 12 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 Stages 8 and 12 include both cut and fill. Table 3 and 4 below shows the lots that have been filled or cut for each of the stages in this report. The engineered fill comprises onsite natural gravel and compacted with a double drum roller. A layer of topsoil has been spread over the engineered fill.

The maximum depth of filling was 0.9m and maximum cut was 0.3m depth. The gravel fill was sourced from areas of cut close to each of the lots to minimise transportation. The extent of cutting and filling for each stage is shown on Figure 3 in Appendix A.

Table 3: Areas of Cut and Fill Stage 8

Earthwork	Lot Number
Fill	164 to 169, 172 to 175 and 177
Cut	165 to 168, 170 to 173, 176 and 177

Table 4: Areas of Cut and Fill Stage 12

Earthwork	Lot Number
Fill	143, 144 and 229 to 240
Cut	143, 144, 237 and 238

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 criterion 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 location of the soil samples obtained for laboratory compaction testing (Test Site A) is shown on Figure 2. The results of the nuclear density tests were compared to the compaction tests to confirm the adequacy of the site compaction.

The compaction test results and the compaction curve for Test Site A is presented in Appendix B.

Stage 8

City Care carried out ten nuclear density tests on lots that had been filled with a test frequency of two tests per lot on Lots 174 to 177 and one test per lot on Lots 172 and 173. The remaining lots with fill have not been tested due to limited depth and extent of filling.

Stage 12

City Care carried out twenty nine nuclear density tests on filled lots within Stage 12. The tests were carried out with a frequency of two tests per lot with exception to Lot 240 which was tested in three locations. Fill was placed in two lifts across Lots 229 to 231 and the fill compaction measured after each lift. The remaining lots with fill have not been tested due to limited depth and extent of filling.

4.4 Compaction Results

The results presented in Appendix C generally indicate that 95% MDD or greater compaction has been consistently achieved. We consider that all the earthfill placed within Stages 8 and 12 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 Stages 8 and 12 are likely to perform to the level of TC1 equivalent.

5.2 Earthworks on Building Lots

The extent of earthfill on Lots within Stages 8 and 12 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 200 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 some 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.

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. Fill placement should only occur away from the timber retaining wall, unless specifically designed.

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 Stages 8 and 12 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.

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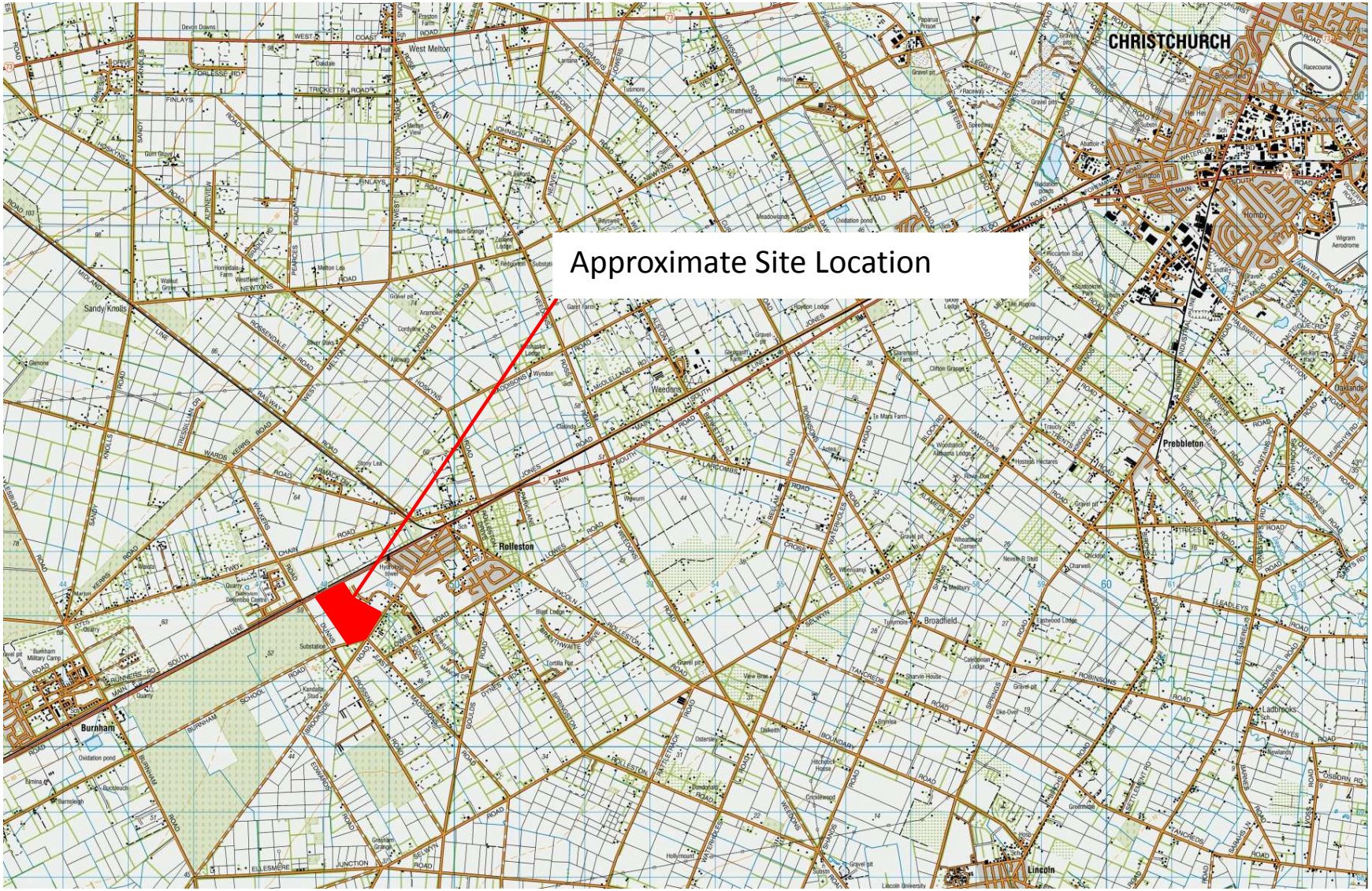
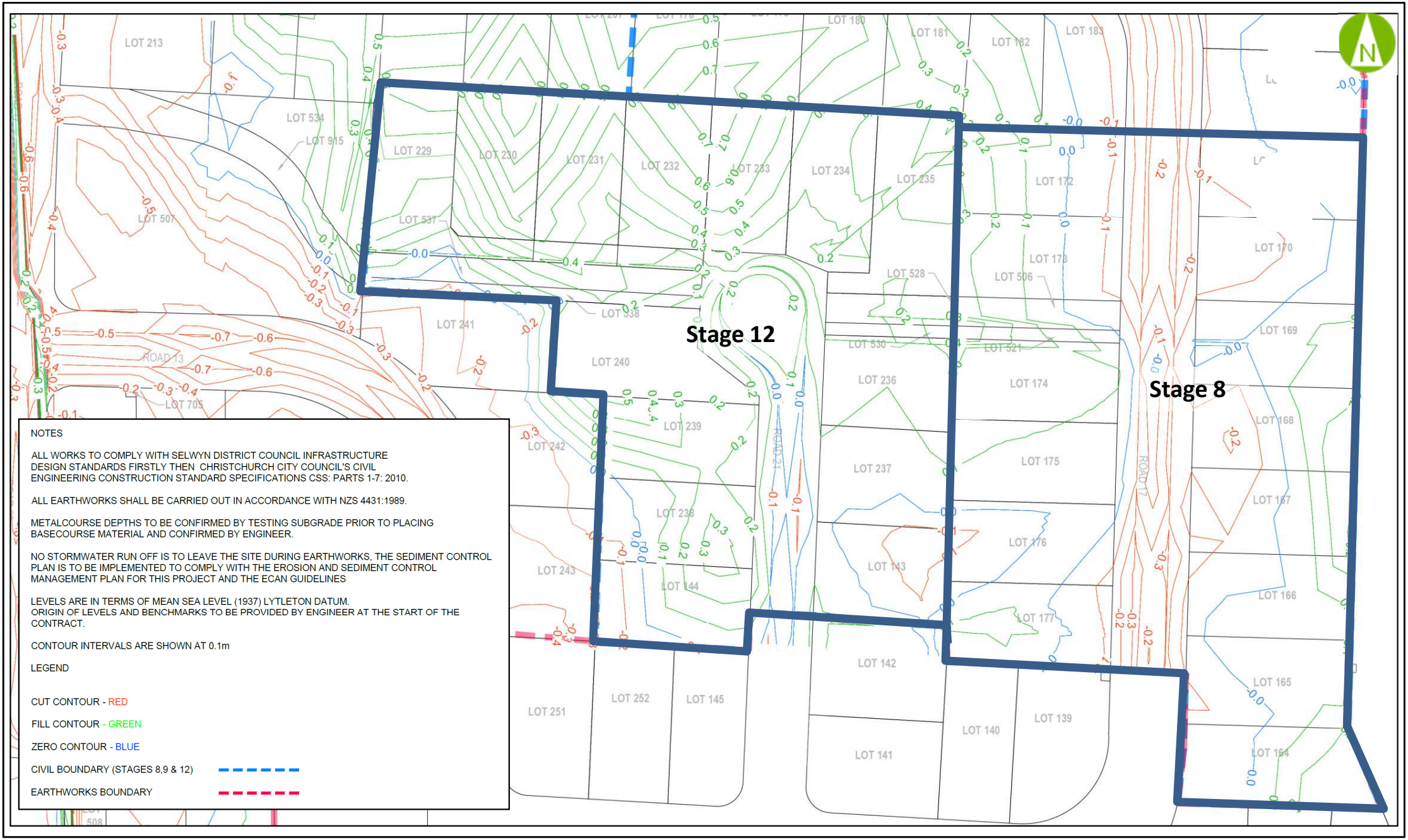
Appendix A

Figures



CLIENT	PRELIMINARY NOT FOR CONSTRUCTION	ALL DIMENSIONS APPROXIMATE ONLY	SCALE	SIZE	TITLE	REGIONAL SITE LOCATION PLAN					
aurecon www.aurecongroup.com	FIGURE	FIGURE 1	NTS	A4							
CDL LAND NEW ZEALAND LIMITED	PROJECT	STONEBROOK SUBDIVISION STAGE 8 AND 12	BY T. MITCHELL		REFERENCE	STONEBROOK SUBDIVISION					
			APPROVED M. DAVIDSON		FIGURE No.	PROJECT	WBS	TYPE	DISC	NUMBER	REV
			DATE 4 SEPTEMBER 2014			224926	003	FIG	TRA	01	0

CLIENT	PRELIMINARY NOT FOR CONSTRUCTION	ALL DIMENSIONS APPROXIMATE ONLY	SCALE	SIZE	TITLE	STONEBROOK SUBDIVISION LAYOUT				
aurecon www.aurecongroup.com	FIGURE	FIGURE 2	NTS	A4						
CDL LAND NEW ZEALAND LIMITED	PROJECT	STONEBROOK SUBDIVISION STAGE 8 AND 12	BY T. MITCHELL		REFERENCE	STONEBROOK SUBDIVISION				
			APPROVED M. DAVIDSON		FIGURE No.	PROJECT	WBS	TYPE	DISC	NUMBER	REV
			DATE 4 SEPTEMBER 2014			224926	003	FIG	TRA	02	0



NOTES

ALL WORKS TO COMPLY WITH SELWYN DISTRICT COUNCIL INFRASTRUCTURE DESIGN STANDARDS FIRSTLY THEN CHRISTCHURCH CITY COUNCIL'S CIVIL ENGINEERING CONSTRUCTION STANDARD SPECIFICATIONS CSS: PARTS 1-7: 2010.

ALL EARTHWORKS SHALL BE CARRIED OUT IN ACCORDANCE WITH NZS 4431:1989.

METALCOURSE DEPTHS TO BE CONFIRMED BY TESTING SUBGRADE PRIOR TO PLACING BASECOURSE MATERIAL AND CONFIRMED BY ENGINEER.

NO STORMWATER RUN OFF IS TO LEAVE THE SITE DURING EARTHWORKS, THE SEDIMENT CONTROL PLAN IS TO BE IMPLEMENTED TO COMPLY WITH THE EROSION AND SEDIMENT CONTROL MANAGEMENT PLAN FOR THIS PROJECT AND THE ECAN GUIDELINES

LEVELS ARE IN TERMS OF MEAN SEA LEVEL (1937) LYTLETON DATUM.
ORIGIN OF LEVELS AND BENCHMARKS TO BE PROVIDED BY ENGINEER AT THE START OF THE CONTRACT.

CONTOUR INTERVALS ARE SHOWN AT 0.1m

LEGEND

CUT CONTOUR - RED

FILL CONTOUR - GREEN

ZERO CONTOUR - BLUE

CIVIL BOUNDARY (STAGES 8,9 & 12)

EARTHWORKS BOUNDARY

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CDL LAND
NEW ZEALAND LIMITED

CLIENT	PRELIMINARY NOT FOR CONSTRUCTION	ALL DIMENSIONS APPROXIMATE ONLY	SCALE	SIZE	TITLE	EARTHWORKS STAGE 8 AND 12 CUT/FILL CONTOURS			
FIGURE	FIGURE 3		NTS	A4					
			BY						
			T. MITCHELL						
PROJECT	STONEBROOK SUBDIVISION STAGE 8 AND 12		APPROVED		REFERENCE	STONEBROOK SUBDIVISION			
			M. DAVIDSON						
			DATE		FIGURE No.	PROJECT	WBS	TYPE	DISC	NUMBER	REV
			4 SEPTEMBER 2014			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 A

Sampled By: M. Foster, L. Sim
Date Sampled: 11 December 2013
Tested By: M. Foster
Date of Test: 18 December 2013

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)
2.6	2110	2060
3.8	2170	2090
4.8	2170	2070
6.2	2200	2070
7.5	2280	2120
8.0	2290	2120

Maximum Dry Density could not be determined by this method.
Maximum Density achieved = 2120 kg/m3 @ 8.0%
Note: Natural Water Content = 2.6 %

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

Date of Issue: 19 December 2013

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

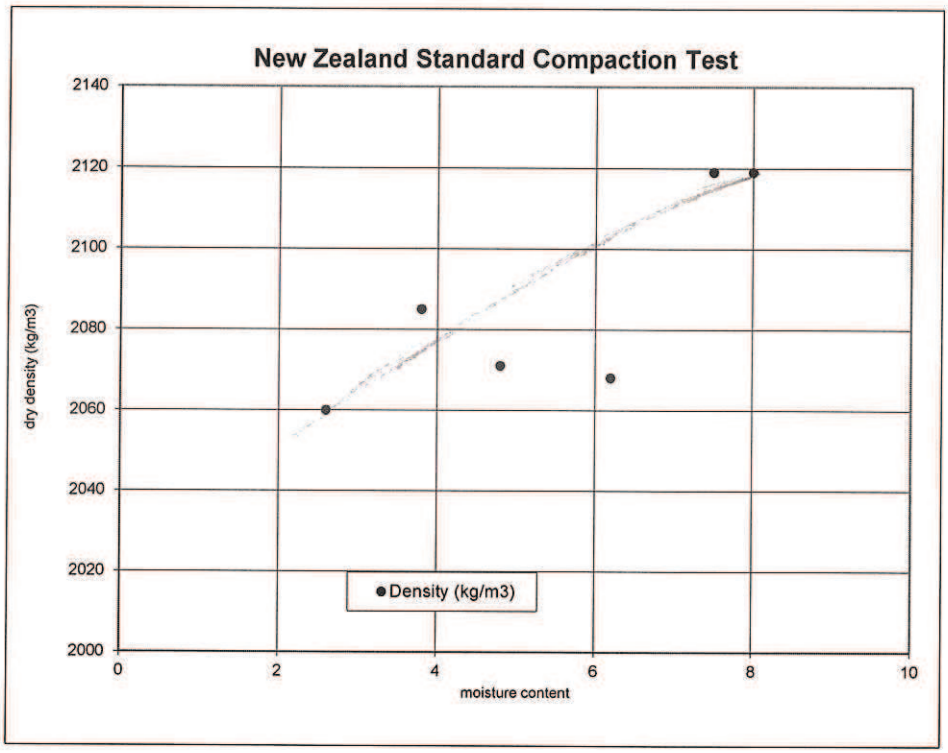
Checked By: J. Kedelington

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation.

new zealand accredited laboratory

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

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



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

Date of Issue: 19 December 2013

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

Checked By: T. Kerrington

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 8 and 12 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 8 Nuclear Densometer Test Results (10 January 2014)

Lot Number	Dry Density (kg/m^3)	Wet Density (kg/m^3)	Moisture (%)	Compaction (%)
Lift 1				
172	2020	2160	7.0	95.3
173	2050	2190	7.0	96.7
174	2050	2150	4.5	96.7
174	2070	2150	3.5	97.6
175	2090	2190	5.0	98.6
175	2070	2170	4.5	97.6
176	2090	2190	5.0	98.6
176	2050	2150	5.0	96.7
177	2070	2160	4.0	97.6
177	2020	2110	4.0	95.3

Table 2 Stonebrook Subdivision Stage 12 Nuclear Densometer Test Results (15 August 2013)

Lot Number	Dry Density (kg/m^3)	Wet Density (kg/m^3)	Moisture (%)	Compaction (%)
Lift 1				
144	2020	2120	5.0	95.3
144	2030	2130	5.0	95.8
229	2050	2120	4.0	96.7
229	2120	2200	3.5	100.0
230	2190	2260	3.0	103.3
230	2130	2200	3.0	100.5
231	2180	2240	3.0	102.8
231	2200	2270	3.5	103.8
232	2030	2130	5.0	95.8
232	2160	2240	4.0	101.9
233	2090	2180	4.5	98.6
233	2020	2120	5.0	95.3
234	2080	2190	5.0	98.1
234	2050	2150	5.0	96.7

Lot Number	Dry Density (kg/m^3)	Wet Density (kg/m^3)	Moisture (%)	Compaction (%)
235	2100	2190	4.54	99.1
235	2040	2140	5.0	96.2
238	2050	2160	5.0	96.7
238	2030	2140	5.5	95.8
239	2100	2210	5.0	99.1
239	2020	2140	6.0	95.3
240	2040	2150	5.0	96.2
240	2060	2200	6.5	97.2
240	2140	2280	6.5	100.9
Lift 2				
229	2130	2220	4.0	100.5
229	2100	2170	3.5	99.1
230	2130	2210	4.0	100.5
230	2100	2200	5.0	99.1
231	2130	2240	5.5	100.5
231	2160	2250	4.0	101.9

Notes: The NDM test results are calculated using a maximum dry density of 2120 kg/m^3 as determined by New Zealand Standard Compaction (NZS 4402:1986, Test 4.1.1). completed on 18 December 2013 by City Care from an onsite sample (Test Site A). Test Site A is located near Stages 8 and 12. The locations of the test sites are shown on Figure 2 and the compaction curve provided by City Care for the material from Test Site A is attached.

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 8 and 12*
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-S3-AB-FC-01 [A]. have been place in compliance with the terms of NZS 4431:1989.

While work was in progress I. Jan Kupec 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-S3-AB-FC-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)

4/9/2014 ..... (date)

On behalf of *CDL Land New Zealand Ltd*

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

-0.0 ZERO FILL CONTOUR
0.0 DEPTH OF FILL CONTOUR

STAGE 12

STAGE 8

LOT 171
LOT 170
LOT 172
LOT 169
LOT 173
LOT 168
LOT 506
LOT 521
LOT 167
LOT 174
LOT 528
LOT 530
LOT 166
LOT 175
LOT 236
LOT 235
LOT 234
LOT 233
LOT 232
LOT 231
LOT 230
LOT 229
LOT 176
LOT 237
LOT 165
LOT 177
LOT 143
LOT 164
LOT 139
LOT 538
LOT 531
LOT 239
LOT 238
LOT 144
LIGNITE DRIVE

LOCATION PLAN

10 0 20 40m
SCALE 1:1000

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CLIENT	REV	DATE	REVISION DETAILS	APPROVED
	A	04-09-14	AS BUILTS ISSUED	

DRAWN	DESIGNED
A GRAY	M CROWE
CHECKED	
D WATSON	
APPROVED	
DATE	
B TOMS	

PROJECT
STONEBROOK ROLLESTON

TITLE
STAGE 12 and 8
FILL CONTOURS
AS BUILTS

AS BUILT

PROJECT No.	
224926	
SCALE	SIZE
1:1000	A3
DRAWING No.	REV
DW-LD-S3-AB-FC-01	A

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