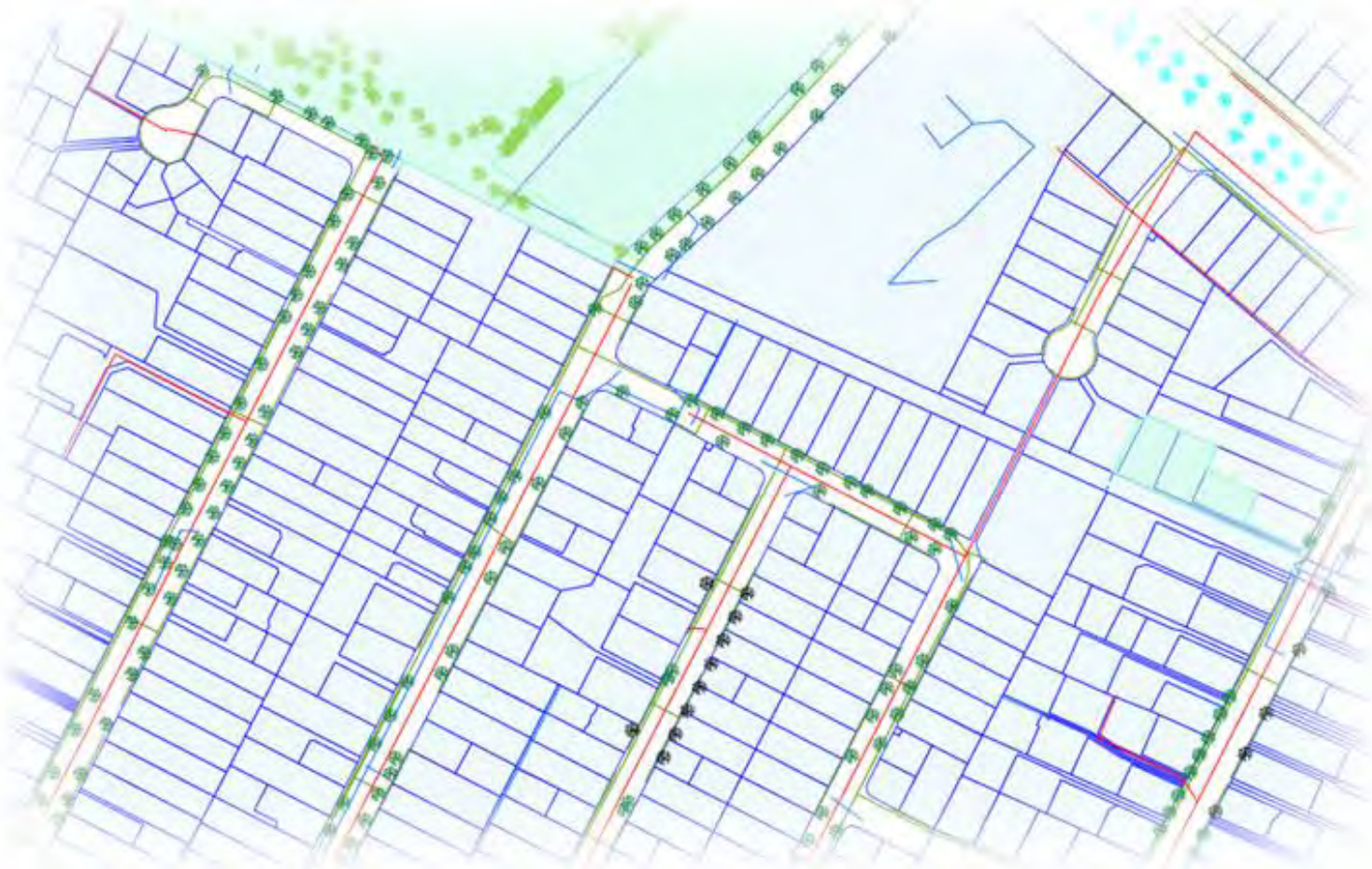
Christchurch City Council

Land Information Memorandum



Property address:
74 Prestons Park Drive

LIM number: 70211004
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Christchurch City Council
53 Hereford Street, PO Box 73015
Christchurch 8154, New Zealand
Tel 64 3 941 8999
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www.ccc.govt.nz

Land Information Memorandum

Christchurch City Council

Application details

Please supply to	ANTHONY HARPER SOLICITORS PO BOX 2646 CHRISTCHURCH 8140
Client reference	102856-795
Phone number	364 3817
Fax number	366 9277
Date issued	18 July 2018
Date received	16 July 2018

Property details

Property address	74 Prestons Park Drive
Valuation roll number	21823 56800
Valuation information	Capital Value: $9120000.00 Land Value: $9120000.00 Improvements Value: $0.00 *Please note: these values are intended for Rating purposes*
Legal description	Lot 3030 DP 509330
Existing owner	CDL Land New Zealand Limited PO Box 3248 Auckland 1140

Council references

Debtor number	3153176
Rate account ID	73185048
LIM number	70211004
Property ID	1181149

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Land Information Memorandum

Document information

This Land Information Memorandum (LIM) has been prepared for the purpose of section 44A of the Local Government Official Information and Meetings Act 1987 (LGOIMA). It is a summary of the information that we hold on the property. Each heading or "clause" in this LIM corresponds to a part of section 44A.

Sections 1 to 11 contain all of the information known to the Christchurch City Council that must be included under section 44A(2) LGOIMA. Any other information concerning the land as the Council considers, at its discretion, to be relevant is included at section 11 of this LIM (section 44A(3) LGOIMA).

The information included in this LIM is based on a search of Council records only and there may be other information relating to the land which is unknown to the Council. Council records may not show illegal or unauthorised building or works on the property. The applicant is solely responsible for ensuring that the land is suitable for a particular purpose.

If there are no comments or information provided in any section of this LIM this means that the Council does not hold information on the property that corresponds to that part of section 44A.

A LIM is only valid at the date of issue as information is based only upon information the Council held at the time of that LIM request being made.

Property file service

This Land Information Memorandum does not contain all information held on a property file. Customers may request property files by phoning the Council's Customer Call Centre on (03) 941 8999, or visiting any of the Council Service Centres. For further information please visit www.ccc.govt.nz .

To enable the Council to measure the accuracy of this LIM document based on our current records, we would appreciate your response should you find any information contained therein which may be considered to be incorrect or omitted. Please telephone the Customer Call Centre on (03) 941 8999.

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Land Information Memorandum

A search of records held by the Council has revealed the following information:

1. Special features and characteristics of the land

Section 44A(2)(a) LGOIMA. This is information known to the Council but not apparent from the district scheme under the Town and Country Planning Act 1977 or a district plan under the Resource Management Act 1991. It identifies each (if any) special feature or characteristic of the land concerned, including but not limited to potential erosion, avulsion, falling debris, subsidence, slippage, alluvion, or inundation, or likely presence of hazardous contaminants.

(For enquiries, please phone (03) 941 8999 or visit www.ccc.govt.nz.

- **ECan Liquefaction Assessment**

  ECan holds indicative information on liquefaction hazard in the Christchurch area.Information on liquefaction can be found on the ECan website at www.ecan.govt.nz/liq or by calling ECan customer services on Ph 03 353 9007. The Christchurch City Council may require site-specific investigations before granting future subdivision or building consent for the property, depending on the liquefaction potential of the area that the property is in.

- **Borelog/Engineer Report Image Available**

  Borelog/Engineer Report Image Available

- **Consultant Report Available**

  Land Information New Zealand (LINZ) engaged Tonkin and Taylor to provide a Geotechnical Report on Ground Movements that occurred as a result of the Canterbury Earthquake Sequence. The report indicates this property may have been effected by a degree of earthquake induced subsidence. The report obtained by LINZ can be accessed on their website at https://www.linz.govt.nz/land/surveying/earthquakes/canterbury-earthquakes/information-for-canterbury-surveyors

- **Coastal Hazard Inundation**

  The Council has a report, Coastal Hazard Assessment for Christchurch and Banks Peninsula (2017), that indicates this property or part of this property may be susceptible to coastal inundation (flooding by the sea). The 2017 report considers four sea level rise scenarios through to the year 2120. A copy of the 2017 report and other coastal hazard information can be found at www.ccc.govt.nz/coastalhazards.

- **Fill**

  This property is located in an area known to have been filled. The year the fill occurred is 2015. The filling was, according to the Councils records carried out in a controlled manner and comprises Sand.

- **Fill**

  This property is located in an area known to have been filled. The year the fill occurred is 2016. The filling was, according to the Councils records carried out in a controlled manner and comprises Engineered Fill.

- **Fill**

  This property is located in an area known to have been filled. The year the fill occurred is 2016. The filling was, according to the Councils records carried out in a controlled manner and comprises Sand.

- **Record of Contamination**

  Records indicate that this site may have been contaminated with Hydrocarbons. For more information on the contamination you can contact the Environmental Health Team on 941 8999.

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- **Contains or contained a Tank**

  Council Records indicate that this site contains or contained a Tank Details of Tank are as follows:Date Installed: NA Tank Function: Diesel Volume(l): 4500 Underground or Above Ground: Underground Tank Status: Tank Does Not Exist Date Removed: 13-04-1994 Condition when Removed: Good

- **Contains or contained a Tank**

  Council Records indicate that this site contains or contained a Tank Details of Tank are as follows:Date Installed: NA Tank Function: Septic Tank Volume(l): NA Underground or Above Ground: Underground Tank Status: Tank Exists Date Removed: NA Condition when Removed: NA

Related information

- There is attached a sub division soil investigation report covering this property.

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2. Private and public stormwater and sewerage drains

Section 44A(2)(b) LGOIMA. This is information about private and public stormwater and sewerage drains as shown in the Council's records.

(For stormwater and sewerage enquiries, please phone (03) 941 8999 or visit www.ccc.govt.nz.

- **Vacuum System Area In Service**

  A Council maintained vacuum sewerage chamber is located on this property. A (drainage) plan showing its location at the property is attached. For further information please contact Christchurch City Council customer services on (03) 941 8999.

Related information

- No up-to-date drainage plan is available for the development of this site. However, the installation of sewer and stormwater drains is checked by the Council prior to the issue of a Code Compliance Certificate.

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3. Drinking Water Supply

Section 44A(2)(ba) and (bb) LGOIMA. This is information notified to the Council about whether the land is supplied with drinking water, whether the supplier is the owner of the land or a networked supplier, any conditions that are applicable, and any information the Council has about the supply.

(For water supply queries, please phone (03) 941 8999 or visit www.ccc.govt.nz.

Water Supply

There is either a water meter not in use or no water connection to this property. Christchurch City Council is the networked supplier of water to this property. An application can be made to the Christchurch City council for a water connection. The conditions of supply are set out in the Christchurch City Council Water Supply, Wastewater & Stormwater Bylaw (2014), refer to www.ccc.govt.nz.

Christchurch City Council is the networked supplier of water to this property. This property can be connected to the Christchurch City Council Water Supply. The conditions of supply are set out in the Christchurch City Council Water Supply, Wastewater & Stormwater Bylaw (2014), refer to www.ccc.govt.nz.

Related information

- No up-to-date drainage plan is available for the development of this site. However, the installation of a water connection is checked by the Council prior to the issue of a Code Compliance Certificate.

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4. Rates

Section 44A(2)(c) LGOIMA. This is information on any rates owing in relation to the land.

(For rates enquiries, please phone (03) 941 8999 or visit www.ccc.govt.nz.

(a) Annual rates

Annual rates to 30/06/2019: $ 46,472.02

	Instalment Amount	Date Due
Instalment 1	$ 11,617.96	31/08/2018
Instalment 2	$ 11,617.96	30/11/2018
Instalment 3	$ 11,617.96	28/02/2019
Instalment 4	$ 11,618.14	31/05/2019

Rates owing as at 18/07/2018: $ 11,617.96

(b) Excess water charges

$ 0.00

(For water charge enquiries, please phone (03) 941 8999 or visit www.ccc.govt.nz.

(c) Final water meter reading required?

No Reading Required

(To arrange a final water meter reading, please phone (03) 941 8999 or visit www.ccc.govt.nz.

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5. Consents, certificates, notices, orders, or requisitions affecting the land and buildings

Section 44A(2)(d) LGOIMA. This is information concerning any consent, certificate, notice, order, or requisition, affecting the land or any building on the land, previously issued by the Council.

Section 44A(2)(da) LGOIMA. The information required to be provided to a territorial authority under section 362T(2) of the Building Act 2004. There is currently no information required to be provided by a building contractor to a territorial authority under section 362T(2) of the Building Act 2004. The Building (Residential Consumer Rights and Remedies) Regulations 2014 only prescribed the information that must be given to the clients of a building contractor.

(For building enquiries, please phone (03) 941 8999 or visit www.ccc.govt.nz.

(a) Consents

- BCN/2018/4168 Applied: 25/06/2018 Status: Completed
  81R Aviemore Drive Burwood
  Exemption from building consent approved 11/07/2018
  Timber viewing platform

(b) Certificates

Note: Code Compliance Certificates were only issued by the Christchurch City Council since January 1993.

(c) Notices

- **Ministry of Business, Innovation & Employment Foundation Design**

  Some properties have experienced land damage and considerable settlement during the sequence of Canterbury earthquakes. While land in the green zone is still generally considered suitable for residential construction, houses in some areas will need more robust foundations or site foundation design where foundation repairs or rebuilding are required. Most properties have been assigned a technical category. Details of the MBIE guidance can be found at www.building.govt.nz/

(d) Orders

(e) Requisitions

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6. Certificates issued by a building certifier

Section 44A(2)(e) LGOIMA. This is information notified to the Council concerning any certificate issued by a building certifier pursuant to the Building Act 1991 or the Building Act 2004.

(For building enquiries, please phone (03) 941 8999 or visit www.ccc.govt.nz.

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7. Weathertightness

Section 44A(2)(ea) LGOIMA. This is information notified to the Council under section 124 of the Weathertight Homes Resolution Services Act 2006.

(For weathertight homes enquiries, please phone (03) 941 8999 or visit www.ccc.govt.nz.

If there is no information below this means Council is unaware of any formal Weathertight Homes Resolution Services claim lodged against this property.

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8. Land use and conditions

Section 44A(2)(f) LGOIMA. This is information relating to the use to which the land may be put and conditions attached to that use. The planning information provided is not exhaustive and reference to the District Plan(s) is recommended. There have been Proposed Christchurch Replacement District Plan provisions notified. The Proposed Christchurch Replacement District Plan may include changes that affect this property. The Proposed Christchurch Replacement District Plan includes provisions relating to protected historic heritage and protected areas of ecological significance that have immediate legal effect. Decisions have also been made on some of the provisions in the Proposed Christchurch Replacement District Plan which also have legal effect, or may be operative or have to be treated as operative. Proposed Replacement District Plan provisions which are operative, or have to be treated as operative, supersede the relevant provisions in the Christchurch City Plan or the Banks Peninsula District Plan. Some decisions on provisions of the Christchurch Replacement District Plan may be subject to changes as a result of further decisions. To find out more about the Proposed Replacement District Plan and what this might mean for this property, please visit https://ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/plans/districtplans for more information.

(For planning queries, please phone (03) 941 8999 or visit www.ccc.govt.nz.

Regional plan or bylaw

There may be objectives, policies or rules in a regional plan or a regional bylaw that regulate land use and activities on this site. Please direct enquiries to Canterbury Regional Council (Environment Canterbury).

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(a)(i) Operative Christchurch City Plan & Banks Peninsula District Plan

1. Special Amenity Area	No
2. Community Footprint	No
3. Opposite Important Open Space	No
4. Designations on Site	No
5. Road Widening Designations	No
6. Historic or Protection Building	No
7. Other Heritage Protection Items	No
8. Protected Trees	
Heritage/Notable Tree	No
Other; eg Category A, B, C Street Plantings; Subdivision trees	No
9. Noise Control	No
10. Coastal Protection	No
11. Landscape Protection	No

(ii) Proposed Christchurch Replacement District Plan/Christchurch District Plan

- **Liquefaction Management Area (LMA)**

  Property or part of property within the Liquefaction Management Area (LMA) Overlay which is operative.

- **Outline Development Plan**

  Property or part of property is within an Outline Development Plan area which is affected by specific provisions that are operative.

- **Flood Management Area**

  Property or part of property within the Flood Management Area (FMA) Overlay which is operative.

- **Fixed Minimum Floor Overlay**

  This property or parts of the property are located within the Fixed Minimum Floor Overlay in the Christchurch Replacement District Plan. Under this plan pre-set minimum floor level requirements apply to new buildings and additions to existing buildings. The fixed minimum floor level can be searched at http://ccc.govt.nz/floorlevelmap. For more information please contact a CCC duty planner on 941 8999.

- **District Plan Zone**

  Property or part of property within the Residential New Neighbourhood Zone which is operative.

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(iii) Notice of Requirement for a Designation

(b) Resource consents

- RMA/2007/1414 - Overseas Investment Certificate
  139 Mairehau Road Burwood
  Overseas Investment Certificate - Historical Reference RMA92008676
  Status: Processing complete
  Applied 12/06/2007
  Decision issued 13/06/2007
  Granted 13/06/2007

- RMA/2012/462 - Subdivision Consent
  153 Mairehau Road Burwood
  400 LOT SUBDIVISION s223 issued 13/8/13 LT 466017 - Historical Reference RMA92019798
  Status: Consent issued
  Applied 30/03/2012
  Decision issued 19/09/2012
  Granted 19/09/2012

- RMA/2017/2545 - Land Use Consent
  153 Mairehau Road Burwood
  To construct buildings on Lots 291-294, 312-318 and 377-389 (Stage 2)up to 4 m from the Mairehau Road boundary and with a reduced landscaping strip of 2m in width
  Status: Processing complete
  Applied 17/10/2017
  Granted 17/01/2018
  Decision issued 17/01/2018

- RMA/2013/116 - Subdivision Consent
  AMENDMENT TO RMA92019798 AND CREATE 2 NEW LOTS Issued 21/05/2013: 223 + 224 Issued 27/05/2013 - Historical Reference RMA92021697
  Status: Processing complete
  Applied 29/01/2013
  Granted 23/05/2013
  Decision issued 23/05/2013

- RMA/2013/1085 - Subdivision Consent
  434 LOT FEE SIMPLE SUBDIVISION - STAGE 2 - Historical Reference RMA92022731
  Status: Consent issued
  Applied 18/06/2013
  Decision issued 26/06/2014
  Granted 26/06/2014

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- RMA/2013/1562 - Subdivision Consent
  200 LOT FEE SIMPLE RESIDENTIAL SUBDIVISION Originally Part of RMA92019798. Split by Land ownership this appication issued origianlly 4 July 2012. - Historical Reference RMA92023244
  Status: Consent issued
  Applied 12/08/2013
  Decision issued 28/08/2013
  Granted 28/08/2013

- RMA/2015/278 - Subdivision Consent
  Fee Simple Subdivision - Sixty Nine Lots 224 Requested 30/5/2016 223 issued 30/5/2016 - Historical Reference RMA92028454
  Status: Consent issued
  Applied 03/02/2015
  Decision issued 01/05/2015
  Granted 01/05/2015

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9. Other land and building classifications

Section 44A(2)(g) LGOIMA. This is information notified to the Council by any statutory organisation having the power to classify land or buildings for any purpose.

(For land and building enquiries, please phone (03) 941 8999 or visit www.ccc.govt.nz.

Please refer to Section 1 for details

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10. Network utility information

Section 44A(2)(h) LGOIMA. This is information notified to the Council by any network utility operator pursuant to the Building Act 1991 or the Building Act 2004.

(For network enquiries, please phone (03) 941 8999 or visit www.ccc.govt.nz.

l **None recorded for this property**

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11. Other information

Section 44A(3) LGOIMA. This is information concerning the land that the Council has the discretion to include if it considers it to be relevant.

(For any enquiries, please phone (03) 941 8999 or visit www.ccc.govt.nz.

(a) Kerbside waste collection

- Your recycling is collected Fortnightly on the Week 2 collection cycle on a Wednesday. Please leave your recycling at the Kerbside by 6:00 a.m. Your nearest recycling depot is the Styx Mill Refuse Station.

- Your refuse is collected Fortnightly on the Week 2 collection cycle on a Wednesday. Please leave your rubbish at the Kerbside by 6:00 a.m. Your nearest rubbish depot is the Styx Mill Refuse Station.

- Your organics are collected Weekly on Wednesday. Please leave your organics at the Kerbside by 6:00 a.m.

(b) Other

- **Community Board**

  Property located in Coastal-Burwood Community Board
- **Electoral Ward**

  Property located in Burwood Electoral Ward
- **Listed Land Use Register**

  Hazardous activities and industries involve the use, storage or disposal of hazardous substances. These substances can sometimes contaminate the soil. Environment Canterbury identifies land that is used or has been used for hazardous activities and industries. This information is held on a publically available database called the Listed Land Use Register (LLUR). The Christchurch City Council may not hold information that is held on the LLUR Therefore, it is recommended that you check Environment Canterbury's online database at www.llur.ecan.govt.nz
- **Spatial Query Report**

  A copy of the spatial query report is attached at the end of this LIM. The spatial query report lists land use resource consents that have been granted within 100 metres of this property.

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aurecon

Project: Prestons Subdivision

Geotechnical Completion Report Prestons South Stages W, X and Y

Reference: 235361

Prepared for: CDL Land New Zealand Ltd

Revision: 0

18 April 2017

Document Control Record

Document prepared by:

Aurecon New Zealand Limited
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Rev	**Date**	**Revision Details/Status**	**Prepared by**	**Author**	**Verifier**	**Approver**
A	18 January 2017	Draft for review	K Foote	K Foote	J Muirson	J Kupec
0	18 April 2017	Issue to Client	K Foote	K Foote	J Muirson	J Kupec
Current Revision		**0**				

Approval			
Author Signature	pp	Approver Signature	
Name	Kieran Foote	Name	Dr Jan Kupec
Title	Geotechnical Engineer	Title	Technical Director

Contents

Appendices

1. Executive Summary

CDL Land New Zealand Limited is developing Stages W, X and Y of the Prestons South Subdivision, located on Prestons Road, Christchurch. As part of the this work, a geotechnical completion report is required to confirm that the site works have been carried out to the required standard and provide recommendations for building developments. This report describes earthworks and ground improvement involved with Stages W, X and Y of the Prestons South Subdivision.

The client's brief indicated that the land shall be developed using an impact compactor with gravel embankments along the stormwater basins as ground improvement to raise the land performance to TC1 equivalent. Aurecon's role was to monitor the ground improvement quality assurance testing, which included CPTs. Assessment of the results indicates the required ground improvement has been achieved.

In addition to impact compaction and gravel embankment construction, extensive earthworks including cutting and filling have occurred on the site. The quality assurance testing of the engineered earthfill indicates that the earthfill placed within Stages W, X and Y area has achieved the compaction levels as per NZS4431:1989.

Following completion of the earthworks and topsoil placement throughout the subdivision, a series of CPT tests were carried out to confirm the ground conditions. The purpose of the CPTs was to allow an assessment of the future land performance during large earthquakes and to determine the equivalent technical category of the land. Assessments of these results indicate the liquefaction deformation limits fit within those of TC1 and therefore we consider the site is likely to perform to the level of TC1.

From the monitoring and testing undertaken as part of the development of Stages W, X and Y the following is concluded:

Certificate of Compliance

Standard of bulk earthworks generally meet the earthworks specification and the applicable codes, including NZS4431:1989.

Land Performance

In line with the subdivision consent soil test results and following the ground improvement carried out as part of the site development, the residential lots within Stages W, X and Y are likely to perform to a level equivalent to TC1 as per MBIE (2012).

Building Considerations

As the residential lots are likely to perform to a level of TC1 and the lots are underlain by earthfill that has achieved the compaction as per NZS4431:1989, we consider NZS 3604:2011 type foundations are suitable for light weight timber or steel frame buildings.

This report shall be read as a whole and our limitations are at the back of this report.

2. Introduction

2.1 Geotechnical Completion

CDL Land New Zealand Limited is developing Stages W, X and Y of the Prestons South Subdivision, located on Prestons Road, Christchurch. The site works on Stages W, X and Y have included ground improvement and bulk earthworks. As part of this work, a geotechnical completion report is required to certify the site works have been carried out to the required standard and provide recommendations for building developments.

This report has been prepared for CDL Land New Zealand Limited and issued to Christchurch City Council (CCC). It describes earthworks and ground improvement involved with Stages W, X and Y of the Prestons South Subdivision (see Figure 1 in Appendix A).

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

- Summarise previous investigation information carried out as part of the subdivision consent and detailed design;
- Summarise the ground conditions and liquefaction risk;
- Extent of ground improvement and quality assurance testing of the ground improvement;
- Extent of earthworks on the lots and compliance testing of bulk earthworks;
- Summary of the findings, land technical category and recommendations for building development.

This report has been prepared based upon geotechnical data from observations and compaction testing during and after earthworks construction and ground improvements. All references to cut-fill depths are based on the original (pre 2011) ground levels.

This report shall be read as a whole. Our limitations are presented in Section 11.

2.2 Site Description

The Prestons Road subdivision is located on the northern fringes of Christchurch City. The site is made up of a series of adjacent properties forming an irregular and elongated rectangle shape, orientated approximately north to south. The total area of the overall Prestons Subdivision site is approximately 190ha. The site can be separated into two distinct blocks. Prestons North runs from the Lower Styx Road in the north through to Prestons Road in the south. Prestons South continues from Prestons Road, through to Mairehau Road to the south.

The focus of the geotechnical completion report is on Stages W, X and Y of the Prestons South Subdivision. Stages W, X and Y incorporate the eastern and north-eastern side of the Prestons South subdivision (see Figure 1 in Appendix A).

As part of the site development a stormwater channel and pond has been constructed, which initially run along a north-south alignment through Prestons South, before altering to an east-west alignment and ending with the stormwater pond at the eastern boundary.

3. Pre-Development Geotechnical Work

3.1 Geotechnical Testing

The subdivision consent and detailed geotechnical design for the subdivision included an extensive series of geotechnical investigations. These comprised cone penetration tests (CPT), test pits, groundwater measurements and laboratory testing.

The details of these investigations are presented in the following Aurecon reports:

- *"Prestons Road Subdivision, Geotechnical Assessment Report for Resource Consent"*, Revision 2 dated 5 March 2012
- *"Prestons Road Subdivision, Detailed Geotechnical Design Report"*, Revision 2 dated 12 July 2012
- *"Prestons South Subdivision, Resource Consent Geotechnical Report"*, Revision 1 dated 6 June 2013

The investigation tests carried out within Stages W, X and Y of the Prestons South area are presented in Figure 2 in Appendix A.

3.2 Ground Conditions

From the extensive geotechnical investigations the ground conditions within Stages W, X and Y area were defined into various geological areas. The location of the geological area within Stages W, X and Y is presented in Figure 2 in Appendix A. The typical ground conditions in the area are presented in Table 1 and Table 2. We note the geological areas numbering is the same as those used in the geotechnical reports above.

Table 1: Typical ground conditions within Geological Area 1

Depth to Top of Unit (m)	Depth to Base of Unit (m)	Soil Unit
0	0.2 to 0.75	TOPSOIL.
0.2 to 0.75	3	SAND, loose to medium dense, with silty PEAT layers up to 0.3m thick within the upper 3m.
3	15+	SAND, medium dense to dense, becoming very dense with depth. Trace PEAT and SILT layers at depths of 10m+.

Table 2: Typical ground conditions within Geological Area 2

Depth to Top of Unit (m)	Depth to Base of Unit (m)	Soil Unit
0	0.2 to 0.5	TOPSOIL.
0.2 to 0.5	0.5 to 1.3	SILT non plastic and hard.
0.5 to 1.3	3	SAND, loose to medium dense, with silty PEAT layers up to 0.3m thick within the upper 3m.
3	15+	SAND, medium dense to dense, becoming very dense with depth. Trace PEAT and SILT layers at depths of 10m+.

Groundwater levels ranged from 0.5m to 1.5m below ground level. During the site earthworks the above soil profile and groundwater levels was typically encountered within the area of interest.

3.3 Liquefaction Potential

As part of the geotechnical assessment and detailed design a liquefaction assessment was carried out. The details of the liquefaction assessments were presented in the above reports. The land categorisation was based on the Ministry of Business, Innovation and Development (MBIE), formerly the Department of Building and Housing (DBH), Technical Categories deformation performance limits are set out in Table 3.

Table 3: Technical category definitions and foundation implications (MBIE, 2012)

Technical Category	Liquefaction Deformation Limits				Likely Implications for House Foundations (Subject to individual assessment)
	Vertical		Lateral Spread		
	SLS	ULS	SLS	ULS	
TC1	15mm	25mm	nil	nil	Standard 3604-like foundation with tied slabs
TC2	50mm	100mm	50mm	100mm	MBIE Enhanced Foundation Solutions
TC3	>50mm	>100mm	>50mm	>100mm	Site Specific Measures – Piles or Ground Improvement

The results from the liquefaction assessment indicated that the Prestons Subdivision can be classified as Technical Category 1 (TC1) and Technical Category 2 (TC2). In addition the presence of the new stormwater retention ponds presents a 'minor to major' lateral spreading hazard that was mitigated as per the following section.

3.4 Liquefaction Mitigation Measures

The requirement from the client was to form TC1 equivalent land for the entire subdivision development. Therefore to address liquefaction and lateral spreading potential the following methodologies were utilised.

Liquefaction

Part of the site was identified as TC1 while part of the site was identified as TC2. On-site trials with the Landpac impact compactor indicated that the underlying sand layers in the upper 3m of the soil profile could be densified using an impact roller. Thus, by densifying the ground the liquefaction potential can be minimised.

A detailed discussion of the trial and results are presented in *"Prestons Road Subdivision, Detailed Geotechnical Design Report"*, Revision 2 dated 12 July 2012 and *"Prestons South Subdivision, Resource Consent Geotechnical Report"*, Revision 1 dated 6 June 2013. Based on these results, ground improvement using the Landpac impact roller has been carried out where TC2 land has been identified. The area treated is shown in Figure 3 in Appendix A.

Lateral Spreading

The construction of the stormwater retention ponds was identified as being a potential cause of lateral spreading in a large seismic event, even with ground improvement using the impact roller. As the liquefiable layers are typically in the upper 2.5m to 3m depth of the soil profile, it was considered more feasible to remove the liquefiable layers and form a compacted gravel embankment.

Lateral spreading requires the need for a continuous liquefiable layer through to the free face. By removing this continuous liquefiable layer and reinstating with a compacted gravel (non-liquefiable) material the lateral spreading potential affecting land adjacent to the ponds can be eliminated. Depending on the depth of the stormwater pond and the extent of liquefaction near each pond the gravel embankments ranged in width and depth.

A stormwater channel and pond is present within Stages W, X and Y, where gravel embankments have been constructed to mitigate the risk of seismically induced lateral spreading. The gravel embankments are discussed further in the Section 5.

4. Ground Improvement

4.1 Introduction

As part of our brief was to raise the performance of the land to an equivalent TC1, ground improvement has been undertaken on any area identified as TC2, within the Stages W, X and Y.

Field trials identified that a Landpac impact compactor sufficiently densified the upper soil layer to a depth of 3m to 3.5m. The soil layers susceptible to seismically triggered liquefaction were located within the upper 3m of the soil column and therefore it was considered that ground improvement carried by Landpac can reduce the liquefaction susceptibility of these soils.

In this section we discuss the impact compactor methodology and quality assurance process used to ensure that ground improvement to the required level was being achieved. The area that has undergone ground improvement is presented in Figure 3 in Appendix A.

4.2 Methodology

Our detailed geotechnical assessment summarised in Section 3 identified that ground improvement could be carried out and a TC1 performance level achieved. The methodology carried out for ground improvement for Stages W, X and Y comprised of the following:

- Use a Landpac Standard 3-Sided dual drum impact compactor, with a total energy input of 250kJ/m^2.
- Carry out 40 passes over the required area, in a staged approach.
- Use a water cart to wet the compaction area, as required, to improve workability.

During the ground improvement works, Landpac monitored the soil response (discussed below) to ensure that maximum compaction force was being applied to the ground. Where the maximum compaction force was not being applied, then all soft soil was stripped and either a compacted gravel working layer up to 300mm deep was placed or alternatively the natural sand soil was compacted with a conventional compactor, provided it was appropriate as a subgrade.

Prior to any impact compaction, pre-compaction CPTs were carried out to confirm the pre-existing soil strengths. Once the required 40 passes were completed, post compaction CPTs were carried out to confirm the extent of the ground improvement. Details of these results are presented in the following sections.

4.3 Quality Assurance

Quality assurance testing of the ground improvement was carried out using continuous impact response (CIR) and pre/post compaction CPTs. Each of these is discussed below.

4.3.1 Continuous Impact Response

Continuous Impact Response (CIR) technology was used to measure the relative soil response to the dynamic loads induced by the impact drums. The recorded soil response measured in g-values (deceleration) is used to identify sub-surface weak materials and indicate relative soil stiffness across the compaction areas.

The recorded g-values (deceleration) and the locations are presented in a plot with the g-values categorised by colours representing low (Red), medium (Yellow), high (Green) and very high soil (Blue) responses.

This provided a good index tool to determine if maximum compaction force was applied to the ground. An initial 5 passes with impact compactor would be carried out to provide a soil response. If low soil responses were identified then the soft soils were over excavated and either a compacted gravel working layer up to 300mm deep placed or alternatively the natural sand soil was compacted with a conventional compactor, provided it was appropriate as a subgrade.

CIR plots that cover Stages W, X and Y are presented in Appendix B. Initial CIR plots were high with some medium areas. Final CIR plots were high with localised very high areas. This indicates that the maximum compaction force was being applied during the impact compaction process.

4.3.2 CPT

Assessment of the ground improvement was carried out using CPT tests. Prior to any impact compaction, pre-compaction CPTs were carried out to confirm the pre-existing soil densities. Once the required 40 passes were completed post compaction CPTs were carried out near the pre-compaction CPTs, offset by 2m to 5m, to confirm the extent of the ground improvement.

As the depth of influence for the impact compactor is approximately 3m and MBIE Guidelines (2012) recommend technical categorisation should be based on the upper 10m of the soil profile, the pre-compaction and post compaction CPTs were taken to a depth of 10m. Pre-compaction CPTs are presented in Appendix C and post compaction CPTs in Appendix D. CPT locations are shown in Figure 3.

Pre and post compaction CPTs were compared by two methods in assessing the ground improvement. The first method included a comparison of the cone resistance between the pre and post compaction to see if there is any overall soil density increase in the upper soil profile. The second method was to run a liquefaction assessment on the pre and post compaction to confirm the likely liquefaction induced settlements prior to impact compaction and those following impact compaction. Results of each of these is discussed below.

a) Cone Resistance Comparison

A comparison of the CPT cone resistance for each CPT, pre and post compaction, is presented in Appendix E. The results indicate that the cone resistance in the upper 3m have increased.

b) Liquefaction Reassessment

Introduction

As technical categories are derived by liquefaction induced deformation limits, liquefaction assessment on the pre and post compaction CPTs have been carried out to determine the extent of liquefaction and the induced settlements.

Earthquake Cases

Earthquake induced ground acceleration and sustained shaking, leading to sufficient load cycles, is a requirement and a potential trigger of liquefaction. For the assessment we have reviewed three levels of seismic shaking.

1. Serviceability Limit State (SLS) design level earthquake, as defined by MBIE.
2. Intermediate design level earthquake, as defined by the subdivision consent.
3. Ultimate Limit State (ULS) design level earthquake, as defined by MBIE.

Each of these earthquake cases is discussed in detail below:

Serviceability Limit State (SLS) Earthquake

From the MBIE Guidelines, we have derived a Peak Ground Acceleration (PGA) of 0.13g for a SLS event with a Magnitude 7.5 earthquake.

Intermediate Level (Int) Earthquake

Subdivision consent conditions indicate that liquefaction mitigation measures for the subdivision infrastructure shall be designed for a 1 in 150 year period of return under the serviceability limit state (SLS) and as defined by NZS1170.5:2004.

Based on NZS1170.5:2004 for an Importance Level 2 (IL2) structure, with an increased Z hazard factor of 0.3, we have derived a PGA of 0.2g for a 1 in 150 year period of return. A Magnitude 7.5 has been assumed.

We note that this PGA is equivalent to the assumed SLS design level earthquake used for the liquefaction analysis as part of our assessment for the subdivision consent and detailed geotechnical design.

Ultimate Limit State (ULS) Earthquake

The MBIE Guidelines (2012) recommend a PGA of 0.35g for residential buildings in Christchurch. We have adopted this PGA value with a magnitude 7.5 earthquake for our ULS assessment.

The liquefaction analysis as part of our assessment for the subdivision consent and detailed geotechnical design used a PGA of 0.34g for ULS, which was based on NZS1170.5:2002. This is slightly less than recommended guidelines and as the difference is 0.01g we consider that this will not alter our original assessment or recommendations. However, to be in in line with current MBIE Guidelines we have used a PGA of 0.35g.

Liquefaction Methodology

In assessing the liquefaction potential, two methods have been used to assess the potential settlement for each of the design level events. Previous experience indicates that some methods can over predict liquefaction induced settlements and the use of two settlement prediction methods will give us a range of results. The two settlement prediction methods are discussed below.

Boulanger and Idriss Method

The liquefaction assessment was carried out using the method developed by Boulanger and Idriss (2014), in accordance with the MBIE Guidelines (2012) for residential properties. The assessment was carried out using an excel spread sheet developed by Aurecon.

The method of Robertson and Wride (1998) with the modified fines content was used to assess the liquefaction potential from the CPT results. The method of Zhang et al (2004) was used for estimating the liquefaction induced settlements from CPT results.

NCEER Method

Liquefaction assessments were carried out using the National Centre for Earthquake Engineering Research (NCEER) method as outlined by Youd et al. (2001), and recommended in the NZGS (2010) Guidelines. The assessment was carried out using an excel spreadsheet developed by Aurecon.

The method of Robertson and Wride (1998) with the modified fines content was used to assess the liquefaction potential from the CPT results. The method of Zhang et al (2004) has been used for calculating potential liquefaction induced settlements for CPT results.

A groundwater depth of 0.5m below finished earthworks level has been allowed. Testing information throughout Stages W, X and Y indicates the groundwater level is typically greater than 1m depth (more likely to be at depths of 1.5m or greater) therefore a conservative groundwater level has been used for the assessment.

Liquefaction Assessment Results

Based on the design earthquake levels and methodologies, the liquefaction induced settlements for pre and post compaction CPT to 10m depth are presented in Table 4.

Table 4: Liquefaction induced settlements for pre and post compaction CPT to 10m depth

Earthquake Magnitude 7.5, Water Depth 0.5m												
CPTs	SLS Design Event (0.13g)				Intermediate Design Event (0.20g)				ULS Design Event (0.35g)			
	Settlement (mm)				Settlement (mm)				Settlement (mm)			
	NCEER		*Idriss & Boulanger*		*NCEER*		*Idriss & Boulanger*		*NCEER*		*Idriss & Boulanger*	
	Pre	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*
CPT511	5	**0**	5	**0**	10	**0**	15	**0**	10	**0**	25	**5**
CPT513	0	**0**	0	**0**	0	**5**	15	**10**	5	**10**	35	**25**
CPT514	0	**0**	5	**0**	10	**0**	35	**0**	25	**5**	60	**15**
CPT515	0	**10**	5	**10**	10	**15**	30	**20**	30	**25**	60	**30**
CPT516	0	**0**	0	**0**	0	**0**	15	**0**	5	**0**	35	**10**
CPT520	0	**0**	0	**0**	0	**0**	15	**0**	5	**5**	30	**10**
CPT522	0	**0**	5	**0**	0	**0**	40	**0**	15	**5**	65	**10**
CPT535	0	**0**	5	**0**	0	**0**	30	**10**	5	**10**	45	**20**
CPT537	0	**0**	0	**0**	0	**0**	0	**0**	5	**0**	10	**5**
CPT538	0	**0**	0	**0**	0	**0**	5	**0**	5	**0**	20	**0**
CPT539	0	**0**	0	**0**	0	**0**	5	**5**	5	**5**	15	**10**
CPT614	5	**0**	5	**0**	10	**0**	15	**5**	20	**5**	30	**20**
CPT625	0	**0**	0	**0**	0	**0**	0	**5**	5	**10**	5	**10**
CPT626	0	**0**	0	**0**	0	**0**	10	**5**	20	**20**	40	**40**
CPT627	0	**0**	0	**0**	0	**0**	10	**0**	5	**0**	30	**5**
CPT628	0	**0**	0	**0**	0	**0**	5	**0**	5	**0**	25	**5**
CPT629	0	**0**	5	**0**	10	**0**	20	**5**	20	**5**	45	**20**
CPT630	0	**0**	0	**0**	0	**0**	10	**0**	5	**0**	25	**5**
CPT631	0	**0**	5	**0**	0	**0**	10	**0**	5	**0**	20	**5**
CPT632	0	**0**	5	**0**	0	**0**	15	**5**	10	**5**	30	**10**
CPT633	0	**0**	0	**0**	0	**0**	5	**0**	0	**0**	15	**0**
CPT634	0	**0**	0	**0**	0	**0**	15	**0**	5	**0**	32	**10**
CPT635	5	**0**	10	**0**	10	**0**	35	**0**	25	**0**	55	**10**
CPT636	0	**0**	5	**0**	0	**0**	15	**0**	10	**5**	40	**15**
CPT637	0	**0**	0	**0**	0	**0**	15	**5**	10	**0**	40	**15**

Earthquake Magnitude 7.5, Water Depth 0.5m												
CPTs	**SLS Design Event (0.13g)**				**Intermediate Design Event (0.20g)**				**ULS Design Event (0.35g)**			
	Settlement (mm)				Settlement (mm)				Settlement (mm)			
	NCEER		*Idriss & Boulanger*		*NCEER*		*Idriss & Boulanger*		*NCEER*		*Idriss & Boulanger*	
	Pre	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*
CPT638	0	**0**	5	**0**	5	**0**	25	**5**	15	**10**	55	**20**
CPT639	0	**0**	0	**0**	0	**0**	10	**5**	10	**5**	35	**15**
CPT640	0	**0**	0	**0**	0	**0**	0	**0**	5	**5**	15	**5**

Note: The settlements presented above are to the nearest 5mm. There are inherent assumptions in the analysis methods used that may cause the actual site settlements to vary from those calculated.

Results indicate that there is a significant decrease in the potential liquefaction settlements for the method used and the various earthquake design levels. The exception is CPT515 and CPT626, where ULS earthquake case settlements where 30mm and 40mm, respectively. On review of the liquefaction profile results the liquefiable layers for CPT515 are at a depth of 7m and a depth 6m for CPT626. As the liquefiable layers as relatively deep and thin there will be a thick non-liquefiable crust that that minimise the effect of any liquefaction at depth.

To compare these results with current MBIE Guidelines we have considered the post compaction assessment on the CPTs. Based on these results the results fit within the liquefaction deformation limits of TC1.

5. Gravel Embankments

5.1 Introduction

The construction of the stormwater channel through Stages W, X and Y was identified as being a potential cause of lateral spreading in a large seismic event, even with ground improvement with the impact roller. As the liquefiable layers are typically in the upper 2.5m to 3m depth of the soil profile, it was considered more feasible to remove the liquefiable layers and form a compacted gravel embankment to eliminate the potential hazard in its entirety.

Lateral spreading requires the need for a continuous liquefiable layer through to the free face. By removing this continuous liquefiable layer and reinstating with a compacted gravel (non-liquefiable) material, lateral spreading affecting land adjacent to the channel can be eliminated.

5.2 Gravel Embankment Details

The design of the gravel embankment was carried out by Aurecon. The overall design of the gravel embankments are discussed in *"Prestons Road Subdivision, Detailed Geotechnical Design Report"*, Revision 2, dated 12 July 2012 and *"Prestons South Subdivision, Resource Consent Geotechnical Report"*, Revision 1, dated 6 June 2013. Subsequent analyses was carried out in November 2013. The purpose of the gravel embankment is to remove the liquefiable soils adjacent to the pond, as lateral spreading requires a continuous liquefiable layer extending through to the pond edge.

Depending on the depth of the stormwater channel and the extent of liquefiable layers near the channel, the gravel embankment size and depth varied. Each gravel embankment was designed so the bulk of the embankment comprises compacted gravel with an overlying layer of compacted sand. This optimisation of design ensured that the core of the embankment resisting lateral spreading comprised gravel while the upper embankment profile was compacted sand.

The details of the embankments are provided in Table 5.

Table 5: Typical embankment profile for stormwater channel within Stages W, X and Y

Stormwater Basin	Base RL of Gravel Embankments	Depth of Embankment	Width of Embankment from Crest	Depth of Compacted Gravel
Open Channel	RL 9.2m to 10.1m	2.5m to 3.4m	7m to 10m	2.5m to 3.4m
Pond	RL 9.8m	2.8m	10m to 11m	2.8m

5.3 Gravel Embankment Construction

The gravel embankment design required that a well graded sandy gravel material was used for the bulk of the embankment. Material used on site comprised of imported, well graded sandy gravel (AP100). The gravel was topped with variable thickness of clean, engineered sand fill. The earthworks specifications required that 98% of MDD for both the gravel and the overlying sand was achieved, to ensure that the required embankment design parameters were attained.

Site observations by Aurecon geotechnical and civil engineers confirm the gravel embankments have been constructed with imported, well graded sandy gravel overlain by a layer of compacted sand. In addition, the compaction quality testing discussed in Section 6 indicates that the required level of compaction has been achieved on site with the sandy gravel fill material and the overlying sand.

A review of as built earthworks information provided by the civil engineers indicates that the required width and depth of the gravel embankment profile has been achieved. Asbuilt plans for the gravel embankments are provided in Appendix F.

A review of post earthworks CPT information and liquefaction analysis, discussed in Sections 7 and 8, indicate that the gravel embankments were founded into non liquefiable soils.

Based on our intended design and the gravel embankment construction, we consider that the gravel embankments have been constructed appropriately and lateral spreading adjacent to the stormwater basins is unlikely. From a lateral spreading perspective the site is likely to perform to the level of TC1 requirements where the fully designed gravel embankments have been constructed.

6. Subdivision Earthworks

6.1 General

Bulk earthworks for Stages W, X and Y of Prestons were carried out in accordance with the requirements of NZS 4404:2010, "*Code of Practice for Urban Subdivision*" 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.

On those occasions when quality control testing did not meet the specification, the Contractor was required to rework the fill to achieve the required compaction.

6.2 Areas of Cut and Fill

Site earthworks within Stages W, X and Y have been predominantly fill with areas of cut. The fill material comprises predominantly sand overlying a natural sand subgrade. A layer of topsoil overlies the fill material. Extent of cutting and filling is shown in Figures 4 in Appendix A.

6.3 Compaction Quality Control Testing

Independent testing of earthfill compaction was carried out using a Nuclear Densometer (NDM). The acceptance criterion was based on the Prestons Subdivision earthworks specification as follows:

- Compaction of fill is to be in accordance with NZS 4431: 1989.
- Compaction standard is 95% Maximum Dry Density (MDD) for all areas of bulk filling.
- The gravel embankments around the stormwater basins required a higher standard of 98% MDD.

Fill material comprised of predominantly site-won sand with gravel fill used for the embankments. Compaction curves for each of the fill material are presented in Appendix G.

The MDD from the compaction curves were used to determine the level of compaction required for the fill material. A summary of these NDM results are presented in Appendix H and the NDM testing locations are presented in Figure 5 in Appendix A. The compaction tests were undertaken at a test frequency of approximately 1 test per 1,000m^3.

6.4 Compaction Results

The results presented in Appendix H indicate that 95% MDD or greater compaction has been consistently achieved in the areas of bulk fill and that 98% MDD or greater compaction has been consistently achieved in the gravel embankment areas. From these results and our site observations we confirm that all the earthfill placed within Stages W, X and Y area has achieved the required compaction.

6.5 Bulk Excavated Areas

As part of the site earthwork, bulk excavation was undertaken in two areas within Stages W, X and Y to remove relatively thick peat and organic layers present at shallow depths. The extent of the excavated area is shown on Figure 4 in Appendix A. The excavation was taken to depth of 1.5m to 1.8m below the original ground level. The bulk excavation was backfilled with sand which was compacted in layers.

Quality assurance testing of the sand placement was undertaken using DCP (dynamic cone penetration tests) undertaken by both Aurecon and the contractor. The testing indicated that the sand has been compacted to an appropriate level. In addition, a number of the post earthworks CPTs were undertaken in these bulk excavated areas once the earthworks was completed to confirm site ground conditions and site performance.

7. Post Earthworks CPT

7.1 Introduction

Following completion of the earthworks and topsoil placement throughout the subdivision, a series of CPT tests have been carried out to confirm the ground conditions. The CPTs have been carried out throughout Stages W, X and Y of the Prestons South subdivision, whether it is within the ground improvement area or not.

The frequency of the CPT testing carried out was one test per hectare for Stages W, X and Y post earthworks assessment. The post filling CPTs are presented in Appendix I and the locations are shown in Figure 6 in Appendix A.

The purpose of the CPTs were to allow an assessment of the land technical category further to that already undertaken as part of the subdivision consent, detailed geotechnical design and ground improvement quality assurance testing.

7.2 Liquefaction Assessment

To allow an assessment of the land technical category, a liquefaction assessment has been carried out on the post filling CPTs. The liquefaction analysis methodologies and earthquake design cases used to assess these CPT results are the same as those detailed in Section 4.3.2. The CPT analysis has been done to a depth of 10m, as this is the required depth in the MBIE Guidelines for technical category assessment.

In addition to determining the liquefaction induced reconsolidation settlement we have assessed the potential for liquefaction induced ground damage based on the Liquefaction Severity Number (LSN), as defined by Tonkin and Taylor (2013). Other ground damage potential methods (such as Ishihara, 1985) were assessed but LSN was considered the more appropriate method. Tonkin & Taylor (T&T) developed the Liquefaction Severity Number (LSN) based on investigation data and observations made following major earthquake events in Christchurch. The LSN number is an index number which qualitatively assesses the effects of liquefaction on a site and on a shallow founded building. The LSN number is calculated by the equation below.

$$LSN = 1000 \int \frac{\varepsilon_v}{z} . dz$$

Where: ε_v = volumetric reconsolidation strain

z = depth of liquefaction below ground level

The LSN number is likely to be a better index of surface damage than reconsolidation settlement because the LSN number is affected more by shallow liquefaction and less by liquefaction at depth, which is less likely to affect the ground surface or shallow founded buildings. Reconsolidation settlement places the same weighting on deep liquefaction as shallow liquefaction, even though settlement will have less impact at the ground surface with increasing depth. LSN numbers have been correlated to observed liquefaction effects during recent earthquakes in Christchurch as shown in Table 6 below.

Table 6: LSN Ranges and Observed Effects (Tonkin and Taylor, 2013)

LSN Range	Predominant Performance
0-10	Little to no expression of liquefaction, minor effects
10-20	Minor expression of liquefaction, some sand boils
20-30	Moderate expression of liquefaction, with sand boils and some structural damage
30-40	Moderate to severe expression of liquefaction, settlement can cause structural damage
40-50	Major expression of liquefaction, undulations and damage to ground surface, severe total and differential settlement of structures
>50	Severe damage, extensive evidence of liquefaction at surface, severe total and differential settlements affecting structures, damage to services

When compared to the broad descriptions of expected land performance in TC1, TC2 and TC3, as outlined in Section 3.3, the LSN number can be approximately correlated to technical categories as follows:

- TC1 = $LSN_{(ULS)} < 10$
- TC2 = $LSN_{(SLS)} < 20$ and $LSN_{(ULS)} < 30$
- TC3 = $LSN_{(SLS)} > 20$ or $LSN_{(ULS)} > 30$

A groundwater depth of 0.5m below finished earthworks level has been allowed. Testing information throughout Stages W, X and Y indicates the groundwater level is typically greater than 1m depth (more likely to be at depths of 1.5m) therefore a conservative groundwater level has been used for the assessment.

The results for the liquefaction induced reconsolidation settlement are presented in Table 7. The results for the liquefaction induced ground damage potential (based on LSN numbers) are presented in Table 8.

The results indicate the liquefaction deformation limits fit within those of TC1 and therefore we consider the site is likely to perform to the level of TC1 requirements. The results indicate that no expression of liquefaction in the SLS case and little to no expression of liquefaction in the ULS case. This is consistent with the definition for TC1.

Table 7: Liquefaction induced settlements for post filling CPTs to 10m depth

Earthquake Magnitude 7.5, Water Depth 0.5m, 10m Analysis						
CPT	SLS Design Event (0.13g)		Intermediate Design Event (0.20g)		ULS Design Event (0.35g)	
	Settlement (mm)		Settlement (mm)		Settlement (mm)	
	NCEER	*Idriss & Boulanger*	*NCEER*	*Idriss & Boulanger*	*NCEER*	*Idriss & Boulanger*
CPTPF24	0	0	0	0	5	15
CPTPF36	0	0	0	0	0	5
CPTPF37	0	0	0	0	0	5
CPTPF38	0	0	0	0	0	0
CPTPF39	0	0	0	10	10	20
CPTPF40	0	0	0	0	0	5
CPTPF41	0	0	0	0	0	5
CPTPF42	0	0	0	0	0	5
CPTPF43	0	0	0	0	0	5
CPTPF44	0	0	0	0	0	5
CPTPF45	0	0	0	5	5	15
CPTPF46	0	0	0	5	5	20
CPTPF47	0	0	0	0	0	5
CPTPF48	0	0	0	5	10	20
CPTPF49	0	0	0	0	5	10
CPTPF50	0	0	0	0	5	5
CPTPF51	0	0	0	5	5	10

Note: The settlements presented above are to the nearest 5mm. There are inherent assumptions in the analysis methods used that may cause the actual site settlements to vary from those calculated.

Table 8: LSN for post earthworks CPTs to 10m depth

Earthquake Magnitude 7.5, Water Depth 0.5m			
CPTs	SLS Design Event (0.13g)	Intermediate Design Event (0.20g)	ULS Design Event (0.35g)
	LSN	*LSN*	*LSN*
CPTPF24	0	0	2
CPTPF36	0	0	1
CPTPF37	0	0	1
CPTPF38	0	0	1
CPTPF39	0	2	6
CPTPF40	0	0	2
CPTPF41	0	0	1
CPTPF42	0	0	1
CPTPF43	0	0	2
CPTPF44	0	0	2
CPTPF45	0	1	3
CPTPF46	0	2	6
CPTPF47	0	0	2
CPTPF48	0	1	3
CPTPF49	0	0	2
CPTPF50	0	0	1
CPTPF51	0	0	3

8. Verification CPT

8.1 Introduction

After at least one month following the post earthworks CPTs a series of verification CPTs were carried out throughout Stages W, X and Y of the Prestons South subdivision, whether it is within the ground improvement area or not. These CPTs have been given the nomenclature CPTV - CPT Verification.

The purpose of the CPTs was to allow further assessment of the land technical category by testing areas previously not covered, as well as confirming whether there was strengthening of the ground over time following the ground improvement and site earthworks.

In total eight CPTs were carried out within and adjacent to Stages W, X and Y. The verification CPTs are presented in Appendix J and the locations are shown in Figure 6 in Appendix A.

8.2 Liquefaction Assessment

To allow an assessment of the land technical category and possible ground improvement we have carried out a liquefaction assessment on the verification CPTs. The liquefaction analysis methodologies and earthquake design cases used to assess these CPT results are the same as those detailed in Section 4.3.2 and 7.2. The CPT analysis has been performed to a depth of 10m, as this is the required depth in the MBIE Guidelines for technical category assessment.

A groundwater depth of 0.5m below finished earthworks level has been allowed. Testing information throughout Stages W, X and Y indicates the groundwater level is typically greater than 1m depth (more likely to be at depths of 1.5m) therefore a conservative groundwater level has been used for the assessment.

The results for the liquefaction induced reconsolidation settlement are presented in Table 9. The results for the liquefaction induced ground damage potential (based on LSN numbers) are presented in Table 10. The results indicate the liquefaction deformation limits fit within those of TC1 and therefore we consider the site is likely to perform to the level of TC1 requirements.

Table 9: Liquefaction induced settlements for verification CPTs to 10m depth

Earthquake Magnitude 7.5, Water Depth 0.5m, 10m Analysis						
CPT	SLS Design Event (0.13g)		Intermediate Design Event (0.20g)		ULS Design Event (0.35g)	
	Settlement (mm)		Settlement (mm)		Settlement (mm)	
	NCEER	*Idriss & Boulanger*	*NCEER*	*Idriss & Boulanger*	*NCEER*	*Idriss & Boulanger*
CPTV19	0	0	0	5	5	10
CPTV20	0	0	0	0	0	5
CPTV21	0	5	0	15	5	20
CPTV22	0	0	0	5	0	10
CPTV23	0	0	0	0	0	0
CPTV24	0	0	0	0	5	15
CPTV25	0	0	0	0	0	5
CPTV26	0	0	0	10	10	25

Note: The settlements presented above are to the nearest 5mm. There are inherent assumptions in the analysis methods used that may cause the actual site settlements to vary from those calculated.

Table 10: LSN for verification CPTs to 10m depth

Earthquake Magnitude 7.5, Water Depth 0.5m			
CPTs	SLS Design Event (0.13g)	Intermediate Design Event (0.20g)	ULS Design Event (0.35g)
	LSN	*LSN*	*LSN*
CPTV19	0	0	1
CPTV20	0	0	1
CPTV21	1	6	11
CPTV22	0	1	2
CPTV23	0	0	1
CPTV24	0	0	3
CPTV25	0	0	1
CPTV26	0	2	8

9. Building Development

9.1 Technical Category

Extensive geotechnical testing has been carried out as part of the subdivision development. The testing indicates the lots within Stages W, X and Y are likely to perform to the level equivalent to TC1.

9.2 Earthworks on Building Lots

The extent of earthfill on the lots in Stages W, X and Y is shown on Figure 4 in Appendix A.

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

9.3 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 or steel 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, specific foundation designs could be used or alternatively excavations can be backfilled to the required level with 10MPa site concrete or compacted hardfill. In line with the client's brief Aurecon undertook site specific investigations on each residential lot and we have prepared a site specific geotechnical report addressing the foundation requirement. The testing data for the lot specific investigations has been uploaded to the Canterbury Geotechnical Database.

9.4 Building Considerations

As the land is likely to perform to a level of TC1 and a number of the lots are underlain by earthfill that has achieved the required compaction, we consider NZS 3604:2011 type foundations are 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 and our recommendations relate to NZS3604:2011 type lightweight timber or steel framed residential buildings only.

9.5 Building Setback

Along the north boundary of Stage Y1 there is a building setback. No residential structures should be constructed within this area.

9.6 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 at Work Act 2015 and the Department of Labour 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 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 should not be placed adjacent to any timber retaining wall, if present.
- Any development where excavations greater than 1.2m in depth are proposed, must be subject to specific investigation and design to confirm these works will have no adverse effect on land stability, infrastructure and/or structures on adjacent lots. Excavations near sensitive structures or near boundaries may require geotechnical engineering input even if shallower than 1200mm.

9.7 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 services.

9.8 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 or a Chartered Professional Engineer who are familiar with this report must be carried out to ensure the adequacy of the foundation subgrade prior to the placement of granular hardfill or the construction of foundations.

10. References

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11. Limitations

This report has been prepared for CDL Land New Zealand Limited. It may be made available to others but only in full. As noted above, it shall not be used by any person as a substitute for specific field observations and testing once house sites are confirmed.

This report has been prepared as part of the development of the Prestons South Stages W, X and Y Subdivision. It has been prepared to provide the following information:

- To report on the management of the earthworks during construction, including compaction standards of fills.
- To report on the extent of ground improvement and the resulting land technical category.

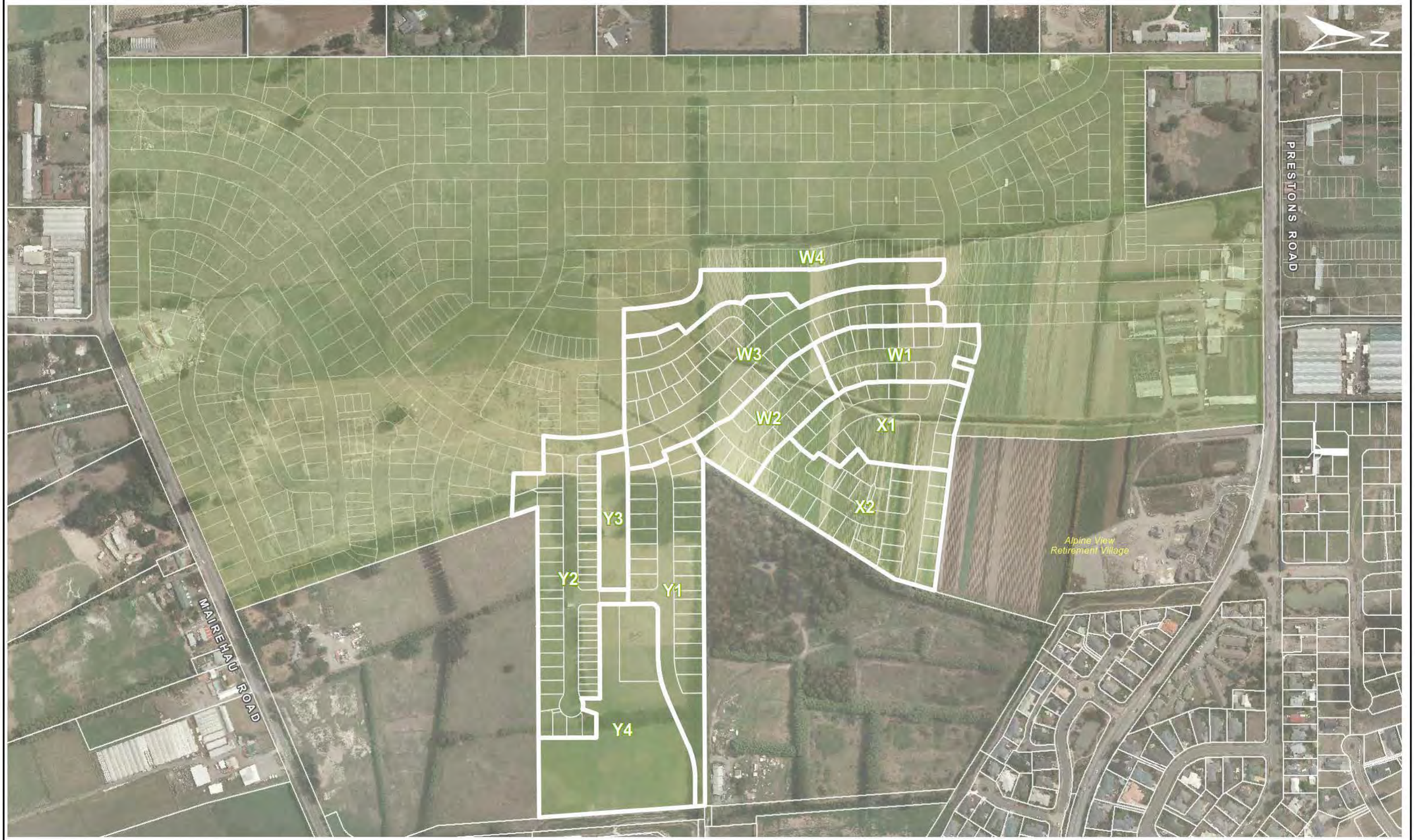
This report does not remove the responsibility of the Owner / Builder / Building Certifier to satisfy themselves of foundation depth and suitability at the finally selected house location.

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



0 60 120 180 240 Meters

NOTES - PROPERTY DATA FROM LINZ
- AERIAL IMAGE FROM CCC POST 2011 EQ

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CLIENT: CDL LAND NEW ZEALAND LIMITED

REV	DATE	REVISION DETAILS	APPROVED
A	07.16	ISSUE	T.BROWNE

DRAWN	DESIGNED
R.Dawson	J.Muirson

CHECKED: J.Kupec

APPROVED: T. Browne July 2016 (DATE)

PROJECT: PRESTONS SOUTH STAGES 2 W, X & Y

TITLE: SITE LOCATION PLAN

PROJECT No.: 235361
SCALE: AS SHOWN
SIZE: A3
DRAWING No.: FIG 1
REV: A

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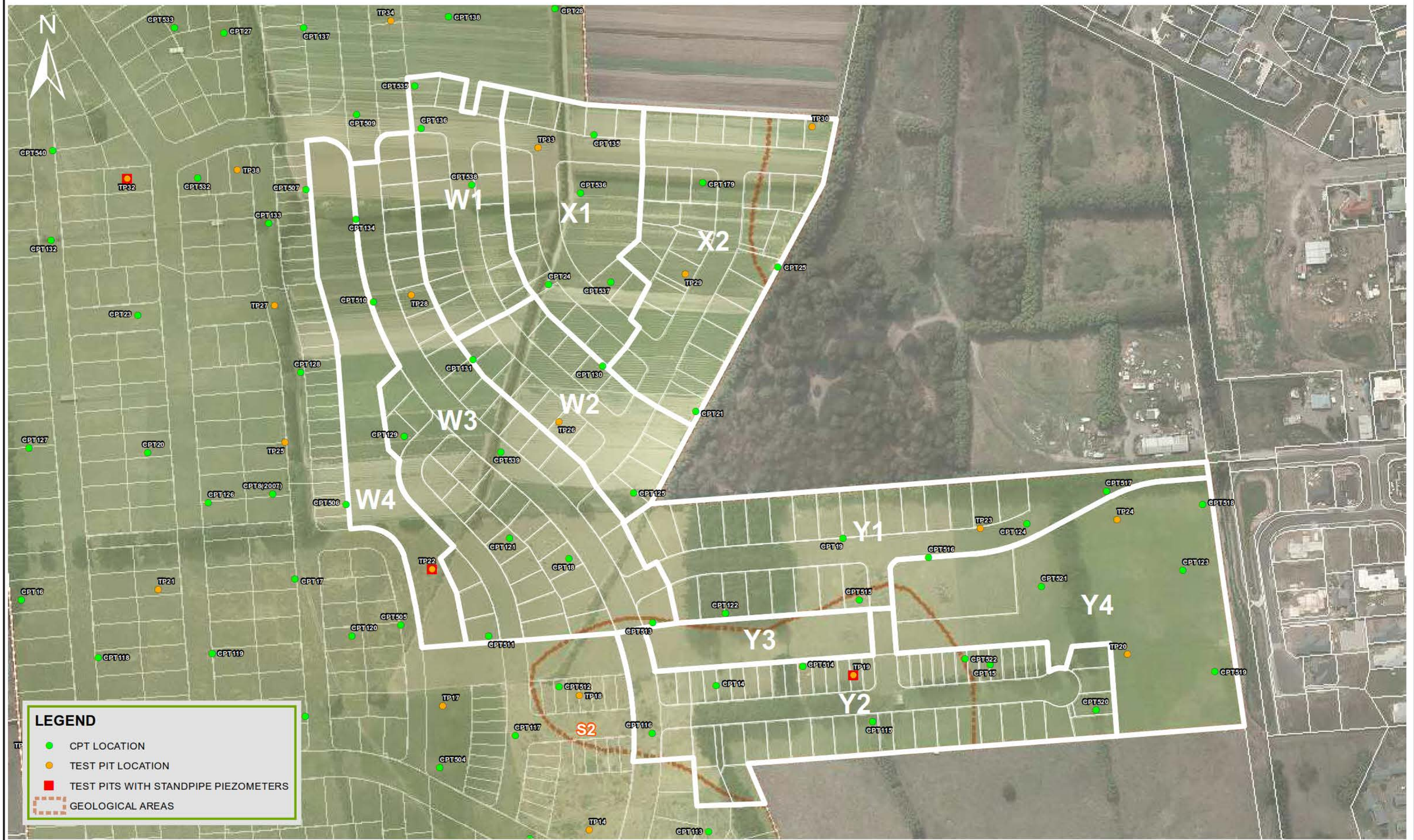

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DRAWN	DESIGNED
R.Dawson	J.Muirson
CHECKED	
J.Kupec	
APPROVED	DATE
T. Browne	July 2016

PROJECT
PRESTONS SOUTH STAGES 2 W, X & Y

TITLE
PREVIOUS INVESTIGATIONS

PROJECT No.	
235361	
SCALE	SIZE
AS SHOWN	A3
DRAWING No.	REV
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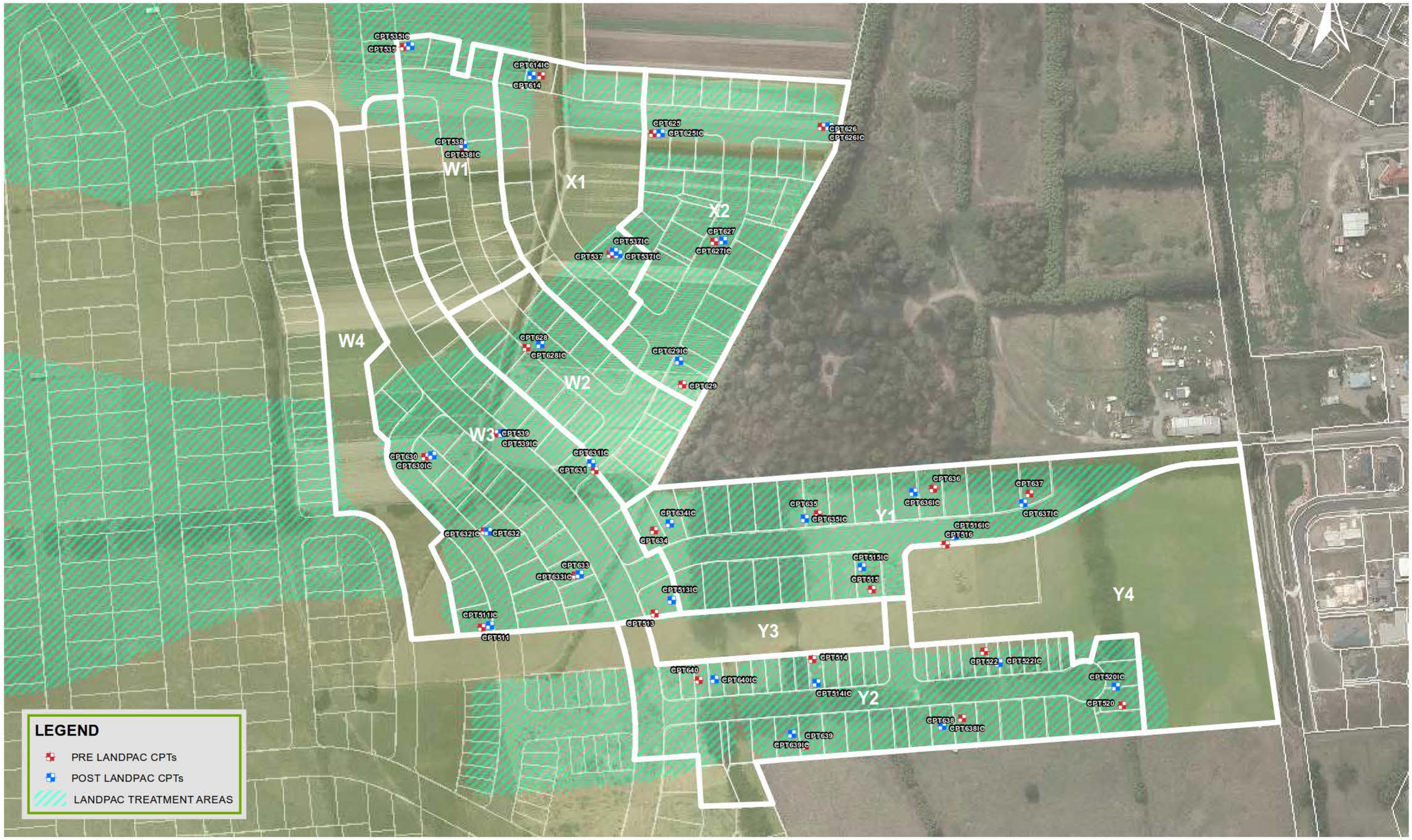

NOTES - PROPERTY DATA FROM LINZ
- AERIAL IMAGE FROM CCC POST 2011 EQ

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DRAWN	DESIGNED
R.Dawson	J.Muirson
CHECKED	
J.Kupec	
APPROVED	DATE
T. Browne	July 2016

PROJECT: PRESTONS SOUTH STAGES 2 W, X & Y

TITLE: GROUND IMPROVEMENT

PROJECT No.	
235361	
SCALE	SIZE
AS SHOWN	A3
DRAWING No.	REV
FIG 3	A

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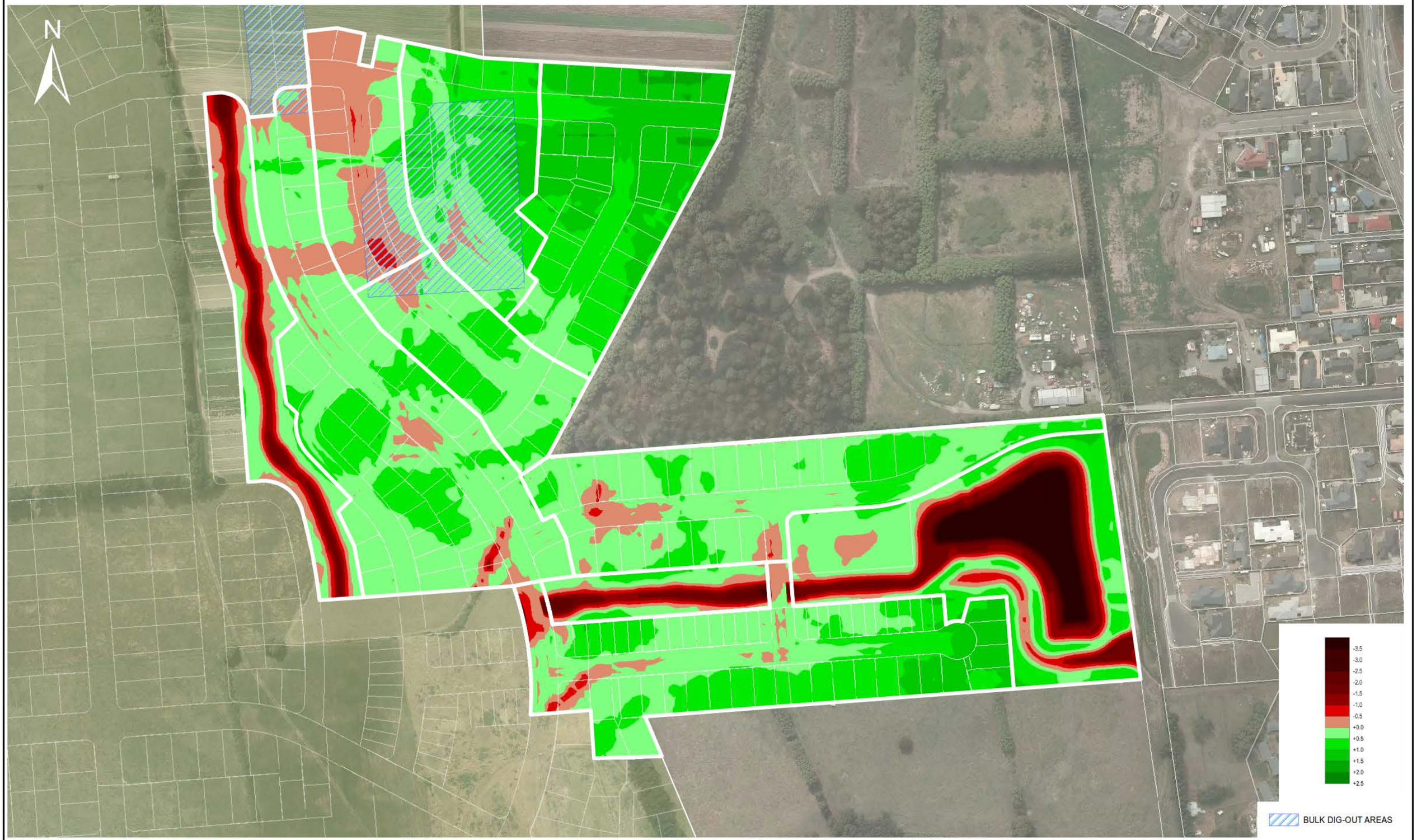

NOTES - PROPERTY DATA FROM LINZ
- AERIAL IMAGE FROM CCC POST 2011 EQ

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DRAWN	DESIGNED
R.Dawson	J.Muirson

CHECKED: J.Kupec

APPROVED: T. Browne *July 2016* (DATE)

PROJECT: PRESTONS SOUTH STAGES 2 W, X & Y

TITLE: CUT FIL BANDING

PROJECT No.: 235361

SCALE: AS SHOWN | SIZE: A3

DRAWING No.: FIG 4 | REV: A

Path: P:\223488\GIS\MXD\geotech figs\detailed design\SOUTH STAGE 2WXY COMP 2016\FIG 4 CUT FILL BANDING.mxd