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25 June 2019

Our ref: 773-CHCGE231429

Carston Developments Limited
c/o Baseline Group
54 Manchester Street
PO Box 8177, Riccarton
Christchurch

Attention: Sally Elford

Liquefaction hazard assessment and Technical Category advice for the proposed subdivision at 308 – 322 Halswell Junction Road, Halswell

1. Introduction and scope of work

Coffey Services (NZ) Limited have been engaged by Andrew Chapman of Carston Developments Limited to review the available information for the proposed subdivision at 308-322 Halswell Junction Road and to provide a second opinion about the liquefaction hazard and corresponding Technical Category for foundation design at the site.

In accordance with our proposal dated 19 June 2019, the following items were carried out as part of our geotechnical evaluation to compile this report:

- Review of available reporting for the site and for the neighbouring Copper Ridge Subdivision including:
  - Soil and Rock Geotechnical Investigation Report dated 19 February 2019.
  - Christchurch City Council RMA Documents for the Copper Ridge Subdivision.
- Review of factual data for the site including:
  - New Zealand Geotechnical Database layers.
  - Investigation data available for the 308 – 322 Halswell Junction Road site.
    - To be requested from Soil and Rock and provided to Coffey by Baseline Group.
- Liquefaction analysis using the existing raw CPT data at the site.
- Provision of a geotechnical letter report summarising the above and providing our opinion of the TC categorisation across the site.

2. Review of existing information

2.1. Soil and Rock Report

The Soil and Rock Report assesses the ground conditions present at the site against Section 106 of the RMA and comments on the suitability of the site for subdivision. The Soil and Rock ground investigation location plan has been attached to this report. As part of this assessment the following ground investigation data was used:

- Environment Canterbury Borehole M36/1629 indicates continuous deposits of sandy gravel from 4.9 mbgl to at least 19.5 mbgl.
- 7 existing onsite cone penetration tests (CPT) were obtained for the site (completed by McMillian Drilling and labelled CPT007, CPT008, CPT010, CPT011, CPT012, CPT014 and CPT015).
  - The CPT's extended to between 5.9 and 10.5 mbgl and no ground water was inferred for any of the locations.
- 5 additional CPT tests were carried out on site as part of the Soil and Rock ground investigation (completed by McNeil Drilling and labelled CPT01, CPT02, CPT03, CPT04, and CPT05/5A).
  - CPT01 refused at approximately 7.2 mbgl.
  - CPT05 refused at approximately 3 mbgl.
    - CPT05A was completed adjacent to CPT05 and extended to 10 mbgl.
  - CPT02, CPT03 and CPT04 extended to 10 mbgl.
  - Ground water was inferred at between 3.7 and 4.1 mbgl across all of the CPT locations.
- 8 hand augered boreholes (AH) were completed to a target depth of 3 m below ground level.
  - Ground water was encountered in AH01 and AH04 at 1.8 and 2.8 mbgl respectively.
  - Ground water was not recorded in the upper 3.0 m of the ground profile for AH02, AH03, AH05, AH06, AH07 and AH08.

The above investigation resulted in the following typical ground model being developed for the site:

- Up 0.4 m of topsoil / fill which overlies between 4.7 and 10.3 m of interbedded alluvial sand and silt deposits and an unconfirmed thickness of dense to very dense sandy gravel below the alluvial sand and silt layer.
- Ground water was described as ranging between 1 and 4 mbgl.

The liquefaction assessment at the site was based on the standard MBIE Guidance analysis methodology using a typical ground water depth of 1.5 mbgl for all CPT locations. This assessment produced a range of TC2-like (5 CPT locations) and TC3-like (7 CPT locations) liquefaction induced settlement predictions.

Other key information identified within the Soil and Rock Report is summarised below:

- The Scaled Conditional PGA assessment identified that the site was only tested to SLS level during the 4 September 2010 event.
- The event with the second highest Scaled Conditional PGA was the 22 February 2011 event and the PGAs determined for the 13 June 2011 and 23 December 2011 events were approximately half of that calculated for the 22 February 2011 event.

2.2. Copper Ridge RMA Documents

Christchurch City Council RMA Decision (Sections 95A/95B and 104 and 104D) makes the following comments (by Ms Yvonne McDonald) in relation to the geotechnical performance of the Copper Ridge Subdivision which is located immediately to the north west of the subject site:

"Tonkin and Taylor found the site to be TC2-like. The 2013 consent required land improvement through placing fill to increase the crust thickness and so to mitigate subsidence, in conjunction with 2, 3 or 4 for foundations in TC2 areas. Due to the improvement analysis of land performance and likely settlements over intervening time, this assessment removes the recommendation for placing fill. Tonkin and Taylor do recommend that "…any localised filling (i.e. for building footprints on individual lots) be limited to 250mm (rather than the 400mm currently permitted in the MBIE Guidance document), without further specific engineering design (SED) of foundations by a Chartered Professional Engineer (CPEng)." They also accept ground lowering up to 200mm but recommend greater depths in the southern portion, be confirmed with Tonkin and Taylor.

The series of reports found that contours of the land preclude risks from erosion, falling debris or slippage.

The Peer Review recommends that there is no reduction in finished ground level in the southern portion of the site, where the crust is thinnest. It also suggested that increased finished levels would be beneficial. The design of infrastructure to be vested should also consider liquefaction risk and mitigation.

I accept Tonkin and Taylors recommendations for the classification of this land and their accompanying conditions."

2.3. MBIE land zoning

The site is currently located within an area zoned as MBIE Technical Category NA – Urban Non Residential.

The majority of the area south east of Wigram Road is zoned as MBIE Technical Category TC2 – which indicates minor to moderate land damage from liquefaction is possible in a future large earthquake.

There is a thin strip of TC3 classified land which runs adjacent to Halswell Junction Road south of Wigram Road. This area appears to loosely correlate with the position of Nottingham Stream and the surrounding low lying areas. A similar area mapped as TC3 is present adjacent to and south of Whincops Road. This feature appears to correlate with Knights Stream.

2.4. Post Earthquake Aerial photo review

In order to better understand the performance of the site during the Canterbury Earthquake Sequence Coffey have reviewed the following aerial imagery at the site:

- Google Earth Image dated 5 September 2010
  - There is no clear evidence of liquefaction or lateral spreading being present at the site.
- NZGD Layer (EQC Aerial Photography) dated 24 February 2011
  - There is no clear evidence of liquefaction or lateral spreading being present at the site.

No clear aerial imagery was available following the 13 June 2011 or 23 December 2011 earthquakes. However due to their small magnitude and duration of shaking, and the large distance from their epicentre, their effects will be much less significant that the September 2010 and February 2011 earthquakes.

2.5. EQC Vertical Ground Movements

In order to better understand the performance of the site during the Canterbury Earthquake Sequence Coffey have reviewed the EQC Vertical Ground Movements Layer for the site:

- 4 Sept + 22 Feb
  - Between 0.1 m of settlement to 0.2 m of uplift described
- 22 Feb + 13 Jun
  - Between 0.2 m settlement to 0.1 m of uplift described
- 13 Jun + 23 Dec
  - Site not covered for 23 Dec event
- 4 Sept + 13 Jun
  - Between 0.1 m of settlement to 0.2 m of uplift described

We understand that the Lidar used for the above assessment has an error of up to plus/minus at least 200 mm meaning that the settlement and uplifts described above are considered to be largely insignificant in the context of other areas of Christchurch where Technical Category classification has been undertaken.

3. Coffey comments on existing information

3.1. Raw data summary

Coffey have summarised the information available within the Soil and Rock assessment in the table below. It order to determine the relative levels (RL) for each of the tests based on 1 m contour lines available on the NZGD, Coffey have also summarised the depth to recorded (or inferred ground) water level and depth to the depth where soil is logged as wet as appropriate for each location.

Table 1: Ground investigation summary table

Test name	RL (+/- 250mm)	Depth of test (mbgl)	Recorded / inferred ground water (mbgl)	Depth to "wet" soil (mbgl)
CPT01	~19.5	7.2	Inferred at 3.9	N/A
CPT02	~19.5	10.0	Inferred at 3.7	N/A
CPT03	~19.0	10.0	Inferred at 4.0	N/A
CPT04	~19.0	10.0	Inferred at 4.0	N/A
CPT05	~18.5	3.0	Not inferred	N/A
CPT05A	~18.5	10.0	Inferred at 4.0	N/A
CPT007	~18.5	9.9	N/A	N/A
CPT008	~18.5	10.5	N/A	N/A
CPT010	~18.0	10.3	N/A	N/A
CPT011	~18.0	9.6	N/A	N/A
CPT012	~18.0	6.5	N/A	N/A
CPT014	~18.0	6.2	N/A	N/A
CPT015	~18.0	5.9	N/A	N/A
AH01	~18.0	3.0	1.8	1.7
AH02	~19.0	3.0	Not encountered	2.8
AH03	~19.0	3.1	Not encountered	2.3
AH04	~18.0	3.0	2.8	2.2
AH05	~18.5	3.1	Not encountered	3.1
AH06	~19.0	3.0	Not encountered	2.9
AH07	~19.0	3.1	Not encountered	3.0
AH08	~18.0	3.0	Not encountered	2.5

3.2. Ground model

Coffey have reviewed the Soil and Rock ground model and are in general agreement with the ground model presented in the report; although following additional review of the raw ground investigation data, the following key comments are considered important for the liquefaction assessment the site:

- The ground water previously adopted for the site seems to be overly simplistic and conservative additional commentary about ground water at the site are included in Section 3.3 of this report.
- The layer between topsoil and the dense gravel at depth is considered to be predominantly fine grained in nature and highly interbedded. Where soil of this nature is present, CPT testing records "transition layers". These layers occur when the pressure bulb of the CPT test advances into a soil of different strength, thus influencing the result at a specific point within the soil profile. It is considered industry best practice to use a transition layer correction in these instances.
- Coffey have adopted a transition layer detection to correct the Ic and corresponding SBT throughout the depth of each of the CPT's in order to ensure that our liquefaction analysis is not overly conservative as a result of erroneous transition layers within the CPT profile.
- CPT05 has been disregarded from the remainder of this report due to its shallow refusal and the assumption that CPT05A supersedes this test. Further to this it appears that the top 3 m of the soil profile in the two CPTs both comprise silty sand to sandy silt and are considered to be very similar to each other.

3.3. Ground water comments

Based on a review of the data presented in Table 1 (noting that the RLs are approximate only and not surveyed) we consider that the depth to ground water at the site generally follows the RL 16.0 m level as shown by the approximation of RL – depth to ground water from Table 1. This is consistent with the only two AHs which encountered ground water being located at RL 18.0 m which is the lowest estimated ground surface RL for the site.

Given this information we consider it most appropriate to assign the different areas of the site ground water values based on the depth to soil logged as "wet" (in the absence of a recorded ground water depth) in each of the AH holes. These values are approximate only, but are considered sufficient for liquefaction assessment of the site and as such AH ground water (or "wet") depths have been paired with the nearby CPTs using engineering judgement to assign a realistic ground water across the site. These pairs are show in Table 2 below.

Table 2: Assumed ground water depths

CPT name	Corresponding AH name	Assigned ground water depth (mbgl)
CPT01	AH02	2.8
CPT02	AH03	2.3
CPT03	AH06	2.6
CPT04	AH07	3.0
CPT05	AH08	2.5
CPT05A		
CPT007	AH03	2.3
CPT008	AH03	2.3
CPT010	AH08	2.5
CPT011	AH01	1.8
CPT012	AH04	2.2
CPT014	AH08	2.5
CPT015	AH08	2.5

4. Liquefaction assessment

4.1. Site sub-soil class

In accordance with Section 3.1.3 of NZS1170.5[1], a site subsoil classification of *"Class D – Deep or soft soil sites"* has been assumed for this site.

4.2. Seismic design ground motion parameters

SLS and ULS design earthquake scenarios were assessed using the parameters provided by the MBIE Guidance and NZGS Guidelines[2] for an IL2 structure and a Class D sub-soil site.

The earthquake parameters adopted for geotechnical seismic design, namely liquefaction analysis, are presented in Table 3.

[1] NZS 1170.5:2004 - Structural design actions - Part 5: Earthquake actions - New Zealand.

[2] MBIE and NZGS (2016): Earthquake geotechnical engineering practice, Module 1: Overview of the guidelines, March 2016.

Table 3: Earthquake scenario and parameters for analysis

Earthquake scenario	Moment magnitude (M_w)	α_{max} (g)
SLS	7.5	0.13
	6.0	0.19
ULS	7.5	0.35

4.2.1. Free-field settlement

An assessment of liquefaction triggering and free-field settlements at the site has been carried out for the soil profile across the site using the available CPT information (see Table 1 and Table 2). The liquefaction assessment has been carried out based on the MBIE Guidance and using proprietary liquefaction assessment software[3].

The results of the liquefaction analysis (for both SLS and ULS) have been summarised in Table 4 above and the estimated free-field settlements are presented in Table 4 below.

Table 4: Estimated "free-field" post-liquefaction ground surface settlements

Earthquake scenario	Moment magnitude (M_w)	α_{max} (m/sec^2)	Predicted liquefaction induced settlement range (mm)	Indicated MBIE Technical Category
SLS	(SLS1) 7.5	0.13g	5 to 35	TC2-like
	(SLS2) 6.0	0.19g	20 to 75**	TC2 & TC3-like**
ULS	7.5	0.35g	5 to 95	TC2-like

Notes:

* Ground surface settlements (mm) to refusal depth (max 10 mbgl)

** 50 mm exceeded in CPT03, CPT04 and CPT05A

Under ULS conditions a consistent crust thickness of between 2 and 3 m was identified for all of the CPTs with the majority of the settlement for each of the CPTs resulting from the soils below 4 mbgl. This is typically consistent for the SLS cases.

Given the depth to liquefiable material Coffey consider that the predicted liquefaction induced settlement values which indicate TC3-like settlements for the SLS2 case in CPT03, CPT04 and CPT05A are not representative of the likely ground performance in a future earthquake event. This is further shown in Figure 1 which shows an overlay of the predicted vertical settlement verses depth for the SLS2 case. In this figure the red lines represents the TC3-like CPTs and the dark blue indicates the TC2-like CPTs. The figure clearly shows that the difference in predicted settlement between the CPT plots which has resulted in different TC classifications is concentrated below 4.5 mbgl. This provides a significant 4.5m thick "crust" of predominantly non-liquefiable material which is likely to reduce the surface manifestation of liquefaction across the entire site.

[3] Geologismiki Geotechnical Software, Cliq v2.0.6.83 – CPT Liquefaction Assessment Software

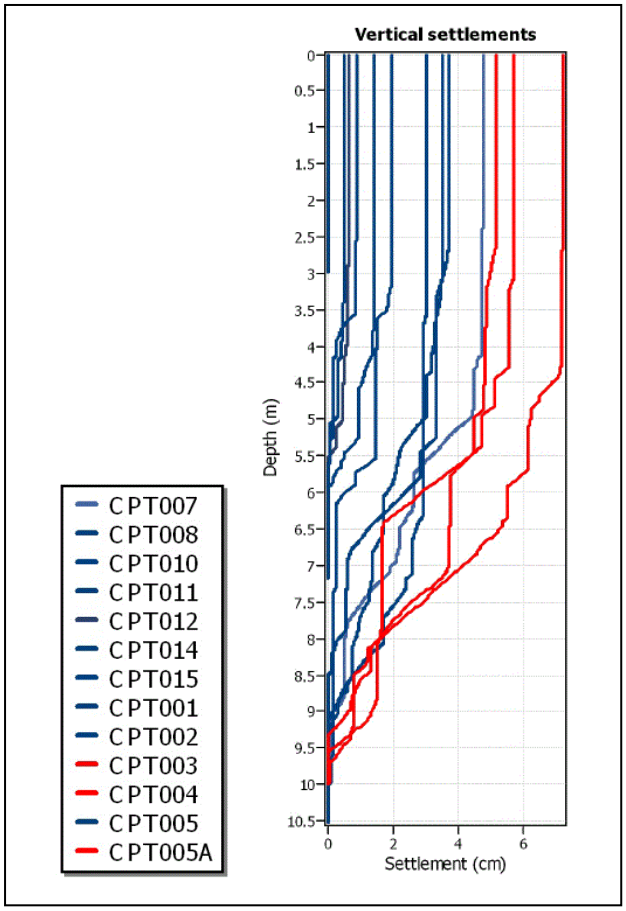


Figure 1: Overlay showing all CPTs predicted settlement verse depth (SLS2)

For this reason Coffey have completed an additional analysis which calculates the LSN values for each of the cases described above. This analysis is included in Section 4.2.2 of this report.

4.2.2. Liquefaction severity number

The liquefaction severity number (LSN) is a parameter which estimates the likelihood of surface deformation due to liquefaction (considering the influence of crust thickness and soil strains verses depth) – i.e. surface ejecta and excessive foundation settlement. An LSN range has been derived for the CPTs across the site and is summarised in Table 5 below.

Table 5: LSN values and interpretation

Earthquake scenario	Moment magnitude (M_w)	α_{max} (m/sec^2)	LSN (range for all CPTs)	Liquefaction expression (qualitative interpretation)	Indicative TC based on predicted liquefaction expression
SLS	7.5	0.13g	0 to 5	Zero/ Little	TC2
	6.0	0.19g	2 to 10	Zero/ Little to Minor	TC2
ULS	7.5	0.35g	2 to 15	Zero/ Little to Minor	TC2

Table 5 describes the range of LSN values for each of the earthquake scenarios described in the MBIE Guidance the resultant values indicate that there is could be to minor expression of liquefaction in some areas of the site under both SLS and ULS conditions. This level of land damage is considered to be generally in line with what could be expected for a TC2 site (i.e. “Minor to moderate land damage from liquefaction in possible in future large earthquakes”).

4.3. Lateral spreading deformation

Coffey have not completed a detailed lateral spreading assessment or site walkover at the site; however, based on the Soil and Rock report we consider that the lateral spreading is likely to fall within the acceptable tolerance for a TC2 site.

5. Conclusion

Based on Coffey’s review of the available reporting and information for the site we consider that the observed land damage (lack of land damage) at the site is not consistent with the predicted liquefaction induced settlements at the site as reported in the Soil and Rock report.

In order to get a more realistic understanding of the likely land performance at the site we have optimized the liquefaction analysis to use a more representative ground water depth for each CPT location and to correct each of the CPT traces using transition layer detection. These two changes resulted in TC2-like performance across the entire site for the ULS case and TC2-like performance across the majority of the site under SLS conditions (CPT03, CPT04 and CPT05A indicated TC3-like performance).

Given the above further attention was given to the three CPT’s which predicted TC3-like performance under SLS conditions. This showed that a non-liquefiable crust thickness of at least 2.5 m and likely up to 4.5 m deep was available at each of these locations.

In order to consider this crust thickness as part of the future site performance of the site we ran a LSN analysis to give a qualitative assessment of the likely land damage for each of these areas of the site under both SLS and ULS conditions. This assessment indicated that zero to minor liquefaction induced land damage was likely to occur at the site under both SLS and ULS conditions.

Based on all of the above information we consider that the future land performance of the entire area covered by the proposed subdivision at 308-322 Halswell Junction Road is TC2-like.

We anticipate that the proposed subdivision would include areas of relatively minor fill (0.5 m to 1.0 m thick in some locations) to prepare the site layout. It is recommended that large excavations at the site are avoided as this could reduce the thickness of non-liquefiable crust at the site and result in less favourable land performance than indicated by this report.

Given the above it is recommended that earthworks to level the site and prepare the subdivision for TC2 style foundations use predominantly imported engineered fill material.

6. Future considerations

We note that Christchurch City Council would likely require additional geotechnical reporting responding to all items covered by the RMA Section 106 including the revised liquefaction assessment included in this report during the consenting procedure.

If this is required Coffey is happy to provide a quote to complete the required additional reporting for the site (we do not anticipate the requirement of any additional testing for the preparation of this report).

7. Limitations

This report has been prepared solely for the use of our Client, Carston Developments Limited, their professional advisers and the Christchurch City Council in relation to the specific project described herein. No liability is accepted in respect of its use for any other purpose or by any other person or entity. It is recommended that all other parties seek professional geotechnical advice to satisfy themselves as to its on-going suitability for their intended use.

Coffey have not carried out any topographical surveys of this site and we have not visited the site prior to the 2010-2011 Canterbury earthquakes.

The opinions, recommendations and comments given in this report have been derived from the application of standard site observation and investigation methods. As information regarding the sub-surface conditions has been obtained solely from testing a small volume of soils, there may be special conditions pertaining to this site that have not been disclosed by the testing or observed by Coffey. If variations in the sub-soils occur from those described or assumed to exist, then the matter should be referred to us immediately.

If you have queries or require further clarification regarding aspects of this report, please contact the undersigned.

For and behalf of Coffey

Andrew Jordan
Bsc
Senior Engineering Geologist

Reviewed by

Richmond Beetham
BE BSc MSc Eng DIC PEngGeol CPEng CMEngNZ
Principal Geotechnical Engineer

Attached:
Important Information Sheet
Soil and Rock Ground Investigation Location Plan
Vertical settlements summary plots
LSN summary plots

Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

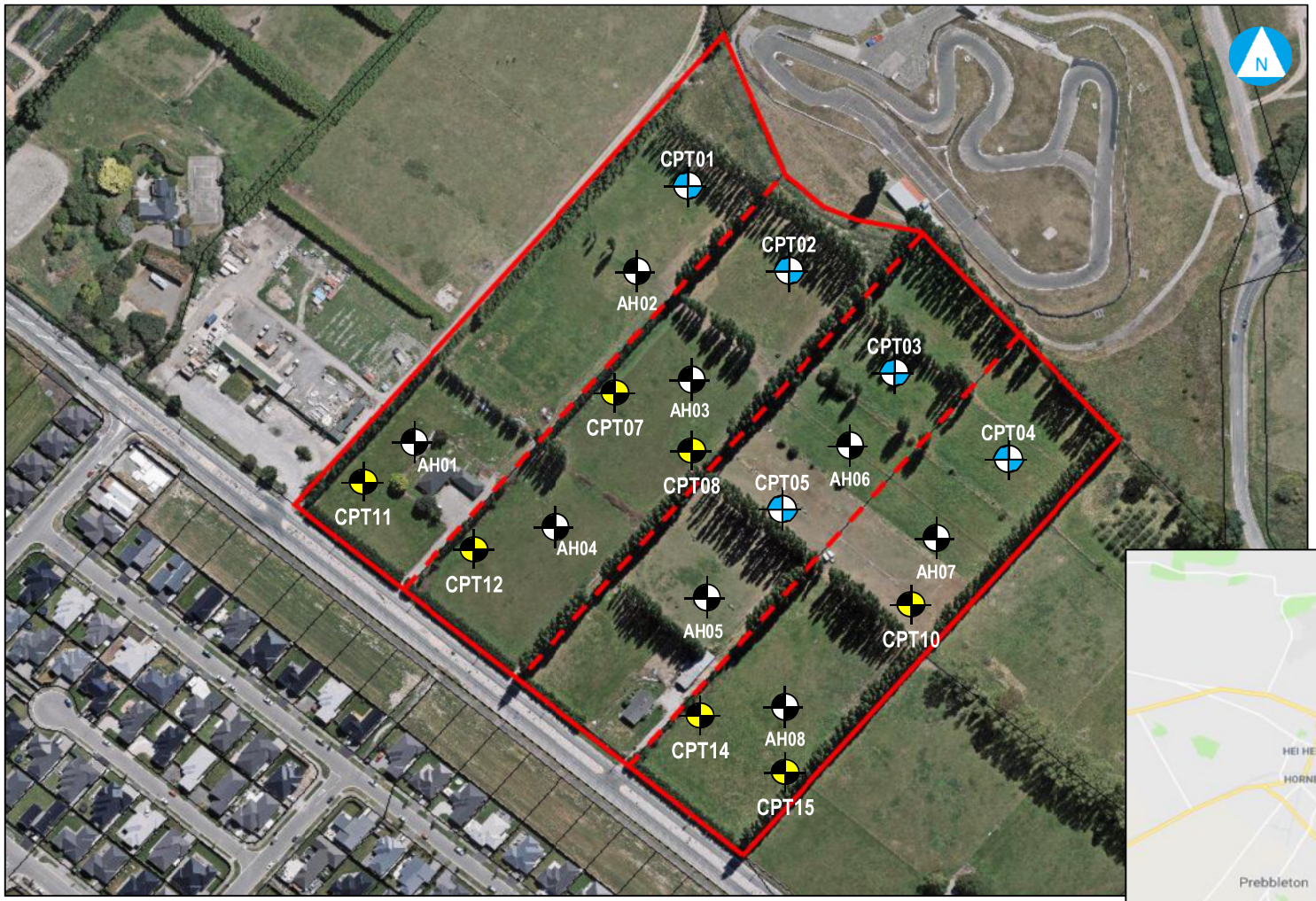
Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

Rely on Coffey for additional assistance

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

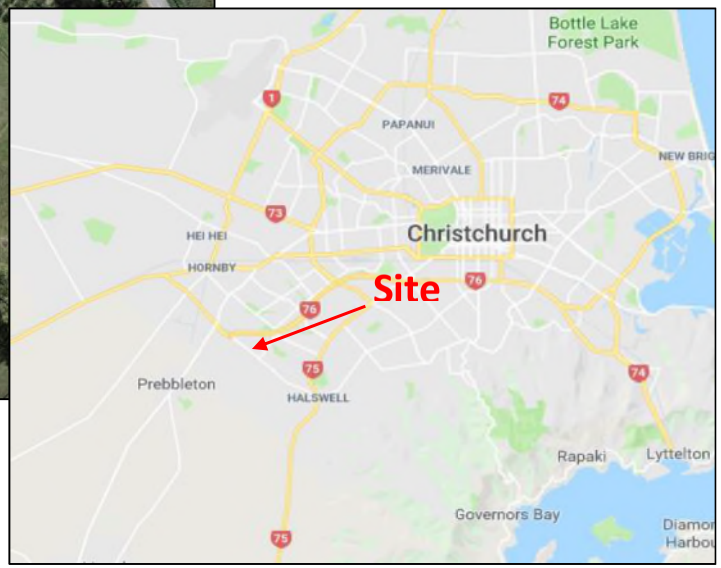
Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.



Legend:

- Approximate Property Boundary
- AH — Approximate Location of Hand Augerholes: Soil & Rock Consultants - 2019
- CPT — Approximate Location of Cone Penetration Test (CPT): McNeills Drilling - 2019
- CPT — Approximate Location of Cone Penetration Test (CPT): McMillan Drilling - 2018



Notes:
1. Soil & Rock Consultants Site Plan adapted from Canterbury Maps and Google Maps
2. Locations of features are approximate only
3. Original sheet size A4

Soil&Rock Consultants
For well-grounded solutions

DATE:	January 2019
DRAWN:	AB
SCALE:	NTS
CAD REF:	C19002/TLP

SITE PLAN
GEOTECHNICAL INVESTIGATION
300-322 HALSWELL JUNCTION ROAD
HALSWELL

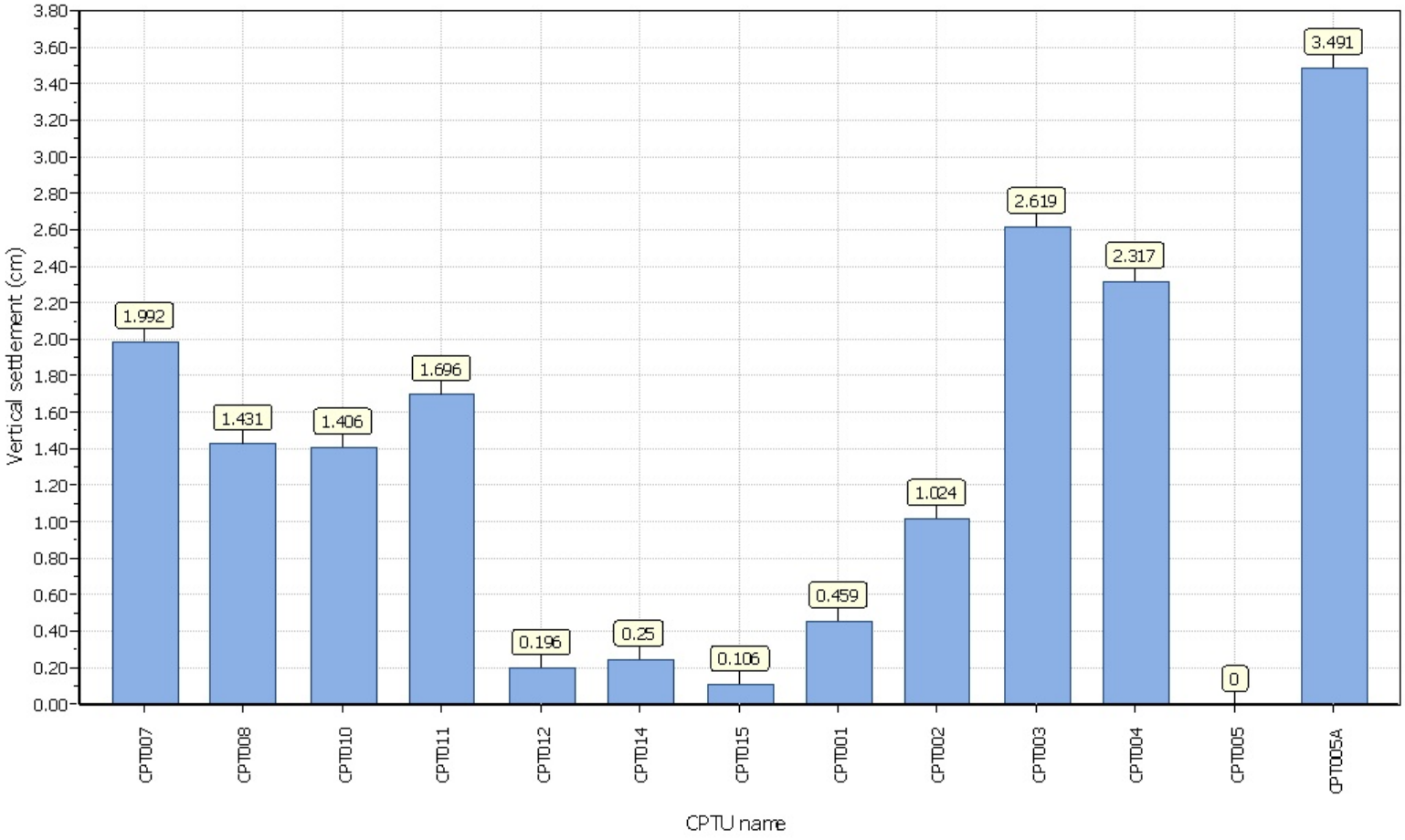
DRAWING NO:
C19002/TLP

SHEET 1 OF 1

Project title : 308-322 Halswell Junction Road SLS case (M7.5 / PGA 0.13)

Location :

Overall vertical settlements report



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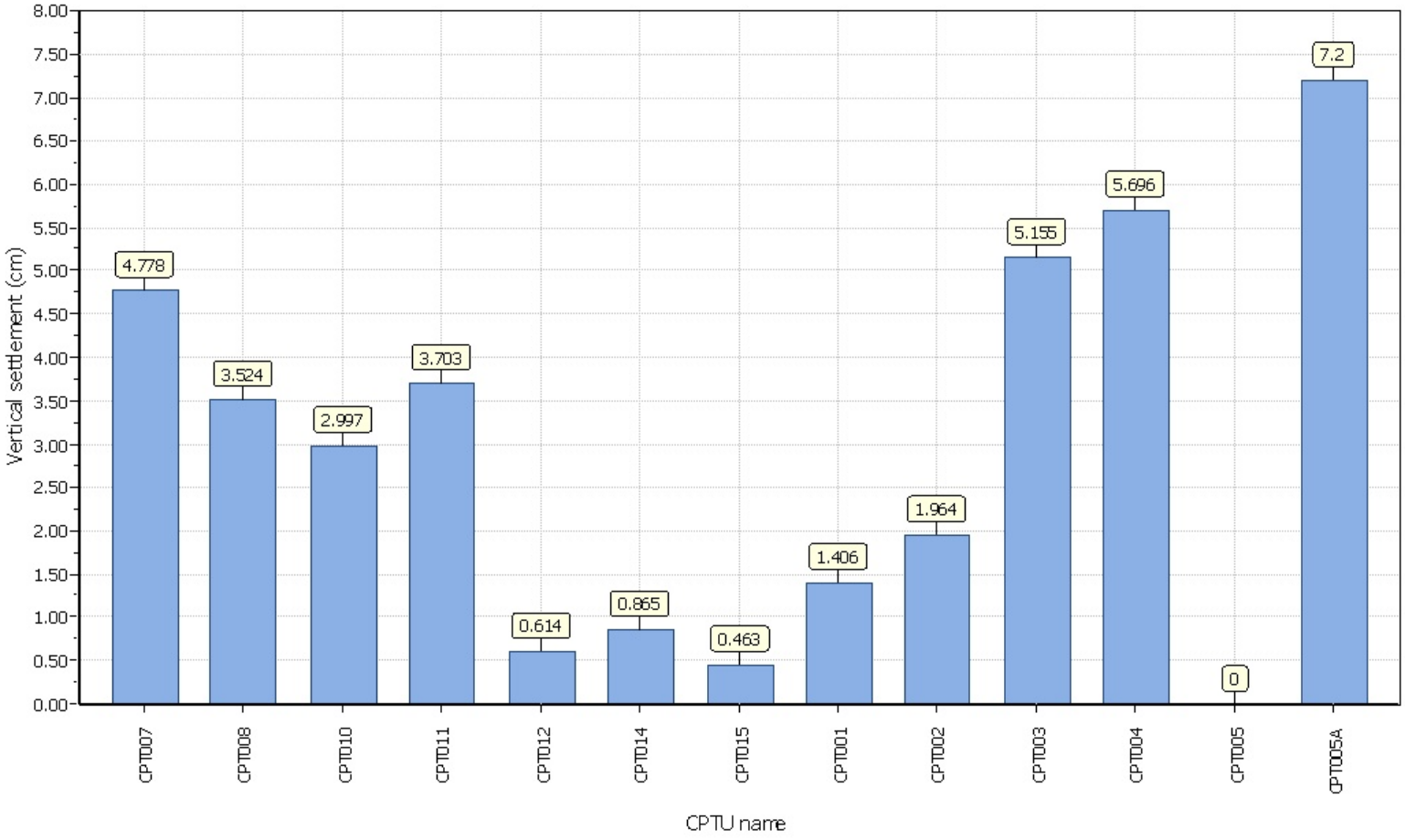
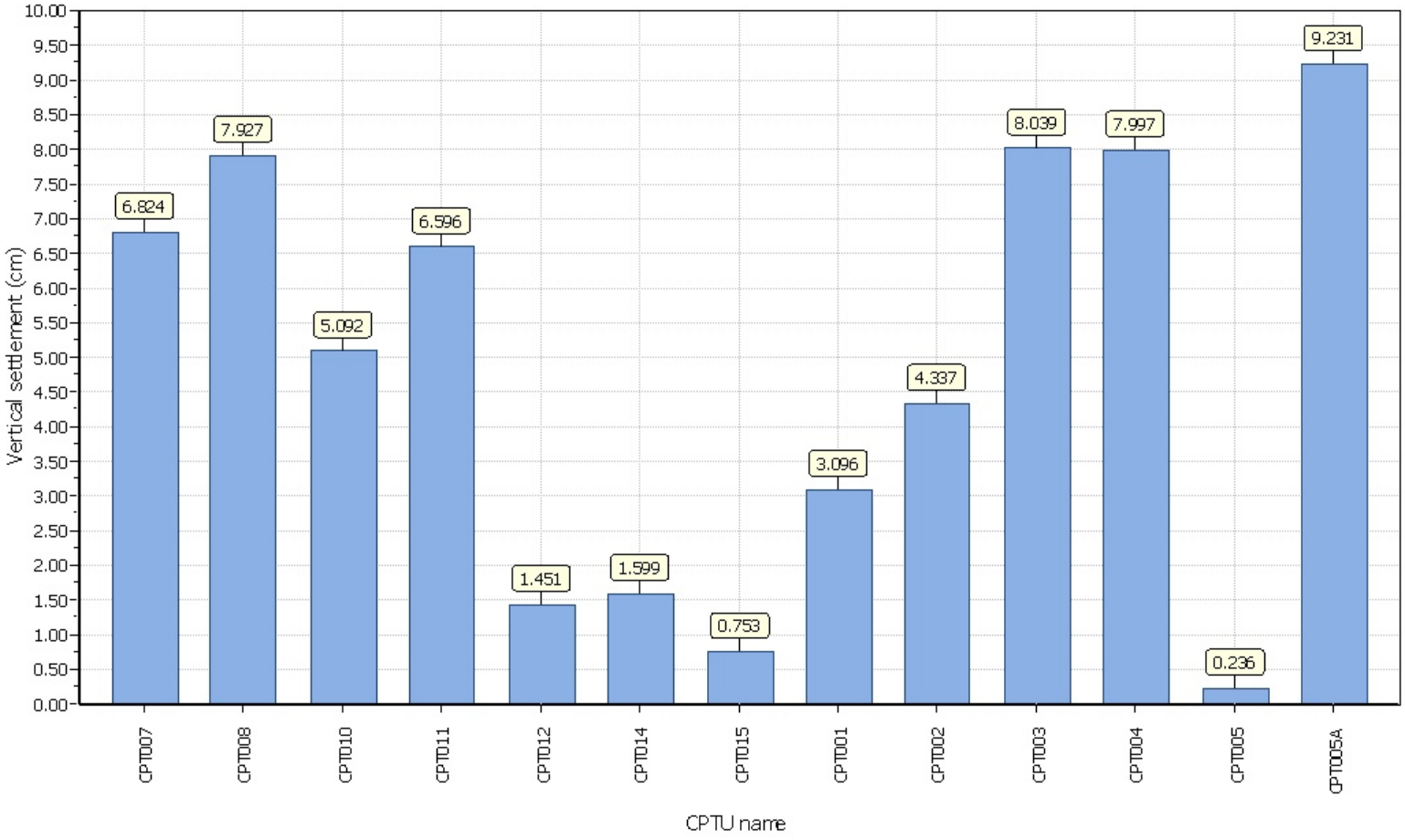
Overall vertical settlements report



Project title : 308-322 Halswell Junction Road ULS case (M7.5 / PGA 0.35)

Location :

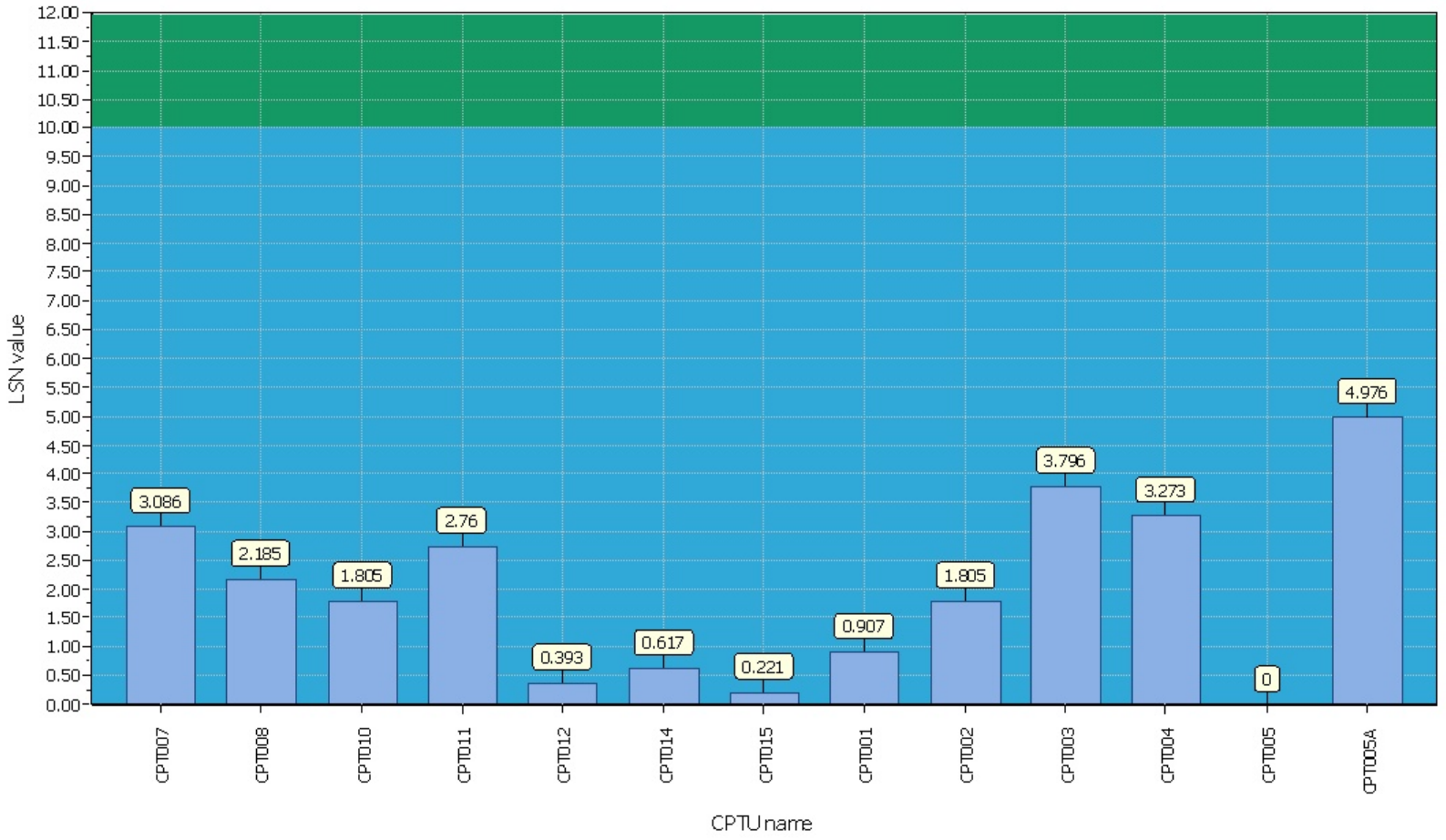
Overall vertical settlements report



Project title : 308-322 Halswell Junction Road SLS case (M7.5 / PGA 0.13)

Location :

Overall Liquefaction Severity Number report



LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

Basic statistics

Total CPT number: 13

100.00% little liquefaction

0.00% minnor liquefaction

0.00% moderate liquefaction

0.00% moderate to major liquefaction

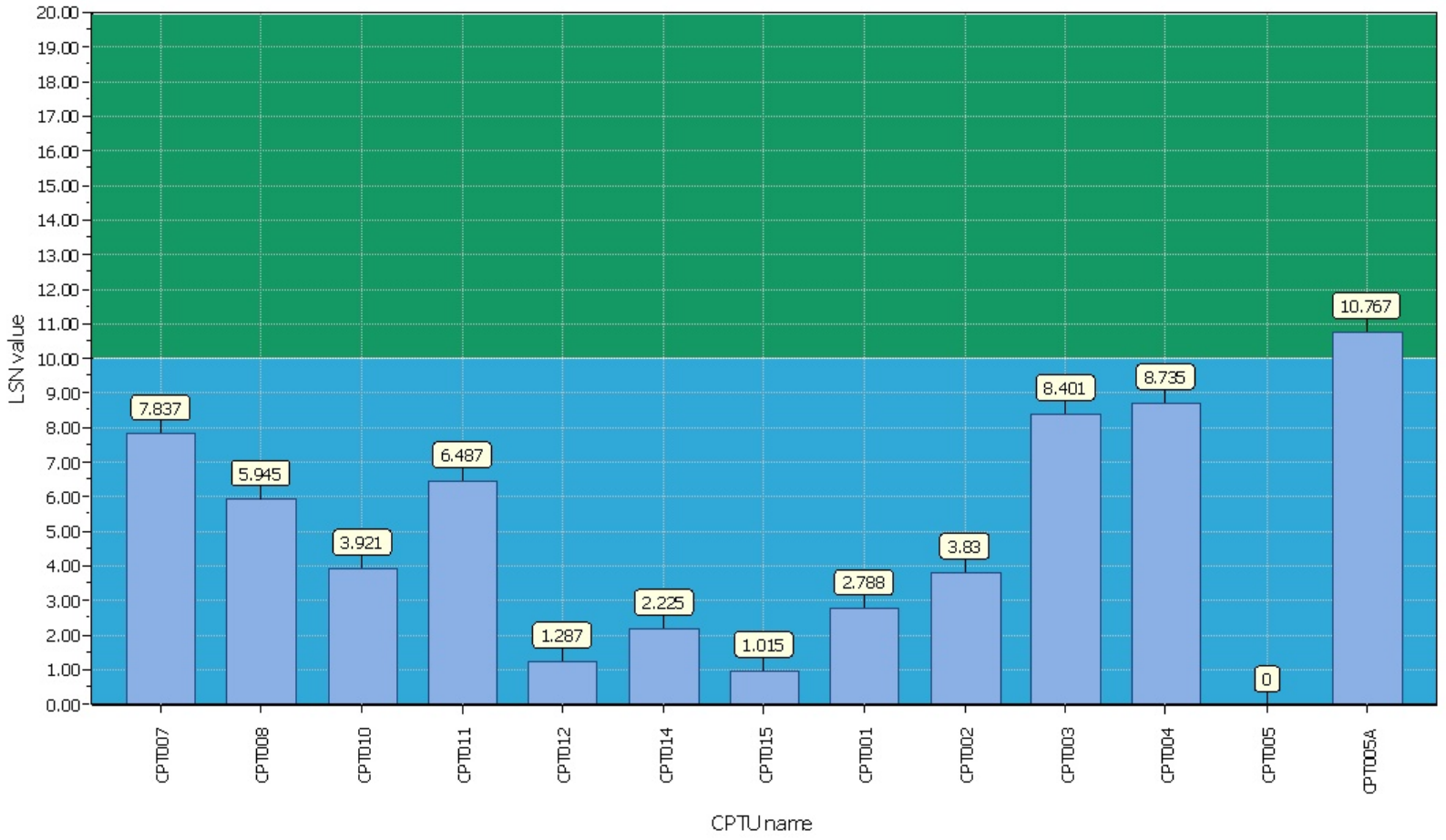
0.00% major liquefaction

0.00% severe liquefaction

Project title : 308-322 Halswell Junction Road SLS case (M6.0 / PGA 0.19)

Location :

Overall Liquefaction Severity Number report



LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

Basic statistics

Total CPT number: 13

92.31% little liquefaction

7.69% minnor liquefaction

0.00% moderate liquefaction

0.00% moderate to major liquefaction

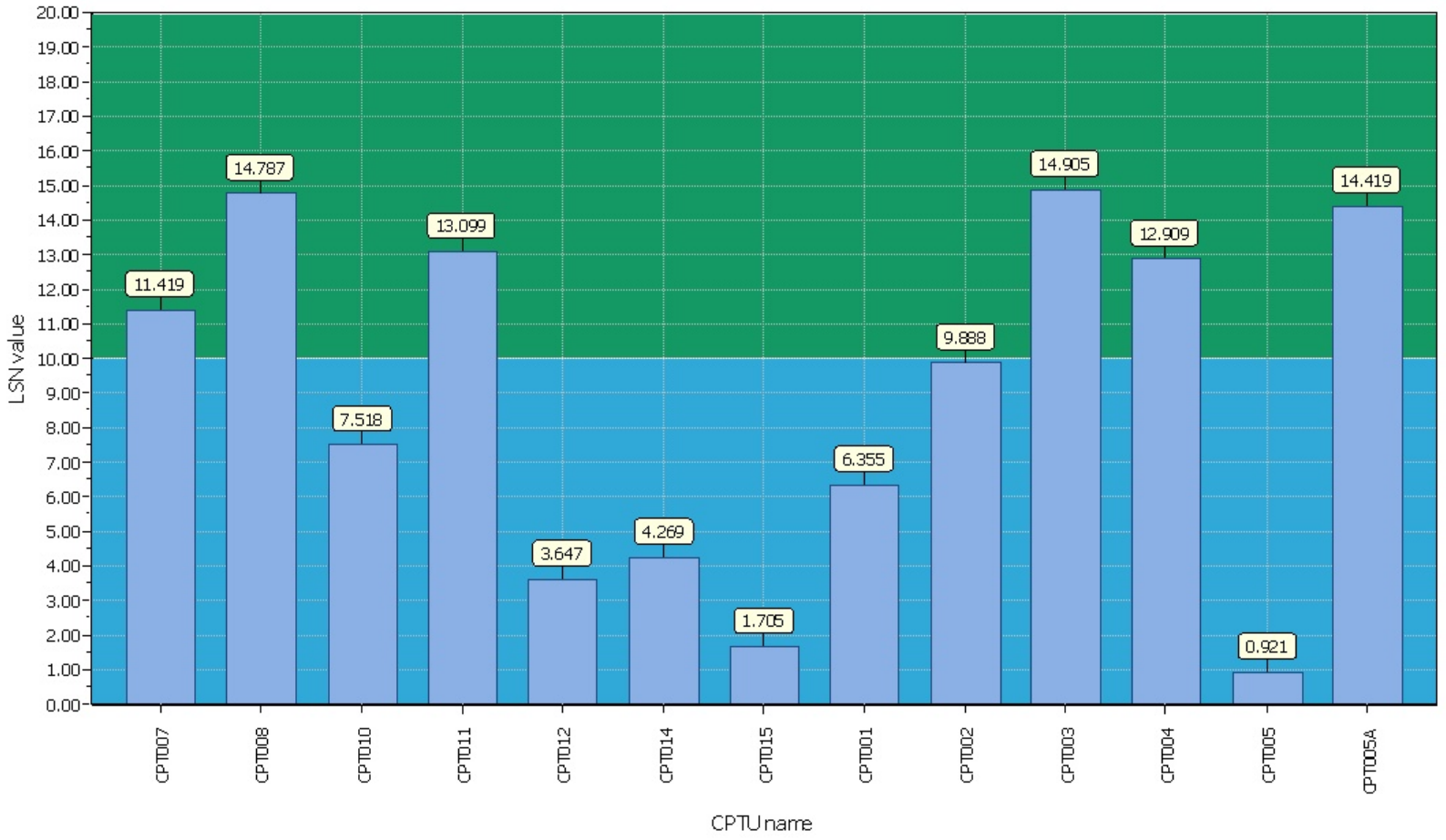
0.00% major liquefaction

0.00% severe liquefaction

Project title : 308-322 Halswell Junction Road ULS case (M7.5 / PGA 0.35)

Location :

Overall Liquefaction Severity Number report



LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

Basic statistics

Total CPT number: 13

53.85% little liquefaction

46.15% minnor liquefaction

0.00% moderate liquefaction

0.00% moderate to major liquefaction

0.00% major liquefaction

0.00% severe liquefaction