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# SOLD ON KĀPITI

## Liquefaction Assessment Report for 161, 167, & 169 Gladstone Road, Levin



**Prepared for:** John Poulton

**Issue Date:** 3/04/2025

**HWEL File:** 250201

## **Introduction & Scope**

### **Introduction**

Hamish Wells Engineer Limited (HWEL) has been engaged by John Poulton to undertake a liquefaction assessment for Lot 3 DP 591637, 161 Gladstone Road, Lot 2 DP 591637, 167 Gladstone road and Lot 1 DP 591637, 169 Gladstone Road, Levin. This report summarises our findings and recommendations and will be used to support building consent applications to the Horowhenua District Council (HDC).

### **Scope of Works**

Provide a liquefaction risk assessment with associated mitigations (if required) and any earthworks and foundation recommendations identified during testing for the 3-lots that can be utilised for building consent.

Tasks:

- Undertake subsurface investigations utilising a machine excavated test pits on the site up to 4m below ground level (bgl) to access site-specific liquefaction potential in accordance with the Tonkin & Taylor ‘Options for Liquefaction Assessment for Resource and Building Consent Report, June 2023 and the ‘Simplified liquefaction vulnerability screening tool’ developed for the HDC to, confirm site soils, depths to the ground water table if identified and to confirm the absence or presence of unsuitable soils or fill material.
- Undertake Scala Penetrometer tests to 2m bgl to identify the bearing capacity of site soils at varying depths.

### **The Site**

Area:

- 161 Gladstone Rd – 0.5007 ha.
- 167 Gladstone Rd – 0.5008 ha
- 169 Gladstone Rd – 0.5023 ha

**Geology:** Q2 – Late Pleistocene alluvial river deposits with poorly to moderately sorted gravel with minor sand or silt underlying terraces, includes minor fan gravel, as per the Institute of Geological & Nuclear Sciences, 1:250,000 Geological Map 10, Wellington & [data.gns.cri.nz/geology/](http://data.gns.cri.nz/geology/).

**Geomorphology:** Q2 - An uplifted and partially dissected marine terrace abuts the western flanks of the Tararua Ranges, sloping gently seaward. The uplifted plain formed flat topped interfluvial (areas between the valleys of adjacent water courses) separated by box shaped valleys. River aggradation surfaces associated with the Ohau River fan out westward from the Tararua Ranges bisecting the older marine terraces with broad corridors of coarse alluvium. Deposits are mapped as Ohakean gravels, and the upper surface of the gravels is mapped as the Ohakean terrace.

**Soils:** Soil mapping implies that the sites are on the boundary of Kopua stony loams and Kiwitea silt loam soils. Both soils are soils of the loess covered, intermediate height, alluvial gravel terraces.

**Drainage Classification:**

- Kopua stony loam – Class 5
- Kiwitea silt loam – Class 4

**Topography:** Flat to gently undulating rural site that falls gently to the East and a small stream running South to North on the southern boundaries of Lots 1 & 2 before trending East to West along the internal boundaries of Lots 2 & 3 before passing under Gladstone Road.

**Rivers, Streams and waterbodies:** The primary water body is the Ohau River to the South and East and the Koputaroa Stream to the North. There are no significant free faces to a water body within 1km of the site which is considered suitable to mitigate any risk of seismic induced lateral spread.



**Groundwater:** No groundwater or perched water was identified during testing to at least 4m bgl.

**Site Vegetation:** Agricultural grasses.

**Geotechnical Hazards from available mapping and onsite observations:**

**Liquefaction:**

- HDC – Liquefaction undetermined.
- HRC - No risk.

**Slope failure:** No risk.

**Faults and fault avoidance zones:** Poroutawhao Fault to the West and the Northern Ohariu Fault 2.1km to the East. The site is well outside any fault avoidance zones and mitigation will not be required.

**Site Sub-soil classification:** A Site sub-soil classification of D (deep soils) has been inferred for this site.

**AS2870:2011 Expansive soils classification:** Class A – non expansive.

### **Field Testing & Data Analysis**

HWEL provided oversight to the testing process and generated a site soil investigation report following analysis of the field data. Testing involved 2 x machine excavated test pits and scale penetrometer testing by HWEL up to 2m bgl which were undertaken on 28/03/2025. Both test pits were very similar in nature with the only discrepancy being the depths of the overlying loess soils above dense alluvial deposits.

Scale testing was conducted as per NZS 3604 to confirm depths to ‘good ground’. Test pits up to 4m bgl were logged as per the Field Description of Soil & Rock – NZ Geotechnical Society Inc, Dec 2005, to assess site specific liquefaction potential as per the HDC screening process, confirm the GWT, soil type and the absence or presence of uncertified fill material.



## Site Testing Locations



Dense Alluvium deposits of gravels, COBBLES & boulders in a coarse sand matrix



Table 1: Test Pit 1 & Scala A, Lot 3, 161 Gladstone Road. Soil classification as per the Field Description of Soil & Rock – NZ Geotechnical Society Inc, Dec 2005

Soil Type	Depths below existing ground level (egl).	Moisture Condition	Density Index (Relative Density) Terms
TOPSOIL with grass & rootlets, dark brown, friable	0 – 0.3m	Dry	Loose
Silty CLAY (loess), brown, firm, trace orangey mottles	0.3 – 1.2m	Dry	Medium dense to 1m bgl, dense from 1 – 1.2m
Grey silty CLAY, moderately plastic	1.2 – 1.3m	Dry	Very dense
Gravels & COBBLES, trace boulders, sub rounded to sub-angular, brown, iron staining & nodules, silty matrix	1.3 – 1.6m	Dry	Very dense
Gravels, COBBLES & Boulders in a coarse sand matrix, grey, clean, subrounded to sub-angular	1.6 - 3.6m EOH  Practical refusal of the digger at 3.6m bgl in densely packed boulders of greater than 300mm dia.	Damp	Very dense estimated, practical refusal of the scala penetrometer at 1.2m bgl

Dense Alluvium deposits of gravels, COBBLES & boulders in a silty matrix



Table 2: Test Pit 2 & Scala I, Lot 1, 169 Gladstone Road. Soil classification as per the Field Description of Soil & Rock – NZ Geotechnical Society Inc, Dec 2005

Soil Type	Depths below existing ground level (egl).	Moisture Condition	Density Index (Relative Density) Terms
TOPSOIL with grass & rootlets, dark brown, friable	0 – 0.3m	Dry	Loose
Silty CLAY (loess), brown, minor gravels, friable, brown	0.3 – 0.5m	Dry	Medium dense
Gravels, COBBLES & boulders in a silt matrix, brown, minor coarse river sand	0.5 – 1.3m	Dry	Very dense, practical refusal of the scala penetrometer at 0.5m bgl in dense river alluvium deposits
Gravels & COBBLES & boulders in a coarse sand & gravel matrix, sub rounded to sub-angular, clean, grey	1.5 – 3.4m EOH Practical refusal of the digger at 3.6m bgl in densely packed boulders of greater than 300mm dia.	Dry	Very dense



## **NZS3604:2011 Shallow Testing for ‘Good Ground’ requirements.**

‘Good Ground’ is defined in Section 1 of NZS 3604, as any soil or rock capable of permanently withstanding an ultimate bearing capacity of 300 kPa (Ultimate Bearing Capacity).

### **Lot 3, 161 Gladstone Road**

- Depths of topsoil and loess soils to very dense alluvium deposits (gravels COBBLES & boulders) range from 0.7m – 1.2m bgl. ‘Good Ground’ or 300kPa soils (5 blows per 100mm) were identified from 0.5m – 0.8m bgl and practical refusal of the scala penetrometer occurred from 0.7 – 1.2m bgl within the dense stony soils. 200kPa soils were generally identified and sustained from 0.3m bgl.

### **Lot 2, 167 Gladstone Road**

- Depths of topsoil and loess soils to very dense alluvium deposits range from 0.3m – 0.8m bgl. ‘Good Ground’ or 300kPa soils (5 blows per 100mm) were identified from 0.3m – 0.6m bgl and practical refusal of the scala penetrometer occurred from 0.3 – 0.8m bgl within the dense alluvium. 200kPa soils were generally identified and sustained from 0.2m bgl.

### **Lot 1, 169 Gladstone Road**

- Depths of topsoil and loess soils to very dense alluvium deposits range from 0.4m – 1.6m bgl. ‘Good Ground’ or 300kPa soils (5 blows per 100mm) were identified from 0.3m – 1.6m bgl and practical refusal of the scala penetrometer occurred from 0.4 – 1.6m bgl within the dense alluvium. 200kPa soils were generally identified and sustained from 0.3 – 0.4m bgl other than scala test site J on the eastern boundary where loess soils extend to 1.6m bgl.

Depths to the alluvium deposits increase from West (Gladstone Road) to East, with stony soils virtually to the surface on the Gladstone Road boundary and up to 1.6m of loess soils overlying the alluvium closer to the eastern boundary of Lot 1.

300kPa soils are generally defined as suitable for founding 3604 type timber subfloor foundations and conventional concrete slabs.

200kPa+ soils are generally considered suitable for founding engineered waffle/raft type concrete slabs.

**Scala Penetrometer Test Results** – test results highlighted yellow do does not meet the ‘good ground’ requirements of NZS 3604. Blows of 25 per 100mm indicate practical refusal/bouncing of the penetrometer in dense river gravels.

Depth bgl	A	B	C	D	E	F	G	H	I	J	K	L
0.1	2	2	2	2	3	3	2	2	2	2	2	3
0.2	2	2	3	3	2	3	2	3	3	3	3	3
0.3	2	2	3	2	25	5	3	2	3	5	3	5
0.4	4	3	4	4		6	9	3	5	25	2	5
0.5	5	3	5	5		7	5	4	25		2	4
0.6	5	4	6	25		25	5	5			3	25
0.7	5	3	25				7	10			3	
0.8	4	4					25	25			3	
0.9	5	25									3	
1.0	5										3	
1.1	10										3	
1.2	25										3	
1.3											3	
1.4											3	
1.5											4	
1.6											25	
1.7												
1.8												
1.9												
2.0												

## **Liquefaction Technical categorisation assessment; potential vertical settlement and lateral spread.**

Liquefaction: Liquefaction requires three key elements to occur.

- The presence of loose, non-cohesive material that will tend to densify under seismic shaking (loose fine sands and loose sand silt mixtures).
- Ground saturation (the above materials below the GWT).
- Sufficient shaking to trigger liquefaction.

Bore logging of the test pit implies a non-liquefiable crust of loess derived silty CLAY's and very dense late Pleistocene alluvial deposits at least 3.6m in thickness above any waterlogged soils or an obvious ground water table.

Damaging seismic induced vertical settlement and lateral spread is generally considered unlikely in older (Pleistocene) alluvial deposits (Q2a) with groundwater deeper than 4m. The Q2a geologic formation identified on this site is expected to be an extension of the Q2a alluvial deposits mapped between Tararua Road and Queen Street East that are identified as having a low liquefaction risk and have been mapped as liquefaction unlikely.

The site is sufficiently distant from a free face to a water body and is gently contoured; therefore, the risk of lateral spread is assessed as minor, and mitigation will not be required.

Therefore, the site has been estimated through testing as Technical Category 1 (TC1) ground, where nominal vertical settlement of the ground is expected to be less than 15mm in the SLS (1/25yr) event and less than 25mm in the ULS (1/500yr) event and nominal lateral stretch is generally not expected. (TC1) was developed by MBIE following the Christchurch earthquakes and provides designers a simplified compliance pathway by providing foundation options appropriate for the assessed liquefaction vulnerability.





Above is an excerpt from the HDC liquefaction risk hazard mapping showing where the Q2a alluvial deposits between Tararua Road and Queen Street are identified as liquefaction risk unlikely and the location of the Poulton property immediately to the East. Below is the site specific Geology for 167 Gladstone Road as mapped by GNS NZ: [data.gns.cri.nz/geology](https://data.gns.cri.nz/geology) & 1:250,000 Geological Map 10, Wellington.

<b>Name:</b>	OIS2 (Late Pleistocene) river deposits
<b>Simple name:</b>	Late Pleistocene river deposits
<b>Main rock name:</b>	gravel
<b>Stratigraphic age:</b>	Q2
<b>Description:</b>	Poorly to moderately sorted gravel with minor sand or silt underlying terraces; includes minor fan gravel.
<b>Subsidiary rocks:</b>	
<b>Key group:</b>	Late Pleistocene sediments
<b>Stratigraphic lexicon name:</b>	Pakihi Supergroup
<b>Terrane equivalent:</b>	
<b>Absolute age (Myr min):</b>	0.014
<b>Absolute age (Myr max):</b>	0.024
<b>Rock group:</b>	gravel
<b>Rock class:</b>	clastic sediment
<b>Code:</b>	Q2.alvgvl
<b>Geological history:</b>	Oxygen Isotope Stage 2

## **Stormwater**

Clean well-draining river gravels are available for the disposal of locally generated stormwater from impermeable surface areas between 0.3 – 1.6m bgl. It is recommended that any soak pits should extend at least 0.3m into the gravels to access the less silty cleaner gravels. Hydraulic neutrality should be easily obtainable for all lots.

## **Conclusion**

**Liquefaction:** Technical Category 1 – Low risk, mitigation not required.

**Ground:** Depths to ‘Good Ground’ increase from West to East. Sites have between 0.3 – 0.4m of TOPSOIL overlying 0.3 – 1.2m of Silty CLAY (loess) soils overlying dense river gravels.

## **Recommendations**

**Earthworks:** Loess soil particles are easily entrained in water and earthworks should be undertaken during dry weather to avoid softening of the subsoil and to minimise potential dig out depths. Between 0.3 - 0.4m of TOPSOIL minimum, will need to be removed for any concrete slab foundations.

**Timber subfloor foundations:** All piles should extend onto or into the dense river gravels and standard piles or extended depth standard piles are likely to be required. As noted within the report, the depth to the gravels increases from West to East across all three lots and pile depths will increase accordingly.

**Driven Timber Piles:** Sites not suitable other than the very eastern most part of the individual lots. Unlikely to be required however, if utilised – all piles should be H5 pressure treated tanapoles, driven to practical refusal, 10mm sets or better, founding on the dense gravels. All driven pile foundations will require Specific Engineer Design.

### **Concrete Slab foundations:**

- **Conventional 3604 type slabs** – Either bridge to 300kPa soils utilising cast in situ augured concrete piles or dig out soft surface loess soils to depths as recommended by the structural engineer and replace with an engineer certified gravel raft.
- **Waffle/raft type concrete slabs** – TOPSOIL to be removed as a minimum. Any further ground improvement earthworks (dig out and replace with a gravel raft) will be dependent on the individual building design requirements and building location within the individual blocks.

**Further testing requirements:** It is recommended that a basic 3604 type scala penetrometer test is undertaken within 1m of the four corners of any new building to confirm depths to the ‘Good Ground’ and river gravels, to inform any Specific Engineer Design (SED) requirements or to confirm as appropriate for NZS 3604 type foundations and earthworks (non-SED).

## **Limitations**

This report has been prepared solely for our client. This report's data is the property of Hamish Wells Engineer Limited and is not to be used in other contexts or for any other purpose without our prior review and agreement.

## **Closure**

If you have any queries or require further clarification of the report, do not hesitate to contact the undersigned.

### **Report by**

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