



**Guidelines for Geotechnical Site Investigation
(Liquefaction)
for Subdivision and Land Development
Resource Consent Applications
Hastings District**

June 2019

Acknowledgements

These guidelines have been prepared with assistance from Tonkin & Taylor, Initia Limited, RDCL, Wentz-Pacific, and Babbage Consultants.

Consultation

The Council has undertaken consultation on the content and extent of these guidelines, and the Council's Geotechnical Engineering Panel has heard and considered submissions received.

Approval and Commencement

These guidelines were released formally in June 2019.

These guidelines supersede all previous draft geotechnical engineering guidelines published by Hastings District Council.

Guideline Review

These guidelines will be reviewed following release of the finalised MBIE guidelines *Planning and engineering guidance for potentially liquefaction-prone land ISBN 978-1-98-851770-4*, or when further technical information is received supporting a need for a review of these guidelines.

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1 Executive Summary

This guideline has been prepared by the Hastings District Council and sets out the Council's expectations for what will constitute appropriate assessment of liquefaction risks when submitting an application for subdivision and relevant land use development consents in Hastings District. Specifically, it provides minimum requirements for geotechnical site investigation for liquefaction vulnerability assessment and reporting, and concludes that the Council may seek independent peer review of any geotechnical report submitted with a resource consent application.

This guideline is based on the Institute of Geological and Nuclear Sciences Limited (GNS Science) report 'Assessment of Liquefaction Risk in Hawkes Bay' (GNS, 2017), the Planning and Engineering Guidance for Potentially Liquefaction-prone Land (MBIE, 2017), and the NZ Geotechnical Society. Earthquake Geotechnical Engineering Module 2 - Geotechnical Investigations for Earthquake Engineering 2016.

The guideline sets out the minimum requirements for residential development within the mapped areas on the Liquefaction Vulnerability Map. The requirements for the specific areas identified on the map are summarised as:

- For **Orange**  and **Brown**  mapped liquefaction vulnerability (moderate and high) areas, subsurface deep investigations to at least 10 - 15m using either machine drilled bore holes and SPT testing, or CPT testing supported as necessary by test pit investigations and/or hand auger recovery of samples, and the evaluation of geotechnical properties as appropriate by laboratory testing, are required to determine site specific foundation design recommendations – refer section 7.3.3. Geotechnical Professional Engineers holding a current geotechnical practice field endorsement must confirm site suitability including foundation design recommendations (for details refer section 6.1.2).
- For **Yellow** liquefaction susceptibility areas, minimum investigations need to include Scala Penetrometer and hand auger investigations to confirm ground bearing and determine if a more detailed geotechnical investigation is required.

These guidelines are a non-statutory document and may be subject to change as new information becomes available.

GLOSSARY

CPEng - A Chartered Professional Engineer as assessed and administered by Engineering New Zealand.

Geotechnical professional - a suitably qualified and experienced geotechnical engineer or an engineering geologist, who is registered as a Chartered Professional Engineer with Engineering New Zealand and awarded a geotechnical practice endorsement, or a Professional Engineering Geologist (PEngGeol) registered with Engineering New Zealand, with a minimum of 10 years demonstrable experience in the investigation, assessment and mitigation of earthquake geotechnical hazards (refer NZ Geotechnical Society Inc. and MBIE (2016) Earthquake geotechnical engineering - Module 2).

Note: Reliance on these professional bodies to determine appropriate levels of qualification and experience in this field is acknowledged as appropriate in the Environment Court decision *Mulholland v Wanganui District Council* (ENV-2017-WLG-000097).

2 Introduction

Hawkes Bay is situated in an area with complex geology. Hazards associated with the geology include, but are not limited to:

- Flooding;
- **Susceptibility to liquefaction;**
- Consolidation settlement;
- Slope stability/Land Slippage; and
- Bearing capacity
- Earthquake faults

The purpose of this document is to provide clear guidance to help surveyors, planners, designers, developers and engineers fulfil the information requirements for resource consent applications. It sets out the **minimum** requirements for geotechnical investigation for liquefaction assessment (i.e. field testing), and the reporting and documentation that should be provided in support of subdivision and land development consent applications.

This guidance document will also assist in achieving consistent practice across the land development sector within the Hastings District.

Geotechnical investigation requirements for building consent applications are identified in the companion document Guidelines for Geotechnical Site Investigation for Residential Building Consents in Hastings District.

The Hastings District Council supports the use of the New Zealand Geotechnical Database and the supply of site specific investigation data on soil and groundwater conditions from work in the Hawke's Bay and encourages geotechnical professionals and property developers to use the NZDG and add data to the database from their investigations. Over time this will assist the community to better understand and quantify the potential for liquefaction and enable the current zones to be refined.

3 Scope of Guidelines

These guidelines are applicable to resource consent applications for subdivision and land development within the Hastings District.

Note that a peer review of a geotechnical report may be required depending on the particular site investigated.

4 Background

Two published documents have a direct impact on the understanding of liquefaction vulnerability within the Hastings District. These documents are:

4.1.1 Planning and Engineering Guidance for Potentially Liquefaction-prone Land (MBIE, September 2017)

This document was developed jointly by the *Ministry of Business, Innovation and Employment* and the *Ministry for the Environment* in response to the Canterbury Earthquake Royal Commission recommendations.

The guidance sets out a consistent planning approach to guide councils to prepare Resource Management Act policies and plans, and to process resource and building consent applications that appropriately address liquefaction risk. This guidance will assist all parties associated with the use and development of land in potentially liquefaction-prone areas.

The guidance document can be viewed and downloaded from:

<https://www.building.govt.nz/building-code-compliance/b-stability/b1-structure/planning-engineering-liquefaction-land>

4.1.2 Assessment of Liquefaction Risk in the Hawkes Bay (GNS Science, 2017)

This study prepared by the Institute of Geological and Nuclear Sciences Limited (GNS Science), was commissioned by the Hawke's Bay Regional Council and the Natural Hazards Research Platform, to re-evaluate the liquefaction hazard across the region as originally described in Dellow et al (1999) and to update the consequential risk posed by liquefaction.

In conjunction with the MBIE/MFE document referenced above (4.1.1), the GNS Science study provides a basis for assessing liquefaction hazards for residential development. The report includes a liquefaction vulnerability map for the Heretaunga Plains (refer to Figure 1) which can be used to determine the appropriate means to identify, investigate, and mitigate or avoid the liquefaction hazard that may be present.

The maps are based on the data available at the time of the report. As additional subsurface and groundwater data becomes available, and the science of liquefaction prediction improves, the maps may be revised.

This document and appendices can be accessed and downloaded from the Hawkes Bay Emergency Management Hazard Portal (<http://www.hbemergency.govt.nz/assets/Hazard-Information-Portal/CR-2015-186.pdf>), and <http://www.hbemergency.govt.nz/assets/Hazard-Information-Portal/CR-2015-186-Appendices.pdf>)

These documents prepared by GNS Science are based on data available as at July 2016 (ref p86 of Vol 1) which over wide areas is limited to geological mapping and limited location specific groundwater data.

4.2 Regulatory Requirements and Resource Consent Applications

The Resource Management Act sets out the information required in an application for resource consent, and included in that is a requirement to address any risk through natural hazards. This assessment of natural hazards is to be subject to the provisions of any policy statement or plan.

4.2.1 Resource Management Act 1991 (RMA)

The 2017 amendment to the RMA introduced changes to section 106 applicable to any application for subdivision consent to ensure risks from natural hazards are appropriately assessed and addressed. Section 106 now provides (emphasis added):

Consent authority may refuse subdivision consent in certain circumstances

(1) A consent authority may refuse to grant a subdivision consent, or may grant a subdivision consent subject to conditions, if it considers that—

- (a) there is a significant risk from natural hazards; or*
- (b) Repealed.*
- (c) sufficient provision has not been made for legal and physical access to each allotment to be created by the subdivision.*

(1A) For the purpose of subsection (1)(a), an assessment of the risk from natural hazards requires a combined assessment of—

- (a) the likelihood of natural hazards occurring (whether individually or in combination); and*
- (b) the material damage to land in respect of which the consent is sought, other land, or structures that would result from natural hazards; and*
- (c) any likely subsequent use of the land in respect of which the consent is sought that would accelerate, worsen, or result in material damage of the kind referred to in paragraph (b).]]*

(2) Conditions under subsection (1) must be—

- (a) for the purposes of avoiding, remedying, or mitigating the effects referred to in subsection (1); and*
- (b) of a type that could be imposed under section [108](#).]*

Section 6(h) of the RMA has also been amended to provide for the management of significant risks from natural hazards as a matter of national importance

4.2.2 District Plan:

The District Plan provides policy direction for assessing and managing natural hazards which include liquefaction. In assessing applications for subdivision and some land development consents, the District Plan requires consideration of natural hazards.

Natural hazards are specifically addressed in:

- Section 4.1 - Information Requirements
- Section 15.1 – Natural Hazards; and
- Section 30.1 – Subdivision and Land Development.

Section 4.1 of the District Plan (Information Requirements) requires that an assessment of the effects on the environment address “any risk to the neighbourhood, the wider community or the environment, through changes to the risks from Natural Hazards” (4.1.4.1(f)), and subdivision applications are required to address natural hazards under 4.1.5.1(i).

In Section 30.1 subdivisions are subject to assessment of natural hazards and assessment criteria 30.1.8.1(5) states that Council will have regard to:

- (i) Whether the land, or any potential structure on that land, will be subject to material damage by erosion, falling debris, subsidence, slippage or inundation from any source.
- (ii) Whether there are any methods/measures available to overcome or reduce the risk of any hazard(s), and whether these methods/measures may have any significant adverse effects on the environment.

And in assessing the above matters, the Council will have regard to the following:

- a) Any information held on the Council's Natural Hazard Database and the Natural Hazards Historical Database.
- b) The Objectives, Policies and Methods of the Natural Hazards Section of the District Plan (see Section 15.1).
- c) Information by suitably qualified professionals whose investigations are supplied with the subdivision consent applications.

Subdivision assessment criteria 30.1.8.1(6) also provides that Council (in relation to building platforms) will have regard to local ground conditions and the suitability of sites for buildings, and 30.1.8.1(7) addresses consideration of the potential for esplanade reserves to contribute to effective management of risk from natural hazards.

Section 15.1 (Natural Hazards) and relevant zone provisions, involve regulating land use activities to ensure that the effects from natural hazards are avoided or minimised. Land use applications may be subject to assessment under Section 15.1.

If you are in doubt about whether your resource consent application is required to include assessment of natural hazards, and a geotechnical and liquefaction vulnerability assessment, please consult a Council planner.

5 Liquefaction Hazard Mapping in Hawkes Bay Region

Liquefaction land vulnerability has been mapped by GNS Science (2017) and the **Liquefaction Land Vulnerability Map** (Figure 1). The full and final GNS Science report is available on the Hawkes Bay Regional Council (HBRC) Hazard Information Portal <http://www.hbemergency.govt.nz/hazards/portal>.

This map forms the basis for the requirements for investigation, detailed assessment and mitigation that might be required under the Resource Management Act and Building Act.

The map shows the potential vulnerability of land to liquefaction only and other potential geotechnical issues and natural hazards will also need to be considered for any development.

Liquefaction is possible in areas of the plains which are underlain by generally cohesionless, saturated sediments. In those parts of the plains where such conditions generally exist (coloured orange or brown in Figure 1) the assessment of liquefaction hazard in the context of subdivision or land development shall be by undertaking deep ground investigation and developing specific foundation measures.

No liquefaction is expected in the hills surrounding the plains and accordingly, liquefaction vulnerability has not been mapped in these areas. However, the geotechnical constraints in such areas may include earthquake-induced land movement.

For further information and an explanation of the liquefaction process reference can be made to the GNS Science report Assessment of Liquefaction Risk in Hawkes Bay (2017).

Figure 1 Map showing liquefaction hazard vulnerability for the Heretaunga Plains



6 Geotechnical Investigations (Liquefaction) for Subdivision and Land Development

6.1 Geotechnical Investigations (Liquefaction)

The minimum requirements for geotechnical site investigation for liquefaction vulnerability assessment and reporting, for subdivision and relevant land development consent applications in Hastings District are set out in the following sections. Applications which are not accompanied by the appropriate level of investigation risk being returned or subject to requests for further information.

The nature and extent of geotechnical investigation required for subdivision and land development depends on the potential liquefaction hazard associated with the area in which the site is located, the data that supported the liquefaction classification (presented in Figure 1), and the data available at the time of the investigation.

6.1.1 Geotechnical Investigations for Assessment of Liquefaction Vulnerability

All consent applications for greenfields and infill subdivision and relevant applications for land development, within the **orange** ■ (Liquefaction possible – medium liquefaction vulnerability) and **brown** ■ (Liquefaction possible – high liquefaction vulnerability) areas will require appropriate geotechnical investigations undertaken by a suitably qualified and experienced chartered geotechnical professional to confirm the suitability of the ground for the proposed development. The consent application should be accompanied by a geotechnical report from the *geotechnical professional* describing:

- The proposed development;
- The geotechnical testing undertaken and rationale;
- Site surface and subsurface conditions – including where appropriate, nearby features such as waterways which may have an effect on the seismic performance of the site and / or proposed development;
- Assessment of liquefaction hazard associated with the ground conditions and proposed development;
- The potential implications of the liquefaction hazard on the proposed development;
- Details of liquefaction hazard mitigation measures if required; and
- Geotechnical foundation design recommendations.

Engineering logs including field descriptions in accordance with New Zealand Geotechnical Society (NZGS) guidelines, should also be provided.

The geotechnical report should also include identification and mitigation of other geotechnical and geological hazards as appropriate (e.g., slope stability, fill material, expansive soils, organic soils, fault displacement, etc).

6.1.2 Minimum Recommended Geotechnical Investigations for Assessment of Liquefaction Vulnerability within the Mapped areas

For subdivision and land development in the mapped areas (Figure 1) the following is applicable:

Liquefaction is unlikely – Very Low to Low Liquefaction Vulnerability Yellow Areas)

- If 'standard testing' confirms the ground is not 'good ground' for the purposes of NZS 3604:2011, or if there is evidence to suggest that the site may be liquefaction prone i.e. shallow water table, loose sands / non-plastic silts found in shallow investigations, a suitably

qualified and experienced geotechnical professional will be required to carry out a geotechnical site investigation sufficient to support the suitability of the land for the proposed development and recommend foundation/geotechnical design parameters.

- Investigations should take in to account the presence or absence of publicly available existing subsurface data, and the quality of that data (e.g. well driller's logs or CPT data).
- Geotechnical investigation may be required to address other geotechnical / geological hazards potentially present at the site.

Liquefaction is Possible – Medium and High Liquefaction Vulnerability (Orange and Brown areas)

In Medium and High Liquefaction Vulnerability areas, (orange and brown areas in Figure 1 above), the scope of geotechnical investigations for subdivision and land development must be confirmed by a suitably qualified and experienced Geotechnical Professional engineer, and investigations should at a minimum comprise:

- “Deep” investigations comprising either machine drilled boreholes with Standard Penetration Testing (SPT) at 1.5 m (maximum) intervals, or Cone Penetration Tests (CPTs) to a depth of at least 10-15 m. Investigations terminating at a shallower depth must be supported by robust geotechnical-based reasoning. For example, termination of a CPT in shallow, dense materials may not be accepted as sufficient justification, unless it can be reasonably demonstrated that these materials are unlikely to be underlain by potentially liquefiable soils that may still affect buildings during an earthquake.
- SPT and CPT test requirements carried out in accordance with accepted testing standards (ref: current ASTM D5778 for CPT and ASTM D6066 for SPT, and NZGS Module 2).
- Measurement of groundwater as part of the investigations, and clear identification of the groundwater depth to be used for design, noting that testing methodology and groundwater levels are subject to seasonal fluctuations.
- For boreholes and SPT, testing of recovered soil samples to support the assessment of liquefaction susceptibility where plasticity is inferred to limit or prevent liquefaction.
- The triggering of liquefaction should be assessed using the simplified procedures recommended in NZGS Module 3.
- In the event that site-specific investigations cannot reach the *minimum target depth* of 10m (CPT refusal on dense gravel layer for example) nearby (i.e., < 300 m) off-site deep investigation data may be considered if it is demonstrated that the off-site data can be considered to be generally representative of on-site soils.
- Investigations should take in to account the presence or absence of publicly available existing subsurface data, historic records and aerial photographs, and should include assessment of typical geotechnical considerations such as settlement, bearing pressure etc. If these investigations do not or cannot extend to a depth sufficient to support the proposed design option or do not clarify liquefaction susceptibility further investigation may be required to determine liquefaction risk.
- The number and spacing of deep investigations should be in general accordance with the Planning and Engineering Guidance for Potentially Liquefaction-prone Land (MBIE, 2017). The key requirement is to perform enough investigation to adequately characterise the ground conditions in consideration of the proposed development. **If the geotechnical investigation is also intended be used for design of foundations for individual buildings, the number and spacing of investigations must be sufficient to confidently characterise the ground conditions at the locations of the proposed buildings.**

- Additional test pits and Dynamic Cone Penetrometer tests can be beneficial to confirm near surface conditions and shallow bearing.

6.1.3 Summary

The following table summarises the minimum requirements for geotechnical investigation for liquefaction and associated foundation design recommendations and reporting for subdivision and land development in Hastings District.

Table 1: Summary of Minimum Testing Required for Subdivision and Land Development

Level of Geotechnical Investigation for Residential Development		
Area and Liquefaction Susceptibility	Minimum testing required	Notes
Yellow Areas Very Low to Low	Hand held investigation using a Dynamic Cone Penetrometer (Scala Penetrometer) and hand auger to confirm the bearing pressure and in-situ strength to confirm 'good' ground. Not less than 2m depth (ref: NZS 3604:2011 and NZGS Module 2). Refer section 6.1.2	Geotechnical investigation and reporting still required as appropriate to address other geotechnical and geological constraints such as slope stability and soil type, earthworks etc; or if there is reason to suspect that the site may be prone to liquefaction.
Orange Areas Medium	"Deep" investigations comprising either machine drilled boreholes or CPT soundings to a minimum depth of 10 - 15 m or a depth that is considered suitable by a suitably qualified and experienced geotechnical professional.	Liquefaction potential is to be assessed in accordance with the New Zealand Geotechnical Society Earthquake Engineering Guidelines.
Brown Areas High	Assessment of liquefaction potential to be made by a suitably qualified and experienced geotechnical professional . Refer section 6.1.2	If as a result of investigation the site is considered prone to liquefaction, additional site investigations and/or foundation design may be required.

6.1.4 Fault Avoidance Zones

The Ministry for the Environment has published Guidelines on development of land on or close to active faults (–Ministry for Environment , 2003). The aim of the Guidelines is to assist planners, emergency managers, earth scientists, and people in the building industry to avoid or mitigate fault rupture hazards.

Subsequently, GNS Science (2016) has published a report mapping active faults in the Hawke's Bay.

Fault avoidance zones in Hastings can be viewed on the Hawke's Bay Hazard Information Portal: <http://www.hbemergency.govt.nz/hazards/portal>. The Council also publishes a copy on its GIS Hazard layer via its web site.

7 Conclusion

These guidelines are current at the time of issue, but will be reviewed and updated as new information becomes available.

Hastings District Council may seek independent peer review of any geotechnical report submitted with a resource consent application, and this would be at the applicant's expense.

8 References

- GNS Science (2016). Active Fault Mapping and Fault Avoidance Zones for Hastings District and environs – Report 2016/112 January.
- GNS Science (2017). Assessment of liquefaction risk in the Hawke's Bay: Volume 1: The liquefaction hazard model. GNS Science Consultancy Report 2015/186, October.
- Ministry of Business Innovation and Employment (2017). Planning and engineering guidance for potentially liquefaction-prone land Resource Management Act and Building Act aspects. September.
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