



5 SEPTEMBER 2018

Weston Lea Ltd

c/- Ben Inger

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HD712 – Amberfield – peer review of the liquefaction assessment

Dear Ben,

Introduction

Weston Lea Ltd have submitted a resource consent application to Hamilton City Council (HCC) for the proposed Amberfield Subdivision. Council requested further information relating to the liquefaction assessment for processing the consent.

Weston Lea Ltd have engaged HD Geo to undertake a geotechnical peer review of the liquefaction assessment that ENGEO prepared as part of their Geotechnical Investigation Report for the subdivision. In this letter, we have presented the findings of the review and provided recommendations.

Overall, we agree with ENGEO that the liquefaction hazard at the site is low to moderate. In that regard, the site is typical for Hamilton. We recommend further definition of liquefaction risk in parts of the site for detailed design. There is likely to be some mitigation required – this is related to slopes and to foundations.

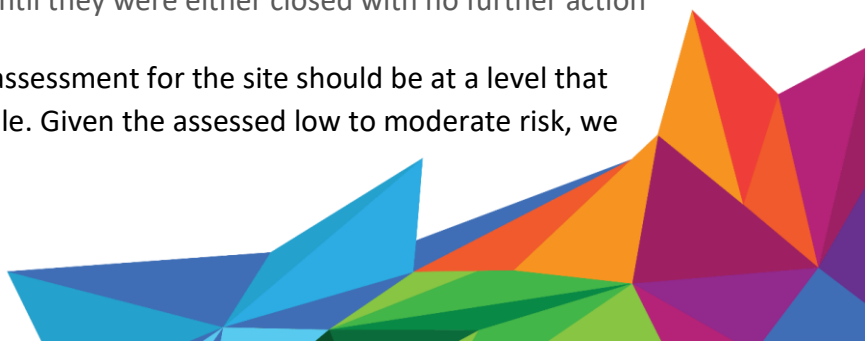
Peer review scope and context

Given that the project is in the resource consent phase, the liquefaction assessment has been reviewed to satisfy a 'suitability level' assessment of the potential effects of liquefaction.

As part of this review, we prepared an issues register and a summary is included with this letter. The peer review process was:

1. Identify potential issues during the review
2. Add the issues to the register
3. ENGEO responded to the issues until they were either closed with no further action needed or actions were agreed.

For resource consent phase, the hazard assessment for the site should be at a level that considers if the development will be viable. Given the assessed low to moderate risk, we



believe detailed questions, such as those in the recommendations, can remain for the design phase of the project.

Site description

The proposed Amberfield development is located on Peacockes Road in the Peacockes growth cell in south-east Hamilton. The site is approximately 105 ha of farmland that sits between Peacockes Road and the Waikato River. The site has variable topography with flat plains, gentle hills, steep gully slopes and low lying areas. There is a steep sided gully running through the middle of the site which is generally considered to be an abandoned channel of the Waikato River.

Desk study assessment

Prior to reviewing the detailed liquefaction assessment, we undertook a high level desk study of the site to establish the likely liquefaction hazard. The desk study showed that the site is mapped as primarily alluvial deposits including:

- Hinuera Formation
- Taupo Pumice Alluvium
- Recent alluvial deposits (Holocene)

The site is mapped as being adjacent to areas of Walton Subgroup.

Given that the site is underlain by alluvial deposits of various ages, and that groundwater is potentially high, we would consider that there is likely to be a liquefaction hazard at the site. The magnitude of the hazard will depend primarily on the groundwater regime including both the global groundwater and perched water tables.

Information provided for review

The information provided for review included:

- ENGEO report 'Amberfield Geotechnical Investigation Report'. Ref: 14280.000.000_19. 16.05.18.
- HCC request for further information (RFI) dated 5.07.18
- ENGEO liquefaction analysis results in response to the HCC RFI
- ENGEO water level monitoring information

HCC request for further information

HCC requested further information following their review of the ENGEO geotechnical assessment report. Their questions, ENGEO's response and our comments are summarised in the table below:

	Question	ENGEO response	HD Geo comment
HCC 31	Please provide a liquefaction assessment against a 1 in 500 year case for the whole site.	This has been provided.	The assessment has been updated to include 1 in 500 year shaking. We have reviewed the assessment undertaken and generally agree with the inputs.
HCC 32	Please provide a consideration of liquefaction risk across the whole site.	Provided in the updated liquefaction hazard plans	Liquefaction hazard plans reviewed. Agree highlighted areas show where additional assessment should be focused.
HCC 33	Please provide an assessment of the liquefaction risk for the proposed ground contours.	This has been provided (as for HCC 31)	Reviewed
HCC 34	Please provide further analysis and discussion on the liquefaction potential of pumiceous soils.	No reliance has been placed on the behavior of pumice soils in the assessment of the liquefaction hazard at the site. This is a conservative approach.	Agree with ENGEO discussion. Shear wave velocity may be a 'best case' assessment however, it is not relied on in establishing the hazard at the site.
HCC 35	Please provide a peer review of the liquefaction assessment	-	This letter presents the results of the peer review.

HD Geo peer review and summary of issues

A summary of our review, the issues raised and recommendations for further work is presented in the table below:

	Issue	ENGEO response	HD Geo comment
HD Geo 1	Groundwater has been assumed for all locations. As the soils on site are often susceptible (refer to 1m water level assessment) the groundwater level will control the hazard.	Monitoring data shows that groundwater levels are consistently below 7m depth.	The monitoring is remote from some locations where there is an indication that groundwater could be higher (eg CPT12 and CPT18). Given the proximity of the site to the river and the gully, global groundwater would be expected to be low however, there is potential for perched groundwater or higher levels remote to the free faces. Further definition is recommended.
HD Geo 2	Justification for the 10m assessment cutoff should be given as well as consideration to the potential for liquefaction below 10m.	10m was used to compare all cpts to each other (some reached refusal by 10m) and to compare site performance to recent guidelines (Christchurch)	Review of the potential for liquefaction below 10m should be undertaken for areas that have a higher hazard and need further assessment in detailed design.
HD Geo 3	Compare cpts that refused shallower than others to review the hazard in a comparable way between locations.	See discussion in HD Geo 2 re: 10m cutoff.	No further action required.

	Issue	ENGEO response	HD Geo comment
HD Geo 4	CPT18 shows a relatively high susceptibility to liquefaction. Further definition may be required to establish mitigation measures required in this area.	CPT18 is in close proximity to SCPT01, SCPT02 and CPT16. It is considered that the variation in response exhibited at these test locations- which are within 300m of CPT18 goes to the variability of the alluvial soils present onsite. Liquefaction potential at these three locations varies from insignificant to moderate though settlement is expected to be significant at 100 to 300mm. While liquefaction of site soils is considered unlikely even under ULS loadings, settlement under ULS loading are significant. However, when considered over the 150 year return period, liquefaction of less than 100 mm is expected within the top 10m in most locations.	CPT18 and sCPT01 appear to be in similar geology. The other tests referenced appear to be in different geology (potentially buried Walton Subgroup – see CPT16 and TP01). The groundwater regime in this area should be further defined. The dynamic pore pressure response in CPT18 indicates a higher groundwater level than 7 m (4 m to 5 m) and so the actual hazard may be higher than being reported. This will not affect the overall hazard for the site. Definition of the hazard in this area for detailed design will establish the recommended mitigation measures.
HD Geo 5	The current 'geotechnical constraints' plans are limited to the impact of slope stability. Consider re-naming the plans to reflect the hazard that they cover and present another plan that shows the liquefaction hazard.	Liquefaction hazard now shown on plans	Liquefaction hazard plans reviewed. Approach shows areas where additional assessment should be focused to define areas needing mitigation/special considerations for development.
HD Geo 6	Slope stability modelling looks at seismic acceleration applied to the ground models but does not consider a post earthquake, liquefied case. Has consideration been given to assessing lateral spreading this way?	The risk of liquefaction is considered low as per the revised analyses. Updated stability modelling shows anticipated instability related to liquefied layers matches closely with currently presented constraints plan.	Analyses have been reviewed. The existing constraints plan appears to cover the potential extent of liquefaction related instability. No further work required for suitability stage – recommendations for refining areas and mitigation needed as above.

Summary of recommended actions

The issues raised in the peer review have been satisfactorily closed for the suitability assessment phase. We recommend the following actions for detailed design:

- Further define the groundwater regime for areas where there is a high susceptibility to liquefaction. Consider perched groundwater and proposed changes in the ground level, particularly cutting the site down.
- Focus further assessment on the areas that show a moderate hazard or high susceptibility.
- Assess slope stability in relation to the potential for deeper layers to liquefy to confirm setbacks, mitigation or higher hazard areas.

Summary of the liquefaction hazard

ENGEO assess the liquefaction hazard at the site as generally low to moderate. In a Hamilton context, this is typical, if not slightly lower than we would usually expect on the alluvial plains. The primary reason for the hazard not being high is that groundwater is low.

It appears that global groundwater is controlled by the gully and river levels. But there is some evidence to suggest perched or trapped water tables in places.

While we have recommended further definition of the liquefaction hazard at the next stage of assessment, this is to establish the details of mitigation and is not expected to change the overall hazard.

The assessed liquefaction hazard at the site does not affect the assessed suitability of the site for development.

Limitations

This report has been prepared for our client, Weston Lea Limited, for the purpose detailed above and may not be relied on by any other party or for any other purpose. This report contains an assessment based on a review of information provided by others. Inferences about the conditions at the site have been made based on the information provided. We recommend further definition of the hazard at the site and that a geotechnical engineer is engaged to observe works during the site preparation.

Kind regards,



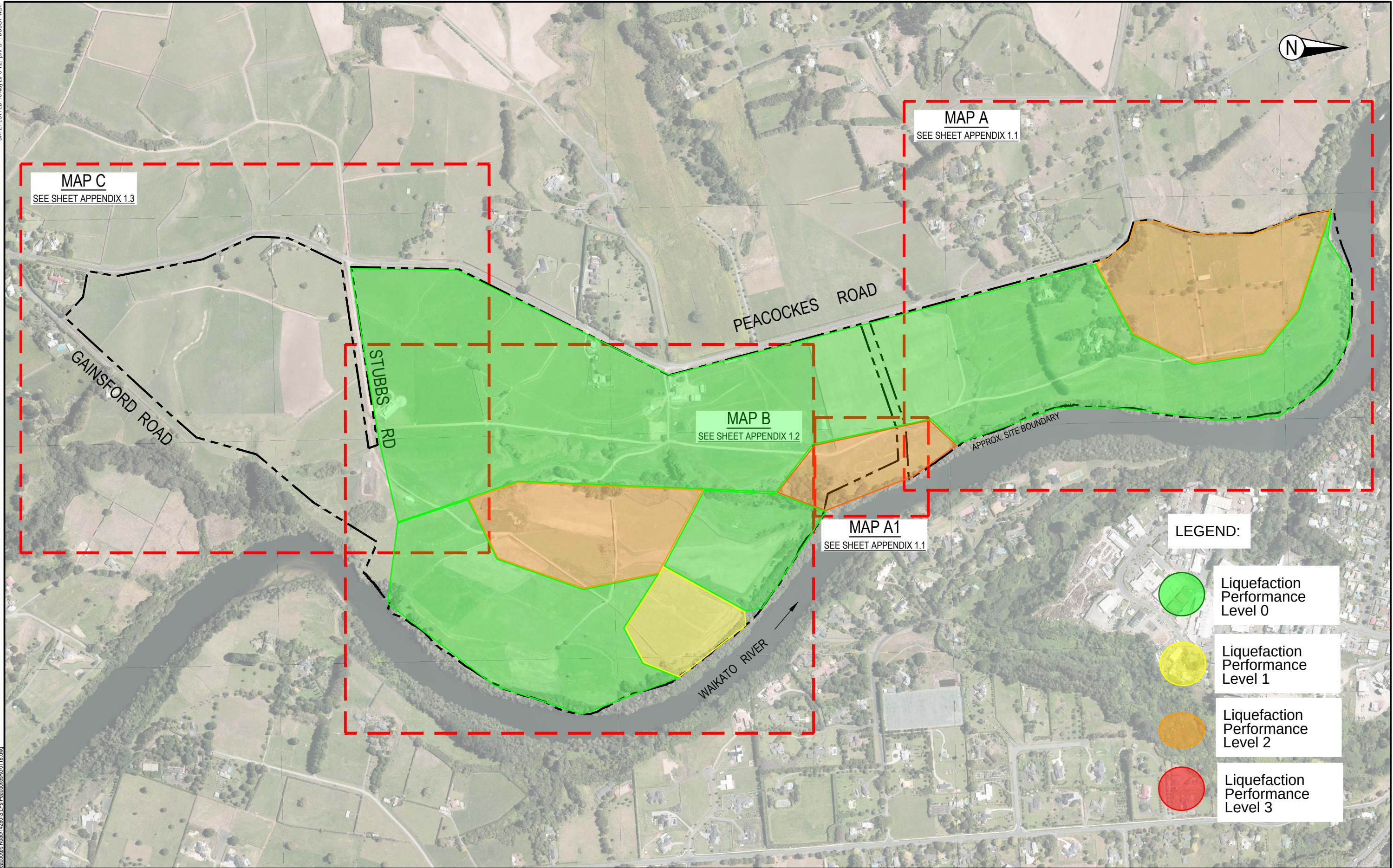
ANDREW HOLLAND, CPENG

Director, Principal Engineer

Andrew@hdgeo.co.nz

Tel 022 048 8441

DATE PLOTTED: 16 May 2018 1:27 p.m. BY: DOUG FINLAY



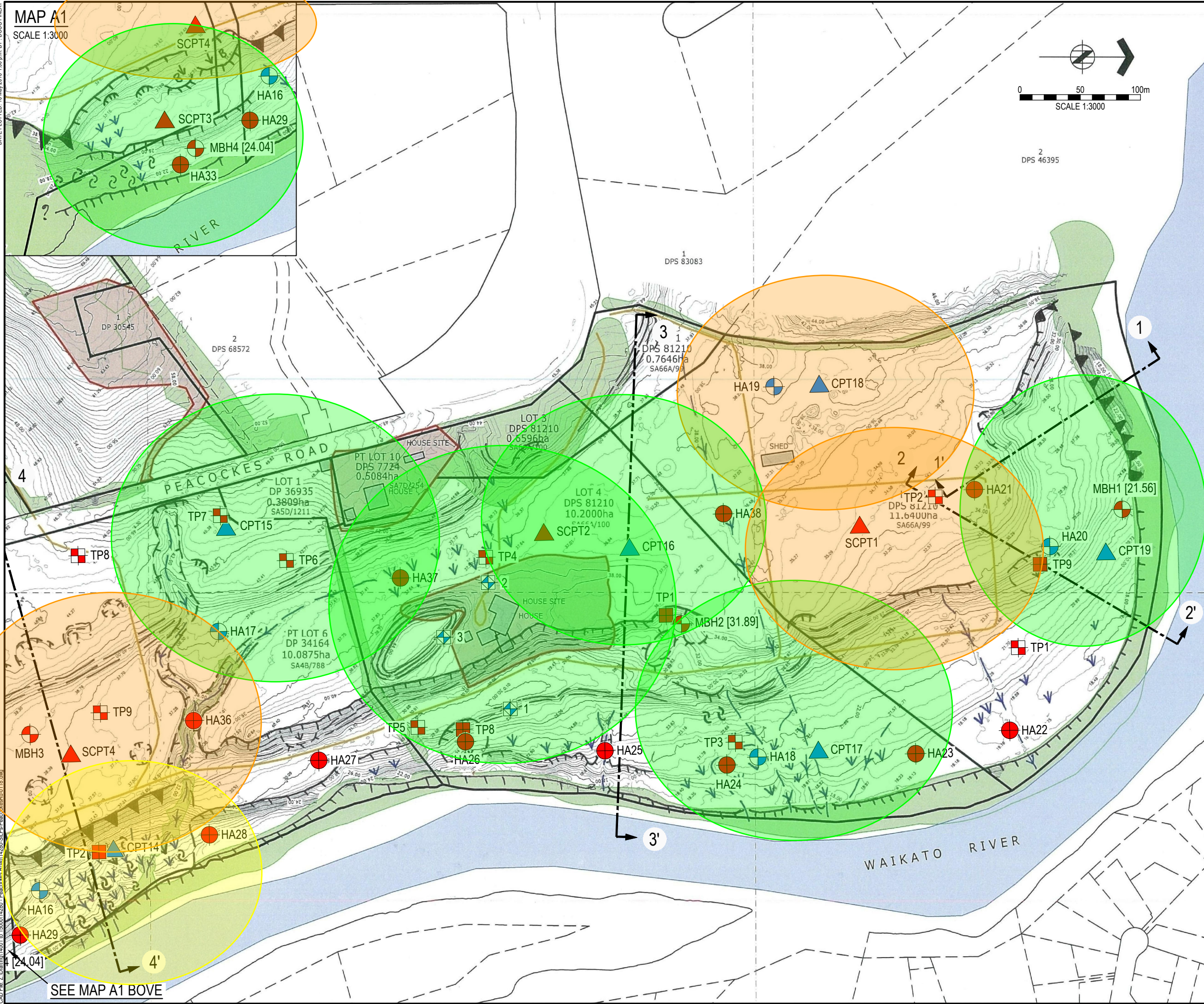
3	16.5.18	Updated client & project details.	DF	PF	
2	29.3.18	Cross section location updates.	DF	MM	
1	30.01.18	MBH location updates.	DF	PF	
Rev	Date	Description	Drwn	Chkd	



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Title: **PLAN OF LIQUEFACTION POTENTIAL MAP INDEX**

Client: WESTON LEA LIMITED		Appendix No: A	
Project: AMBERFIELD SUBDIVISION HAMILTON	Designed: PF	Size: A3	
	Drawn: PF		
	Checked: -		
Proj No: 14280.000.000	Date: 04.09.18	Rev: 0	
	Scale: 1:7500		



- Testing Legend**
- 1 Soakage Test (Aug 2017)
 - HA01 Hand Auger Test (Aug 2017)
 - CPT01 Cone Penetrometer Test (Aug 2017)
 - MBH1 [21.56] Machine Borehole Test [with level] (Dec 2017)
 - SCPT1 Seismic Cone Penetrometer Test (Dec 2017)
 - TP1 AWA Test Pits (Dec 2017)
 - TP1 ENGEO Test Pits (Dec 2017)
 - HA21 ENGEO Hand Auger Test (Dec 2017)

- LEGEND:**
- Liquefaction Performance Level 0
 - Liquefaction Performance Level 1
 - Liquefaction Performance Level 2
 - Liquefaction Performance Level 3



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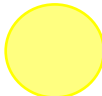
Rev	Date	Description	Drwn	Chkd

PLAN OF LIQUEFACTION POTENTIAL

Base drawing source: H&G drawing 141842-SS02A.

Client: WESTON LEA LIMITED		Appendix No:
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Project No: 14280.000.000	Scale: 1:3000	
		Rev: 0

LEGEND:

	Liquefaction Performance Level 0
	Liquefaction Performance Level 1
	Liquefaction Performance Level 2
	Liquefaction Performance Level 3



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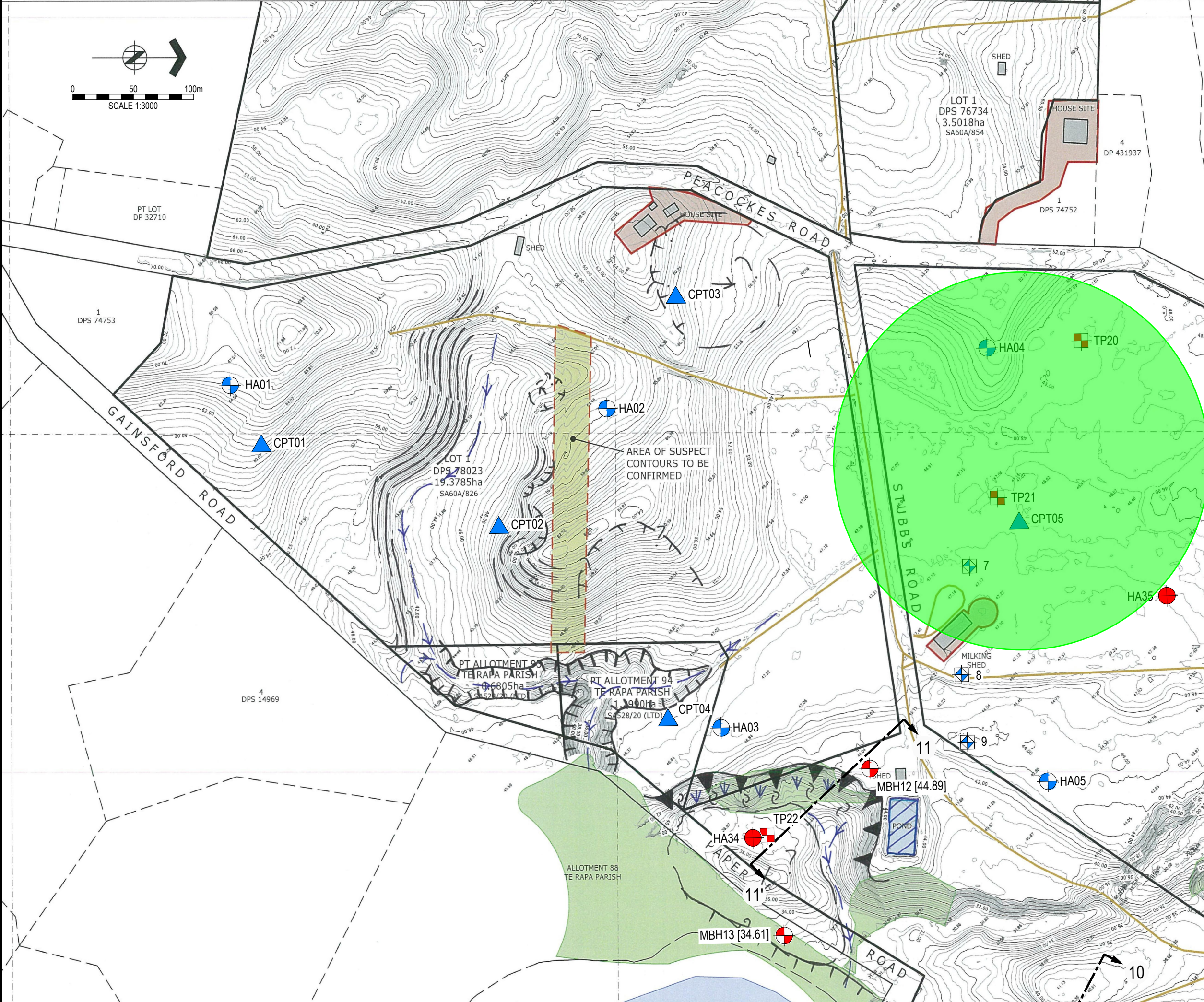
PLAN OF LIQUEFACTION POTENTIAL

Base drawing source: H&G drawing 141842-SS04A.

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	Checked: -	
	Date: 04.09.18	
Project No: 14280.000.000	Scale: 1:3000	Size: A3 Rev: 0

DATE PLOTTED: 16 May 2018 1:33 p.m. BY: DOUG FINLAY

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- Testing Legend**
- 1 Soakage Test (Aug 2017)
 - HA01 Hand Auger Test (Aug 2017)
 - CPT01 Cone Penetrometer Test (Aug 2017)
 - MBH1 [21.56] Machine Borehole Test [with level] (Dec 2017)
 - SCPT1 Seismic Cone Penetrometer Test (Dec 2017)
 - TP1 AWA Test Pits (Dec 2017)
 - TP1 ENGEO Test Pits (Dec 2017)
 - HA21 ENGEO Hand Auger Test (Dec 2017)

- LEGEND:**
- Liquefaction Performance Level 0
 - Liquefaction Performance Level 1
 - Liquefaction Performance Level 2
 - Liquefaction Performance Level 3



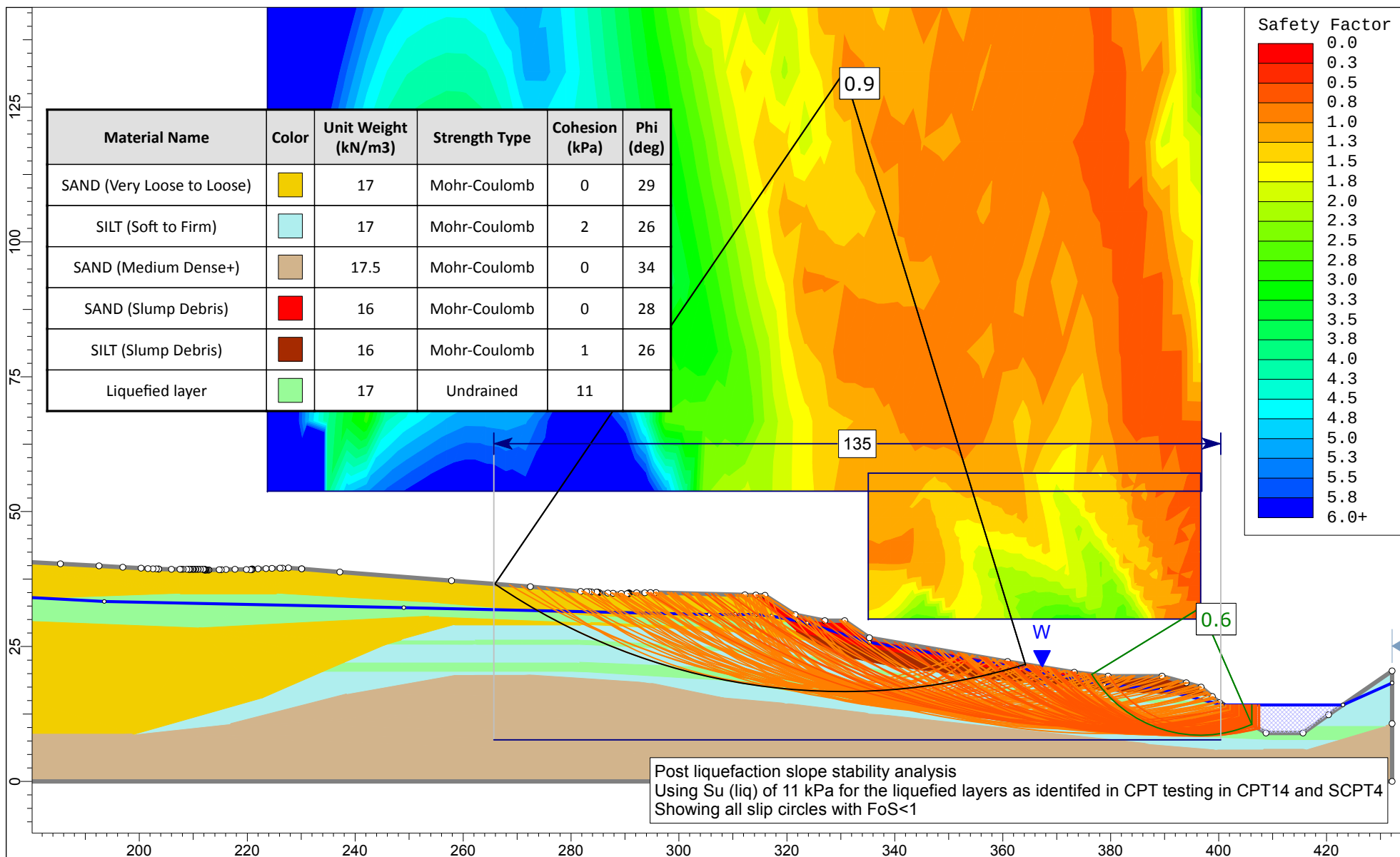
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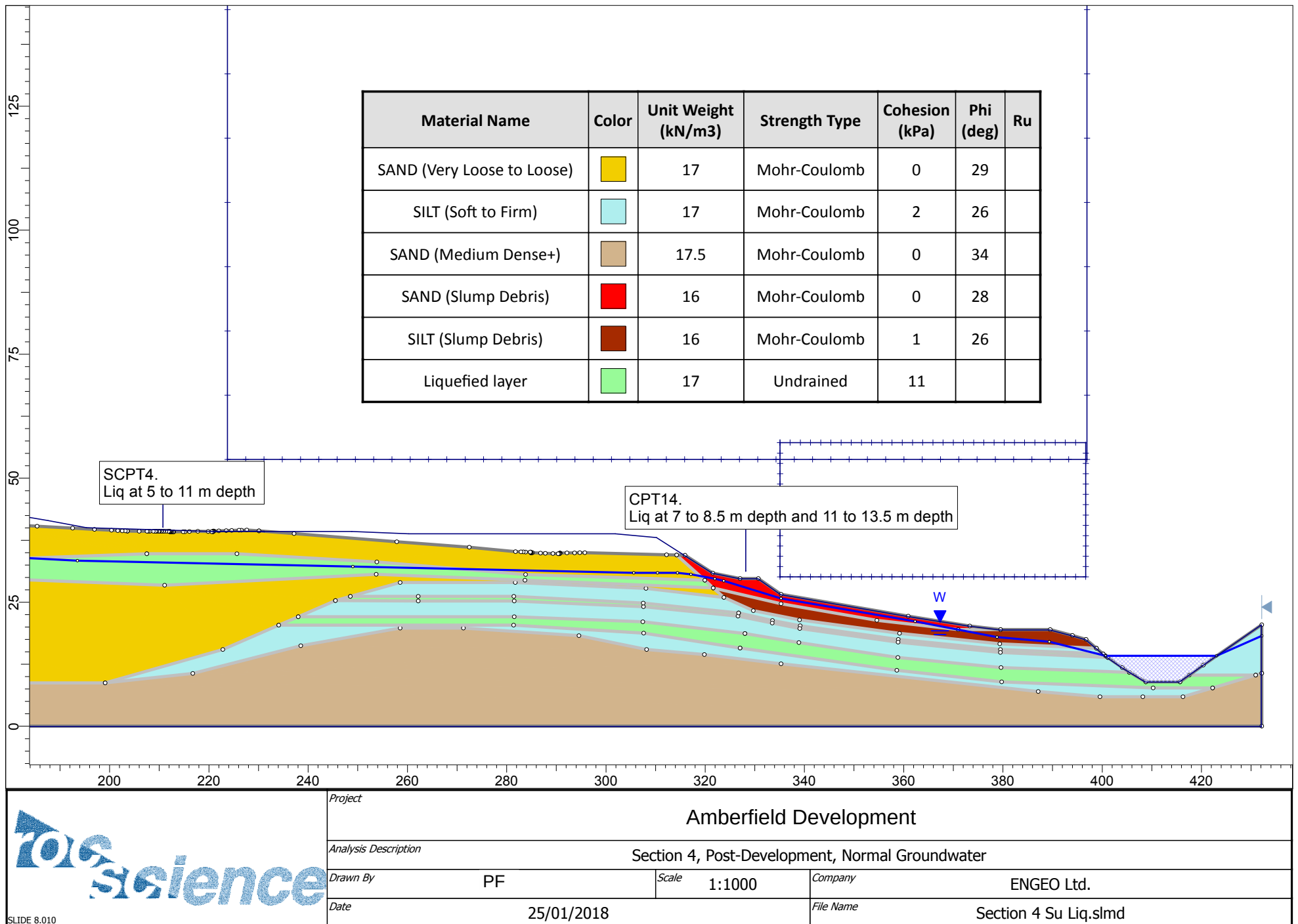
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Title:
PLAN OF LIQUEFACTION POTENTIAL
Base drawing source: H&G drawing 141842-SS05A.

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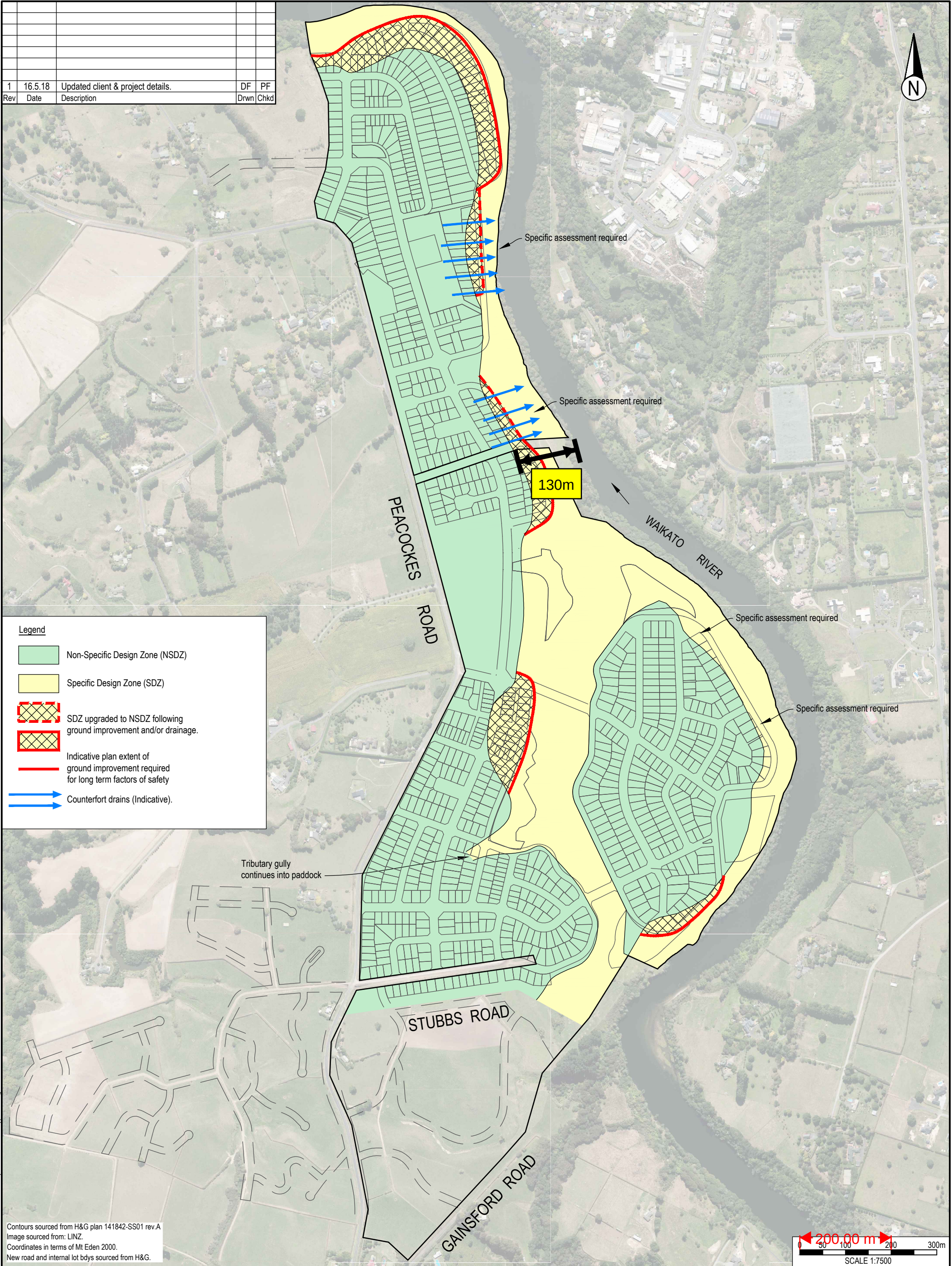
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DATE PLOTTED: 16 May 2018 1:38 p.m. BY: DOUG FINLAY

1	16.5.18	Updated client & project details.	DF	PF	
Rev	Date	Description	Drwn	Chkd	



Legend

- Non-Specific Design Zone (NSDZ)
- Specific Design Zone (SDZ)
- SDZ upgraded to NSDZ following ground improvement and/or drainage.
- Indicative plan extent of ground improvement required for long term factors of safety
- Counterfort drains (Indicative).

Contours sourced from H&G plan 141842-SS01 rev.A
Image sourced from: LINZ.
Coordinates in terms of Mt Eden 2000.
New road and internal lot bdys sourced from H&G.



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Title:

GEOTECHNICAL CONSTRAINTS PLAN
- PROPOSED CONTOURS

Client: WESTON LEA LIMITED

Project: AMBERFIELD SUBDIVISION
HAMILTON

Proj No: 14280.000.000

Designed: MM
Drawn: DF
Checked: -
Date: 29.3.18
Scale: 1:7500

Appendix No:

3B

Size: A3

Rev: 1