27 October 2023

Peter McEvoy

[redacted]

Dear Peter

Request for Information – Local Government Official Information and Meetings Act 1987

We refer to your official information request dated 28 September 2023 for:

The copies of:

1. Safety in Design workshop/s meeting notes and risk analysis undertaken for this project
   Answer: The safety in design is set out in part 8 on page 14 of the report titled "Howard Road Detailed Design Report" by ENGEO Limited. See full report in attachment 1.
   There were no workshop/s or meeting notes.
   The risk analys is set out in page 14 of the report titled "Howard Road Detailed Design Report" by ENGEO Limited. See full report in attachment 1.

2. Consultation with the Regional Council on the use of the Dillon St tracks for pedestrian management
   Answer: Email correspondance between HCC staff and Jo Greenman - East Harbour Regional Park Ranger Greater Wellington Te Pane Matua Taiao. See attachment 2.

3. The temporary traffic management plan for the work (site).
   Answer: For the temporary traffic management plan, see attachment 3.

4. The site specific health and safety plan for the project.
   Answer: The Safe Work Method Statement for Anchoring & Excavation & Operating Drill Rig (with Excavator) and the Safe Work Method Statement for Piling and Drilling (Excavator)are attachments 4.1 and 4.2 respectively.

5. The Building Consent for the works.
   Answer: The Producer Statement is set out in Appendix 1 of the report titled "Howard Road Detailed Design Report" by ENGEO Limited. See full report in attachment 1. Email correspondance between Council staff is in attachment 5.

You have the right to seek an investigation and review by the Ombudsman of this decision. Information about how to make a complaint is available at www.ombudsman.parliament.nz or freephone 0800 802 602.

Please note that this response to your information request may be published on Hutt City Council's website. Please refer to the following link: www.huttcity.govt.nz/council/contactus/make-an-official-information-act-request/proactive-releases

Yours sincerely

Lakna Siriwardena

Legal Operations Advisor

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Project Number 21700.000.002

Detailed Design Report

Howard Road, Point Howard, Wellington

Submitted to:
Hutt City Council
30 Laings Road
Lower Hutt
Wellington 5040

Contents

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ENGEO Document Control:

Report Title	Detailed Design Report - Howard Road, Point Howard			
Project No.	21700.000.002	**Doc ID**	02	
Client	Hutt City Council	**Client Contact**	Natasha Garcia	
Distribution (PDF)	Hutt City Council ENGEO (File Copy)			
Date	**Revision Details / Status**	**Author**	**Reviewer**	**WP**
04/08/2023	Issued to Client	DH	GMS / MJP	BK

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1 Introduction

ENGEO Ltd (ENGEO) was requested by Hutt City Council (HCC) to undertake retaining wall design to remediate the landform where a landslide has occurred within the council owned road reserve, impacting the private properties of 76 and 78 Howard Road, Point Howard, Lower Hutt.

This report outlines the design of the proposed reinforced concrete wall, including construction drawings and specification. This report is intended to be used to support construction of the wall as part of emergency works procedure and to support a retrospective building consent application to HCC following construction of the solution under emergency works.

The design solution provided is based on visual surface information collected over the course of several site visits and our experience in the local terrane. Given the constrained nature of the site there were no intrusive investigations carried out as part of design of the remediation solution.

This work has been carried out in accordance with our signed agreement dated 15 May 2023.

2 Background

ENGEO prepared an initial landslide assessment report (ref. 21700.000.001_05) dated 22 March 2023, which interpreted the landslide to have occurred as a result of saturated ground conditions contributed from a leaking water main and moderate rainfall event.

Following the initial assessment, ENGEO prepared a preliminary design option letter (ref. 21700.000.002_01) dated 15 May 2023, which outlined two preliminary design options to mitigate further regression of the landslide and reinstatement of the carriageway. The two options were:

- Option 1: Rock Bolt – a series of rock bolts with mesh and shotcrete facing installed across the current excavated slope profile below the road reserve, encompassing facing of the land within council ownership. This option has been provided to mitigate further regression of the landslip only and does not reinstate the road reserve width to pre-slip conditions.
- Option 2: Reinforced Concrete Wall – a reinforced concrete wall constructed to reinstate the road reserve width to pre-failure conditions. This option requires initial installation of permanent rock bolts to facilitate drill rig access on the road reserve and reduce the forces acting on the wall. This option will also include installation of rock bolts below the wall location within the council reserve zone to support the vacated slope surface.

Based on correspondence with HCC and Halverson (contractors), including initial pricing estimates, we understand a reinforced concrete wall is the preferred option for the site. This is based on construction difficulties with respect to anchors beneath the road alignment and potential effects on interaction with existing services within the road corridor. Discussions with the contractor also indicated that a specific construction methodology is to be adopted with progressive railing and backfilling of the wall, with construction being undertaken progressively from the lower portion of Howard Road onwards to reduce temporary works stability risk.

To mitigate shallow surface erosion and establish escarpment stability, the remediation solution is to also include placement of geocell erosion protection (installed with pins is preferred below the wall alignment), with the geocells backfilled with seeded topsoil to establish vegetation on the slope.

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Alternatively, planting may be incorporated into the webs between geocells to provide a more substantial vegetated face.

3 Site Description

The landslide occurred on the downslope side of Howard Road (at approximately Lat: -41.251093; Long: 174.909924), resulting in vacation of the HCC road reserve, and evacuation and inundation of land within the private properties at 76 and 78 Howard Road below the road carriageway.

At the location of the landslide, Howard Road traverses steep flanking slopes below the road with overall gradients of 40 to 50 degrees.

The observed headscarp is approximately 10 m long and is approximately 2 m high, formed at approximately 60 degrees from horizontal. Beyond the headscarp, slope gradients reduce to approximately 45 degrees, being similar to the original slope gradients. Debris associated with the landslide had runout to the base of the gully, approximately 20 m below the headscarp.

The failure mechanism appears to be shallow translational sliding of the surface fill and colluvium soils. It appears that the upper 1 m to 1.5 m of soil has been released downslope.

The landslip has reduced the road carriageway width to approximately 3.8 m at its narrowest point, measured from the crest of the headscarp to the road cutting.

To the northeast of the landslide, a pile supported concrete car parking platform is present. To the southwest, a timber staircase provides access to the lower level of the site.

Within the asphalt surface of the road to the northeast and southwest of the site there are multiple depressions and cracks suggesting past movement / settlement. Vegetation growth within cracks suggests that these have not formed in conjunction with the recent landslide.

There are a number of services located within the road corridor:

- Gas and water mains were broken and exposed within the headscarp; temporary repairs have been completed. It is understood these services are to be reinstated within the road carriageway.
- The landslide caused collapse of a power pole which supported overhead powerlines. The powerlines have since been reinstated with the power pole on the upslope side of Howard Road.

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4 Ground Conditions

The published geological maps for the area[1] indicate the site is underlain by Greywacke of the Rakaia Terrane, which is consistent with observation on the upslope side of the road where slightly weathered Greywacke is exposed within the road cut. The road cut is formed at approximately 60 degrees to 70 degrees from horizontal.

Based on a visual observation of the landslide headscarp, fill and pavement materials are present within the upper 1.5 m, overlying colluvial soils to approximately 3 m depth. Inferred highly weathered Greywacke was observed at the change in slope within the landslide backscarp. Our geological interpretation of the headscarp is shown in Figure 1 below.

Through observation of the trenching works undertaken by Wellington Water to reinstate the water main within the centre of Howard Road, moderately weathered Greywacke was observed within the north (upslope) side of the trench, with colluvium and fill material observed in the southern side of the trench (downslope).

Based on our observations, and typical road construction techniques which traverse on steep terrain, Howard Road is likely to have been formed through cut to fill operations.

Our interpreted ground model is shown on our analyses' outputs.

Figure 1: Geological Interpretation

4.1 Ground Model Assumptions

Due to the lack of intrusive investigations for this emergency design, the following assumptions have been made on the ground model analysed for the remediation solution:

[1] Begg, J.G.; Johnston, M.R. (compilers) 2000. Geology of the Wellington area. Institute of Geological and Nuclear Sciences 1:250 000 geological map 10. 1 sheet + 64p. Lower Hutt, New Zealand: Institute of Geological and Nuclear Sciences Limited.

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- We have assumed that the weathering transition through the Greywacke units is uniform and rock strength generally improves with depth, such that no allowance had been made for planes of weakness within the lower rockmass.
- We have assumed Highly Weathered (HW) Greywacke is present throughout the profile using conservate rockmass parameters with no unweathered rockmass parameters being adopted.
- We have assumed that given the elevation of the slope with respect to the phreatic surface (permanent groundwater table) it is beyond the limit of the slope stability analyses, such that permanent groundwater levels don't influence the stability analyses, with instability caused by pore pressure increases within the upper soil / rockmass from rainfall and watermain water infiltration into these units.
- We have assumed that the slopes above the road are generally stable, such that our analyses have been limited to the toe of the slopes above the road reserve.
- Our ground models have assumed thickness of residual soils and completely weathered Greywacke within the slope is based on visual evidence following the slip event and assuming average slope gradients of the HW rockmass surface.

Given the lack of intrusive investigations to confirm the retaining wall design, where ground conditions vary significantly from the presented stability models, including:

- Depth to completely weathered (CW) and HW Greywacke within influence of the walls;
- Permanent groundwater levels within the embedment depths of the wall;

ENGEO should be contacted to confirm whether the design actions remain appropriate for the prepared design and address any changes to the construction if required.

5 Reinforced Concrete Wall Design

5.1 Methodology

The proposed landslide remediation is to comprise a series of closely spaced reinforced concrete soldier piles to be installed along the location of the former road carriageway extent. The wall is considered to act as a palisade wall and retaining wall to stabilise the affected area of the road reserve and support minor fills to reconstruct the extent of the carriageway as close to prior to the event.

As the landslide has resulted in vacation of materials from the carriageway, formation of a temporary construction bench together with above ground casing (Formatube or similar) will be required to construct the uprights where located above the current landslip profile.

The design methodology used to determine the depth, spacing and structural requirements of the proposed wall is as follows:

- Back analyses of the existing slope using the proprietary limit equilibrium stability analyses software SLIDE to determine the soil parameters. Back analyses considered the inferred pre-failure profile, saturation of the near surface soils and the observed post failure slip surface.
- Remediated design assessed in slope stability analyses, using SLIDE, adopting pile embedment, shear capacity and spacing required to achieve the requisite factors of safety for the road carriageway.
- Analyses of the required bending moment, shear force demands and a confirmation of embedment depth using the proprietary wall design software WALLAP.
- Design of the pile steel reinforcement using SESOC Gen-Col software.
- Assessment of horizontal railing supports using in-house design calculations spreadsheets.

5.2 Building Code Compliance Pathways

The following building code compliance paths have been considered for our design:

- B1 Structure[2]: Designs are considered specific engineering design (SED) in accordance with specific design aspects outlined in related sections below.
- B2 Durability[3]: Compliance with B2 does not include a verification method for concrete durability for such designs. However, the reinforced concrete wall has been designed to include appropriate cover to the structural steel reinforcement in accordance with the Concrete Structures Standard, NZS 3101: 2006.

  The timber rails supporting the retained soils have been selected to comply with Table 1A of B2/AS1.
- F4 Safety from Falling[4]: Given the retained height of the retaining wall, construction of a fall protection system is required to meet the building code requirements for F/4: Safety from Falling. Given the wall is supporting a road reserve, construction of a traffic barrier may be required above the wall. Design of this structure is outside the scope of this report. However, design of a traffic barrier system should be considered independent of the wall members, rather than being tied into the members, as our design has not allowed for dynamic forces from a collision into a traffic barrier fixed to the retaining wall piles.
- F5 Construction and Demolition Hazards[5]: Compliance with F5 does not include a verification method for such designs, however temporary fencing and barriers have been recommended as part of the safety in design discussion in Section 7 below in accordance with F5/AS1.

[2] MBIE (2021): Acceptable Solutions and Verification Methods, for New Zealand Building Code Clause B1 Structure
[3] MBIE (2019): Acceptable Solutions and Verification Methods, For New Zealand Building Code Clause B2 Durability
[4] MBIE (2016): Acceptable Solutions and Verification Methods, For New Zealand Building Code Clause F4 Safety from Falling
[5] Department of Building and Housing (2006): Compliance Document for New Zealand Building Code Clause F5 Construction and Demolition Hazards

5.3 Geotechnical Design Parameters

Geotechnical design parameters are based on back analyses of the landslide during the rainfall event, supplemented with local knowledge of the ground conditions and generalised Greywacke parameters within Point Howard.

Mohr-Coulomb (M-C) parameters have been adopted within the stability model for all units, with conservative M-C parameters with respect to failure criteria within the rock strength materials.

Table 1: Geotechnical Design Parameters

Geological Unit	Unit Weight, γ' (kN/m³)	Eff. Cohesion, c' (kPa)	Eff. Friction Angle, ϕ' (deg.)	Pore Pressure Coefficient, Ru	Youngs Modulus, E (MPa)
HARDFILL (pavement or gravel backfill)	20	0	38	0	30
Fill; silty sandy Gravel	20	5	36	0.3	30
Colluvium; silty Gravel	20	4	36	0.2	20
Completely weathered GREYWACKE	20	5	35	0.1	30
Highly weathered GREYWACKE	22	30	38	0	100

5.4 Seismic Design Parameters

Based on the wall being an Importance Level 2 (IL2) structure, with a design life of 50 years, the ultimate limit state (ULS) return period event for design is assessed to be 500 years in general accordance with NZS1170.0[6]. Peak horizontal ground accelerations (a_{max}) for use in geotechnical assessments are provided in Table 2 below, based on the recommended values for Wellington published in MBIE/NZGS Module 1[7].

Design horizontal accelerations (k_h) for retaining wall design are based on the recommended approach provided in MBIE/NZGS Module 6[8], considering topographic amplification factors (A_{topo}) and wall displacement factors (w_d).

[6] New Zealand Standard. (2011). NZS 1170.0:2002 Incorporating Amendment No. 5, Structural design actions – Part 0: General principals.
[7] New Zealand Geotechnical Society (NZGS) and Ministry of Business, Innovation and Employment (MBIE) (2021). Earthquake geotechnical engineering practice, Module 1: Overview of the guidelines, Version 1, November 2021.
[8] New Zealand Geotechnical Society (NZGS) and Ministry of Business, Innovation and Employment (MBIE) (2021). Earthquake geotechnical engineering practice, Module 6: Earthquake resistant retaining wall design, Version 1, November 2021.

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Table 2: Design Peak Ground Acceleration

Limit State	Return Period	a_{max}	A_{topo}	W_d	k_h	Magnitude
ULS	500	0.68g	1.2	0.5	0.41g	7.7

For cantilever retaining walls, the earthquake induced lateral earth pressure has been calculated in general accordance with MBIE Module 6 assuming the retaining wall is a flexible structure, with the seismic load and inertial force of the retaining wall applied at one third of the retained height.

5.5 Surcharge

A 12kPa dead load surcharge, to reflect traffic loading, has been adopted for SLIDE and WALLAP models under static design scenarios.

5.6 Slope Stability Analyses

Global deep-seated rotational instability of the slopes beneath Howard Road is considered to be low risk based on the geological composition (highly to moderately weathered Greywacke) and age of the Greywacke deposits, which have been subject to many large earthquakes over the last millennia. Slope stability analyses have therefore been considered as shallow seated rotational and translational failure mechanisms, within the near surface soils and upper weak rock materials (fill, colluvium, completely weathered and highly weathered Greywacke).

Static and seismic slope stability analyses have been undertaken using the proprietary software SLIDE2 (ver. 9.025), adopting GLE-Morgenstern-Price methods and non-circular failure surfaces under long term static, shot term transient and seismic conditions.

Back analyses of the inferred pre-failure profile with elevated pore pressure conditions, using an r_u coefficient of between 0.1 and 0.3 within the fill, colluvium / residual soils and completely weathered Greywacke units to simulate the leaking watermain and rainfall conditions were undertaken to develop the design material paraments within Table 1 above. Calculated failure surfaces were consistent with the observed failure profile on site.

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Table 3: Summary of Stability Analyses

Scenario	Required FoS	Analysed FOS*	Notes
Back analyses; Short term transient conditions (elevated pore water pressure)	n/a	0.75	Lowest FoS failure profile consistent with observed failure profile on site
Long-term static conditions (normal groundwater)	1.5	2.0	Satisfies FOS requirements
Short term transient conditions (elevated pore water pressure)	1.2	2.0	Satisfies FOS requirements
Seismic conditions, ULS PGA 0.82g	1.0**	0.7	FOS < 1.0 for full PGA, seismic displacement approach to be considered
Seismic conditions, yield PGA 0.52g	n/a	1.0	Yield PGA through wall alignment; assessed 30 – 50 mm seismic displacement
Seismic conditions, PGA 0.41g (considers w_d factor of 0.5)	1.2	1.2	Governing depth and shear requirements; requires 10 m long pile and 225kN shear strength (unfactored)
Seismic Conditions, SLS PGA 0.16g	n/a	1.6	Satisfies SLS requirements

Note: * FOS analysed through wall alignment. Lower FoS below the wall alignment may be present.
** FOS < 1.0 where seismic displacement considered. Seismic displacement considered in general accordance with Bray & Travasarou (2007)[9]

5.7 WALLAP Analyses

The retaining wall structural members (concrete piles) have been designed using the proprietary software WALLAP (ver. 6.07) to determine the moment and shear demands for concrete reinforcement design, pile dimensions and verify the depths and spacings initially determined from stability analyses.

The following assumptions have been made in the WALLAP design:

- The analyses adopted the Strength Factor Method for factor of safety calculation, with minimum factors of safety of 1.5 and 1.1 for the prevailing and seismic conditions, respectively.
- WALLAP analyses adopt a simplified ground model considering fill materials behind the wall, and embedment into HW Greywacke. No cohesion has been applied to the fill materials, making the model conservative.

[9] Bray, J.D., Travasarou, T. (2007). Simplified Procedure for Estimating Earthquake-Induced Deviatoric Slope Displacements. Journal of Geotechnical and Geo-environmental Engineering. ASCE. pp 381-392.

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- Based on the SLIDE analyses, the design retained height is taken as approximately 3.5 m, with a downslope gradient of 37 degrees. In order to assess equivalent ground conditions as horizontal layers required by WALLAP, an additional 1.8 m of retained height is assumed based on the following formula: *tan(toe slope angle) x 4 x diameter of pile.* The diameter of the pile is taken as 600 mm. The design retained height is therefore 5.3 m, increased from 3.5 m.
- The wall supports the approx. 5 m wide carriageway. A 12 kPa traffic load is applied as a deadload.
- Moderately weathered Greywacke rock is observed in the road cutting upslope of the wall. This elevated rock profile is not considered to surcharge the wall.

A summary of the WALLAP analyses is provided below. WALLAP outputs are included as Appendix 3.

Table 4: Summary of WALLAP Analyses

Scenario	Pile Dia. (m)	Pile Spacing (m)	Pile Length (m)	FoS	Max. Unfactored Bending Moment (kNm/m)	Max. Unfactored Shear Force (kN/m)	Max. Pile Displacement (mm)
Static	0.6	1.0	10	2.1	119	48	20 – 25
Seismic				1.7	338	151	40 – 45

Based on the analyses, there is less than 50 mm horizontal displacement post ULS seismic event, corresponding to approximately 1% deflection of the wall. The assessed seismic displacement is unlikely to affect performance of the wall following a ULS earthquake event.

5.8 Reinforcement Design

The proprietary column reinforcement design software Gen-Col and in-house spreadsheets have been used to calculate steel reinforcement requirements for the reinforced concrete piles.

The piles shear capacity was calculated using equation 10-11 in NZS3101:2006[10]. Strength reduction factors of 0.85 and 0.75 were included for the calculation of bending moment and shear resistance, respectively.

Resultant reinforcement details are outlined in Table 5 below; reinforcement calculations are attached in Appendix 3.

[10] New Zealand Standard, NZS3101: Part 1: 2006. Concrete Structures Standard, Part 1 – The Design of Concrete Structures. Issued August 2008.

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Table 5: Summary of Proposed Pile Reinforcement

Pile Diameter	Pile Reinforcement	Bending Moment Resistance	Shear Resistance	Pile Compressive Strength
0.6 m	8HD25, HR 10 (150 mm c/c)	352.6 kNm	245 kN	40 MPa

5.9 Railing Design

The design of horizontal timber rails supporting the backfilled section of the wall takes into account lateral soil loads behind the wall and the pile spacing outlined in Section 5.7 above. The design assumes rough sawn SG8 H4 treated Radiata Pine with absolute dimensions of 50 mm by 150 mm rectangular timber rails. Timber with dimensions of less than this and tongue and groove timber are expressly excluded.

Calculations for the railing design are included in Appendix 3.

Given the use of formatube set reinforced concrete piles, we suggest the rail construction is formed by dynabolting a vertical 50 mm by 150 mm batten to the pile uprights following initial set (within two days of pouring), with the horizontal rails nailed to the batten with the railing completed progressively to allow progressive backfill of the wall. Details are provided in the design drawings (Appendix 2).

5.10 Drainage Measures

A perforated subsoil drain (minimum 110 mm diameter) shall be laid behind the lowest lagging board and shall be surrounded in free draining aggregate (DR5/20 or similar), with the drainage aggregate also placed up the back of the railed section of the wall to provide a drainage column. The outlet of the subsoil drain shall outlet via a solid draincoil pinned to the surface and outlet to the base of the gully within the vegetated areas below the wall.

The proposed pavement above the wall shall include a kerb and channel to divert surface water away from the wall. Specific design of this paving is outside the scope of this report.

6 Erosion Protection

The soils below the wall alignment are susceptible to ongoing erosion from surface water. To reduce the magnitude of ongoing erosion, protection measures such as 75 mm strataweb geocell (or engineer approved equivalent) could be adopted downslope of the wall. Backfill of the geocell should incorporate seeded topsoil and/or placed deep rooting vegetation such as flaxes, grasses or similar species that provide quick establishment.

Specific details are presented on the design drawings in Appendix 2. Product information is included in Appendix 4.

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7 Construction Considerations

Groundwater is not anticipated to be encountered during drilling of pile holes, and therefore dewatering or casing is not expected to be required.

All spoil is to be removed from site. Spoil should not be placed downslope of the proposed wall or above any unsupported slope faces.

The staged construction of the wall requires the concrete piles to provide support for the drill rig to facilitate drilling of the upslope piles. Concrete must be allowed to cure while railing and backfill works are completed prior to any additional surcharge from the drill rig. It is recommended that the concrete is allowed to cure for three days (from concrete pour) prior to any backfill works and eight days (from concrete pour) prior to surcharging from the drilling rig.

8 Safety in Design

In conducting our scope of works, we have considered and addressed Safety in Design (SiD) aspects considered relevant to our understanding of the proposed design and construction work. SiD must consider the construction, operation, maintenance and ultimate demolition phases of the relevant works.

It is noted that ENGEO is focused on design aspects, and whilst we have attempted to be comprehensive in our assessment, it is the contractor's responsibility to cover construction related risks in a more comprehensive manner (being the competent party in that respect).

There are potential construction stability issues associated with the construction of the proposed wall and construction risk must be accepted by the contractor, with precautions made to ensure the risk of additional instability is low. This includes an appropriate construction methodology such as progressive construction, railing and backfilling to allow appropriate location of plant and equipment with relation to the slope (no plant should be placed above the unsupported slope).

Wall construction includes construction of near vertical excavations of substantial heights. Such temporary excavations are considered a construction hazard. Any temporary trench or confined space that requires person entry, such as to facilitate installation of the timber rails, must be adequately benched or shored to be safe.

Until such time as the permanent fall protection barrier is installed, the work site shall be adequately fenced to prevent unauthorised entry, such as a temporary linkmesh fence, with the dimensions, post spacing and netting requirements in accordance with NZBC F5/AS1.

Works should be covered during periods of heavy or prolonged rainfall.

If, at any stage, a contractor does not consider that a design can be safely constructed, then ENGEO must be contacted immediately to discuss alternative designs and / or methods to avoid unnecessary risks to personnel.

Our SiD risk assessment is included on the design drawings in Appendix 2. This risk assessment must be communicated with all affected parties involved in the project and dealt with through specific on-site risk assessment plans.

9 Design Summary

Our producer statement is included as Appendix 1.

The construction drawings, which include the wall specification and safety in design register, are included within Appendix 2.

The design calculations are included as Appendix 3.

Strataweb geocell product information is included as Appendix 4.

Should site conditions change from those considered in preparation of this design, ENGEO should be contacted to review the applicability of this design and revise as required.

10 Limitations

i. We have prepared this report in accordance with the brief as provided. This report has been prepared for the use of our client, Hutt City Council, their professional advisers and the relevant Territorial Authorities in relation to the specified project brief described in this report. No liability is accepted for the use of any part of the report for any other purpose or by any other person or entity.

ii. The recommendations in this report are based on the ground conditions indicated from visual site assessments. Only a limited amount of information has been collected to meet the specific technical requirements of the client's brief and this report does not purport to completely describe all the site characteristics and properties. The nature and continuity of the ground has been inferred using experience and judgement and it should be appreciated that actual conditions could vary from the assumed model.

iii. Subsurface conditions relevant to construction works should be assessed by contractors who can make their own interpretation of the factual data provided. They should perform any additional tests as necessary for their own purposes.

iv. This Limitation should be read in conjunction with the Engineering NZ / ACENZ Standard Terms of Engagement.

v. This report is not to be reproduced either wholly or in part without our prior written permission.

We trust that this information meets your current requirements. Please do not hesitate to contact the undersigned on (04) 472 0820 if you require any further information.

Report prepared by

Devon Halligan

Geotechnical Engineer

Report reviewed by

Greg Snook CMEngNZ (PEngGeol)

Associate Engineering Geologist

Matt Packard CMEngNZ, CPEng

Senior Geotechnical Engineer

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APPENDIX 1:

Producer Statement – PS1 – Design

PRODUCER STATEMENT – PS1
DESIGN

BUILDING CODE CLAUSE(S): B1 **JOB NUMBER:** 21700.000.002
ISSUED BY: ENGEO Limited
(Engineering Design Firm)
TO: Hutt City Council
(Owner/Developer)
TO BE SUPPLIED TO: Hutt City Council
(Building Consent Authority)
IN RESPECT OF: Design of Reinforced Concrete Wall
(Description of Building Work)
AT: Howard Road Road Reserve, adjacent to 76 and 78 Howard Road, Point Howard
(Address, Town/City)
LEGAL DESCRIPTION: N/A ☑

We have been engaged by the owner/developer referred to above to provide *(Extent of Engagement)*:
Design of landslide remediation comprising reinforced concrete wall. Refer ENGEO report ref. 21700.000.002_02
in respect of the requirements of the Clause(s) of the Building Code specified above for Part only , as specified in the Schedule, of the proposed building work.

The design carried out by us has been prepared in accordance with:

- ☑ Compliance documents issued by the Ministry of Business, Innovation & Employment *(Verification method/acceptable solution)* B1/VM4, B2/AS1 and/or;
- ☑ Alternative solution as per the attached Schedule.

The proposed building work covered by this producer statement is described on the drawings specified in the Schedule, together with the specification, and other documents set out in the Schedule.

On behalf of the Engineering Design Firm, and subject to:

- Site verification of the following design assumptions: wall dimensions; soil conditions; drainage; backfill requirements.
- All proprietary products meeting their performance specification requirements;

I believe on reasonable grounds that:

- the building, if constructed in accordance with the drawings, specifications, and other documents provided or listed in the Schedule, will comply with the relevant provisions of the Building Code and that;
- the persons who have undertaken the design have the necessary competency to do so.

I recommend the CM 3 level of **construction monitoring**.

I, *(Name of Engineering Design Professional)* Matthew Packard , am:

- ☑ CPEng number 241901

and hold the following qualifications BSc, MEngSc, CMEngNZ, CPEng

The Engineering Design Firm holds a current policy of Professional Indemnity Insurance no less than $200,000
The Engineering Design Firm is a member of ACE New Zealand.

SIGNED BY *(Name of Engineering Design Professional)*: Matthew Packard
(Signature below):

ON BEHALF OF *(Engineering Design Firm)*: ENGEO Limited Date: 4/8/2023

Note: This statement has been prepared solely for the Building Consent Authority named above and shall not be relied upon by any other person or entity. Any liability in relation to this statement accrues to the Engineering Design Firm only. As a condition of reliance on this statement, the Building Consent Authority accepts that the total maximum amount of liability of any kind arising from this statement and all other statements provided to the Building Consent Authority in relation to this building work, whether in tort or otherwise, is limited to the sum of $200,000.

This form is to accompany **Form 2 of the Building (Forms) Regulations 2004** for the application of a Building Consent.

SCHEDULE to PS1

Please include an itemised list of all referenced documents, drawings, or other supporting materials in relation to this producer statement below:

ENGEO Design Report; referenced 21700.000.002_02

Appendices are included in the Design Report as follows:

Appendix 2: ENGEO Construction Drawings (Drawing 1 to Drawing 6, dated 04/082023)

Appendix 3: Design Calculations

Appendix 4: Strataweb Geocell Product Information

GUIDANCE ON USE OF PRODUCER STATEMENTS

Information on the use of Producer Statements and Construction Monitoring Guidelines can be found on the Engineering New Zealand website
https://www.engineeringnz.org/engineer-tools/engineering-documents/producer-statements/

Producer statements were first introduced with the Building Act 1991. The producer statements were developed by a combined task committee consisting of members of the New Zealand Institute of Architects (NZIA), Institution of Professional Engineers New Zealand (now Engineering New Zealand), Association of Consulting and Engineering New Zealand (ACE NZ) in consultation with the Building Officials Institute of New Zealand (BOINZ). The original suite of producer statements has been revised at the date of this form to ensure standard use within the industry.

The producer statement system is intended to provide Building Consent Authorities (BCAs) with part of the reasonable grounds necessary for the issue of a Building Consent or a Code Compliance Certificate, without necessarily having to duplicate review of design or construction monitoring undertaken by others.

PS1 DESIGN Intended for use by a suitably qualified independent engineering design professional in circumstances where the BCA accepts a producer statement for establishing reasonable grounds to issue a Building Consent;

PS2 DESIGN REVIEW Intended for use by a suitably qualified independent engineering design review professional where the BCA accepts an independent design professional's review as the basis for establishing reasonable grounds to issue a Building Consent;

PS3 CONSTRUCTION Forms commonly used as a certificate of completion of building work are Schedule 6 of NZS 3910:2013 or Schedules E1/E2 of NZIA's SCC 2011[2]

PS4 CONSTRUCTION REVIEW Intended for use by a suitably qualified independent engineering construction monitoring professional who either undertakes or supervises construction monitoring of the building works where the BCA requests a producer statement prior to issuing a Code Compliance Certificate.

This must be accompanied by a statement of completion of building work (Schedule 6).

The following guidelines are provided by ACE New Zealand and Engineering New Zealand to interpret the Producer Statement.

Competence of Engineering Professional
This statement is made by an engineering firm that has undertaken a contract of services for the services named, and is signed by a person authorised by that firm to verify the processes within the firm and competence of its personnel.

The person signing the Producer Statement on behalf of the engineering firm will have a professional qualification and proven current competence through registration on a national competence-based register such as a Chartered Professional Engineer (CPEng).

Membership of a professional body, such as Engineering New Zealand provides additional assurance of the designer's standing within the profession. If the engineering firm is a member of ACE New Zealand, this provides additional assurance about the standing of the firm.

Persons or firms meeting these criteria satisfy the term "suitably qualified independent engineering professional".

Professional Indemnity Insurance
As part of membership requirements, ACE New Zealand requires all member firms to hold Professional Indemnity Insurance to a minimum level.

The PI Insurance minimum stated on the front of this form reflects standard practice for the relationship between the BCA and the engineering firm.

Professional Services during Construction Phase
There are several levels of service that an engineering firm may provide during the construction phase of a project (CM1-CM5 for engineers[3]). The building Consent Authority is encouraged to require that the service to be provided by the engineering firm is appropriate for the project concerned.

Requirement to provide Producer Statement PS4
Building Consent Authorities should ensure that the applicant is aware of any requirement for producer statements for the construction phase of building work at the time the building consent is issued as no design professional should be expected to provide a producer statement unless such a requirement forms part of the Design Firm's engagement.

Refer Also:

1 Conditions of Contract for Building & Civil Engineering Construction NZS 3910: 2013
2 NZIA Standard Conditions of Contract SCC 2011
3 Guideline on the Briefing & Engagement for Consulting Engineering Services (ACE New Zealand/Engineering New Zealand 2004)
4 PN01 Guidelines on Producer Statements

www.acenz.org.nz
www.engineeringnz.org

APPENDIX 2:

Construction Drawings

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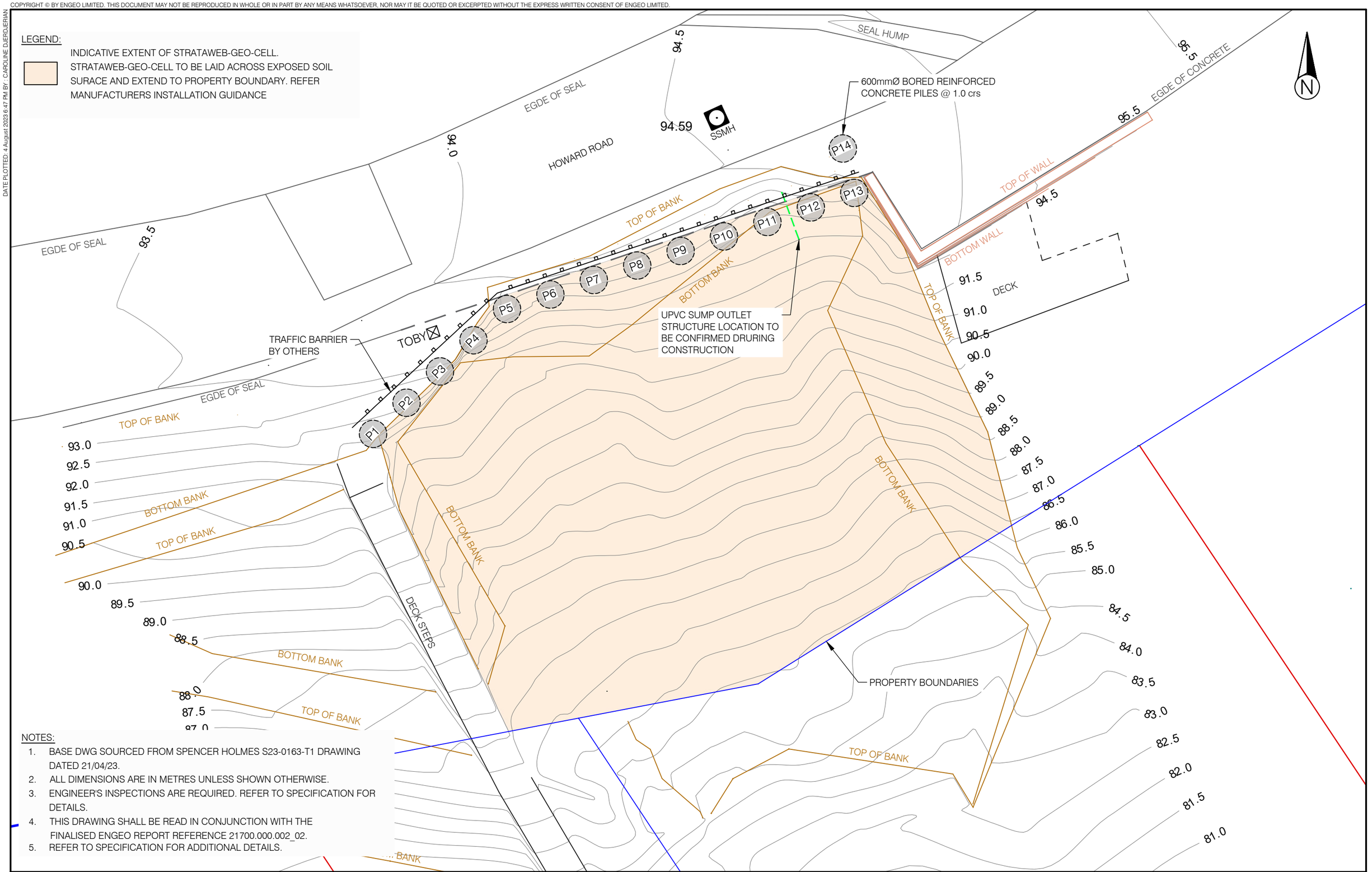
DATE PLOTTED: 4 August 2023 6:47 PM BY : CAROLINE DJERDJERIAN

LEGEND:

INDICATIVE EXTENT OF STRATAWEB-GEO-CELL. STRATAWEB-GEO-CELL TO BE LAID ACROSS EXPOSED SOIL SURACE AND EXTEND TO PROPERTY BOUNDARY. REFER MANUFACTURERS INSTALLATION GUIDANCE



NOTES:

1. BASE DWG SOURCED FROM SPENCER HOLMES S23-0163-T1 DRAWING DATED 21/04/23.
2. ALL DIMENSIONS ARE IN METRES UNLESS SHOWN OTHERWISE.
3. ENGINEER'S INSPECTIONS ARE REQUIRED. REFER TO SPECIFICATION FOR DETAILS.
4. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH THE FINALISED ENGEO REPORT REFERENCE 21700.000.002_02.
5. REFER TO SPECIFICATION FOR ADDITIONAL DETAILS.

Rev	Date	Description	Drwn	Chkd
A	8.23	For Construction	CD	MP

ENGEO

Wellington Office
Level 18, Grand Plimmer Tower, 2 - 6 Gilmer Tce
Wellington 6011
Tel: 04 472 0820
www.engeo.co.nz

Title: RETAINING WALL LAYOUT PLAN

Client: Hutt City Council

Project: Howard Road Slip Remediation

Designed: DH
Drawn: CD
Checked: MP
Date: 8.23

Drawing: 1
Size: A3

Proj No: 21700.000.002
Scale: 1:75
Rev: A

CAD File: Z:\Drafting\21001 to 22000\21700 - Howard Road Slip Remediation\21700 - HowardRoadSlipRemediation-723.dwg

ORIGINAL FIGURE PRINTED IN COLOUR

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DATE PLOTTED: 4 August 2023 6:42 PM BY : CAROLINE DJERDJERIAN

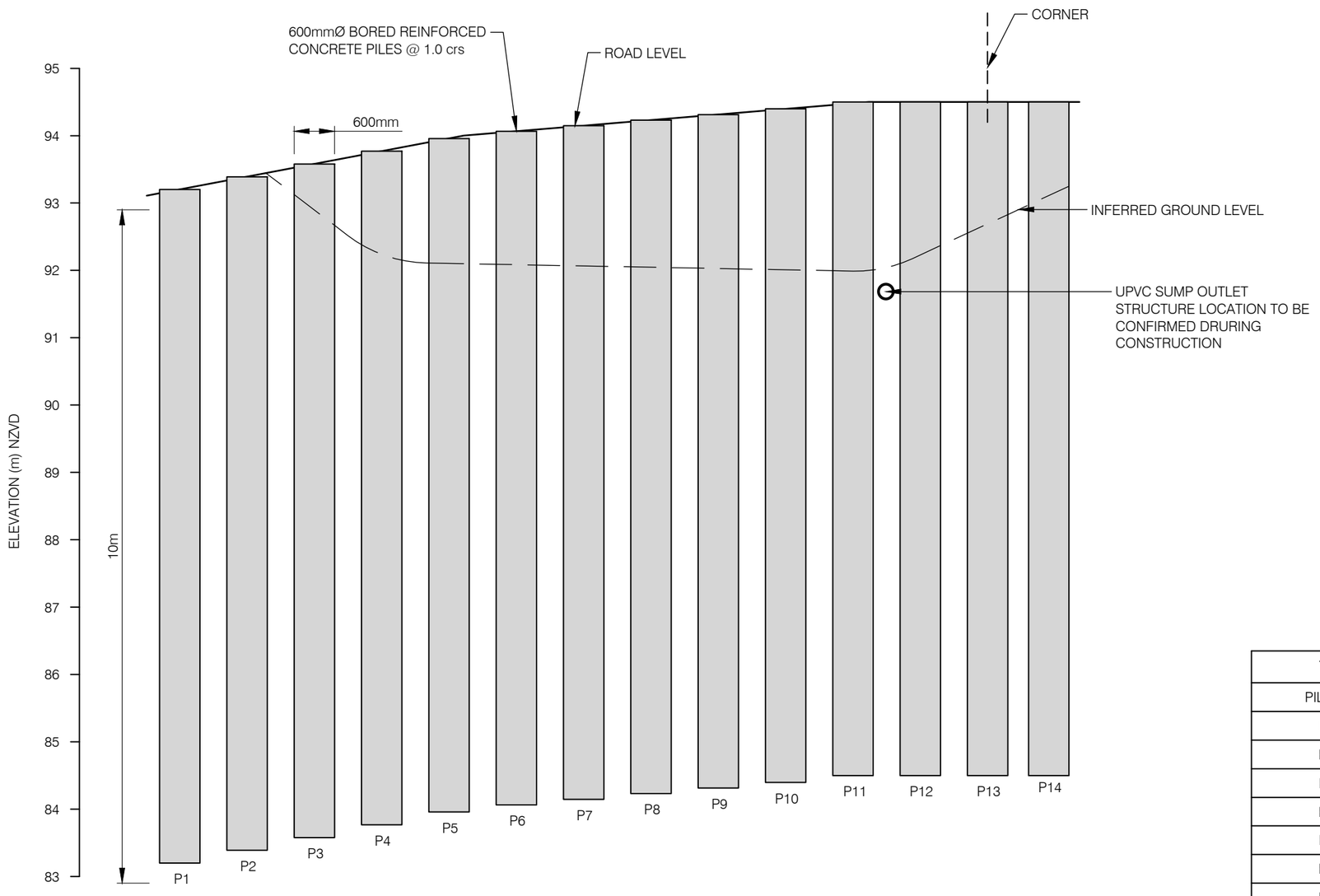

TABLE1: PILE TOP RL	
PILE ID	PILE TOP RL * (RLm)
P1	93.6m
P2	93.8m
P3	93.9m
P4	94.1m
P5	94.2m
P6	94.3m
P7	94.3m
P8	94.4m
P9	94.5m
P10	94.5m
P11	94.5m
P12	94.0m

* TO BE CONFIRMED DURING SETOUT

NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS SHOWN OTHERWISE.
2. ENGINEER'S INSPECTIONS ARE REQUIRED. REFER TO SPECIFICATION FOR DETAILS.
3. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH THE FINALISED ENGEO REPORT REFERENCE 21700.000.002_02.
4. REFER TO SPECIFICATION FOR ADDITIONAL DETAILS.

Rev	Date	Description	Drwn	Chkd
A	8.23	For Construction	CD	MP

ENGEO
Wellington Office
Level 18, Grand Plimmer Tower, 2 - 6 Gilmer Tce
Wellington 6011
Tel: 04 472 0820
www.engeo.co.nz

Title: RETAINING WALL ELEVATION

Client: Hutt City Council

Project: Howard Road Slip Remediation

Designed: DH
Drawn: CD
Checked: MP
Date: 8.23

Proj No: 21700.000.002

Scale: 1:75

Drawing: 2

Size: A3

Rev: A

CAD File: Z:\Drafting\21001 to 22000\21700 - Howard Road Slip Remediation\21700 - HowardRoadSlipRemediation-723.dwg

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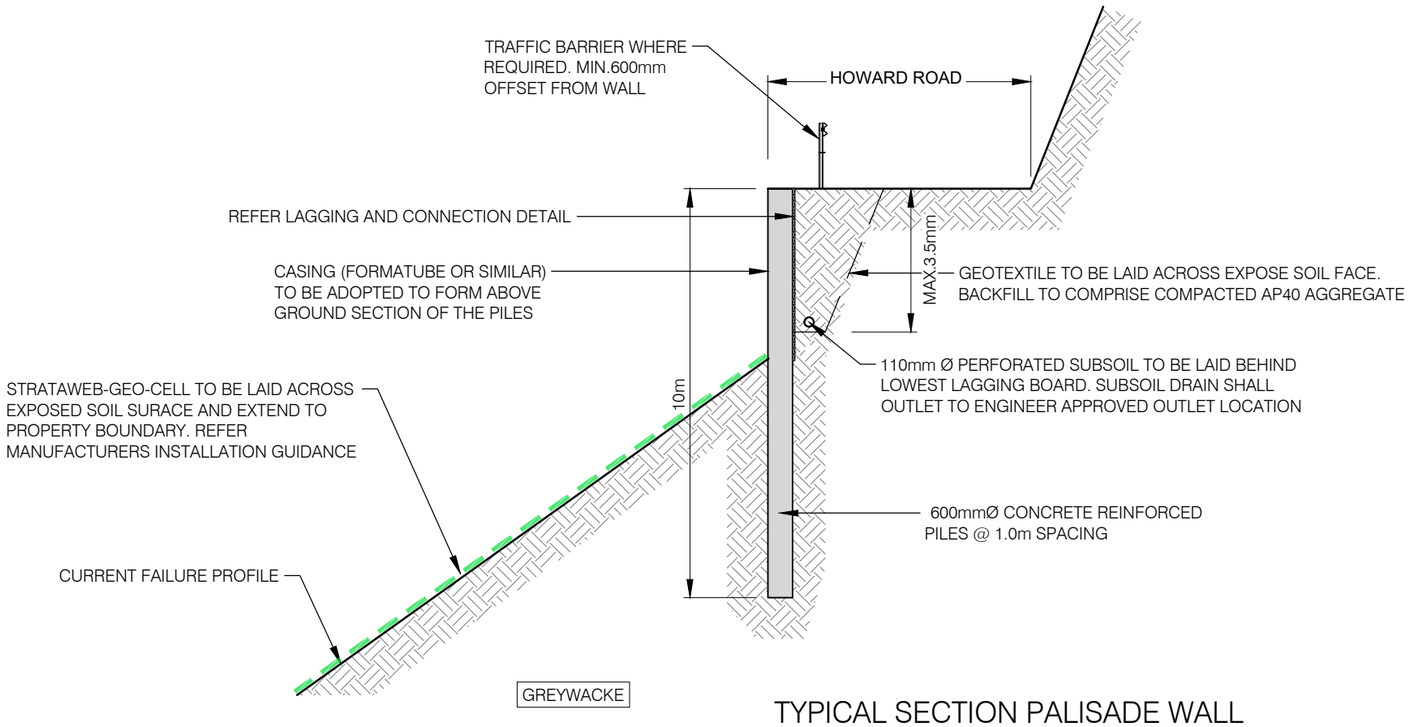
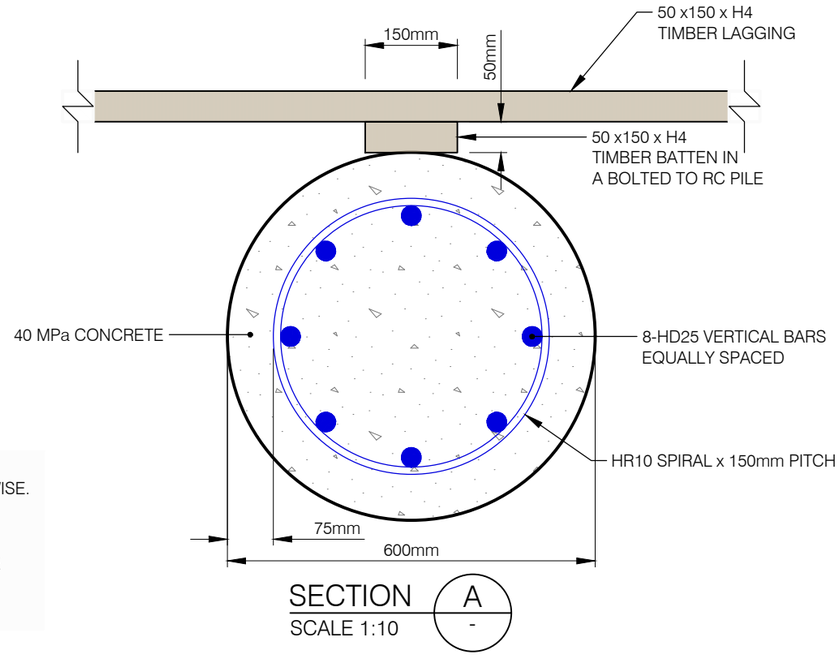
DATE PLOTTED: 4 August 2023 6:43 PM BY : CAROLINE.DJERDJERIAN



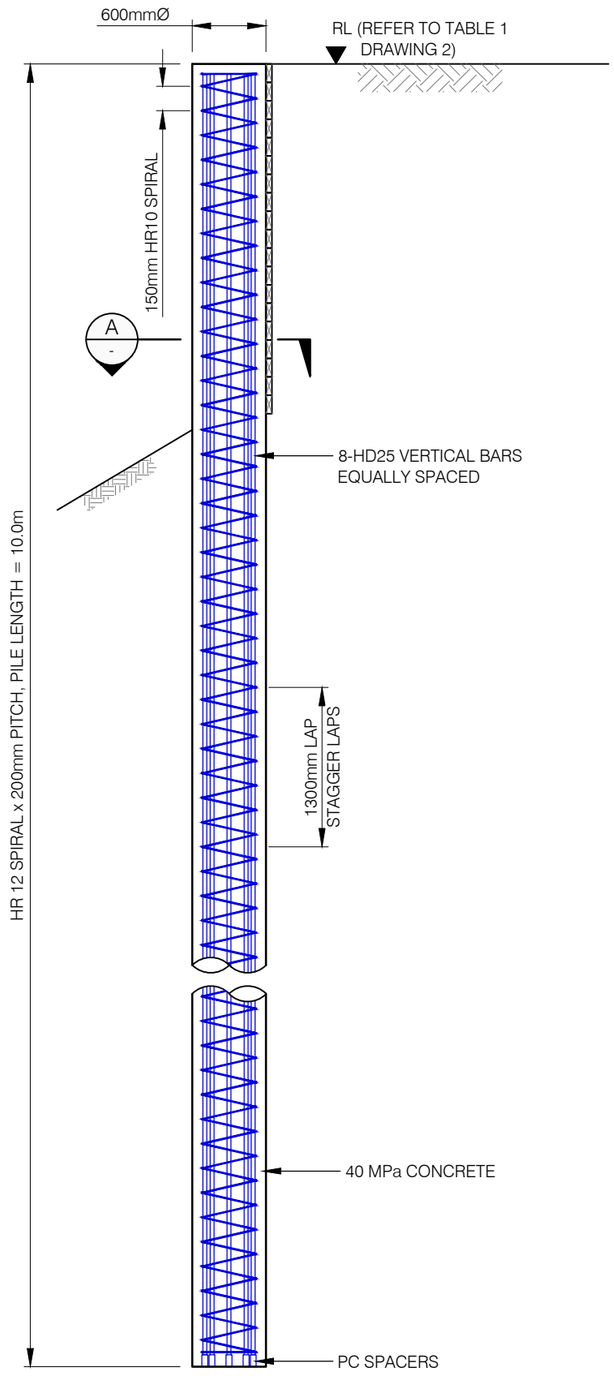
TYPICAL SECTION PALISADE WALL

SCALE: NTS



SECTION A-

SCALE 1:10



600mmØ PILE ELEVATION

SCALE 1:50

NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS SHOWN OTHERWISE.
2. ENGINEER'S INSPECTIONS ARE REQUIRED. REFER TO SPECIFICATION FOR DETAILS.
3. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH THE FINALISED ENGEO REPORT REFERENCE 21700.000.002_02.
4. REFER TO SPECIFICATION FOR ADDITIONAL DETAILS.

Rev	Date	Description	Drwn	Chkd
A	8.23	For Construction	CD	MP

ENGEO

Wellington Office
Level 18, Grand Plimmer Tower, 2 - 6 Gilmer Tce
Wellington 6011
Tel: 04 472 0820
www.engeo.co.nz

Title: REINFORCED CONCRETE WALL TYPICAL DETAILS

Client: Hutt City Council

Project: Howard Road Slip Remediation

Designed: DH
Drawn: CD
Checked: MP
Date: 8.23

Proj No: 21700.000.002
Scale: As shown

Drawing: 3
Size: A3
Rev: A

CAD File: Z:\Drafting\21001 to 22000\21700 - Howard Road Slip Remediation\21700 - HowardRoadSlipRemediation-723.dwg

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DATE PLOTTED: 4 August 2023 6:44 PM BY: CAROLINE DJERDJERIAN

1 GENERAL

1.1 SCOPE OF WORKS

THE WORKS DETAILED IN THIS SPECIFICATION INCLUDES THE SUPPLY OF ALL PLANT, MATERIALS AND LABOUR TO CONSTRUCT A BORED PILE RETAINING WALL. IT ALSO ENCOMPASSES THE NECESSARY EARTHWORKS TO ACHIEVE THE WALL CONSTRUCTION.

1.2 SERVICES AND UTILITIES

THE CONTRACTOR SHALL LOCATE ALL SERVICES AND UTILITIES PRIOR TO BREAKING GROUND.

1.3 SLOPE STABILITY

THE CONTRACTOR IS RESPONSIBLE FOR PROVIDING AND MAINTAINING STABLE SLOPES ABOVE AND BELOW THE WALL DURING CONSTRUCTION.

2 MATERIALS

2.1 EROSION PROTECTION MATTING

SHALL BE MACMAT R-6822G0 OR AN APPROVED EQUIVALENT INSTALLED IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATIONS. MACMAT R SHALL BE LAID ON THE SLOPE SUCH THAT IF ANY ROLL ARE SHINGLED; THE UPPER ROLL IS BETWEEN THE LOWER ROLL AND THE SLOPE, TO PREVENT CATCHMENT POCKETS.

2.2 TOPSOIL

SHALL BE SITE WON, FREE OF STONES, ROCK OR ROOTLETS/TREES BRANCHES GREATER THAN 5 mm THICK.

2.3 CONCRETE PILES

ALL CONCRETE SHALL BE SPECIAL GRADE AS DEFINED IN NZS 3109 FROM AN APPROVED READY MIX PLANT. THE MAXIMUM AGGREGATE SIZE SHALL BE 20mm UNLESS SPECIFIED OTHERWISE. CALCIUM CHLORIDE HARDENER SHALL NOT BE USED. CONCRETE SHALL HAVE THE FOLLOWING STRENGTHS AT 28 DAYS:

- BLINDING CONCRETE 10 MPa
- BORED PILES 40 MPa
- ALL OTHER CONCRETE NOT SPECIFICALLY MENTIONED 40 MPa

MINIMUM COVER SHALL BE AS NOTED ON THE DRAWINGS OR OTHERWISE AS SPECIFIED BELOW. IN ANY CASE THE TOLERANCE SPECIFIED IN NZS 3109 SHALL APPLY. IN PARTICULAR THERE SHALL BE ZERO TOLERANCE ON REDUCTION OF COVER.

- SURFACE OF MEMBER CAST AGAINST GROUND (E.G. PILES) 75mm
- SURFACE OF MEMBER IN CONTACT WITH GROUND (NOT CAST AGAINST GROUND (E.G. CAPPING BEAM) 50mm
- SURFACE OF MEMBER EXPOSED TO ABOVE-GROUND EXTERIOR ENVIRONMENT (E.G. CAPPING BEAM) 50mm

2.4 REINFORCEMENT

GRADE 300 STEEL BARS SHALL COMPLY WITH AS/NZS 3679.1:GRADE 300 OR AS/NZS 4671 GRADE 300E. PLAIN ROUND BARS ARE SHOWN BY THE SYMBOL "R" AND DEFORMED BARS ARE SHOWN BY THE SYMBOL "D", BOTH FOLLOWED BY THE DIAMETER IN MILLIMETRES.

2.5 WIRE TIES

SHALL BE ANNEALED IRON WIRE NOT SMALLER THAN 1.25MM DIAMETER OR AN APPROVED CLIPS.

2.6 SUBSOIL DRAIN

SHALL BE 110mm HIGHWAY GRADE NEXUSFLO TWIN WALLED SMOOTH BORE PE DRAINAGE PIPE (PUNCHED).

2.7 DRAINAGE FILL

DRAINAGE METAL SURROUNDING THE SUBSOIL DRAIN SHALL BE DR25/5 OR SIMILAR "GAP GRADED" DRAINAGE AGGREGATE IT SHALL BE FREE OF FINES AND VEGETATIVE MATTER.

2.8 GEOTEXTILE

SHALL BE NON-WOVEN GEOTEXTILE WITH MINIMUM STRENGTH CLASS 'C' AND MINIMUM FILTRATION CLASS '2' AS PER TNZ F/7:2003.

2.9 STORMWATER INSPECTION CHAMBER

SHALL BE A PVC INSPECTION CHAMBER FLAT CHANNEL OR YARD SUMP CONNECTED TO SN8 PVC PIPEWORK TO OUTLET.

2.10 HARDFILL

SHALL BE TNZ M/4 AP40 COMPACTED TO AT LEAST 95% MDD.

3 TYPICAL CONSTRUCTION SEQUENCE

THIS CONSTRUCTION SEQUENCE IS INTENDED TO PROVIDE GUIDANCE FOR THE CONTRACTOR'S METHODOLOGY. IT DOES NOT RELIEVE THE CONTRACTOR FROM THEIR RESPONSIBILITY TO DEVELOP THEIR OWN SPECIFIC CONSTRUCTION SEQUENCE FOR THE WORKS.

3.1 LOCATE ALL EXISTING SERVICES AND UTILITIES IN THE VICINITY OF THE WORKS.

3.2 CONFIRM DRILLING PLATFORM LOCATION DOWNSLOPE / DOWN ROAD GRADIENT OF PILE. DRILLING RIG SHOULD NOT BE LOCATED IMMEDIATLY ABOVE UNSUPPORTED SLOPES.

3.3 MARK OUT PILE LOCATIONS.

3.4 PILES TO BE COMPLETED PROGRESSIVELY.

3.5 BORE OUT PILE HOLES AT SPACING SPECIFIED IN DRAWINGS.

3.6 ASSEMBLE PILE CAGES, LIFT INTO PLACE AND CONCRETE CAGES INTO HOLES

3.7 FOLLOWING 1 DAYS CURING, INSTALL BATTEN AND RAILING.

3.8 FOLLOWING 3 DAYS CURING, PLACE GEOTEXTILE WRAP, DRAINAGE AND BACKFILL MATERIALS TO FINISHED LEVELS

3.9 CONNECT ALL DRAINS T SECTION TO INSPECTION CHAMBER AND OUTLET LOCATION DOWNSLOPE.

3.10 CLEAN UP SITE AND DEMOBILISE.

4 EARTHWORKS

4.1 GENERAL

EARTHWORKS SHALL BE CARRIED OUT IN ACCORDANCE WITH TNZ F/1:1997 SPECIFICATION FOR EARTHWORKS CONSTRUCTION.

4.2 SITE CLEARANCE

CLEAR TOPSOIL AND VEGETATION FROM THE SITE EXTENTS AND STOCKPILE FOR REUSE.

4.3 EXCAVATION

GENERAL EXCAVATION SHALL BE UNDERTAKEN TO THE EXTENTS DETAILED ON THE DRAWINGS. EXCAVATE TO FORM A SAFE AND STABLE BATTER NO STEEPER THAN 30 DEGREES. USE PROCEDURES WHICH PREVENT OVER-EXCAVATION, PREVENT GAIN OF SOIL MOISTURE TO THE SLOPE AND PREVENT GROUND LOSS/INSTABILITY OF THE SLOPE.

ALL COSTS ASSOCIATE WITH CLEARING, REMOVAL, CARTING AND DISPOSAL OF VEGETATION SHALL BE BORNE BY THE CONTRACTOR.

5 BORED PILES

5.1 SETTING OUT

THE POSITION AND SPACING OF THE BORED PILES SHALL BE AS SHOWN IN THE DRAWINGS.

5.2 AUGERING

AUGER OUT ALL PILE HOLES IN THE LOCATIONS SHOWN IN THE DRAWINGS. ALL SPOIL FROM THE EXCAVATION SHALL BE REMOVED FROM SITE AND NO SPOIL SHALL REMAIN WITHIN 2m OF ANY HOLE. THE CONTRACTOR SHALL PROVIDE A SUITABLE MEANS (COVER OR SUCH) TO PREVENT ANYONE/THING FALLING DOWN THE HOLE FOR SAFETY CONSIDERATIONS.

5.3 DRILLERS LOG

THE CONTRACTOR SHALL LOG THE SOIL DURING DRILLING TO BE PROVIDED TO THE GEOTECHNICAL ENGINEER.

5.4 CASING

CASING IS NOT ENVISIONED TO BE REQUIRED TO KEEP THE HOLE OPEN WHEN BORING.

IF THE HOLE IS UNSTABLE PRIOR TO STANDING THE CAGE, THE CONTRACTOR MAY UTILISE A TEMPORARY STEEL LINER TO CASE THE PILE HOLE DURING EXCAVATION. PERMANENT CASING IS NOT PERMITTED. HOLE STABILITY REMAINS THE CONTRACTOR'S RESPONSIBILITY.

5.5 CLEAN OUT AND INSPECTION

THE EXCAVATION SHALL BE CLEANED OUT TO REMOVED ALL DISTURBED GRAVEL, SOIL, ACCUMULATED SAND AND EXTRANEOUS MATERIAL. THE BASE OF THE EXCAVATION SHALL BE CLEANED SO THAT THE DEPTH OF LOOSE MATERIAL OR MUD IN THE EXCAVATION DOES NOT EXCEED 10 mm.

5.6 PILE CAGE INSTALLATION

INSTALLATION OF PILE CAGES AND PLACEMENT OF CONCRETE SHALL PROCEED AS SOON AS IT IS PRACTICABLE AFTER THE ENGINEER HAS ACCEPTED THE EXCAVATION.

THE PILE CAGES SHALL BE INSTALLED IN PRE-BORED HOLES TO THE REQUIRED DEPTH AND ALIGNMENT INDICATED IN THE DRAWINGS. IF INSUFFICIENT EMBEDMENT IS ACHIEVED THEN REFER TO THE ENGINEER FOR RESOLUTION. THE CONTRACTOR SHALL DETERMINE THE REQUIRED DRILLING AND INSTALLATION METHODS.

5.7 HANDLING AND STORAGE

ALL OPERATIONS SUCH AS HANDLING, TRANSPORTING, LIFTING AND PITCHING OF THE CAGES SHALL BE CARRIED OUT IN SUCH A MANNER TO PREVENT DAMAGE TO THEM.

CAGES SHALL BE STACKED ON SUITABLE SUPPORTS ON FIRM GROUND, IN A MANNER WHICH WILL ELIMINATE EXCESSIVE HANDLING STRESSES OR OTHER DAMAGE. DAMAGE TO THE CAGES, SUCH AS ABRASION, CUTS, NICKS, AND NATURAL DEFECTS SHALL BE CAUSE FOR REJECTION.

5.8 CONCRETE PLACEMENT

CONCRETE SHALL BE HANDLED AND PLACED IN ACCORDANCE WITH NZS 3109. ONCE CONCRETING HAS COMMENCED FOR A PILE, IT SHALL PROCEED AS A CONTINUOUS OPERATION UNTIL THE CYLINDER IS COMPLETED. AS THE CONCRETE IS PLACED, IT SHALL BE HANDLED AS TO ENSURE THAT IS PASSES THROUGH THE REINFORCEMENT CAGE TO COMPLETELY FILL THE PILE HOLE WITHOUT VOIDS. THE CONCRETE LEVEL AT THE TOP OF THE PILE SHALL BE WITHIN 15 mm OF THE LEVEL INDICATED IN THE DRAWINGS.

Rev	Date	Description	Drwn	Chkd
A	8.23	For Construction	CD	MP

ENGEO
Wellington Office
Level 18, Grand Plimmer Tower, 2 - 6 Gilmer Tce
Wellington 6011
Tel: 04 472 0820
www.engeo.co.nz

Title: SPECIFICATION NOTES 1

Client: Hutt City Council

Project: Howard Road Slip Remediation

Designed: DH
Drawn: CD
Checked: MP
Date: 8.23
Scale: -

Drawing: 4
Size: A3
Rev: A

Proj No: 21700.000.002

CAD File: Z:\Drafting\21001 to 22000\21700 - Howard Road Slip Remediation\21700 - HowardRoadSlipRemediation-723.dwg

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DATE PLOTTED: 4 August 2023 6:44 PM BY: CAROLINE DJERDJERIAN

6 REINFORCEMENT

6.1 GENERAL

REINFORCEMENT SHALL BE CLEAN AT THE TIME OF PLACING CONCRETE, FREE OF ALL LOOSE MILL SCALE, LOOSE RUST AND ANY OTHER CONTAMINATION THAT MAY REDUCE BONDING CAPACITY.

6.2 PLACEMENT

HANDLING, FABRICATION, PLACING AND FIXING OF REINFORCING SHALL COMPLY WITH SECTION 3 OF NZS 3109:1997.

ALL STARTERS SHALL PROJECT THE MINIMUM DISTANCE PRESCRIBED FOR ALL LENGTHS UNLESS DETAILED OTHERWISE. ALL STARTERS AND OTHER REINFORCING PROTRUDING FROM A CONCRETE POUR SHALL BE SECURELY BRACED TO PREVENT MOVEMENT IN THE WET CONCRETE. STARTERS ARE NOT TO BE PLACED INTO CONCRETE AFTER IT HAS BEEN POURED. THE CONTRACTOR SHALL STRAIGHTEN AND CLEAN ALL STARTERS BENT DURING CONCRETING BEFORE PLACING STEEL FOR SUBSEQUENT POURING.

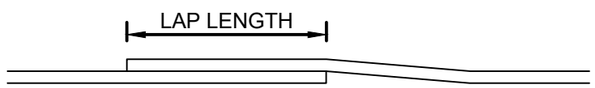
6.3 SPLICING OF REINFORCING STEEL

ONLY CARRY OUT SPLICING OF REINFORCEMENT, WHETHER BY LAPPING OR MECHANICAL SPLICE AS SHOWN ON THE DRAWINGS, OR AS SPECIFICALLY APPROVED BY THE ENGINEER, EXCEPT AS NOTED BELOW.

SPLICES IN ADJACENT BARS SHALL BE STAGGERED BY AT LEAST 600mm UNLESS SHOWN OTHERWISE IN THE DRAWINGS. LAP LENGTHS FOR DEFORMED BARS WHERE NOT SHOWN IN THE DRAWINGS SHALL COMPLY WITH THE FOLLOWING TABLE (TO NZS3101) WHERE SPACING OF ADJACENT BARS ARE EQUAL TO OR GREATER THAN 2.5 TIMES THE BAR DIAMETER.

SPLICING SHALL NOT OCCUR OVER A CONSTRUCTION, EXPANSION OR SHRINKAGE CRACK JOINT. EXCEPT WHERE SHOWN, NO LAPPING OF RODS WILL BE PERMITTED WITHOUT THE APPROVAL OF THE ENGINEER. RODS OR KINKS OR BENDS NOT SHOWN IN THE DRAWINGS SHALL NOT BE USED.

MINIMUM LAP LENGTHS		Bar Diameter (mm)				
		10	12	16	20	25
Concrete Strength	30 MPa	600	720	950	1190	1490
Steel Grade	500 MPa					

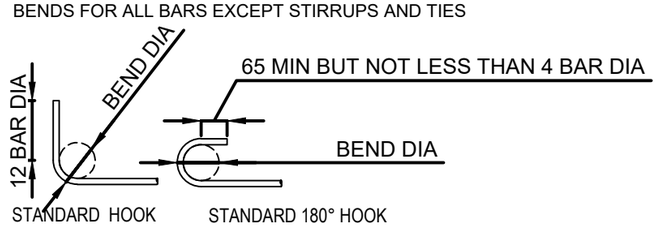


ALL HOOKS AND STIRRUPS AND TIES MUST FIT CLOSELY AROUND THE MAIN BARS UNLESS NOTED OTHERWISE. CRANKED LAPS SHOULD BE AS SHOWN BELOW:

6.4 BENDING OF REINFORCEMENT

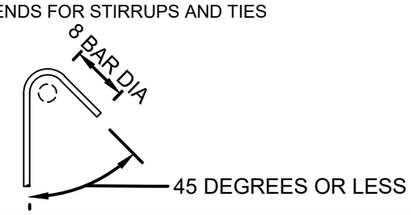
BENDING OF REINFORCEMENT SHALL NOT OCCUR ONSITE WITHOUT THE ENGINEERS SPECIFIC APPROVAL.

A) BENDS FOR ALL BARS EXCEPT STIRRUPS AND TIES



Steel Grade	Bar Diameter	Minimum Bend Diameter
Grade 500 for concrete strength less than 40 MPa	6 to 20 25 to 40	8 bar diameters 10 bar diameters

B) BENDS FOR STIRRUPS AND TIES



Steel Grade	Bar Diameter	Minimum Bend Diameter	
		Plain Bars	Deformed Bars
Grade 300/500	6 to 20	2 BAR DIA	4 BAR DIA
Grade 300/500	25 to 32	3 BAR DIA	6 BAR DIA

DO NOT BEND BARS PARTIALLY EMBEDDED IN CONCRETE AND DO NOT RE-BEND UNLESS SHOWN IN THE DRAWINGS OR SPECIFICALLY APPROVED BY THE ENGINEER

6.5 PILE CAGE REINFORCEMENT

THE SPIRAL SHALL BE TIED WITH TIE WIRE TO THE MAIN REINFORCEMENT IN ACCORDANCE WITH NZS 3109. NO LAP SPLICES IN THE MAIN LONGITUDINAL BARS ARE PERMITTED WITHIN THE UPPER 7 m OF THE PILE. BELOW THIS LEVEL, STAGGERED LAP SPLICES ARE PERMITTED.

AFTER ASSEMBLY, EACH REINFORCEMENT CAGE SHOULD BE A STABLE UNIT WHICH CAN BE HANDLED WITHOUT UNDUE DISTORTION AND WHICH WILL RETAIN ITS SHAPE DURING CONCRETING. ANY TEMPORARY BRACING NEEDED TO FACILITATE HANDLING AND PLACING OF CAGES SHALL BE PROVIDED BY THE CONTRACTOR AND SHALL BE LOCATED SO AS TO NOT INTERFERE WITH THE SATISFACTORY PLACEMENT OF CONCRETE.

6.6 WELDING

THE SPIRAL AND HOOPS SHALL BE SINGLE FLARE LAP WELDED AT ALL SPLICES IN ACCORDANCE WITH AS/NZS 1554.3. NO TACK WELDING SHALL BE USED.

6.7 CAPPING BEAM, WALER BEAM AND SHOTCRETE REINFORCEMENT

REINFORCEMENT SHALL BE SUPPORTED WITH SPACERS AND CHAIRS, PURPOSE MADE FROM MOLDED PVC AND APPROVED BY THE ENGINEER.

ALL REINFORCEMENT IS TO BE SECURED ADEQUATELY WITH TIE WIRE AND PLACED/POSITIONED ACCURATELY. REINFORCEMENT IS TO BE ADEQUATELY SUPPORTED TO PREVENT DISPLACEMENT DURING CONCRETE PLACEMENT.

TIE WIRE IS TO BE BENT BACK WELL CLEAR OF FORMWORK AND EXPOSED SURFACES.

6.8 COVER

SHALL BE IN ACCORDANCE WITH NZS 3101; 75 mm AGAINST THE GROUND AND 50 mm AGAINST FORMWORK.

7 TOLERANCE

7.1 THE ENGINEER SHALL BE NOTIFIED OF ANY DISCREPANCIES IN THE DIMENSIONS OF DRAWINGS.

7.2 PILE HOLE DEPTH: +0.5m, -0.0m.

7.3 PILES TRANSVERSE POSITION LOCATION: +0mm (I.E PILE IS NOT ALLOWED TO BE CLOSER TO THE PROPOSED LODGE BUILDING), -50mm (I.E INTO THE SLOPE),

7.4 PILES LONGITUDINAL POSITION LOCATION: ±50mm (IN LINE WITH THE WALL)

7.5 PILE VERTICALITY: EQUAL TO OR BETTER THAN 1 IN 125 OF THE PILE LENGTH.

7.6 REINFORCEMENT COVER: +10mm, -0mm

7.7 CONCRETE TOLERANCES SPECIFIED IN NZS 3109 SHALL APPLY EXCEPT WHERE OVERRIDDEN BY REQUIREMENTS SHOWN IN THIS SPECIFICATION.

8 CONTRACTORS QA REQUIREMENTS

8.1 THE CONTRACTOR SHALL PREPARE AND SUBMIT A CONSTRUCTION METHODOLOGY TO THE ENGINEER FOR COMMENT PRIOR TO THE COMMENCEMENT OF WORKS.

8.2 PREPARE AND SUBMIT TO THE ENGINEER A DRILLER'S RECORD FOR EACH PILE LOCATION RECORDING:

- HOLE DIAMETER;
- UNUSUAL DRILLING/DRIVING CONDITIONS;
- SOIL STRATIGRAPHY;
- GROUNDWATER LEVEL;
- DRILLING/DRIVING METHOD; AND,
- OTHER USEFUL DATA.

8.3 SUPPLY CONCRETE DISPATCH DOCKETS CLEARLY IDENTIFYING THE MIX DESIGN REFERENCE NUMBER, THE TIME OF BATCHING, THE TIME OF DEPARTURE FROM THE PLANT AND TARGET SLUMP FOR ALL CONCRETE RECEIVED ONSITE.

9 INSPECTION AND TEST PLAN

THE FOLLOWING SCHEDULE DEFINES HOLD POINTS WHEN WORK COVERED BY THE SPECIFICATION SHALL NOT PROCEED UNTIL THE ENGINEER HAS BEEN GIVEN THE OPPORTUNITY TO INSPECT OR REVIEW THE SPECIFIED INFORMATION.

- CONFIRM EXTENT OF SITE WORKS WITH THE ENGINEER.
- INSPECT FIRST CUT AND BATTER SLOPE ONCE DRILLERS PLATFORM IS ESTABLISHED.
- INSPECT BORED PILE HOLES TO CONFIRM CORRECT EMBEDMENT ACHIEVED AND BASE OF HOLE IS FREE OF LOOSE SPOIL. PREPOUR INSPECTION OF PILE CAGES PRIOR PLACING IN PILE HOLES.
- REVIEW OF DRILLERS LOGS/DOCUMENTATION.
- INSPECTION OF DRAINAGE INSTALLATION BETWEEN PILES.
- FINAL INSPECTION OF COMPLETED WORKS.

Rev	Date	Description	Drwn	Chkd
A	8.23	For Construction	CD	MP

ENGEO
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Title: SPECIFICATION NOTES 2

Client: Hutt City Council

Project: Howard Road Slip Remediation

Designed: DH
Drawn: CD
Checked: MP
Date: 8.23

Proj No: 21700.000.002

Scale: -

Drawing: 5

Size: A3

Rev: A

CAD File: Z:\Drafting\21001 to 22000\21700 - Howard Road Slip Remediation\21700 - HowardRoadSlipRemediation-723.dwg

ORIGINAL FIGURE PRINTED IN COLOUR

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DATE PLOTTED: 4 August 2023 6:44 PM BY: CAROLINE DJERDJERIAN

#	Design Stage (Lifecycle)	"Hazards"	"Consequence"	Existing Control Measure	Initial Risk Rating (IRR)			"Potential Control Measures "	Responsibility		When	Decision /Status	Residual Risk Rating (RRR)			Comments
					Likeli.	Consq.	Rating	Role	Name				Likeli.	Consq.	Rating	
1	Install/Supply	Falling from height	Injury to construction staff while constructing or public once wall constructed	None	3 – Possible	C – Severe	Moderate	Temporary barrier fence noted as required in design drawings, wall facing type to consider avoidance of public climbing, permanent fencing to be considered to prevent fall access	Contractor		Before construction starts	To be incorporated into the ENGEO drawings	3 – Possible	B – Major	Low	
2	Install/Supply	Striking underground services	Injury to construction staff if live services are struck	None	4 – Likely	C – Severe	Moderate	All sites cleared for services prior to site investigations and construction requiring digging or boring into the ground. Existing services marked and Setout to occur from these services.	Designer/Contractor		Detailed design	To be incorporated into the ENGEO drawings	4 – Likely	B – Major	Low	
3	Install/Supply	Moving Machinery	Lifting and swing area of machinery may cause injury to construction staff	None	4 – Likely	C – Severe	Moderate	Separate moving machinery from light vehicles and person movements with fencing and/or safe distances from exposed construction staff operations. Appropriate PPE when handling formatubes, training on the use of ramset tools for railing activities.	Contractor		Before construction starts	To be incorporated into the ENGEO drawings	4 – Likely	A – Minor	Low	
4	Install/Supply	Surface runoff and elevated/perched groundwater causing instability	Prolonged heavy rainfall causing collapse of pile holes and instability of slope or unstable subgrade conditions.	None	4 – Likely	C – Severe	Moderate	Review surface conditions and groundwater levels where appropriate following heavy rainfall prior to further excavation of pile holes and cut batters for walls. Geotechnical engineer to observe stability and/or survey monitoring required.	Contractor		During construction	To be included on SSSP	3 – Possible	C – Severe	Moderate	
5	Install/Supply	Traffic Management	Vehicles entering construction area causing damage and/or injury to public	Temporary fencing and cones	3 – Possible	C – Severe	Moderate	Maintain existing traffic management and supplement with traffic management plan and STMS services during works to control traffic and speed	Contractor		Before construction starts and during construction	To be included on SSSP	3 – Possible	C – Severe	Moderate	
6	Install/Supply	Public site access	Injury to public from entering site	Temporary fencing and cones	3 – Possible	C – Severe	Moderate	Maintain existing traffic management and supplement with traffic management plan and STMS services during works. Site to be fenced and secured when personnel not onsite.	Contractor		Before construction starts and during construction	To be included on SSSP	3 – Possible	C – Severe	Moderate	
7	Install/Supply	Working at edges of excavations (including pile holes)	Injury to construction staff and/or public by falling into excavations	None	4 – Likely	C – Severe	Moderate	"Construct retaining wall using staged construction methodology. Progressive installation of piles, lagging and backfill from west (down road) to east (up road). Assume 3 piles per installation run. Site to be made safe if excavations are to be left open and public can access, excavations to be filled or securely covered on same day of excavations, safe distances from excavations maintained and demarked with boundary fencing. "	Contractor		Before construction starts and during construction	To be incorporated in ENGEO report and SSSP	4 – Likely	A – Minor	Low	
8	Install/Supply	Excavation collapse	Serious injury or fatality due to crushing of personnel located between slope and retaining wall	None	3 – Possible	D – Critical	Significant	Construct retaining wall using staged construction methodology. Progressive installation of piles, lagging and backfill from west (down road) to east (up road). Assume 3 piles per installation run. Any variance to be discussed and approved by geotechnical engineer. Construction of timber railing undertaken from front of piles on safe work bench to avoid personnel situated between railing and unsupported berm.	Contractor		During construction	To be incorporated in ENGEO report and SSSP	3 – Possible	B – Major	Low	
9	Install/Supply	Spoil during temporary works	Damage to property downslope from excess spoil during installation, including fouling of waterways and/or injury to public	None	3 – Possible	C – Severe	Moderate	Construction of catchfence and erosion and sediment controls below works area prior to construction. All spoil to be removed from site, and not to be placed across or above any sloping areas. Regular maintenance of controls during construction to clear any debris.	Contractor		Before construction starts and during construction	To be included on SSSP	3 – Possible	B – Major	Low	
10	Install/Supply	Installation of geocell works / planting	Injury to construction staff during installation of geocell and/or planting below wall using rope access methods	None	3 – Possible	C – Severe	Moderate	Appropriately qualified contractors to undertake works. Risk assessment to be undertaken prior to works starting by qualified contractors.	Contractor		During construction	To be included on SSSP	3 – Possible	C – Severe	Moderate	
11	Maintain	Retaining wall failure	Works above or below wall exceeding specified loading conditions, wall drainage blockage	None	3 – Possible	C – Severe	Moderate	Appropriate construction and permanent loading conditions allowed for in the design. Design of adequate permanent drainage measures and outlets. Assess impact of blocked drainage and surcharge overloading potentials	Designer		Detailed Design	To be incorporated into the ENGEO drawings and included in SSSP	3 – Possible	B – Major	Low	
12	Install/Supply	Falling objects from above	Injury to construction staff or persons under the proposed wall location.	None	3 – Possible	C – Severe	Moderate	Use of hard hats worn at all times during construction. Use of spotter where lifting exercises conducted. Maintaining clearance zones during lifting exercises.	Contractor		Detailed Design	To be incorporated into the ENGEO drawings and included in SSSP	3 – Possible	B – Major	Low	

Rev	Date	Description	Drwn	Chkd
A	8.23	For Construction	CD	MP

ENGEO
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Wellington 6011
Tel: 04 472 0820
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Title: SAFETY IN DESIGN REGISTER

Client: Hutt City Council
Project: Howard Road Slip Remediation
Designed: DH
Drawn: CD
Checked: MP
Date: 8.23
Proj No: 21700.000.002
Scale: -
Drawing: 6
Size: A3
Rev: A

CAD File: Z:\Drafting\21001 to 22000\21700 - Howard Road Slip Remediation\21700 - HowardRoadSlipRemediation-723.dwg
ORIGINAL FIGURE PRINTED IN COLOUR

APPENDIX 3:

Selected Analyses Outputs

This spreadsheet calculates the design horizontal acceleration for retaining wall and slope stability analysis, according to the November 2021 update of the NZGS / MBIE Guidelines. This template approved for use by Alan Wightman, August 2022.

Town/City	Wellington	The return period depends on the design life of the structure, and the importance level. The most typical cases are a 50 year design life, and an importance level 2, in which case, the return period is 500 years for ULS analysis. For other cases, refer to NZS1170.0 Tables 3.2 and 3.3
Return Period	25 years	

$a_{max} := 0.13\ g$

Peak ground acceleration. Refer to Module 1, Appendix A, Table A1, based on the Town/City and Return Period.

For quick reference, the following values apply for 500 year return periods:
Auckland 0.19g (the higher of the two values in Table A1 should be used)
Tauranga 0.30g
Wellington 0.68g
Christchurch 0.35g
Queenstown 0.41g

Site specific studies of PGA should be used where available.
Regional studies (e.g. Bradley 2019 for Tauranga) may be applicable in some circumstances.

The amax value can be used as a direct input to liquefaction analyses, in association with the magnitudes given in Table A1.

$A_{topo} := 1.2$

Topographical amplification factor, Module 6, Table 5.1, page 13. If you are doing slope stability analysis, then Module 6, Section 4.3, implies that you can use this approach. However, NZTA's "Seismic design and performance of high cut slopes" has a somewhat different approach that should also be considered for cuts above say 5m in height.

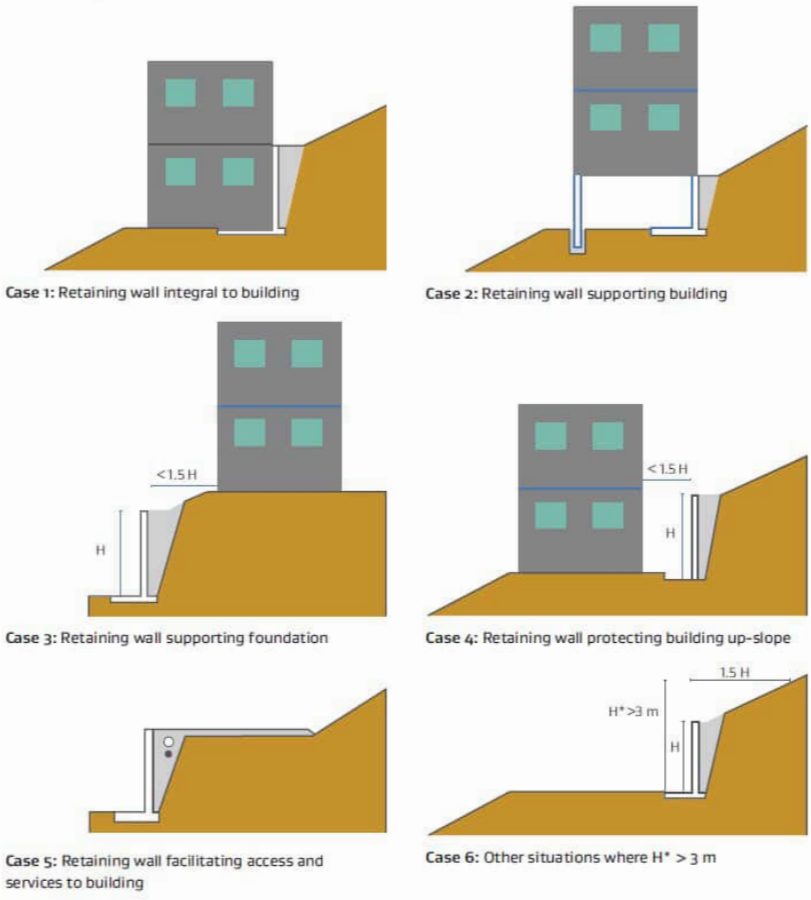
Table 5.1: Topographic amplification factor

TOPOGRAPHIC SITUATION	A_{TOPO}
For cliff features >30 m in height	1.2 at the cliff edge and the area on top of the cliff of width equal to the height of the cliff
For ridge lines >30 m in height with crest width significantly less than base width, and average slope angle[1] greater than 30°	1.4 at the crest diminishing to unity at the base
For ridge lines >30 m in height with crest width significantly less than base width, and average slope angle greater than 15° and less than 30°	1.2 at the crest diminishing to unity at the base
For average slope angles of less than 15°	1.0

1 Average slope angle refers to the natural slope angle averaged over the height of the ridge, not the slope angle of the site.

Wall displacement factor:

Figure 4.1: Typical situations where retaining walls are used for building development



Case 1: Retaining wall integral to building

Case 2: Retaining wall supporting building

Case 3: Retaining wall supporting foundation

Case 4: Retaining wall protecting building up-slope

Case 5: Retaining wall facilitating access and services to building

Case 6: Other situations where H* > 3 m

Table 5.2: Wall displacement factor, W_d for pseudo-static design of retaining walls for ultimate limit state (ULS)

CASE (from TABLE 4.1)	SITUATION (refer to Table 4.1 and Figure 4.1)	W_d
Case 1	Retaining wall integral to building	0.7
Case 1a	Retaining wall integral to building	0.5
Case 2	Retaining wall supporting building	0.5
Case 3	Downslope and supporting building foundations	0.5
Case 4	Upslope and within 1.5H of building	0.4
Case 5	Facilitating access and services to building (eg driveway)	0.3
Case 6	Other situations, H* >3 m	0.3

$w_d := 1$ Wall displacement factor (SLS)

(Module 6 Tables 4.1 and 5.2)

For retaining walls - this must be 1.0 for SLS analysis or if the wall is stiff or rigid. - if a value less than 1.0 is used, it is implied that retaining wall movement is likely, and therefore should be allowed for.

For slope stability - you should only use wd less than 1.0 if you are satisfied that the material will not lose strength with displacement, or you have used the post-displacement strength. With rock, for instance, a wd of less than 1.0 should only be considered with residual strengths.

$k_h := a_{max} \cdot A_{topo} \cdot w_d = 0.156\ g$

Design horizontal acceleration for retaining wall design, Module 6 (Nov 2021 update), Eq 5-1, page 13

This spreadsheet calculates the design horizontal acceleration for retaining wall and slope stability analysis, according to the November 2021 update of the NZGS / MBIE Guidelines. This template approved for use by Alan Wightman, August 2022.

Town/City	Wellington	The return period depends on the design life of the structure, and the importance level. The most typical cases are a 50 year design life, and an importance level 2, in which case, the return period is 500 years for ULS analysis. For other cases, refer to NZS1170.0 Tables 3.2 and 3.3
Return Period	500 years	

$a_{max} := 0.68\ g$

Peak ground acceleration. Refer to Module 1, Appendix A, Table A1, based on the Town/City and Return Period.

For quick reference, the following values apply for 500 year return periods:
Auckland 0.19g (the higher of the two values in Table A1 should be used)
Tauranga 0.30g
Wellington 0.68g
Christchurch 0.35g
Queenstown 0.41g

Site specific studies of PGA should be used where available.
Regional studies (e.g. Bradley 2019 for Tauranga) may be applicable in some circumstances.

The amax value can be used as a direct input to liquefaction analyses, in association with the magnitudes given in Table A1.

$A_{topo} := 1.2$

Topographical amplification factor, Module 6, Table 5.1, page 13. If you are doing slope stability analysis, then Module 6, Section 4.3, implies that you can use this approach. However, NZTA's "Seismic design and performance of high cut slopes" has a somewhat different approach that should also be considered for cuts above say 5m in height.

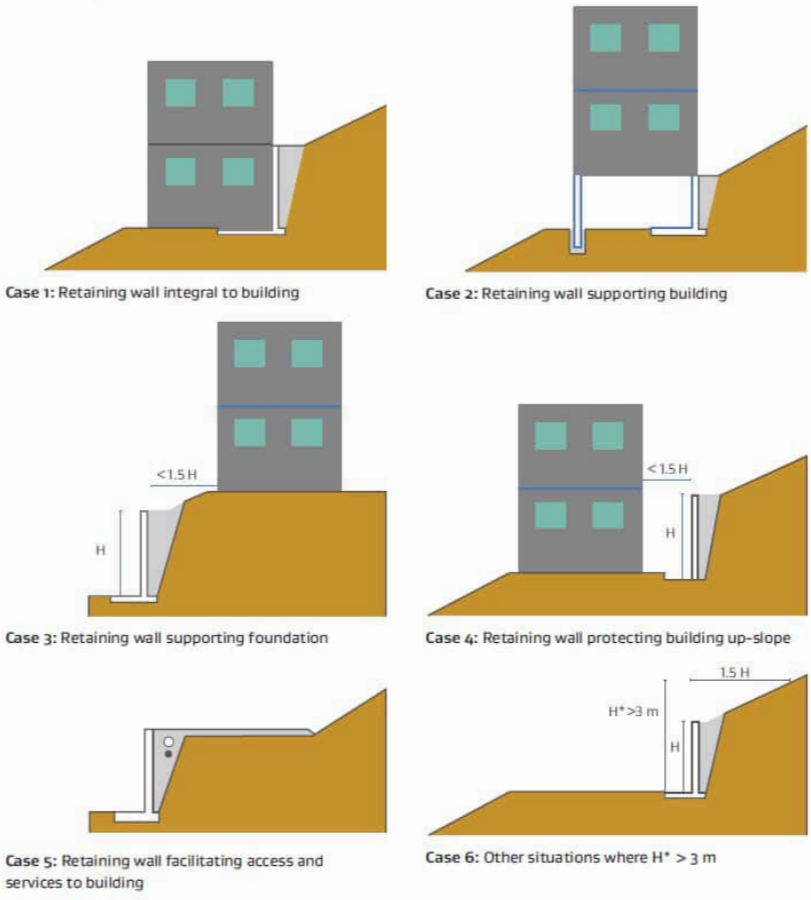
Table 5.1: Topographic amplification factor

TOPOGRAPHIC SITUATION	A_{TOPO}
For cliff features >30 m in height	1.2 at the cliff edge and the area on top of the cliff of width equal to the height of the cliff
For ridge lines >30 m in height with crest width significantly less than base width, and average slope angle[1] greater than 30°	1.4 at the crest diminishing to unity at the base
For ridge lines >30 m in height with crest width significantly less than base width, and average slope angle greater than 15° and less than 30°	1.2 at the crest diminishing to unity at the base
For average slope angles of less than 15°	1.0

1 Average slope angle refers to the natural slope angle averaged over the height of the ridge, not the slope angle of the site.

Wall displacement factor:

Figure 4.1: Typical situations where retaining walls are used for building development



Case 1: Retaining wall integral to building

Case 2: Retaining wall supporting building

Case 3: Retaining wall supporting foundation

Case 4: Retaining wall protecting building up-slope

Case 5: Retaining wall facilitating access and services to building

Case 6: Other situations where H* > 3 m

Table 5.2: Wall displacement factor, W_d for pseudo-static design of retaining walls for ultimate limit state (ULS)

CASE (from TABLE 4.1)	SITUATION (refer to Table 4.1 and Figure 4.1)	W_d
Case 1	Retaining wall integral to building	0.7
Case 1a	Retaining wall integral to building	0.5
Case 2	Retaining wall supporting building	0.5
Case 3	Downslope and supporting building foundations	0.5
Case 4	Upslope and within 1.5H of building	0.4
Case 5	Facilitating access and services to building (eg driveway)	0.3
Case 6	Other situations, H* >3 m	0.3

$w_d := 0.5$ Wall displacement factor (Case 2)

(Module 6 Tables 4.1 and 5.2)

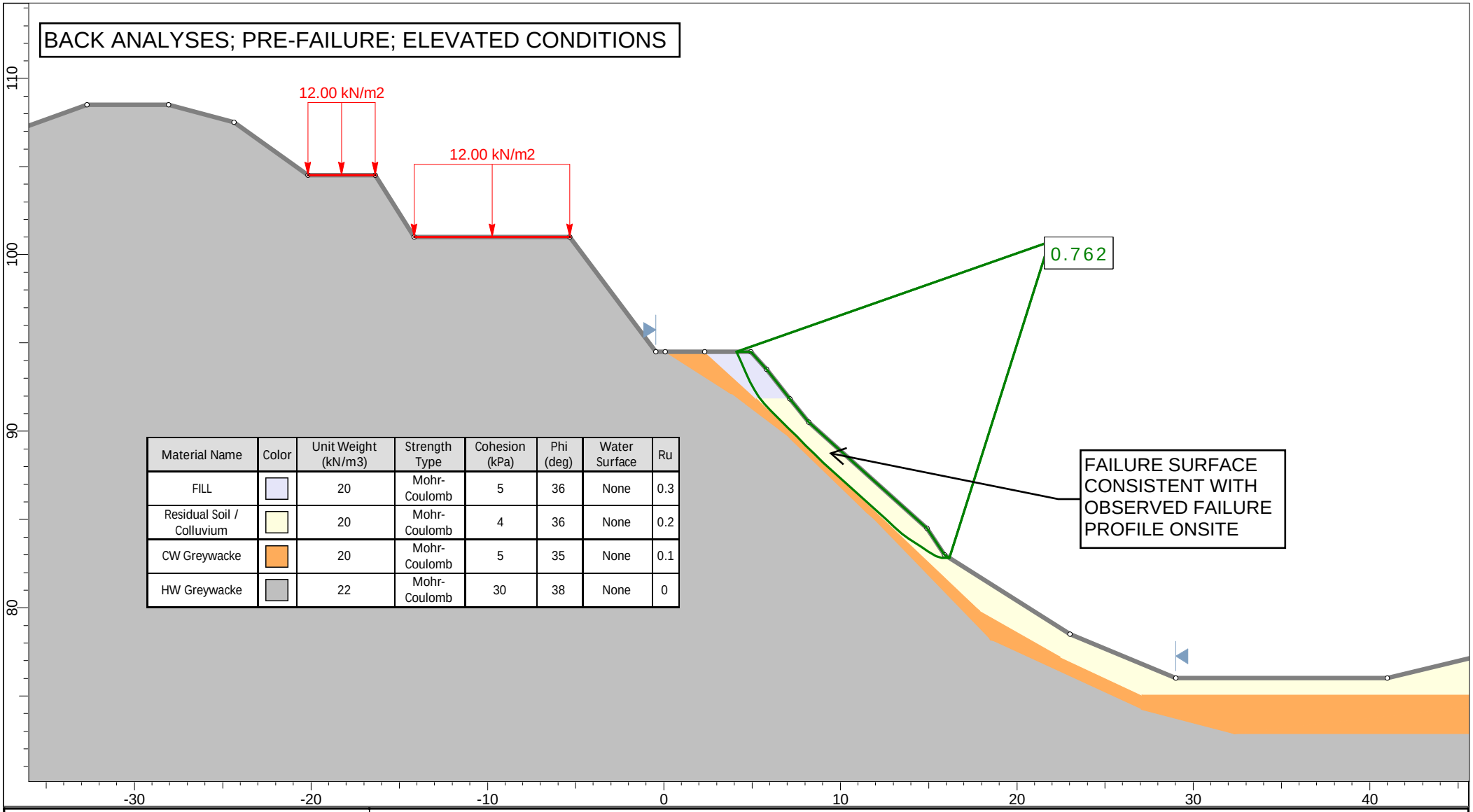
For retaining walls - this must be 1.0 for SLS analysis or if the wall is stiff or rigid. - if a value less than 1.0 is used, it is implied that retaining wall movement is likely, and therefore should be allowed for.

For slope stability - you should only use wd less than 1.0 if you are satisfied that the material will not lose strength with displacement, or you have used the post-displacement strength. With rock, for instance, a wd of less than 1.0 should only be considered with residual strengths.

$k_h := a_{max} \cdot A_{topo} \cdot w_d = 0.408\ g$

Design horizontal acceleration for retaining wall design, Module 6 (Nov 2021 update), Eq 5-1, page 13

BACK ANALYSES; PRE-FAILURE; ELEVATED CONDITIONS



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
FILL		20	Mohr-Coulomb	5	36	None	0.3
Residual Soil / Colluvium		20	Mohr-Coulomb	4	36	None	0.2
CW Greywacke		20	Mohr-Coulomb	5	35	None	0.1
HW Greywacke		22	Mohr-Coulomb	30	38	None	0

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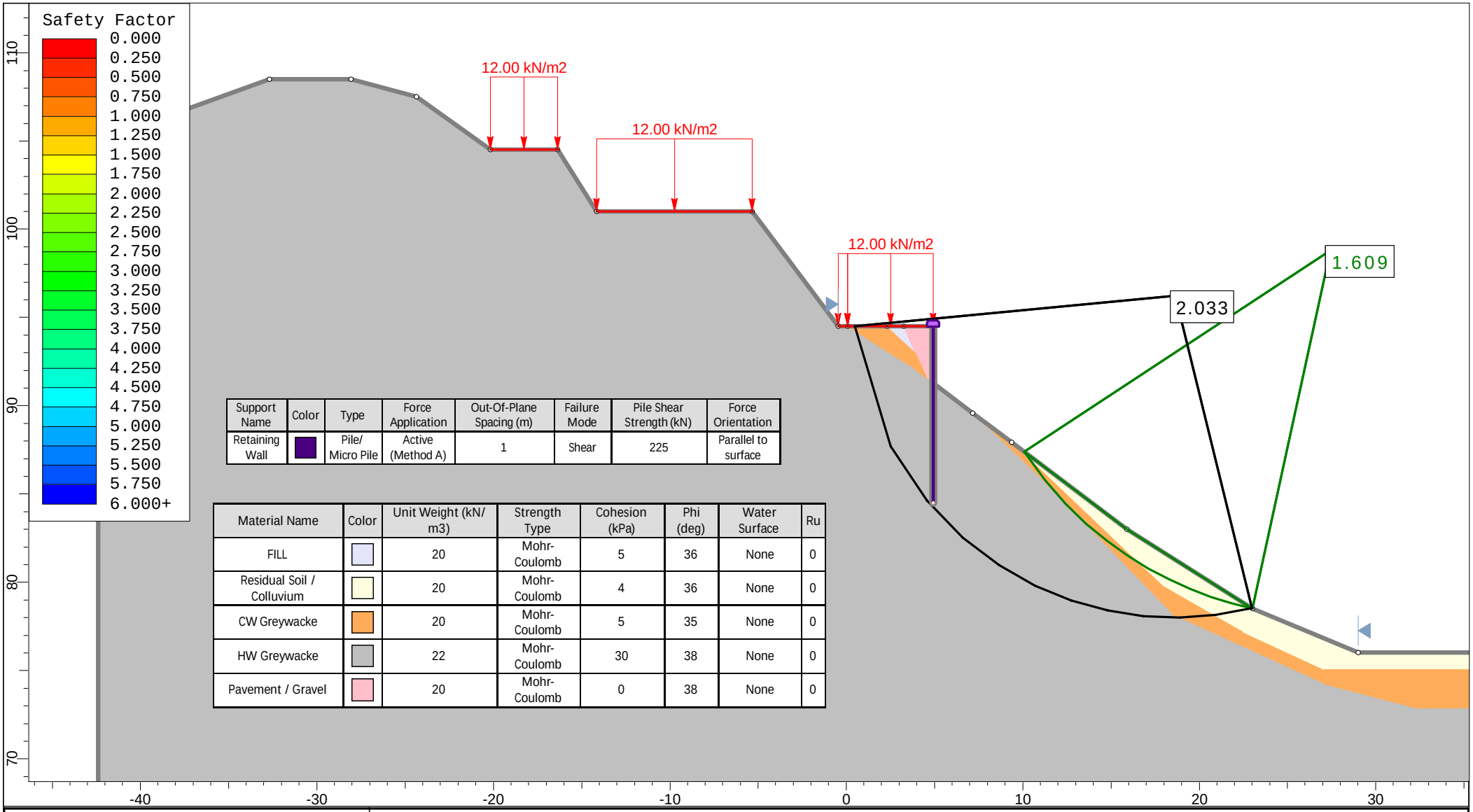
SLIDEINTERPRET 9.025

Project	Landslide Remediation - Howard Road		
Group	Pre-failure, Back Analyses - Elevated	*Scenario*	Master Scenario
Drawn By	DH	*Company*	Hutt City Council
Date	14/04/2023	*File Name*	Howard Road Slip.slmd



Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (m)	Failure Mode	Pile Shear Strength (kN)	Force Orientation
Retaining Wall		Pile/ Micro Pile	Active (Method A)	1	Shear	225	Parallel to surface

Material Name	Color	Unit Weight (kN/ m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
FILL		20	Mohr-Coulomb	5	36	None	0
Residual Soil / Colluvium		20	Mohr-Coulomb	4	36	None	0
CW Greywacke		20	Mohr-Coulomb	5	35	None	0
HW Greywacke		22	Mohr-Coulomb	30	38	None	0
Pavement / Gravel		20	Mohr-Coulomb	0	38	None	0

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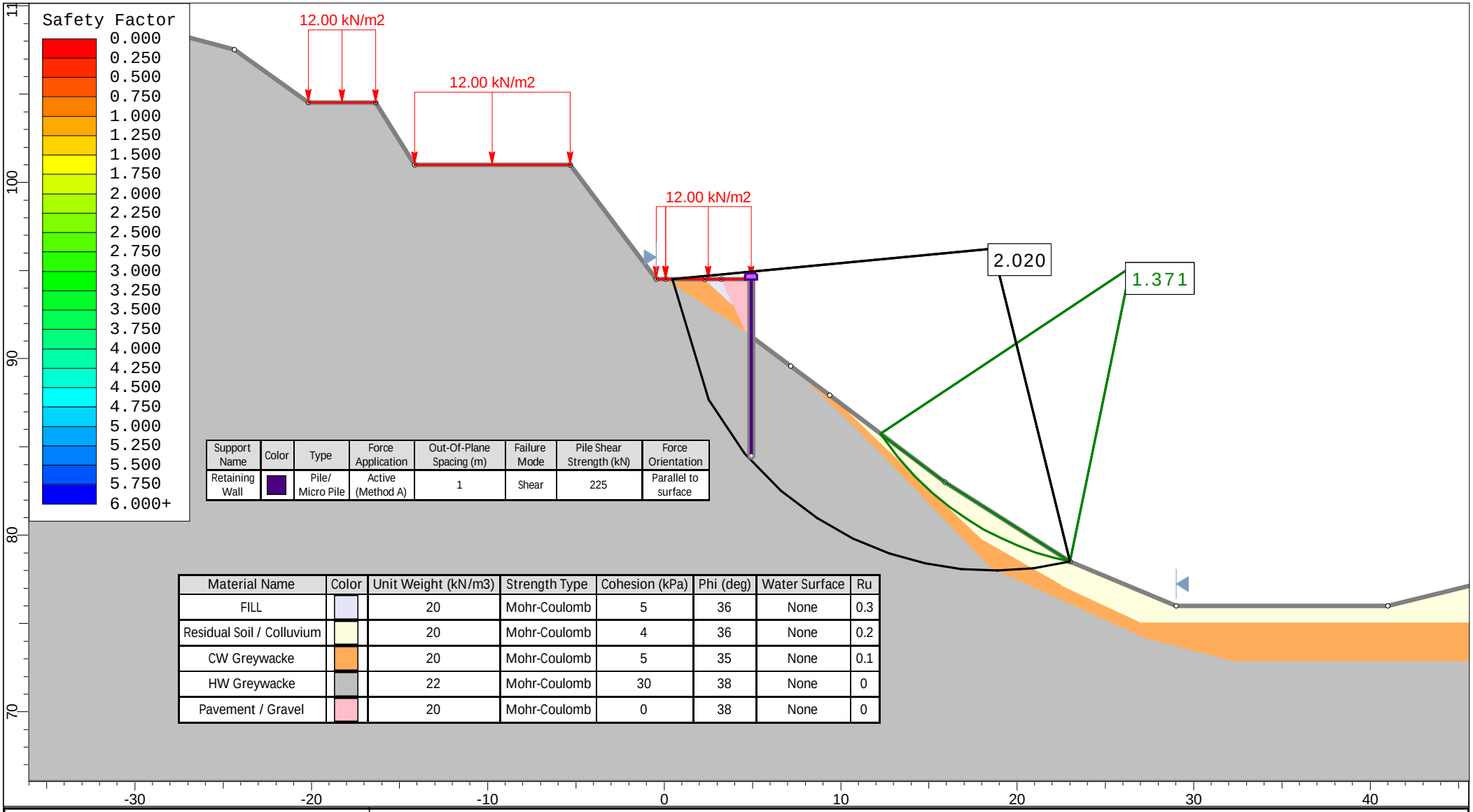
SLIDEINTERPRET 9.025

Project	Landslide Remediation - Howard Road		
Group	02. SLIDE Prevailing.slim	*Scenario*	02. SLIDE Prevailing.slim
Drawn By	DH	*Company*	Hutt City Council
Date	14/04/2023	*File Name*	02. SLIDE Prevailing.slim



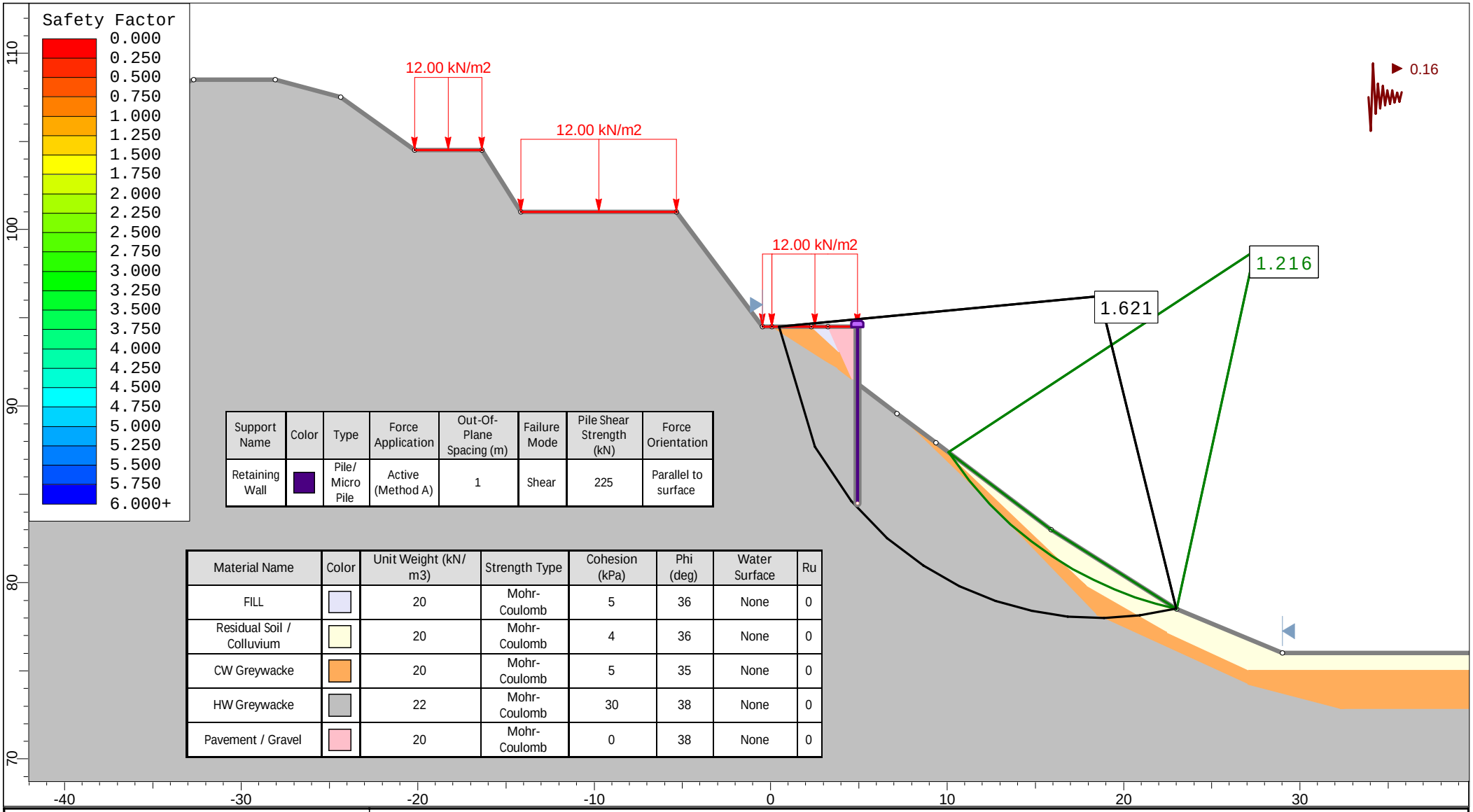
Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (m)	Failure Mode	Pile Shear Strength (kN)	Force Orientation
Retaining Wall		Pile/ Micro Pile	Active (Method A)	1	Shear	225	Parallel to surface

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
FILL		20	Mohr-Coulomb	5	36	None	0.3
Residual Soil / Colluvium		20	Mohr-Coulomb	4	36	None	0.2
CW Greywacke		20	Mohr-Coulomb	5	35	None	0.1
HW Greywacke		22	Mohr-Coulomb	30	38	None	0
Pavement / Gravel		20	Mohr-Coulomb	0	38	None	0

ENGEO

SLIDEINTERPRET 9.025

Project	Landslide Remediation - Howard Road		
Group	02. SLIDE Elevated.slim	*Scenario*	02. SLIDE Elevated.slim
Drawn By	DH	*Company*	Hutt City Council
Date	14/04/2023	*File Name*	02. SLIDE Elevated.slim



Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (m)	Failure Mode	Pile Shear Strength (kN)	Force Orientation
Retaining Wall		Pile/ Micro Pile	Active (Method A)	1	Shear	225	Parallel to surface

Material Name	Color	Unit Weight (kN/ m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
FILL		20	Mohr-Coulomb	5	36	None	0
Residual Soil / Colluvium		20	Mohr-Coulomb	4	36	None	0
CW Greywacke		20	Mohr-Coulomb	5	35	None	0
HW Greywacke		22	Mohr-Coulomb	30	38	None	0
Pavement / Gravel		20	Mohr-Coulomb	0	38	None	0

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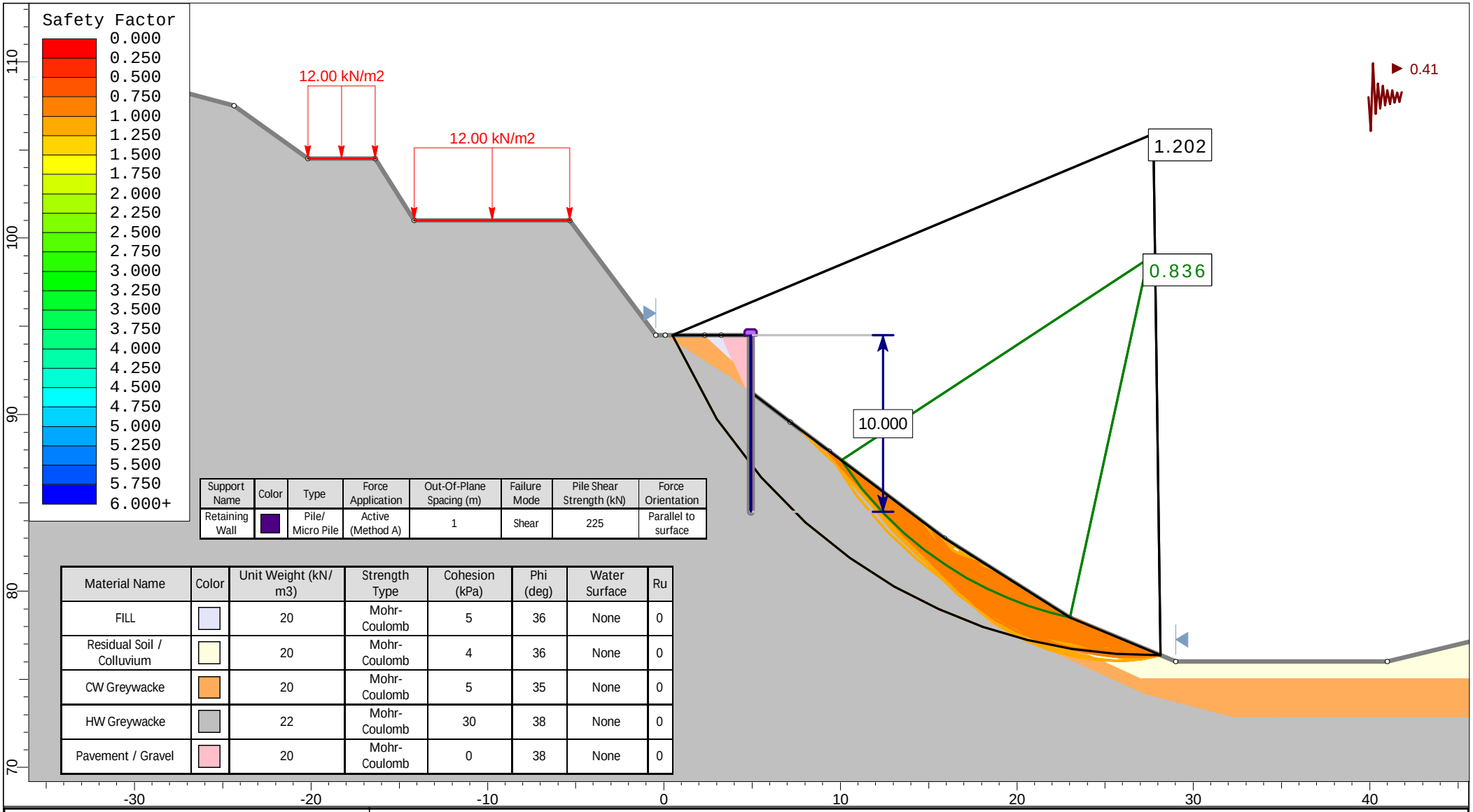
SLIDEINTERPRET 9.025

Project	Landslide Remediation - Howard Road		
Group	02. Sesimic 0.16g.slim	*Scenario*	02. Sesimic 0.16g.slim
Drawn By	DH	*Company*	Hutt City Council
Date	14/04/2023	*File Name*	02. Sesimic 0.16g.slim



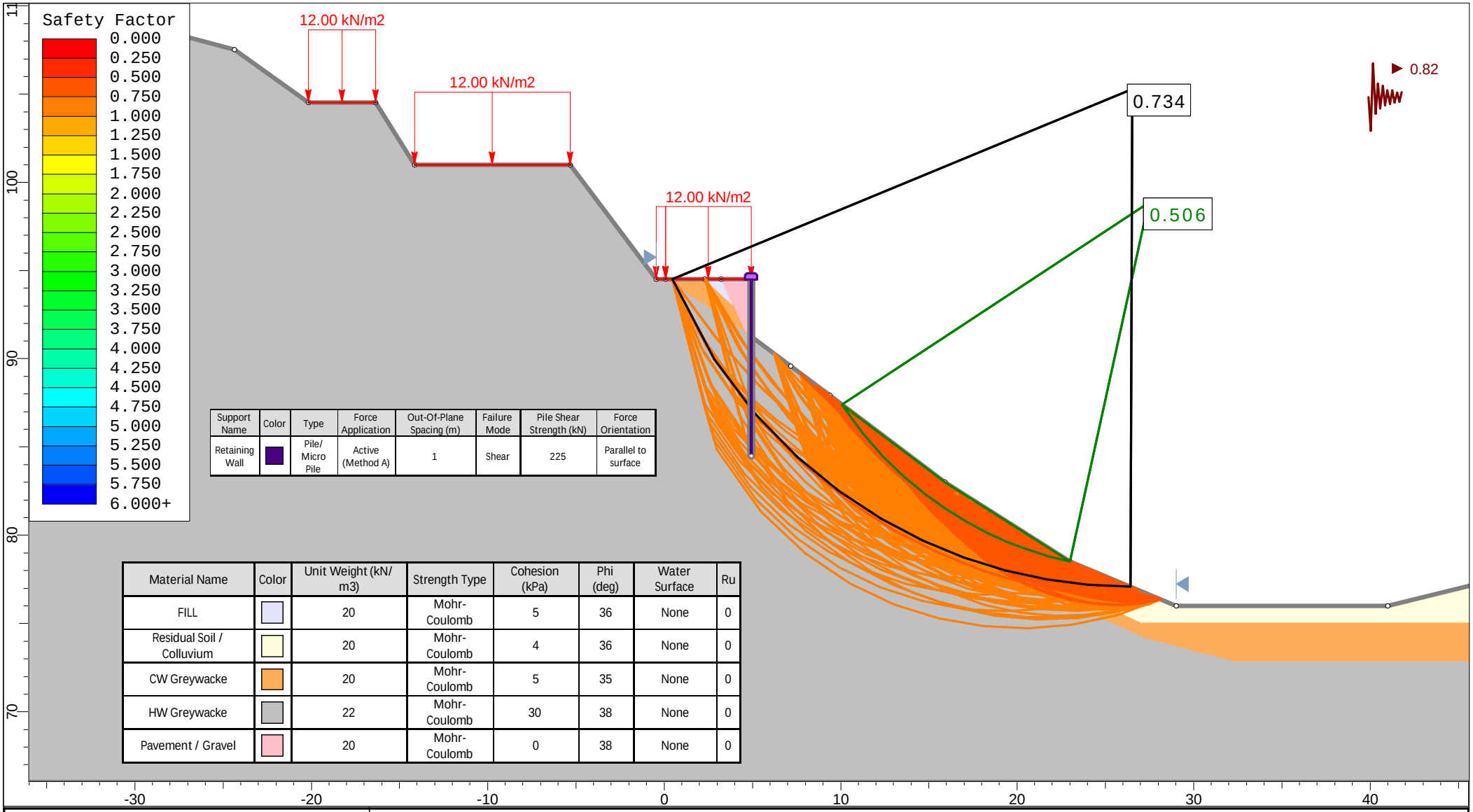
Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (m)	Failure Mode	Pile Shear Strength (kN)	Force Orientation
Retaining Wall		Pile/ Micro Pile	Active (Method A)	1	Shear	225	Parallel to surface

Material Name	Color	Unit Weight (kN/ m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
FILL		20	Mohr-Coulomb	5	36	None	0
Residual Soil / Colluvium		20	Mohr-Coulomb	4	36	None	0
CW Greywacke		20	Mohr-Coulomb	5	35	None	0
HW Greywacke		22	Mohr-Coulomb	30	38	None	0
Pavement / Gravel		20	Mohr-Coulomb	0	38	None	0

ENGEO

SLIDEINTERPRET 9.025

Project	Landslide Remediation - Howard Road		
Group	02. SLIDE Seismic ULS full PGA.slim	*Scenario*	02. SLIDE Seismic ULS full PGA.slim
Drawn By	DH	*Company*	Hutt City Council
Date	14/04/2023	*File Name*	02. SLIDE Seismic ULS full PGA.slim



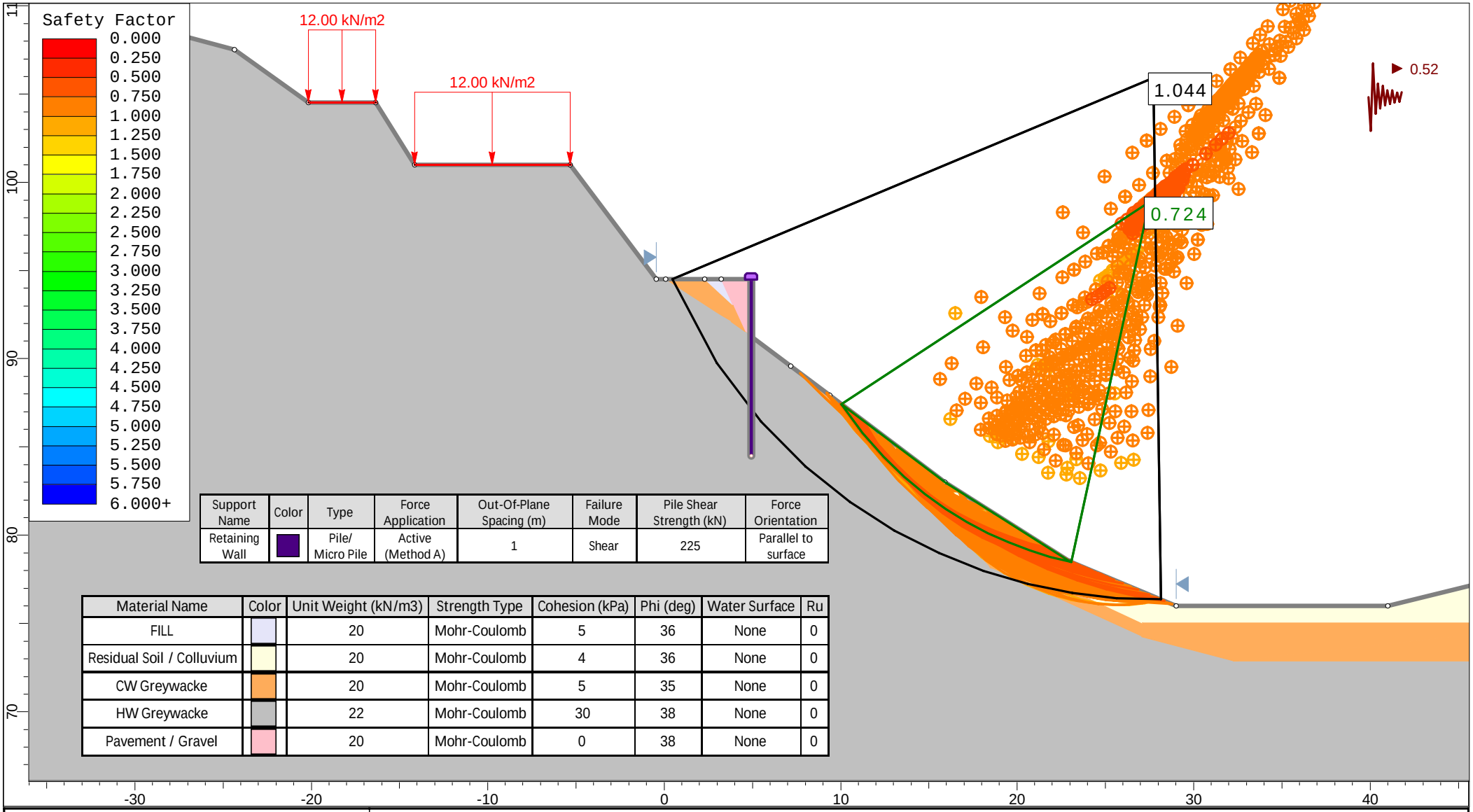
Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (m)	Failure Mode	Pile Shear Strength (kN)	Force Orientation
Retaining Wall		Pile/ Micro Pile	Active (Method A)	1	Shear	225	Parallel to surface

Material Name	Color	Unit Weight (kN/ m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
FILL		20	Mohr-Coulomb	5	36	None	0
Residual Soil / Colluvium		20	Mohr-Coulomb	4	36	None	0
CW Greywacke		20	Mohr-Coulomb	5	35	None	0
HW Greywacke		22	Mohr-Coulomb	30	38	None	0
Pavement / Gravel		20	Mohr-Coulomb	0	38	None	0

ENGEO

SLIDEINTERPRET 9.025

Project	Landslide Remediation - Howard Road		
Group	02. Sesimic 0.82g.slim	*Scenario*	02. Sesimic 0.82g.slim
Drawn By	DH	*Company*	Hutt City Council
Date	14/04/2023	*File Name*	02. Sesimic 0.82g.slim



Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (m)	Failure Mode	Pile Shear Strength (kN)	Force Orientation
Retaining Wall		Pile/ Micro Pile	Active (Method A)	1	Shear	225	Parallel to surface

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
FILL		20	Mohr-Coulomb	5	36	None	0
Residual Soil / Colluvium		20	Mohr-Coulomb	4	36	None	0
CW Greywacke		20	Mohr-Coulomb	5	35	None	0
HW Greywacke		22	Mohr-Coulomb	30	38	None	0
Pavement / Gravel		20	Mohr-Coulomb	0	38	None	0

ENGEO

SLIDEINTERPRET 9.025

Project	Landslide Remediation - Howard Road		
Group	02. Sesimic 0.52g.slim	*Scenario*	02. Sesimic 0.52g.slim
Drawn By	DH	*Company*	Hutt City Council
Date	14/04/2023	*File Name*	02. Sesimic 0.52g.slim

Active Earth Coefficients for Static and Seismic Cases

References are "Geotechnical Earthquake Engineering" by Steven Kramer (1996), and NZGS/MBIE's Module 6: "Earthquake resistant retaining wall design" (2021). This template approved for use by Alan Wightman February 2022.

Soil Properties

$\phi := 36 \cdot deg$ Soil friction angle, taken as weighted average of retained soils

$\delta := \frac{2}{3} \cdot 36 \cdot deg$ Friction angle between soil and wall. Module 6 recommends using 2/3*ϕ for cantilever walls with rough sawn timber lagging (Example 1) and crib walls (Example 3), 1*ϕ for concrete block walls (Example 2), and zero for anchored walls (Example 4).

$\beta := 0 \cdot deg$ Slope angle above the wall

$\theta := 0 \cdot deg$ Rake of wall (zero = vertical, negative = raked back)

$k_h := 0.41$ Horizontal pseudo-static coefficient as a ratio of g, calculated using the design horizontal acceleration spreadsheet

$k_v := 0.0$ Vertical pseudo-static coefficient as a ratio of g. This is usually zero, except for high risk retaining structures, and structures associated with IL 4 facilities. See Module 6, Section 6.10.

$k_{hcalc} := \min\left(k_h, \tan(\phi)\right) = 0.41$ Effective kh used in calculations. kh cannot exceed tan phi (see Module 6, p66) hence the effective limit placed on kh by the min function.

$\psi := \operatorname{atan}\left(\frac{k_{hcalc}}{1 - k_v}\right) = 22\ deg$ Effective rotation of the geometry provided by the pseudo-static accelerations

Static coefficient - Coulomb

$$K_{Ac} := \frac{\cos(\phi - \theta)^2}{\cos(\theta)^2 \cdot \cos(\delta + \theta) \cdot \left(1 + \sqrt{\frac{\sin(\delta + \phi) \cdot \sin(\phi - \beta)}{\cos(\delta + \theta) \cdot \cos(\beta - \theta)}}\right)^2}$$

$K_{Ac} = 0.235$

Kramer 11.10

Static coefficient - Rankine

$$K_{Ar} := \cos(\beta) \cdot \frac{\cos(\beta) - \sqrt{\cos(\beta)^2 - \cos(\phi)^2}}{\cos(\beta) + \sqrt{\cos(\beta)^2 - \cos(\phi)^2}}$$

$K_{Ar} = 0.26$

Kramer 11.3

Seismic coefficient - Mononobe-Okabe

$$K_{AE} := \frac{\cos(\phi - \theta - \psi)^2}{\cos(\psi)\cdot\cos(\theta)^2\cdot\cos(\delta+\theta+\psi)\cdot\left(1+\sqrt{\frac{\sin(\delta+\phi)\cdot\sin(\phi-\beta-\psi)}{\cos(\delta+\theta+\psi)\cdot\cos(\beta-\theta)}}\right)^2}$$

$K_{AE} = 0.619$

Kramer 11.16. If this is an imaginary number (has an "i"), then see the next section. If this is a real number, then this is the number you should use.

Seismic coefficient - Infinite Slope

If there is a steep slope above the wall, and a significant seismic coefficient, then Kae can be imaginary, because the $\phi - \beta - \psi$ term becomes negative, and the square root of a negative number is imaginary. In this case, if the cohesionless assumption, on which the K values rests, remains, then the slope would fail, and hence the slope should be modelled, under seismic conditions, as the smaller angle $\beta + (\phi - \beta - \psi) = \phi - \psi$. This is recognised in Module 6 Appendix F, which states that:

For any given horizontal acceleration *kh*, the corresponding stable, 'infinite slope' angle may be calculated as *i* = φ– tan-1(*kh*).

We use β for slope angle, rather than i, and ψ = tan-1(*kh*). Thus the infinite slope angle is $\phi - \psi$. However, there are a few situations where, due to what seems to be a rounding error, an imaginary number is still produced. Hence, a tiny fraction of a degree is subtracted from β to create a real Kae.

$\beta_{is} := \phi - \psi - 10^{-10}\cdot\text{deg} = 13.706\ \text{deg}$ Infinite slope angle

$$K_{AEis} := \frac{\cos(\phi - \theta - \psi)^2}{\cos(\psi)\cdot\cos(\theta)^2\cdot\cos(\delta+\theta+\psi)\cdot\left(1+\sqrt{\frac{\sin(\delta+\phi)\cdot\sin(\phi-\beta_{is}-\psi)}{\cos(\delta+\theta+\psi)\cdot\cos(\beta_{is}-\theta)}}\right)^2}$$

$K_{AEis} = 1.476$

Kae assuming infinite slope conditions. If the regular Kae (in the previous section) returns a real value, then Kaeis represents the maximum value for *Kae* for the chosen value of *kh* for all slope angles.

Notes

1. Active pressure can only be realised when the wall movement is sufficient to fully mobilise the strength of the soil. Where lateral wall movement is restrained, such as for tieback walls, anchored bulkheads, basement walls and bridge abutments, earth pressures may be greater than active and the designer should instead use "at rest" soil pressures under static conditions.

2. For stiff or rigid walls, the seismic pressure should be calculated as per Section 6.6 of Module 6.

Howard Road Slip Remediation, assumes 37 deg downslope and max 3.5m wall height

RESOLVE FOR SLOPING TOE

Input Cell

NOT TO SCALE

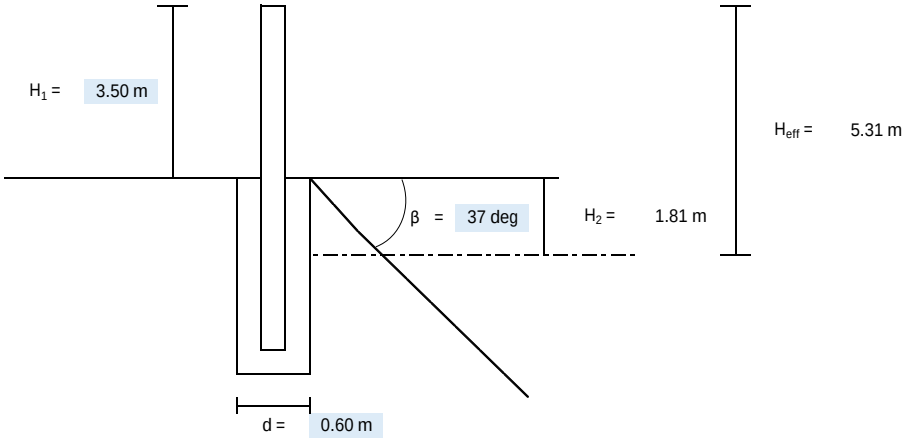
$H_2 = \tan\beta \times 4 \times d$

β = 37 deg
d = 0.60 m
H_1 = 3.50 m

H_2 = 1.81

$H_{eff} = H_1 + H_2$

H_{eff} = 5.31 m



Job No.	21700	Name:	Howard Road Slip Remediation
By	DH (June 2023)	Checked:	MP (July 2023)

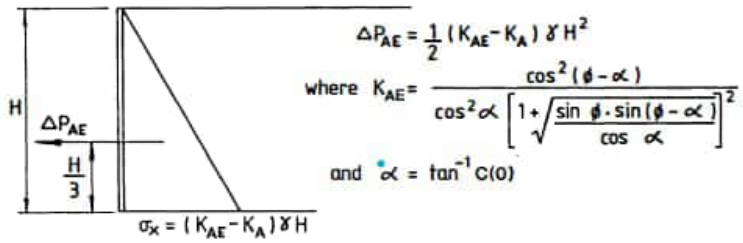


FIG. 3.5 EQ PRESSURE INCREMENT ON FLEXIBLE WALL

ULS PGA	0.410	g	(Atopo=1.2, Wd=0.5, ULS PGA = 0.68g)
Unit weight of backfill	20.0	kN/m3	
Top of retained height	0.0	m RL	
Bottom of retained height	-5.3	m RL	(Note: effective retained height adopted)
Height of wall	5.3	m	
No. point loads	1		
Height Increments	5.3	m	
Kae	0.619		From Active coefficients mathcad sheet (M-O)
Ka	0.235		From Active coefficients mathcad sheet (Coulomb)

Pile Weight

pile diameter	0.6	m
pile spacing	1.0	m
concrete unit weight	24	kN/m3
pile cross sectional area	0.2827	m2
wall retained height	5.3	m
volume per pile	1.4985	m3
volume per m run	1.4985	m3/m
Pile weight	36.0	kN per m run

Shotcrete Weight

shotcrete thickness	0	m
concrete unit weight	24	kN/m3
Volume per m run	0.0000	m3/m
Shotcrete weight	0.00	kN per m run

Total Weight (Pile plus Shotcrete)

Pile + Shotcrete weight	35.96	kN per m run

Inertial Loads

Total inertia load	ULS	14.7	kN per m run
Inertia point load	ULS	14.7	kN per m run

Summary

Load No.	depth (m)	RL (m)	Seismic Load (kN)	Inertial Load (kN)	Seismic + Inertial Load (kN per m run)
1	3.53	-3.53	107.87	14.75	122.61

Job No: 21700 Name: Howard Road Slip Remediation
By: DH Checked: MJP
Date: July 2023

Calculation of Pile EI CONCRETE ONLY

f'c (concrete) 40 MPa
E (concrete) 2.973E+07 kPa E = 4700xSQRT(f'c)

E (concrete) = 29.73 GPa 2.97E+07 kPa
Ix (circule) = π*d^4 / 64

Concrete Piles	Spacing (m)	E(kPa)	Ix (m4)	I/m	EI/m	0.7 EI / m	0.5 EI / m	0.5 E (for WALLAP)
400	2	2.97E+07	1.26E-03	6.28E-04	1.87E+04	1.31E+04	9.34E+03	
400	1.8	2.97E+07	1.26E-03	6.98E-04	2.08E+04	1.45E+04	1.04E+04	
400	1.5	2.97E+07	1.26E-03	8.38E-04	2.49E+04	1.74E+04	1.25E+04	
400	1.2	2.97E+07	1.26E-03	1.05E-03	3.11E+04	2.18E+04	1.56E+04	
500	1	2.97E+07	3.07E-03	3.07E-03	9.12E+04	6.38E+04	4.56E+04	
		2.97E+07						
600	2.7	2.97E+07	6.36E-03	2.36E-03	7.00E+04	4.90E+04	3.50E+04	
600	1.8	2.97E+07	6.36E-03	3.53E-03	1.05E+05	7.35E+04	5.25E+04	
600	1.5	2.97E+07	6.36E-03	4.24E-03	1.26E+05	8.82E+04	6.30E+04	
600	1.2	2.97E+07	6.36E-03	5.30E-03	1.58E+05	1.10E+05	7.88E+04	
600	1	2.97E+07	6.36E-03	6.36E-03	1.89E+05	1.32E+05	9.46E+04	1.49E+07
		2.97E+07						
900	2.25	2.97E+07	3.22E-02	1.43E-02	4.25E+05	2.98E+05	2.13E+05	
750	1.8	2.97E+07	1.55E-02	8.63E-03	2.56E+05	1.80E+05	1.28E+05	
750	1.5	2.97E+07	1.55E-02	1.04E-02	3.08E+05	2.15E+05	1.54E+05	
750	1.2	2.97E+07	1.55E-02	1.29E-02	3.85E+05	2.69E+05	1.92E+05	
750	1	2.97E+07	1.55E-02	1.55E-02	4.62E+05	3.23E+05	2.31E+05	
		2.97E+07						
900	2	2.97E+07	3.22E-02	1.61E-02	4.79E+05	3.35E+05	2.39E+05	
900	1.8	2.97E+07	3.22E-02	1.79E-02	5.32E+05	3.72E+05	2.66E+05	
900	1.5	2.97E+07	3.22E-02	2.15E-02	6.38E+05	4.47E+05	3.19E+05	
900	1.2	2.97E+07	3.22E-02	2.68E-02	7.98E+05	5.58E+05	3.99E+05	
900	1	2.97E+07	3.22E-02	3.22E-02	9.57E+05	6.70E+05	4.79E+05	
				3.22E-02	957343.49			

E (concrete) = 29.73 GPa
E (steel) = 200 GPa

Longitudinal steel 8HD25
Bar dia 25 mm
Bar area 491 mm2
No bars 8
Total bar area 3927 mm2

Pile dia 600 mm
Pile area 282743 mm2 1.4% Steel

Job No: 21700 Name: Howard Road Slip Remediation
By: DH Checked: MJP
Date: July 2023

Calculation of Pile Shear Capacity

1 Inputs

Diameter =	600	mm		
Longitudinal bar dia =	25	mm		
No. of longitudinal bars =	8	no.		
Spiral bar dia =	10	mm	Cover=	75 mm
Spiral spacing =	150	mm		
fyt =	500	MPa		
f'c =	40	MPa		

10.3.10.5.2 *Spacing of spirals or circular hoops*

The centre-to-centre spacing of spirals or circular hoops along the member shall be less than or equal to the smaller of one-third of the diameter of the cross section of the member or ten longitudinal bar diameters. Clear spacing shall be equal to or greater than 25 mm.

1/3 dia =	200 mm
10 bar dia:	250 mm
Sprial spacing less than or equal to:	
	200 mm

2 Shear capacity of concrete pile

2.1 Shear strength provided by concrete

Vc = ka * kn * vb * Acv NZS 3101:2006 Eq. 10-11

ka =	1		ka is equal to 1.0 for maximum aggregate size of 20 mm or more and equal to 0.85 for a maximum aggregate size of 10 mm. Interpolation may be used for intermediate sizes.
kn	1		NZS 3101:2006 Eq. 10-14 and 10-15 kn allows for the influence of axial load and it is given for members subjected to axial compression by: kn = 1 + (3 * N* / (Ag * f'c)), and axial tension by kn = 1 + (12 * N* / (Ag * f'c))
N* =	0	kN	Positive N* = compression, negative N* = tension
Ast =	3927	mm2	Area of longitudinal steel
Acv =	145220	mm2	Effective shear area (10.3.10.2.1)
pw = 0.33 Ast / Acv =	0.0089		
vb = (0.07 + 10pw) √f'c =	1.0071	MPa	
0.08 * √f'c =	0.51	MPa	
0.08 * √f'c < vb	OK		NZS 3101:2006 Eq. 10-13
0.2 * √f'c =	1.26	MPa	
0.2 * √f'c > vb	OK		NZS 3101:2006 Eq. 10-13
Vc =	146	kN	

2.2 Nominal shear strength provided by shear reinforcement

Vs = π/2 * Ah * fyt * d'' / s NZS 3101:2006 Eq. 10-18

d'' =	440	mm
Ah =	79	mm
s =	150	mm
fyt =	500	MPa
Vs =	181	kN

2.3 Maximum spacing of shear reinforcement (10.3.10.4.3)

If Vs > 0.33 * √f'c * Acv, spiral spacing shall not exceed d/4

0.33 * √f'c * Acv =	303	kN
Vs < 0.33 * √f'c * Acv	OK	

2.4 Shear capacity of pile

Vn = Vc + Vs =	327	kN
ϕ =	0.75	
ϕVn =	245	kN

Job number (or name): 21700
Column number: 8HD25

Circular section.

Dimensions of the column section:

Diameter = 600.0 mm
Clear Cover to ties = 75.0 mm

Reinforcement:

Bar no.	x, mm	y, mm	Bar dia, mm
1	201.3	0.0	25.0
2	142.3	142.3	25.0
3	0.0	201.3	25.0
4	-142.3	142.3	25.0
5	-201.3	0.0	25.0
6	-142.3	-142.3	25.0
7	0.0	-201.3	25.0
8	142.3	-142.3	25.0

With bars supported by ties, an allowance for deformations of db/10 is made in placing the bars

Ties:

Ties diameter = 10.0 mm

Sectional area & reinforcement ratio:

Column sectional area = 282600 mm2
Reinforcement area = 3927 mm2
Reinforcement ratio = 0.01390

Job number (or name): 21700
Column number: 8HD25

User name : DHalligan

Concrete properties:

Rectangular stress block as defined by NZS 3101:2006.
Concrete cylindrical compressive strength = 40.0 MPa
Concrete compression stress coefficient, a1 = 0.85
Compression zone depth coefficient, B1 = 0.77
Concrete maximum strain = 0.0030

Steel properties:

Steel modulus of elasticity = 200 000 MPa
Steel yield strength = 500.0 MPa

Dimensions of the column section:

Circular section.
Diameter = 600.0 mm
Clear cover to ties = 75.0 mm

Results:

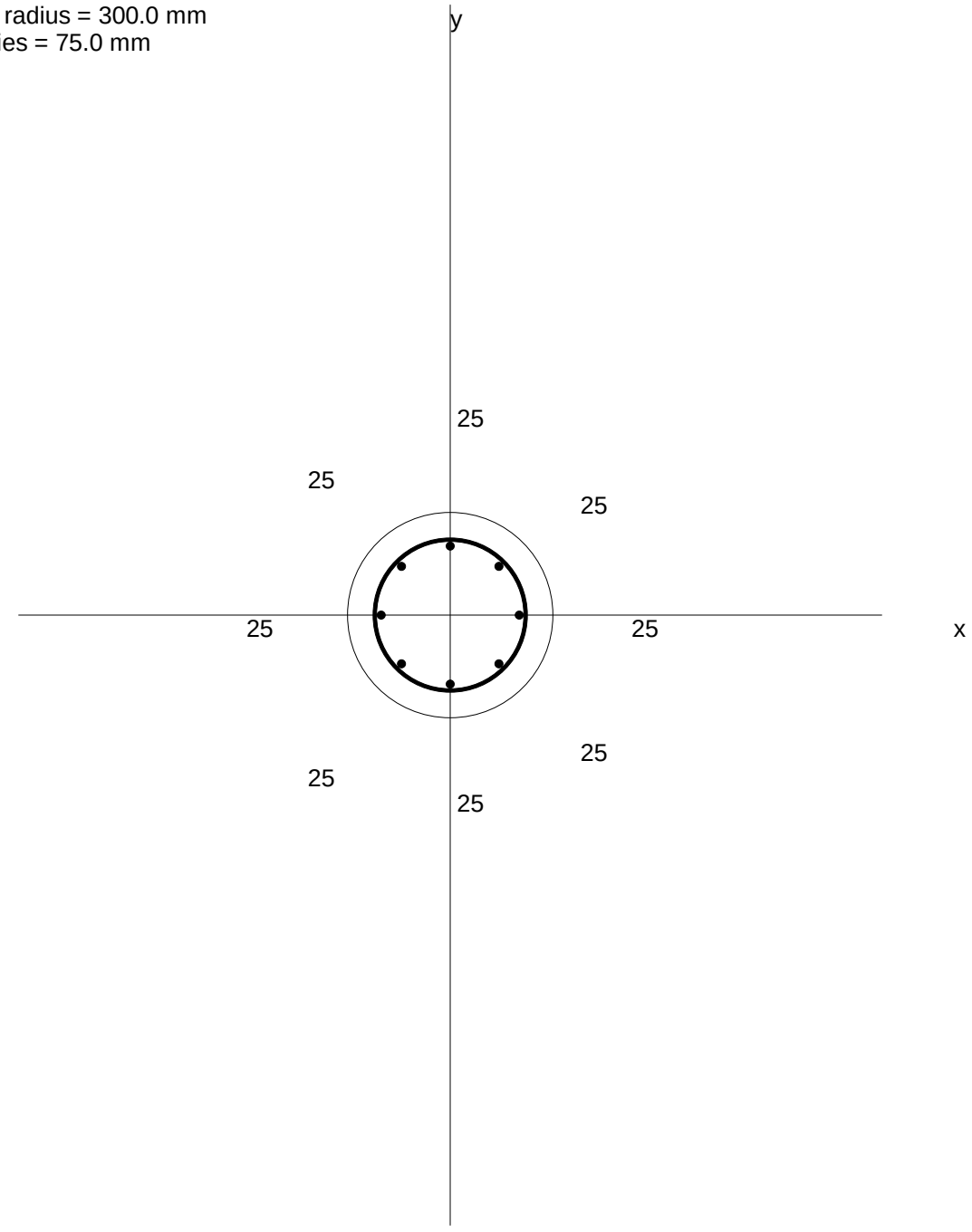
Load combination number 1 :
Strength reduction factor, Phi = 0.85
Phi Axial load = -1.1 kN, Phi Mx = 352.6 kNm, Phi My = 0.0 kNm
Required reinforcement ratio = 0.01389, Required reinforcement area = 3925.3 mm2
Initial reinforcement ratio = 0.01389, Initial reinforcement area = 3925.3 mm2
Initial reinforcement ratio scaled by = 1.0000
Moment ratio = 0.00000, Target moment ratio = N/A
Skew angle = 0.0 degrees, NA depth = 140.9 mm
Force (unfactored) carried by concrete = 1224.4 kN
Force (unfactored) carried by reinforcement = -1225.7 kN
Axial load eccentricity: ex = 0.0 mm, ey = 320545.5 mm

The analysis has been finished.

Job number (or name): 21700
Column number: 8HD25

Column area = 282600 mm2
Reinforcement area = 3927 mm2
Reinforcement ratio = 0.01390

Drawing Scale : 1 / 20
Column section radius = 300.0 mm
Clear cover to ties = 75.0 mm



Job number (or name): 21700
Column number: 8HD25

The results are for the last load combination. (Phi is not included in the following forces calculations)

Concrete (Phi=1, Material factor=1) :
Element number = 1
Element x & y coordinates = (0, 277) mm
Element area = 10651 mm^2
Strain = 0.00251
Stress = 34.0 MPa
Force in the element = 362.1 kN
Moment x-axis = 100.3 kNm
Moment y-axis = 0.0 kNm

Element number = 2
Element x & y coordinates = (0, 231) mm
Element area = 17695 mm^2
Strain = 0.00153
Stress = 34.0 MPa
Force in the element = 601.6 kN
Moment x-axis = 138.8 kNm
Moment y-axis = 0.0 kNm

Element number = 3
Element x & y coordinates = (0, 200) mm
Element area = 7667 mm^2
Strain = 0.00086
Stress = 34.0 MPa
Force in the element = 260.7 kN
Moment x-axis = 52.0 kNm
Moment y-axis = 0.0 kNm

Reinforcement (Phi=1, Material factor=1):
bar number = 1
Bar x & y coordinates = (201, 0) mm
Bar area = 491 mm^2
Strain = -0.00339
Stress = -500.0 MPa
Effective bar force = -245.4 kN
Moment x-axis = 0.0 kNm
Moment y-axis = -49.4 kNm
---
bar number = 2
Bar x & y coordinates = (142, 142) mm
Bar area = 491 mm^2
Strain = -0.00036
Stress = -71.4 MPa
Effective bar force = -35.0 kN
Moment x-axis = -5.0 kNm
Moment y-axis = -5.0 kNm
---
bar number = 3
Bar x & y coordinates = (0, 201) mm
Bar area = 491 mm^2
Strain = 0.00090
Stress = 145.8 MPa
Effective bar force = 71.6 kN
Moment x-axis = 14.4 kNm
Moment y-axis = 0.0 kNm

Job number (or name): 21700
Column number: 8HD25

bar number = 4
Bar x & y coordinates = (-142, 142) mm
Bar area = 491 mm^2
Strain = -0.00036
Stress = -71.4 MPa
Effective bar force = -35.0 kN
Moment x-axis = -5.0 kNm
Moment y-axis = 5.0 kNm
---
bar number = 5
Bar x & y coordinates = (-201, 0) mm
Bar area = 491 mm^2
Strain = -0.00339
Stress = -500.0 MPa
Effective bar force = -245.4 kN
Moment x-axis = 0.0 kNm
Moment y-axis = 49.4 kNm
---
bar number = 6
Bar x & y coordinates = (-142, -142) mm
Bar area = 491 mm^2
Strain = -0.00642
Stress = -500.0 MPa
Effective bar force = -245.4 kN
Moment x-axis = 34.9 kNm
Moment y-axis = 34.9 kNm
---
bar number = 7
Bar x & y coordinates = (0, -201) mm
Bar area = 491 mm^2
Strain = -0.00767
Stress = -500.0 MPa
Effective bar force = -245.4 kN
Moment x-axis = 49.4 kNm
Moment y-axis = 0.0 kNm
---
bar number = 8
Bar x & y coordinates = (142, -142) mm
Bar area = 491 mm^2
Strain = -0.00642
Stress = -500.0 MPa
Effective bar force = -245.4 kN
Moment x-axis = 34.9 kNm
Moment y-axis = -34.9 kNm

NA equation:

y = x * 0.000 + 159.07
Skew angle = 0.0 degrees
NA depth = 140.9 mm

The a line equation:
y = x * 0.000 + 191.48
Skew angle = 0.0 degrees
The a line depth = 108.5 mm

ENGEO LTD | Sheet No.
Program: WALLAP Version 6.06 Revision A51.B69.R54 | Job No. 21700
Licensed from GEOSOLVE | Made by : DH
Data filename/Run ID: 21700_25072023 |
Howard Road Landslide Remediation | Date: 1-08-2023
600dia 40MPa Concrete | Checked : MJP

Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	-3.60	2 HW GREYWACKE	2 HW GREYWACKE

SOIL PROPERTIES

No.	Soil type -- Description	Bulk density kN/m3	Young's Modulus Eh,kN/m2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion kN/m2 (dc/dy)
1	FILL/GRAVEL (Datum elev.)	20.00	30000 (0.200)	0.412 (0.000)	OC (0.000)	0.217	6.535	
2	HW GREYWACKE	22.00	100000 (0.200)	0.380 (1.027)	OC (8.432)	0.198	7.588	30.00d

Additional soil parameters associated with Ka and Kp

No.	Soil type Description	parameters for Ka: Soil friction angle	Wall adhesion coeff.	Back-fill angle	parameters for Kp: Soil friction angle	Wall adhesion coeff.	Back-fill angle
1	FILL/GRAVEL	36.00	0.667	0.00	36.00	0.500	0.00
2	HW GREYWACKE	38.00	0.667	0.00	38.00	0.500	0.00

GROUND WATER CONDITIONS

Density of water = 10.00 kN/m3

	Left side	Right side
Initial water table elevation	-15.00	-15.00

Automatic water pressure balancing at toe of wall : No

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = -10.00
Maximum finite element length = 0.60 m
Youngs modulus of wall E = 1.4900E+07 kN/m2
Moment of inertia of wall I = 6.3600E-03 m4/m run
E.I = 94764 kN.m2/m run
Yield Moment of wall = Not defined

HORIZONTAL and MOMENT LOADS/RESTRAINTS

Load no.	Elevation	Horizontal load kN/m run	Moment load kN.m/m run	Moment restraint kN.m/m/rad	Partial factor (Category)
1	-3.53	122.6	0	0	N/A

SURCHARGE LOADS

Surch-arge no.	Distance from wall Elev.	Length parallel to wall	Width perpend. to wall	Surcharge kN/m2 ----- Near edge	Far edge	Equiv. soil type	Partial factor/ Category
1	0.00	0.50(L)	50.00	5.00	24.00	=	N/A	N/A

Note: L = Left side, R = Right side

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Excavate to elevation -5.30 on RIGHT side
2	Change EI of wall to 94764 kN.m2/m run Yield moment not defined Reset wall displacements to zero at this stage
3	Fill to elevation 0.00 on LEFT side with soil type 1
4	Apply surcharge no.1 at elevation 0.00
5	Remove surcharge no.1 at elevation 0.00 No analysis at this stage
6	Apply load no.1 at elevation -3.53

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
Method of analysis - Strength Factor method
Factor on soil strength for calculating wall depth = 1.50

Parameters for undrained strata:
Minimum equivalent fluid density = 5.00 kN/m3
Maximum depth of water filled tension crack = 0.00 m

Bending moment and displacement calculation:
Method - Subgrade reaction model using Influence Coefficients
Open Tension Crack analysis? - No
Non-linear Modulus Parameter (L) = 0 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 1000.00 m

Width of excavation on Left side of wall = 20.00 m
Width of excavation on Right side of wall = 20.00 m

Distance to rigid boundary on Left side = 20.00 m
Distance to rigid boundary on Right side = 20.00 m

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Excav. to elev. -5.30 on RIGHT side	Yes	Yes	Yes
2	Change EI of wall to 94764kN.m2/m run	No	No	No
3	Fill to elev. 0.00 on LEFT side	Yes	Yes	Yes
4	Apply surcharge no.1 at elev. 0.00	Yes	Yes	Yes
5	Remove surcharge no.1 at elev. 0.00	No	No	No
6	Apply load no.1 at elev. -3.53	No	No	No
*	Summary output	Yes	-	Yes

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Units: kN,m

Stage No. 1 Excavate to elevation -5.30 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	G.L. Act.	G.L. Pass.	Strut Elev.	Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.500	Wall Penetration	Direction of failure
				FoS for toe elev. = -10.00				
1	-3.60	-5.30	Cant.	Conditions not suitable for FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Strut forces kN/m
1	0.00	0.00	0.001	1.00E-04	0.0	-0.0	
2	-0.60	0.00	0.001	1.00E-04	0.0	0.0	
3	-1.20	0.00	0.001	1.00E-04	0.0	-0.0	
4	-1.80	0.00	0.001	1.00E-04	0.0	-0.0	
5	-2.40	0.00	0.001	1.00E-04	0.0	-0.0	
6	-2.97	0.00	0.001	1.00E-04	0.0	-0.0	
7	-3.53	0.00	0.001	1.00E-04	0.0	-0.0	
8	-3.60	0.00	0.001	1.00E-04	0.0	0.0	
9	-4.20	0.00	0.001	1.00E-04	0.0	-0.0	
10	-4.75	2.24	0.001	9.90E-05	0.6	0.5	
11	-5.30	7.55	0.001	9.36E-05	3.3	1.4	
		-4.24	0.001	9.36E-05	3.3	1.4	
12	-5.65	-3.38	0.000	8.68E-05	2.0	2.3	
13	-6.00	-2.60	0.000	7.74E-05	0.9	2.8	
14	-6.60	-1.48	0.000	5.95E-05	-0.3	2.9	
15	-7.20	-0.65	0.000	4.28E-05	-0.9	2.4	
16	-7.80	-0.08	0.000	2.96E-05	-1.2	1.7	
17	-8.40	0.32	0.000	2.08E-05	-1.1	1.0	
18	-9.00	0.61	0.000	1.61E-05	-0.8	0.4	
19	-9.50	0.80	0.000	1.46E-05	-0.4	0.1	
20	-10.00	0.99	0.000	1.42E-05	0.0	-0.0	

Node no.	Y coord	LEFT side ------- Effective stresses ------- Water press. kN/m2	Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	-0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	-1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	-1.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	-2.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0

(continued)

Stage No.1 Excavate to elevation -5.30 on RIGHT side

LEFT side

Node no.	Y coord	Water press. kN/m2	Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
		------- Effective stresses -------						
6	-2.97	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	-3.53	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	-3.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	252.96	0.00	0.00a	13302
9	-4.20	0.00	13.20	0.00	353.12	0.00	0.00a	13302
10	-4.75	0.00	25.30	0.00	444.93	2.24	2.24	13302
11	-5.30	0.00	37.40	0.00	536.74	7.55	7.55	13302
12	-5.65	0.00	45.10	0.00	595.17	10.89	10.89	13302
13	-6.00	0.00	52.80	0.00	653.59	14.20	14.20	13302
14	-6.60	0.00	66.00	0.00	753.75	19.77	19.77	13302
15	-7.20	0.00	79.20	0.00	853.91	25.19	25.19	13302
16	-7.80	0.00	92.40	0.00	954.07	30.49	30.49	13302
17	-8.40	0.00	105.60	0.00	1054.23	35.71	35.71	13302
18	-9.00	0.00	118.80	0.00	1154.38	40.87	40.87	13302
19	-9.50	0.00	129.80	0.00	1237.85	45.15	45.15	13302
20	-10.00	0.00	140.80	0.00	1321.31	49.42	49.42	13302

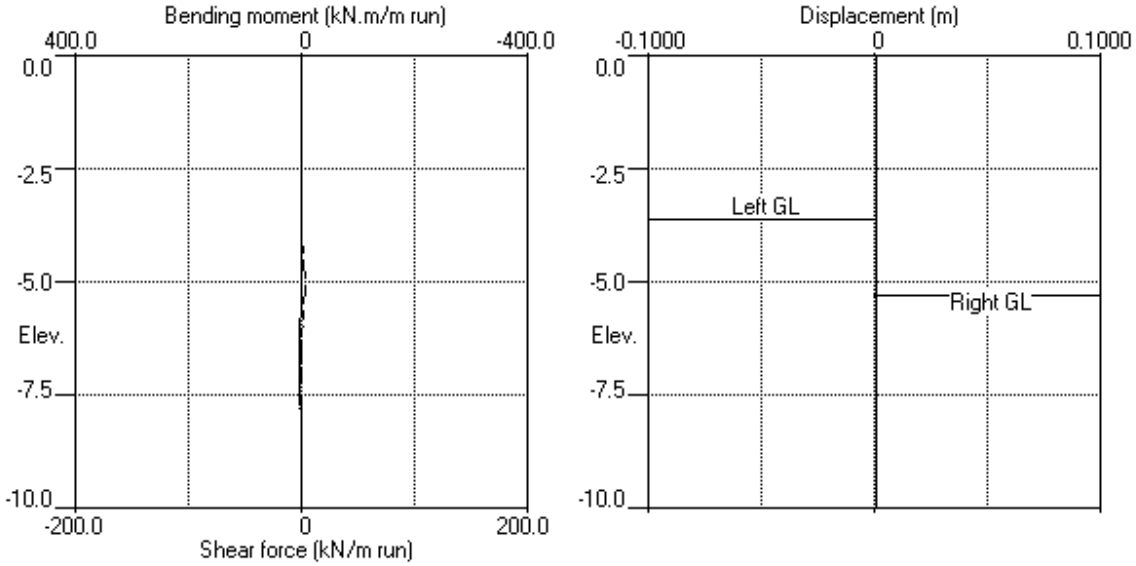
RIGHT side

Node no.	Y coord	Water press. kN/m2	Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
		------- Effective stresses -------						
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	-0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	-1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	-1.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	-2.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	-2.97	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	-3.53	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	-3.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	-4.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	-4.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	-5.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	252.96	11.78	11.78	13806
12	-5.65	0.00	7.70	0.00	311.39	14.27	14.27	13806
13	-6.00	0.00	15.40	0.00	369.82	16.80	16.80	13806
14	-6.60	0.00	28.60	0.00	470.00	21.25	21.25	13806
15	-7.20	0.00	41.81	0.00	570.23	25.84	25.84	13806
16	-7.80	0.00	55.03	0.00	670.52	30.57	30.57	13806
17	-8.40	0.00	68.26	0.00	770.88	35.38	35.38	13806
18	-9.00	0.00	81.50	0.00	871.33	40.26	40.26	13806
19	-9.50	0.00	92.54	0.00	955.13	44.34	44.34	13806
20	-10.00	0.00	103.59	0.00	1039.00	48.44	48.44	13806

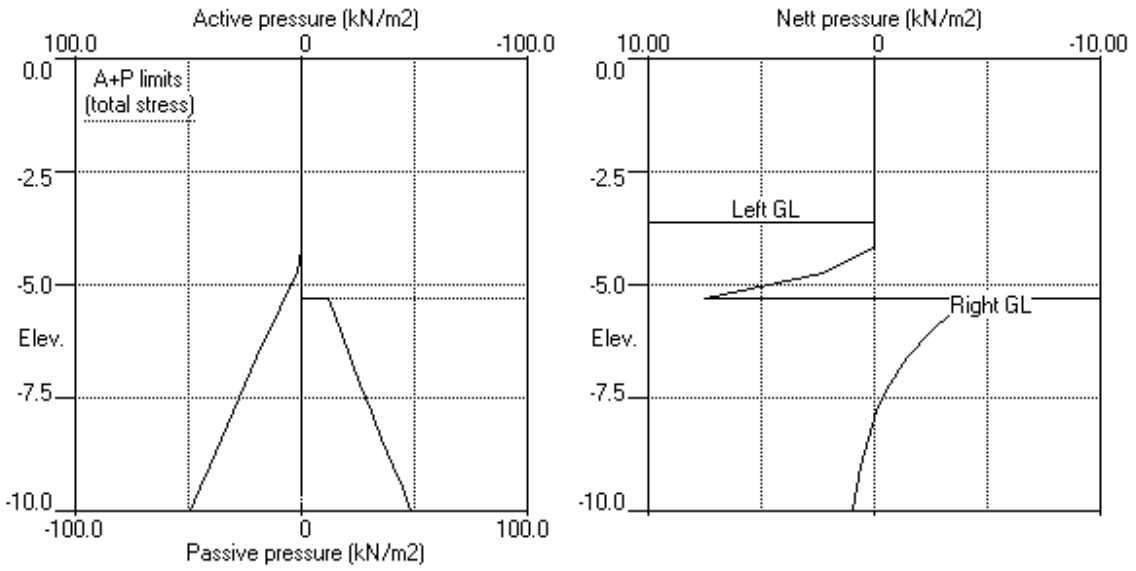
Note: 0.00a Soil pressure at active limit
123.45p Soil pressure at passive limit

Units: kN,m

Stage No.1 Excav. to elev. -5.30 on RIGHT side



Stage No.1 Excav. to elev. -5.30 on RIGHT side



Units: kN,m

Stage No. 3 Fill to elevation 0.00 on LEFT side with soil type 1

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	G.L. Act.	G.L. Pass.	Strut Elev.	Factor of Safety	Moment equilib. at elev.	FoS for toe elev. = -10.00 Toe elev.	Toe Penetr -ation	Wall elev. for FoS = 1.500	Direction of failure
3	0.00	-5.30	Cant.	2.353	-9.37	-7.34	2.04		L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00m

Subgrade reaction model - Boussinesq Influence coefficients

Soil deformations are elastic until the active or passive limit is reached

Open Tension Crack analysis - No

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

*** Wall displacements reset to zero at stage 2

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Strut forces kN/m
1	0.00	0.00	0.015	2.89E-03	0.0	0.0	
2	-0.60	2.60	0.014	2.89E-03	0.8	0.2	
3	-1.20	5.20	0.012	2.88E-03	3.1	1.2	
4	-1.80	7.80	0.010	2.87E-03	7.0	4.2	
5	-2.40	10.41	0.008	2.82E-03	12.5	10.0	
6	-2.97	12.85	0.007	2.74E-03	19.1	18.8	
7	-3.53	15.30	0.005	2.59E-03	27.0	31.8	
8	-3.60	15.61	0.005	2.56E-03	28.1	33.7	
		0.00	0.005	2.56E-03	28.1	33.7	
9	-4.20	0.00	0.004	2.29E-03	28.1	50.6	
10	-4.75	0.00	0.003	1.96E-03	28.1	66.4	
11	-5.30	0.00	0.002	1.53E-03	28.1	81.8	
		-102.05	0.002	1.53E-03	28.1	81.8	
12	-5.65	-69.57	0.001	1.23E-03	-1.9	85.9	
13	-6.00	-39.59	0.001	9.35E-04	-21.0	81.0	
14	-6.60	-5.73	0.000	5.03E-04	-34.6	61.2	
15	-7.20	10.85	0.000	2.01E-04	-33.1	39.4	
16	-7.80	16.16	0.000	2.16E-05	-25.0	21.5	
17	-8.40	15.23	0.000	-6.73E-05	-15.6	9.4	
18	-9.00	11.47	0.000	-1.01E-04	-7.6	2.8	
19	-9.50	7.60	0.000	-1.08E-04	-2.8	0.4	
20	-10.00	3.59	0.000	-1.09E-04	0.0	-0.0	

(continued)

Stage No.3 Fill to elevation 0.00 on LEFT side with soil type 1

LEFT side

Node no.	Y coord	Water press. kN/m2	Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5951
2	-0.60	0.00	12.00	2.60	78.42	2.60	2.60a	5951
3	-1.20	0.00	24.00	5.20	156.85	5.20	5.20a	5951
4	-1.80	0.00	36.00	7.80	235.27	7.80	7.80a	5951
5	-2.40	0.00	48.00	10.41	313.69	10.41	10.41a	5951
6	-2.97	0.00	59.30	12.85	387.54	12.85	12.85a	5951
7	-3.53	0.00	70.60	15.30	461.39	15.30	15.30a	5951
8	-3.60	0.00	72.00	15.61	470.54	15.61	15.61a	5951
		0.00	72.00	0.00	799.28	0.00	0.00a	19835
9	-4.20	0.00	85.20	0.00	899.44	0.00	0.00a	19835
10	-4.75	0.00	97.30	0.00	991.25	0.00	0.00a	19835
11	-5.30	0.00	109.40	0.00	1083.06	0.00	0.00a	19835
12	-5.65	0.00	117.10	0.00	1141.48	7.21	7.21	19835
13	-6.00	0.00	124.80	0.00	1199.91	18.04	18.04	19835
14	-6.60	0.00	138.00	0.00	1300.07	32.04	32.04	19835
15	-7.20	0.00	151.20	0.00	1400.23	41.52	41.52	19835
16	-7.80	0.00	164.40	1.67	1500.38	48.04	48.04	19835
17	-8.40	0.00	177.60	4.27	1600.54	52.91	52.91	19835
18	-9.00	0.00	190.80	6.88	1700.70	57.03	57.03	19835
19	-9.50	0.00	201.80	9.06	1784.17	60.26	60.26	19835
20	-10.00	0.00	212.80	11.23	1867.63	63.46	63.46	19835

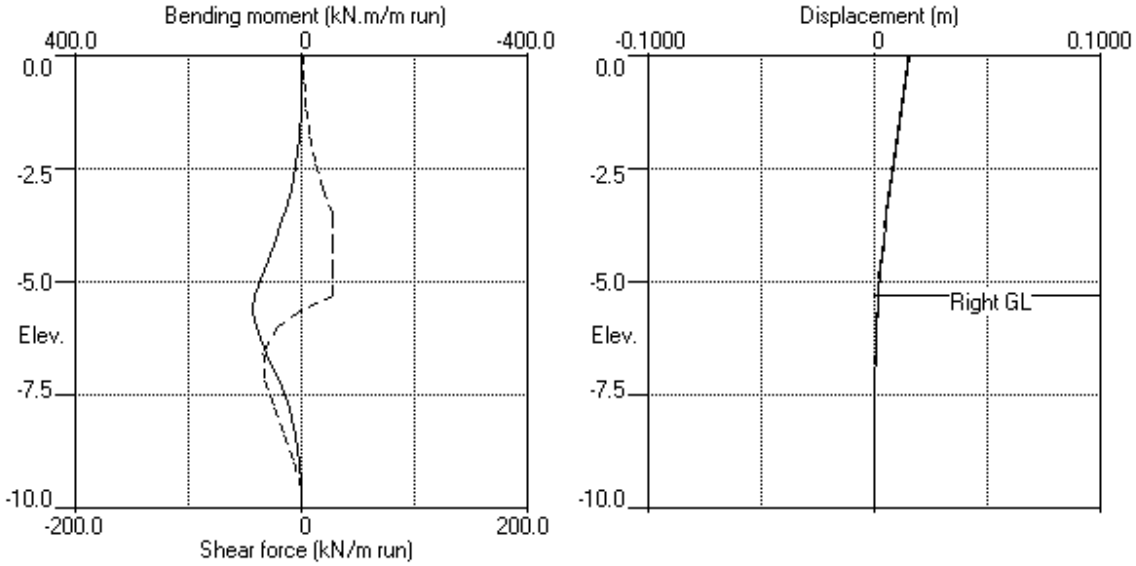
RIGHT side

Node no.	Y coord	Water press. kN/m2	Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	-0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	-1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	-1.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	-2.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	-2.97	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	-3.53	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	-3.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	-4.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	-4.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	-5.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	252.96	102.05	102.05	57185
12	-5.65	0.00	7.70	0.00	311.39	76.78	76.78	57185
13	-6.00	0.00	15.40	0.00	369.82	57.63	57.63	57185
14	-6.60	0.00	28.60	0.00	470.00	37.76	37.76	57185
15	-7.20	0.00	41.81	0.00	570.23	30.66	30.66	57185
16	-7.80	0.00	55.03	0.00	670.52	31.87	31.87	57185
17	-8.40	0.00	68.26	0.00	770.88	37.68	37.68	57185
18	-9.00	0.00	81.50	0.00	871.33	45.55	45.55	57185
19	-9.50	0.00	92.54	0.00	955.13	52.66	52.66	57185
20	-10.00	0.00	103.59	0.00	1039.00	59.87	59.87	57185

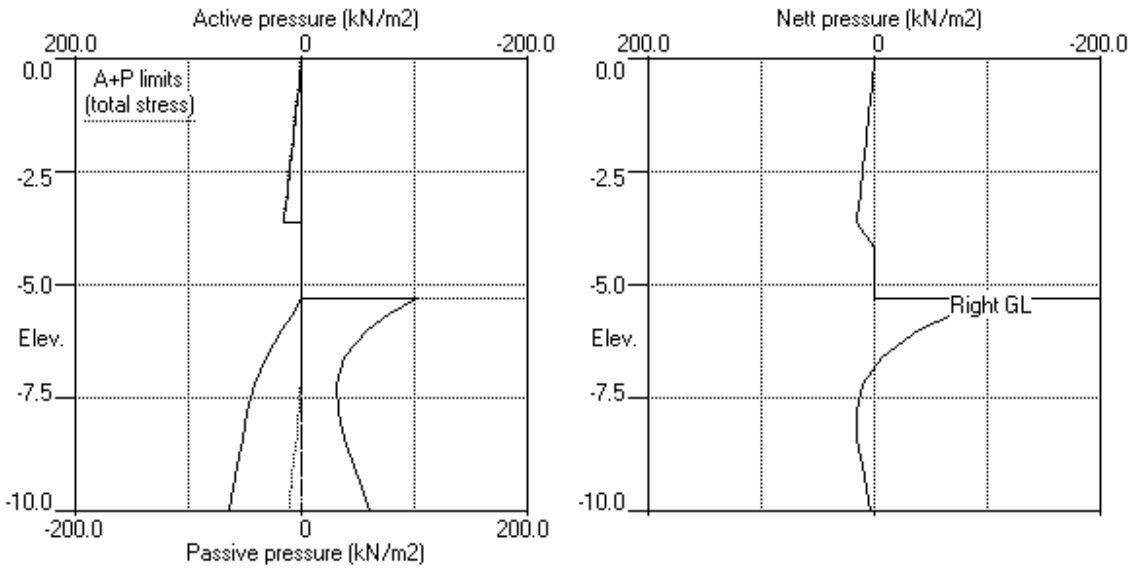
Note: 0.00a Soil pressure at active limit
123.45p Soil pressure at passive limit

Units: kN,m

Stage No.3 Fill to elev. 0.00 on LEFT side



Stage No.3 Fill to elev. 0.00 on LEFT side



Units: kN,m

Stage No. 4 Apply surcharge no.1 at elevation 0.00

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	G.L. Act.	G.L. Pass.	Strut Elev.	FoS for toe elev. = -10.00 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
4	0.00	-5.30	Cant.	2.101	-9.36	-7.81	2.51	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

*** Wall displacements reset to zero at stage 2

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Strut forces kN/m
1	0.00	0.00	0.021	4.05E-03	0.0	0.0	
2	-0.60	3.87	0.019	4.05E-03	1.2	0.2	
3	-1.20	7.90	0.017	4.05E-03	4.7	1.9	
4	-1.80	11.19	0.014	4.02E-03	10.4	6.3	
5	-2.40	14.12	0.012	3.95E-03	18.0	14.7	
6	-2.97	16.71	0.010	3.83E-03	26.7	27.3	
7	-3.53	19.20	0.007	3.61E-03	36.9	45.2	
8	-3.60	19.50	0.007	3.58E-03	38.2	47.8	
		0.00	0.007	3.58E-03	38.2	47.8	
9	-4.20	0.00	0.005	3.20E-03	38.2	70.8	
10	-4.75	0.00	0.004	2.73E-03	38.2	92.1	
11	-5.30	0.00	0.002	2.14E-03	38.2	113.1	
		-137.70	0.002	2.14E-03	38.2	113.1	
12	-5.65	-97.06	0.001	1.72E-03	-2.9	118.7	
13	-6.00	-54.90	0.001	1.30E-03	-29.5	111.7	
14	-6.60	-7.34	0.000	7.06E-04	-48.1	84.2	
15	-7.20	15.51	0.000	2.85E-04	-45.7	53.9	
16	-7.80	22.20	-0.000	3.53E-05	-34.4	29.3	
17	-8.40	20.91	0.000	-8.87E-05	-21.4	12.7	
18	-9.00	16.03	0.000	-1.35E-04	-10.4	3.6	
19	-9.50	11.19	0.000	-1.44E-04	-3.6	0.4	
20	-10.00	3.02	0.000	-1.45E-04	0.0	-0.0	

(continued)

Stage No.4 Apply surcharge no.1 at elevation 0.00

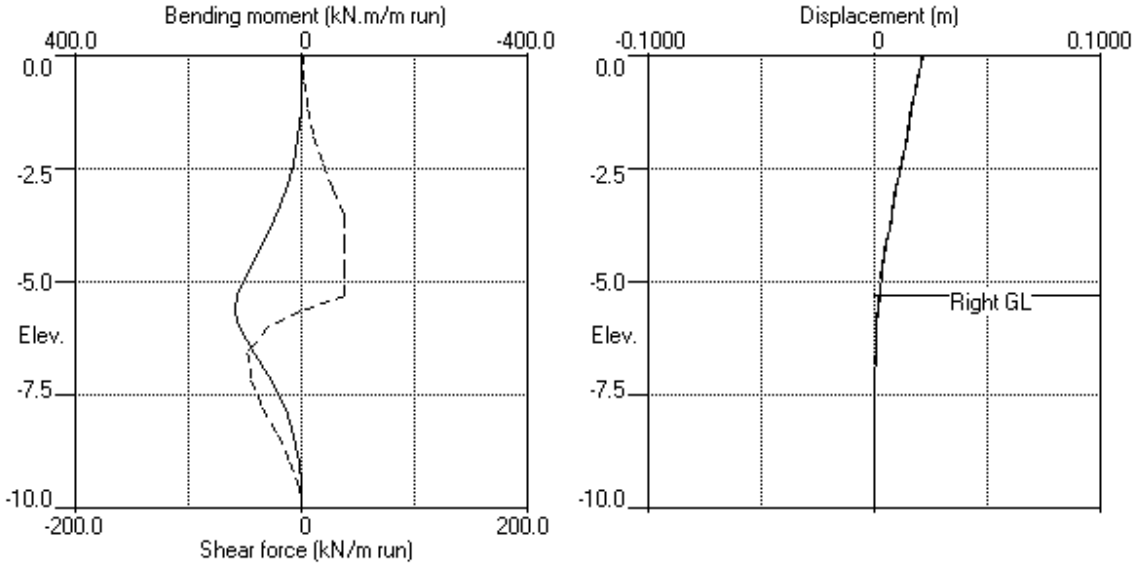
Node no.	Y coord	LEFT side ------- Effective stresses ------- Water press. kN/m2	Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6010
2	-0.60	0.00	17.86	3.87	116.71	3.87	3.87a	6010
3	-1.20	0.00	36.44	7.90	238.17	7.90	7.90a	6010
4	-1.80	0.00	51.60	11.19	337.24	11.19	11.19a	6010
5	-2.40	0.00	65.12	14.12	425.60	14.12	14.12a	6010
6	-2.97	0.00	77.07	16.71	503.65	16.71	16.71a	6010
7	-3.53	0.00	88.55	19.20	578.70	19.20	19.20a	6010
8	-3.60	0.00	89.95	19.50	587.84	19.50	19.50a	6010
		0.00	89.95	0.00	935.47	0.00	0.00a	20033
9	-4.20	0.00	102.99	0.00	1034.43	0.00	0.00a	20033
10	-4.75	0.00	114.77	0.00	1123.78	0.00	0.00a	20033
11	-5.30	0.00	126.43	0.00	1212.29	0.00	0.00a	20033
12	-5.65	0.00	133.82	0.00	1268.33	3.59	3.59	20033
13	-6.00	0.00	141.18	0.00	1324.23	17.35	17.35	20033
14	-6.60	0.00	153.79	0.00	1419.85	34.61	34.61	20033
15	-7.20	0.00	166.38	2.06	1515.37	45.74	45.74	28173
16	-7.80	0.00	178.97	4.54	1610.92	52.88	52.88	28173
17	-8.40	0.00	191.57	7.04	1706.57	57.50	57.50	28173
18	-9.00	0.00	204.20	9.53	1802.38	60.98	60.98	28173
19	-9.50	0.00	214.74	11.61	1882.35	63.68	63.68	50251
20	-10.00	0.00	225.30	13.70	1962.46	64.74	64.74	128235

Node no.	Y coord	RIGHT side ------- Effective stresses ------- Water press. kN/m2	Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	-0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	-1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	-1.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	-2.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	-2.97	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	-3.53	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	-3.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	-4.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	-4.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	-5.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	252.96	137.70	137.70	61264
12	-5.65	0.00	7.70	0.00	311.39	100.65	100.65	61264
13	-6.00	0.00	15.40	0.00	369.82	72.26	72.26	61264
14	-6.60	0.00	28.60	0.00	470.00	41.95	41.95	61264
15	-7.20	0.00	41.81	0.00	570.23	30.23	30.23	28173
16	-7.80	0.00	55.03	0.00	670.52	30.67	30.67	28173
17	-8.40	0.00	68.26	0.00	770.88	36.59	36.59	28173
18	-9.00	0.00	81.50	0.00	871.33	44.95	44.95	28173
19	-9.50	0.00	92.54	0.00	955.13	52.48	52.48	50251
20	-10.00	0.00	103.59	0.00	1039.00	61.71	61.71	128235

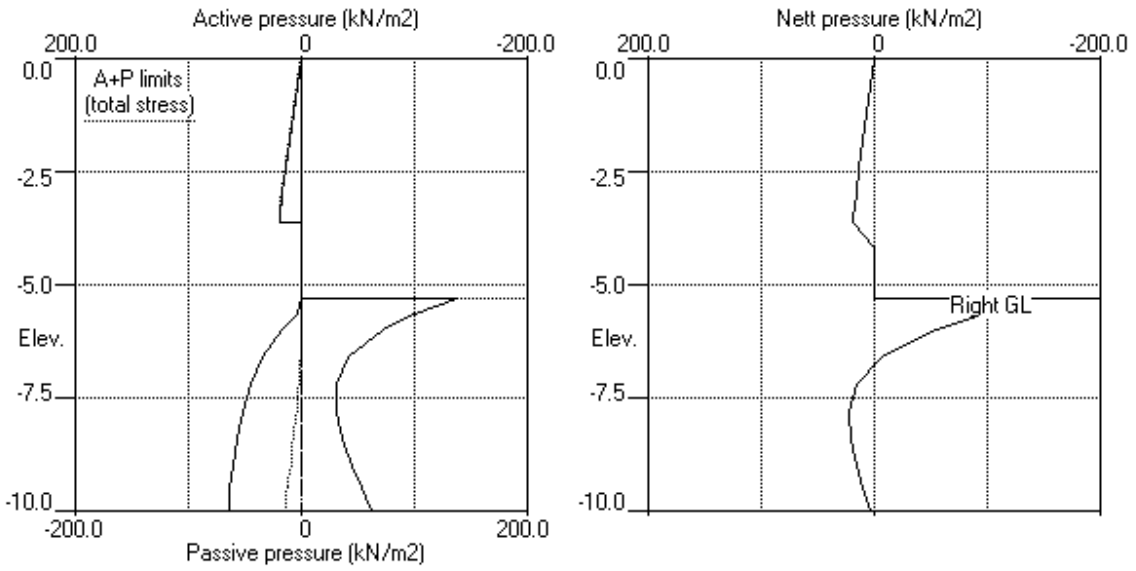
Note: 0.00a Soil pressure at active limit
123.45p Soil pressure at passive limit

Units: kN,m

Stage No.4 Apply surcharge no.1 at elev. 0.00



Stage No.4 Apply surcharge no.1 at elev. 0.00



Units: kN,m

Stage No. 6 Apply load no.1 at elevation -3.53

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

Stage No.	--- G.L. --- Act.	Pass.	Strut Elev.	Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.500	Wall Penetr -ation	Direction of failure
				FoS for toe elev. = -10.00				
6	0.00	-5.30	Cant.	1.753	-9.24	-9.09	3.79	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

*** Wall displacements reset to zero at stage 2

Node no.	Y coord	Nett pressure kN/m2	Wall disp. m	Wall rotation rad.	Shear force kN/m	Bending moment kN.m/m	Strut forces kN/m
1	0.00	0.00	0.061	1.06E-02	0.0	0.0	
2	-0.60	2.60	0.055	1.06E-02	0.8	0.2	
3	-1.20	5.20	0.049	1.06E-02	3.1	1.2	
4	-1.80	7.80	0.042	1.06E-02	7.0	4.2	
5	-2.40	10.41	0.036	1.06E-02	12.5	10.0	
6	-2.97	12.85	0.030	1.05E-02	19.1	18.8	
7	-3.53	15.30	0.024	1.03E-02	27.0	31.8	-122.6
		15.30	0.024	1.03E-02	149.6	31.8	
8	-3.60	15.61	0.023	1.03E-02	150.7	42.3	
		0.00	0.023	1.03E-02	150.7	42.3	
9	-4.20	0.00	0.017	9.78E-03	150.7	132.7	
10	-4.75	0.00	0.012	8.77E-03	150.7	216.0	
11	-5.30	0.00	0.008	7.28E-03	150.7	298.8	
		-252.96	0.008	7.28E-03	150.7	298.8	
12	-5.65	-311.39	0.005	6.12E-03	51.9	334.6	
13	-6.00	-213.39	0.003	4.88E-03	-39.9	337.8	
14	-6.60	-64.13	0.001	2.96E-03	-123.2	276.2	
15	-7.20	25.15	-0.000	1.50E-03	-134.9	190.8	
16	-7.80	52.34	-0.001	5.47E-04	-111.6	114.4	
17	-8.40	58.15	-0.001	1.42E-05	-78.5	56.8	
18	-9.00	53.22	-0.001	-2.25E-04	-45.0	20.2	
19	-9.50	46.03	-0.001	-2.88E-04	-20.2	4.4	
20	-10.00	34.90	-0.001	-2.99E-04	0.0	0.0	

(continued)

Stage No.6 Apply load no.1 at elevation -3.53

Node Y ---------- LEFT side ----------

no.	coord	Water press. kN/m2	Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
		------- Effective stresses -------						
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5491
2	-0.60	0.00	12.00	2.60	78.42	2.60	2.60a	5491
3	-1.20	0.00	24.00	5.20	156.85	5.20	5.20a	5491
4	-1.80	0.00	36.00	7.80	235.27	7.80	7.80a	5491
5	-2.40	0.00	48.00	10.41	313.69	10.41	10.41a	5491
6	-2.97	0.00	59.30	12.85	387.54	12.85	12.85a	5491
7	-3.53	0.00	70.60	15.30	461.39	15.30	15.30a	5491
8	-3.60	0.00	72.00	15.61	470.54	15.61	15.61a	5491
		0.00	72.00	0.00	799.28	0.00	0.00a	18303
9	-4.20	0.00	85.20	0.00	899.44	0.00	0.00a	18303
10	-4.75	0.00	97.30	0.00	991.25	0.00	0.00a	18303
11	-5.30	0.00	109.40	0.00	1083.06	0.00	0.00a	18303
12	-5.65	0.00	117.10	0.00	1141.48	0.00	0.00a	18303
13	-6.00	0.00	124.80	0.00	1199.91	0.00	0.00a	18303
14	-6.60	0.00	138.00	0.00	1300.07	17.99	17.99	18303
15	-7.20	0.00	151.20	0.00	1400.23	48.66	48.66	20277
16	-7.80	0.00	164.40	1.67	1500.38	66.13	66.13	20277
17	-8.40	0.00	177.60	4.27	1600.54	74.37	74.37	20277
18	-9.00	0.00	190.80	6.88	1700.70	77.90	77.90	20277
19	-9.50	0.00	201.80	9.06	1784.17	79.48	79.48	20277
20	-10.00	0.00	212.80	11.23	1867.63	79.11	79.11	20277

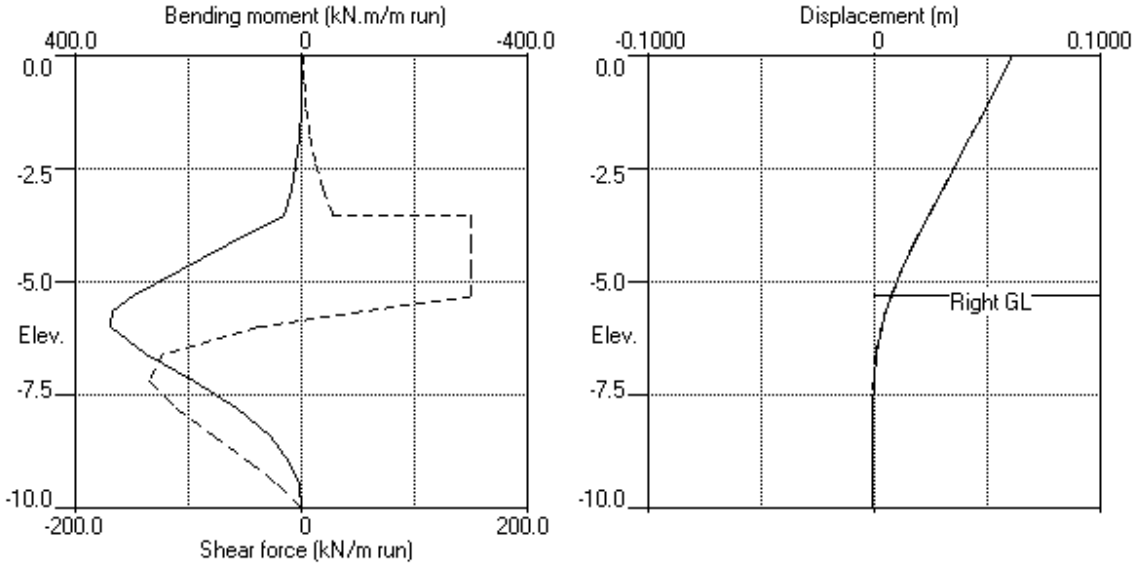
Node Y ---------- RIGHT side ----------

no.	coord	Water press. kN/m2	Vertic -al kN/m2	Active limit kN/m2	Passive limit kN/m2	Earth pressure kN/m2	Total earth pressure kN/m2	Coeff. of subgrade reaction kN/m3
		------- Effective stresses -------						
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	-0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	-1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	-1.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	-2.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	-2.97	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	-3.53	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	-3.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	-4.20	0.00	0.00	0.00	0.00	0.00	0.00	0.0
10	-4.75	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11	-5.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	252.96	252.96	252.96p	58023
12	-5.65	0.00	7.70	0.00	311.39	311.39	311.39p	58023
13	-6.00	0.00	15.40	0.00	369.82	213.39	213.39	58023
14	-6.60	0.00	28.60	0.00	470.00	82.13	82.13	58023
15	-7.20	0.00	41.81	0.00	570.23	23.52	23.52	20277
16	-7.80	0.00	55.03	0.00	670.52	13.78	13.78	20277
17	-8.40	0.00	68.26	0.00	770.88	16.22	16.22	20277
18	-9.00	0.00	81.50	0.00	871.33	24.68	24.68	20277
19	-9.50	0.00	92.54	0.00	955.13	33.45	33.45	20277
20	-10.00	0.00	103.59	0.00	1039.00	44.21	44.21	20277

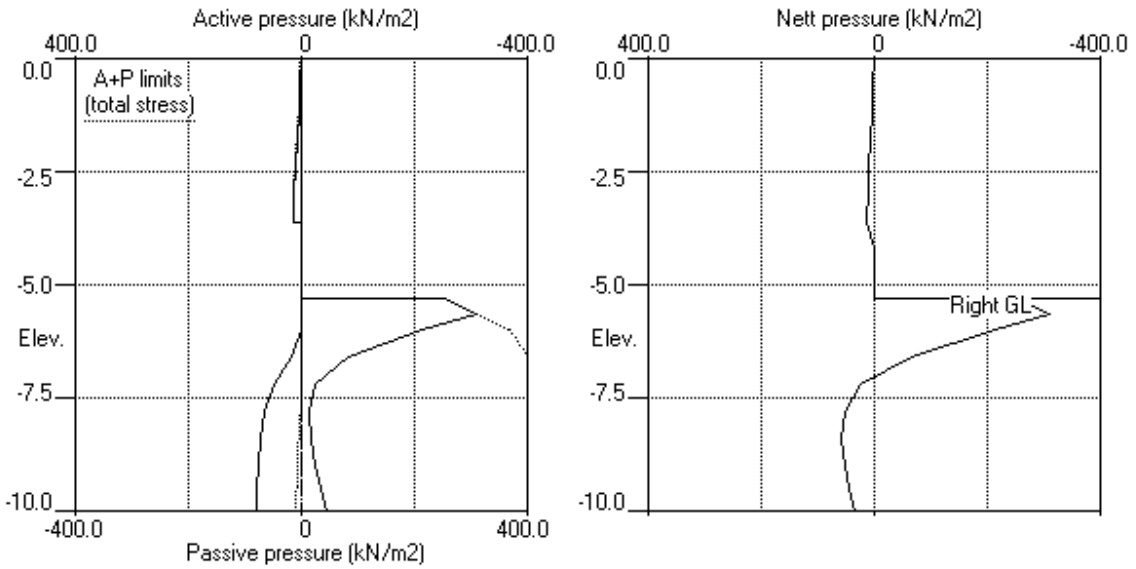
Note: 0.00a Soil pressure at active limit
311.39p Soil pressure at passive limit

Units: kN,m

Stage No.6 Apply load no.1 at elev. -3.53



Stage No.6 Apply load no.1 at elev. -3.53



Units: kN,m

Summary of results

STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method
Factor of safety on soil strength

Stage No.	--- G.L. --- Act.	Pass.	Strut Elev.	Factor of Safety	Moment equilib. at elev.	FoS for toe elev. = -10.00 Toe elev.	Toe elev. for FoS = 1.500 Wall Penetr-ation	Direction of failure
1	-3.60	-5.30	Cant.	Conditions not suitable for FoS calc.				
2	-3.60	-5.30		No analysis at this stage				
3	0.00	-5.30	Cant.	2.353	-9.37	-7.34	2.04	L to R
4	0.00	-5.30	Cant.	2.101	-9.36	-7.81	2.51	L to R
5	0.00	-5.30		No analysis at this stage				
6	0.00	-5.30	Cant.	1.753	-9.24	-9.09	3.79	L to R

Units: kN,m

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00m
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 20.00 from wall
Right side 20.00 from wall

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum	Displacement minimum	Bending moment maximum	Bending moment minimum	Shear force maximum	Shear force minimum
		m	m	kN.m/m	kN.m/m	kN/m	kN/m
1	0.00	0.061	0.000	0.0	-0.0	0.0	0.0
2	-0.60	0.055	0.000	0.2	0.0	1.2	0.0
3	-1.20	0.049	0.000	1.9	-0.0	4.7	0.0
4	-1.80	0.042	0.000	6.3	-0.0	10.4	0.0
5	-2.40	0.036	0.000	14.7	-0.0	18.0	0.0
6	-2.97	0.030	0.000	27.3	-0.0	26.7	0.0
7	-3.53	0.024	0.000	45.2	-0.0	149.6	0.0
8	-3.60	0.023	0.000	47.8	0.0	150.7	0.0
9	-4.20	0.017	0.000	132.7	-0.0	150.7	0.0
10	-4.75	0.012	0.000	216.0	0.0	150.7	0.0
11	-5.30	0.008	0.000	298.8	0.0	150.7	0.0
12	-5.65	0.005	0.000	334.6	0.0	51.9	-2.9
13	-6.00	0.003	0.000	337.8	0.0	0.9	-39.9
14	-6.60	0.001	0.000	276.2	0.0	0.0	-123.2
15	-7.20	0.000	-0.000	190.8	0.0	0.0	-134.9
16	-7.80	0.000	-0.001	114.4	0.0	0.0	-111.6
17	-8.40	0.000	-0.001	56.8	0.0	0.0	-78.5
18	-9.00	0.000	-0.001	20.2	0.0	0.0	-45.0
19	-9.50	0.000	-0.001	4.4	0.0	0.0	-20.2
20	-10.00	0.000	-0.001	0.0	-0.0	0.0	0.0

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment maximum	elev.	Bending moment minimum	elev.	Shear force maximum	elev.	Shear force minimum	elev.
	kN.m/m		kN.m/m		kN/m		kN/m	
1	2.9	-6.60	-0.0	-4.20	3.3	-5.30	-1.2	-7.80
2	No calculation at this stage							
3	85.9	-5.65	-0.0	-10.00	28.1	-3.60	-34.6	-6.60
4	118.7	-5.65	-0.0	-10.00	38.2	-3.60	-48.1	-6.60
5	No calculation at this stage							
6	337.8	-6.00	0.0	0.00	150.7	-3.60	-134.9	-7.20

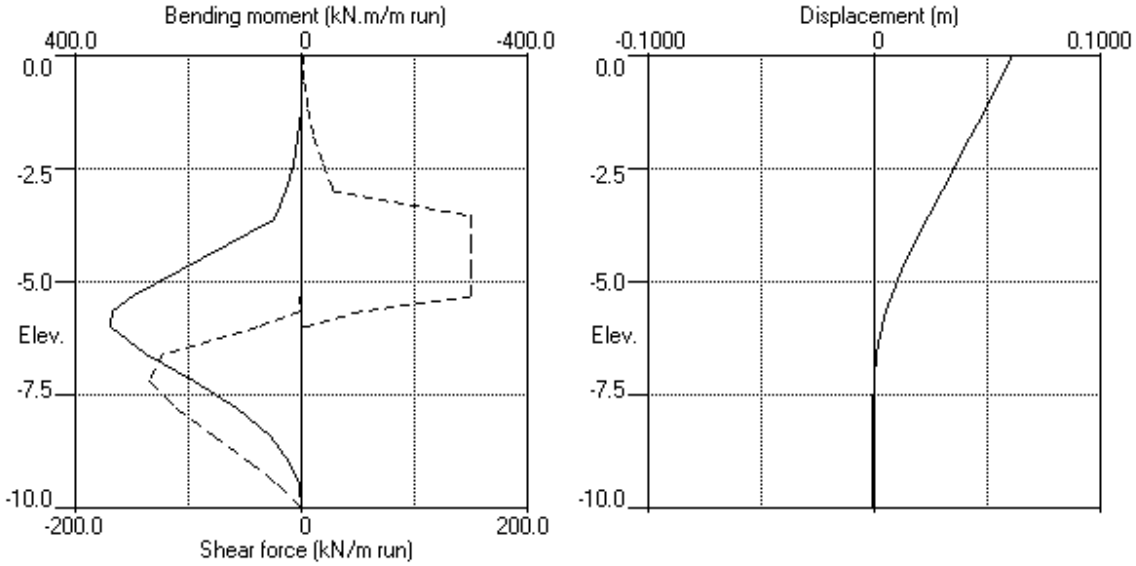
Maximum and minimum displacement at each stage

Stage no.	Displacement maximum	elev.	Displacement minimum	elev.	Stage description
	m		m		
1	0.001	0.00	0.000	0.00	Excav. to elev. -5.30 on RIGHT side
2	Wall displacements reset to zero Change EI of wall to 94764kN.m2/m run				
3	0.015	0.00	0.000	0.00	Fill to elev. 0.00 on LEFT side
4	0.021	0.00	-0.000	-7.80	Apply surcharge no.1 at elev. 0.00
5	No calculation at this stage				Remove surcharge no.1 at elev. 0.00
6	0.061	0.00	-0.001	-8.40	Apply load no.1 at elev. -3.53

Summary of results (continued)

Units: kN,m

Bending moment, shear force, displacement envelopes



This spreadsheet is for design of timber lagging for pole walls. This template approved for use by Alan Wightman in September 2019. Updated November 2021.

Input parameters

$K_A := 0.235$ Soil Active pressure coefficient (Coulomb)

$K_{AE} := 0.619$ Soil Active seismic pressure coefficient (Mononobe-Okabe)

$\phi := 20 \cdot \frac{kN}{m^3}$ Backfill unit weight

$Q_s := 12 \cdot kPa$ Surcharge applied behind wall on the active side

$H_{ret} := 3.5 \cdot m$ Depth of lagging.

$Post\_Spacing := 1.0\ m$ Pole Spacing (centre to centre)

$Post\_Width := 0.6\ m$ Width of retaining post

$Seating := 0 \cdot m$ Seating of the lagging. Equal to the post width if the post edge is flat (e.g. UC posts), and zero if the post is round

$b := 150 \cdot mm$ Lagging height (not too important; 200mm is typical). In terms of NZS3603, this is "breadth of member perpendicular to direction of flexural loading".

$d := 50 \cdot mm$ Lagging thickness (contractor will probably want to use 50mm - they need to pre-order 75mm). In terms of NZS3603, this is "depth of member in direction of flexural loading."

$N_l := 1$ Number of lagging layers

Timber factors

Contractors report that they can only get SG8 (wet) or SG6 (wet) - suggest you use SG8 (wet)

$E := 6.5 \cdot GPa$ Modulus of Elasticity of timber

$f_b := 11.7 \cdot MPa$ Timber flexural strength

Grade	Colour Marks (MSG)	Bending Strength (MPa)	Bending Stiffness (GPa)
SG10 (dry) (old VSG10)		20.0	10.0
SG8(dry) (old VSG8)		14.0	8.0
SG8(wet) (old G8 grade)		11.7	6.5
SG6(wet) (new grade)		7.5	4.8

Source of table "Timber_Grade_Verified_Info_Sheet.pdf"

$\delta := 0.8$ Reduction factor for timber in bending (clause 2.5 of NZS 3603:1993)

$k_4 := 1$ Parallel support factor (clause 2.9 of NZS 3603)

$L_{ay} := Post\_Spacing - Seating = 1\ m$

Distance between points of restraint against lateral movements of the compression edge of the lagging (clause 3.2.5.2)

$k_8 := 0.98$

Stability factor. As lagging is oriented in the opposite way to normal beams (lagging's weak side is parallel to direction of flexural loading), have juxtaposed b and d in the equations.

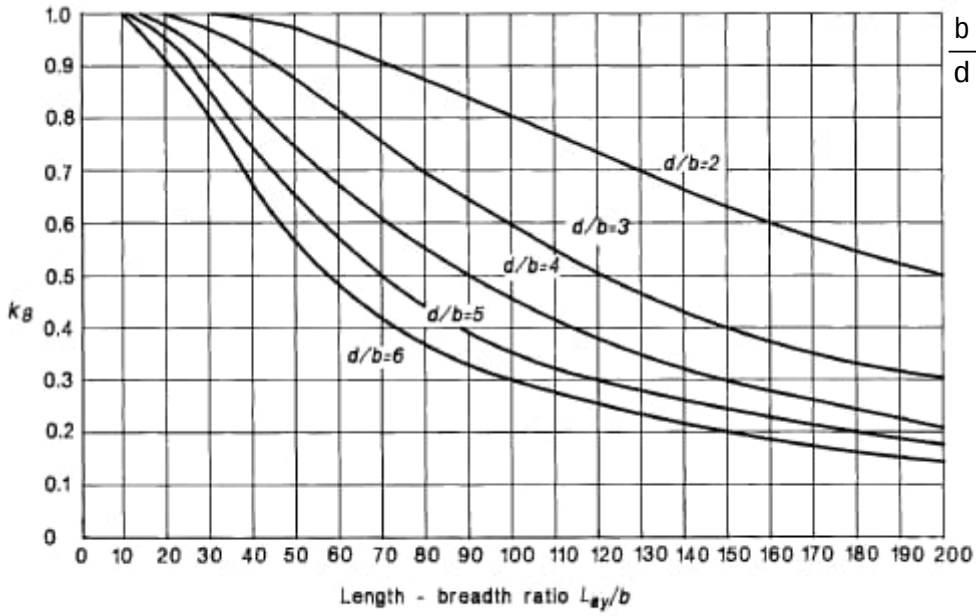


Figure 3.2 – k_8 for beams – green timber

$\frac{b}{d} = 3$

$\frac{L_{ay}}{d} = 20$

$$S_f := \min\left(\left(\frac{\left(\frac{Post\_Spacing}{Post\_Width} - 2\right)}{4}\right), 1\right) = -0.083$$

$\frac{Post\_Spacing}{Post\_Width} = 1.667$

Active pressure reduction factor to allow for arching between the poles. High sf = more pressure on the lagging. This takes account that not all soil pressure will be taken by the lagging - much of it will go onto the poles. Kourkoulis et al (2011) suggest that full arching is available when the spacing ratio is 2, and that almost no arching is available when the spacing ratio is above 5 - this equation allows an interpolation between spacing ratios of 2 and 6.

Case 1 - Gravity Case

Load and reduction factors

$LF_{ep} := 1.5$

Load factor for lateral earth pressure. A factor of 1.5 for gravity conditions is stated in Module 6, equation 6-4.

$LF_{sur} := 0.4$

Load factor for surcharge. If the surcharge is a live load, this is 0.4. If the surcharge is a dead load, this is 1.2 (Module 6, equation 6-4.)

$k_1 := 0.6$

Timber load duration factor for permanent loads (clause 2.7 of NZS 3603)

Calculations:

$$Pressure := \left\langle LF_{ep} \cdot K_A \cdot \phi \cdot H_{ret} + LF_{sur} \cdot K_A \cdot Q_s \right\rangle \cdot S_f = -2.15\ kPa$$

convert pressure to UDL on plank

$$\beta := Pressure \cdot b = -0.323\ \frac{kN}{m}$$

Maximum moment in the plank, conservatively assuming lagging lies across a single span

$$Mstar := \beta \cdot \frac{(Post\_Spacing - Seating)^2}{8} = -40\ N \cdot m$$

$$\delta M_n := \delta \cdot k_1 \cdot k_4 \cdot k_8 \cdot f_b \cdot d^2 \cdot b \cdot \frac{1}{6} \cdot N_l = 344\ N \cdot m$$

$$Status_1 := \begin{cases} \text{if } \delta M_n > Mstar \\ \quad \text{“OK”} \\ \text{if } \delta M_n \| Mstar \\ \quad \text{“NG”} \end{cases}$$

$Status_1 = \text{“OK”}$

$$I := b \cdot \frac{d^3}{12} \qquad Deflection := 5 \cdot \frac{\beta}{N_l \cdot LF_{ep}} \cdot \frac{(Post\_Spacing - Seating)^4}{384 \cdot E \cdot I} = -3 \cdot 10^{-1}\ mm$$

Note L.f included to get back to unfactored loads for calculating displacement

Case 2 - Seismic Case

Load and reduction factors

$LF_{epeq} := 1.0$ — Load factor for lateral earth pressure. A factor of 1.0 for seismic conditions is stated in Module 6, equation 6-5.

$LF_{sureq} := 0.3$ — Load factor for surcharge. If the surcharge is a live load, this is 0.3. If the surcharge is a dead load, this is 1.0 (Module 6, equation 6-5.)

$k_{1eq} := 1.0$ — Timber load duration factor for short term loads (clause 2.7 of NZS 3603)

Calculations:

$$Pressure_{eq} := \left\langle LF_{epeq} \cdot K_{AE} \cdot \phi \cdot H_{ret} + LF_{sureq} \cdot K_{AE} \cdot Q_s \right\rangle \cdot S_f = -3.797\ kPa$$

$$\beta_{eq} := Pressure_{eq} \cdot b = -0.569\ \frac{kN}{m}$$

$$Mstar_{eq} := \beta_{eq} \cdot \frac{(Post\_Spacing - Seating)^2}{8} = -71\ N \cdot m$$

$$\delta M_{neq} := \delta \cdot k_{1eq} \cdot k_4 \cdot k_8 \cdot f_b \cdot d^2 \cdot b \cdot \frac{1}{6} \cdot N_l = 573\ N \cdot m$$

$$Status_2 := \begin{cases} \text{if } \delta M_{neq} > Mstar_{eq} \\ \quad \text{“OK”} \\ \text{if } \delta M_{neq} \| Mstar_{eq} \\ \quad \text{“NG”} \end{cases}$$

$Status_2 = \text{“OK”}$

APPENDIX 4:

Strataweb Geocell Product Information

StrataWeb®

Installation Guidelines – Slope protection

StrataWeb® geocells are light weight but strong three dimensional honeycomb-like cellular confinement systems. StrataWeb® is fabricated from ultrasonically-welded HDPE strips that are expandable at site to form a rhomboidal structure.

STRATA
Geosystems (India) Pvt Ltd

1. Site preparation

Stone, debris, rank material, dead wood etc should be removed from the site. In order to remove undulation and ensure proper placement of StrataWeb®, the slope should be dressed and compacted properly.


Dressing of slope

2. Crest anchorage

The anchor trench should be excavated as per the size and shape required. A minimum distance of 500 mm should be provided between trench and slope edge; to ensure that the anchor trench does not fail in shear or the anchor mound material does not erode over the crest. There should be no flow of water; which results in erosion of anchorage.


Excavation of trench

3. Connections and placement

The J hook (plain mild steel rods) has to be installed with 50mm protruding above the ground. The anchorage should be done as per the detailed drawing submitted. The adjoining panels of StrataWeb® should be connected by Strata connectors as per the drawing in length & width. StrataCord should be passed through the perforation/slot prior to expansion of the StrataWeb® panels. The panel should be connected face to face or flap to flap.


StrataFast


StrataLock


StrataCord


Cable ties

4. StrataWeb® placement

The sections of StrataWeb® should be expanded in designed position. After laying StrataWeb® in the anchor trench, the trench is infilled with specified material. The StrataWeb® panels are then expanded in length down the slope in the prescribed manner. Care should be taken that the expanded area conforms to the specifications.


Placement of StrataWeb®

5. Infill

Infilling should commence from top and gradually progress towards the bottom in order to avoid stressing the system. To prevent possible damage to the system, the height of infill drop should be limited to 0.5 m. The StrataWeb® panels should be overfilled by 25 mm to 50 mm with sand, granular or top soil fills, and should also allow for settling and compacting of the material.


Infilling with vegetative soil

Soil fills should be lightly hand-tamped with a mechanical tamper. In case of concrete (grade shall be as specified on the drawing), the infill should overtop StrataWeb® just adequate to trowel smooth without the rim of StrataWeb® being visible.

6. Finished slope


Finished slope with concrete infill


Finished slope with vegetative infill

Please note that the information above is given as a guide only. All sizes and weights are nominal figures and may vary to what is published. Strata Geosystems (India) Pvt. Ltd. will not be liable for damage caused by incorrect installation of this product. Final determination of the suitability of any information or material for the use contemplated and the manner of its use is the sole responsibility of the user and the user must assume all risk and responsibility in connection therewith. This field guide is provided as an aid to assessing the mechanical stabilization requirements in commonly encountered site conditions.

StrataWeb® 445 Product Data

STRATAWEB® is a high performance three dimensional cellular confinement system. Filled with granular material, StrataWeb provides superior confinement and reinforcement for load support, erosion control, and slope renforcement applications. StrataWeb is manufactured from extruded strips of HDPE that are precision welded to form multiple cell heights and sizes. Sections consist of 58 strips of HDPE, resulting in sections of 29 cells long and 8 cells wide. If perforations are required then 11% ± 2%, and up to 16% ± 3%, of the cell wall is removed.

MATERIAL PROPERTIES	TEST METHOD	UNIT	TEST VALUE
Polymer Density	ASTM D 1505	g/cm^3 (lb/ft^3)	0.935-0.965 (58.4-60.2)
Environmental Stress Crack Resistance	ASTM D 5397	hours	>400
Carbon Black Content	ASTM D 1603	% by weight	1.5% minimum
Nominal Sheet Thickness after texturing	ASTM D 5199	mm (mil)	1.52 (60) -5%, +10%
Polyethylene strip shall be textured with a multitude of rhomboidal (diamond shape) indentations. The rhomboidal indentations shall have a surface density of 22 to 31 per cm^2 (140 to 200 per in^2).			

PHYSICAL PROPERTIES	UNIT	TYPICAL VALUE			
Nominal-Expanded Cell Size (width x length)	mm (in)	320 (12.6) x 287 (11.3)			
Nominal-Expanded Cell Area	cm^2 (in^2)	460 (71.3)			
Nominal-Expanded Section (width x length)	m (ft)	2.56 (8.4) x 8.35 (27.4)			
Nominal-Expanded Section Area (width x length)	m^2 (ft^2)	21.4 (230)			
Cell Depth	mm (in)	75 (3)	100 (4)	150 (6)	200 (8)
Seam Peel Strength[1]	N (lbs)	1065 (240)	1420 (320)	2130 (480)	2840 (640)
Section Weight	kg (lbs)	19.5 (43)	25.9 (57)	39 (86)	51.7 (114)
Sections per Pallet	--	60	50	30	25
Seam Hang Strength	--	A 102mm (4in) weld joint supporting a load of 72.5 kg (160 lbs) for 30 days minimum or a 102mm (4in) weld joint supporting a load of 72.5 kg (160 lbs) for 7 days minimum while undergoing temperature change from 23°C (74°F) to 54°C (130°F) on a 1 hour cycle.			

[1] *Seam Peel Strength per U.S. Army Corps of Engineers Technical Report GL-86-19, Appendix A*

Strata Systems Inc
380 Dahlonega Rd., Suite 200, Cumming, GA 30040 USA
(770) 888-6688 • (800) 680-7750 • (770) 888-6680 Fax
Email: strata@geogrid.com • Website: www.geogrid.com

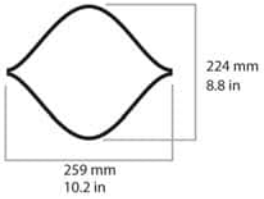
Specification is subject to change without notice. The sizing, use and selection of the products should be completed by a licensed design professional.

The performance data herein reflect Strata System, Inc.'s expectation based on tests conducted in accordance with recognized standard methods. The sale of these products shall be subject to the Terms and Conditions of Sale as set forth in Strata Systems, Inc. sales forms. Such Terms and Conditions of Sale will provide that Strata Systems, Inc. will have no liability for consequential damages and will include certain limited express warranties concerning these products. ALL OTHER EXPRESS AND IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED BY STRATA SYSTEMS, INC. No agent, employee or representative of Strata Systems, Inc. is authorized to modify this disclaimer.

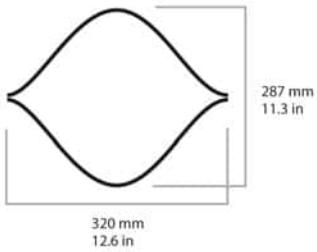
This product specification supersedes all prior specifications for the product described and is not applicable to any products shipped prior to January 1, 2015.

StrataWeb®

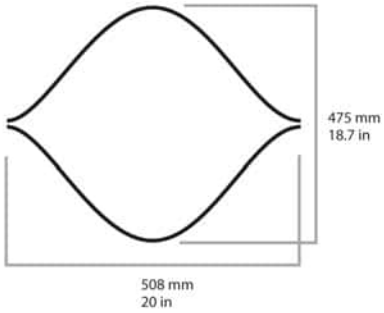
StrataWeb® is manufactured in three cell sizes



StrataWeb 356
8.4' x 21.4' (2.56m x 6.52m)



StrataWeb 445
8.4' x 27.4' (2.56m x 8.35m)

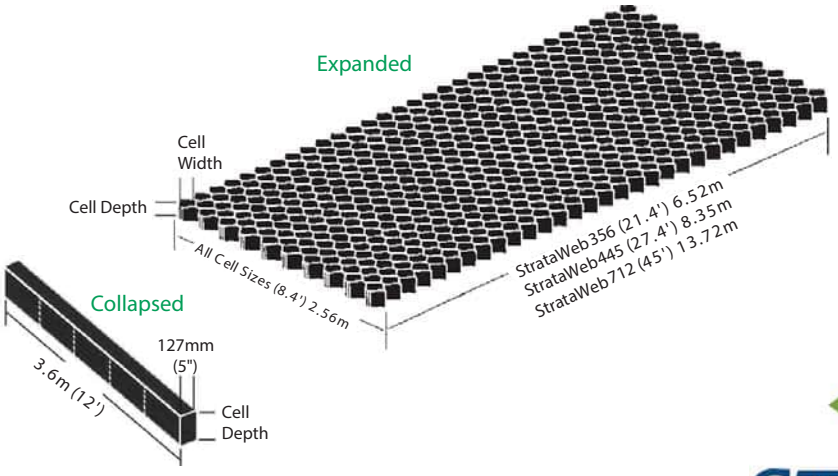


StrataWeb 712
8.4' x 45' (2.56m x 13.72m)

StrataWeb panels can be provided in cell heights of 3" (75mm), 4" (100mm), 6" (150mm), and 8" (200mm). Standard panels are constructed of 58 strips with the dimensions above.

Custom sizes and solid or perforated cell walls are available.
When perforations are required. Cell wall is perforated as follows:

1. Horizontal Rows: 10-mm diameter holes, 16.6 mm on center.
2. Stagger horizontal rows and separate 8.3 mm relative to hole centers.
3. Edge of Cell Wall to Nearest Edge of Perforations: 7.93 mm.
4. Centerline of Weld to Nearest Edge of Perforations: 27.9 mm minimum.
5. This corresponds to 11% ± 2%, and up to 16% ± 3% cell wall removed depending on the cell width and depth.



STRATA
Global GeoSolutions

www.geogrid.com

1.800.680.7750 380 Dahlonega Road, Suite 200, Cumming, GA 30040 USA

From: Natasha Garcia
To: Lakna Siriwardena
Subject: FW: [EXTERNAL] Re: Upcoming Road Closure at Point Howard
Date: Thursday, 26 October 2023 9:35:20 am

Nat Garcia
Project Manager - Transport
Hutt City Council, 30 Laings Road, Hutt Central, Lower Hutt, Lower Hutt 5010
P: M: 021 122 0083 W: www.huttcity.govt.nz

Natasha Garcia

Project Manager (Contractor)

Hutt City Council, 30 Laings Road, Hutt Central, Lower Hutt, Lower Hutt 5010

P: M: 021 122 0083 W: www.huttcity.govt.nz
-----Original Message-----
From: Jo Greenman [redacted]
Sent: Thursday, October 5, 2023 9:12 PM
To: Natasha Garcia <Natasha.Garcia@huttcity.govt.nz>
Subject: RE: [EXTERNAL] Re: Upcoming Road Closure at Point Howard

Thanks Natasha

Jo Greenman
KaiÄ piha Papa Atawhai |East Harbour Regional Park Ranger Greater Wellington Te Pane Matua Taiao
1056 Fergusson Drive, Upper Hutt 5018
PO Box 4087, Upper Hutt 5140
[redacted]
www.gw.govt.nz
Follow us online: Facebook | Twitter | gw.govt nz

-----Original Message-----
From: Natasha Garcia <Natasha.Garcia@huttcity.govt.nz>
Sent: Thursday, October 5, 2023 5:04 PM
To: Jo Greenman [redacted]; Claire Harman <Claire.Harman@huttcity.govt.nz>; Rochelle Carrig <Rochelle.Carrig@huttcity.govt.nz>
Subject: Re: [EXTERNAL] Re: Upcoming Road Closure at Point Howard

Hi Jo

I've put the signs out as requested.

Many thanks
Nat

Get Outlook for Android<https://aka.ms/AAb9ysg> _____ Natasha Garcia

Project Manager (Contractor)

Hutt City Council, 30 Laings Road, Hutt Central, Lower Hutt, Lower Hutt 5010

P: M: 021 122 0083 W: www.huttcity.govt.nzIMPORTANT: The information contained in this e-mail message may be legally privileged or confidential. The information is intended only for the recipient named in the e-mail message. If the reader of this e-mail message is not the intended recipient, you are notified that any use, copying or distribution of this e-mail message is prohibited. If you have received this e-mail message in error, please notify the sender immediately. Thank youFrom: Natasha Garcia
Sent: Thursday, October 5, 2023 12:36:31 PM
To: Jo Greenman [redacted]
Subject: RE: [EXTERNAL] Re: Upcoming Road Closure at Point Howard

Hi Jo

Just to let you know, the signs have arrived today and I will be putting them up later this afternoon.

Many thanks

Nat Garcia
Project Manager - Transport

Hutt City Council, 30 Laings Road, Hutt Central, Lower Hutt, Lower Hutt 5010
P: M: 021 122 0083 W: www.huttcity.govt.nz

[cid:image001.png@01D9F788.90FD42B0]

From: Jo Greenman [redacted]
Sent: Friday, September 15, 2023 8:08 AM
To: Natasha Garcia <Natasha.Garcia@huttcity.govt.nz>
Subject: [EXTERNAL] Re: Upcoming Road Closure at Point Howard

HI Natasha

Thanks for the heads up.

I will put a notice on our east harbour website. And In our in house park schedule.

You will need to put up signs at Lowry Bay Park entrances at Dillon and Cheviot roads. Also a sign at the top of wainui hill and Point howard Cheviot track junction.

Call me to chat.

[redacted]

Jo

Get Outlook for Android<https://aka.ms/AAb9ysg>

From: East Harbour Ranger <EastHarbour.Ranger@gw.govt nz<mailto:EastHarbour.Ranger@gw.govt.nz>>
Sent: Thursday, September 14, 2023 8:58:53 pm
To: Jo Greenman [redacted]
Subject: FW: Upcoming Road Closure at Point Howard

From: Natasha Garcia <Natasha.Garcia@huttcity.govt.nz<mailto:Natasha.Garcia@huttcity.govt nz>>
Sent: Thursday, 14 September 2023 8:58:32 pm (UTC+12:00) Auckland, Wellington
To: East Harbour Ranger <EastHarbour.Ranger@gw.govt nz<mailto:EastHarbour.Ranger@gw.govt nz>>
Subject: Upcoming Road Closure at Point Howard

Hi,

By way of introduction, I am a project manager at Hutt City Council within the Transport Team.

We are in the process of planning a slip repair at 76/78 Howard Road, Point Howard, which partially collapsed in March.

Due to width restrictions, the contractor has advised us that the road will need to be closed during the repairs. More specifically there will be

limited pedestrian access between 7.30-9am and 3-4pm on weekdays

no pedestrian or vehicle access from 9am-3pm on weekdays

Construction will start on the 9th October and run for around six weeks.

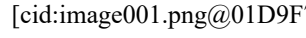
I need to understand what GWRC will require from us in terms of planning for access to the East Harbour Regional Park during the road closures.

Iā€™m happy to discuss in person, or over email, and provide you with whatever information you require.

Many thanks

Nat Garcia
Project Manager - Transport

Hutt City Council, 30 Laings Road, Lower Hutt 5010
P: M: 021 122 0083 W: www.huttcity.govt.nz



Natasha Garcia
Project Manager (Contractor)

Hutt City Council, 30 Laings Road, Hutt Central, Lower Hutt, Lower Hutt 5010
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WAKA KOTAHI NZ TRANSPORT AGENCY	RCA consent (eg CAR/WAP) and/or RCA contract reference	

TRAFFIC MANAGEMENT PLAN (TMP) – FULL FORM

Use this form for complex activities. Refer to the NZ Transport Agency's Traffic control devices manual, part 8 Code of practice for temporary traffic management (CoPTTM), section E, appendix A for a guide on how to complete each field.

Organisations /TMP reference	**TMP reference:** HA7678	**Contractor (Working space):** Halverson Civil Ltd	**Principal** *(Client)*: Hutt City Council
		Contractor (TTM): Halverson Civil Ltd	**RCA:** Hutt City Council

Location details and road characteristics	**Road names and suburb**	**House no./RPs** *(from and to)*	**Road level**	**Permanent speed**
	Howard Road, Point Howard	66-82	1	50Kph
	Ngaumatau Rd Nikau Road	1-2 25-41	1 1	50Kph 50Kph

Traffic details (main route)	**AADT**	**Peak flows**
	N/A - Dead end road servicing all properties past 76 and 78 Howard Road	N/A - Dead end road servicing all properties past 76 and 78 Howard Road

Description of work activity

- Construction of new retaining wall on downslope section of road, outside 76 and 78 Howard Road.
- Works to be complete in 2 stages – 1st stage involves temporary works and stage 2 is drilling and installing retaining wall.
- Stage 1 & 2 – Excavators and work vehicles on site in road closed areas.
- Road will be closed to CARS during construction activities between 8am to 4pm to enable construction, no space to enable cars or pedestrians to safely pass through.
- HCC to manage all communications regarding access times and requirements. Letter attached to CAR – residents meeting handout.
- Minor Setup - Setup and packing down site between 7.30am and 8.00am and 4.00pm and 4.30pm.
- Minor Works – Pedestrian Access Only 8-9am, 12-12.30pm, 3-4.00pm.
- Full Works – NO ACCESS Through works for anyone – alternative route for pedestrians as per meeting handout.
- STMS and or TC to manage deliveries into site, stopping access through during construction times.

(refer pg 2 for additional comments

Emergency services have been notified – emergency access plan to be in place with HCC to arrange plan. Attached to CAR.

Planned work programme

Start date	09/10/2023	**Time**	7:30	**End date**	01/12/2023	**Time**	16.30

Consider significant stages, for example:

- road closures
- detours
- no activity periods.

STMS and 1 ~~TMC~~* on site *TC or TMO

Site will be setup each day from 7.30am – 8.00am and packed down by 16.00pm to 16.30pm.

Daytime STMS & TMC will manage the pedestrians and cyclists and stop vehicle from going past the Closed Road when road is closed 8.00 – 16.00.

The existing slip currently has road narrowing to 2.5m with weight limits of 3.5ton. This will be maintained and installed at the end of each day, on weekends and overnight – or when any works are not taking place on site for other reasons – Excavator to remain on site and parked off the road.

No works permitted on weekends or public holidays (Labour Day, 23 Oct) unless prior written approval has been provided by the Corridor Manager, to be uploaded to the CAR

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Jason Wildman
STMS Number 307 43
Hutt City Council
04 October 2023

RCA consent (eg CAR/WAP) and/or RCA contract reference	

Alternative dates if activity delayed	Works to be completed within the dates on this TMP TMP will be resubmitted with new dates if required

Road aspects affected *(delete either Yes or No to show which aspects are affected)*					
Pedestrians affected?	Yes	**Property access affected?**	Yes	**Traffic lanes affected?**	Yes
Cyclists affected?	Yes	**Restricted parking affected?**	No	**Delays or queuing likely?**	Yes
Proposed traffic management methods					

TMC comments (in reference to pg 1)

1. Cannot prevent entry / exit to residential properties during *Full Works*. As previously discussed there may be unforeseen / unplanned instances where residents may need for example, a medical delivery (none emergency situation), leaving to pick up an ill child from school, an unplanned/urgent doctor's appointment etc. Anyone with a mobility issue are to be considered as well as alternative route ie track is unsuitable for them to use. Such instances are to be considered and permitted at all times under TM personnel assistance and guidance.
2. Arrangements for kerb side collections are to be made with residents and Waste Management.

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Hutt City Council
04 October 2023

Installation *(includes parking of plant and materials storage)*	Upon arrival the STMS will carry out the following: Emergency Services are to be notified at least 30min prior to closing the road ➢ A site briefing to identify existing and potential hazards, ➢ If working in the live lane, perform a traffic count to ascertain queuing thresholds and postpone work if required, ➢ Confirm TTM requirements and select the appropriate approved TMD ➢ Confirm and working space crew roles and their understanding of intended procedures as per the approved TMP/TMD, ➢ Inspect all TTM apparatus including vehicle mounted beacons, mobile mounted and static sign systems to ensure all is in acceptable condition and in working order, ➢ Perform a drive through of the intended site. 1st Drive through pre-site establishment procedures: Upon arrival the STMS will carry out the following: ➢ Perform a drive through and check the site before establishment of the static setups in order to carry-out a hazard assessment, confirm the correct TMD has been chosen and ensure the site can be established safely. Installation procedures: ➢ Mobile operations to establish the static closure will be carried out as per the minimum vehicle requirements outlined in: ➢ CoPTTM Section D5.4.4 Summary of Requirements for Mobile Closures, ➢ The approved mobile and static TMDs approved under this TMP Operations to install TTM signs and devices to establish the static site shall be performed in this order: ➢ 1st sign installed must be a left-hand advanced warning sign on each road-user approach, ➢ Additional direction and protection signage and end of works signage installed on same side of road including any side streets, ➢ Vehicle completes a loop on a single direction carriageway or performs a safe turn on a bidirectional road to install advanced warning, direction and protection and end of works signs on opposite side of the road, ➢ Once all signs have been installed, delineation devices that form the taper or lateral exclusion zones may be installed. Drive through and site check procedures: ➢ Prior to personnel, vehicle, plant and machinery populating the worksite, a drive through check must be performed by the STMS to ensure the site has been set up as per the selected TMDs, this should include the checking of worksite layout distances as per CoPTTM 2.5 level 1-dimension tables. Working space population: ➢ All work vehicles and mobile plant and machinery will be migrated onto site as per the delineated merge/site access points or as per the STMS directions, ➢ Flashing amber beacons shall be utilized on all vehicles entering the worksite along with vehicle indicators. Once inside a static working space all beacons shell be turned off and vehicle hazard lights initiated, ➢ Flashing amber beacons shall be kept on in a semi-static or mobile type operation, ➢ Where the working space cannot accommodate a working vehicle, all personnel, plant and machinery will be migrated onto site utilizing a mobile operation or by way of an existing pedestrian thoroughfare or by way of a temporary thoroughfare that is safe, controlled and managed by the STMS.The Onsite Record form will be completed to record the establishment details for the site.

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Jason Waldron
STMS Number 307 43
Waka Kotahi
04 October 2023

Attended (day)	STMS or delegated TC to stay onsite at all times /TMD Proposed traffic management measures will be implemented as per the static TMD requirements. of this TMP by the warranted STMS, this will require: ➢ A road closure will be in place as per site specific diagrams, and in accordance with F2.24 (as attached excluding detour owing to no detour route being available ➢ The road level and speed ➢ the duration of the work ➢ the position of the working space and the dimensions of the closure ➢ the effect on special zones i.e. footpaths, cycle-lanes, parking, loading and service zones The relevant TMD will be selected based off the above site attributes and traffic management methods implemented as per the approved TMD and other parameters covered in the approved TMD.
Attended (night)	N/A
Unattended (day)	STMS to check site at the completion of each day and check that the site is set out in compliance to the approved TMP and all hazards are adequately barricaded. as per Section B7 of the CoPTTM The site is to be checked at least once in a 24 hour period. In adverse weather will check it one in 12 hours.
Unattended (night)	STMS to check site at the completion of each day and check that the site is set out in compliance to the approved TMP and all hazards are adequately barricaded. The site is to be checked at least once in a 24 hour period. In adverse weather will check it one in 12 hours.
Detour route	None available
	Does detour route go into another RCA's roading network? Yes *(delete either Yes or No)* *If Yes, has confirmation of acceptance been requested from that RCA?* No *(delete either Yes or No)* ***Note:*** *Confirmation of acceptance from affected RCA must be submitted prior to occupying the site.*

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Jason Wildman
STMS Number 307 43
Hutt City Council
04 October 2023

RCA consent (eg CAR/WAP) and/or RCA contract reference	

Removal	Pre-removal procedures: Emergency Services are to be notified at least 30min prior to disestablishing the road closure ➢ Identify any site-specific issues to be addressed regarding disestablishment of the site, document them and make notes on the TMP if required, ➢ Confirm that the closure area/working space has been safely cleared of all non TTM personnel and, equipment Removal procedure: ➢ Mobile operations to disestablish the static closure will be carried out as per the minimum vehicle requirements outlined in: ➢ CoPTTM Section D5.4.4 Summary of Requirements for LV/LR, LV and L1 Mobile Closures, ➢ The approved mobile TMDs approved under this TMP Operations to remove TTM signs and devices to disestablish a static site shall be performed in this order: ➢ All work vehicles and mobile plant and machinery will be removed and vacated from site as per the delineated merge/site access points or as per the STMS directions. Flashing amber beacons shall be utilized on all vehicles leaving the worksite along with vehicle indicators. Once outside the closure area all beacons shall be turned off, ➢ If no work vehicles are within the working space, any personnel, plant and machinery will be vacated from site utilizing a mobile operation or by way of an existing pedestrian thoroughfare or by way of a temporary thoroughfare that is safe, controlled and managed by the STMS, ➢ The STMS shall check the working space is clear and then precede to safely remove all delineation devices that formed the closure area, ➢ All direction and protection and end of works signage shall be removed from each side of the road including any side streets, all advanced warning signage will be left in place ➢ All advanced warning signage shall be removed including all side streets, ➢ A drive through check shall be performed by the STMS to ensure the site has been completely disestablished The Onsite Record form will be completed to record the ~~establishment~~ disestablishment details for the site.~~30~~

Proposed TSLs *(see TSL decision matrix for guidance)*

	TSL details as required Approval of Temporary Speed Limits (TSL) are in terms of Section 6 of Land Transport Rule: Setting of Speed Limits 2017, Rule 54001/2017 *(List speed, length and location)*	**Times** *(From and to)*	**Dates** *(Start and finish)*	**Diagram ref. no.s** *(Layout drawings or traffic management diagrams)*
Attended day/night	A temporary maximum speed limit of km/h is hereby fixed for motor vehicles travelling over the length of m situated between (House no./RP) and (House no./RP) on (street or road name)	N/A	N/A	N/A

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Jason Wildman
STMS Number 307 43
Site Owner
04 October 2023

WAKA KOTAHI NZ TRANSPORT AGENCY	RCA consent (eg CAR/WAP) and/or RCA contract reference	

Unattended day/night	A temporary maximum speed limit of **30**km/h is hereby fixed for motor vehicles travelling over the length of **100**m situated between **82A** (House no./RP) and **66** (House no./RP) on **howard Rd** (street or road name) Actual TSL details to be documented on the day as these may vary based on work progress	~~09/10/2023~~ 16:30 to 07.30	~~01/12/2023~~ ~~07:30~~ 9/10/23 to 1/12/23	F2.16
TSL duration	Will the TSL be required for longer than 12 months? ***If yes**, attach the completed checklist from section I-18: Guidance on TMP Monitoring Processes for TSLs to this TMP.*			No

Positive traffic management measures

All signs, cones and equipment will comply with NZTA COPTTM version 4. *

Delineation devises will be 900mm cones and 750mm x 750mm signs * with 900 x 300 supplementary signage.

Closures will be put in place as per the attached diagrams

Pedestrian Management

STMS will remain onsite at all times while the site is active *

A Briefing / Toolbox meeting will be held prior to setup with STMS and Contractors *

* TMC comment - these are not positive TM measures, they are a required TM equipment / requirements regardless. Refer to Section C10 for description and examples

Contingency plans

Generic contingencies for:	**Major Incident**	**Actions**
• major incidents • incidents • pre planed detours. *Remove any options which do not apply to your job*	A major incident is described as: • Fatality or notifiable injury - real or potential • Significant property damage, or • Emergency services (police, fire, etc) require access or control of the site.	The STMS must immediately conduct the following: • stop all activity and traffic movement • secure the site to prevent (further) injury or damage • contact the appropriate emergency authorities • render first aid if competent and able to do so • notify the RCA representative and / or the engineer • under the guidance of the officer in charge of the site, reduce effects of TTM on the road or remove the activity if safe to do so • re-establish TTM and traffic movements when advised by emergency authorities that it is safe to do so • Comply with any obligation to notify WorkSafe.
	Incident	**Actions**
	An incident is described as: • excessive delays - real or potential • minor or non-inquiry accident that has the potential to affect traffic flow • structural failure of the road.	The STMS must immediately conduct the following: • stop all activity and traffic movement if required • secure the site to prevent the prospect of injury or further damage • notify the RCA representative and / or the engineer • STMS to implement a plan to safely remove TTM and to establish normal traffic flow if safe to do so • re-establish TTM and traffic movements when it is safe to do so and when traffic volumes have reduced.

APPROVED
CAR R970960
Jason Wildman
STMS Number 307 43
Hutt City Council
04 October 2023

TMC comment - no detour has been designed, and there is no detour route available

Detour

If because of the on-site activity it will not be possible to remove or reduce the effects of TTM once it is established a detour route must be designed. This is likely for:

- excessive delays when using an alternating flow design for TTM
- redirecting one direction of flow and / or
- total road closure and redirection of traffic until such time that traffic volumes reduce and tailbacks have been cleared.

The risks in the type of work being undertaken, the risks inherent in the detour, the probable duration of closure and availability and suitability of detour routes need to be considered.

The detour and route must be designed including:

- pre- approval form the RCA's whose roads will be used or affected by the detour route
- ensure that TTM equipment for the detour - signs etc are on site and pre-installed.

Actions

When it is necessary to implement the pre-planned detour the STMS must immediately undertake the following:

- Notify the RCA and / or the engineer when the detour is to be established
- Drive through the detour in both directions to check that it is stable and safe
- Remove the detour as soon as it practicable and safe to do so and the traffic volumes have reduced and tailbacks have cleared
- Notify the RCA and / or the engineer when the detour has been disestablished and normal traffic flows have resumed.

Note also the requirements for no interference at an accident scene:

In the event of an accident involving serious harm the STMS must ensure that nothing, including TTM equipment, is removed or disturbed and any wreckage article or thing must not be disturbed or interfered with, except to:

- save a life of, prevent harm to or relieve the suffering of any person, or
- make the site safe or to minimise the risk of a further accident; or
- maintain the access of the general public to an essential service or utility, or
- prevent serious damage to or serious loss of property, or
- follow the direction of a constable acting in his or her duties or act with the permission of an inspector.

Other contingencies to be identified by the applicant *(i.e. steel plates to quickly cover excavations)*

1. If due to inclement weather conditions, work may be cancelled until the next fine day providing it is within the dates of this TMP.
2. All works will cease immediately in the case of an emergency or for emergency services that passing through the worksite. The STMS will guide the emergency services through the worksite should there be any obstructions.
3. STMS is to monitor all traffic flows through the worksite at all times. Should any delays exceeding 2 minutes, all work is to stop immediately and when the site has been made safe, an extra lane will be available as soon as possible.

Authorisations

Parking restriction(s) alteration authority	**Will controlled street parking be affected?**	No ~~Yes~~	**Has approval been granted?**	No
	Unrestricted on-street parking affected only			
Authorisation to work at permanent traffic signal sites	**Will portable traffic signals be used or permanent traffic signals be changed?**	No	**Has approval been granted?**	No
Road closure authorisation(s)	**Will full carriageway closure continue for more than 5 minutes (or other RCA stipulated time)?**	No	**Has approval been granted?**	No

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WAKA KOTAHI NZ TRANSPORT AGENCY	**RCA consent (eg CAR/WAP) and/or RCA contract reference**			

Bus stop relocation(s) – closure(s)	**Will bus stop(s) be obstructed by the activity?**	No	**Has approval been granted?**	No
Authorisation to use portable traffic signals	**Make, model and description/number**	N/A		
	NZTA compliant?	Yes No *(delete either Yes or No)*		

EED			
Is an EED applicable?	No *(delete either Yes or No)*	**EED attached?**	No

Delay calculations/trial plan to determine potential extent of delays

If requested by engineer or TMC

Public notification plan

- HCC has been in contact on this project, all residents have been notified in advance of impending road closure.
- Emergency services have been notified by HCC, emergency plan to be in place to enable access during such emergencies
- STMS contact details and project manager for site details to be provided for project.

Ongoing communication with affected stakeholders is required, including the Point Howard Residents Association

Public notification plan attached?	YES (public notification has been complete by HCC – handout ~~attached~~) uploaded to the CAR)

On-site monitoring plan	
Attended *(day and/or night)*	STMS or TC will remain onsite at all times while the site is active 2 hourly site checks will be completed & and recorded on the onsite record form
Unattended *(day and/or night)*	STMS to check site at the completion of each day and check that the site is set out in compliance to the approved TMP and all hazards are adequately barricaded. The site is to be checked at least once in a 24 hour period. In adverse weather will check it one in 12 hours.

Method for recording daily site TTM activity *(eg CoPTTM on-site record)*

- Hazard ID Sheet
- Onsite Record
- Worksite Monitoring
  - Site Job Sheet

- **Site safety measures**

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➢ Full Cover / Safety Overalls, Day-Glo jackets and steel capped boots must be worn by all personnel onsite at all times.

➢ Traffic Management Staff must follow any PPE requirements of the contractor. (eg: Hard hats, gloves, safety glasses)

➢ All visitors to site must be inducted and sign hazard id.

➢ STMS will hold a briefing prior to start of works and get all personnel onsite to sign hazard id.

Contractor's carrying out the work onsite are to identify hazards related to them on their own QA and use any appropriate PPE required for their operation.

Temporary safety barrier system	**Will a temporary safety barrier system be used at this worksite?**	~~Yes~~ No	**If yes, has the temporary safety barrier system been designed by an installation designer and independently reviewed as being fit for purpose?**	~~Yes~~ No	
	Statement from temporary safety barrier installation designer attached			Attached Not attached	

Other information

N/A

Site specific layout diagrams

Number	Title
13	Down Hill Side Work Area
13	Downside end of Road Closed
14	Work Area
15	Up Hill Side end of Road Closed
15	Up Hill Side Work Area
16	Over Night
17	Excavator Parking Overnight

Contact details

	Name	24/7 contact number	CoPTTM ID	Qualification	Expiry date
Principal	HCC Natasha Garcia	021-122-0083			
TMC	Jason ~~Wilman~~ Wildman	027-330-3097	30743	STMS (ABC) NP R	26/10/2025
Engineers' representative	ENGEO- Adam Smith	021-479-990			
Contractor	Halverson Civil Ltd- Paul Rogers	021-479-990			
STMS	Halverson Civil Ltd- Craig Ekins	027-511-9987	22890	STMS(AB) NP R	04/10/2025

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WAKA KOTAHI NZ TRANSPORT AGENCY	RCA consent (eg CAR/WAP) and/or RCA contract reference	

TC	Chosen on the day				
Others as required	Kara Collins (Corridor Manager) ~~Metlink (as required)~~ ~~WTOC (as required)~~ Emergency Services (as required) **Any others as required**	027 258 3801 ~~0800 801 700~~ ~~0800 869 286~~ *555	TMC comment - bus route, signalised intersections not affected at this location		

TMP preparation						
Preparation	Craig Ekins	27/09/2023	*Craig Ekins*	22890	STMS (AB) NP R	04/10/2025
	Name (STMS qualified)	*Date*	*Signature*	*ID no.*	*Qualification*	*Expiry date*
This TMP meets CoPTTM requirements attached			**Number of diagrams**		9 ~~6~~	
TMP returned for correction *(if required)*						
	Name	*Date*	*Signature*	*ID no.*	*Qualification*	*Expiry date*

Engineer/TMC to complete following section when approval or acceptance required						
Temporary safety barrier system	**The attached temporary road safety barrier design has been independently reviewed as being fit for purpose**				Yes No Not required	
TMP Approved						
	Name	*Date*	*Signature*	*ID no.*	*Qualification*	*Expiry date*
Acceptance by TMC *(only required if TMP approved by engineer)*						
	Name	*Date*	*Signature*	*ID no.*	*Qualification*	*Expiry date*

Qualifier for engineer or TMC approval

Approval of this TMP authorises the use of any regulatory signs included in the TMP or attached traffic management diagrams.

This TMP is approved on the following basis:

1. To the best of the approving engineer's/TMC's judgment this TMP conforms to the requirements of CoPTTM.
2. This plan is approved on the basis that the activity, the location and the road environment have been correctly represented by the applicant. Any inaccuracy in the portrayal of this information is the responsibility of the applicant.
3. The TMP provides so far as is reasonably practicable, a safe and fit for purpose TTM system.
4. The STMS for the activity is reminded that it is the STMS's duty to postpone, cancel or modify operations due to the adverse traffic, weather or other conditions that affect the safety of this site.

Notification to TMC prior to occupying worksite/Notification completed			
Type of notification to TMC required		**Notification completed**	Date Time

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TMP or generic plan reference	

ON-SITE RECORD On-site record must be retained with TMP for 12 months.			Today's date	
Location details	Road names(s):	House number/RPs:	Suburb:	

Working space

Person responsible for working space		
	Name	*Signature*
Where the STMS/TC is responsible for both the working space and TTM they sign above and in the appropriate TTM box below		

TTM

STMS in charge of TTM					
	Name	*TTM ID Number*	*Warrant expiry date*	*Signature*	*Time*
Worksite handover accepted by replacement STMS					
	Name	*ID Number*	*Warrant expiry date*	*Signature*	*Time*
	Tick to confirm handover briefing completed				

Delegation

Worksite control accepted by TC/STMS-NP					
	Name	*ID Number*	*Warrant expiry date*	*Signature*	*Time*
	Tick to confirm briefing completed				

Temporary speed limit

Street/road name (RPs or street numbers):	TSL action	Date:	Time:	TSL speed:	Length of TSL (m):
	TSL installed				
	TSL remains in place				
From: To:	TSL removed				

Street/road name (RPs or street numbers):	TSL action	Date:	Time:	TSL speed:	Length of TSL (m):
	TSL installed				
	TSL remains in place				
From: To:	TSL removed				

Street/road name (RPs or street numbers):	TSL action	Date:	Time:	TSL speed:	Length of TSL (m):
	TSL installed				
	TSL remains in place				
From: To:	TSL removed				

Street/road name (RPs or street numbers):	TSL action	Date:	Time:	TSL speed:	Length of TSL (m):
	TSL installed				
	TSL remains in place				
From: To:	TSL removed				

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TMP or generic plan reference	

Worksite monitoring

TTM to be monitored and 2 hourly inspections documented below.

Items to be inspected	TTM set-up	2 hourly check	2 hourly check	2 hourly check	2 hourly check	2 hourly check	TTM removal
High-visibility garment worn by all?							
Signs positioned as per TMP?							
Conflicting signs covered?							
Correct delineation as per TMP?							
Lane widths appropriate?							
Appropriate positive TTM used?							
Footpath standards met?							
Cycle lane standards met?							
Traffic flows OK?							
Adequate property access?							
Barrier deflection area is clear?							
Add others as required							
Time inspection completed:							
Signature:							

Comments:

Time	Adjustment made and reason for change

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TMC comments - TC/TMO to be actively monitoring road closure locations. Refer to attached F2.24 for minimum road closure requirements as regards delineation placement, barricades and safety zone

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TMC comments - 1) as regards intervisibility refer to attached F2.16 for priority give way requirements 2) Ngaumatau Rd - sign visibility requirements not met, either place further south or include an additional advance warning sign. Signs should not be placed on corners, and placed accordingly ie sign spacing increased or additional placed where the environment does not allow.

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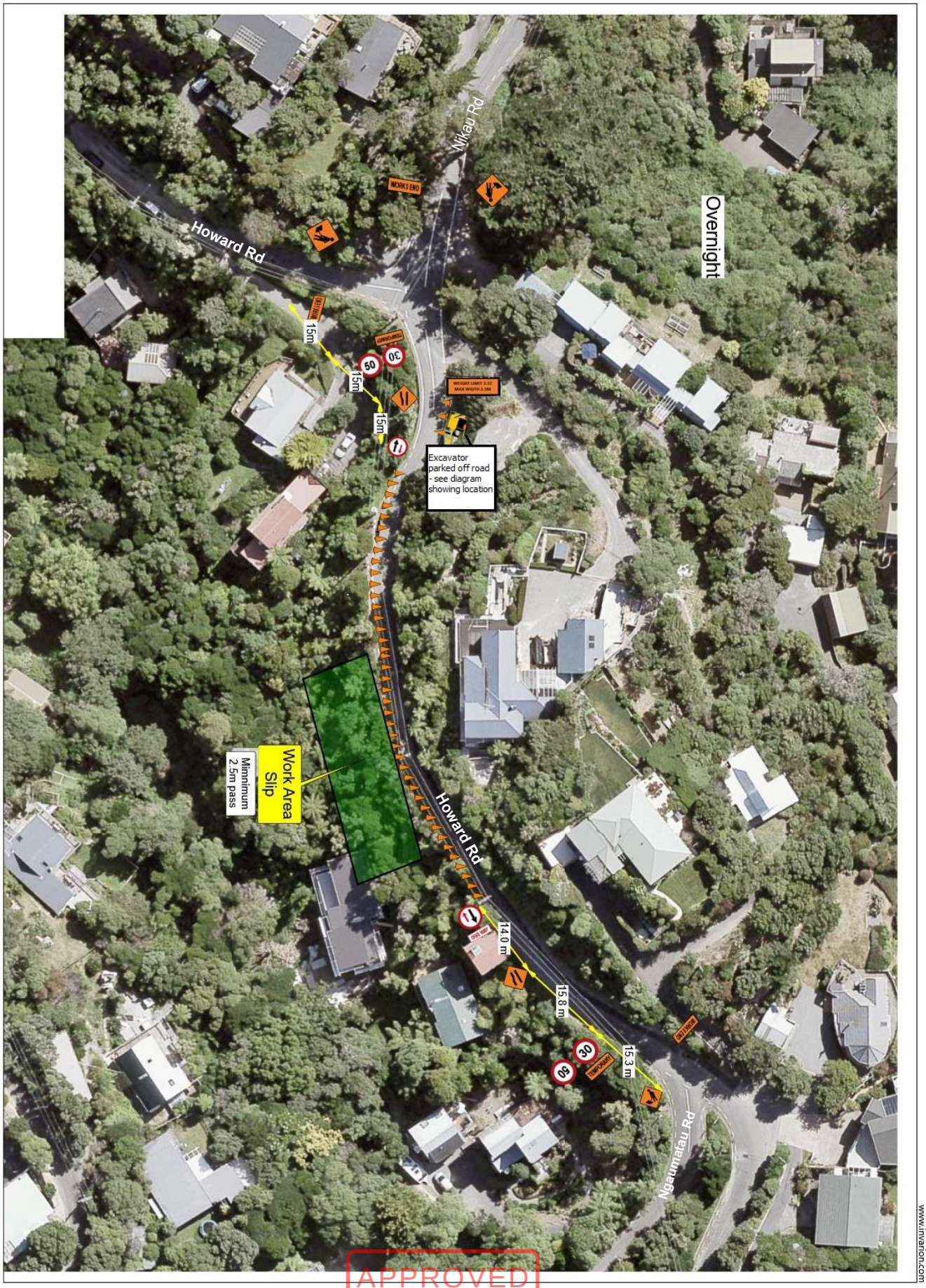
TMP or generic plan reference	



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Host Site Owner
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TMC comment - refer to Section C14.1.4 of the CoPTTM for minimum requirements relating to plant storage.

TMP or generic plan reference	

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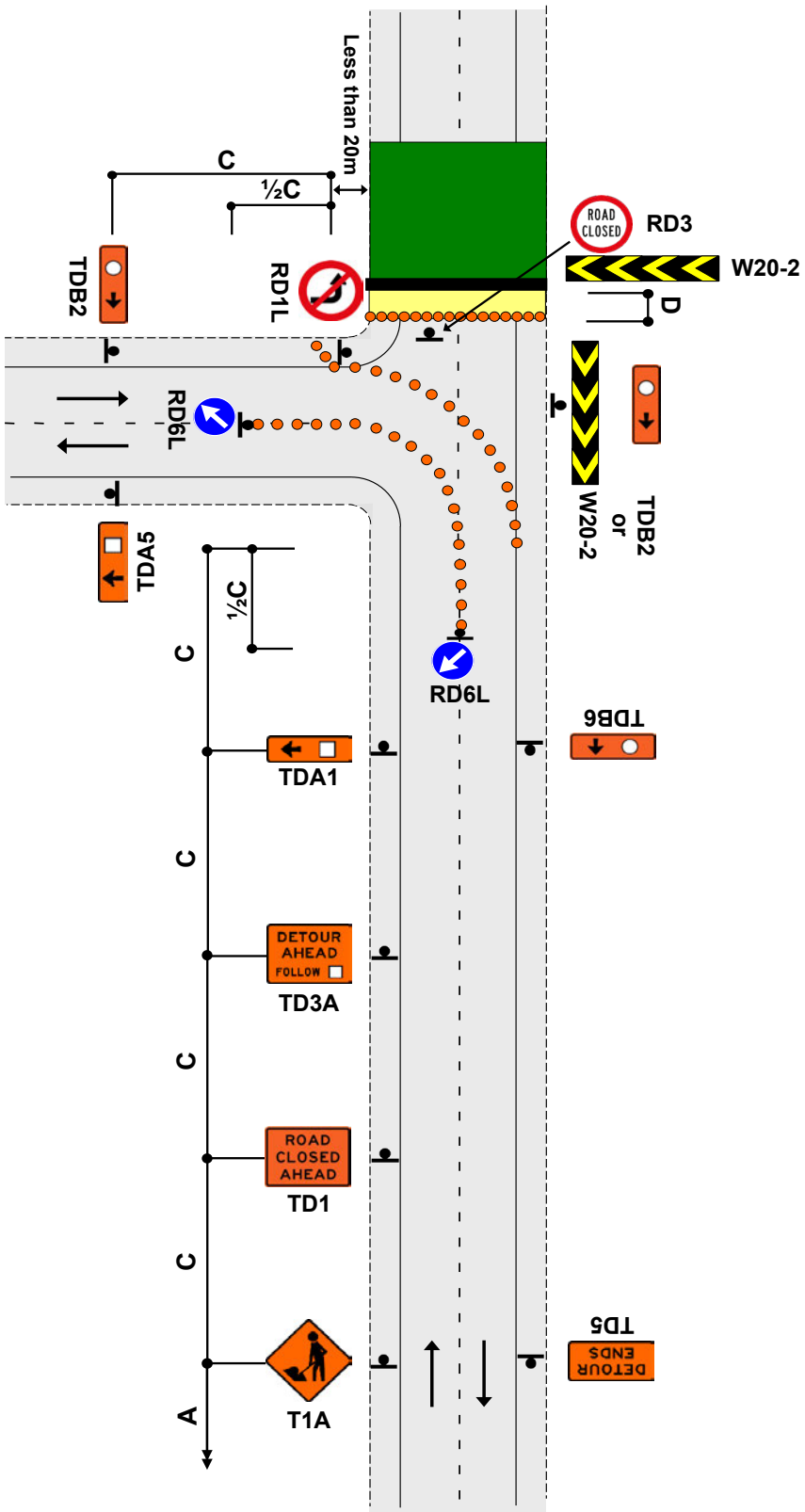
TWO-WAY TWO-LANE ROAD - Road closures and detours
Road closure - detour route
Example

F2.24
Level 1

Notes

1. Block access to road with barricade
2. If a longer term site, use chevron sight board to direct traffic



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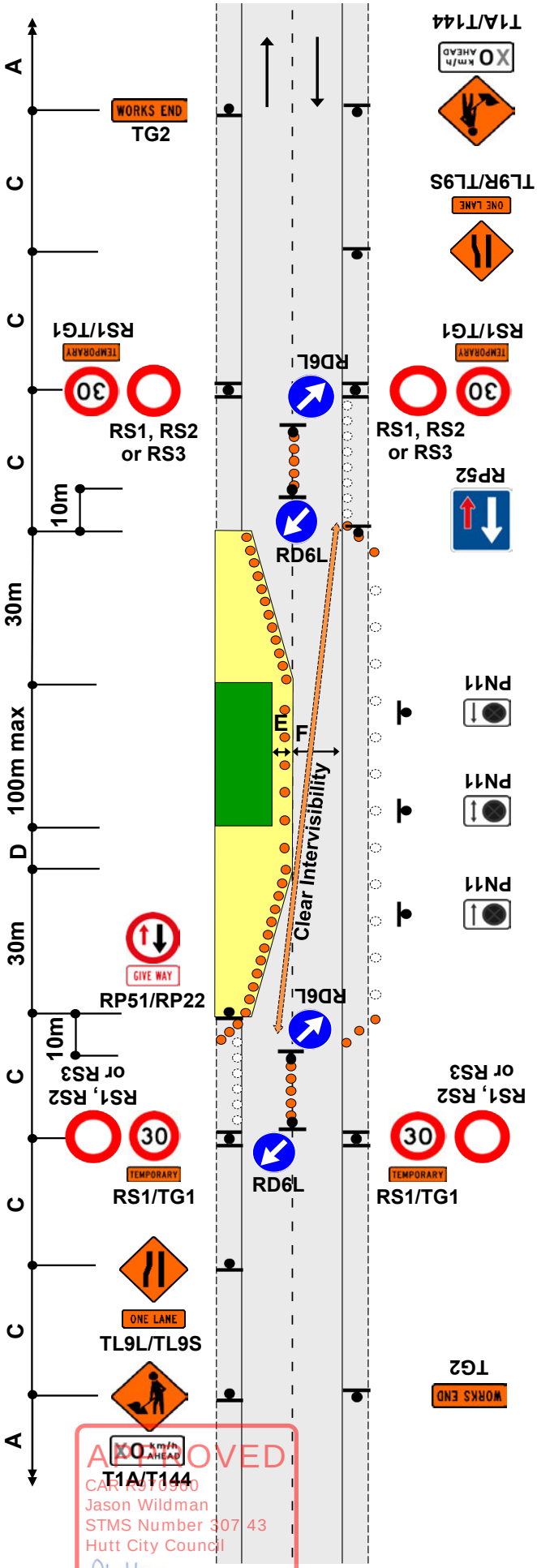
TWO-WAY TWO-LANE ROAD
Single-lane (traffic volume less than 1000vpd - 80vph)
Give way control

F2.16
Level 1

Notes

1. The RP51/RP22 and RP52 controls must be placed in the following priority order:
   - downhill traffic must give way to uphill traffic
   - traffic that has to cross into the opposing lane gives way, however where visibility for this vehicle is marginal the contractor may require the other vehicle with better visibility to give way
2. Intervisibility is required as indicated on diagram. This means that a vehicle at one sign is able to see whether the way ahead is clear
3. A 30m return taper at the end of the closure is mandatory
4. Use PN11 No Stopping signs, if necessary
5. Cones are required on edge of the temporary lane opposite closure if road is not well defined
6. The T144 X0km/h AHEAD sign is optional



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Jason Wildman
STMS Number 307 43
Hutt City Council
04 October 2023

Halverson Civil Ltd - Safe Work Method Statement

Work Method Statement: ANCHORING & Excavation & OPERATING DRILL RIG (with Excavator)

Client Name: **Hutt City Council**
Project / Site: **Howard Road Slip Remediation**

Company Name: Halverson Civil Ltd
Location/Address: 34 Takapu Road, Grenada North, Wellington
PH : 021 479990

Commencement Date: **09/10/2023**

Qualification/Prescribed Occupation Required:
Yes ☒ No ☐

If Yes What? Operators licence of competency
WTR, Excavator Experience

Plant Required On Site:
Excavator, Drill Rig

Engineering Details/Certificates Required
(I.e. tilt up panels design & construction)
Yes ☐ No ☒

Training Required to Complete Work:
Mandatory Site Induction, Daily pre-start, Weekly toolbox talks and site induction

Person Responsible for onsite supervision of SWMS: ……
(To be completed on site)

Work Method Statement Instruction only:
Yes ☒ No ☐

Suitable Workplace Area: Yes ☒ No ☐

PPE Requirements:

☒ Hard Hat	☒ Ear Protection	☒ Steel Cap Boots	☒ Eye Protection	☒ Hi-Vis Clothing
☐ ~~Welding Gloves~~	☐ ~~Welding Helmet~~	☐ ~~Double Eye Protection~~	☒ Protective Gloves	☐ ~~Harness~~
☒ Hi-Viz Shirt	☐ ~~Sun Screen~~	☒ Respirator		

Special Condition:
Each employee is issued with Personal Protective Equipment (PPE). There is additional PPE available for specific tasks. Each issue of PPE is recorded on a PPE Issue Register and the employee is responsible for his own issue. Replacement of faulty or wear and tear items of PPE will be re-issued by the company on return of faulty or worn items. Any item of PPE that is lost or negligently treated will be replaced by the company and charged to the employee.

Prepared By: Paul Rogers Date 26*/05/22*

Signature

Approved By: Ryan Halverson Date *3/10/23*

Signature

Reviewed By: Ryan Halverson Date: *3/10/23*
Signature/s

*This document can be used to identify the level of risk and help to prioritize any control measures. Consider the **consequences** and **likelihood** for each of the identified hazards and use the table to obtain the risk level.*

Table 1- Hazard and Risk Classifications

	Risk Assessment Process	
Step 1 Determine Probability	**Step 2** **Determine Consequences** (highest of the two)	
Probability	**People Consequences**	**Environmental Consequences (Pollution, Loss of Species or Habitat, Community Compliant, Damage to reputation)**
A = Common or Frequent Occurrence	**1** = Fatality, permanent disability	**1** = National media attention, significant visible damage, court case, major delay
B = Is known to occur or "It has happened"	**2** = Serious lost time, injury or illness	**2** = Widespread complaints, local media, exposure, EPA prosecution with some project delay, visible damage
C = Could occur or "I've heard of it happening"	**3** = Disabling or short term lost time, illness	**3** = EPA infringement notice or consistent complaints, limited impact, minor press, limited delay
D = Not likely to occur	**4** = Medical treatment, injury	**4** = Off site impact possible, few complaints, EPA or media interest not expected
E = Practically Impossible	**5** = First aid injury	**5** = No pollution or harm to the environment, complaints most unlikely, under $500 to rectify

Table 2 - Risk Matrix

	Risk Assessment Calculator				
Step 3 – Calculator Risk (Likelihood)					
	A	**B**	**C**	**D**	**E**
1	Class One (1)	Class One (2)	Class One (4)	Class One (7)	Class Two (11)
2	Class One (3)	Class One (5)	Class One (8)	Class Two (12)	Class Three (16)
3	Class One (6)	Class Two (9)	Class Two (13)	Class Three (17)	Class Three (20)
4	Class Two (10)	Class Two (14)	Class Three (18)	Class Three (21)	Class Three (23)
5	Class Two (15)	Class Three (19)	Class Three (22)	Class Three (24)	Class Three (25)

Controls identified may be a mixture of the hierarchy in order to provide minimum operator exposure.

Table 3- Hierarchy of Controls

1. Elimination	Eliminate the hazard.
2. Substitution	Provide an alternative that is capable of performing the same task and is safer to use.
3. Engineering Controls	Provide or construct a physical barrier or guard.
4. Administrative Controls	Develop policies, procedures practices and guidelines, in consultation with employees, to mitigate the risk. Provide training, instruction and supervision about the hazard.
5. Personal Protective Equipment	Personal equipment designed to protect the individual from the hazard.

Table 4 - Rock Anchoring Risk Matrix

No	Activity	Hazard Description	Risk Rating	Controls 1:Elimination 2:Substitution 3:Engineering Controls 4:Administrative Controls 5:Personal Protective Equipment	Residual Risk	Responsibility
1.	Arriving / Departing Site	Oncoming Traffic / Vehicles / Pedestrians	3C	• 4 Regulatory (obey road rules) **Land Transport Management Act 2003**. This and other legislation, such as the **Land Transport Act 1998** (Road Use Management - Road Rules) • 3 Traffic control • 3 Walk way zones • 3 Signage	3E	Operator / Supervisor / Foreman / Workers
2.	Pre-Start Check	Electricity Lines Equipment Environment Noise Other workers onsite	4D	• 4 Risk Assess area before commencement • 4 Check all equipment before start to ensure its safe to use. Excavator, Auger, Hydraulic Lines, Auger, Drill Rig, Airtrack. • 4 All employees must be site inducted • 4 job sheet/plans/specifications • 5 Appropriate PPE: Gloves, hard hat, sunscreen, hearing protection • 4 basic first aid training and access to first aid kits • 4 Access to sufficient drinking water	4E	Operator / Supervisor / Foreman / Workers

3.	Loading / Unloading Trucks	Pains & Strains due to Manual Handling	2B	• 4 Use of excavator or plant
				• 4 If pant used -Workers to maintain a safe distance of at least 1.0 metre before commencing lift
				  • See Manual handling - Code of practice for manual handling
				  • http://www.business.govt.nz/worksafe/information-guidance/all-guidance-items/manual-handling-code-of-practice-for
				• 4 If pant used - Operators & workers to maintain communication before and during lifts
				• 4 If manual lifting required, to be trained at pre-start on safe lifting techniques
					2D	Operator / Supervisor / Foreman / Workers

		Traffic	3D	• 4 Comply with site traffic rules and Traffic Controllers directions if applicable • 3 Signage / Barriers	3E	Operator / Supervisor / Foreman / Workers
		Other workers onsite	2C	• 4 All employees must be site inducted • 4 Operator to make exclusion zones and be aware of other plant and material onsite	2E	Operator / Supervisor / Foreman
4.	Anchoring (use of excavator) See **Operator protective structures on self-propelled mobile mechanical plant - Approved Code of Practice (ACOP)** http://www.business.govt.nz/worksafe/information-guidance/all-guidance-items/acop-operator-protective-structures-on-self-propelled-mobile-mechanical-plant	Crushing by falling objects/Sheet Metal	5D	• 4 Operator to take pre-start inspection • 3 All mobile plant to have reverse alarms/Beepers • 4 Operator to ensure all unnecessary personnel are excluded from the work area	5E	Operator / Supervisor / Foreman / Workers

		Noise	2D	• 5 Supervisor to ensure that all staff wear appropriate PPE e.g. Ear muffs, Ear plugs
				  • 4 Noise *See* Noise in the workplace - Approved Code of Practice (ACOP)
				  • http://www.business.govt.nz/worksafe/information-guidance/all-guidance-items/acop-%20noise-in-the-workplace
				• 4 If operational noise levels are considered excessive monitoring may be undertaken
					2E	Operator / Supervisor / Foreman / Workers

		Struck by falling objects due to faulty Lifting gear	4C	• 4 Dogman/Operator to ensure all lifting equipment is certified and within inspection date • 4 Workers to maintain a safe distance of at least 1.0 metre before commencing lift • 4 Operators & workers to maintain communication before and during lifts • 4 Operator to undertake a visual inspection of lifting equipment and accessorise prior to use • 4 Operator to ensure all lift and swing areas are clear of all unnecessary personnel	4E	Operator / Supervisor / Foreman / Workers
No	**Activity**	**Hazard Description**	**Risk Rating**	**Controls 1:Elimination 2:Substitution 3:Engineering Controls 4:Administrative Controls 5:Personal Protective Equipment**	**Residual Risk**	**Responsibility**
5.	Underground Services	Electrocution	5D	• 4 Check presence and location of in ground services i.e. Dial before you dig information • 4 Check Plans • 4 Training / Supervision	5E	Operator / Supervisor / Foreman
~~6.~~	~~Pre-drilling~~	~~Bodily injuries due to Rotating Auger~~	~~3E~~	~~• 4 No loose clothing~~	~~4C~~	~~Operator / Supervisor /~~

	~~(use of excavator)~~			• ~~4 Self and environment awareness~~ • ~~4 Operator to ensure all unnecessary personnel are excluded from the work area~~ • ~~4 Workers to maintain a safe distance of at least 1.0 metre from moving plant~~		~~Foreman / Workers~~
7.	Setting up at Anchor Location	Uneven Ground	3D	• 4 Prepare a stable and level platform	3E	Operator / Supervisor / Foreman

8.	Anchor Installation (Operating scaffold mounted Morath HD25 aluminium drill system or Excavator Mounted AFO Drill Rig)	Excessive air pressure (blow-back of materials)
		Noise
		Underground Services
			5D	• 4 Ensure anchor is installed square/at right angles
				• 4 Protect yourself from Blow-Back of materials due to excessive Air Pressure
				• 4 When changing rods on the airtrack good communication between operator and worker is a must, when lifting the rod keep it close to your body and bend your knees then lower rod into the guide.
				  • See Manual handling - Code of practice for manual handling
				  • http://www.business.govt.nz/worksafe/information-guidance/all-guidance-items/manual-handling-code-of-practice-for
				• 3 Use of safety lanyard (if required)
				• 4 Training / Supervision
				  • 4 Noise *See* Noise in the workplace - Approved Code of Practice (ACOP)
				  • http://www.business.govt.nz/worksafe/information-guidance/all-guidance-items/acop-%20noise-in-the-workplace
				• 5 Appropriate PPE: riggers gloves, hearing protection, safety glasses
				• 4 Stand Clear of Plant while in Operation
				• 4 Check presence and location of in ground services i.e. Dial before you dig information
					5E	Operator / Supervisor / Foreman / Workers

No	**Activity**	**Hazard Description**	**Risk Rating**	**Controls 1:Elimination 2:Substitution 3:Engineering Controls 4:Administrative Controls 5:Personal Protective Equipment**	**Residual Risk**	**Responsibility**
9.	Stressing Anchors	Sharp edges / Spurs on rod Manual Handling	2C	• 5 Wear appropriate PPE i.e. glasses / gloves / Helmet • 4 Training / Supervision • 4 Frequent Toolbox talks on correct lifting techniques	2E	Supervisor / Foreman / Workers

10.	Use of Generators	Noise
		Electrical Shock
			5D	• 4 Pre-start check
				  • 4 Noise *See* Noise in the workplace - Approved Code of Practice (ACOP)
				  • http://www.business.govt.nz/worksafe/information-guidance/all-guidance-items/acop-%20noise-in-the-workplace
				• 5 Appropriate PPE i.e. earmuffs / earplugs
				• 4 Appropriate Training
				• 4 Maintenance
				• 4 Make sure the generator is placed in a well ventilated area so there is no fume build ups
					5E	Supervisor / Foreman / Workers

11.	Anchor Removal	Sharp Edges Other Trades Housekeeping	2C	• 4 Risk Assess area before commencement • 4 Operator / Worker to ensure all unnecessary personnel are excluded from the work area • 4 Training / Supervision • 4 Make sure area is clean and free from debris	2E	Operator / Supervisor / Foreman / Workers
12.	Refuelling Equipment	Electrical sparks & ignition Fire Pollution to environment	5D	• 4 Safe use of hazardous Substances *See Hazardous Substances Code of Practice 2003* • *Or http://www.business.govt.nz/worksafe/information-guidance/all-guidance-items/acop-moshh* • 4 Ensure engine is switch off • 4 Ensure all mobile phones in immediate area are turned off • 4 Ensure no naked flame or sparks are present • 4 Ensure no person smoking in immediate area • 4 Ensure fuelling hoses are away from trafficable area • 4 Secure fuel locks to prevent spillage or tampering by others • 4 Ensure a fire extinguisher is close at hand • 4 Ensure no spillages occur if they do occur know where spill kits are located onsite	5E	Supervisor / Foreman / Workers

13.	Lifting & Carrying Objects	Sprains / Strains Manual Handling	2B	• 4 If lifting required, to be trained at pre-start on safe lifting techniques • 4 Frequent Toolbox talks on correct lifting techniques • *4 See* Hazardous Manual Tasks Code Of Practice 2011	2E	Supervisor / Foreman / Workers
No	**Activity**	**Hazard Description**	**Risk Rating**	**Controls 1:Elimination 2:Substitution 3:Engineering Controls 4:Administrative Controls 5:Personal Protective Equipment**	**Residual Risk**	**Responsibility**
14.	All tasks	Housekeeping	2B	• 4 Operator is to keep work area free from unnecessary tools and equipment from operation • 4 Operator is to ensure work area is clear of any waste material or rubbish prior to leaving site	2E	Operator / Supervisor / Foreman / Workers
15.	Plant Maintenance	Unsafe plant	3C	• 4 All plant is to be checked daily by operators and any faults to recorded and reported to Construction Manager immediately.	3E	Operator

***Note**: It is advised that constant monitoring of Safe Work Methods is undertaken and the company relies on information relating to day to day changes in activities. All staff should be aware that their suggestions in respect of the improvement of Safe Work Methods are welcomed and in most cases necessary.*

Halverson Civil Ltd - Safe Work Method Statement

*THE SITE SUPERVISOR/ FOREMAN SHALL MAKE SURE ALL HALVERSON CIVIL WORKERS ARE FOLLOWING THE **SWMS** CORRECTLY*

I, the undersigned confirm that the (1) SWMS has been explained to me (2) its contents are clearly understood by me (3) my qualifications are current to undertake this activity (4) I have been consulted in the preparation of the SWMS and (5) I will comply with the SWMS otherwise work will stop immediately. (5) I will not wilfully or recklessly interfere with or misuse anything provided for workplace health and safety at the workplace; (6) I will not wilfully place at risk the workplace health and safety of any person at the workplace; and (7) I will not work in unsafe areas

NAME	ROLE	SIGNATURE	DATE
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This acceptance to be signed off by Principal Contractor or Relevant person in control of the workplace

Work method statement has been received and accepted.	
Name:	
Date:	
Signature:	

Halverson Civil Ltd - Safe Work Method Statement

Work Method Statement: Piling and Drilling (Excavator)

Client Name: **Hutt City Council**
Project / Site: **Howard Road Slip Remediation**

Company Name: Halverson Civil Ltd
Location/Address: 34 Takapu Road, Grenada North, Wellington
PH: 021 479990

Commencement Date: **09/10/2023**

Qualification/Prescribed Occupation Required:
Yes ☒ No ☐

If Yes What? Operators licence of competency
WTR, Excavator Experience

Plant Required On Site:
Excavator, Drill Rig

Engineering Details/Certificates Required
(I.e. tilt up panels design & construction)
Yes ☐ No ☒

Training Required to Complete Work:
Mandatory Site Induction, Daily pre-start, Weekly toolbox talks and site induction

Person Responsible for onsite supervision of SWMS: _____

(To be completed on site)

Work Method Statement Instruction only:
Yes ☒ No ☐

Suitable Workplace Area: Yes ☒ No ☐

PPE Requirements:

☒ Hard Hat	☒ Ear Protection	☒ Steel Cap Boots	☒ Eye Protection	☒ Hi-Vis Clothing
☐ ~~Welding Gloves~~	☐ ~~Welding Helmet~~	☐ ~~Double Eye Protection~~	☒ Protective Gloves	☐ ~~Harness~~
☒ Hi-Viz Shirt	☒ Sun Screen	☐ ~~Respirator~~		

Special Condition:
Each employee is issued with Personal Protective Equipment (PPE). There is additional PPE available for specific tasks. Each issue of PPE is recorded on a PPE Issue Register and the employee is responsible for his own issue. Replacement of faulty or wear and tear items of PPE will be re-issued by the company on return of faulty or worn items. Any item of PPE that is lost or negligently treated will be replaced by the company and charged to the employee.

Prepared By: Paul Rogers Date *3/10/23*

Signature

Approved By: Ryan Halverson Date *3/10/23*

Signature

Reviewed By: Clarke Halverson Date: 3/10/23
Signature/s

*This document can be used to identify the level of risk and help to prioritize any control measures. Consider the **consequences** and **likelihood** for each of the identified hazards and use the table to obtain the risk level.*

Table 1- Hazard and Risk Classifications

	Risk Assessment Process	
Step 1 Determine Probability	**Step 2** **Determine Consequences** (highest of the two)	
Probability	**People Consequences**	**Environmental Consequences (Pollution, Loss of Species or Habitat, Community Compliant, Damage to reputation)**
A = Common or Frequent Occurrence	**1** = Fatality, permanent disability	**1** = National media attention, significant visible damage, court case, major delay
B = Is known to occur or "It has happened"	**2** = Serious lost time, injury or illness	**2** = Widespread complaints, local media, exposure, EPA prosecution with some project delay, visible damage
C = Could occur or "I've heard of it happening"	**3** = Disabling or short term lost time, illness	**3** = EPA infringement notice or consistent complaints, limited impact, minor press, limited delay
D = Not likely to occur	**4** = Medical treatment, injury	**4** = Off site impact possible, few complaints, EPA or media interest not expected
E = Practically Impossible	**5** = First aid injury	**5** = No pollution or harm to the environment, complaints most unlikely, under $500 to rectify

Table 2 - Risk Matrix

	Risk Assessment Calculator				
Step 3 – Calculator Risk (Likelihood)					
	A	**B**	**C**	**D**	**E**
1	Class One (1)	Class One (2)	Class One (4)	Class One (7)	Class Two (11)
2	Class One (3)	Class One (5)	Class One (8)	Class Two (12)	Class Three (16)
3	Class One (6)	Class Two (9)	Class Two (13)	Class Three (17)	Class Three (20)
4	Class Two (10)	Class Two (14)	Class Three (18)	Class Three (21)	Class Three (23)
5	Class Two (15)	Class Three (19)	Class Three (22)	Class Three (24)	Class Three (25)

Controls identified may be a mixture of the hierarchy in order to provide minimum operator exposure.

Table 3- Hierarchy of Controls

1. Elimination	Eliminate the hazard.
2. Substitution	Provide an alternative that is capable of performing the same task and is safer to use.
3. Engineering Controls	Provide or construct a physical barrier or guard.
4. Administrative Controls	Develop policies, procedures practices and guidelines, in consultation with employees, to mitigate the risk. Provide training, instruction and supervision about the hazard.
5. Personal Protective Equipment	Personal equipment designed to protect the individual from the hazard.

Table 4 - Excavator Drilling and Piling

No	Activity	Hazard Description	Risk Rating	Controls 1:Elimination 2:Substitution 3:Engineering Controls 4:Administrative Controls 5:Personal Protective Equipment	Residual Risk	Responsibility
1.	Arriving / Departing Site	Oncoming Traffic / Vehicles / Pedestrians	3C	• 4 Regulatory (obey road rules) Land Transport Management Act 2003. This and other legislation, such as the Land Transport Act 1998 (Road Use Management - Road Rules) • 3 Traffic control • 3 Walk way zones • 3 Signage	3E	Operator / Supervisor / Foreman / Workers
2.	Pre-Start Check	Electricity Lines Equipment Environment Noise Other workers onsite	4D	• 4 Risk Assess area before commencement • 4 Check all equipment before start to ensure its safe to use. Excavator, Auger, Hydraulic Lines, Auger, Drill Rig, Airtrack. • 4 All employees must be site inducted • 4 job sheet/plans/specifications • 5 Appropriate PPE: Gloves, hard hat, sunscreen, hearing protection • 4 basic first aid training and access to first aid kits • 4 Access to sufficient drinking water	4E	Operator / Supervisor / Foreman / Workers

3.	Loading / Unloading Trucks	Pains & Strains due to Manual Handling	2B	• 4 Use of excavator or plant
				• 4 If pant used -Workers to maintain a safe distance of at least 1.0 metre before commencing lift
				  • See Manual handling - Code of practice for manual handling
				  • http://www.business.govt.nz/worksafe/information-guidance/all-guidance-items/manual-handling-code-of-practice-for
				• 4 If pant used - Operators & workers to maintain communication before and during lifts
				• 4 If manual lifting required, to be trained at pre-start on safe lifting techniques
					2D	Operator / Supervisor / Foreman / Workers

		Traffic	3D	• 4 Comply with site traffic rules and Traffic Controllers directions if applicable • 3 Signage / Barriers	3E	Operator / Supervisor / Foreman / Workers
		Other workers onsite	2C	• 4 All employees must be site inducted • 4 Operator to make exclusion zones and be aware of other plant and material onsite	2E	Operator / Supervisor / Foreman
4.	Piling & Drilling (use of excavator) See **Operator protective structures on self-propelled mobile mechanical plant -**	Crushing by falling objects/Sheet Metal	5D	• 4 Operator to take pre-start inspection • 3 All mobile plant to have reverse alarms/Beepers • 4 Operator to ensure all unnecessary personnel are excluded from the work area	5E	Operator / Supervisor / Foreman / Workers

		Noise	2D	• 5 Supervisor to ensure that all staff wear appropriate PPE e.g. Ear muffs, Ear plugs
				  • 4 Noise *See* Noise in the workplace - Approved Code of Practice (ACOP)
				  • http://www.business.govt.nz/worksafe/information-guidance/all-guidance-items/acop-%20noise-in-the-workplace
					2E	Operator / Supervisor / Foreman / Workers

	Approved Code of Practice (ACOP) http://www.business.govt.nz/worksafe/information-guidance/all-guidance-items/acop-operator-protective-structures-on-self-propelled-mobile-mechanical-plant			• 4 If operational noise levels are considered excessive monitoring may be undertaken		
		Struck by falling objects due to faulty Lifting gear	4C	• 4 Dogman/Operator to ensure all lifting equipment is certified and within inspection date • 4 Workers to maintain a safe distance of at least 1.0 metre before commencing lift • 4 Operators & workers to maintain communication before and during lifts • 4 Operator to undertake a visual inspection of lifting equipment and accessorise prior to use • 4 Operator to ensure all lift and swing areas are clear of all unnecessary personnel	4E	Operator / Supervisor / Foreman / Workers
No	**Activity**	**Hazard Description**	**Risk Rating**	**Controls 1:Elimination 2:Substitution 3:Engineering Controls 4:Administrative Controls 5:Personal Protective Equipment**	**Residual Risk**	**Responsibility**
5.	Underground Services	Electrocution	5D	• 4 Check presence and location of in ground services i.e. Dial before you dig information • 4 Check Plans • 4 Training / Supervision	5E	Operator / Supervisor / Foreman
6.	Drilling (use of excavator)	Bodily injuries due to Rotating Auger	3E	• 4 No loose clothing • 4 Self and environment awareness • 4 Operator to ensure all unnecessary personnel are excluded from the work area • 4 Workers to maintain a safe distance of at least 1.0 metre from moving plant	4C	Operator / Supervisor / Foreman / Workers
7.	Setting up at Pile/Drill Location	Uneven Ground	3D	• 4 Prepare a stable and level platform	3E	Operator / Supervisor / Foreman

8.	Pile Installation (use of Excavator)	Heavy Equipment/Objects
		Moving Plant/Machinery
		Noise
		Underground Services
			5D	• 4 Ensure Pile Cage is installed correctly with correct procedures.
				• 4 When Augers on the excavator are to be changed workers must stand clear until operator has placed auger horizontal on ground with no load, so good communication between operator and worker is a must.
				  • See Manual handling - Code of practice for manual handling
				  • http://www.business.govt.nz/worksafe/information-guidance/all-guidance-items/manual-handling-code-of-practice-for
				• 3 Use of safety lanyard or chains when required.
				• 4 Training / Supervision
				  • 4 Noise *See* Noise in the workplace - Approved Code of Practice (ACOP)
				  • http://www.business.govt.nz/worksafe/information-guidance/all-guidance-items/acop-%20noise-in-the-workplace
				• 5 Appropriate PPE: riggers gloves, hearing protection, safety glasses
				• 4 Stand Clear of Plant while in Operation
					5E	Operator / Supervisor / Foreman / Workers

No	Activity	Hazard Description	Risk Rating	Controls 1:Elimination 2:Substitution 3:Engineering Controls 4:Administrative Controls 5:Personal Protective Equipment	Residual Risk	Responsibility
				• 4 Check presence and location of in ground services i.e. Dial before you dig information		
~~9.~~	~~Stressing of Piles (If Required)~~	~~Sharp edges / Spurs on rod~~ ~~Manual Handling~~	~~2C~~	• ~~5 Wear appropriate PPE i.e. Gloves / Hard hat / Glasses~~ • ~~4 Training / Supervision~~ • ~~4 Frequent Toolbox talks on correct lifting techniques~~	~~2E~~	~~Supervisor / Foreman / Workers~~

10.	Use of Generators	Noise
		Electrical Shock
			5D	• 4 Pre-start check
				  • 4 Noise *See* Noise in the workplace - Approved Code of Practice (ACOP)
				  • http://www.business.govt.nz/worksafe/information-guidance/all-guidance-items/acop-%20noise-in-the-workplace
				• 5 Appropriate PPE i.e. earmuffs / earplugs
				• 4 Appropriate Training
				• 4 Maintenance
				• 4 Make sure the generator is placed in a well ventilated area so there is no fume build ups
					5E	Supervisor / Foreman / Workers

11.	Steel Cage Removal or Placement	Sharp Edges Other Trades Housekeeping	2C	• 4 Risk Assess area before commencement • 4 Operator / Worker to ensure all unnecessary personnel are excluded from the work area • 4 Training / Supervision • 4 Make sure area is clean and free from debris	2E	Operator / Supervisor / Foreman / Workers
~~12.~~	~~Welding (If Required)~~	~~Welding slag~~ ~~Fumes~~ ~~electrical circuit~~	~~2C~~	• ~~5 Wear appropriate PPE i.e. welding shield / gloves~~ • ~~4 Good ventilation or if not possible use of respirator~~ • ~~5 Wear rubber insulated shoes.~~ • ~~4 Always get a qualified electrician to do any electrical repairs~~	~~3E~~	~~Supervisor / Foreman / Workers~~
13.	Gas cutting (if required) *See* ***Electricity (Safety) Regulations 2010***	Stray spark from oxy Gas Leakage Excess Pressure	2C	• 5 Wear appropriate PPE for the required task i.e. oxy goggles/ gloves • 4 Training • 4 Maintenance • 4 Check damage to hoses or equipment. • 4 Use of flashback arrester	3E	Supervisor / Foreman / Workers

	http://www.legislation.co.nz/regulation/public/2010/0036/latest/DLM2763501.html					
14.	Refuelling Equipment	Electrical sparks & ignition Fire Pollution to environment	5D	• 4 Safe use of hazardous Substances *See Hazardous Substances Code of Practice 2003* • *Or http://www.business.govt.nz/worksafe/information-guidance/all-guidance-items/acop-moshh* • 4 Ensure engine is switch off • 4 Ensure all mobile phones in immediate area are turned off • 4 Ensure no naked flame or sparks are present • 4 Ensure no person smoking in immediate area • 4 Ensure fuelling hoses are away from trafficable area • 4 Secure fuel locks to prevent spillage or tampering by others • 4 Ensure a fire extinguisher is close at hand • 4 Ensure no spillages occur if they do occur know where spill kits are located onsite •	5E	Supervisor / Foreman / Workers
15.	Lifting & Carrying Objects	Sprains / Strains Manual Handling	2B	• 4 If lifting required, to be trained at pre-start on safe lifting techniques • 4 Frequent Toolbox talks on correct lifting techniques • *4 See* Hazardous Manual Tasks Code Of Practice 2011	2E	Supervisor / Foreman / Workers
No	**Activity**	**Hazard Description**	**Risk Rating**	**Controls 1:Elimination 2:Substitution 3:Engineering Controls 4:Administrative Controls 5:Personal Protective Equipment**	**Residual Risk**	**Responsibility**
16.	All tasks	Housekeeping	2B	• 4 Operator is to keep work area free from unnecessary tools and equipment from operation • 4 Operator is to ensure work area is clear of any waste material or rubbish prior to leaving site	2E	Operator / Supervisor / Foreman / Workers
17.	Plant Maintenance	Unsafe plant	3C	• 4 All plant is to be checked daily by operators and any faults to recorded and reported to Construction Manager immediately.	3E	Operator

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Work method statement has been received and accepted.	
Name:	
Date:	
Signature:	

This acceptance to be signed off by Principal Contractor or Relevant person in control of the workplace

From: Natasha Garcia
To: Lakna Siriwardena
Subject: FW: [EXTERNAL] RE: Point Howard Design and Reporting
Date: Thursday, 26 October 2023 9:31:57 am
Attachments: image001.png
image002.png
ATT00001.png

Nat Garcia
Project Manager - Transport
Hutt City Council, 30 Laings Road, Hutt Central, Lower Hutt, Lower Hutt 5010
P: **M:** 021 122 0083 **W:** www.huttcity.govt.nz

Natasha Garcia
Project Manager (Contractor)

Hutt City Council, 30 Laings Road, Hutt Central, Lower Hutt, Lower Hutt 5010
P: **M:** 021 122 0083 **W:** www.huttcity.govt.nz

From: Derek Kerite <Derek.Kerite@huttcity.govt.nz>
Sent: Tuesday, August 8, 2023 10:53 AM
To: Natasha Garcia <Natasha.Garcia@huttcity.govt.nz>; Paul Pugh <Paul.Pugh@huttcity.govt.nz>
Cc: Jon Kingsbury <Jon.Kingsbury@huttcity.govt.nz>
Subject: RE: [EXTERNAL] RE: Point Howard Design and Reporting

Kia ora Natalie

In confirmation of our conversation yesterday and previous discussions with our consenting staff, as the designs are by a CPEng Engineer and supported by a PS1 we would be comfortable for the works to be completed under emergency circumstances. We would require a PS4 on completion of work to support your application for a Certificate of Acceptance. Also noting that the works are entirely on road reserve and not encroaching on any private land.

Regards,

Derek Kerite
Head Of Regulatory Services

Hutt City Council, 30 Laings Road, Hutt Central, Lower Hutt, Lower Hutt 5010
P: **M:** 027 202 1187 **W:** www.huttcity.govt.nz

From: Information Management Team
To: [redacted]
[redacted] [redacted].ca
Subject: RE: [EXTERNAL] Howard Road slip s te planned remed al works - potential breaches of the HSWA
Date: 27 October 2023 16:51:00
Attachments: image001.jpg
image002.j g
Peter McEvoy - LGOIMA.pdf

Hi Peter
Please see attached our response to your request.
Thank you
Lakna

[redacted] [redacted]
Sent: Thursday September 28 2023 4:58 PM
To: Jo Miller <Jo.Miller@huttcity.govt.nz>
Cc: Campbell Barry <Campbell.Barry@huttcity.govt.nz>; Phil.Parkes@worksafe.govt.nz; info@worksafe.govt.nz
Subject: [EXTERNAL] Howard Road slip site planned remedial works - potential breaches of the HSWA

Dear Jo.

I refer to the above the public meeting at the Point Howard Play Centre building at 7pm on Tues 26-9-23 and the remedial works four page information handout (provided to residents at the meeting) attached here.

The purpose of this email is as follows:

1. to bring to your attention specific health and safety risks **arising** out of the proposed work (place) due to the temporary traffic management (TTM) set up that you intend to implement for the duration of the works.
2. to bring to your attention potential breaches of the Health and Safety at Work Act 2015 in performing your duties as the territorial authority and as the lead PCBU respons ble for ensuring the works are well organised and also for approving the works as the land owner (Road Controller).
3. to request either safe escorted pedestrian access through the site or the Hutt Council makes arrangements for a suitable alternative when a resident has a specific requirement during the hours of 9am to 3pm.
4. To request copies of documents under the Local Government Official Information and Meetings Act 1987 (LGOIMA).

With regards item 1 and 2 above I make reference to the following:

Health and Safety at Work Act 2015 (HSWA)

Section 36 - Primary duty of care

Sub section (2) - "A PCBU must ensure so far as reasonably practicable that the health and safety of other persons is not put at risk from work carried out as part of the conduct of the business or undertaking".

Section 37 - Duty of PCBU who manages or controls the workplace

Sub section (1) - "A PCBU who manages or controls a workplace must ensure so far is reasonably practicable that the workplace the means of entering and exiting the workplace and anything arising from the workplace are without risks to the health and safety of any person".

Section 34 - **PCBU must consult with other PCBUs with same duty.**

Sub section (1) - "If more than 1 PCBU has a duty in relation to the same matter imposed by or under this Act each PCBU with the duty must so far has reasonably practicable consult co-operate and coordinate activities with all other PCBUs who have a duty in relation to the same matter".

NZTA Code of practice for temporary traffic management (CoPTTM)

Glossary of Terms

Temporary Traffic Management (TTM) - "The process of managing road users through or past a closure in a safe manner with minimum delay or inconvenience".

Road - For the purpose of temporary traffic management (TTM) a road is defined as the entire road reserve".

Road user - "Any user of the road including motor vehicle drivers motorcyclists pedestrians and cyclists".

1. Specific health and safety risks

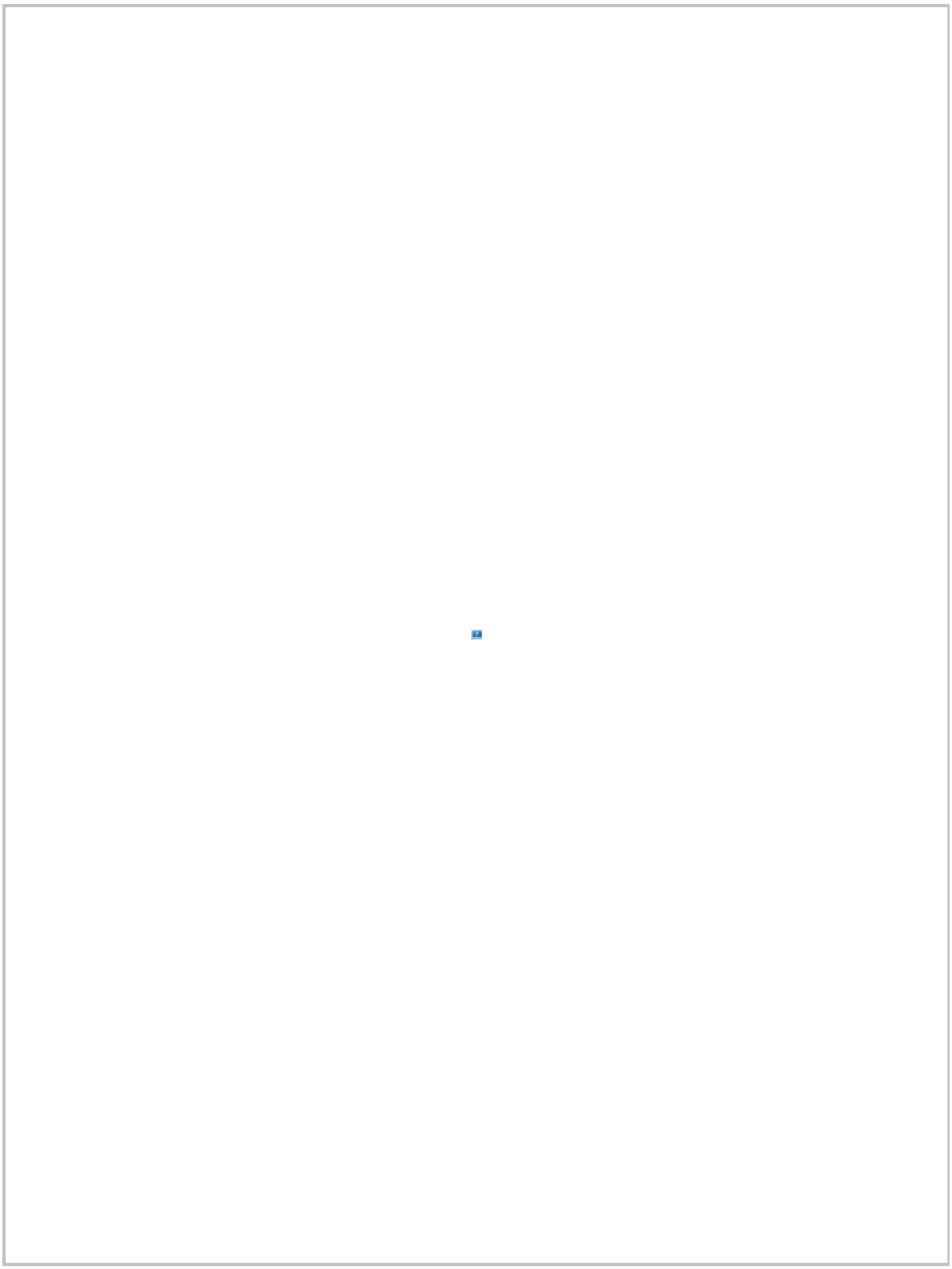
As per the attached document the slip' section of Howard Road is to be closed to **everyone** other than workers on the site from 9am to 12pm and 12.30pm to 3pm for at least six weeks from the 09-10-23. In doing this the Hutt Council will be preventing all the resident located above' the slip from being able to undertake normal activities on weekdays for a minimum of six weeks and potentially up to Christmas.

To mitigate this you have proposed as part of your outline pedestrian management plan that the Dillon Street tracks are used (refer to page 2 and page 4 of the attached handout) for pedestrian access to and from upper Howard Road and Ngaumatau Road. My comments below focus on this specific pedestrian management proposal.

The Dillon Street tracks are **recreational tracks** (for outdoor pursuits) and clearly do not meet the standards required for pedestrian management under the NZTA CoPTTM. Examples of hazards on **many** sections of the tracks include but are not imited to the following:

- steep narrow slippery wooden steps that are inconsistently constructed and poorly maintained (see photo example attached).

- fall from height with no handrails to prevent a fall or for negotiating the steps (handrails which are normally provided on footpath on a road where the same such hazards exist).
- The path surface (including the steps) is at best rough stone chips and at worst a collection of mud and weeds and in several places protruding slippery tree routes (see photo example attached).



The overwhelming majority of the potential users (residents that live above the slip) are also elderly and this was clearly evident at the public meeting on the 26-9-23 where a significant portion of the attendees were over 70 years old and my next door but one neighbour is 98.

In addition to the hazards listed above no pre assessment or consideration appears to have been undertaken regarding the general suitability of the tracks (for the actual users) as the only pedestrian access to and from the dwellings above the slip. This includes consulting with the Residents Association or the Wellington Regional Council on the tracks suitability prior to the meeting on the 26-09-23.

As well as the above listed hazards the track is unsuitable for the majority of the users due to the following:

- The gradient and length of the path is excessive.
- The track is often subject to storm damage and is sometimes un-passable. In the past six weeks the track has been unsuitable for use on a number of occasions due to hazardous weather including fallen trees and one of the other Point Howard tracks is currently unusable due to multiple fallen trees across it.

In summary the Dillon Street tracks are clearly not suitable for pedestrian use (including the elderly and small children) for access to and from the dwellings above the slip.

2 Potential breaches of the Health and Safety at Work Act 2015

By having these tracks as the only means of access to and from above the slip I believe you (as a PCBU) are failing to ensure as far as reasonably practicable that the health and safety of other persons (in this case all the residents) is not put at risk from the work carried out as part of the conduct of your business or undertaking (ref Section 36 - Primary duty of care under the HSWA).

Also as the PCBU who will manage and control the workplace (site) you are fa ling to ensure so far is reasonably practicable that the workplace the means of entering and exiting the workplace and anything arising from the workplace are without risks to the health and safety of any person (ref Section 37 - Duty of PCBU who manages or controls the workplace under the HSWA).

I'm also concerned given the comments at the meeting on the 26-09-23 that the Wellington Regional Council had not been consulted on the suitabi ity of the Dillon Street track for its intended purpose that you appear to have failed in your duty so far has reasonably practicable to consult co-operate and coordinate activities with all other PCBUs who have a duty in relation to the same matter" (ref Section 34 - PCBU must consult with other PCBUs with same duty under the HSWA).

An extreme lack of duty of care appears to have been exercised and examples of simple practicable steps that should have been undertaken in the planning of this project but were not include but are not limited to the following:

- A visual pre-assessment of the suitability of the alternate pedestrian route. Even a quick visit to the Dillon St tracks by a single competent person would have identified that the Dillon St tracks are unsuitable as a means of pedestrian management.
- Requests for deta ls of any specific needs that the residents have during the planning stage. An example of how this could have been done is through a simple letter drop.
- Invitation to a suitable resident representative to attend the safety in design workshop/s (if you have even had one) for the project.
- Holding a public meeting for the residents before you had determined how the site is to be set up and let a contract (set the terms and conditions) for the project to take place in less than two weeks' time. One of your officers commented at the meeting on the 26-09-23 that the project is being done under emergency works. The slip occurred on the 14-3-23 more then six months ago. Whilst the response to the slip can be considered as emergency works this work is not it is a planned infrastructure project in response to a serious incident six months ago.
- Proactive consultation on the design to be implemented and even putting a contact name and appropriate contact number on any information documents issued such as the handout attached here would have been a good start.

3. Request for specific pedestrian access

I have a three year old child who attends Kindergarten in Petone from 8.30am until 2.30pm. Both my partner and I work full time with a limited allowance to work from home (one day for myself and one or two for my partner) to enable us to break from work to pick our child up who then goes to his Grandparents next door. Two to three days a week the Grandparents do the pick up. Following the public meeting on the 26-09-23 the Grandparents have confirmed that they will not be able to any pick ups due to the restrictions put in place by Hutt Council unless they are allowed through the site at a pre arranged time between 2.00pm and 2.15.

My request is therefore that escorted pedestrian access is allowed / provided for in a limited number of circumstances when a resident has a specific need. For example our situation above but this could include a specific appointment such as medical or an urgent repair for other residents.

Our requirement is that either myself my partner or our child's Grandparents are able to safely leave our homes and do the Kindergarten pick up at 2.30pm. Alternatively the Hutt Council could find a suitable alternate route around the work site so we are able to do the Kindergarten pick up or the Hutt Council can arrange for our child to be safely picked up by a competent person at 2.30pm each afternoon or the Hutt Council can contact both of our employers and explain why we need to take a half days leave for at least the next six weeks and reimburse us our loss of income.

4. Request for copies of documents under the Local Government Official Information and Meetings Act 1987 (LGOIMA).

Finally I have other health and safety concerns arising from your proposal to totally close the road for a duration of six and a half hours each day and this includes your proposal for dealing with health / fire emergencies by the use of a Ute as a satisfactory solution and I therefore feel that this work needs careful further planning. This includes specific risk analysis and subsequent risk management including further consultation with affected PCBUs and importantly the affected residents of Point Howard.

To this end under the Local Government Act I request copies of the following documents please:

- Safety in Design workshop/s meeting notes and risk analysis undertaken for this project work.
- Consultation with the Regional Council on the use of the Dillon St tracks for pedestrian management.
- Copy of the temporary traffic management plan for the work (site).
- Copy of the site specific health and safety plan for the project.
- Copy of the Building Consent for the works.

Yours sincerely

[redacted]