NGS

Northland Geotechnical Specialists

GEOTECHNICAL DESIGN REPORT FOR LANDSLIP MITIGATION

Location	1A Seaview Road, Paihia
Client	Jane Banfield
NGS Ref	0213
Date	11 March 2022
Report prepared by	Rebekah Buxton
Authorised for NGS by	David Buxton

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1. Introduction & Scope

Northland Geotechnical Specialists Ltd (NGS) was engaged by Jane Banfield to undertake subsoil investigations, assess landslip movement and provide a design of landslide remediation works at 1A Seaview Road, Paihia. The scope of works comprises:

1) Visual assessment of damage;
2) Review of investigation completed by others;
3) Undertake subsurface investigations;
4) Geomorphic assessment of the site and surrounding area from LiDAR terrain models and historic aerial photographs;
5) Stability modelling to assess the landslip and remedial design measures;
6) Retaining wall analysis to design remedial works; and
7) Preparation of design drawings for the proposed terraced retaining walls.

This report is suitable to support a Building Consent application to Far North District Council (FNDC).

2. Background

A landslide has occurred on the subject property located adjacent to the southern side of the dwelling and the southern property boundary. The landslide occurred in February 2021 during intense rainfall in the Bay of Islands area. It is proposed to construct a system of two retaining walls to stabilise the land supporting the dwelling and reinstate the amenity of the land to the south of the dwelling. The lower (southernmost) retaining wall will facilitate creation of a stable platform from which to construct the upper (northernmost) wall. Underpinning of exposed and inadequate foundations is proposed as part of this works. The work will allow for extension of the existing concrete surfaced accessway further to the south. SCS Structures has completed the structural component of this design work. This report and drawings should be read in conjunction with the SCS Drawings SK-SE-000 to -003.

3. Site Description

3.1. Property Description

The subject property is legally described as Lot 2 DP 124280 and covers an approximate area of 1105m^2. The site is and irregular pentagon in shape, being approximately rectangular at the southern end with dimensions of approximately 28m (E-W), 26m along the eastern boundary, 31m along the western boundary and extending to a triangular point centrally at the northernmost point at a maximum length of 47m.

The property has a total change in elevation of approximately 7m with a maximum elevation of centrally on the eastern boundary and a minimum in the north eastern corner of the site. The property has two distinct typically level terraces. The elevation drops steeply beyond the property boundaries to both the east (up to 40°) and south (up to 45°) towards the foreshore.

The property is accessed by a long driveway from Seaview Road at the southwestern corner. The property is bound by a vacant, grassed site (formerly a hotel) to the west, neighbouring residential properties to the far north and the foreshore to the east and south. The land to the north, east and south is vegetated with trees.

The dwelling with attached deck on the eastern side is located at the southern end of the site and has been constructed over several additions and alterations varying between one to three levels.

The landslide which occurred in February 2021 is located at the eastern end of the southern edge of the dwelling on the steep slope to the south. The landslide is steep and shallow (<1m deep). Shallow dwelling foundations have been exposed. A large tree to the west of the slip has previously been cut down, with the remaining tree stump also causing tension in the area around the foundations. (Ref Photo 1 below).

Photo 1: View to west along southern edge of dwelling showing exposed shallow foundation (right) and tree stump (left)

A walkover of the foreshore indicates outcrops of slightly to moderately weathered intact greywacke rock are present at the base of the slopes, as shown in Photo 2, below.

Photo 2: View to east along the base of the southern slope

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3.2. Existing Dwelling Foundations

The dwelling onsite has been developed in several phases, with extensions to, then significant renovations of, the original dwelling. Along the southeast side of the dwelling, where the slip and proposed retaining walls are located, the foundations appear to have been constructed in four or five phases with the original dwelling having been set back from the slope. A brief description of the dwelling, based on plans and calculations held on the FNDC property file is below.

The original dwelling onsite was constructed around or soon after 1975. Dwelling plans are not held on the FNDC file however structural engineering design calculations[1] indicate the main structural form. The dwelling was of two-level concrete construction with the lower level being a part basement and having an upslope concrete block retaining wall. The upper level has a unispan type floor, including a cantilevered terrace. A garage was attached to the upper level of the dwelling with an on-grade floor, upslope of the concrete retaining wall. The roof was of a flat nature with timber truss construction. The original dwelling appears to have been set back from the landslip area. The main dwelling structural form is shown in Figure 3-1 below.

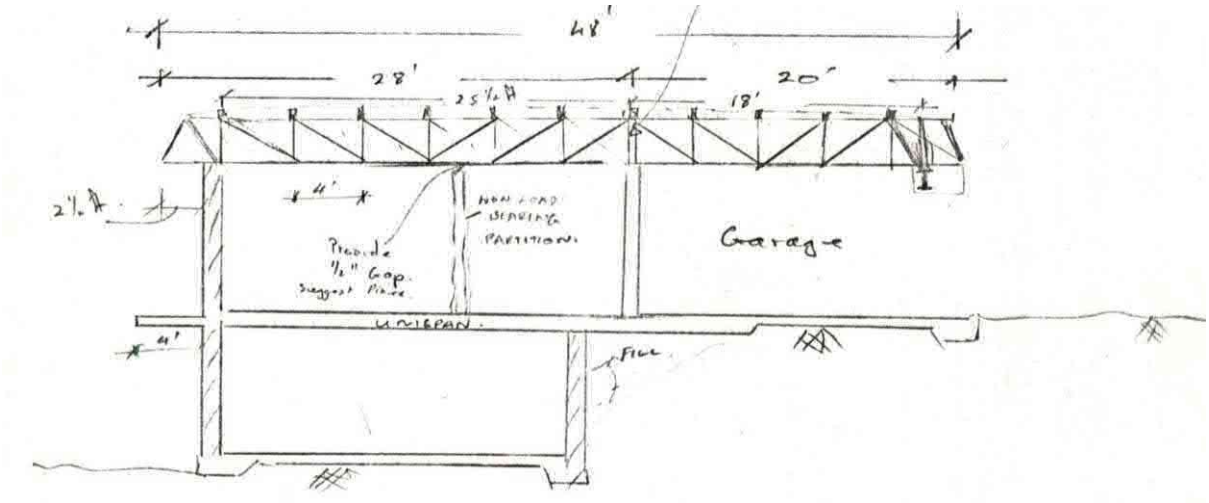


Figure 3-1: Main dwelling form from 1975 structural design calculations. The section is a SW-NE direction.

Plans from 1978[2] indicate the original garage may have been converted to a living space and a new garage was constructed to the southeast of the original garage. The new garage floor has been designed to cantilever out over the top of the slope to the east of the dwelling, with a footing supported by a row of min. 1200mm deep piles. This new garage forms the structure directly adjacent to the southern portion of the slope. The design cross section is shown in Figure 3-2 below.

[1] Tapper Cotter Brown and Partners, Noon House, Structural Calculations & Design Certificate, September 1975.
[2] Proposed Garage for Mr and Mrs N Noon off Seaview Rd in Paihia, Feb 1978, Brown & Thompson Consulting Engineers, Plans, elevations and structural details.

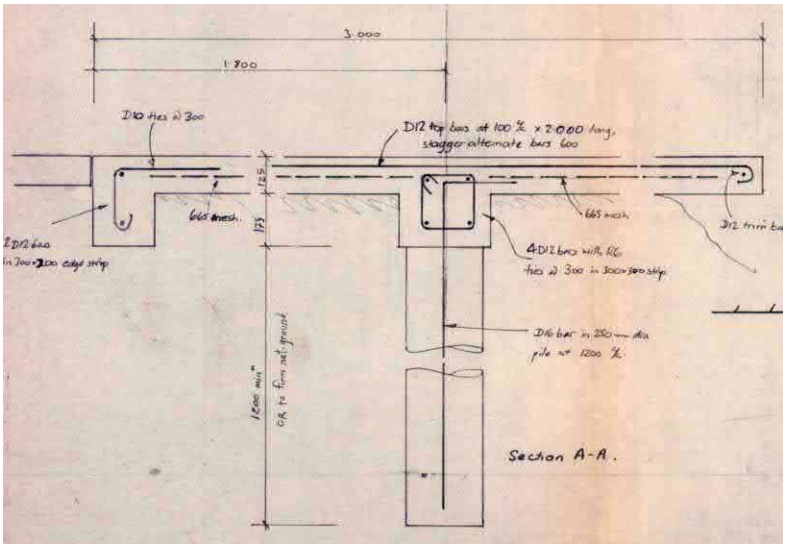


Figure 3-2: 1978 garage floor and foundation details. The cantilevered portion of floor overhangs the southern portion of the slope where new retaining walls are proposed.

Plans from 1983[3] indicate a new upper-level study was added directly above the slip area. The upper level study was of timber construction. A concrete floor slab with shallow footings is shown below, separated from the main dwelling structure. This extension likely forms the foundations directly above the slip area which are most at risk. The 1983 plans don't show the slope proximity and it is inferred the extension extended onto the slope area, with foundations likely amended onsite. The cross section through the extension is shown in Figure 3-3 below.

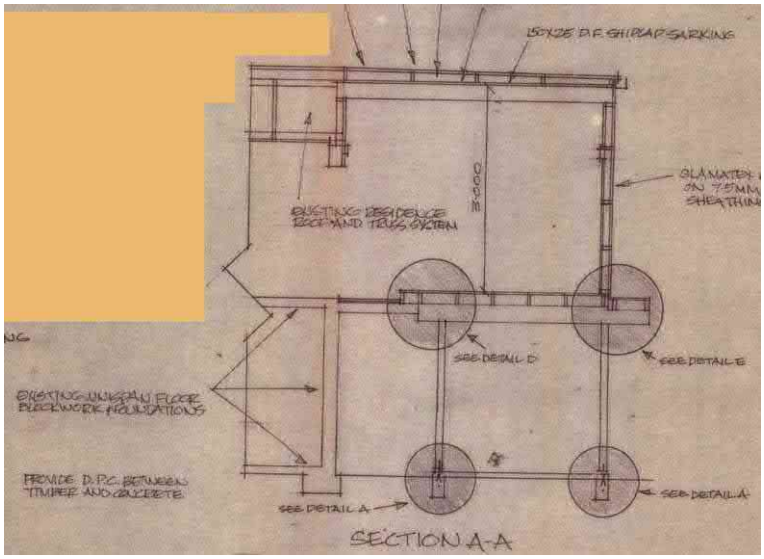


Figure 3-3: 1983 extension to form an upper-level study. The section is directly above the slip area however the section does not show the slope. The outer (right side of section) foundations extend over the slope crest and were likely adapted onsite.

Plans from 2001[4] indicate the dwelling was significantly renovated with new decks/terraces and new architectural facades. As part of this work the lower level of the extension in Figure 3-3 has been converted to a studio, the gap between the dwelling and 1983 ground slab infilled to form a new hall

[3] Proposed Study for Mr and Mrs Couch off Seaview Road in Paihia, sheets 1 to 3, March 1983,
[4] Architectural Design, Banfield House Alteration, Paihia, July 2001, 5 Pages, Stamped approved by FNDC BC 20020208.

and a new lower-level area constructed to the south, forming a new bathroom. The lower-level terrace to the north has also been re-constructed. The layout of the extensions/renovations of the lower level directly above the slope/slip area are shown in Figure 3-4 below.

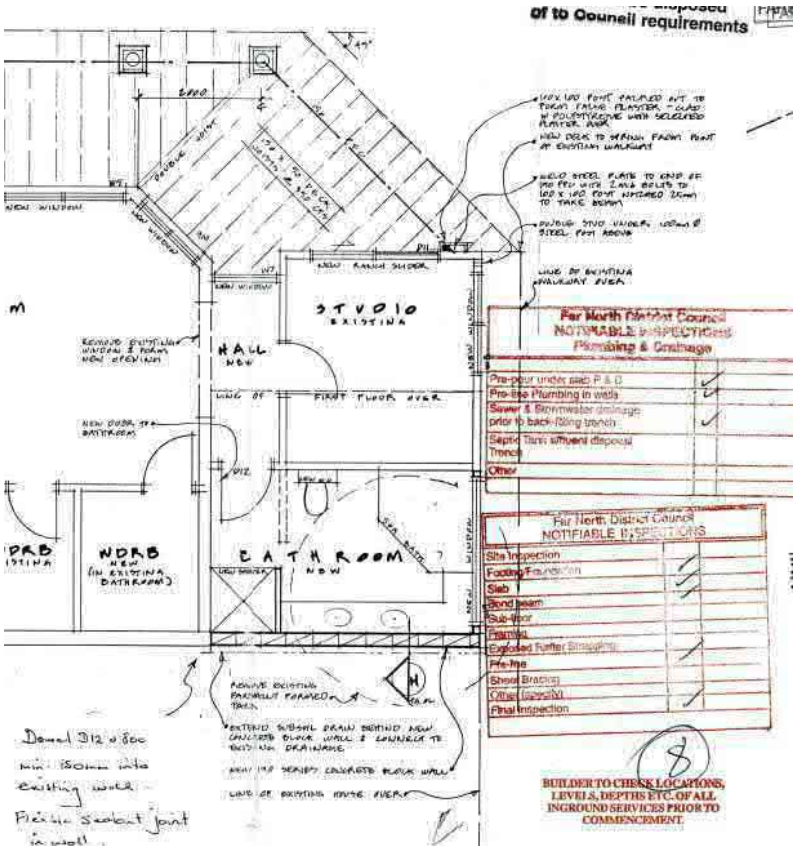


Figure 3-4: 2001 plan of extensions/renovations. The slip and proposed retaining walls are immediately to the right of the building footprint. The Studio appears to be the 1983 extension floor slab. The bathroom is of new construction, including extending the concrete block retaining wall. The new bathroom floor slab, directly above the slope, is shown as having a 200 wide footing extending 400 into solid bearing elsewhere in the drawing set.

A sketched structural detail[5] from 2001 suggests a single 3m deep 400mm diameter pile may have been installed to the northeast of the studio and under the terrace shown in Figure 3-4.

Based on the information in the FNDC property file it appears foundations of the lower level adjacent to the slip area are typically shallow and not specifically designed to resist slope movement, except for the single 3m deep underpinning pile shown under the terrace. To the southwest, where there is no lower level adjacent to the slope, a cantilevered concrete slab dating from approximately 1978 exists with plans showing it is supported by approx. 1200mm deep piles.

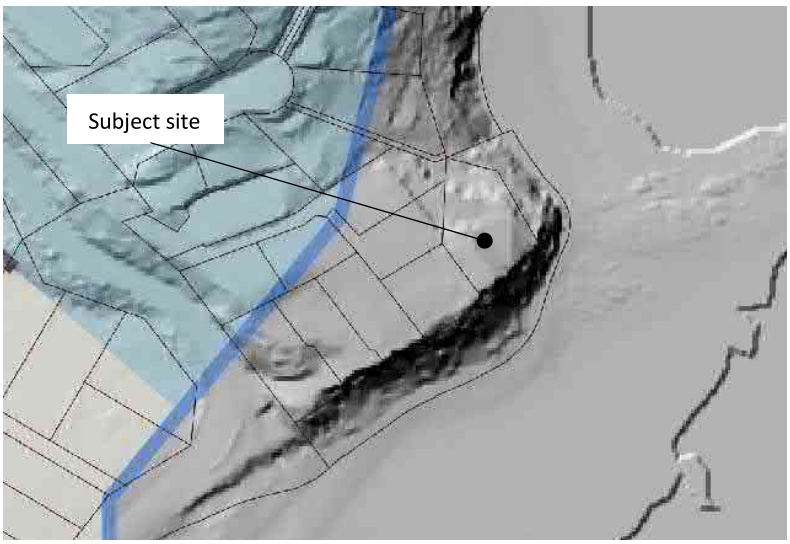
[5] Fraser Thomas Ltd, underpinning detail, signed by Roger Toplis 10/08/01

4. Geological Conditions

4.1. Published Geology

The published geology[6] indicates that the subject property is underlain by Waipapa Group Sandstone and Siltstone. This typically comprises massive- to thin-bedded, lithic volcaniclastic metasandstone and argillite with tectonically enclosed basalt, chert and siliceous argillite. The Waipapa Group is considered to be basement terrane and the main rock type is likely to be greywacke.

The published geology is shown in Figure 4-1 below, noting that the coastal boundary is offset in this location.



Legend

Blue	Waipapa Group Sandstone and Siltstone
White	Holocene Shoreline Deposits

Figure 4-1 – Published Geology[6] on 2018 NRC LiDAR DEM

4.2.2 Aerial Photograph Review

Review of historic aerial photographs and present day images[7] has been completed, as well as a selection in stereopairs.

- In 1953 the properties to the west of the subject site have been developed. The subject site is tree covered and undeveloped. There are some large trees along the southern slope.
- By 1972 the subject site has been cleared across the central and northern area. A cleared track is visible across the northern end of the property leading down to the beach. The structure present in1953 on the property to the west of the site has been removed and new structures. The existing access way from Seaview Road is visible along the southern end of the neighbouring properties. The accessway does not yet extend to the subject property.
- By 1981 the dwelling on the subject property has been constructed on the south eastern corner of the site above the steep slopes. Some landscaping of the area to the north of the

[6] Edbrooke, S.W.; Brook, F.J. (compilers) 2009: Geology of the Whangarei area. Institute of Geological & Nuclear Sciences 1:250,000 geological map 2. 1 sheet + 68 p. Lower Hutt, New Zealand. GNS Science.

[7] Historical Photographs sourced from Retrolens.nz, photographs dated 1953, 1972, and 1981. Google Earth pro aerial photography dating between 2004 and 2021.

dwelling has been completed. The structure to the west of the subject property has been extended to the north.

- In 2004 the footprint of the subject dwelling has been altered with extensions to both the west and south east. The structures on the neighbouring properties on the west of the site have been completely removed and replaced with a hotel complex development including carpark and swimming pool.
- By 2016 the western neighbouring property has been cleared and is in grass. There is little change noted between the 2016 and present day images.

There is little observed movement of the slopes to the south or east of the property however tree cover has obscured visibility.

Photo 3a: Crown_209_546_75, 1953

Photo 3b: Crown_3406_4482_25, 1972

Photo 3c: Crown_5651_F_5, 1981

Photo 3d: Google Earth Pro – historical imagery 2004

4.2. Site Investigations

4.2.1. Previous Investigation (Cook Costello 2021)

Investigations were completed by Cook Costello/Geocivil in July and August 2021.The investigations are presented in the Cook Costello Geotechnical Factual Report[8] and Land Damage Assessment Report[9]. Investigations comprised:

- 7No. Hand augered boreholes (HA2 – HA8) to 0.6m – 2.2m depth
- 9No. Scala Penetrometer tests (SP1 – SP8 & SP6a) to effective refusal (>10 scala blows/50mm penetration)
- One machine drilled borehole (MBH01) to a depth of 11.5m. SPT measurements were taken at regular intervals down the depth of the borehole. An inclinometer was installed in the borehole on completion.

Previous Cook Costello investigation locations are shown on *Figure 101 – Site Investigation Plan* presented in Appendix A. Cook Costello investigation logs are presented in Appendix B.

4.2.2. Recent Investigation (NGS 2022)

Recent site investigations were completed by a geotechnical engineer from NGS on 13 January 2022. The investigations comprised two hand augered boreholes (HA9 – HA10) with scala penetrometer testing completed from the base of the borehole to effective refusal (>20 scala blows/100mm penetration).

The exposed dwelling foundations along the southern side of the dwelling were probed with a gum spear to ascertain existing embedment depth.

Investigation locations are indicated on *Figure 101 – Site Investigation Plan* in Appendix A, and recent hand augered borehole logs are presented in Appendix B.

4.3. Subsoil Conditions

Fill was identified beneath the site next to the dwelling (HA9) to a depth of 0.8m. The fill comprised loose, reworked, likely site won, residual soils.

Beneath the fill, and in the other hand augered boreholes the site is underlain by residual soils of greywacke comprising silty clay/clayey silt with occasional trace sand and gravel and trace organics (rootlets) in the upper layers. The residual soils are typically stiff to hard, orange-brown, moist and of low plasticity. Undrained shear strength measurements in the residual soils are typically between 90-200kPa with one outlier of 45kPa at a depth of 0.5m in HA4. One SPT test conducted at a depth of 1.5m in MBH01 returned a value of N=17. A void was identified at a depth of 1.1 – 1.5m in HA4 and loose/"voidy" material was inferred in HA9 to a depth of 1.8m. It is inferred that this is a tension zone in the area of the felled tree identified in Section 3 (ref Photo 1), above.

The investigations indicate a weathering profile of greywacke decreasing with depth. Scala penetrometer measurements increased with depth from the base of the hand augered boreholes to

[8] Cook Costello report for Jane Banfield, *Geotechnical Factual Report; 1A Seaview Road, Paihia*, Project Number: 16057-001, Date: 11/01/2022.
[9] Cook Costello report for Jane Banfield, *Land Damage Assessment; 1A Seaview Road, Paihia*, Project Number: 16057-001, Date: 06/10/2021.

effective refusal to the scala (>10 scala blows/50mm penetration and >20 scala blows/100mm penetration). Refusal to the scala is inferred to be at the approximate depth of change from highly to moderately weathered greywacke. SPT results typically increased with depth to N>50 from a depth of 8m. N>50 is inferred to be at the approximate depth of change from moderately weathered to slightly weathered/unweathered greywacke.

4.4. Groundwater

Groundwater was not identified during or on completion of the investigations.

5. Remediation Design

5.1. General

The nature and continuity of the subsoil conditions onsite have been inferred from nine hand augered boreholes, 10 scala penetrometer tests and one machine drilled borehole at discrete locations. Two of the hand augered boreholes and scala penetrometer tests were undertaken by NGS with the rest completed by others. It must be appreciated that actual subsoil conditions could differ from those inferred. If the subsoil conditions differ in any way from those described in this report is it essential that we be contacted.

5.2. Design Philosophy

The landslide is occurring on an over steepened slope with dwelling loads and fill placed at the crest, in shallow residual soils of the Waipapa Formation (Greywacke). The absence of settlement damage to the dwelling suggests that dwelling foundations have not been undermined by the landslide however the soils providing passive support have evacuated downslope, exposing the foundations. Furthermore the foundations are not of a type and standard appropriate for a dwelling on the crest of a coastal cliff. A large tree near the crest of the slope and in proximity to foundations has recently been felled. The stump is still present and the soil in the area is seen to be in tension with voids forming as the organic material decomposes and the tree pulls away. Access to the site limits the size of plant and construction materials. Accordingly, the following design philosophy has been adopted:

1) The landslide is assessed to be shallow based on visual observations, subsoil investigations showing increasing strength and decreasing weathering with depth, and the occurrence immediately following an extreme rainfall event. Although some of the movement may have occurred unnoticed over a longer period.
2) The site investigation clearly indicates better material is present with increasing depth.
3) A system of two terraced retaining walls has been selected. The lower wall will provide global stability to the site and retain some imported fill immediately behind it to provide a level area to improve amenity and safety and allow progressive construction access. The upper wall will be constructed in close proximity to the southern wall of the dwelling to provide passive support to the exposed foundations as well as limit the required height of the lower wall. The foundations will be underpinned as the construction advances (design undertaken by others).
4) Construction will commence at the level concrete accessway at the south western corner of the property to prepare a stable and level platform. Construction will progress to the east along the length of the walls as a stable platform is formed to construct the next length.

5) The existing felled tree stump shall be removed as part of the construction works. The void this creates should be backfilled with appropriate, well compacted fill material. The methodology of removing the tree stump requires construction of both the lower and upper wall and likely burial of the tree stump to allow construction of the full length of wall and underpinning prior to removal. Over excavation of the upper wall to account for the stump removal has been assessed in this zone.
6) The lower wall has been designed to tolerate an additional 1.0m retained height to account for future evacuation of soils downslope of the wall. This allows for complete evacuation of all residual soil (based on depth of soil in HA10) and the assessed coastal regression (Ref Section 5.4, below).
7) The landslip surface is within the residual soils. Back analysis of the assumed pre landslide slope was undertaken using the Rocscience software Slide 2.0. Soil/rock parameters were selected from the back analysis and correlations with the measured in-situ strengths during investigation.
8) Pile retaining wall analysis (Wallap) has been used to assess pile structural actions and check the adopted minimum pile embedment provides adequate passive resistance.
9) Minimum design Factor of Safety (FoS) values of 1.5 for static/design groundwater, 1.3 for elevated groundwater and 1.1 for seismic have been adopted.
10) The concrete accessway is to be extended from its present location to the boundary. As such there will be no upper wall. This results in a larger retained height at this end of the wall. In the case of future evacuation of soils in front of the wall due to coastal regression the resulting estimated deflection is greater than typically acceptable and the factor of safety about the pile toe is slightly less than the criteria adopted along the rest of the wall chainage. This is considered to be generally acceptable due to the offset from the dwelling. If in the future, the downslope evacuation of soils or deflection at the top of the wall is realised anchoring of the pile head or other remediation may be adopted at that stage.
11) To facilitate the extension of the accessway, the three western most upper wall piles will be abandoned and three extra piles linking the western ends of the two walls will be constructed at completion of the works to form the level accessway.

5.3. Site Seismic Characteristics

In accordance with NZS 1170.0[10] the residential dwelling and supporting structures is considered to be an Importance level 2 (IL2) structure. Return periods for limit state design events for an IL2 structure are Serviceability Limit State (SLS) 1/25 years and Ultimate Limit State (ULS) 1/500 years. Based on the subsoil conditions observed the site is considered to be a Class C- shallow site in accordance with NZS 1170.5[11]. This classification is based on the identification of greywacke rock at shallow depths.

Ground motion inputs from Table A1 of the NZGS/MBIE Earthquake Geotechnical Engineering Practice Module 1 have been adopted for the purpose of geotechnical assessment within this report and are summarised in Table 5-1.

[10] Standards New Zealand, 2004. Structural Design Actions Part 0: General Principles. NZS 1170.0:2002
[11] Standards New Zealand, 2004. Structural Design Actions Part 5: Earthquake Actions. NZS 1170.5:2004

Table 5-1: Site seismic parameters

Design Level	Annual probability of exceedance	Peak Ground Acceleration (PGA)	Earthquake Magnitude (Mw)
SLS	1 in 25 years	0.03	5.8
ULS	1 in 500 years	0.13	5.8
Minimum seismicity[1]	Less than 1 in 500 years	0.19	6.5
Notes 1	Minimum level of seismicity for design is recommended in areas of low seismicity and comprises a magnitude 6.5 earthquake at 20km distance		

In accordance with NZGS/MBIE Earthquake Geotechnical Engineering Practice Module 6, Table 5-2, the retaining walls presented in this report are considered to be Case 3: Downslope and supporting building foundations. As such, the PGA for pseudo-static design of retaining walls is reduced by a factor (W_d) of 0.5, i.e. $PGA_{min\ seismicity}$ of 0.095g is adopted. This factor accepts that some displacement under a seismic design scenario is typically acceptable.

5.4. Coastal Regression

The greywacke foreshore will gradually retreat due to coastal erosion, resulting in slips on the slopes above. The rate of foreshore regression is not readily apparent from review of aerial photographs dating from 1951 (i.e. 71 years ago) due to tree cover of the slopes however it does not indicate rapid coastal erosion. The rate of foreshore regression is limited by both the strength of the greywacke rocks and the lower energy coastal environment given the relatively sheltered setting of the southern slope (i.e. it is not exposed to open ocean). No significant preferential erosion features likely to accelerate average coastal regression rates (e.g. sea caves) were observed. An average long-term coastal regression of 1.0m per 100 years is considered appropriate for the southern slope. We note that coastal regression is not consistent and slope regression often occurs as intermittent landslip events rather than as a continuous process.

An assessed regression line is presented on *Figure SA-1: Section A – Coastal Regression*. The regression line assumes:

1. Coastal regression of 1.0m.
2. A long-term stable slope angle of approximately 45˚ (i.e. approximately parallel to the existing slope).

5.5. Numerical Slope Stability Analysis

Numerical slope stability analysis has been undertaken on Section A through the main body of the landslide (Section A, Ref *Figures SA & 2*, attached). The analysis was undertaken using the software package *Slide*-2018.8.031 provided by RocScience. The topography has been developed based on the site survey completed by Williams & King[12].

Groundwater has been modelled using an R_u coefficient for the less permeable residual soils and highly weathered greywacke. This develops a porewater pressure profile specific to each slip surface and is appropriate for the short term perched (transient) pore water pressures that are expected to develop following rainfall onsite and the groundwater flow conditions that will result due to the sloping topography. Groundwater in the moderately weathered greywacke is modelled by a piezometric surface at the assumed interface between the highly weathered and moderately

[12] Williams & King, *Slip Survey Lot 2 DP124280, Jane Banfield, Paihia*. Job No. 22451; File: Slip Survey, Sheet No. 1/4. Dated Dec 21.

weathered greywacke. The seismic case is considered to occur under design groundwater conditions.

The soil parameters adopted for wall design have been derived based on the site investigation and through back analysis of the existing landslide. The soil parameters are presented in Table 5-2 below.

Table 5-2: Soil parameters from back analysis

Parameter	Fill	Residual soils	Highly weathered Greywacke	Moderately weathered Greywacke
Unit weight (kN/m^3)	18	18	19	20
Drained cohesion, c' (kPa)	2	6	10	20
Friction angle, ϕ' (deg)	28	32	34	37
R_u Coefficient[a]	0.05 [0.2]	0.1 [0.3]	0.05 [0.2]	N/A

Notes a Ru value for design groundwater [elevated groundwater]

The soil parameters determined from the back analysis were adopted for design of the wall at Sections A, B and C (Refer *Figures 2 – Site Plan, SA – Section A, SB – Section B & SC – Section C*). Results of the stability analyses are given in Table 5-3 below. A 10kPa surcharge was applied upslope of the upper wall to model loads arising from the dwelling and long term live load, noting that proposed underpinning works will minimise some of this applied load.

Table 5-3: Stability Analysis Results

Design Case		FoS	Target FoS	OK?
Section A	Back analysis	0.92	1.0	Yes
	Design Groundwater	1.61	1.5	Yes
	Elevated Groundwater	1.46	1.3	Yes
	Seismic	1.23	1.1	Yes

Notes a Design, Groundwater, Elevated Groundwater and Seismic analyses completed for 2No piles: Upper wall - 4m length force upper wall, and Lower wall - 5m length. Shear force selected to force failure below toe of walls.

Results from the stability analysis are presented in Appendix C.

5.6. Wall Design

Geotechnical design of the wall has been undertaken using the software package *Wallap* Version 6.06, provided by Geosolve.

Three sections, A, B & C, along the chainage of the walls have been analysed. The sections are shown on Figure 2 – Site Plan and Figures SA, SB & SC presented in Appendix A.

Section A: Used for back analysis (ref Section 5.5 above). Retention in front of double level dwelling. Lowest point on lower wall resulting in maximum combined retained height. Underpinning of inadequate dwelling foundations above upper wall. Removal of tree stump between upper and lower walls resulting in potential over excavation of upper wall.

Section B: Retention in front of single (upper) level dwelling.

Section C: Lower wall only forming machine access from existing driveway to construction area. Maximum retained height for lower wall.

The following additional parameters as well as those shown in Table 5-2 were used in the wall analysis. The wall-soil interface friction value has been adopted as ⅔ϕ on the active side and ⅓ϕ on the passive side.

Table 5-3: Additional soil parameters for wall design

Parameter	Light weight fill	Fill/ Loose soils	Residual soils	Highly weathered Greywacke	Moderately weathered Greywacke
Unit weight (kN/m^3)	16	18	18	19	20
Drained cohesion, c' (kPa)	0	1	6	10	20
Friction angle, ϕ' (deg)	42	30	30	34	37
Modulus of Elasticity, E'(MPa)	20	20	25	50	200
Poisson's ratio	0.2	0.2	0.3	0.2	0.2

Surcharges are applied in the model to account for the dwelling, construction loads and the effect of the upper wall on the lower. Three design cases for the lower wall have been assessed:

a) Short term load condition of 13T excavator applying asymmetrical surcharge behind the lower retaining wall (i.e. during pile holes excavation and construction with higher loads on one track). k_1 (timber strength duration factor) in bending and shear capacity of timber pile = 1.0.
b) Medium term load condition of 13T excavator stationary above lower retaining wall. k_1 factor in bending and shear capacity of timber pile = 0.8.
c) Long term post construction conditions with 2.5kPa live load above the lower retaining wall. k_1 factor in bending and shear capacity of timber pile = 0.6.

Section A

The design staging for analysis of the Section A lower wall is as follows:

0. Model set up includes 9m deep pile modelled as a 400mm diameter SED timber pile spaced at 1.3m c/c (2.5xD). A groundwater level within the moderately weathered Greywacke is adopted. The soil profile from the stability model is adopted.
1. Apply surcharge at RL 10.0m located 3.66m behind top of wall to model the upper retaining wall.
2. Apply surcharge at RL 10.0m located 4.5m behind top of wall to model additional soil above upper wall, beneath dwelling and dwelling dead load.
3. Apply load at RL 8.67m (i.e. 2/3 retained height below top of wall) to model water pressure.
4. Excavate to RL 8.0m (i.e. 2.0m deep excavation) to existing ground level.

5 & 6. Apply surcharge representing load case a).
7 & 8. *Remove surcharge representing load case a).*
9 & 10. Apply surcharge representing load case b).
11 & 12. *Remove surcharge representing load case b).*
13. Apply surcharge representing load case c).

14. Excavate to RL 7.0m (i.e. an additional 1.0m evacuation of soils of downslope soils over the long term).
15. Apply load at RL 8.67m (i.e. 2/3 retained height below top of wall) to model seismic load.

The design staging for analysis of the Section A upper wall is as follows:

0. Model set up includes 6.0m deep pile modelled as a 300mm diameter SED timber pile spaced at 1.0m c/c. A groundwater level within the moderately weathered Greywacke is adopted. The soil profile from the stability model is adopted.
1. Apply surcharge at RL 12.47m immediately behind the wall to model the dwelling.
2. Apply load at RL 10.82m (i.e. 2/3 retained height below top of wall) to model possible transient water pressure.
3. Excavate to RL 10.0m (i.e. 2.47m deep excavation).
4. Excavate to RL 9.0m (i.e. potential over excavation during removal of tree stump).
5. Fill behind wall to RL 10.0m.
6. Apply load at RL 10.82m (i.e. 2/3 retained height below top of wall) to model seismic load.

Section B

The design staging for analysis of the Section B lower wall is as follows:

0. Model set up includes 9m deep pile modelled as a 400mm diameter SED timber pile spaced at 1.3m c/c (2.5xD). A groundwater level within the moderately weathered Greywacke is adopted. The soil profile from the stability model is adopted.
1. Apply surcharge at RL 11.7m located 3.66m behind top of wall to model the upper retaining wall.
2. Apply surcharge at RL 11.7m located 3.66m behind top of wall to model slope aboe retaining wall.
3. Apply surcharge at RL 11.7m located 5.8m behind top of wall to model additional soil above upper wall, beneath dwelling and dwelling dead load.
4. Apply load at RL 10.37m (i.e. 2/3 retained height below top of wall) to model water pressure.
5. Excavate to RL 9.7m (i.e. 2.0m deep excavation) to existing ground level.

6 & 7. Apply surcharge representing load case a).
8 & 9. *Remove surcharge representing load case a).*
10 & 11. Apply surcharge representing load case b).
12 & 13. *Remove surcharge representing load case b).*

14. Apply surcharge representing load case c).
15. Excavate to RL 8.7m (i.e. an additional 1.0m evacuation of soils of downslope soils over the long term).
16. Apply load at RL 10.37m (i.e. 2/3 retained height below top of wall) to model seismic load.

The design staging for analysis of the Section B upper wall is as follows:

0. Model set up includes 6.0m deep pile modelled as a 300mm diameter SED timber pile spaced at 1.0m c/c. A groundwater level within the moderately weathered Greywacke is adopted. The soil profile from the stability model is adopted.
1. Apply surcharge at RL 13.3m immediately behind the wall to model the dwelling.
2. Apply surcharge at RL 13.3m immediately behind the wall to model the slope above the wall.
3. Apply load at RL 12.23m (i.e. 2/3 retained height below top of wall) to model possible transient water pressure.

4. Excavate to RL 11.7m (i.e. 1.6m deep excavation).
5. Apply load at RL 12.23m (i.e. 2/3 retained height below top of wall) to model seismic load.

Section C

The design staging for analysis of the Section C wall is as follows:

0. Model set up includes 9m deep pile modelled as a 400mm diameter SED timber pile spaced at 1.25m c/c. A groundwater level within the moderately weathered Greywacke is adopted. The soil profile from the stability model is adopted. Lightweight fill (i.e. scoria, γ=16kN/m^3) is modelled behind the wall.
1. Apply load at RL 13.63m (i.e. 2/3 retained height below top of wall) to model water pressure.
2. Excavate to RL 12.62m (i.e. 2.6m deep excavation) to existing ground level.

3 & 4. Apply surcharge representing load case a).

5 & 6. *Remove surcharge representing load case a).*

7 & 8. Apply surcharge representing load case b).

9 & 10. *Remove surcharge representing load case b).*

11. Apply surcharge representing load case c).
12. Excavate to RL 11.62m (i.e. an additional 1.0m evacuation of soils of downslope soils over the long term).
13. Apply load at RL 13.63m (i.e. 2/3 retained height below top of wall) to model seismic load.

The analysed shear force and bending moment loads for each design scenario are shown in Table 5-4 below. Expected top of wall displacements are also provided however it should be noted that the majority of deflection will be experienced under construction loads only. A load factor of 1.5 has been applied to the design loads.

Table 5-4: Pile design loads

			Lower wall[a]			Upper wall[b]
			Load case a)Short term	Load case b)Medium term	Load case c)Long term	
Section A	Design load based on output from Wallap	V* (kN/pole)	65.3	64.7	53.8 [36.0]	65.6 [46.5]
		M* (kNm/pole)	130.7	129.9	112.9 [75.8]	58.7 [41.9]
	Timber Pole Capacity (with appropriate k_1 value)	ϕV_n (kN/pole)	237.5	190.0	142.5 [237.5]	93.7 [156.2]
		ϕM_n (kNm/pole)	188.8	151.1	113.3 [188.8]	59.6 [98.0]
	Top of wall deflection (mm)		106	38	41 [0]	23 (54[e]) [58]
Section B	Design load based on output from Wallap	V* (kN/pole)	94.4	66.3	64.5 [39.7]	7.2 [6.3]
		M* (kNm/pole)	135.5	93.4	121.1 [75.5]	4.4 [3.8]
	Timber Pole Capacity (with appropriate k_1 value)	ϕV_n (kN/pole)	237.5	190.0	165.6[c] [237.5]	80.2 [133.6]
		ϕM_n (kNm/pole)	188.8	151.1	136.7[c] [188.8]	47.8 [79.7]
	Top of wall deflection (mm)		44	45	27 [28]	4 [5]
Section C	Design load based on output from Wallap	V* (kN/pole)	43.9	43.9	87.7 [69.8]	N/A
		M* (kNm/pole)	95.6	95.0	121.9 [97.8]	N/A
	Timber Pole Capacity (with appropriate k_1 value)	ϕV_n (kN/pole)	237.5	190.0	171.2[c] [237.5]	N/A
		ϕM_n (kNm/pole)	188.8	151.1	142.1[c] [188.8]	N/A
	Top of wall deflection (mm)[f]		74	42	42 [25]	N/A

Notes
- a Lower wall: 400mm SED timber poles at 1.3m c/c
- b Upper wall: 300mm SED timber poles at 1.0m c/c
- c An increase in diameter of 6mmm per m length has been allowed.
- d Figure in square brackets denotes seismic loading case
- e Over excavation deflection during tree stump removal, likely conservative as water pressure and live load surcharge applied during over excavation in analysis.
- f Excessive deflection and FoS<2.0 with long term drop out in front of wall. Potential to anchor wall in the future if this is seen to occur.
- g Lower wall deflection likely to occur during construction reducing its long term impact

The retaining wall analysis (Wallap) output and timber pole capacity design spreadsheets are presented in Appendix D.

Factor of safety at toe of wall decreases below 2.0 (Burland-Potts) and deflection at Section C (retaining accessway) is considered to be excessive during long term drop out in front of the wall due to coastal regression. Should drop out in front of the wall be observed to be occurring in the future, remediation could include installing anchors at the top of the piles to limit this deflection. The deflection of the wall is not considered to influence dwelling support.

5.7. Dwelling underpinning design

Vertical support of the eastern portion of the southern wall of the dwelling is not considered to be adequate. Underpinning piles have been designed to support this length of the dwelling. Design of the underpinning works has been completed by SCS Structures Ltd and the SCS drawings are attached in Appendix G. The structural underpinning works shall be undertaken in conjunction and concurrently with the remedial works presented in this report.

5.8. Safety in Design

The proposed retaining walls involve work on an existing landslide, significant retained heights with potential falls of up to 2.6m. The constructor shall ensure onsite worker safety and prevention of damage to the existing dwelling at all times.

Construction shall begin on a stable area on the accessway in the south western corner of the site. Construction shall be progressed eastwards along the wall chainage, ensuring the formed working platform is stable before progressing. The lower retaining wall has been designed assuming an excavator of 13T or less is used. The design surcharge should not be exceeded.

Excavation and retaining walls shall be subject to a specific job safety analysis (JSA) including but not limited to, restrictions during wet weather, delineation of unsafe/no entry zones, use of safety fencing and pre-entry inspections of any cut faces by site staff.

Cuts of up to 1.6m are required adjacent to the existing dwelling. The dwelling foundations have been deemed inadequate and support of the dwelling shall be maintained at all times. The upper wall will be constructed by top down methodology. No cutting down in front of the dwelling shall be undertaken prior to the pile be installed. Soil arching will be relied on during construction. Shotcrete facing below natural ground level shall be applied following construction of the walls.

6. Applicability

This report has been prepared for the soil use of our client, Jane Banfield and the Far North District Council with respect to Building Consent application for the particular brief and on the terms and conditions agreed with our client. It may not be used or relied on (in whole or in part) by anyone else, or for any other purpose or in any other contexts, without out prior written agreement.

The nature and continuity of the subsoil conditions onsite have been inferred from visual observations and two hand augered boreholes, as well as seven hand augered boreholes, nine scala penetrometer tests and one machine drilled boreholes (undertaken by others). It must be appreciated that actual subsoil conditions could differ from those inferred. If the subsoil conditions differ in any way from those described in this report it is essential that Northland Geotechnical Specialists Ltd be contacted.

Report prepared by:

Rebekah Buxton
Geotechnical Engineer, BE Civil (Hons), MEngNZ

Authorised for Northland Geotechnical Specialists Limited by:

_____

David Buxton
Geotechnical Engineer, BE Civil (Hons), CPEng, CMEngNZ

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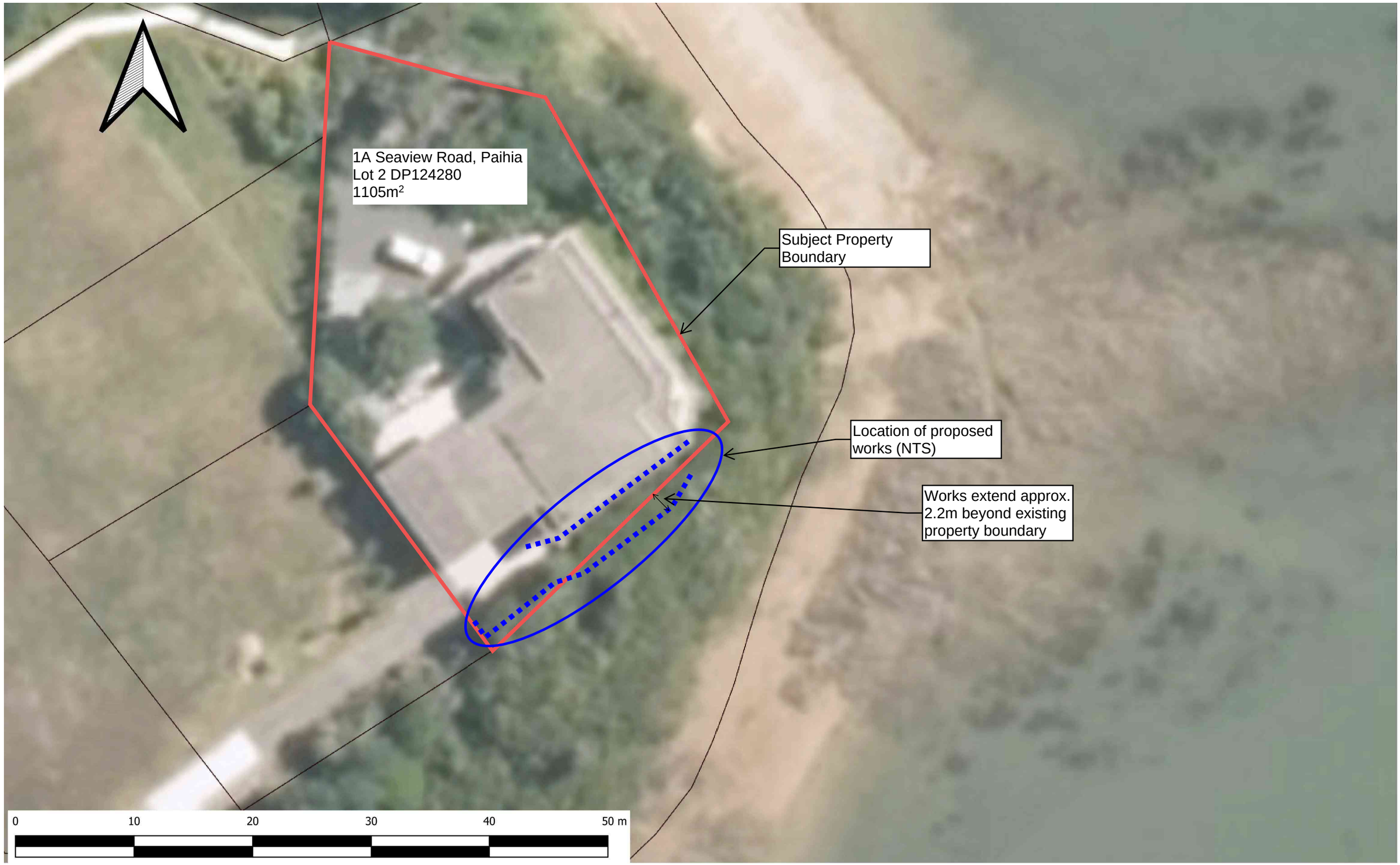
Appendix A:

A1. Construction Drawings

- NGS Figure 1 – Location Plan
- NGS Figure 2 – Site Plan
- NGS Figure 3 – Lower Wall Set Out
- NGS Figure 4 – Retaining Wall Elevation – Lower Wall
- NGS Figure 5 – Retaining Wall Elevation – Upper Wall
- NGS Figure 6 – Typical Section
- NGS Figure SA – Section A
- NGS Figure SB – Section B
- NGS Figure SC – Section C

A2. Not for construction drawings

- NGS Figure 101 – Site investigation Plan
- NGS Figure SA-1 – Section A Coastal Regression



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NOTES:
Aerial Imagery: LINZ, Northland 0.4m Rural Aerial Photos (2014-2016) CC by 4.0.

This figure is not for construction unless signed as approved
Approved: DS Button Date: 11/03/2014

CLIENT **Jane Banfield**
PROJECT **Landslip Remediation**
LOCATION **1A Seaview Road, Paihia**
TITLE **Location Plan**

Scale 1:300 @ A3

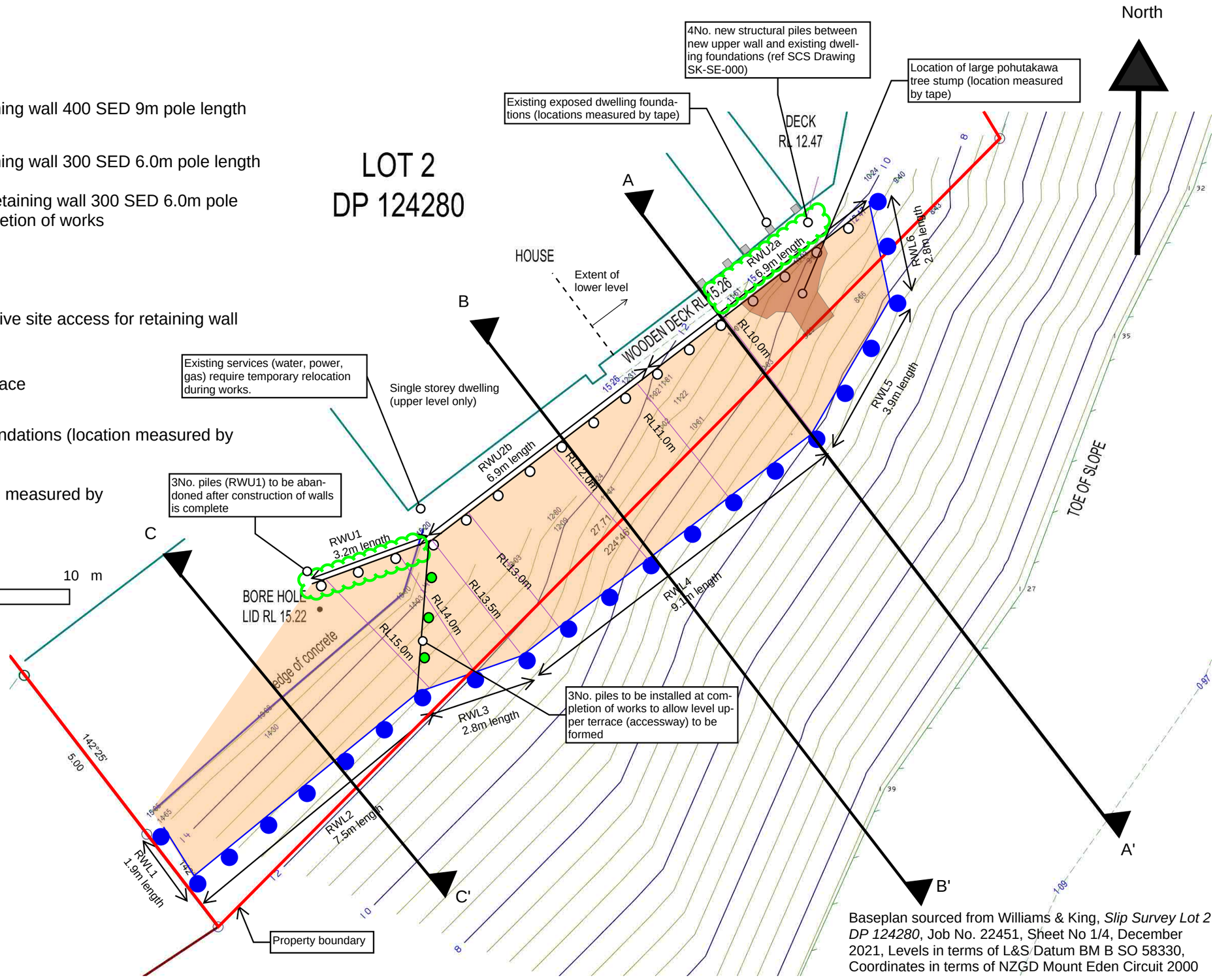
Project No. **NGS 0213**
Date **17/02/2022**
By **RB**
Figure No. **1**
Revision **0**

LEGEND

- Lower wall: Timber pole retaining wall 400 SED 9m pole length
- Upper wall: Timber pole retaining wall 300 SED 6.0m pole length
- Additional wall: Timber pole retaining wall 300 SED 6.0m pole length to be installed at completion of works
- Property boundary
- New terrace to allow progressive site access for retaining wall construction
- RL13.0m — Finished contours on new terrace
- Existing exposed dwelling foundations (location measured by tape rather than survey)
- Pohutaka tree stump (location measured by tape rather than survey)

0 5 10 m

Scale 1 : 100 at A3



Notes:
1. Refer to Figure No.s 3 to 5 for locations and details of new timber pole retaining walls.
2. These drawings shall be read in conjunction with the NGS report, *1A Seaview Road, Paihia; Landslip Remediation*, dated March 2022. NGS Ref 0213.
3. Drawings shall be read in conjunction with SCS Drawings SK-SE-000 to -003.
4. All discrepancies to be referred to the Engineer for decision prior to proceeding with works.
5. All works to comply with Constructor's approved Health & Safety Manual and Health and Safety at Work Act 2015.
6. All works to comply with the Far North District Council Engineering Standards & Guidelines 2009.

Baseplan sourced from Williams & King, *Slip Survey Lot 2 DP 124280*, Job No. 22451, Sheet No 1/4, December 2021, Levels in terms of L&S Datum BM B SO 58330, Coordinates in terms of NZGD Mount Eden Circuit 2000

Project No.	Date			
0213	March 2022	**Jane Banfield** **1A Seaview Road, Paihia**	FOR CONSTRUCTION This drawing is not to be used for construction unless signed as approved	
Figure No.	Revision		Signed	Date
2	A	**Site Plan**	DS Button	11/03/2021

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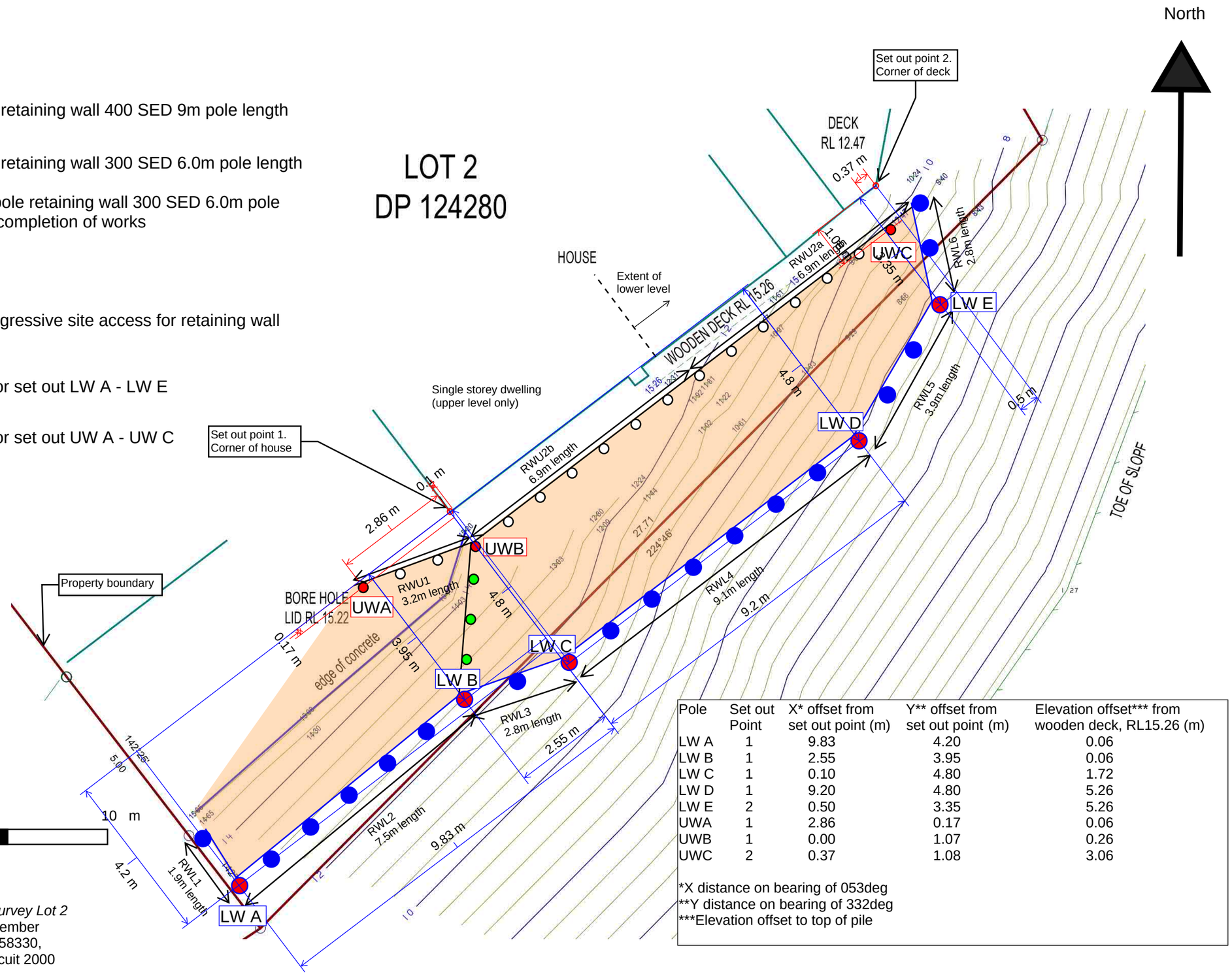
LEGEND

- Lower wall: Timber pole retaining wall 400 SED 9m pole length
- Upper wall: Timber pole retaining wall 300 SED 6.0m pole length
- Additional wall: Timber pole retaining wall 300 SED 6.0m pole length to be installed at completion of works
- Property boundary
- New terrace to allow progressive site access for retaining wall construction
- LW B — Lower wall pole to use for set out LW A - LW E
- UW A — Upper wall pole to use for set out UW A - UW C
- 1 — Set out point 1 - 2



Pole	Set out Point	X* offset from set out point (m)	Y** offset from set out point (m)	Elevation offset*** from wooden deck, RL15.26 (m)
LW A	1	9.83	4.20	0.06
LW B	1	2.55	3.95	0.06
LW C	1	0.10	4.80	1.72
LW D	1	9.20	4.80	5.26
LW E	2	0.50	3.35	5.26
UWA	1	2.86	0.17	0.06
UWB	1	0.00	1.07	0.26
UWC	2	0.37	1.08	3.06

*X distance on bearing of 053deg
**Y distance on bearing of 332deg
***Elevation offset to top of pile

Baseplan sourced from Williams & King, *Slip Survey Lot 2 DP 124280*, Job No. 22451, Sheet No 1/4, December 2021, Levels in terms of L&S Datum BM B SO 58330, Coordinates in terms of NZGD Mount Eden Circuit 2000

Project No.	Date	
0213	March 2022	**Jane Banfield** **1A Seaview Road, Paihia**
Figure No.	Revision	
3	0	**Retaining Wall Set Out**

FOR CONSTRUCTION
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Signed: DS Button — Date: 11/03/2021

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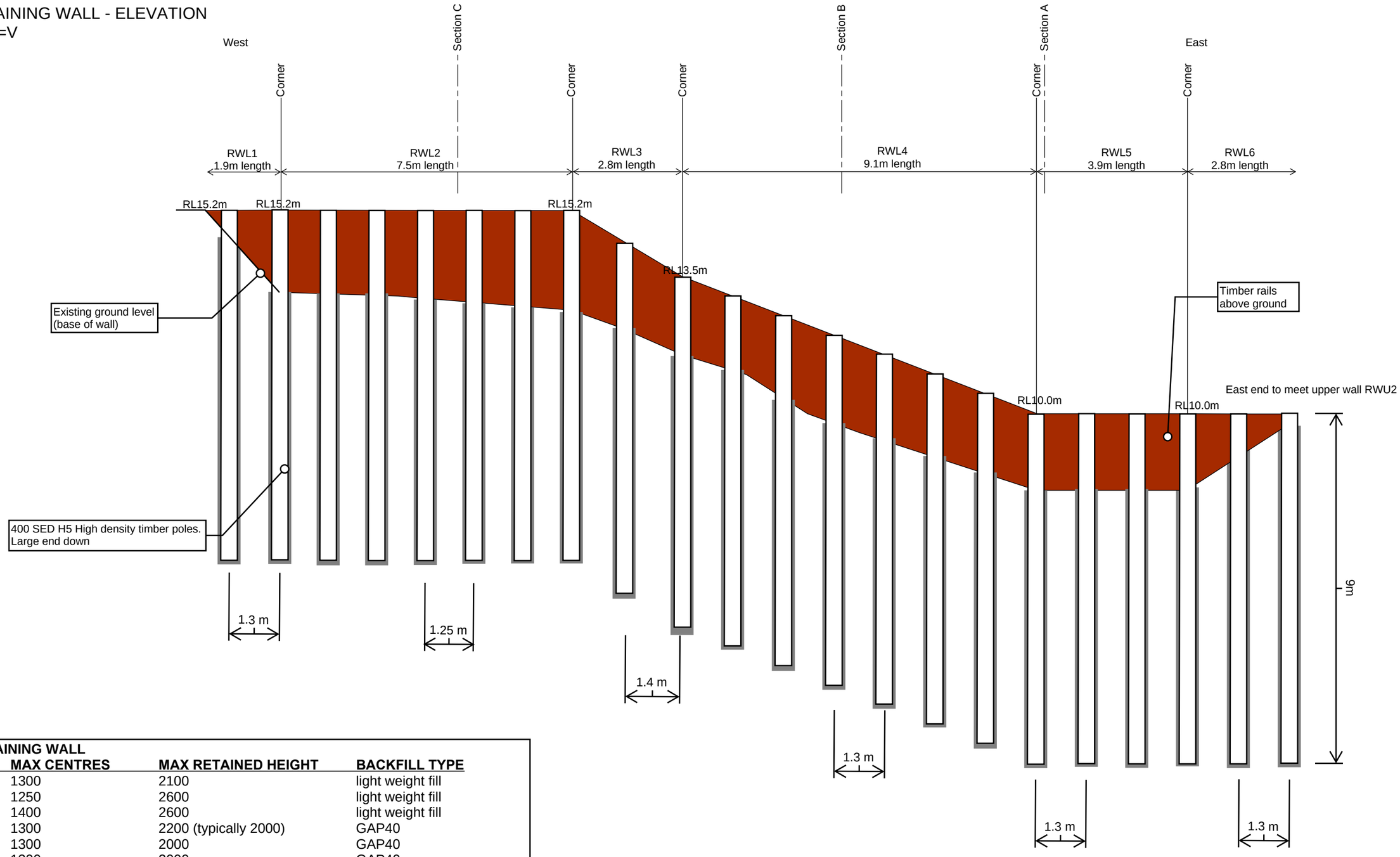
LOWER RETAINING WALL - ELEVATION
1:100 at A3 H=V



Table

LOWER RETAINING WALL

SECTION	MAX CENTRES	MAX RETAINED HEIGHT	BACKFILL TYPE
RWL1	1300	2100	light weight fill
RWL2	1250	2600	light weight fill
RWL3	1400	2600	light weight fill
RWL4	1300	2200 (typically 2000)	GAP40
RWL5	1300	2000	GAP40
RWL6	1300	2000	GAP40

Project No. 0213	Date March 2022	**Jane Banfield** **1A Seaview Road, Paihia**	FOR CONSTRUCTION This drawing is not to be used for construction unless signed as approved
Figure No. 4	Revision 0	**Retaining Wall Elevation - Lower Wall**	Signed DS Button — Date 11/03/2021

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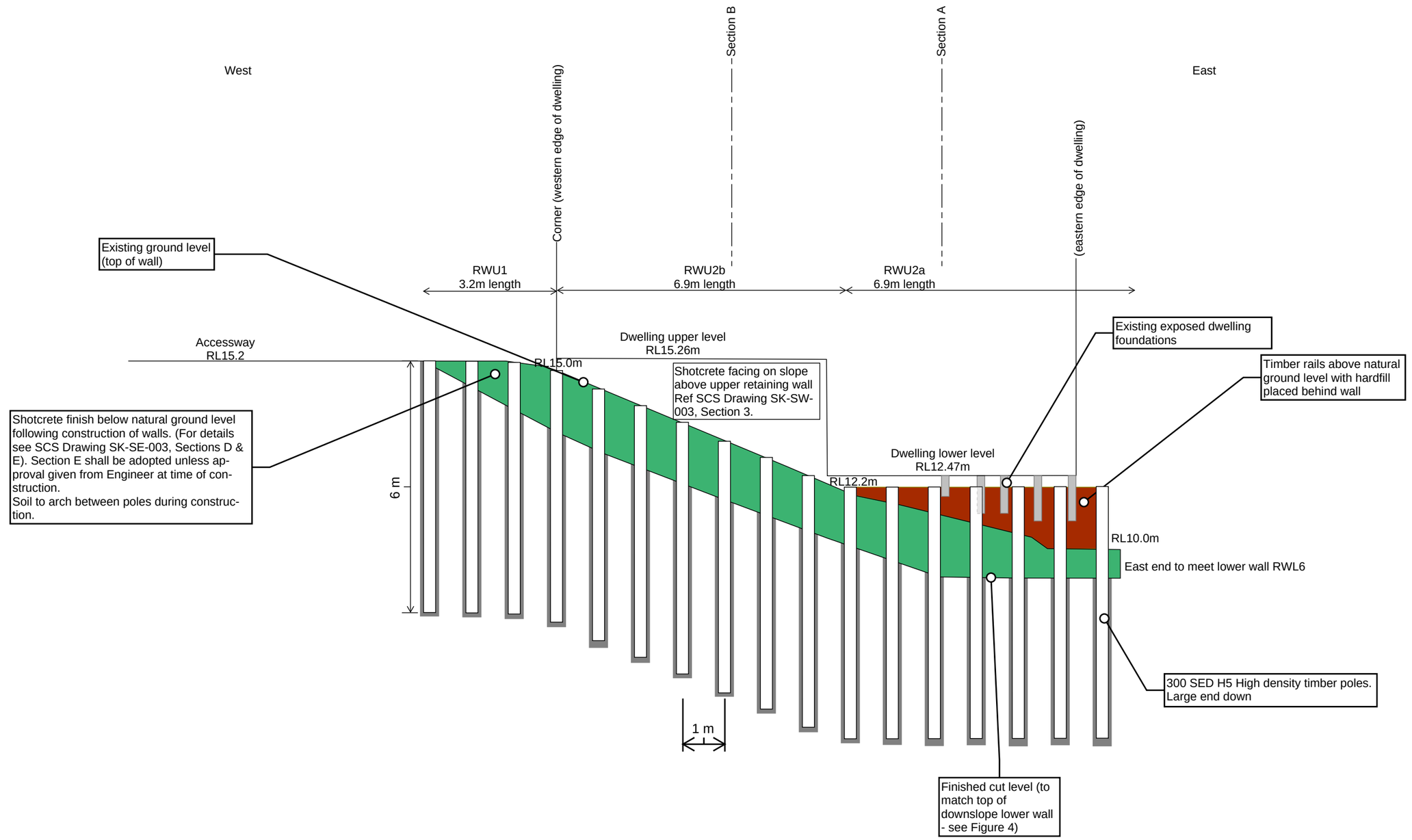
UPPER RETAINING WALL - ELEVATION
1:100 at A3 H=V



Project No. 0213	Date March 2022	**Jane Banfield** **1A Seaview Road, Paihia**	FOR CONSTRUCTION This drawing is not to be used for construction unless signed as approved	NGS Northland Geotechnical Specialists Ph: +64 226981129 E: info@northlandgeotech.co.nz
Figure No. 5	Revision 0	**Retaining Wall Elevation - Upper Wall**	Signed DS Button Date 11/03/2021	

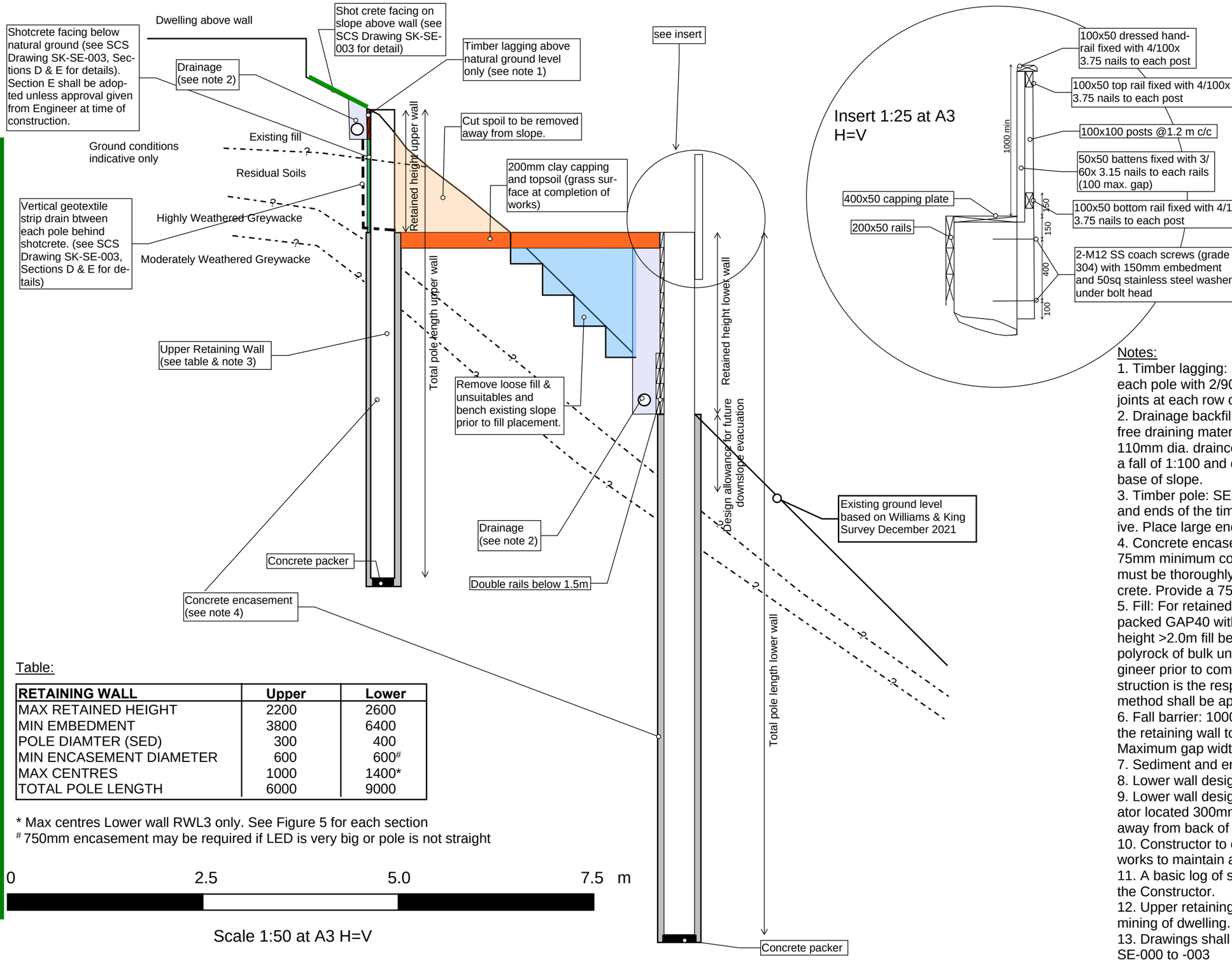


Table:

RETAINING WALL	Upper	Lower
MAX RETAINED HEIGHT	2200	2600
MIN EMBEDMENT	3800	6400
POLE DIAMTER (SED)	300	400
MIN ENCASEMENT DIAMETER	600	600#
MAX CENTRES	1000	1400*
TOTAL POLE LENGTH	6000	9000

* Max centres Lower wall RWL3 only. See Figure 5 for each section

750mm encasement may be required if LED is very big or pole is not straight

0 2.5 5.0 7.5 m

Scale 1:50 at A3 H=V

Notes:

1. Timber lagging: 200x50 H4 RS timber rails fastened to the back of each pole with 2/90x3.15mm dia. HDG FH nails. Stagger timber rail joints at each row over the poles.
2. Drainage backfill: 7mm to 20mm clean scoria backfill or similar free draining material behind the retaining wall with filter cloth. 110mm dia. draincoil placed behind the wall at the bottom rail laid to a fall of 1:100 and discharging at a suitable outlet with pipe outlet to base of slope.
3. Timber pole: SED H5 High density timber poles. Paint cut edges and ends of the timber with a copper napthenate brush on preservative. Place large end down.
4. Concrete encasement: 17.5MPa concrete encasement with a 75mm minimum cover to the sides and base of the pole. The hole must be thoroughly cleaned out and dry prior to placing any concrete. Provide a 75mm thick punch pad at the base of the hole.
5. Fill: For retained height ≤2.0m fill behind wall to comprise well packed GAP40 with min clegg impact value (CIV) of 15. For retained height >2.0m fill behind wall to comprise light weight scoria or polyrock of bulk unit weight less than 16kN/m^3 to be approved by Engineer prior to commencement. Lateral restraint of fill during construction is the responsibility of the Constructor and safe working method shall be approved by the Engineer prior to commencement.
6. Fall barrier: 1000mm high timber pedestrian barrier at the top of the retaining wall to be provided where fall height exceeds 1000mm. Maximum gap width of 100mm between any member.
7. Sediment and erosion control to be in accordance with AC GD05.
8. Lower wall designed for a long term surcharge load of 2.5kPa.
9. Lower wall designed for short term construction load of 13T excavator located 300mm behind wall. Excavator shall be parked overnight away from back of wall and with no active load.
10. Constructor to ensure pile bores are covered or fenced during works to maintain a safe site.
11. A basic log of soil/rock condition for all piles is to be prepared by the Constructor.
12. Upper retaining wall to be constructed in stages to prevent undermining of dwelling.
13. Drawings shall be read in conjunction with SCS Drawings SK-SE-000 to -003

Project No.	Date	
0213	March 2022	**Jane Banfield** **1A Seaview Road, Paihia**
Figure No.	Revision	
6	0	**Typical Section**

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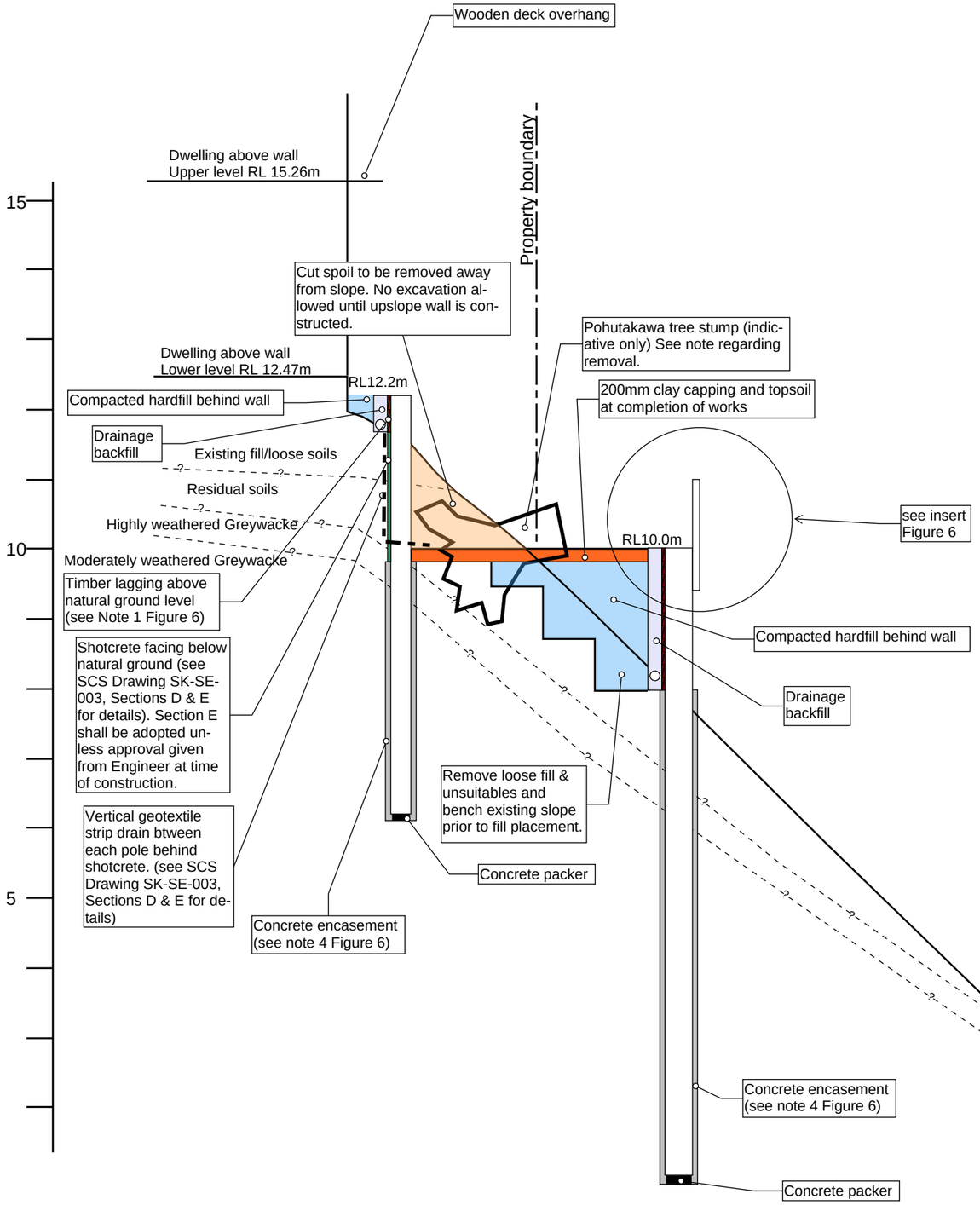

Table:

Section A	Upper (RWUa)	Lower (RWL4&5)
RETAINED HEIGHT	2200	2000
EMBEDMENT	3800	7000
POLE DIAMTER (SED)	300	400
MIN ENCASEMENT DIAMETER	600	600#
MAX CENTRES	1000	1200
TOTAL POLE LENGTH	6000	9000

750mm encasement may be required if LED is very big or pole is not straight

Notes:

For notes refer to Figure 6, *Typical Section* and SCS Drawings SK-SE-000 to -003

TREE STUMP REMOVAL IS A HIGH RISK ACTIVITY FOR DWELLING

Tree stump is not suitable to be left in place and shall be removed after construction of full upper wall and underpinning works is complete. This may require temporary burial to allow progression of wall construction and subsequent exposure and removal. Removal must ensure no loss of support to the dwelling. The method shall be approved by Engineer before commencing.

0 2.5 5.0 7.5 m

Scale 1:75 @A3 H=V

Project No.	Date		
0213	March 2022	**Jane Banfield** **1A Seaview Road, Paihia**	FOR CONSTRUCTION This drawing is not to be used for construction unless signed as approved
Figure No.	Revision		Signed: DS Button — Date: 11/03/2021
SA	0	**Section A**	

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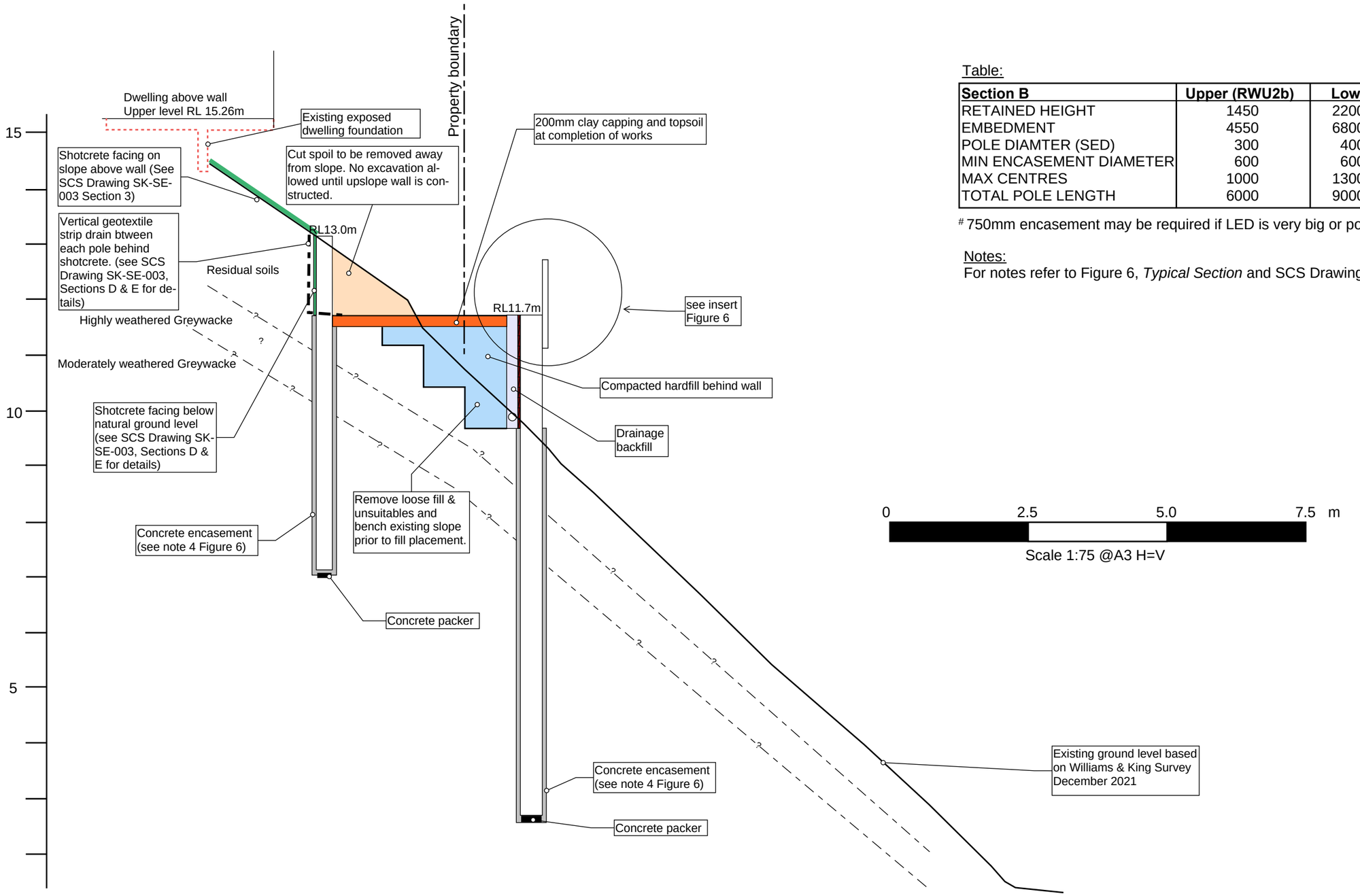

Table:

Section B	Upper (RWU2b)	Lower (RWL4)
RETAINED HEIGHT	1450	2200 (typically 2000)
EMBEDMENT	4550	6800
POLE DIAMTER (SED)	300	400
MIN ENCASEMENT DIAMETER	600	600#
MAX CENTRES	1000	1300
TOTAL POLE LENGTH	6000	9000

750mm encasement may be required if LED is very big or pole is not straight

Notes:
For notes refer to Figure 6, *Typical Section* and SCS Drawings SK-SE-000 to -003

Project No.	Date		
0213	March 2022	**Jane Banfield** **1A Seaview Road, Paihia**	FOR CONSTRUCTION This drawing is not to be used for construction unless signed as approved
Figure No.	Revision		Signed: DS Button — Date: 11/03/2021
SB	0	**Section B**	

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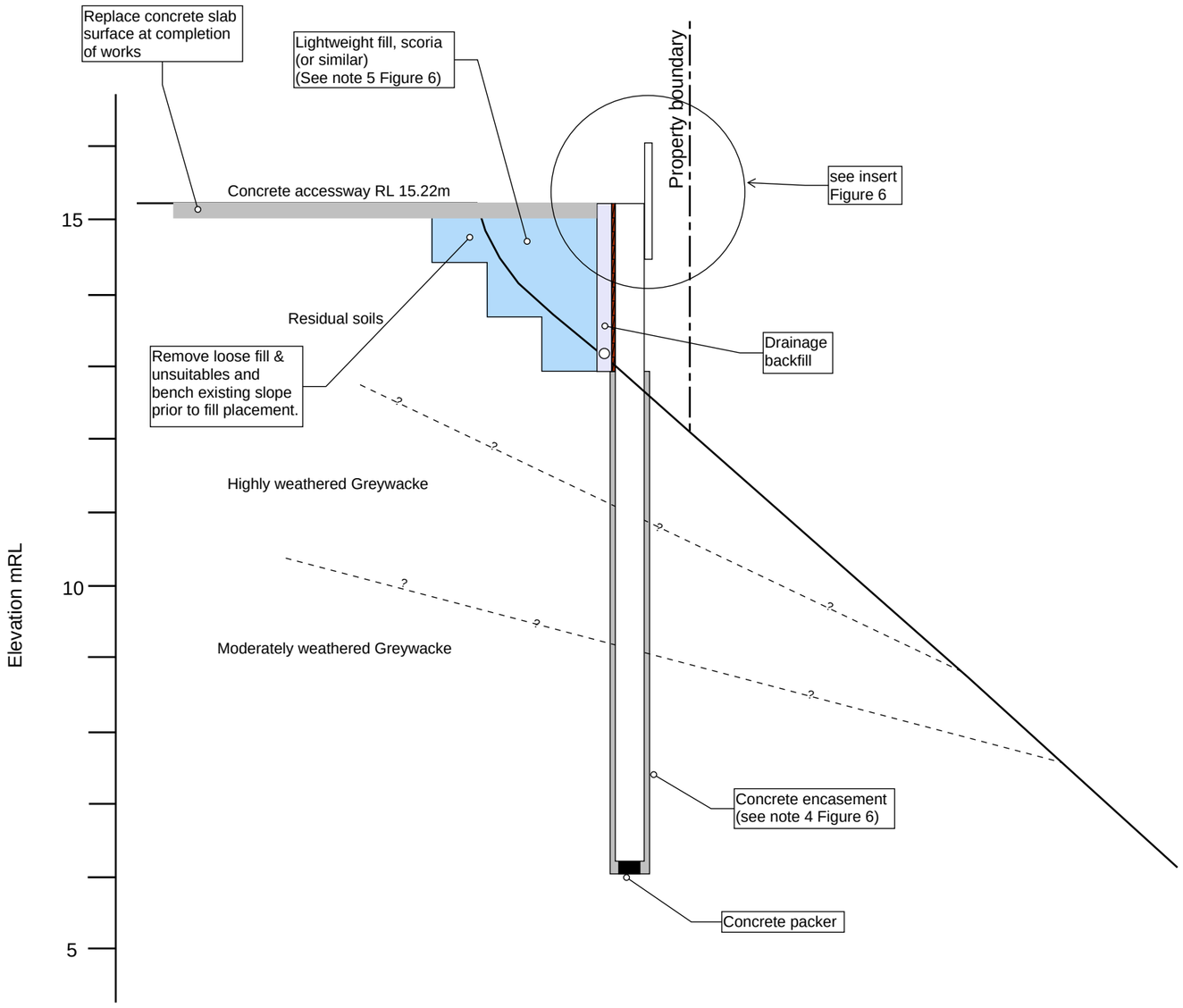

Table:

Section C	Lower (RWL2)
RETAINED HEIGHT	2600
EMBEDMENT	6400
POLE DIAMTER (SED)	400
MIN ENCASEMENT DIAMETER	550
MAX CENTRES	1250
TOTAL POLE LENGTH	9000

Notes:
For notes refer to Figure 6, *Typical Section* and SCS Drawings SK-SE-000 to -003

0 2.5 5.0 7.5 m

Scale 1:75 @A3 H=V

Project No.	Date		
0213	March 2022	**Jane Banfield** **1A Seaview Road, Paihia**	FOR CONSTRUCTION This drawing is not to be used for construction unless signed as approved
Figure No.	Revision		Signed / Date
SC	0	**Section C**	DS Button — 11/03/2021

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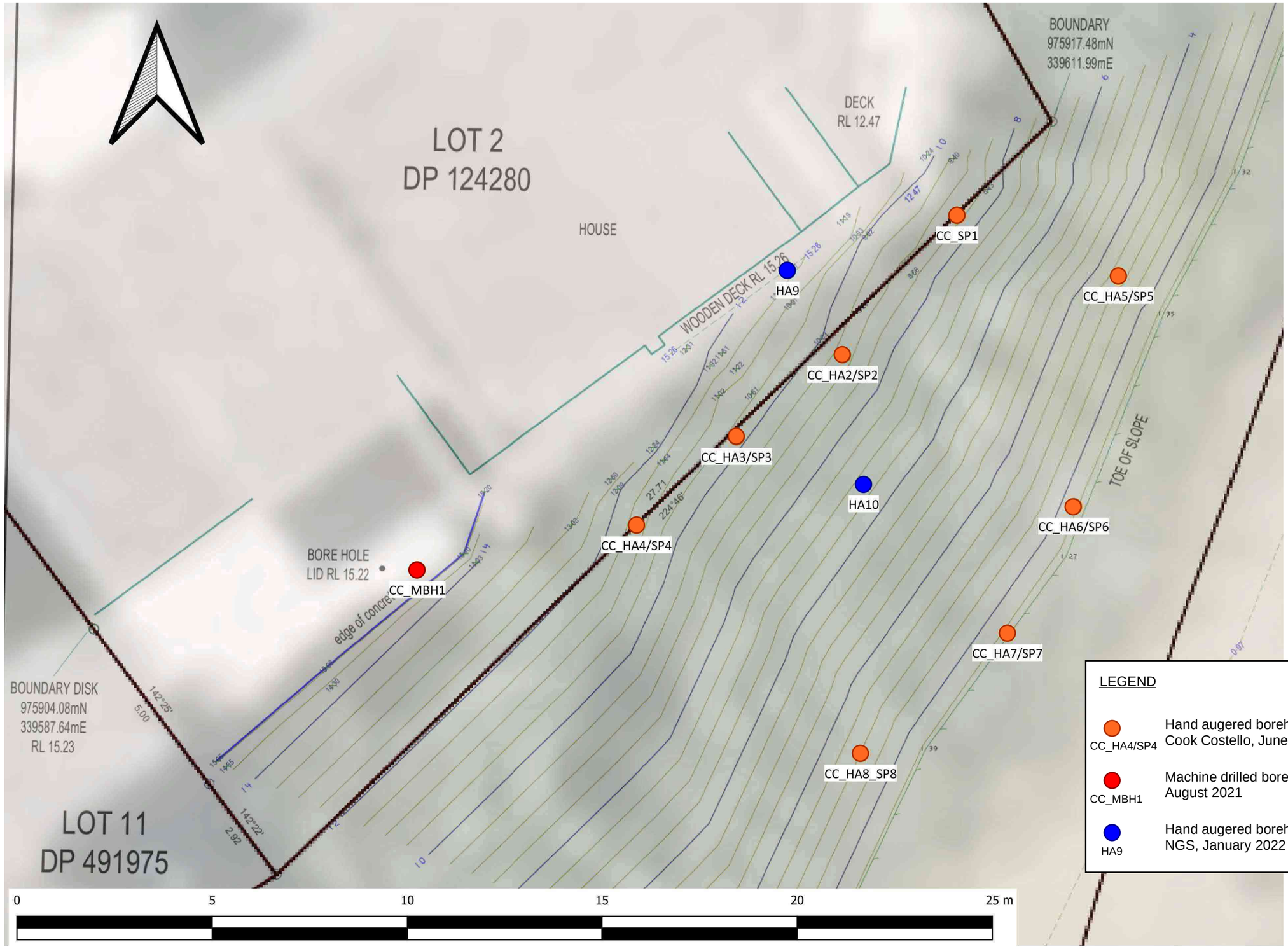

NGS
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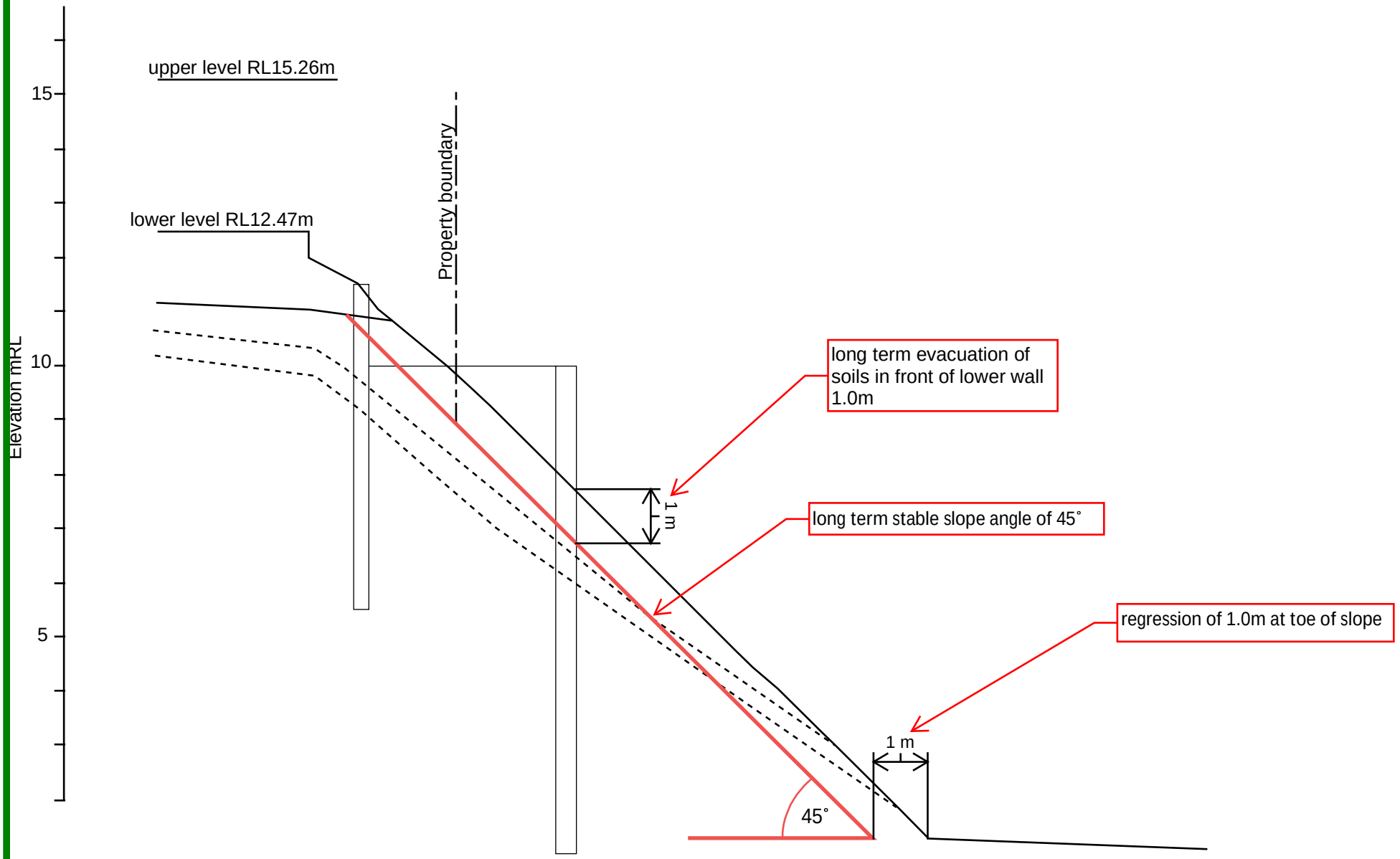
NOTES:
Base plan sourced from Williams & King, Slip Survey Lot 2 DP 124280, JOab No. 22451, Sheet No 1/4, December 2021, Levels in terms of L&S Datum BM B SO 58330, Coordinates in terms of NZGD Mount Eden Circuit, 2000.

This figure is not for construction unless signed as approved
Approved: Date:

CLIENT **Jane Banfield**
PROJECT **Landslip Remediation**
LOCATION **1A Seaview Road, Paihia**
TITLE **Site investigation plan**

Scale 1:100 @ A3

Project No.	NGS 0213
Date	23/02/2022
By	RB
Figure No.	101
Revision	0



Project No. 0213	Date Feb 2022	**Jane Banfield** **1A Seaview Road, Paihia**	NOT FOR CONSTRUCTION This drawing is not to be used for construction unless signed as approved	NGS Northland Geotechnical Specialists
Figure No. SA-1	Revision 0	**Section A - Coastal regression**	Signed / Date	Ph: +64 226981129 E: info@northlandgeotech.co.nz

Appendix B: Site Investigation Logs

B1. Recent investigations (NGS)

- Hand auger borehole logs (HA9-HA10)

B2. Historical investigations (Cook Costello)

- Hand auger borehole logs (HA2 -HA8)
- Scala penetrometer logs (SP1 – SP8)
- Machine drilled borehole log (MBH1)

HAND AUGER LOG

Northland Geotechnical Specialists (NGS)

HOLE NO.: HA9
JOB NO.: 0213

CLIENT: Jane Banfield
PROJECT: Geotechnical assessment for landslide remediation

SITE LOCATION: 1A Seaview Road, Paihia
CO-ORDINATES: 1700034mE, 6093978mN
ELEVATION: Ground
START DATE: 13/01/2022
END DATE: 13/01/2022
LOGGED BY: DB

MATERIAL DESCRIPTION
(See Classification & Symbology sheet for details)

Depth (m)	Material description
0.0 – 0.8	Orange and light grey. Dry; friable. Residual soils fill. 0.5m: Brown, white chips. 0.8m: voids zone - tension from tree?
0.8 – 1.8	Silty CLAY; orange and light grey. Stiff, moist to dry, low plasticity; loose/void feel to auger - tension zone. 1.8m: harder to auger
1.8 – 2.2	SILT, with some clay; light grey and orange. Hard, moist, low plasticity; Highly weathered Greywacke.
2.2	Target lithology. Hard to auger. Dry on completion. EOH: 2.20m

SCALA PENETROMETER
(Blows / 100mm)

Depth (m)	Blows / 100mm
2.2 – 2.3	8
2.3 – 2.4	13
2.4 – 2.5	15
2.5 – 2.6	16
2.6 – 2.7	15
2.7 – 2.8	18
2.8 – 2.9	18
2.9 – 3.0	18
3.0 – 3.1	17
3.1 – 3.2	18
3.2 – 3.3	23 >>

VANE SHEAR STRENGTH (kPa)
Vane: NGS Vane 2 - 19mm

Depth (m)	Values
0.9	108 / 5
1.3	113 / 7
1.7	161 / 44
1.9	UTP / -
2.1	UTP / -

WATER: Groundwater Not Encountered

REMARKS

loose slip/free fall debris to 1.8m then competent residual/HW GW

WATER
- Standing Water Level
- Out flow
- In flow

INVESTIGATION TYPE
- [x] Hand Auger
- [ ] Test Pit

HAND AUGER LOG

NGS Northland Geotechnical Specialists

HOLE NO.: HA10

JOB NO.: 0213

CLIENT: Jane Banfield

PROJECT: Geotechnical assessment for landslide remediation

SITE LOCATION: 1A Seaview Road, Paihia

CO-ORDINATES: 1700036mE, 6093974mN

ELEVATION: Ground

START DATE: 13/01/2022

END DATE: 13/01/2022

LOGGED BY: DB

Depth (m)	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)
0.0 – 0.5	Clayey SILT; brown. Very stiff to hard, dry; friable (likely low - high plasticity), common roots.
0.5 – 1.0	SILT, with some clay; light grey and orange. Very stiff to hard, dry; friable.
1.0	Refusal to auger. EOH: 1.00m

SCALA PENETROMETER (Blows / 100mm)

Depth (m)	Blows
1.0–1.1	12
1.1–1.2	20
1.2–1.3	20
1.3–1.4	28 >>
1.4–1.5	27 >>
1.5–1.6	13
1.6–1.7	21 >>
1.7–1.8	25 >>
1.8–1.9	26 >>

VANE SHEAR STRENGTH (kPa) Vane: NGS Vane 2 - 19mm

Values	
UTP	-
167	18
UTP	-

WATER: Groundwater Not Encountered

REMARKS

WATER

- Standing Water Level
- Out flow
- In flow

INVESTIGATION TYPE

- ☑ Hand Auger
- ☐ Test Pit

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AUGERHOLE LOG

166 Bank Street,
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Lab Job No.: 8020-1863 **Borehole No.:** HA2/SP2 **Sheet:** 1 of 1

Client: Cook Costello **Hole Depth:** 2.70 m

Job: Geotechnical Investigation **Coordinates:** **Date:** 24/06/21

Report No.: W21-870 **Location:** 1a Seaview Road, Paihia **Ground Level:**

Client Ref. No.: 16057

Geological Interpretation (In accordance with NZGS 2005)	UCS	Legend	Depth (m)	Water	Relative Density
Silty TOPSOIL, traces of rootlets, traces of subangular gravels up to 10mm, dark brown, moist, low to moderate plasticity.	OL	TS	0		
Clayey SILT, traces of rootlets, traces of fine sands, traces of subangular gravels up to 10mm, brown with orangey mottling, moist, low to moderate plasticity	ML		0.5		
Colour Change: dark brown	ML				
SILT, some clay, friable, brown with orangey mottling, traces of gravels up to 10mm, low plasticity.	ML		1.0	Groundwater Not Encountered	
Colour change: brown with grey-orangey mottling.	ML		1.5		
E.O.B, no retrieval at 2.2m			2.0		
			2.5		

Vane Shear Strength (kPa) — Tested in accordance with NZGS Aug 2001

Scala Penetrometer — NZS4402: 1988 Test 6.5.2 - Procedure 2 (blows / 50mm)

Blows	Peak / Residual	Samples
2	154/29	
2		
2		
3		
3		
2	99/11	
2		
1		
3	256+	
2		
3		
3		
4		
3		
5		
8		
8		
9		
9		
15		

Remarks

S -35.71821
E 174.32225

Note: All Scala Penetrometer readings taken below 1.5m from start depth are outside the scope of this test
Note: Scala Penetrometer interpretation is not endorsed

Water

- Standing Water Level
- Out flow
- In flow

Investigation Type

- ☐ Hand Auger
- ☑ Hand Auger + Scala (DCP)

Contractor:	Equipment:	Recorded By:	Laboratory Technician:	Approved Signatory:
Geocivil	Hand Auger and Scala	J.H Recorded Date: 24/06/2021	Alex Millar	Sean Kokich

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AUGERHOLE LOG

Lab Job No.: 8020-1863 **Borehole No.:** HA3/SP3 **Sheet:** 1 of 1

Client: Cook Costello **Hole Depth:** 3.65 m

Job: Geotechnical Investigation **Coordinates:** **Date:** 06/07/21

Report No.: W21-870 **Location:** 1a Seaview Road, Paihia **Ground Level:**

Client Ref. No.: 16057

Geological Interpretation (In accordance with NZGS 2005)	UCS	Depth (m)
Clayey TOPSOIL, traces of rootlets, traces of sands, dark brown, moist, moderate plasticity	OL	0.0
CLAY, some silt, traces of angular gravels upto 6mm, traces of rootlets and roots, traces of fine to coarse sands, moist, brown, moderate plasticity	CH	0.5
Clayey SILT, minor fine sands, traces of highly weathered gravels, red/brown, moist, moderate plasticity	MH	1.0
Colour Change: darker red	MH	1.5
End of borehole (no retrieval)		2.0
		2.5
		3.0
		3.5

Legend: TS

Water: Groundwater Not Encountered

Relative Density: -

Vane Shear Strength (kPa)
Tested in accordance with NZGS Aug 2001
25 50 75 100 125 150 175 200 225

Scala Penetrometer
NZS4402: 1988 Test 6.5.2 - Procedure 2
(blows / 50mm)
5 10 15 20

Blows: 0 0 0 0 1 1 1 1 0 1 1 1 2 1 1 1 1 2 1 1 1 2 2 3 3 2 2 3 4 3 3 3 2 3 3 4 4 6 5 5 5 7 10 8 8 6 5 6 5 4 3 5 9 9 8 8 8 9 9 7 9 10 11 10 8 5 5 8 7 8 11 15

Peak ● Residual ○

Samples: 129/17 (0.5 m), 162/8 (1.0 m), 108/29 (1.5 m), 210+ (2.0 m)

Remarks

S -35.29231
E 174.10010

Note: All Scala Penetrometer readings taken below 1.5m from start depth are outside the scope of this test
Note: Scala Penetrometer interpretation is not endorsed

Water
- ▼ Standing Water Level
- ◁ Out flow
- ▷ In flow

Investigation Type
- ☐ Hand Auger
- ☑ Hand Auger + Scala (DCP)

Contractor:	Equipment:	Recorded By:	Laboratory Technician:	Approved Signatory:
Geocivil	Hand Auger and Scala	J.H/A.B/J.A	Alex Millar	Sean Kokich
		Recorded Date: 6/07/2021		

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AUGERHOLE LOG

Lab Job No.: 8020-1863 **Borehole No.:** HA4/SP4 **Sheet:** 1 of 1

Client: Cook Costello **Hole Depth:** 2.55 m

Job: Geotechnical Investigation **Coordinates:** **Date:** 06/07/21

Report No.: W21-870 **Location:** 1a Seaview Road, Paihia **Ground Level:**

Client Ref. No.: 16057

Geological Interpretation (In accordance with NZGS 2005)	UCS	Legend	Depth (m)	Water	Relative Density
Clayey TOPSOIL, traces of rootlets, traces of sands, dark brown, moist, moderate plasticity	OL	TS			
CLAY, some silt, minor fine-coarse sand, orangish brown, moist, moderate plasticity	CH				
CLAY, some silt, minor fine gravels (upto 10mm), traces of sands, brown, moist, low plasticity	CL		0.5		
SILT, minor fine gravels upto 5mm, some clay, traces of sand, brown, dry-moist, low plasticity	ML				
CLAY, some silt, minor fine gravels (upto 10mm), traces of sands, brown, moist, low plasticity	CL		1.0	Groundwater Not Encountered	
Extremely weathered rock, light brown					
Void		VOID			
Extremely weathered rock, light brown			1.5		
End of Borehole (too firm to dig)					
			2.0		
			2.5		

Vane Shear Strength (kPa) — Tested in accordance with NZGS Aug 2001

Scala Penetrometer — NZS4402: 1988 Test 6.5.2 - Procedure 2 (blows / 50mm)

Blows	Peak	Residual
4		
3		
1		
1		
1		
2		
1		
1		
1		
1	45/38	
2		
2		
1		
2		
1		
2		
2		
3		
5		
3	210+	
3		
3		
4		
3		
3		
4		
5		
7		
5		
4		
5		
5		
5		
5		
5		
5		
6		
4		
4		
6		
6		
6		
5		
3		
4		
6		
10		
11		
11		
12		

Remarks

S -35.29210
E 174.10011

Note: All Scala Penetrometer readings taken below 1.5m from start depth are outside the scope of this test
Note: Scala Penetrometer interpretation is not endorsed

Water

- Standing Water Level
- Out flow
- In flow

Investigation Type

- ☐ Hand Auger
- ☑ Hand Auger + Scala (DCP)

Contractor:	Equipment:	Recorded By:	Laboratory Technician:	Approved Signatory:
Geocivil	Hand Auger and Scala	J.H/A.B/J.A Recorded Date: 6/07/2021	Alex Millar	Sean Kokich

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AUGERHOLE LOG

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Lab Job No.: 8020-1863 **Borehole No.:** HA5/SP5 **Sheet:** 1 of 1

Client: Cook Costello **Hole Depth:** 3.50 m

Job: Geotechnical Investigation **Coordinates:** **Date:** 06/07/21

Report No.: W21-870 **Location:** 1a Seaview Road, Paihia **Ground Level:**

Client Ref. No.: 16057

Geological Interpretation (In accordance with NZGS 2005)	UCS	Legend	Depth (m)	Water	Relative Density
Clayey TOPSOIL, traces of rootlets, dark brown, damp, moderate plasticity	OL	TS	0	Groundwater Not Encountered	-
Clayey SILT, traces of rootlets, traces of fine to coarse sands, damp, brown with red/brown streaking, moderate plasticity	CH		0.5		
End of Borehole (no retrieval)			1.0		
			1.5		
			2.0		
			2.5		
			3.0		
			3.5		

Vane Shear Strength (kPa) — Tested in accordance with NZGS Aug 2001

Scala Penetrometer — NZS4402: 1988 Test 6.5.2 - Procedure 2 (blows / 50mm)

Blows: 1 1 1 1 3 3 1 1 3 3 3 4 5 5 3 3 4 2 3 5 3 3 4 3 3 3 1 2 4 2 3 3 2 3 3 2 2 2 3 5 3 4 4 3 4 4 4 3 3 3 2 2 2 1 3 1 2 2 2 2 2 2 3 3 2 3 2 5 9 12 12

Peak: 210+ Residual

Samples

Remarks

S -35.29240
E 174.10019

Note: All Scala Penetrometer readings taken below 1.5m from start depth are outside the scope of this test
Note: Scala Penetrometer interpretation is not endorsed

Water

- Standing Water Level
- Out flow
- In flow

Investigation Type

- [ ] Hand Auger
- [x] Hand Auger + Scala (DCP)

Contractor:	Equipment:	Recorded By:	Laboratory Technician:	Approved Signatory:
Geocivil	Hand Auger and Scala	J.H/A.B/J.A Recorded Date: 6/07/2021	Alex Millar	Sean Kokich

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AUGERHOLE LOG

Lab Job No.: 8020-1863 **Borehole No.:** HA6/SP6 **Sheet:** 1 of 1

Client: Cook Costello **Hole Depth:** 1.60 m

Job: Geotechnical Investigation **Coordinates:** **Date:** 06/07/21

Report No.: W21-870 **Location:** 1a Seaview Road, Paihia **Ground Level:**

Client Ref. No.: 16057

Geological Interpretation (In accordance with NZGS 2005)	UCS	Depth (m)	Water	Relative Density	Scala Penetrometer Blows (NZS4402: 1988 Test 6.5.2 - Procedure 2, blows / 50mm)	Vane Shear Strength (kPa) Peak / Residual (Tested in accordance with NZGS Aug 2001)	Samples
Clayey TOPSOIL, traces of rootlets, traces of angular gravels upto 10mm, damp, dark brown, moderate plasticity	OH				1		
Clayey SILT, traces of angular gravels upto 8mm, traces of rootlets, traces of fine to coarse sands, damp, brown, moderate plasticity.					0		
					0		
					1		
					2		
					2		
					1		
					2		
					1		
		0.5			1		90/20
					1		
					1		
					0		
					2		
	MH				10		
					13		
					13		
		1.0	Groundwater Not Encountered				87/20
		1.5					123/23
End of Borehole (no retrieval)							

Remarks

S -35.29241
E 174.10022

Note: All Scala Penetrometer readings taken below 1.5m from start depth are outside the scope of this test
Note: Scala Penetrometer interpretation is not endorsed

Water

- Standing Water Level
- Out flow
- In flow

Investigation Type

- ☐ Hand Auger
- ☑ Hand Auger + Scala (DCP)

Contractor:	Equipment:	Recorded By:	Laboratory Technician:	Approved Signatory:
Geocivil	Hand Auger and Scala	J.H/A.B/J.A	Alex Millar	Sean Kokich
		Recorded Date: 6/07/2021		

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AUGERHOLE LOG

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Lab Job No.: 8020-1863 **Borehole No.:** HA7/SP7 **Sheet:** 1 of 1

Client: Cook Costello **Hole Depth:** 2.10 m

Job: Geotechnical Investigation **Coordinates:** **Date:** 06/07/21

Report No.: W21-870 **Location:** 1a Seaview Road, Paihia **Ground Level:**

Client Ref. No.: 16057

Geological Interpretation (In accordance with NZGS 2005)	UCS	Legend	Depth (m)	Water	Relative Density
Clayey TOPSOIL, traces of rootlets, dark brown, slightly damp, low plasticity	OL	TS			
Clayey SILT, traces of rootlets, traces if angular gravels upto 10mm, traces of fine to coarse sands, brown, damp, low to moderate plasticity	ML		0.5	Groundwater Not Encountered	-
End of Borehole (no retrieval)			1.0, 1.5, 2.0		

Vane Shear Strength (kPa) — Tested in accordance with NZGS Aug 2001

Scala Penetrometer — NZS4402: 1988 Test 6.5.2 - Procedure 2 (blows / 50mm)

Blows	Peak	Residual
0 0 0 1 1 1 1 1 1 1 1 0 1 1 1 2 3 2 3 2 2 3 3 4 2 4 4 4 5 6 8 6 4 5 5 4 3 7 15	138/29	

Samples

Remarks

S -35.29243
E 174.10025

Note: All Scala Penetrometer readings taken below 1.5m from start depth are outside the scope of this test
Note: Scala Penetrometer interpretation is not endorsed

Water

- Standing Water Level
- Out flow
- In flow

Investigation Type

- ☐ Hand Auger
- ☑ Hand Auger + Scala (DCP)

Contractor:	Equipment:	Recorded By:	Laboratory Technician:	Approved Signatory:
Geocivil	Hand Auger and Scala	J.H/A.B/J.A Recorded Date: 6/07/2021	Alex Millar	Sean Kokich

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AUGERHOLE LOG

Lab Job No.: 8020-1863 **Borehole No.:** HA8/SP8 **Sheet:** 1 of 1

Client: Cook Costello **Hole Depth:** 1.60 m

Job: Geotechnical Investigation **Coordinates:** **Date:** 06/07/21

Report No.: W21-870 **Location:** 1a Seaview Road, Paihia **Ground Level:**

Client Ref. No.: 16057

Geological Interpretation (In accordance with NZGS 2005)	UCS	Legend	Depth (m)	Water	Relative Density	Vane Shear Strength (kPa) / Scala Penetrometer (NZS4402: 1988 Test 6.5.2 - Procedure 2, blows / 50mm)	Blows	Peak / Residual	Samples
Silty TOPSOIL, minor rootlets, dark brown, moist, low plasticity	OL	TS					0		
Silty CLAY, traces of rootlets, brown, moist, low plasticity	CL						0		
Clayey SILT, minor fine to coarse sands, minor highly weathered gravels, extremely weak, subrounded upto 10mm, brown with light grey mottling, moist, low plasticity	ML		0.5	Groundwater Not Encountered	-		0 0 0 0 1 2 2 2 1 2 1 2 2 3 3 3 5 4 3 2 3 2 1 1 2 3 6 12 12	193/18	
End of Borehole (too firm to dig)			1.0 1.5						

Vane Shear Strength (kPa) — Tested in accordance with NZGS Aug 2001: 25, 50, 75, 100, 125, 150, 175, 200, 225

Scala Penetrometer — NZS4402: 1988 Test 6.5.2 - Procedure 2 (blows / 50mm): 5, 10, 15, 20; Blows; Peak; Residual

Remarks

S -35.29251
E 174.10016

Note: All Scala Penetrometer readings taken below 1.5m from start depth are outside the scope of this test
Note: Scala Penetrometer interpretation is not endorsed

Water

- Standing Water Level
- Out flow
- In flow

Investigation Type

- [ ] Hand Auger
- [x] Hand Auger + Scala (DCP)

Contractor:	Equipment:	Recorded By:	Laboratory Technician:	Approved Signatory:
Geocivil	Hand Auger and Scala	J.H/A.B/J.A Recorded Date: 6/07/2021	Alex Millar	Sean Kokich

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DYNAMIC CONE PENETROMETER TEST

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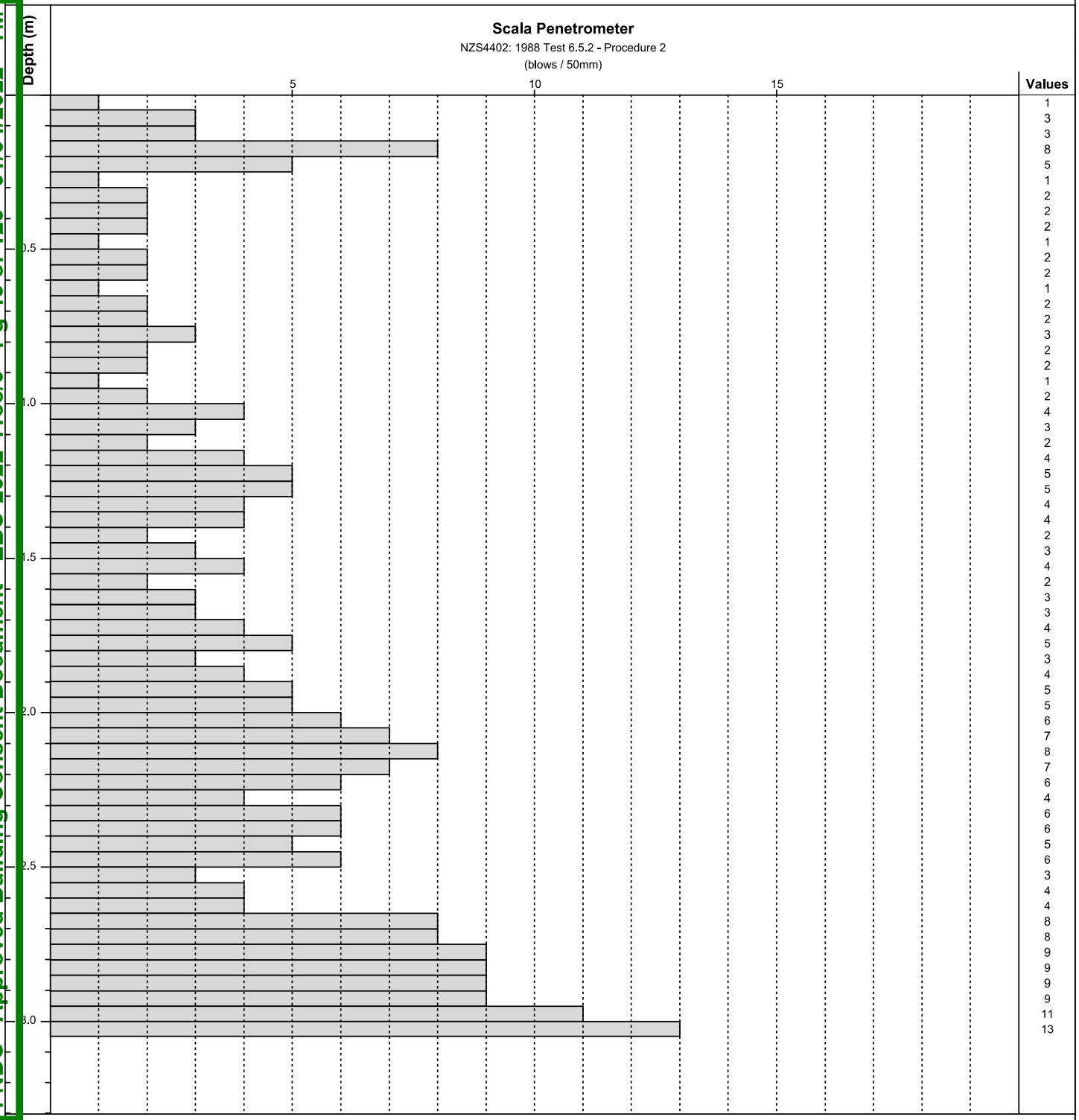
Lab Job No.: 8020-1863 **Test No.:** SP1 **Sheet:** 1 of 1

Client: Cook Costello **Hole Depth:** 3.05 m

Job: Geotechnical Investigation **Coordinates:** **Date:** 06/07/21

Report No.: W21-870 **Location:** 1a Seaview Road, Paihia **Ground Level:**

Client Ref. No.: 16057



Remarks

S -35.29241
E 174.10022

Investigation Type

☑ Scala (DCP)

Note: All Scala Penetrometer readings taken below 1.5m from start depth are outside the scope of this test
Note: Scala Penetrometer interpretation is not endorsed

Contractor:	Equipment:	Recorded By:	Laboratory Technician:	Approved Signatory:
Geocivil	Scala Penetrometer	J.H/A.B/J.A	Alex Millar	Sean Kokich
		Recorded Date: 6/07/2021		

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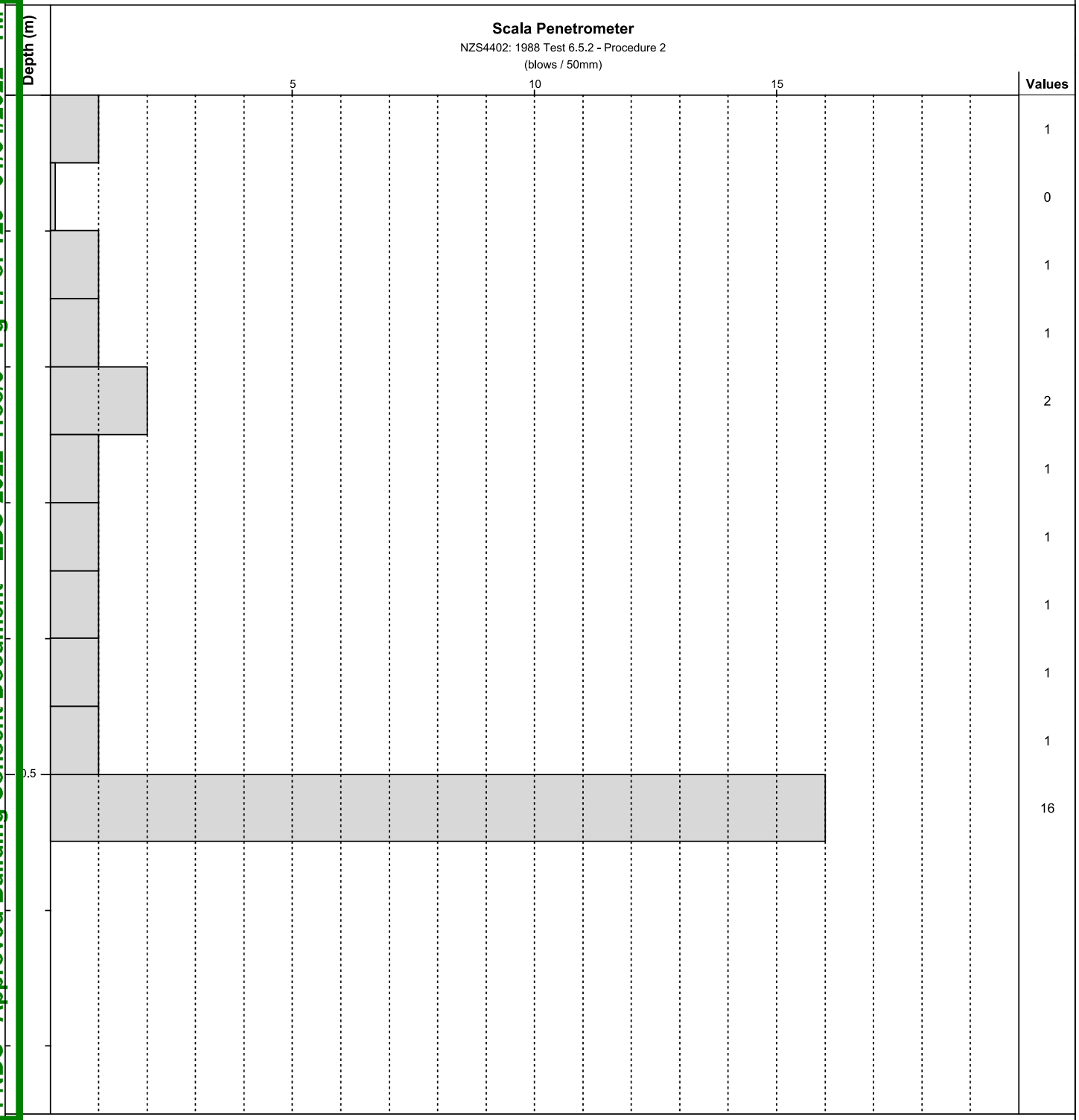
DYNAMIC CONE PENETROMETER TEST

Lab Job No.:	**8020-1863**	**Test No.:**	**SP6a**	**Sheet:**	1 of 1
Client:	Cook Costello	**Hole Depth:**	0.55 m		
Job:	Geotechnical Investigation	**Coordinates:**		**Date:**	06/07/21
Report No.:	W21-870	**Location:**	1a Seaview Road, Paihia	**Ground Level:**	
Client Ref. No.:	16057				



Remarks

S -35.29241
E 174.10022

Investigation Type

☑ Scala (DCP)

Note: All Scala Penetrometer readings taken below 1.5m from start depth are outside the scope of this test
Note: Scala Penetrometer interpretation is not endorsed

Contractor:	Equipment:	Recorded By:	Laboratory Technician:	Approved Signatory:
Geocivil	Scala Penetrometer	J.H/A.B/J.A Recorded Date: 6/07/2021	Alex Millar Alex Millar	Sean Kokich

cook | costello

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BOREHOLE LOG AND TEST SHEET

NZGS December 2005

Ref.: 16057-001
Client: Jane Banfield
Date: 03&04/08/2021
Borehole No.: MBH01
Location: 1A Seaview Road, Pahia
Drilling Method: Machine Borehole

Page: 1
Tested by: ProDrill
Logger: HJ
Checked: HJ
Date Checked: 6/08/2021

Depth (mbgl)	Legend	Soil Description	Recovery	SPT
0.0 – 0.2		Concrete		
0.3 – 0.5		Silty CLAY with some gravel, orange & brown, stiff, moist, high plasticity, gravel is fine, strong & sub-rounded		
0.6 – 1.0		Silty CLAY with some shells, orange & dark brown, stiff, moist, high plasticity		
1.1 – 2.0		Gravelly CLAY (residual soil), light grey, brown & orange mottle, stiff, moist, high plasticity, gravels are fine-medium, orange with some light grey, extremely weak, subangular	100%	2/2/4/4/4/5 N = 17
2.1 – 2.3		Pushtube Sample		
2.4 – 2.7		Gravelly CLAY (residual soil), light grey, brown & orange mottle, stiff, moist, high plasticity, gravels are fine-medium, orange with some light grey, extremely weak, subangular		
2.8 – 3.0		Pushtube Sample		3/4/5/4/3/5 N = 17
3.1 – 3.5		Completely weathered, massive, grey, orange & dark brown SILTSTONE, extremely weak; Discontinuities: extremely closely spaced, tight aperture, randomly oriented		

Remarks

Topsoil
Fill
Clay
Silt
Sand
Gravel
Concrete
Rock

cook | costello

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BOREHOLE LOG AND TEST SHEET

NZGS December 2005

Ref.: 16057-001
Client: Jane Banfield
Date: 03&04/08/2021
Borehole No.: MBH01
Location: 1A Seaview Road, Pahia
Drilling Method: Machine Borehole

Page: 1
Tested by: ProDrill
Logger: HJ
Checked: HJ
Date Checked: 6/08/2021

Depth (mbgl)	Legend	Soil Description	Recovery	SPT
3.5		Completely weathered, massive, grey, orange & dark brown SILTSTONE, extremely weak; Discontinuities: extremely closely spaced, tight aperture, randomly oriented		
3.6				
3.7				
3.8				
3.9				
4.0				
4.1				
4.2				
4.3				
4.4				
4.5				3/3/4/6/10/11
4.6				N = 31
4.7				
4.8				
4.9				
5.0			100%	
5.1		Highly weathered, massive, grey, orange & dark brown SILTSTONE, extremely weak; Discontinuities: extremely closely spaced, tight aperture, randomly oriented		
5.2				
5.3				
5.4				
5.5				
5.6				
5.7				
5.8				
5.9				
6.0				
6.1				
6.2				
6.3				
6.4				
6.5				4/4/4/6/7/11
6.6				N = 28
6.7				
6.8			33%	
6.9				
7.0				

Remarks 1 m core loss from 6.5 - 8.0 m (highly fractured)

Topsoil
Fill
Clay
Silt
Sand
Gravel
Peat
Rock

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BOREHOLE LOG AND TEST SHEET

NZGS December 2005

Ref.: 16057-001
Client: Jane Banfielc
Date: 03&04/08/2021
Borehole No.: MBH01
Location: 1A Seaview Road, Pahi
Drilling Method: Machine Borehole

Page: 1
Tested by: ProDrill
Logger: HJ
Checked: HJ
Date Checked: 6/08/2021

Depth (mbgl)	Legend	Soil Description	Recovery	SPT
7.0 – 7.9, 8.0 – 8.5		Highly weathered, massive, grey, orange & dark brown SILTSTONE, extremely weak; Discontinuities: extremely closely spaced, tight aperture, randomly oriented	100%	8/8/12/12/11/13/14 for 65 mm N = 50+
8.5 – 9.4		Moderately weathered, massive, grey, orange & dark brown SILTSTONE, extremely weak; Discontinuities: extremely closely spaced, tight aperture, randomly oriented, 1 joint set with approx 70 degree inclination, closely spaced, slickensided planar		
9.4 – 9.5		Moderately weathered, massive, grey, orange & dark brown SILTSTONE, extremely weak; Discontinuities: extremely closely spaced, tight aperture, randomly oriented		12/20/20/20/10 for 45 mm N = 50+
9.6 – 10.0		Moderately weathered, massive, grey, orange & dark brown SILTSTONE, extremely weak; Discontinuities: extremely closely spaced, tight aperture, randomly oriented, 2 joint sets intersecting at approx 45 degrees, very closely to closely spaced		

Remarks:

Topsoil
Fill
Clay
Silt
Sand
Gravel
Peat
Rock

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BOREHOLE LOG AND TEST SHEET

NZGS December 2005

Ref.: 16057-001
Client: Jane Banfielc
Date: 03&04/08/2021
Borehole No.: MBH01
Location: 1A Seaview Road, Pahi
Drilling Method: Machine Borehole

Page: 1
Tested by: ProDrill
Logger: HJ
Checked: HJ
Date Checked: 6/08/2021

Depth (mbgl)	Legend	Soil Description	Recovery	SPT
10.0		Moderately weathered, massive, grey, orange & dark brown SILTSTONE, extremely weak; Discontinuities: extremely closely spaced, tight aperture, randomly oriented, 2 joint sets intersecting at approx 45 degrees, very closely to closely spaced	100%	7/9/10/9/9/10 N = 38
10.1				
10.2				
10.3				
10.4		Highly weathered, massive, grey, orange & dark brown SILTSTONE, extremely weak; Discontinuities: extremely closely spaced, tight aperture, randomly oriented	50%	
10.5				
10.6				
10.7				
10.8				
10.9				
11.0				6/6/5/9/27/9 for 20 mm N = 50+
11.1		Highly weathered, massive, grey, orange & dark brown SILTSTONE, extremely weak; Discontinuities: extremely closely spaced, tight aperture, randomly oriented	No recovery	
11.2				
11.3				
11.4				
11.5		Moderately weathered, SILTSTONE (inferred based on final SPT)		
		End of Borehole at 11.5 mbgl		

Remarks:

Topsoil
Fill
Clay
Silt
Sand
Gravel
Peat
Rock

CAUTION

LIFT WITH CARE

PRO-DRILL

SPECIALIST DRILLING ENGINEERS

CLIENT : _____ DATE: 2/8/21

PROJECT NO: 16057-001 BORE NO: MBH01

SITE: 1A Seaview Road, Pahia

BOX NO: 1 OF _____

FROM 0.0 METRES TO 4.3 METRES

Phone 0800-477 637

CAUTION

LIFT WITH CARE

PRO-DRILL
SPECIALIST DRILLING ENGINEERS

CLIENT : _____ DATE: 2/8/21

PROJECT NO: 16057-001 BORE NO: MBH01

SITE: 1A Seaview Rd, Pahia

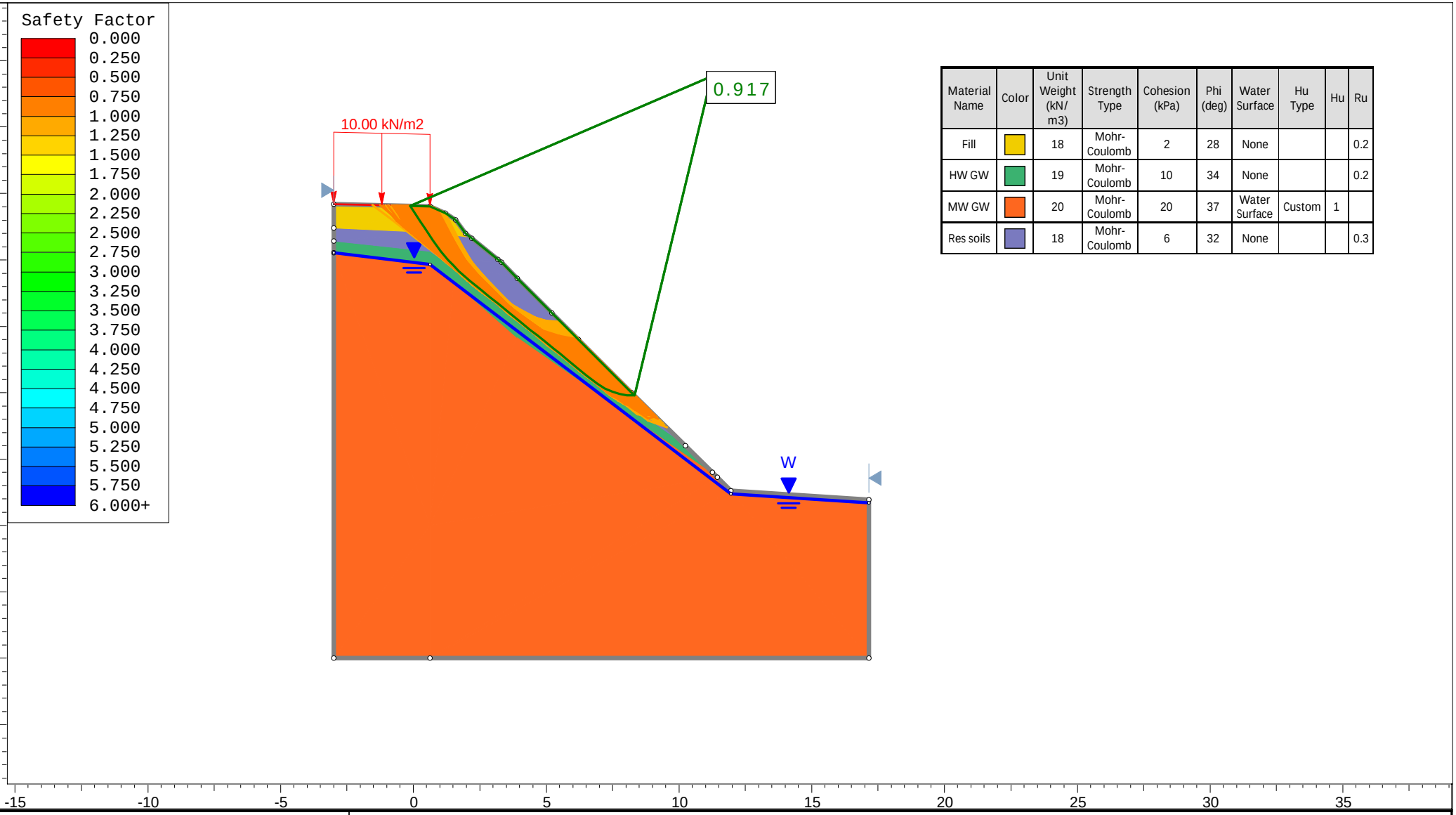
BOX NO: 2 OF _____

FROM 4.3 METRES TO 8.0 METRES

Phone 0800-477 637

Appendix C: Stability Analysis Results

- Back analysis
  - Design Groundwater
  - Elevated Groundwater
- Wall design
  - Design Groundwater
  - Elevated Groundwater
  - Seismic

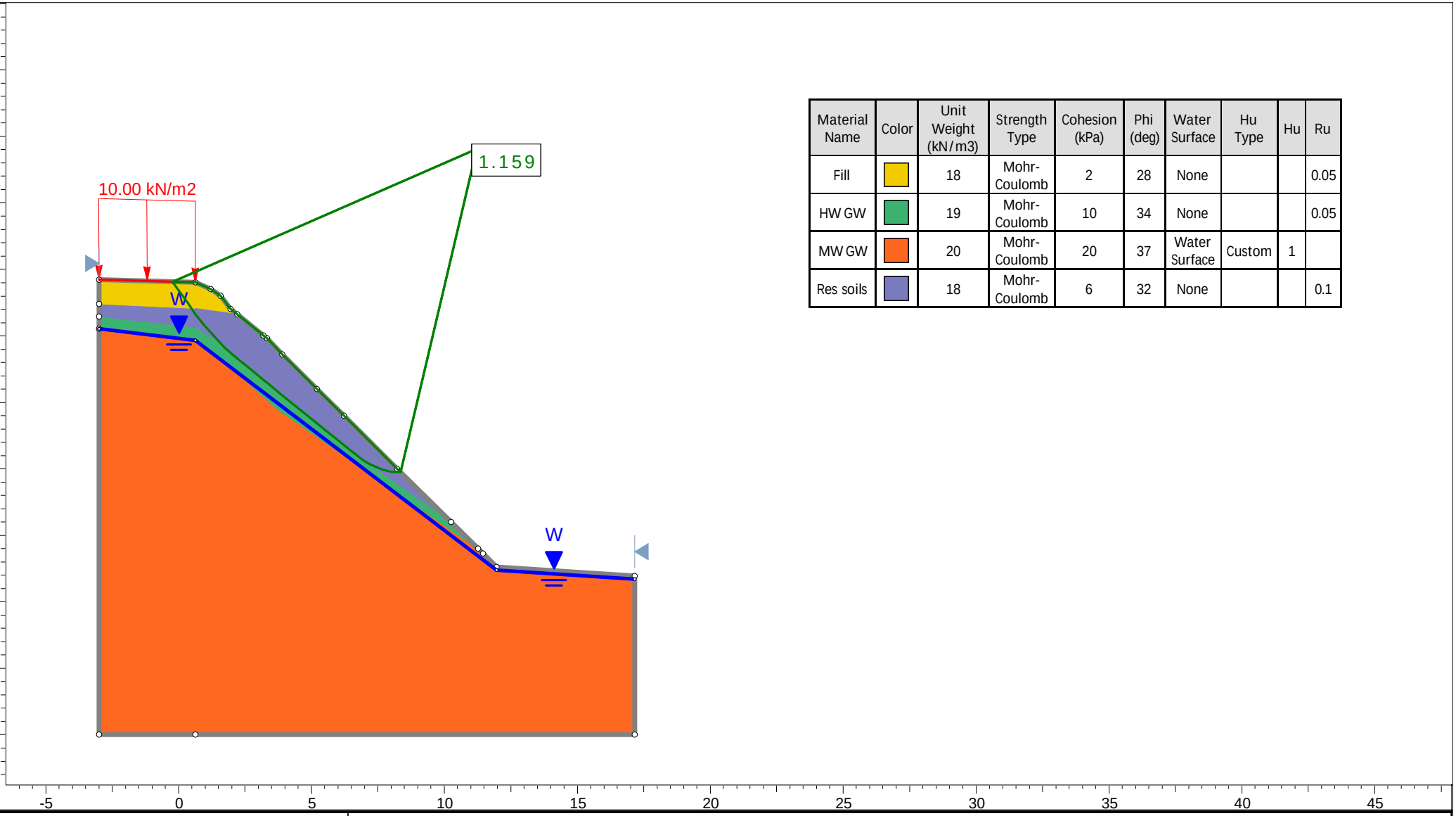


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Fill		18	Mohr-Coulomb	2	28	None			0.2
HW GW		19	Mohr-Coulomb	10	34	None			0.2
MW GW		20	Mohr-Coulomb	20	37	Water Surface	Custom	1	
Res soils		18	Mohr-Coulomb	6	32	None			0.3

NGS Northland Geotechnical Specialists

SLIDEINTERPRET 9.020

Project	Mackesy Road Landslide Remediation - Preliminary Design		
Analysis Description	Section A EGW		
Drawn By		*Scale* 1:200	*Company*
Date	21/02/2022	*File Name*	back analysis.slmd

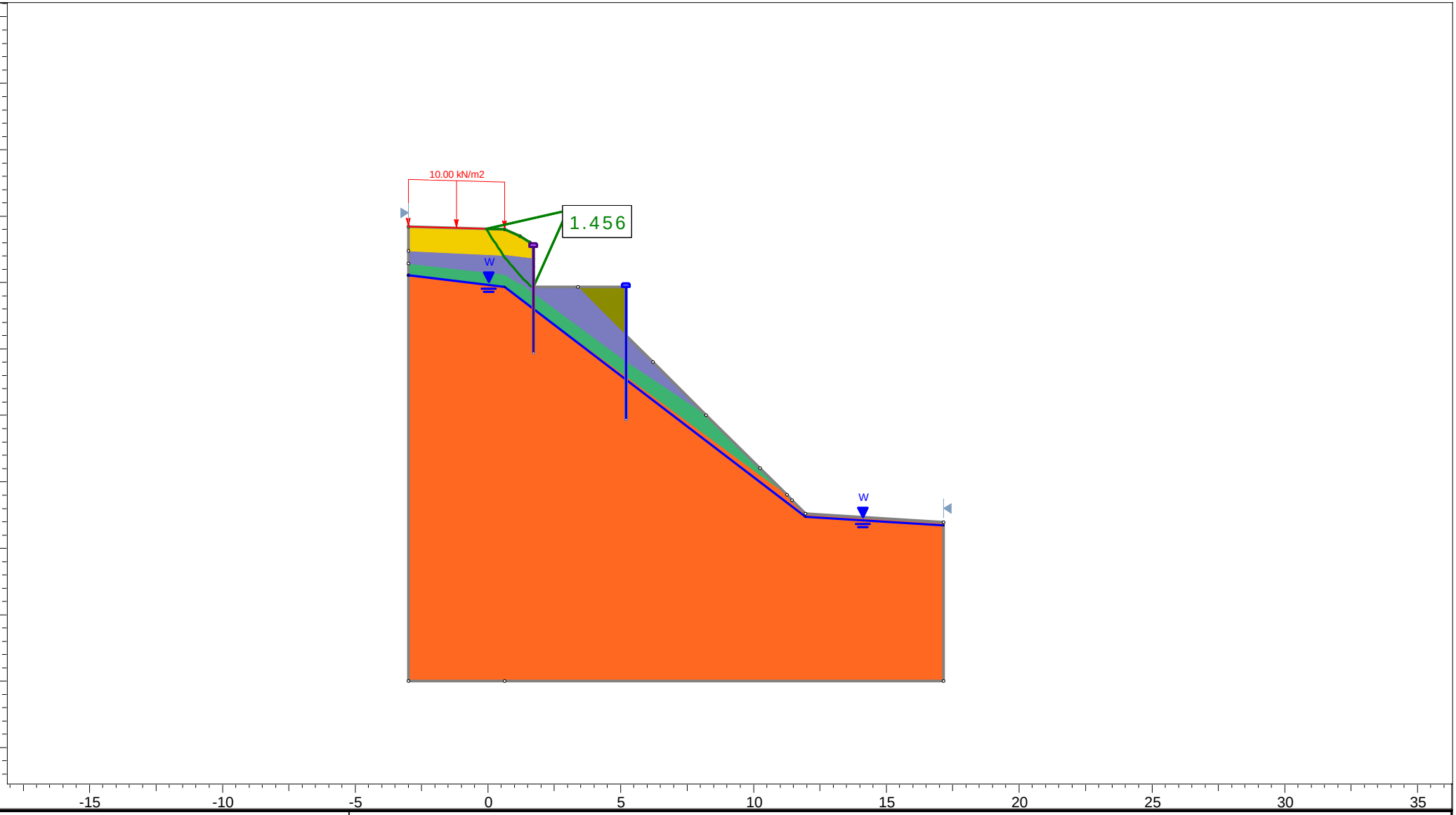


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Fill		18	Mohr-Coulomb	2	28	None			0.05
HW GW		19	Mohr-Coulomb	10	34	None			0.05
MW GW		20	Mohr-Coulomb	20	37	Water Surface	Custom	1	
Res soils		18	Mohr-Coulomb	6	32	None			0.1

NGS Northland Geotechnical Specialists

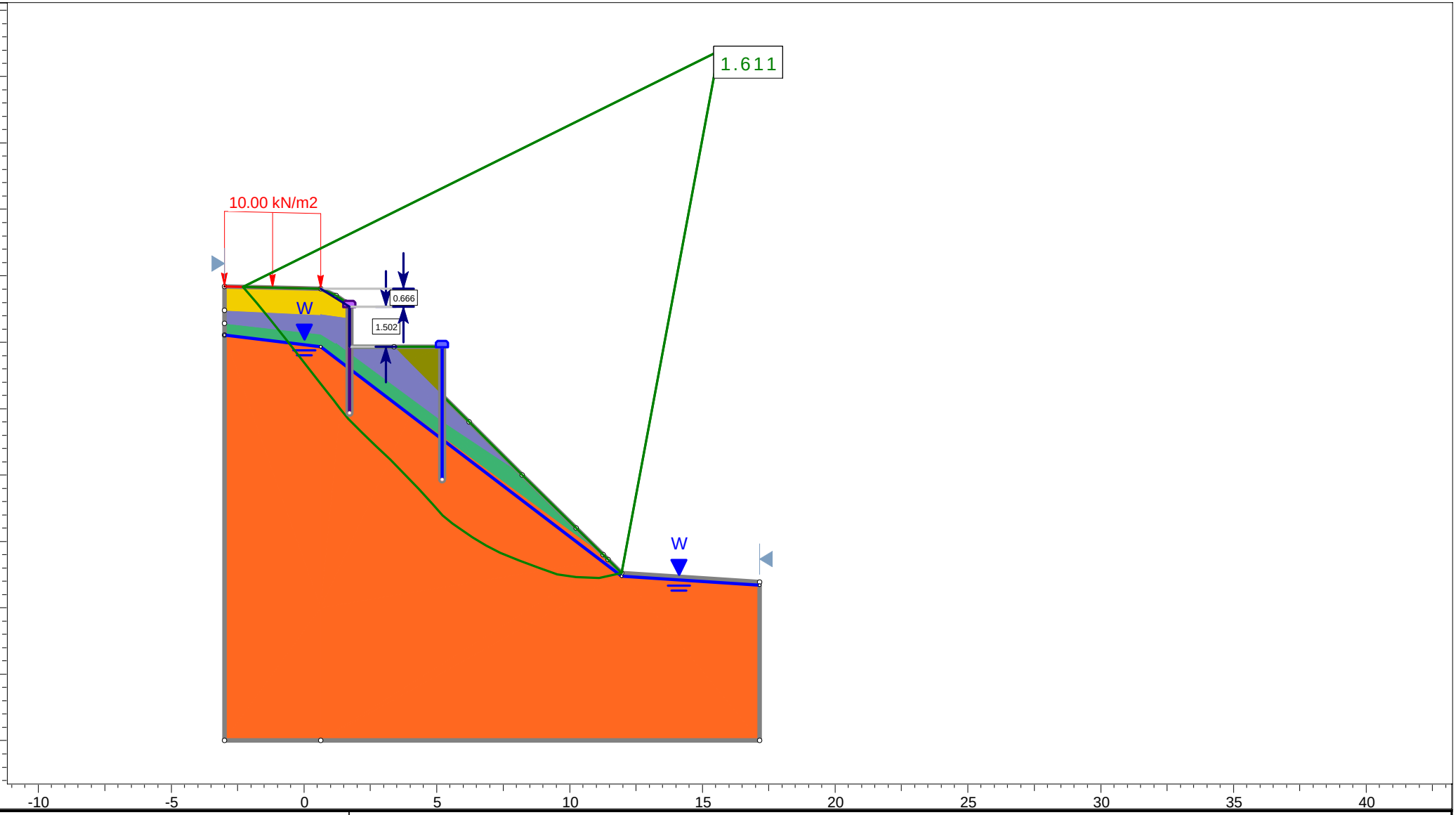
SLIDEINTERPRET 9.020

Project	Mackesy Road Landslide Remediation - Preliminary Design		
Analysis Description	Section A DGW		
Drawn By		*Scale* 1:200	*Company*
Date	21/02/2022	*File Name*	back analysis.slmd



NGS Northland Geotechnical Specialists	*Project*	Mackesy Road Landslide Remediation - Preliminary Design	
	Analysis Description	wall design EGW	
	Drawn By	*Scale* 1:200	*Company*
	Date 21/02/2022		*File Name* back analysis.slmd

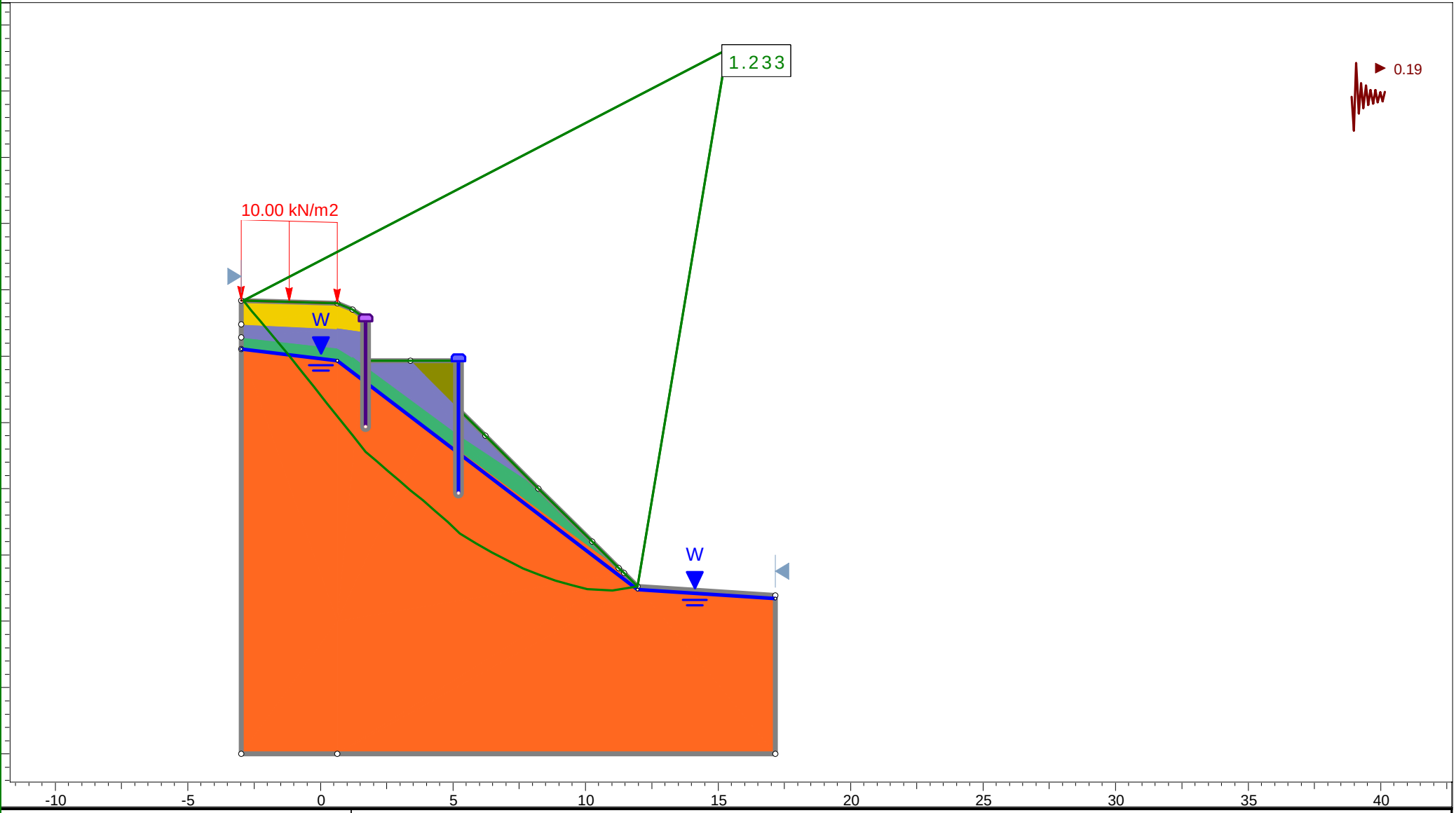
SLIDEINTERPRET 9.020



NGS
Northland Geotechnical Specialists

SLIDEINTERPRET 9.020

Project	Mackesy Road Landslide Remediation - Preliminary Design		
Analysis Description	wall design DGW		
Drawn By		*Scale* 1:200	*Company*
Date	21/02/2022		*File Name* back analysis.slmd



NGS
Northland Geotechnical Specialists

SLIDEINTERPRET 9.020

Project	Mackesy Road Landslide Remediation - Preliminary Design		
Analysis Description	wall design Seismic		
Drawn By		*Scale* 1:200	*Company*
Date	21/02/2022		*File Name* back analysis.slmd

Appendix D: Retaining Wall Analysis

- Wallap Output
  - Section A: Lower wall
  - Section A: Upper wall
  - Section B: Lower wall
  - Section B: Upper wall
  - Section C: Lower wall
- Timber Pole Capacity Spreadsheet (x17)

NORTHLAND GEOTECHNICAL SPECIALISTS | Sheet No.
Program: WALLAP Version 6.06 Revision A51.B69.R55 | Job No. 0213
Licensed from GEOSOLVE | Made by : RB
Data filename/Run ID: Section_A-lowerwall |
1A Seaview Road | Date: 9-03-2022
Section A - lower wall | Checked :

Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	10.00	1 Back Fill	1 Back Fill
2	8.00	2 Res soils	2 Res soils
3	7.00	3 HW Greywacke	3 HW Greywacke
4	6.47	4 MW Greywacke	4 MW Greywacke

SOIL PROPERTIES

-- Soil type -- No.	Description (Datum elev.)	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	Back Fill	18.00	20000	0.470	OC (0.200)	0.283 (1.241)	3.960 (5.127)	1.000d
2	Res soils	18.00	25000	0.470	OC (0.300)	0.260 (1.185)	4.448 (5.518)	6.000d
3	HW Greywacke	19.00	50000	0.440	OC (0.200)	0.237 (1.131)	5.023 (5.965)	10.00d
4	MW Greywacke	20.00	200000	0.398	OC (0.200)	0.207 (1.052)	6.100 (6.768)	20.00d
5	Existing fill	18.00	15000	0.530	OC (0.300)	0.309 (1.299)	3.543 (4.783)	2.000d

Additional soil parameters associated with Ka and Kp

------- Soil type ------- No.	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	Back Fill	30.00	0.667	0.00	30.00	0.333	0.00
2	Res soils	32.00	0.667	0.00	32.00	0.333	0.00
3	HW Greywacke	34.00	0.667	0.00	34.00	0.333	0.00
4	MW Greywacke	37.00	0.667	0.00	37.00	0.333	0.00
5	Existing fill	28.00	0.667	0.00	28.00	0.333	0.00

GROUND WATER CONDITIONS

Density of water = 10.00 kN/m3

	Left side	Right side
Initial water table elevation	1.00	1.00

Automatic water pressure balancing at toe of wall : No

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 1.00
Maximum finite element length = 0.50 m
Youngs modulus of wall E = 1.2100E+07 kN/m2
Moment of inertia of wall I = 9.6660E-04 m4/m run
E.I = 11696 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	8.67	4.910	0	0	N/A
2	8.67	2.520	0	0	N/A

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge kN/m2 Near edge		Far edge	Equiv. soil type	Partial factor/ Category
1	10.00	3.66(L)	100.00	20.00	44.46	=		2	N/A
2	10.00	4.50(L)	100.00	20.00	20.00	=		2	N/A
3	10.00	0.00(L)	100.00	3.66	2.50	=		0	N/A
4	10.00	0.30(L)	3.00	0.60	35.00	=		0	N/A
5	10.00	2.70(L)	3.00	0.60	35.00	=		0	N/A
6	10.00	0.30(L)	3.00	0.60	53.00	=		0	N/A
7	10.00	2.70(L)	3.00	0.60	17.00	=		0	N/A

Note: L = Left side, R = Right side

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Apply surcharge no.1 at elevation 10.00
2	Apply surcharge no.2 at elevation 10.00 No analysis at this stage
3	Apply load no.1 at elevation 8.67
4	Excavate to elevation 8.00 on RIGHT side Toe of berm at elevation 1.00 Width of top of berm = 0.10 Width of toe of berm = 7.00
5	Apply surcharge no.7 at elevation 10.00
6	Apply surcharge no.6 at elevation 10.00
7	Remove surcharge no.7 at elevation 10.00 No analysis at this stage
8	Remove surcharge no.6 at elevation 10.00 No analysis at this stage
9	Apply surcharge no.5 at elevation 10.00
10	Apply surcharge no.4 at elevation 10.00
11	Remove surcharge no.5 at elevation 10.00 No analysis at this stage
12	Remove surcharge no.4 at elevation 10.00 No analysis at this stage
13	Apply surcharge no.3 at elevation 10.00
14	Excavate to elevation 7.00 on RIGHT side Toe of berm at elevation 1.00 Width of top of berm = 0.10 Width of toe of berm = 6.00
15	Apply load no.2 at elevation 8.67

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
Method of analysis - Burland-Potts
Factor on passive for calculating wall depth = 2.00
Passive limit pressures calculated by Wedge Stability

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 - 2-D finite element model
Open Tension Crack analysis? - No
Soil arching modelled? - No
Non-linear Modulus Parameter (L) = 10.00 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 20.00 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
Elevation of rigid lower boundary = -10.00

Lower rigid boundary at elevation -10.00 - Rough
Rigid boundary on Left side - Smooth
Rigid boundary on Right side - Smooth
Wall / soil interface - Smooth

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Apply surcharge no.1 at elev. 10.00	Yes	Yes	Yes
2	Apply surcharge no.2 at elev. 10.00	No	No	No
3	Apply load no.1 at elev. 8.67	No	No	No
4	Excav. to elev. 8.00 on RIGHT side	Yes	Yes	Yes
5	Apply surcharge no.7 at elev. 10.00	Yes	Yes	Yes
6	Apply surcharge no.6 at elev. 10.00	Yes	Yes	Yes
7	Remove surcharge no.7 at elev. 10.00	No	No	No
8	Remove surcharge no.6 at elev. 10.00	No	No	No
9	Apply surcharge no.5 at elev. 10.00	Yes	Yes	Yes
10	Apply surcharge no.4 at elev. 10.00	Yes	Yes	Yes
11	Remove surcharge no.5 at elev. 10.00	No	No	No
12	Remove surcharge no.4 at elev. 10.00	No	No	No
13	Apply surcharge no.3 at elev. 10.00	Yes	Yes	Yes
14	Excav. to elev. 7.00 on RIGHT side	No	Yes	No
15	Apply load no.2 at elev. 8.67	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

Units: kN,m

Summary of results

STABILITY ANALYSIS of Fully Embedded Wall according to Burland-Potts method
Factor of safety on nett available passive
Passive limit pressures calculated by Wedge Stability

Stage No.	G.L. Act.	G.L. Pass.	Strut Elev.	FoS for toe elev. = 1.00: Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 2.000: Toe elev.	Wall Penetr-ation	Direction of failure
1	10.00	10.00	---	Conditions not suitable for FoS calc.				
2	10.00	10.00		No analysis at this stage				
3	10.00	10.00	Cant.	124.570	4.80	***	***	L to R
4	10.00	8.00	Cant.	3.372	1.18	2.80	5.20	L to R
5	10.00	8.00	Cant.	3.346	1.18	2.78	5.22	L to R
6	10.00	8.00	Cant.	2.403	1.19	1.69	6.31	L to R
7	10.00	8.00		No analysis at this stage				
8	10.00	8.00		No analysis at this stage				
9	10.00	8.00	Cant.	3.320	1.18	2.76	5.24	L to R
10	10.00	8.00	Cant.	2.635	1.19	2.01	5.99	L to R
11	10.00	8.00		No analysis at this stage				
12	10.00	8.00		No analysis at this stage				
13	10.00	8.00	Cant.	3.159	1.18	2.60	5.40	L to R
14	10.00	7.00	Cant.	2.351	1.13	1.76	5.24	L to R
15	10.00	7.00	Cant.	2.238	1.14	1.53	5.47	L to R

Legend: *** Result not found

Units: kN,m

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 20.00m
2-D finite element model. Soil arching not modelled.
Soil deformations are elastic until the active or passive limit is reached
Passive limit pressures calculated by Wedge Stability
Open Tension Crack analysis - No
All soil moduli were factored to take account of
3-D effects due to the finite length of wall:
Modulus factors - Left side = 1.04
Right side = 1.03

Rigid boundaries: Left side 20.00 from wall Smooth boundary
Right side 20.00 from wall Smooth boundary
Lower rigid boundary at elevation -10.00 Rough boundary

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum m	Displacement minimum m	Bending moment maximum kN.m/m	Bending moment minimum kN.m/m	Shear force maximum kN/m	Shear force minimum kN/m
1	10.00	0.108	0.000	0.0	-0.0	0.0	0.0
2	9.50	0.098	0.000	0.9	-0.1	2.8	-0.6
3	9.09	0.089	0.000	2.7	-0.5	5.2	-1.5
4	8.67	0.081	0.000	5.3	-1.3	14.0	-2.5
5	8.34	0.074	0.000	10.4	-0.7	17.9	-0.2
6	8.00	0.067	0.000	16.8	-0.2	22.3	-0.2
7	7.50	0.057	0.000	28.4	-0.2	24.7	-0.0
8	7.00	0.048	0.000	41.3	-0.1	26.5	0.0
9	6.74	0.043	0.000	48.2	-0.0	24.9	0.0
10	6.47	0.039	0.000	54.4	0.0	21.9	0.0
11	5.99	0.032	0.000	63.2	0.0	14.3	-0.5
12	5.50	0.025	0.000	67.0	0.0	3.9	-12.9
13	5.00	0.020	0.000	61.7	0.0	0.0	-21.4
14	4.50	0.016	0.000	50.4	0.0	0.0	-33.5
15	4.00	0.013	0.000	34.4	0.0	0.0	-27.9
16	3.50	0.011	0.000	22.0	-0.0	0.0	-19.6
17	3.00	0.010	0.000	14.7	-0.0	0.0	-11.2
18	2.50	0.008	0.000	10.7	-0.0	0.0	-6.5
19	2.00	0.007	0.000	8.0	-0.0	0.0	-5.8
20	1.50	0.006	0.000	4.8	-0.0	0.0	-7.9
21	1.00	0.005	0.000	0.0	-0.0	0.0	-1.8
22	0.88	0.005	0.000	0.0	0.0	0.1	-0.0
23	-0.56	0.004	0.000	0.0	0.0	0.0	-0.2
24	-2.00	0.002	0.000	0.0	0.0	0.1	-0.1
25	-4.00	0.001	0.000	0.0	0.0	0.1	-0.1
26	-6.00	0.001	0.000	0.0	0.0	0.2	-0.1
27	-8.00	0.001	0.000	0.0	0.0	0.3	-0.0
28	-10.00	0.000	0.000	0.0	0.0	0.1	-0.0

Summary of results (continued)

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment maximum kN.m/m	Bending moment elev.	Bending moment minimum kN.m/m	Bending moment elev.	Shear force maximum kN/m	Shear force elev.	Shear force minimum kN/m	Shear force elev.
1	0.2	5.99	-0.2	7.50	0.6	6.47	-0.2	8.00
2	No calculation at this stage							
3	0.7	6.47	-1.3	8.67	2.4	8.67	-2.5	8.67
4	32.5	5.99	-0.0	1.00	14.9	7.00	-19.6	5.00
5	32.9	5.99	-0.0	1.00	15.1	7.00	-19.9	5.00
6	67.0	5.50	-0.0	1.00	26.5	7.00	-33.5	4.50
7	No calculation at this stage							
8	No calculation at this stage							
9	66.3	5.50	-0.0	1.00	25.2	7.00	-33.2	4.50
10	66.6	5.50	-0.0	1.00	26.1	7.00	-33.2	4.50
11	No calculation at this stage							
12	No calculation at this stage							
13	66.3	5.50	-0.0	1.00	25.4	7.00	-33.1	4.50
14	57.9	5.50	-0.0	1.00	24.5	7.00	-27.6	4.00
15	58.3	5.50	-0.0	1.00	25.6	7.00	-27.7	4.00

Maximum and minimum displacement at each stage

Stage no.	Displacement maximum m	Displacement elev.	Displacement minimum m	Displacement elev.	Stage description
1	0.000	-0.56	0.000	10.00	Apply surcharge no.1 at elev. 10.00
2	No calculation at this stage				Apply surcharge no.2 at elev. 10.00
3	0.000	9.09	0.000	10.00	Apply load no.1 at elev. 8.67
4	0.038	10.00	0.000	10.00	Excav. to elev. 8.00 on RIGHT side
5	0.039	10.00	0.000	10.00	Apply surcharge no.7 at elev. 10.00
6	0.106	10.00	0.000	10.00	Apply surcharge no.6 at elev. 10.00
7	No calculation at this stage				Remove surcharge no.7 at elev. 10.00
8	No calculation at this stage				Remove surcharge no.6 at elev. 10.00
9	0.105	10.00	0.000	10.00	Apply surcharge no.5 at elev. 10.00
10	0.106	10.00	0.000	10.00	Apply surcharge no.4 at elev. 10.00
11	No calculation at this stage				Remove surcharge no.5 at elev. 10.00
12	No calculation at this stage				Remove surcharge no.4 at elev. 10.00
13	0.105	10.00	0.000	10.00	Apply surcharge no.3 at elev. 10.00
14	0.108	10.00	0.000	10.00	Excav. to elev. 7.00 on RIGHT side
15	0.108	10.00	0.000	10.00	Apply load no.2 at elev. 8.67

NORTHLAND GEOTECHNICAL SPECIALISTS | Sheet No.
Program: WALLAP Version 6.06 Revision A51.B69.R55 | Job No. 0213
Licensed from GEOSOLVE | Made by : RB
Data filename/Run ID: Section_A-upperwall |
1A Seaview Road | Date: 9-03-2022
Section A-upper wall | Checked :

Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	11.50	5 Existing fill	5 Existing fill
2	10.82	2 Res soils	2 Res soils
3	9.54	3 HW Greywacke	3 HW Greywacke
4	8.90	4 MW Greywacke	4 MW Greywacke

SOIL PROPERTIES

No.	Soil type -- Description (Datum elev.)	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	Back Fill	18.00	20000	0.470	OC (0.200)	0.283 (1.241)	3.960 (5.127)	1.000d
2	Res soils	18.00	25000	0.470	OC (0.300)	0.260 (1.185)	4.448 (5.518)	6.000d
3	HW Greywacke	19.00	50000	0.440	OC (0.200)	0.237 (1.131)	5.023 (5.965)	10.00d
4	MW Greywacke	20.00	200000	0.398	OC (0.200)	0.207 (1.052)	6.100 (6.768)	20.00d
5	Existing fill	18.00	15000	0.530	OC (0.300)	0.309 (1.299)	3.543 (4.783)	2.000d

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	Back Fill	30.00	0.667	0.00	30.00	0.333	0.00
2	Res soils	32.00	0.667	0.00	32.00	0.333	0.00
3	HW Greywacke	34.00	0.667	0.00	34.00	0.333	0.00
4	MW Greywacke	37.00	0.667	0.00	37.00	0.333	0.00
5	Existing fill	28.00	0.667	0.00	28.00	0.333	0.00

GROUND WATER CONDITIONS

Density of water = 10.00 kN/m3

	Left side	Right side
Initial water table elevation	1.83	1.83

Automatic water pressure balancing at toe of wall : No

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 7.30
Maximum finite element length = 0.30 m
Youngs modulus of wall E = 1.2100E+07 kN/m2
Moment of inertia of wall I = 3.9760E-04 m4/m run
E.I = 4811.0 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	10.82	7.480	0	0	N/A
2	10.82	3.840	0	0	N/A

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge kN/m2 Near edge	Surcharge kN/m2 Far edge	Equiv. soil type	Partial factor/ Category
1	12.47	0.90(L)	100.00	20.00	20.00	=	N/A	N/A

Note: L = Left side, R = Right side

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Fill to elevation 12.47 on LEFT side with soil type 1
2	Change EI of wall to 4811.0 kN.m2/m run
	Yield moment not defined
	Reset wall displacements to zero at this stage
3	Apply surcharge no.1 at elevation 12.47
4	Apply load no.1 at elevation 10.82
5	Excavate to elevation 10.00 on RIGHT side
6	Excavate to elevation 9.00 on RIGHT side
7	Fill to elevation 10.00 on RIGHT side with soil type 1
8	Apply load no.2 at elevation 10.82

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
Method of analysis - Burland-Potts
Factor on passive for calculating wall depth = 2.00

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 - 2-D finite element model
Open Tension Crack analysis? - No
Soil arching modelled? - No
Non-linear Modulus Parameter (L) = 6.000 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 20.00 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
Elevation of rigid lower boundary = 0.00

Lower rigid boundary at elevation 0.00 - Rough
Rigid boundary on Left side - Smooth
Rigid boundary on Right side - Smooth
Wall / soil interface - Smooth

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Fill to elev. 12.47 on LEFT side	No	No	No
2	Change EI of wall to 4811.0kN.m2/m run	No	No	No
3	Apply surcharge no.1 at elev. 12.47	Yes	Yes	Yes
4	Apply load no.1 at elev. 10.82	No	No	No
5	Excav. to elev. 10.00 on RIGHT side	Yes	Yes	Yes
6	Excav. to elev. 9.00 on RIGHT side	Yes	Yes	Yes
7	Fill to elev. 10.00 on RIGHT side	Yes	Yes	Yes
8	Apply load no.2 at elev. 10.82	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

Units: kN,m

Summary of results

STABILITY ANALYSIS of Fully Embedded Wall according to Burland-Potts method
Factor of safety on nett available passive

Stage No.	G.L. Act.	G.L. Pass.	Strut Elev.	FoS for toe elev. = 7.30: Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 2.000: Toe elev.	Wall Penetr-ation	Direction of failure
1	12.47	11.50	Cant.	25.902	7.90	10.85	0.65	L to R
2	12.47	11.50		No analysis at this stage				
3	12.47	11.50	Cant.	21.165	7.85	10.72	0.78	L to R
4	12.47	11.50	Cant.	13.959	7.88	10.57	0.93	L to R
5	12.47	10.00	Cant.	4.598	7.69	8.29	1.71	L to R
6	12.47	9.00	Cant.	2.260	7.57	7.43	1.57	L to R
7	12.47	10.00	Cant.	3.661	7.67	7.94	2.06	L to R
8	12.47	10.00	Cant.	3.220	7.68	7.81	2.19	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 = 20.00m
2-D finite element model. Soil arching not modelled.
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 Smooth boundary
Right side 20.00 from wall Smooth boundary
Lower rigid boundary at elevation 0.00 Rough boundary

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum m	Displacement minimum m	Bending moment maximum kN.m/m	Bending moment minimum kN.m/m	Shear force maximum kN/m	Shear force minimum kN/m
1	12.47	0.058	0.000	0.0	-0.0	0.0	0.0
2	12.24	0.055	0.000	0.0	0.0	0.0	0.0
3	12.00	0.051	0.000	0.0	0.0	0.2	0.0
4	11.75	0.047	0.000	0.1	0.0	0.7	0.0
5	11.50	0.043	0.000	0.4	0.0	1.7	0.0
6	11.33	0.040	0.000	0.8	0.0	2.5	0.0
7	11.16	0.037	0.000	1.3	0.0	3.6	-0.7
8	10.99	0.035	0.000	2.0	0.0	4.8	-1.8
9	10.82	0.032	0.000	2.9	0.0	17.6	-2.6
10	10.66	0.029	0.000	5.8	0.0	18.1	-0.3
11	10.50	0.027	0.000	8.7	0.0	18.7	-0.7
12	10.25	0.023	0.000	13.6	0.0	20.1	-0.7
13	10.00	0.019	0.000	18.8	0.0	21.8	-0.2
14	9.77	0.016	0.000	24.0	0.0	21.8	0.0
15	9.54	0.013	0.000	28.9	0.0	22.1	0.0
16	9.27	0.010	0.000	34.3	0.0	23.2	-9.5
17	9.00	0.008	0.000	39.9	0.0	24.9	-13.2
18	8.90	0.007	0.000	41.9	0.0	19.2	-13.3
19	8.65	0.005	0.000	41.0	0.0	0.0	-25.4
20	8.40	0.004	0.000	29.2	0.0	0.0	-46.5
21	8.10	0.003	0.000	15.5	0.0	0.0	-36.8
22	7.80	0.003	0.000	7.1	0.0	0.0	-22.0
23	7.55	0.002	0.000	2.9	0.0	0.0	-14.2
24	7.30	0.002	0.000	0.0	-0.0	0.0	-2.6
25	7.23	0.002	0.000	0.0	0.0	0.0	-0.0
26	6.61	0.002	0.000	0.0	0.0	0.0	-0.0
27	6.00	0.001	0.000	0.0	0.0	0.0	-0.0
28	4.80	0.001	0.000	0.0	0.0	0.0	-0.0
29	3.60	0.001	0.000	0.0	0.0	0.0	-0.0
30	2.40	0.000	0.000	0.0	0.0	0.0	-0.0
31	1.20	0.000	0.000	0.0	0.0	0.0	0.0
32	0.00	0.000	0.000	0.0	0.0	0.0	0.0

Run ID. Section_A-upperwall | Sheet No.
1A Seaview Road | Date: 9-03-2022
Section A-upper wall | Checked :

Summary of results (continued)

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment maximum kN.m/m	Bending moment elev.	Bending moment minimum kN.m/m	Bending moment elev.	Shear force maximum kN/m	Shear force elev.	Shear force minimum kN/m	Shear force elev.
1	0.9	8.90	0.0	12.47	1.4	11.50	-1.0	8.40
2	No calculation at this stage							
3	1.4	8.90	0.0	12.47	2.1	9.54	-1.5	8.40
4	1.9	8.90	0.0	12.47	4.9	10.82	-2.6	10.82
5	20.9	9.54	-0.0	12.47	17.9	10.00	-18.6	8.65
6	39.2	8.65	-0.0	12.47	24.9	9.00	-43.7	8.40
7	39.1	8.65	-0.0	12.47	24.2	9.00	-43.7	8.40
8	41.9	8.90	-0.0	12.47	22.3	9.00	-46.5	8.40

Maximum and minimum displacement at each stage

Stage no.	Displacement maximum m	Displacement elev.	Displacement minimum m	Displacement elev.	Stage description
1	0.002	12.47	0.000	12.47	Fill to elev. 12.47 on LEFT side
2	Wall displacements reset to zero				Change EI of wall to 4811.0kN.m2/m run
3	0.001	12.47	0.000	12.47	Apply surcharge no.1 at elev. 12.47
4	0.001	12.47	0.000	12.47	Apply load no.1 at elev. 10.82
5	0.023	12.47	0.000	12.47	Excav. to elev. 10.00 on RIGHT side
6	0.054	12.47	0.000	12.47	Excav. to elev. 9.00 on RIGHT side
7	0.054	12.47	0.000	12.47	Fill to elev. 10.00 on RIGHT side
8	0.058	12.47	0.000	12.47	Apply load no.2 at elev. 10.82

NORTHLAND GEOTECHNICAL SPECIALISTS | Sheet No.
Program: WALLAP Version 6.06 Revision A51.B69.R55 | Job No. 0213
Licensed from GEOSOLVE | Made by : RB
Data filename/Run ID: Section_B-lowerwall |
1A Seaview Road | Date: 9-03-2022
Section B - lower wall | Checked :

Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	11.70	1 Back Fill	1 Back Fill
2	9.70	2 Res soils	2 Res soils
3	8.40	3 HW Greywacke	3 HW Greywacke
4	7.40	4 MW Greywacke	4 MW Greywacke

SOIL PROPERTIES

-- Soil type -- No.	Description (Datum elev.)	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	Back Fill	18.00	20000	0.470	OC (0.200)	0.283 (1.241)	3.960 (5.127)	1.000d
2	Res soils	18.00	25000	0.470	OC (0.300)	0.260 (1.185)	4.448 (5.518)	6.000d
3	HW Greywacke	19.00	50000	0.440	OC (0.200)	0.237 (1.131)	5.023 (5.965)	10.00d
4	MW Greywacke	20.00	200000	0.398	OC (0.200)	0.207 (1.052)	6.100 (6.768)	20.00d
5	Existing fill	18.00	15000	0.530	OC (0.300)	0.309 (1.299)	3.543 (4.783)	2.000d

Additional soil parameters associated with Ka and Kp

------- Soil type ------- No.	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	Back Fill	30.00	0.667	0.00	30.00	0.333	0.00
2	Res soils	32.00	0.667	0.00	32.00	0.333	0.00
3	HW Greywacke	34.00	0.667	0.00	34.00	0.333	0.00
4	MW Greywacke	37.00	0.667	0.00	37.00	0.333	0.00
5	Existing fill	28.00	0.667	0.00	28.00	0.333	0.00

GROUND WATER CONDITIONS

Density of water = 10.00 kN/m3

	Left side	Right side
Initial water table elevation	1.83	1.83

Automatic water pressure balancing at toe of wall : No

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 2.70
Maximum finite element length = 0.50 m
Youngs modulus of wall E = 1.2100E+07 kN/m2
Moment of inertia of wall I = 9.6660E-04 m4/m run
E.I = 11696 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	10.37	4.910	0	0	N/A
2	10.37	2.520	0	0	N/A

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge kN/m2 Near edge	Far edge	Equiv. soil type	Partial factor/ Category
1	11.70	3.66(L)	100.00	20.00	28.80	=	2	N/A
2	11.70	5.80(L)	100.00	20.00	52.40	=	2	N/A
3	11.70	3.66(L)	100.00	2.14	0.00	21.60	2	N/A
4	11.70	0.00(L)	3.66	100.00	2.50	=	0	N/A
5	11.70	0.30(L)	3.00	0.60	35.00	=	0	N/A
6	11.70	2.70(L)	3.00	0.60	35.00	=	0	N/A
7	11.70	0.30(L)	3.00	0.60	53.00	=	0	N/A
8	11.70	2.70(L)	3.00	0.60	17.00	=	0	N/A

Note: L = Left side, R = Right side
A trapezoidal surcharge is defined by two values:
N = at edge near to wall, F = at edge far from wall

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Apply surcharge no.1 at elevation 11.70
2	Apply surcharge no.2 at elevation 11.70
	No analysis at this stage
3	Apply surcharge no.3 at elevation 11.70
4	Apply load no.1 at elevation 10.37
5	Excavate to elevation 9.70 on RIGHT side
	Toe of berm at elevation 2.70
	Width of top of berm = 0.10
	Width of toe of berm = 7.00
6	Apply surcharge no.6 at elevation 11.70
7	Apply surcharge no.5 at elevation 11.70
	No analysis at this stage
8	Remove surcharge no.5 at elevation 11.70
	No analysis at this stage
9	Remove surcharge no.6 at elevation 11.70
	No analysis at this stage
10	Apply surcharge no.7 at elevation 11.70
11	Apply surcharge no.8 at elevation 11.70
12	Remove surcharge no.7 at elevation 11.70
	No analysis at this stage
13	Remove surcharge no.8 at elevation 11.70
	No analysis at this stage
14	Apply surcharge no.4 at elevation 11.70
15	Excavate to elevation 8.70 on RIGHT side
	Toe of berm at elevation 2.70
	Width of top of berm = 0.10
	Width of toe of berm = 6.00
16	Apply load no.2 at elevation 10.37

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
Method of analysis - Burland-Potts
Factor on passive for calculating wall depth = 2.00
Active limit pressures calculated by Wedge Stability

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 - 2-D finite element model
Open Tension Crack analysis? - No
Soil arching modelled? - No
Non-linear Modulus Parameter (L) = 9.000 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 20.00 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
Elevation of rigid lower boundary = -10.00

Lower rigid boundary at elevation -10.00 - Rough
Rigid boundary on Left side - Smooth

Rigid boundary on Right side - Smooth
Wall / soil interface - Smooth

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Apply surcharge no.1 at elev. 11.70	Yes	Yes	Yes
2	Apply surcharge no.2 at elev. 11.70	No	No	No
3	Apply surcharge no.3 at elev. 11.70	Yes	Yes	Yes
4	Apply load no.1 at elev. 10.37	No	No	No
5	Excav. to elev. 9.70 on RIGHT side	Yes	Yes	Yes
6	Apply surcharge no.6 at elev. 11.70	Yes	Yes	Yes
7	Apply surcharge no.5 at elev. 11.70	No	No	No
8	Remove surcharge no.5 at elev. 11.70	No	No	No
9	Remove surcharge no.6 at elev. 11.70	No	No	No
10	Apply surcharge no.7 at elev. 11.70	No	No	No
11	Apply surcharge no.8 at elev. 11.70	Yes	Yes	Yes
12	Remove surcharge no.7 at elev. 11.70	No	No	No
13	Remove surcharge no.8 at elev. 11.70	No	No	No
14	Apply surcharge no.4 at elev. 11.70	Yes	Yes	Yes
15	Excav. to elev. 8.70 on RIGHT side	Yes	Yes	Yes
16	Apply load no.2 at elev. 10.37	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

Units: kN,m

Summary of results

STABILITY ANALYSIS of Fully Embedded Wall according to Burland-Potts method
Factor of safety on nett available passive
Active limit pressures calculated by Wedge Stability

Stage No.	G.L. Act.	G.L. Pass.	Strut Elev.	FoS for toe elev. = 2.70 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 2.000 Toe elev.	Wall Penetr -ation	Direction of failure
1	11.70	11.70	---	Conditions not suitable for FoS calc.				
2	11.70	11.70		No analysis at this stage				
3	11.70	11.70	---	Conditions not suitable for FoS calc.				
4	11.70	11.70	---	Conditions not suitable for FoS calc.				
5	11.70	9.70	Cant.	3.711	2.82	5.98	3.72	L to R
6	11.70	9.70	Cant.	3.591	2.82	5.85	3.85	L to R
7	11.70	9.70		No analysis at this stage				
8	11.70	9.70		No analysis at this stage				
9	11.70	9.70		No analysis at this stage				
10	11.70	9.70	Cant.	2.393	2.84	3.84	5.86	L to R
11	11.70	9.70	Cant.	2.368	2.84	3.78	5.92	L to R
12	11.70	9.70		No analysis at this stage				
13	11.70	9.70		No analysis at this stage				
14	11.70	9.70	Cant.	3.447	2.82	5.73	3.97	L to R
15	11.70	8.70	Cant.	2.135	2.79	3.13	5.57	L to R
16	11.70	8.70	Cant.	2.032	2.79	2.80	5.90	L to R

NORTHLAND GEOTECHNICAL SPECIALISTS | Sheet No.
Program: WALLAP Version 6.06 Revision A51.B69.R55 | Job No. 0213
Licensed from GEOSOLVE | Made by : RB
Data filename/Run ID: Section_B-lowerwall |
1A Seaview Road | Date: 9-03-2022
Section B - lower wall | Checked :

Units: kN,m

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 20.00m
2-D finite element model. Soil arching not modelled.
Soil deformations are elastic until the active or passive limit is reached
Active limit pressures calculated by Wedge Stability
Open Tension Crack analysis - No
All soil moduli were factored to take account of
3-D effects due to the finite length of wall:
Modulus factors - Left side = 1.04
Right side = 1.03

Rigid boundaries: Left side 20.00 from wall Smooth boundary
Right side 20.00 from wall Smooth boundary
Lower rigid boundary at elevation -10.00 Rough boundary

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum m	Displacement minimum m	Bending moment maximum kN.m/m	Bending moment minimum kN.m/m	Shear force maximum kN/m	Shear force minimum kN/m
1	11.70	0.083	0.000	0.0	0.0	0.0	0.0
2	11.35	0.077	0.000	0.3	-0.0	5.8	-0.3
3	11.00	0.071	0.000	4.2	-0.2	12.9	-1.0
4	10.68	0.065	0.000	8.9	-0.6	15.7	-1.7
5	10.37	0.060	0.000	14.1	-1.3	23.4	-2.5
6	10.04	0.054	0.000	22.0	-0.6	26.8	-0.2
7	9.70	0.048	0.000	31.6	-0.2	30.6	-0.3
8	9.20	0.039	0.000	46.5	-0.3	27.2	-0.3
9	8.70	0.032	0.000	59.2	-0.4	25.0	0.0
10	8.40	0.027	0.000	65.3	-0.3	24.5	0.0
11	7.90	0.021	0.000	69.5	-0.1	17.4	-5.1
12	7.40	0.016	0.000	64.7	0.0	12.9	-17.0
13	6.95	0.012	0.000	60.3	0.0	0.0	-48.4
14	6.50	0.010	0.000	47.2	0.0	0.0	-39.2
15	6.00	0.008	0.000	28.1	0.0	0.0	-31.9
16	5.50	0.006	0.000	15.3	0.0	0.0	-18.9
17	5.00	0.005	0.000	9.2	0.0	0.0	-8.9
18	4.50	0.005	0.000	6.4	0.0	0.0	-4.4
19	4.00	0.004	0.000	4.9	-0.0	0.0	-2.9
20	3.50	0.003	0.000	3.5	-0.0	0.0	-3.3
21	3.10	0.003	0.000	2.0	-0.0	0.0	-4.4
22	2.70	0.003	0.000	0.0	-0.0	0.0	-1.2
23	2.58	0.003	0.000	0.0	0.0	0.0	-0.0
24	1.29	0.002	0.000	0.0	0.0	0.0	-0.2
25	0.00	0.001	0.000	0.0	0.0	0.0	-0.2
26	-2.00	0.001	0.000	0.0	0.0	0.0	-0.2
27	-4.00	0.001	0.000	0.0	0.0	0.0	-0.1
28	-6.00	0.000	0.000	0.0	0.0	0.1	-0.1
29	-8.00	0.000	0.000	0.0	0.0	0.1	-0.0
30	-10.00	0.000	0.000	0.0	0.0	0.0	0.0

Summary of results (continued)

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment maximum kN.m/m	Bending moment elev.	Bending moment minimum kN.m/m	Bending moment elev.	Shear force maximum kN/m	Shear force elev.	Shear force minimum kN/m	Shear force elev.
1	0.1	6.95	-0.2	8.70	0.5	7.40	-0.2	9.70
2	No calculation at this stage							
3	0.3	6.95	-0.4	8.70	0.9	7.40	-0.3	9.70
4	0.4	7.40	-1.3	10.37	2.4	10.37	-2.5	10.37
5	19.3	8.40	-0.0	2.70	12.6	9.70	-12.4	6.95
6	19.4	8.40	-0.0	2.70	12.6	9.70	-12.5	6.95
7	No calculation at this stage							
8	No calculation at this stage							
9	No calculation at this stage							
10	69.5	7.90	-0.0	2.70	30.6	9.70	-48.4	6.95
11	69.5	7.90	-0.0	2.70	30.6	9.70	-48.4	6.95
12	No calculation at this stage							
13	No calculation at this stage							
14	66.8	7.90	-0.0	2.70	27.7	9.70	-46.6	6.95
15	62.1	7.40	-0.0	2.70	24.2	8.70	-33.2	6.50
16	62.9	7.40	-0.0	2.70	25.0	8.70	-33.1	6.50

Maximum and minimum displacement at each stage

Stage no.	Displacement maximum m	Displacement elev.	Displacement minimum m	Displacement elev.	Stage description
1	0.000	9.20	0.000	11.70	Apply surcharge no.1 at elev. 11.70
2	No calculation at this stage				Apply surcharge no.2 at elev. 11.70
3	0.000	-2.00	0.000	11.70	Apply surcharge no.3 at elev. 11.70
4	0.000	10.68	0.000	11.70	Apply load no.1 at elev. 10.37
5	0.017	11.70	0.000	11.70	Excav. to elev. 9.70 on RIGHT side
6	0.017	11.70	0.000	11.70	Apply surcharge no.6 at elev. 11.70
7	No calculation at this stage				Apply surcharge no.5 at elev. 11.70
8	No calculation at this stage				Remove surcharge no.5 at elev. 11.70
9	No calculation at this stage				Remove surcharge no.6 at elev. 11.70
10	0.072	11.70	0.000	11.70	Apply surcharge no.7 at elev. 11.70
11	0.072	11.70	0.000	11.70	Apply surcharge no.8 at elev. 11.70
12	No calculation at this stage				Remove surcharge no.7 at elev. 11.70
13	No calculation at this stage				Remove surcharge no.8 at elev. 11.70
14	0.072	11.70	0.000	11.70	Apply surcharge no.4 at elev. 11.70
15	0.082	11.70	0.000	11.70	Excav. to elev. 8.70 on RIGHT side
16	0.083	11.70	0.000	11.70	Apply load no.2 at elev. 10.37

Run ID. Section_B-lowerwall | Sheet No.
1A Seaview Road | Date: 9-03-2022
Section B - lower wall | Checked :

Summary of results (continued)

Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	11.70	1 Back Fill	1 Back Fill
2	9.70	2 Res soils	2 Res soils
3	8.40	3 HW Greywacke	3 HW Greywacke
4	7.40	4 MW Greywacke	4 MW Greywacke

SOIL PROPERTIES

No.	Soil type -- Description (Datum elev.)	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	Back Fill	18.00	20000	0.470	OC (0.200)	0.283 (1.241)	3.960 (5.127)	1.000d
2	Res soils	18.00	25000	0.470	OC (0.300)	0.260 (1.185)	4.448 (5.518)	6.000d
3	HW Greywacke	19.00	50000	0.440	OC (0.200)	0.237 (1.131)	5.023 (5.965)	10.00d
4	MW Greywacke	20.00	200000	0.398	OC (0.200)	0.207 (1.052)	6.100 (6.768)	20.00d
5	Existing fill	18.00	15000	0.530	OC (0.300)	0.309 (1.299)	3.543 (4.783)	2.000d

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	Back Fill	30.00	0.667	0.00	30.00	0.333	0.00
2	Res soils	32.00	0.667	0.00	32.00	0.333	0.00
3	HW Greywacke	34.00	0.667	0.00	34.00	0.333	0.00
4	MW Greywacke	37.00	0.667	0.00	37.00	0.333	0.00
5	Existing fill	28.00	0.667	0.00	28.00	0.333	0.00

GROUND WATER CONDITIONS

Density of water = 10.00 kN/m3

	Left side	Right side
Initial water table elevation	1.83	1.83

Automatic water pressure balancing at toe of wall : No

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 2.70
Maximum finite element length = 0.50 m
Youngs modulus of wall E = 1.2100E+07 kN/m2
Moment of inertia of wall I = 9.6660E-04 m4/m run
E.I = 11696 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	10.37	4.910	0	0	N/A
2	10.37	2.520	0	0	N/A

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge kN/m2 Near edge	Far edge	Equiv. soil type	Partial factor/ Category
1	11.70	3.66(L)	100.00	20.00	28.80	=	2	N/A
2	11.70	5.80(L)	100.00	20.00	52.40	=	2	N/A
3	11.70	3.66(L)	100.00	2.14	0.00	21.60	2	N/A
4	11.70	0.00(L)	3.66	100.00	2.50	=	0	N/A
5	11.70	0.30(L)	3.00	0.60	35.00	=	0	N/A
6	11.70	2.70(L)	3.00	0.60	35.00	=	0	N/A
7	11.70	0.30(L)	3.00	0.60	53.00	=	0	N/A
8	11.70	2.70(L)	3.00	0.60	17.00	=	0	N/A

Note: L = Left side, R = Right side
A trapezoidal surcharge is defined by two values:
N = at edge near to wall, F = at edge far from wall

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Apply surcharge no.1 at elevation 11.70
2	Apply surcharge no.2 at elevation 11.70
	No analysis at this stage
3	Apply surcharge no.3 at elevation 11.70
4	Apply load no.1 at elevation 10.37
5	Excavate to elevation 9.70 on RIGHT side
	Toe of berm at elevation 2.70
	Width of top of berm = 0.10
	Width of toe of berm = 7.00
6	Apply surcharge no.6 at elevation 11.70
7	Apply surcharge no.5 at elevation 11.70
	No analysis at this stage
8	Remove surcharge no.5 at elevation 11.70
	No analysis at this stage
9	Remove surcharge no.6 at elevation 11.70
	No analysis at this stage
10	Apply surcharge no.7 at elevation 11.70
11	Apply surcharge no.8 at elevation 11.70
12	Remove surcharge no.7 at elevation 11.70
	No analysis at this stage
13	Remove surcharge no.8 at elevation 11.70
	No analysis at this stage
14	Apply surcharge no.4 at elevation 11.70
15	Excavate to elevation 8.70 on RIGHT side
	Toe of berm at elevation 2.70
	Width of top of berm = 0.10
	Width of toe of berm = 6.00
16	Apply load no.2 at elevation 10.37

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
Method of analysis - Burland-Potts
Factor on passive for calculating wall depth = 2.00
Active limit pressures calculated by Wedge Stability

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 - 2-D finite element model
Open Tension Crack analysis? - No
Soil arching modelled? - No
Non-linear Modulus Parameter (L) = 9.000 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 20.00 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
Elevation of rigid lower boundary = -10.00

Lower rigid boundary at elevation -10.00 - Rough
Rigid boundary on Left side - Smooth

Rigid boundary on Right side - Smooth
Wall / soil interface - Smooth

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Apply surcharge no.1 at elev. 11.70	Yes	Yes	Yes
2	Apply surcharge no.2 at elev. 11.70	No	No	No
3	Apply surcharge no.3 at elev. 11.70	Yes	Yes	Yes
4	Apply load no.1 at elev. 10.37	No	No	No
5	Excav. to elev. 9.70 on RIGHT side	Yes	Yes	Yes
6	Apply surcharge no.6 at elev. 11.70	Yes	Yes	Yes
7	Apply surcharge no.5 at elev. 11.70	No	No	No
8	Remove surcharge no.5 at elev. 11.70	No	No	No
9	Remove surcharge no.6 at elev. 11.70	No	No	No
10	Apply surcharge no.7 at elev. 11.70	No	No	No
11	Apply surcharge no.8 at elev. 11.70	Yes	Yes	Yes
12	Remove surcharge no.7 at elev. 11.70	No	No	No
13	Remove surcharge no.8 at elev. 11.70	No	No	No
14	Apply surcharge no.4 at elev. 11.70	Yes	Yes	Yes
15	Excav. to elev. 8.70 on RIGHT side	Yes	Yes	Yes
16	Apply load no.2 at elev. 10.37	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

Units: kN,m

Summary of results

STABILITY ANALYSIS of Fully Embedded Wall according to Burland-Potts method
Factor of safety on nett available passive
Active limit pressures calculated by Wedge Stability

Stage No.	G.L. Act.	G.L. Pass.	Strut Elev.	FoS for toe elev. = 2.70 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 2.000 Toe elev.	Wall Penetr -ation	Direction of failure
1	11.70	11.70	---	Conditions not suitable for FoS calc.				
2	11.70	11.70		No analysis at this stage				
3	11.70	11.70	---	Conditions not suitable for FoS calc.				
4	11.70	11.70	---	Conditions not suitable for FoS calc.				
5	11.70	9.70	Cant.	3.711	2.82	5.98	3.72	L to R
6	11.70	9.70	Cant.	3.591	2.82	5.85	3.85	L to R
7	11.70	9.70		No analysis at this stage				
8	11.70	9.70		No analysis at this stage				
9	11.70	9.70		No analysis at this stage				
10	11.70	9.70	Cant.	2.393	2.84	3.84	5.86	L to R
11	11.70	9.70	Cant.	2.368	2.84	3.78	5.92	L to R
12	11.70	9.70		No analysis at this stage				
13	11.70	9.70		No analysis at this stage				
14	11.70	9.70	Cant.	3.447	2.82	5.73	3.97	L to R
15	11.70	8.70	Cant.	2.135	2.79	3.13	5.57	L to R
16	11.70	8.70	Cant.	2.032	2.79	2.80	5.90	L to R

NORTHLAND GEOTECHNICAL SPECIALISTS | Sheet No.
Program: WALLAP Version 6.06 Revision A51.B69.R55 | Job No. 0213
Licensed from GEOSOLVE | Made by : RB
Data filename/Run ID: Section_B |
1A Seaview Road | Date: 9-03-2022
Section B | Checked :

Units: kN,m

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 20.00m
2-D finite element model. Soil arching not modelled.
Soil deformations are elastic until the active or passive limit is reached
Active limit pressures calculated by Wedge Stability
Open Tension Crack analysis - No
All soil moduli were factored to take account of
3-D effects due to the finite length of wall:
Modulus factors - Left side = 1.04
Right side = 1.03

Rigid boundaries: Left side 20.00 from wall Smooth boundary
Right side 20.00 from wall Smooth boundary
Lower rigid boundary at elevation -10.00 Rough boundary

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum m	Displacement minimum m	Bending moment maximum kN.m/m	Bending moment minimum kN.m/m	Shear force maximum kN/m	Shear force minimum kN/m
1	11.70	0.083	0.000	0.0	0.0	0.0	0.0
2	11.35	0.077	0.000	0.3	-0.0	5.8	-0.3
3	11.00	0.071	0.000	4.2	-0.2	12.9	-1.0
4	10.68	0.065	0.000	8.9	-0.6	15.7	-1.7
5	10.37	0.060	0.000	14.1	-1.3	23.4	-2.5
6	10.04	0.054	0.000	22.0	-0.6	26.8	-0.2
7	9.70	0.048	0.000	31.6	-0.2	30.6	-0.3
8	9.20	0.039	0.000	46.5	-0.3	27.2	-0.3
9	8.70	0.032	0.000	59.2	-0.4	25.0	0.0
10	8.40	0.027	0.000	65.3	-0.3	24.5	0.0
11	7.90	0.021	0.000	69.5	-0.1	17.4	-5.1
12	7.40	0.016	0.000	64.7	0.0	12.9	-17.0
13	6.95	0.012	0.000	60.3	0.0	0.0	-48.4
14	6.50	0.010	0.000	47.2	0.0	0.0	-39.2
15	6.00	0.008	0.000	28.1	0.0	0.0	-31.9
16	5.50	0.006	0.000	15.3	0.0	0.0	-18.9
17	5.00	0.005	0.000	9.2	0.0	0.0	-8.9
18	4.50	0.005	0.000	6.4	0.0	0.0	-4.4
19	4.00	0.004	0.000	4.9	-0.0	0.0	-2.9
20	3.50	0.003	0.000	3.5	-0.0	0.0	-3.3
21	3.10	0.003	0.000	2.0	-0.0	0.0	-4.4
22	2.70	0.003	0.000	0.0	-0.0	0.0	-1.2
23	2.58	0.003	0.000	0.0	0.0	0.0	-0.0
24	1.29	0.002	0.000	0.0	0.0	0.0	-0.2
25	0.00	0.001	0.000	0.0	0.0	0.0	-0.2
26	-2.00	0.001	0.000	0.0	0.0	0.0	-0.2
27	-4.00	0.001	0.000	0.0	0.0	0.0	-0.1
28	-6.00	0.000	0.000	0.0	0.0	0.1	-0.1
29	-8.00	0.000	0.000	0.0	0.0	0.1	-0.0
30	-10.00	0.000	0.000	0.0	0.0	0.0	0.0

Summary of results (continued)

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment maximum kN.m/m	elev.	minimum kN.m/m	elev.	Shear force maximum kN/m	elev.	minimum kN/m	elev.
1	0.1	6.95	-0.2	8.70	0.5	7.40	-0.2	9.70
2	No calculation at this stage							
3	0.3	6.95	-0.4	8.70	0.9	7.40	-0.3	9.70
4	0.4	7.40	-1.3	10.37	2.4	10.37	-2.5	10.37
5	19.3	8.40	-0.0	2.70	12.6	9.70	-12.4	6.95
6	19.4	8.40	-0.0	2.70	12.6	9.70	-12.5	6.95
7	No calculation at this stage							
8	No calculation at this stage							
9	No calculation at this stage							
10	69.5	7.90	-0.0	2.70	30.6	9.70	-48.4	6.95
11	69.5	7.90	-0.0	2.70	30.6	9.70	-48.4	6.95
12	No calculation at this stage							
13	No calculation at this stage							
14	66.8	7.90	-0.0	2.70	27.7	9.70	-46.6	6.95
15	62.1	7.40	-0.0	2.70	24.2	8.70	-33.2	6.50
16	62.9	7.40	-0.0	2.70	25.0	8.70	-33.1	6.50

Maximum and minimum displacement at each stage

Stage no.	Displacement maximum m	elev.	minimum m	elev.	Stage description
1	0.000	9.20	0.000	11.70	Apply surcharge no.1 at elev. 11.70
2	No calculation at this stage				Apply surcharge no.2 at elev. 11.70
3	0.000	-2.00	0.000	11.70	Apply surcharge no.3 at elev. 11.70
4	0.000	10.68	0.000	11.70	Apply load no.1 at elev. 10.37
5	0.017	11.70	0.000	11.70	Excav. to elev. 9.70 on RIGHT side
6	0.017	11.70	0.000	11.70	Apply surcharge no.6 at elev. 11.70
7	No calculation at this stage				Apply surcharge no.5 at elev. 11.70
8	No calculation at this stage				Remove surcharge no.5 at elev. 11.70
9	No calculation at this stage				Remove surcharge no.6 at elev. 11.70
10	0.072	11.70	0.000	11.70	Apply surcharge no.7 at elev. 11.70
11	0.072	11.70	0.000	11.70	Apply surcharge no.8 at elev. 11.70
12	No calculation at this stage				Remove surcharge no.7 at elev. 11.70
13	No calculation at this stage				Remove surcharge no.8 at elev. 11.70
14	0.072	11.70	0.000	11.70	Apply surcharge no.4 at elev. 11.70
15	0.082	11.70	0.000	11.70	Excav. to elev. 8.70 on RIGHT side
16	0.083	11.70	0.000	11.70	Apply load no.2 at elev. 10.37

Run ID. Section_B | Sheet No.
1A Seaview Road | Date: 9-03-2022
Section B | Checked :

Summary of results (continued)

NORTHLAND GEOTECHNICAL SPECIALISTS | Sheet No.
Program: WALLAP Version 6.06 Revision A51.B69.R55 | Job No. 0213
Licensed from GEOSOLVE | Made by : RB
Data filename/Run ID: Section_C-lowerwall |
1A Seaview Road | Date: 9-03-2022
Section C - lower wall | Checked :

Units: kN,m

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	15.22	6 light weight fill	6 light weight fill
2	12.84	2 Res soils	2 Res soils
3	11.00	3 HW Greywacke	3 HW Greywacke
4	9.15	4 MW Greywacke	4 MW Greywacke

SOIL PROPERTIES

No.	Soil type -- Description (Datum elev.)	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	Back Fill	18.00	20000	0.470	OC (0.200)	0.283 (1.241)	3.960 (5.127)	1.000d
2	Res soils	18.00	25000	0.470	OC (0.300)	0.260 (1.185)	4.448 (5.518)	6.000d
3	HW Greywacke	19.00	50000	0.440	OC (0.200)	0.237 (1.131)	5.023 (5.965)	10.00d
4	MW Greywacke	20.00	200000	0.398	OC (0.200)	0.207 (1.052)	6.100 (6.768)	20.00d
5	Existing fill	18.00	15000	0.530	OC (0.300)	0.309 (1.299)	3.543 (4.783)	2.000d
6	light weight fill	16.00	20000	1.917	OC (0.200)	0.163 (0.000)	8.766 (0.000)	

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	Back Fill	30.00	0.667	0.00	30.00	0.333	0.00
2	Res soils	32.00	0.667	0.00	32.00	0.333	0.00
3	HW Greywacke	34.00	0.667	0.00	34.00	0.333	0.00
4	MW Greywacke	37.00	0.667	0.00	37.00	0.333	0.00
5	Existing fill	28.00	0.667	0.00	28.00	0.333	0.00
6	light weight fill	42.00	0.667	0.00	42.00	0.333	0.00

GROUND WATER CONDITIONS

Density of water = 10.00 kN/m3

	Left side	Right side
Initial water table elevation	1.83	1.83

Automatic water pressure balancing at toe of wall : No

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 6.22
Maximum finite element length = 0.50 m
Youngs modulus of wall E = 1.2100E+07 kN/m2
Moment of inertia of wall I = 9.6660E-04 m4/m run
E.I = 11696 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	13.63	6.950	0	0	N/A
2	13.63	3.570	0	0	N/A

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge kN/m2 Near edge	Surcharge kN/m2 Far edge	Equiv. soil type	Partial factor/ Category
1	15.22	0.30(L)	3.00	0.60	35.00	=	N/A	N/A
2	15.22	2.70(L)	3.00	0.60	35.00	=	N/A	N/A
3	15.22	0.30(L)	3.00	0.60	53.00	=	N/A	N/A
4	15.22	2.70(L)	3.00	0.60	17.00	=	N/A	N/A
5	15.22	0.00(L)	3.00	5.00	5.00	=	N/A	N/A

Note: L = Left side, R = Right side

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Apply load no.1 at elevation 13.63
	The effect of strut/anchor stiffness at this elevation
	will be included while applying this load
2	Excavate to elevation 12.62 on RIGHT side
	Toe of berm at elevation 6.22
	Width of top of berm = 0.10
	Width of toe of berm = 6.40
3	Apply surcharge no.3 at elevation 15.22
4	Apply surcharge no.4 at elevation 15.22
5	Remove surcharge no.3 at elevation 15.22
	No analysis at this stage
6	Remove surcharge no.4 at elevation 15.22
	No analysis at this stage
7	Apply surcharge no.1 at elevation 15.22
8	Apply surcharge no.2 at elevation 15.22
9	Remove surcharge no.1 at elevation 15.22
	No analysis at this stage
10	Remove surcharge no.2 at elevation 15.22
	No analysis at this stage
11	Apply surcharge no.5 at elevation 15.22
12	Excavate to elevation 11.62 on RIGHT side
	Toe of berm at elevation 6.22
	Width of top of berm = 0.10
	Width of toe of berm = 5.40
13	Apply load no.2 at elevation 13.63

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
Method of analysis - Burland-Potts
Factor on passive for calculating wall depth = 2.00

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 - 2-D finite element model
Open Tension Crack analysis? - No
Soil arching modelled? - No
Non-linear Modulus Parameter (L) = 9.000 m

Boundary conditions:
Length of wall (normal to plane of analysis) = 20.00 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
Elevation of rigid lower boundary = -10.00

Lower rigid boundary at elevation -10.00 - Rough
Rigid boundary on Left side - Smooth
Rigid boundary on Right side - Smooth
Wall / soil interface - Smooth

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Apply load no.1 at elev. 13.63	No	No	No
2	Excav. to elev. 12.62 on RIGHT side	No	No	No
3	Apply surcharge no.3 at elev. 15.22	No	No	No
4	Apply surcharge no.4 at elev. 15.22	Yes	Yes	Yes
5	Remove surcharge no.3 at elev. 15.22	No	No	No
6	Remove surcharge no.4 at elev. 15.22	No	No	No
7	Apply surcharge no.1 at elev. 15.22	Yes	Yes	Yes
8	Apply surcharge no.2 at elev. 15.22	Yes	Yes	Yes
9	Remove surcharge no.1 at elev. 15.22	No	No	No
10	Remove surcharge no.2 at elev. 15.22	No	No	No
11	Apply surcharge no.5 at elev. 15.22	Yes	Yes	Yes
12	Excav. to elev. 11.62 on RIGHT side	No	No	No
13	Apply load no.2 at elev. 13.63	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

Units: kN,m

Summary of results

STABILITY ANALYSIS of Fully Embedded Wall according to Burland-Potts method
Factor of safety on nett available passive

Stage No.	--- G.L. --- Act.	Pass.	Strut Elev.	FoS for toe elev. = 6.22 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 2.000 Toe elev.	Wall Penetr -ation	Direction of failure
1	15.22	15.22	Cant.	87.208	10.59	***	***	L to R
2	15.22	12.62	Cant.	2.980	6.39	7.87	4.75	L to R
3	15.22	12.62	Cant.	2.345	6.40	6.93	5.69	L to R
4	15.22	12.62	Cant.	2.329	6.40	6.90	5.72	L to R
5	15.22	12.62		No analysis at this stage				
6	15.22	12.62		No analysis at this stage				
7	15.22	12.62	Cant.	2.525	6.39	7.24	5.38	L to R
8	15.22	12.62	Cant.	2.486	6.39	7.18	5.44	L to R
9	15.22	12.62		No analysis at this stage				
10	15.22	12.62		No analysis at this stage				
11	15.22	12.62	Cant.	2.744	6.39	7.57	5.05	L to R
12	15.22	11.62	Cant.	1.835	6.36	***	***	L to R
13	15.22	11.62	Cant.	1.711	6.36	***	***	L to R

Legend: *** Result not found

NORTHLAND GEOTECHNICAL SPECIALISTS | Sheet No.
Program: WALLAP Version 6.06 Revision A51.B69.R55 | Job No. 0213
Licensed from GEOSOLVE | Made by : RB
Data filename/Run ID: Section_C-lowerwall |
1A Seaview Road | Date: 9-03-2022
Section C - lower wall | Checked :

Units: kN,m

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 20.00m
2-D finite element model. Soil arching not modelled.
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No
All soil moduli were factored to take account of
3-D effects due to the finite length of wall:
Modulus factors - Left side = 1.04
Right side = 1.03

Rigid boundaries: Left side 20.00 from wall Smooth boundary
Right side 20.00 from wall Smooth boundary
Lower rigid boundary at elevation -10.00 Rough boundary

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	15.22	0.151	0.000	0.0	-0.0	0.0	0.0
2	14.86	0.141	0.000	0.4	-0.0	1.2	-0.2
3	14.50	0.132	0.000	1.3	-0.2	2.6	-0.9
4	14.07	0.120	0.000	3.3	-0.8	4.6	-2.0
5	13.63	0.108	0.000	6.2	-1.9	15.0	-3.4
6	13.24	0.097	0.000	12.4	-0.8	17.1	0.0
7	12.84	0.086	0.000	19.8	-0.0	20.2	0.0
8	12.62	0.080	0.000	24.4	0.0	21.5	0.0
9	12.12	0.068	0.000	35.0	0.0	23.3	0.0
10	11.62	0.055	0.000	46.5	0.0	27.3	-0.1
11	11.31	0.048	0.000	55.0	0.0	27.0	-0.1
12	11.00	0.042	0.000	63.4	0.0	26.7	-0.1
13	10.50	0.032	0.000	74.6	0.0	16.2	-12.5
14	10.00	0.024	0.000	80.7	0.0	6.7	-19.8
15	9.57	0.019	0.000	81.5	0.0	0.0	-17.4
16	9.15	0.015	0.000	78.8	0.0	0.0	-15.5
17	8.82	0.012	0.000	67.2	0.0	0.0	-58.2
18	8.50	0.011	0.000	46.1	0.0	0.0	-58.8
19	8.00	0.009	0.000	23.6	0.0	0.0	-31.8
20	7.50	0.007	0.000	13.4	0.0	0.0	-14.4
21	7.00	0.006	0.000	8.4	0.0	0.0	-9.9
22	6.61	0.006	0.000	4.5	0.0	0.0	-10.7
23	6.22	0.005	0.000	0.0	-0.0	0.0	-2.8
24	6.10	0.005	0.000	0.0	0.0	0.0	0.0
25	5.05	0.004	0.000	0.0	0.0	0.1	0.0
26	4.00	0.003	0.000	0.0	0.0	0.1	0.0
27	2.00	0.001	0.000	0.0	0.0	0.1	0.0
28	0.00	0.001	0.000	0.0	0.0	0.2	0.0
29	-2.00	0.000	0.000	0.0	0.0	0.2	0.0
30	-4.00	0.000	-0.000	0.0	0.0	0.2	0.0
31	-6.00	0.000	-0.000	0.0	0.0	0.2	0.0
32	-8.00	0.000	0.000	0.0	0.0	0.2	0.0
33	-10.00	0.000	0.000	0.0	0.0	0.0	0.0

Summary of results (continued)

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment maximum kN.m/m	elev.	minimum kN.m/m	elev.	Shear force maximum kN/m	elev.	minimum kN/m	elev.
1	0.5	11.62	-1.9	13.63	3.6	13.63	-3.4	13.63
2	32.8	11.00	-0.0	15.22	15.1	12.62	-15.1	10.00
3	52.5	10.50	-0.0	15.22	21.4	12.62	-24.3	8.82
4	53.1	10.50	-0.0	15.22	21.5	12.62	-25.0	8.82
5	No calculation at this stage							
6	No calculation at this stage							
7	52.8	10.50	-0.0	15.22	21.0	12.62	-24.9	8.82
8	52.8	10.50	-0.0	15.22	21.0	12.62	-25.0	8.82
9	No calculation at this stage							
10	No calculation at this stage							
11	52.5	10.50	-0.0	15.22	20.3	12.62	-24.8	8.82
12	67.7	10.00	-0.0	15.22	23.7	11.62	-50.0	8.82
13	81.5	9.57	-0.0	15.22	27.3	11.62	-58.8	8.50

Maximum and minimum displacement at each stage

Stage no.	Displacement maximum m	elev.	minimum m	elev.	Stage description
1	0.000	14.07	-0.000	-6.00	Apply load no.1 at elev. 13.63
2	0.044	15.22	0.000	15.22	Excav. to elev. 12.62 on RIGHT side
3	0.079	15.22	0.000	15.22	Apply surcharge no.3 at elev. 15.22
4	0.080	15.22	0.000	15.22	Apply surcharge no.4 at elev. 15.22
5	No calculation at this stage				Remove surcharge no.3 at elev. 15.22
6	No calculation at this stage				Remove surcharge no.4 at elev. 15.22
7	0.080	15.22	0.000	15.22	Apply surcharge no.1 at elev. 15.22
8	0.080	15.22	0.000	15.22	Apply surcharge no.2 at elev. 15.22
9	No calculation at this stage				Remove surcharge no.1 at elev. 15.22
10	No calculation at this stage				Remove surcharge no.2 at elev. 15.22
11	0.079	15.22	0.000	15.22	Apply surcharge no.5 at elev. 15.22
12	0.124	15.22	0.000	15.22	Excav. to elev. 11.62 on RIGHT side
13	0.151	15.22	0.000	15.22	Apply load no.2 at elev. 13.63

Timber Pole Capacity

Title	**1A Seaview Road, Paihia. Section A - Lower wall Long Term**	Job no	0213
		Date	9/03/2022
Design by	RB		
Checked			

Chosen Size	400	mm
spacing	1.3	m
$M_{(Wallap)}$ =	57.9	kNm/m
$V_{(Wallap)}$ =	27.6	kN/m
Depth to max moment	4.5	m
Depth to max shear	6	m
Increase in dia./metre	0	mm
Load Factor	1.5	Seismic = 1 otherwise = 1.5
deflection	41	mm

Bending and Shear only (no Axial)

Shear Capacity

f_s =	3.5	MPa
k_1 =	0.6	duration
k_{20} =	1	shaved
k_{21} =	0.9	steamed
ϕ =	0.8	
V* =	**53.8**	kNm/pole
ϕ Vn =	**142.5**	
Check ϕ Vn > V*	**OK**	

Moment Capacity

E =	12.1	GPa = E
f_b =	52	MPa
k_1 =	0.6	duration
k_{20} =	0.85	shaved
k_{21} =	0.85	steamed
ϕ =	0.8	
M* =	**112.9**	kNm/pole
ϕ Mn =	**113.3**	
Check ϕ Mn > M*	**OK**	

SED Size mm	Diameter (at max moment) mm	Diameter (at max shear) mm	As m2	I m^4	I/m m^4/m	Z m^3	ϕ Mn / pole kNm	ϕ Vn / pole kNm
100	100	100	0.006	4.909E-06	3.776E-06	9.817E-05	1.8	8.91
125	125	125	0.009	1.198E-05	9.219E-06	1.917E-04	3.5	13.92
150	150	150	0.013	2.485E-05	1.912E-05	3.313E-04	6.0	20.04
175	175	175	0.018	4.604E-05	3.541E-05	5.262E-04	9.5	27.28
200	200	200	0.024	7.854E-05	6.042E-05	7.854E-04	14.2	35.63
225	225	225	0.030	1.258E-04	9.677E-05	1.118E-03	20.2	45.09
250	250	250	0.037	1.917E-04	1.475E-04	1.534E-03	27.7	55.67
275	275	275	0.045	2.807E-04	2.160E-04	2.042E-03	36.8	67.35
300	300	300	0.053	3.976E-04	3.059E-04	2.651E-03	47.8	80.16
325	325	325	0.062	5.477E-04	4.213E-04	3.370E-03	60.8	94.07
350	350	350	0.072	7.366E-04	5.666E-04	4.209E-03	75.9	109.10
375	375	375	0.083	9.707E-04	7.467E-04	5.177E-03	93.4	125.25
400	400	400	0.094	1.257E-03	9.666E-04	6.283E-03	113.3	142.50

Timber Pole Capacity

Title	**1A Seaview Road, Paihia. Section A - Lower wall Med Term**	Job no	0213
		Date	9/03/2022
Design by	RB		
Checked			

Chosen Size	400	mm
spacing	1.3	m
$M_{(Wallap)}$ =	66.6	kNm/m
$V_{(Wallap)}$ =	33.2	kN/m
Depth to max moment	4.5	m
Depth to max shear	5.5	m
Increase in dia./metre	0	mm
Load Factor	1.5	Seismic = 1 otherwise = 1.5
deflection	38	mm

Bending and Shear only (no Axial)

Shear Capacity

f_s =	3.5	MPa
k_1 =	0.8	duration
k_{20} =	1	shaved
k_{21} =	0.9	steamed
ϕ =	0.8	
V* =	**64.7**	kNm/pole
ϕ Vn =	**190.0**	
Check ϕ Vn > V*	**OK**	

Moment Capacity

E =	12.1	GPa = E
f_b =	52	MPa
k_1 =	0.8	duration
k_{20} =	0.85	shaved
k_{21} =	0.85	steamed
ϕ =	0.8	
M* =	**129.9**	kNm/pole
ϕ Mn =	**151.1**	
Check ϕ Mn > M*	**OK**	

SED Size mm	Diameter (at max moment) mm	Diameter (at max shear) mm	As m2	I m^4	I/m m^4/m	Z m^3	ϕ Mn / pole kNm	ϕ Vn / pole kNm
100	100	100	0.006	4.909E-06	3.776E-06	9.817E-05	2.4	11.88
125	125	125	0.009	1.198E-05	9.219E-06	1.917E-04	4.6	18.56
150	150	150	0.013	2.485E-05	1.912E-05	3.313E-04	8.0	26.72
175	175	175	0.018	4.604E-05	3.541E-05	5.262E-04	12.7	36.37
200	200	200	0.024	7.854E-05	6.042E-05	7.854E-04	18.9	47.50
225	225	225	0.030	1.258E-04	9.677E-05	1.118E-03	26.9	60.12
250	250	250	0.037	1.917E-04	1.475E-04	1.534E-03	36.9	74.22
275	275	275	0.045	2.807E-04	2.160E-04	2.042E-03	49.1	89.81
300	300	300	0.053	3.976E-04	3.059E-04	2.651E-03	63.7	106.88
325	325	325	0.062	5.477E-04	4.213E-04	3.370E-03	81.0	125.43
350	350	350	0.072	7.366E-04	5.666E-04	4.209E-03	101.2	145.47
375	375	375	0.083	9.707E-04	7.467E-04	5.177E-03	124.5	167.00
400	400	400	0.094	1.257E-03	9.666E-04	6.283E-03	151.1	190.00

Timber Pole Capacity

Title	**1A Seaview Road, Paihia. Section A - Lower wall Short Term**	Job no	0213	Design by	RB
		Date	9/03/2022	Checked	

Chosen Size	400	mm
spacing	1.3	m
$M_{(Wallap)}$ =	67	kNm/m
$V_{(Wallap)}$ =	33.5	kN/m
Depth to max moment	4.5	m
Depth to max shear	5.5	m
Increase in dia./metre	0	mm
Load Factor	1.5	Seismic = 1 otherwise = 1.5
deflection	106	mm

Bending and Shear only (no Axial)

Shear Capacity

f_s =	3.5	MPa
k_1 =	1	duration
k_{20} =	1	shaved
k_{21} =	0.9	steamed
ϕ =	0.8	
V* =	**65.3**	kNm/pole
ϕ Vn =	**237.5**	
Check ϕ Vn > V*	**OK**	

Moment Capacity

E =	12.1	GPa = E
f_b =	52	MPa
k_1 =	1	duration
k_{20} =	0.85	shaved
k_{21} =	0.85	steamed
ϕ =	0.8	
M* =	**130.7**	kNm/pole
ϕ Mn =	**188.8**	
Check ϕ Mn > M*	**OK**	

SED Size mm	Diameter (at max moment) mm	Diameter (at max shear) mm	As m2	I m^4	I/m m^4/m	Z m^3	ϕ Mn / pole kNm	ϕ Vn / pole kNm
100	100	100	0.006	4.909E-06	3.776E-06	9.817E-05	3.0	14.84
125	125	125	0.009	1.198E-05	9.219E-06	1.917E-04	5.8	23.19
150	150	150	0.013	2.485E-05	1.912E-05	3.313E-04	10.0	33.40
175	175	175	0.018	4.604E-05	3.541E-05	5.262E-04	15.8	45.46
200	200	200	0.024	7.854E-05	6.042E-05	7.854E-04	23.6	59.38
225	225	225	0.030	1.258E-04	9.677E-05	1.118E-03	33.6	75.15
250	250	250	0.037	1.917E-04	1.475E-04	1.534E-03	46.1	92.78
275	275	275	0.045	2.807E-04	2.160E-04	2.042E-03	61.4	112.26
300	300	300	0.053	3.976E-04	3.059E-04	2.651E-03	79.7	133.60
325	325	325	0.062	5.477E-04	4.213E-04	3.370E-03	101.3	156.79
350	350	350	0.072	7.366E-04	5.666E-04	4.209E-03	126.5	181.84
375	375	375	0.083	9.707E-04	7.467E-04	5.177E-03	155.6	208.74
400	400	400	0.094	1.257E-03	9.666E-04	6.283E-03	188.8	237.50

Timber Pole Capacity

Title	**1A Seaview Road, Paihia. Section A- Lower wall Seismic**	Job no	0213	Design by	RB
		Date	9/03/2022	Checked	

Chosen Size	400	mm
spacing	1.3	m
$M_{(Wallap)}$ =	58.3	kNm/m
$V_{(Wallap)}$ =	27.7	kN/m
Depth to max moment	4.5	m
Depth to max shear	6	m
Increase in dia./metre	0	mm
Load Factor	1	Seismic = 1 otherwise = 1.5
deflection	0	mm

Bending and Shear only (no Axial)

Shear Capacity

f_s =	3.5	MPa
k_1 =	1	duration
k_{20} =	1	shaved
k_{21} =	0.9	steamed
ϕ =	0.8	
V* =	**36.0**	kNm/pole
ϕ Vn =	**237.5**	
Check ϕ Vn > V*	**OK**	

Moment Capacity

E =	12.1	GPa = E
f_b =	52	MPa
k_1 =	1	duration
k_{20} =	0.85	shaved
k_{21} =	0.85	steamed
ϕ =	0.8	
M* =	**75.8**	kNm/pole
ϕ Mn =	**188.8**	
Check ϕ Mn > M*	**OK**	

SED Size mm	Diameter (at max moment) mm	Diameter (at max shear) mm	As m2	I m^4	I/m m^4/m	Z m^3	ϕ Mn / pole kNm	ϕ Vn / pole kNm
100	100	100	0.006	4.909E-06	3.776E-06	9.817E-05	3.0	14.84
125	125	125	0.009	1.198E-05	9.219E-06	1.917E-04	5.8	23.19
150	150	150	0.013	2.485E-05	1.912E-05	3.313E-04	10.0	33.40
175	175	175	0.018	4.604E-05	3.541E-05	5.262E-04	15.8	45.46
200	200	200	0.024	7.854E-05	6.042E-05	7.854E-04	23.6	59.38
225	225	225	0.030	1.258E-04	9.677E-05	1.118E-03	33.6	75.15
250	250	250	0.037	1.917E-04	1.475E-04	1.534E-03	46.1	92.78
275	275	275	0.045	2.807E-04	2.160E-04	2.042E-03	61.4	112.26
300	300	300	0.053	3.976E-04	3.059E-04	2.651E-03	79.7	133.60
325	325	325	0.062	5.477E-04	4.213E-04	3.370E-03	101.3	156.79
350	350	350	0.072	7.366E-04	5.666E-04	4.209E-03	126.5	181.84
375	375	375	0.083	9.707E-04	7.467E-04	5.177E-03	155.6	208.74
400	400	400	0.094	1.257E-03	9.666E-04	6.283E-03	188.8	237.50

Timber Pole Capacity

Title	**1A Seaview Road, Paihia. Section A - Upper Wall Long term**	Job no	0213	Design by	RB
		Date	28/02/2022	Checked	

Chosen Size	300	mm
spacing	1	m
$M_{(Wallap)}$ =	39.1	kNm/m
$V_{(Wallap)}$ =	43.7	kN/m
Depth to max moment	3.82	m
Depth to max shear	4.07	m
Increase in dia./metre	6	mm
Load Factor	1.5	Seismic = 1 otherwise = 1.5

Bending and Shear only (no Axial)

Shear Capacity

f_s =	3.5	MPa
k_1 =	0.6	duration
k_{20} =	1	shaved
k_{21} =	0.9	steamed
ϕ =	0.8	
V* =	**65.6**	kNm/pole
ϕ Vn =	**93.7**	
Check ϕ Vn > V*	**OK**	

Moment Capacity

E =	12.1	GPa = E
f_b =	52	MPa
k_1 =	0.6	duration
k_{20} =	0.85	shaved
k_{21} =	0.85	steamed
ϕ =	0.8	
M* =	**58.7**	kNm/pole
ϕ Mn =	**59.6**	
Check ϕ Mn > M*	**OK**	

SED Size mm	Diameter (at max moment) mm	Diameter (at max shear) mm	As m2	I m^4	I/m m^4/m	Z m^3	ϕ Mn / pole kNm	ϕ Vn / pole kNm
100	123	124	0.009	1.121E-05	1.121E-05	1.823E-04	3.3	13.79
125	148	149	0.013	2.350E-05	2.350E-05	3.177E-04	5.7	19.88
150	173	174	0.018	4.389E-05	4.389E-05	5.076E-04	9.2	27.10
175	198	199	0.023	7.532E-05	7.532E-05	7.611E-04	13.7	35.42
200	223	224	0.030	1.212E-04	1.212E-04	1.088E-03	19.6	44.86
225	248	249	0.037	1.854E-04	1.854E-04	1.496E-03	27.0	55.41
250	273	274	0.044	2.723E-04	2.723E-04	1.996E-03	36.0	67.07
275	298	299	0.053	3.867E-04	3.867E-04	2.596E-03	46.8	79.85
300	323	324	0.062	5.338E-04	5.338E-04	3.306E-03	59.6	93.74
325	348	349	0.072	7.193E-04	7.193E-04	4.135E-03	74.6	108.74
350	373	374	0.083	9.494E-04	9.494E-04	5.092E-03	91.8	124.86
375	398	399	0.094	1.231E-03	1.231E-03	6.186E-03	111.6	142.09
400	423	424	0.106	1.570E-03	1.570E-03	7.426E-03	133.9	160.43

Timber Pole Capacity

Title	**1A Seaview Road, Paihia. Section A - Upper Wall Med term (overexcavation)**	Job no	0213	Design by	RB
		Date	28/02/2022	Checked	

Chosen Size	300	mm
spacing	1	m
$M_{(Wallap)}$ =	39.2	kNm/m
$V_{(Wallap)}$ =	63.7	kN/m
Depth to max moment	3.57	m
Depth to max shear	4.07	m
Increase in dia./metre	6	mm
Load Factor	1.5	Seismic = 1 otherwise = 1.5

Bending and Shear only (no Axial)

Shear Capacity

f_s =	3.5	MPa
k_1 =	0.8	duration
k_{20} =	1	shaved
k_{21} =	0.9	steamed
ϕ =	0.8	
V* =	**95.6**	kNm/pole
ϕ Vn =	**125.0**	
Check ϕ Vn > V*	**OK**	

Moment Capacity

E =	12.1	GPa = E
f_b =	52	MPa
k_1 =	0.8	duration
k_{20} =	0.85	shaved
k_{21} =	0.85	steamed
ϕ =	0.8	
M* =	**58.8**	kNm/pole
ϕ Mn =	**78.4**	
Check ϕ Mn > M*	**OK**	

SED Size mm	Diameter (at max moment) mm	Diameter (at max shear) mm	As m2	I m^4	I/m m^4/m	Z m^3	ϕ Mn / pole kNm	ϕ Vn / pole kNm
100	121	124	0.009	1.067E-05	1.067E-05	1.757E-04	4.2	18.38
125	146	149	0.013	2.256E-05	2.256E-05	3.082E-04	7.4	26.51
150	171	174	0.018	4.239E-05	4.239E-05	4.945E-04	11.9	36.13
175	196	199	0.023	7.307E-05	7.307E-05	7.440E-04	17.9	47.23
200	221	224	0.030	1.180E-04	1.180E-04	1.066E-03	25.6	59.81
225	246	249	0.037	1.810E-04	1.810E-04	1.469E-03	35.3	73.88
250	271	274	0.044	2.664E-04	2.664E-04	1.963E-03	47.2	89.43
275	296	299	0.053	3.790E-04	3.790E-04	2.557E-03	61.5	106.46
300	321	324	0.062	5.239E-04	5.239E-04	3.260E-03	78.4	124.98
325	346	349	0.072	7.069E-04	7.069E-04	4.081E-03	98.1	144.99
350	371	374	0.083	9.342E-04	9.342E-04	5.030E-03	121.0	166.48
375	396	399	0.094	1.212E-03	1.212E-03	6.116E-03	147.1	189.45
400	421	424	0.106	1.548E-03	1.548E-03	7.348E-03	176.7	213.91

Timber Pole Capacity

Title	**1A Seaview Road, Paihia. Section A - Upper Wall Seismic**	Job no	0213	Design by	RB
		Date	28/02/2022	Checked	

Chosen Size	300	mm
spacing	1	m
$M_{(Wallap)}$ =	41.9	kNm/m
$V_{(Wallap)}$ =	46.5	kN/m
Depth to max moment	3.57	m
Depth to max shear	4.07	m
Increase in dia./metre	6	mm
Load Factor	1	Seismic = 1 otherwise = 1.5

Bending and Shear only (no Axial)

Shear Capacity

f_s =	3.5	MPa
k_1 =	1	duration
k_{20} =	1	shaved
k_{21} =	0.9	steamed
ϕ =	0.8	
V* =	**46.5**	kNm/pole
ϕ Vn =	**156.2**	
Check ϕ Vn > V*	**OK**	

Moment Capacity

E =	12.1	GPa = E
f_b =	52	MPa
k_1 =	1	duration
k_{20} =	0.85	shaved
k_{21} =	0.85	steamed
ϕ =	0.8	
M* =	**41.9**	kNm/pole
ϕ Mn =	**98.0**	
Check ϕ Mn > M*	**OK**	

SED Size mm	Diameter (at max moment) mm	Diameter (at max shear) mm	As m2	I m^4	I/m m^4/m	Z m^3	ϕ Mn / pole kNm	ϕ Vn / pole kNm
100	121	124	0.009	1.067E-05	1.067E-05	1.757E-04	5.3	22.98
125	146	149	0.013	2.256E-05	2.256E-05	3.082E-04	9.3	33.14
150	171	174	0.018	4.239E-05	4.239E-05	4.945E-04	14.9	45.16
175	196	199	0.023	7.307E-05	7.307E-05	7.440E-04	22.4	59.03
200	221	224	0.030	1.180E-04	1.180E-04	1.066E-03	32.0	74.76
225	246	249	0.037	1.810E-04	1.810E-04	1.469E-03	44.2	92.35
250	271	274	0.044	2.664E-04	2.664E-04	1.963E-03	59.0	111.78
275	296	299	0.053	3.790E-04	3.790E-04	2.557E-03	76.9	133.08
300	321	324	0.062	5.239E-04	5.239E-04	3.260E-03	98.0	156.23
325	346	349	0.072	7.069E-04	7.069E-04	4.081E-03	122.7	181.24
350	371	374	0.083	9.342E-04	9.342E-04	5.030E-03	151.2	208.10
375	396	399	0.094	1.212E-03	1.212E-03	6.116E-03	183.8	236.82
400	421	424	0.106	1.548E-03	1.548E-03	7.348E-03	220.8	267.39

Timber Pole Capacity

Title	**1A Seaview Road, Paihia. Section B- Lower wall Long term**	Job no	0213	Design by	RB
		Date	9/03/2022	Checked	

Chosen Size	400	mm
spacing	1.3	m
$M_{(Wallap)}$ =	62.1	kNm/m
$V_{(Wallap)}$ =	33.1	kN/m
Depth to max moment	4.3	m
Depth to max shear	5.2	m
Increase in dia./metre	6	mm
Load Factor	1.5	Seismic = 1 otherwise = 1.5
deflection	27	mm

Bending and Shear only (no Axial)

Shear Capacity

f_s =	3.5	MPa
k_1 =	0.6	duration
k_{20} =	1	shaved
k_{21} =	0.9	steamed
ϕ =	0.8	
V* =	**64.5**	kNm/pole
ϕ Vn =	**165.6**	
Check ϕ Vn > V*	**OK**	

Moment Capacity

E =	12.1	GPa = E
f_b =	52	MPa
k_1 =	0.6	duration
k_{20} =	0.85	shaved
k_{21} =	0.85	steamed
ϕ =	0.8	
M* =	**121.1**	kNm/pole
ϕ Mn =	**136.7**	
Check ϕ Mn > M*	**OK**	

SED Size mm	Diameter (at max moment) mm	Diameter (at max shear) mm	As m2	I m^4	I/m m^4/m	Z m^3	ϕ Mn / pole kNm	ϕ Vn / pole kNm
100	126	131	0.010	1.229E-05	9.457E-06	1.955E-04	3.5	15.33
125	151	156	0.014	2.538E-05	1.953E-05	3.367E-04	6.1	21.73
150	176	181	0.019	4.689E-05	3.607E-05	5.334E-04	9.6	29.24
175	201	206	0.025	7.980E-05	6.139E-05	7.949E-04	14.3	37.87
200	226	231	0.031	1.276E-04	9.816E-05	1.130E-03	20.4	47.61
225	251	256	0.039	1.942E-04	1.494E-04	1.549E-03	27.9	58.46
250	276	281	0.047	2.840E-04	2.185E-04	2.060E-03	37.1	70.43
275	301	306	0.055	4.019E-04	3.091E-04	2.672E-03	48.2	83.51
300	326	331	0.065	5.531E-04	4.254E-04	3.395E-03	61.2	97.70
325	351	356	0.075	7.434E-04	5.718E-04	4.238E-03	76.4	113.00
350	376	381	0.086	9.790E-04	7.531E-04	5.210E-03	94.0	129.42
375	401	406	0.097	1.267E-03	9.744E-04	6.321E-03	114.0	146.95
400	426	431	0.110	1.614E-03	1.241E-03	7.579E-03	136.7	165.60

Timber Pole Capacity

Title	**1A Seaview Road, Paihia. Section B- Lower wall Med term**	Job no	0213	Design by	RB
		Date	9/03/2022	Checked	

Chosen Size	400	mm
spacing	1.3	m
$M_{(Wallap)}$ =	47.9	kNm/m
$V_{(Wallap)}$ =	34	kN/m
Depth to max moment	3.8	m
Depth to max shear	4.75	m
Increase in dia./metre	0	mm
Load Factor	1.5	Seismic = 1 otherwise = 1.5
deflection	45	mm

Bending and Shear only (no Axial)

Shear Capacity

f_s =	3.5	MPa
k_1 =	0.8	duration
k_{20} =	1	shaved
k_{21} =	0.9	steamed
ϕ =	0.8	
V* =	**66.3**	kNm/pole
ϕ Vn =	**190.0**	
Check ϕ Vn > V*	**OK**	

Moment Capacity

E =	12.1	GPa = E
f_b =	52	MPa
k_1 =	0.8	duration
k_{20} =	0.85	shaved
k_{21} =	0.85	steamed
ϕ =	0.8	
M* =	**93.4**	kNm/pole
ϕ Mn =	**151.1**	
Check ϕ Mn > M*	**OK**	

SED Size mm	Diameter (at max moment) mm	Diameter (at max shear) mm	As m2	I m^4	I/m m^4/m	Z m^3	ϕ Mn / pole kNm	ϕ Vn / pole kNm
100	100	100	0.006	4.909E-06	3.776E-06	9.817E-05	2.4	11.88
125	125	125	0.009	1.198E-05	9.219E-06	1.917E-04	4.6	18.56
150	150	150	0.013	2.485E-05	1.912E-05	3.313E-04	8.0	26.72
175	175	175	0.018	4.604E-05	3.541E-05	5.262E-04	12.7	36.37
200	200	200	0.024	7.854E-05	6.042E-05	7.854E-04	18.9	47.50
225	225	225	0.030	1.258E-04	9.677E-05	1.118E-03	26.9	60.12
250	250	250	0.037	1.917E-04	1.475E-04	1.534E-03	36.9	74.22
275	275	275	0.045	2.807E-04	2.160E-04	2.042E-03	49.1	89.81
300	300	300	0.053	3.976E-04	3.059E-04	2.651E-03	63.7	106.88
325	325	325	0.062	5.477E-04	4.213E-04	3.370E-03	81.0	125.43
350	350	350	0.072	7.366E-04	5.666E-04	4.209E-03	101.2	145.47
375	375	375	0.083	9.707E-04	7.467E-04	5.177E-03	124.5	167.00
400	400	400	0.094	1.257E-03	9.666E-04	6.283E-03	151.1	190.00

Timber Pole Capacity

Title	**1A Seaview Road, Paihia. Section B- Lower wall Short term**	Job no	0213	Design by	RB
		Date	9/03/2022	Checked	

Chosen Size	400	mm
spacing	1.3	m
$M_{(Wallap)}$ =	69.5	kNm/m
$V_{(Wallap)}$ =	48.4	kN/m
Depth to max moment	3.8	m
Depth to max shear	4.75	m
Increase in dia./metre	0	mm
Load Factor	1.5	Seismic = 1 otherwise = 1.5
deflection	44	mm

Bending and Shear only (no Axial)

Shear Capacity

f_s =	3.5	MPa
k_1 =	1	duration
k_{20} =	1	shaved
k_{21} =	0.9	steamed
ϕ =	0.8	
V* =	**94.4**	kNm/pole
ϕ Vn =	**237.5**	
Check ϕ Vn > V*	**OK**	

Moment Capacity

E =	12.1	GPa = E
f_b =	52	MPa
k_1 =	1	duration
k_{20} =	0.85	shaved
k_{21} =	0.85	steamed
ϕ =	0.8	
M* =	**135.5**	kNm/pole
ϕ Mn =	**188.8**	
Check ϕ Mn > M*	**OK**	

SED Size mm	Diameter (at max moment) mm	Diameter (at max shear) mm	As m2	I m^4	I/m m^4/m	Z m^3	ϕ Mn / pole kNm	ϕ Vn / pole kNm
100	100	100	0.006	4.909E-06	3.776E-06	9.817E-05	3.0	14.84
125	125	125	0.009	1.198E-05	9.219E-06	1.917E-04	5.8	23.19
150	150	150	0.013	2.485E-05	1.912E-05	3.313E-04	10.0	33.40
175	175	175	0.018	4.604E-05	3.541E-05	5.262E-04	15.8	45.46
200	200	200	0.024	7.854E-05	6.042E-05	7.854E-04	23.6	59.38
225	225	225	0.030	1.258E-04	9.677E-05	1.118E-03	33.6	75.15
250	250	250	0.037	1.917E-04	1.475E-04	1.534E-03	46.1	92.78
275	275	275	0.045	2.807E-04	2.160E-04	2.042E-03	61.4	112.26
300	300	300	0.053	3.976E-04	3.059E-04	2.651E-03	79.7	133.60
325	325	325	0.062	5.477E-04	4.213E-04	3.370E-03	101.3	156.79
350	350	350	0.072	7.366E-04	5.666E-04	4.209E-03	126.5	181.84
375	375	375	0.083	9.707E-04	7.467E-04	5.177E-03	155.6	208.74
400	400	400	0.094	1.257E-03	9.666E-04	6.283E-03	188.8	237.50

Timber Pole Capacity

Title	**1A Seaview Road, Paihia. Section B- Lower wall Seismic**	Job no	0213	Design by	RB
		Date	9/03/2022	Checked	

Chosen Size	400	mm
spacing	1.2	m
$M_{(Wallap)}$ =	62.9	kNm/m
$V_{(Wallap)}$ =	33.1	kN/m
Depth to max moment	4.3	m
Depth to max shear	5.2	m
Increase in dia./metre	0	mm
Load Factor	1	Seismic = 1 otherwise = 1.5
deflection	28	mm

Bending and Shear only (no Axial)

Shear Capacity

f_s =	3.5	MPa
k_1 =	1	duration
k_{20} =	1	shaved
k_{21} =	0.9	steamed
ϕ =	0.8	
V* =	**39.7**	kNm/pole
ϕ Vn =	**237.5**	
Check ϕ Vn > V*	**OK**	

Moment Capacity

E =	12.1	GPa = E
f_b =	52	MPa
k_1 =	1	duration
k_{20} =	0.85	shaved
k_{21} =	0.85	steamed
ϕ =	0.8	
M* =	**75.5**	kNm/pole
ϕ Mn =	**188.8**	
Check ϕ Mn > M*	**OK**	

SED Size mm	Diameter (at max moment) mm	Diameter (at max shear) mm	As m2	I m^4	I/m m^4/m	Z m^3	ϕ Mn / pole kNm	ϕ Vn / pole kNm
100	100	100	0.006	4.909E-06	4.091E-06	9.817E-05	3.0	14.84
125	125	125	0.009	1.198E-05	9.987E-06	1.917E-04	5.8	23.19
150	150	150	0.013	2.485E-05	2.071E-05	3.313E-04	10.0	33.40
175	175	175	0.018	4.604E-05	3.837E-05	5.262E-04	15.8	45.46
200	200	200	0.024	7.854E-05	6.545E-05	7.854E-04	23.6	59.38
225	225	225	0.030	1.258E-04	1.048E-04	1.118E-03	33.6	75.15
250	250	250	0.037	1.917E-04	1.598E-04	1.534E-03	46.1	92.78
275	275	275	0.045	2.807E-04	2.339E-04	2.042E-03	61.4	112.26
300	300	300	0.053	3.976E-04	3.313E-04	2.651E-03	79.7	133.60
325	325	325	0.062	5.477E-04	4.564E-04	3.370E-03	101.3	156.79
350	350	350	0.072	7.366E-04	6.138E-04	4.209E-03	126.5	181.84
375	375	375	0.083	9.707E-04	8.089E-04	5.177E-03	155.6	208.74
400	400	400	0.094	1.257E-03	1.047E-03	6.283E-03	188.8	237.50

Timber Pole Capacity

Title	**1A Seaview Road, Paihia. Section B - Upper wall long term**	Job no	0213	Design by	RB
		Date	4/03/2022	Checked	

Chosen Size	300	mm
spacing	1	m
$M_{(Wallap)}$ =	2.9	kNm/m
$V_{(Wallap)}$ =	4.8	kN/m
Depth to max moment	2.6	m
Depth to max shear	1.6	m
Increase in dia./metre	0	mm
Load Factor	1.5	Seismic = 1 otherwise = 1.5

Bending and Shear only (no Axial)

Shear Capacity

f_s =	3.5	MPa
k_1 =	0.6	duration
k_{20} =	1	shaved
k_{21} =	0.9	steamed
ϕ =	0.8	
V* =	**7.2**	kNm/pole
ϕ Vn =	**80.2**	
Check ϕ Vn > V*	**OK**	

Moment Capacity

E =	12.1	GPa = E
f_b =	52	MPa
k_1 =	0.6	duration
k_{20} =	0.85	shaved
k_{21} =	0.85	steamed
ϕ =	0.8	
M* =	**4.4**	kNm/pole
ϕ Mn =	**47.8**	
Check ϕ Mn > M*	**OK**	

SED Size mm	Diameter (at max moment) mm	Diameter (at max shear) mm	As m2	I m^4	I/m m^4/m	Z m^3	ϕ Mn / pole kNm	ϕ Vn / pole kNm
100	100	100	0.006	4.909E-06	4.909E-06	9.817E-05	1.8	8.91
125	125	125	0.009	1.198E-05	1.198E-05	1.917E-04	3.5	13.92
150	150	150	0.013	2.485E-05	2.485E-05	3.313E-04	6.0	20.04
175	175	175	0.018	4.604E-05	4.604E-05	5.262E-04	9.5	27.28
200	200	200	0.024	7.854E-05	7.854E-05	7.854E-04	14.2	35.63
225	225	225	0.030	1.258E-04	1.258E-04	1.118E-03	20.2	45.09
250	250	250	0.037	1.917E-04	1.917E-04	1.534E-03	27.7	55.67
275	275	275	0.045	2.807E-04	2.807E-04	2.042E-03	36.8	67.35
300	300	300	0.053	3.976E-04	3.976E-04	2.651E-03	47.8	80.16
325	325	325	0.062	5.477E-04	5.477E-04	3.370E-03	60.8	94.07
350	350	350	0.072	7.366E-04	7.366E-04	4.209E-03	75.9	109.10
375	375	375	0.083	9.707E-04	9.707E-04	5.177E-03	93.4	125.25
400	400	400	0.094	1.257E-03	1.257E-03	6.283E-03	113.3	142.50

Timber Pole Capacity

Title	**1A Seaview Road, Paihia. Section B - Upper wall seismic**	Job no	0213	Design by	RB
		Date	4/03/2022	Checked	

Chosen Size	300	mm
spacing	1	m
$M_{(Wallap)}$ =	3.8	kNm/m
$V_{(Wallap)}$ =	6.3	kN/m
Depth to max moment	2.6	m
Depth to max shear	1.6	m
Increase in dia./metre	0	mm
Load Factor	1	Seismic = 1 otherwise = 1.5

Bending and Shear only (no Axial)

Shear Capacity

f_s =	3.5	MPa
k_1 =	1	duration
k_{20} =	1	shaved
k_{21} =	0.9	steamed
ϕ =	0.8	
V* =	**6.3**	kNm/pole
ϕ Vn =	**133.6**	
Check ϕ Vn > V*	**OK**	

Moment Capacity

E =	12.1	GPa = E
f_b =	52	MPa
k_1 =	1	duration
k_{20} =	0.85	shaved
k_{21} =	0.85	steamed
ϕ =	0.8	
M* =	**3.8**	kNm/pole
ϕ Mn =	**79.7**	
Check ϕ Mn > M*	**OK**	

SED Size mm	Diameter (at max moment) mm	Diameter (at max shear) mm	As m2	I m^4	I/m m^4/m	Z m^3	ϕ Mn / pole kNm	ϕ Vn / pole kNm
100	100	100	0.006	4.909E-06	4.909E-06	9.817E-05	3.0	14.84
125	125	125	0.009	1.198E-05	1.198E-05	1.917E-04	5.8	23.19
150	150	150	0.013	2.485E-05	2.485E-05	3.313E-04	10.0	33.40
175	175	175	0.018	4.604E-05	4.604E-05	5.262E-04	15.8	45.46
200	200	200	0.024	7.854E-05	7.854E-05	7.854E-04	23.6	59.38
225	225	225	0.030	1.258E-04	1.258E-04	1.118E-03	33.6	75.15
250	250	250	0.037	1.917E-04	1.917E-04	1.534E-03	46.1	92.78
275	275	275	0.045	2.807E-04	2.807E-04	2.042E-03	61.4	112.26
300	300	300	0.053	3.976E-04	3.976E-04	2.651E-03	79.7	133.60
325	325	325	0.062	5.477E-04	5.477E-04	3.370E-03	101.3	156.79
350	350	350	0.072	7.366E-04	7.366E-04	4.209E-03	126.5	181.84
375	375	375	0.083	9.707E-04	9.707E-04	5.177E-03	155.6	208.74
400	400	400	0.094	1.257E-03	1.257E-03	6.283E-03	188.8	237.50

Timber Pole Capacity

Title	**1A Seaview Road, Paihia. Section C- Lower wall Long term**	Job no	0213	Design by	RB
		Date	9/03/2022	Checked	

Chosen Size	400	mm
spacing	1.2	m
$M_{(Wallap)}$ =	67.7	kNm/m
$V_{(Wallap)}$ =	48.7	kN/m
Depth to max moment	5.22	m
Depth to max shear	6.4	m
Increase in dia./metre	6	mm
Load Factor	1.5	Seismic = 1 otherwise = 1.5
deflection	42	mm

Bending and Shear only (no Axial)

Shear Capacity

f_s =	3.5	MPa
k_1 =	0.6	duration
k_{20} =	1	shaved
k_{21} =	0.9	steamed
ϕ =	0.8	
V* =	**87.7**	kNm/pole
ϕ Vn =	**171.2**	
Check ϕ Vn > V*	**OK**	

Moment Capacity

E =	12.1	GPa = E
f_b =	52	MPa
k_1 =	0.6	duration
k_{20} =	0.85	shaved
k_{21} =	0.85	steamed
ϕ =	0.8	
M* =	**121.9**	kNm/pole
ϕ Mn =	**142.1**	
Check ϕ Mn > M*	**OK**	

SED Size mm	Diameter (at max moment) mm	Diameter (at max shear) mm	As m2	I m^4	I/m m^4/m	Z m^3	ϕ Mn / pole kNm	ϕ Vn / pole kNm
100	131	138	0.011	1.460E-05	1.217E-05	2.223E-04	4.0	17.06
125	156	163	0.016	2.931E-05	2.443E-05	3.750E-04	6.8	23.78
150	181	188	0.021	5.306E-05	4.422E-05	5.852E-04	10.6	31.61
175	206	213	0.027	8.895E-05	7.412E-05	8.622E-04	15.5	40.56
200	231	238	0.033	1.405E-04	1.171E-04	1.215E-03	21.9	50.62
225	256	263	0.041	2.119E-04	1.766E-04	1.653E-03	29.8	61.79
250	281	288	0.049	3.074E-04	2.562E-04	2.186E-03	39.4	74.08
275	306	313	0.058	4.322E-04	3.602E-04	2.822E-03	50.9	87.48
300	331	338	0.067	5.915E-04	4.929E-04	3.571E-03	64.4	101.99
325	356	363	0.078	7.913E-04	6.594E-04	4.441E-03	80.1	117.62
350	381	388	0.089	1.038E-03	8.649E-04	5.443E-03	98.2	134.36
375	406	413	0.101	1.338E-03	1.115E-03	6.586E-03	118.8	152.21
400	431	438	0.113	1.699E-03	1.416E-03	7.878E-03	142.1	171.18

Timber Pole Capacity

Title	**1A Seaview Road, Paihia. Section C- Lower wall Medium Term**	Job no	0213	Design by	RB
		Date	9/03/2022	Checked	

Chosen Size	400	mm
spacing	1.2	m
$M_{(Wallap)}$ =	52.8	kNm/m
$V_{(Wallap)}$ =	24.4	kN/m
Depth to max moment	5.65	m
Depth to max shear	6.72	m
Increase in dia./metre	0	mm
Load Factor	1.5	Seismic = 1 otherwise = 1.5
deflection	0	mm

Bending and Shear only (no Axial)

Shear Capacity

f_s =	3.5	MPa
k_1 =	0.8	duration
k_{20} =	1	shaved
k_{21} =	0.9	steamed
ϕ =	0.8	
V* =	**43.9**	kNm/pole
ϕ Vn =	**190.0**	
Check ϕ Vn > V*	**OK**	

Moment Capacity

E =	12.1	GPa = E
f_b =	52	MPa
k_1 =	0.8	duration
k_{20} =	0.85	shaved
k_{21} =	0.85	steamed
ϕ =	0.8	
M* =	**95.0**	kNm/pole
ϕ Mn =	**151.1**	
Check ϕ Mn > M*	**OK**	

SED Size mm	Diameter (at max moment) mm	Diameter (at max shear) mm	As m2	I m^4	I/m m^4/m	Z m^3	ϕ Mn / pole kNm	ϕ Vn / pole kNm
100	100	100	0.006	4.909E-06	4.091E-06	9.817E-05	2.4	11.88
125	125	125	0.009	1.198E-05	9.987E-06	1.917E-04	4.6	18.56
150	150	150	0.013	2.485E-05	2.071E-05	3.313E-04	8.0	26.72
175	175	175	0.018	4.604E-05	3.837E-05	5.262E-04	12.7	36.37
200	200	200	0.024	7.854E-05	6.545E-05	7.854E-04	18.9	47.50
225	225	225	0.030	1.258E-04	1.048E-04	1.118E-03	26.9	60.12
250	250	250	0.037	1.917E-04	1.598E-04	1.534E-03	36.9	74.22
275	275	275	0.045	2.807E-04	2.339E-04	2.042E-03	49.1	89.81
300	300	300	0.053	3.976E-04	3.313E-04	2.651E-03	63.7	106.88
325	325	325	0.062	5.477E-04	4.564E-04	3.370E-03	81.0	125.43
350	350	350	0.072	7.366E-04	6.138E-04	4.209E-03	101.2	145.47
375	375	375	0.083	9.707E-04	8.089E-04	5.177E-03	124.5	167.00
400	400	400	0.094	1.257E-03	1.047E-03	6.283E-03	151.1	190.00

Timber Pole Capacity

Title	**1A Seaview Road, Paihia. Section C- Lower wall Short term**	Job no	0213	Design by	RB
		Date	9/03/2022	Checked	

Chosen Size	400	mm
spacing	1.2	m
$M_{(Wallap)}$ =	53.1	kNm/m
$V_{(Wallap)}$ =	24.4	kN/m
Depth to max moment	4.72	m
Depth to max shear	6.4	m
Increase in dia./metre	0	mm
Load Factor	1.5	Seismic = 1 otherwise = 1.5
deflection	74	mm

Bending and Shear only (no Axial)

Shear Capacity

f_s =	3.5	MPa
k_1 =	1	duration
k_{20} =	1	shaved
k_{21} =	0.9	steamed
ϕ =	0.8	
V* =	**43.9**	kNm/pole
ϕ Vn =	**237.5**	
Check ϕ Vn > V*	**OK**	

Moment Capacity

E =	12.1	GPa = E
f_b =	52	MPa
k_1 =	1	duration
k_{20} =	0.85	shaved
k_{21} =	0.85	steamed
ϕ =	0.8	
M* =	**95.6**	kNm/pole
ϕ Mn =	**188.8**	
Check ϕ Mn > M*	**OK**	

SED Size mm	Diameter (at max moment) mm	Diameter (at max shear) mm	As m2	I m^4	I/m m^4/m	Z m^3	ϕ Mn / pole kNm	ϕ Vn / pole kNm
100	100	100	0.006	4.909E-06	4.091E-06	9.817E-05	3.0	14.84
125	125	125	0.009	1.198E-05	9.987E-06	1.917E-04	5.8	23.19
150	150	150	0.013	2.485E-05	2.071E-05	3.313E-04	10.0	33.40
175	175	175	0.018	4.604E-05	3.837E-05	5.262E-04	15.8	45.46
200	200	200	0.024	7.854E-05	6.545E-05	7.854E-04	23.6	59.38
225	225	225	0.030	1.258E-04	1.048E-04	1.118E-03	33.6	75.15
250	250	250	0.037	1.917E-04	1.598E-04	1.534E-03	46.1	92.78
275	275	275	0.045	2.807E-04	2.339E-04	2.042E-03	61.4	112.26
300	300	300	0.053	3.976E-04	3.313E-04	2.651E-03	79.7	133.60
325	325	325	0.062	5.477E-04	4.564E-04	3.370E-03	101.3	156.79
350	350	350	0.072	7.366E-04	6.138E-04	4.209E-03	126.5	181.84
375	375	375	0.083	9.707E-04	8.089E-04	5.177E-03	155.6	208.74
400	400	400	0.094	1.257E-03	1.047E-03	6.283E-03	188.8	237.50

Timber Pole Capacity

Title	**1A Seaview Road, Paihia. Section C- Lower wall Seismic**	Job no	0213	Design by	RB
		Date	9/03/2022	Checked	

Chosen Size	400	mm
spacing	1.2	m
$M_{(Wallap)}$ =	81.5	kNm/m
$V_{(Wallap)}$ =	58.2	kN/m
Depth to max moment	5.65	m
Depth to max shear	6.72	m
Increase in dia./metre	0	mm
Load Factor	1	Seismic = 1 otherwise = 1.5
deflection	25	mm

Bending and Shear only (no Axial)

Shear Capacity

f_s =	3.5	MPa
k_1 =	1	duration
k_{20} =	1	shaved
k_{21} =	0.9	steamed
ϕ =	0.8	
V* =	**69.8**	kNm/pole
ϕ Vn =	**237.5**	
Check ϕ Vn > V*	**OK**	

Moment Capacity

E =	12.1	GPa = E
f_b =	52	MPa
k_1 =	1	duration
k_{20} =	0.85	shaved
k_{21} =	0.85	steamed
ϕ =	0.8	
M* =	**97.8**	kNm/pole
ϕ Mn =	**188.8**	
Check ϕ Mn > M*	**OK**	

SED Size mm	Diameter (at max moment) mm	Diameter (at max shear) mm	As m2	I m^4	I/m m^4/m	Z m^3	ϕ Mn / pole kNm	ϕ Vn / pole kNm
100	100	100	0.006	4.909E-06	4.091E-06	9.817E-05	3.0	14.84
125	125	125	0.009	1.198E-05	9.987E-06	1.917E-04	5.8	23.19
150	150	150	0.013	2.485E-05	2.071E-05	3.313E-04	10.0	33.40
175	175	175	0.018	4.604E-05	3.837E-05	5.262E-04	15.8	45.46
200	200	200	0.024	7.854E-05	6.545E-05	7.854E-04	23.6	59.38
225	225	225	0.030	1.258E-04	1.048E-04	1.118E-03	33.6	75.15
250	250	250	0.037	1.917E-04	1.598E-04	1.534E-03	46.1	92.78
275	275	275	0.045	2.807E-04	2.339E-04	2.042E-03	61.4	112.26
300	300	300	0.053	3.976E-04	3.313E-04	2.651E-03	79.7	133.60
325	325	325	0.062	5.477E-04	4.564E-04	3.370E-03	101.3	156.79
350	350	350	0.072	7.366E-04	6.138E-04	4.209E-03	126.5	181.84
375	375	375	0.083	9.707E-04	8.089E-04	5.177E-03	155.6	208.74
400	400	400	0.094	1.257E-03	1.047E-03	6.283E-03	188.8	237.50

Appendix E: Producer Statement

- PS1 – Design
- Certificate of Design Work
- Construction Monitoring Schedule
- Durability Statement

PRODUCER STATEMENT – PS1
DESIGN

BUILDING CODE CLAUSE(S): B1 **JOB NUMBER:** 0213
ISSUED BY: Northland Geotechnical Specialists Ltd
(Engineering Design Firm)
TO: Mrs Jane Banfield
(Owner/Developer)
TO BE SUPPLIED TO: Far North District Council
(Building Consent Authority)
IN RESPECT OF: Terraced retaining wall construction
(Description of Building Work)
AT: 1A Seaview Road, Paihia
(Address, Town/City)
LEGAL DESCRIPTION: Lot 2, DP 124280 **N/A** ☐

We have been engaged by the owner/developer referred to above to provide *(Extent of Engagement)*:
Design of a system of two terraced retaining walls for landslide remediation
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)* 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: Ground conditions .
- 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)* David Buxton , am:

- ☑ CPEng number 1010928

and hold the following qualifications BE Civil (Hons)

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

SIGNED BY *(Name of Engineering Design Professional)*: David Buxton
(Signature below):

ON BEHALF OF *(Engineering Design Firm)*: Northland Geotechnical Specialists Ltd Date: 9/03/2022

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:

NGS Report for Jane Banfield, "Geotechnical Design report for Landslip Mitigation", NGS Ref 0213, dated March 2022

NGS Figures 1 - 6, SA, SB & SC.

SCS Drawings, SK-SE-000 to -003, dated March 2022

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

engineering new zealand

CERTIFICATE OF DESIGN WORK
MEMORANDUM FROM LICENSED BUILDING PRACTITIONER

Section 30C and Section 45, Building Act 2004

The Building

Street address	1A Seaview Road		
Suburb	Paihia	**Town/city**	Bay of Islands
Postcode	0200	**Building consent no.**	

The Owner

Name(s)	Jane Banfield		
Email	accommodationatthebeach@gmail.com	**Phone**	0220183366
Address	1A Seaview Road, Paihia		

Basis for providing this memorandum

I am providing this memorandum in my role as the **specialist** designer who carried out or supervised specific Primary structure elements of restricted building work (RBW) design work as described in this memorandum. Other designers will provide memoranda covering the remaining RBW design work. Refer also to the attached PS1.

Identification of restricted building work (RBW) design work

I, David Buxton carried out or supervised the following RBW design work:

Primary structure: B1

Design work that is RBW	Description (as required) and reference to plans and specifications	Carried out or supervised
Foundations and subfloor framing ✕		
Retaining walls ✕	2No. timber pole retaining walls as per NGS plans and report Ref 0213, Figures 1 - 6, SA, SB & SC	Supervised
Beams ✕		
Portal ✕		
Bracing ✕		
Other (primary) ✕		

Note: SED = Elements subject to Specific Engineering Design outside of the scope of NZS3604:2011, unless otherwise noted.

DS Buxton

Initial _____ **Date** 9/03/2022

Waivers and modifications

Are waivers or modifications of the Building Code required?

If yes, please provide details of the waivers or modifications:

Building Code clause	Waiver/modification required

Issued by

Name	David Buxton	**Design entity/company**	Northland Geotechnical Specialists
Chartered status	CPEng	**Chartered no.**	1010928
Email	david@northlandgeotech.co.nz	**Website**	www.northlandgeotech.co.nz
Phone (daytime)	0226981129	**Phone (after hours)**	0226981129
Mobile			
Postal address	558 Crane Road, RD1 Kamo, Whangarei 0185		
Physical address	558 Crane Road, Kauri, Whangarei		

Declaration

I, David Buxton, LBP state that I have applied the skills and care reasonably required of a competent design professional in carrying out or supervising the RBW described in this memorandum and that based on this, I certify that the RBW described in this memorandum:

- complies with the Building Code; or
- complies with the Building Code subject to any waiver or modification of the Building Code described in this memorandum.

Signature  **Date** 09/03/2022

CONSTRUCTION MONITORING SCHEDULE
RESIDENTIAL

Schedule of inspections for

Address 1A Seaview Road, Paihia

We confirm that NGS have been engaged to undertake construction monitoring of the specific engineering design items to an Engineering New Zealand/ACENZ CM level and propose to undertake at least the following site inspections:

No.	Item of inspection	Timeframe
(Delete any that do not apply)		
1	Timber poles	Pre-pour
2	Ground conditions of excavated pile holes	Pre-pour
3	Pre start meeting to confirm methodolody	Pre-start
4	Daily monitoring of floor level using zip level	Daily until directed otherwise by Engineer

Notes:

a) The above items of inspection are the minimum required to enable NGS to issue a PS4 – Producer Statement Construction Review for the specific engineering design items.

b) The above items of inspection do not cover work constructed in accordance with NZS 3604:2011, for which inspections are to be undertaken by the Building Consent Authority.

c) The Contractor/Builder is to provide NGS at least 24 hours' notice of the requirement for an inspection. The above timeframes are indicative, the Engineer and Contractor are to agree the timing of inspection prior to work commencing on site.

d) A copy of this inspection schedule is to be held on site during the works, and the Contractor/Builder is to provide reasonable and safe access to enable works to be inspected according to the schedule.

e) The above schedule does not necessarily represent the actual number of inspections to be undertaken. The number of inspections will depend on the construction method, sequence of the works and whether or not unforeseen conditions or difficulties are encountered on site.

Northland Geotechnical Specialists

Project Ref: 0213
4 March 2022

To the Building Official
Far North District Council
New retaining walls to remediate landslide at 1A Seaview Road, Paihia

Compliance with Building Code Clause B2 – Durability

The purpose of this letter is to demonstrate how compliance with Clause B2 (Durability) of the Building Code will be achieved for the above project. We can confirm that for specifically designed structural elements that are included within our design documentation:

Material	Means of compliance	Details
Structural Timber	B2/AS1	Timber treatment has been selected in accordance with 1A of B2/AS1

Yours faithfully,
David Buxton, Geotechnical Engineer, CPEng

For and on behalf of
Northland Geotechnical Specialists Limited

Applicability

This Letter has been prepared solely for the benefit of our client Jane Banfield and the Far North District Council with respect to Building Consent application for which it has been prepared. The recommendations and opinions in this report are limited to the purpose stated within the report. Northland Geotechnical Specialists take no liability for use of any matter in this report by any other party without prior review and agreement in writing. Any other party using this report does so entirely at their own risk.

File: ngs durability_1a seaview road

Appendix F: Property Title

- Title: Lot 1 DP 42205

RECORD OF TITLE
UNDER LAND TRANSFER ACT 2017
FREEHOLD

Search Copy

R.W. Muir
Registrar-General
of Land

Identifier **NA72C/345**

Land Registration District **North Auckland**

Date Issued 07 February 1990

Prior References
NA66A/532

Estate Fee Simple

Area 1103 square metres more or less

Legal Description Lot 2 Deposited Plan 124280

Registered Owners

Jane Barbara Banfield as to a 1/2 share

Jane Barbara Banfield and TW Trustees 2011 Limited as to a 1/2 share

---

Interests

A54171 Building Line Restriction

Appurtenant hereto is a right of way created by Transfer A69583

The easements created by Transfer A69583 are subject to Section 37 (1) (a) Counties Amendment Act 1961

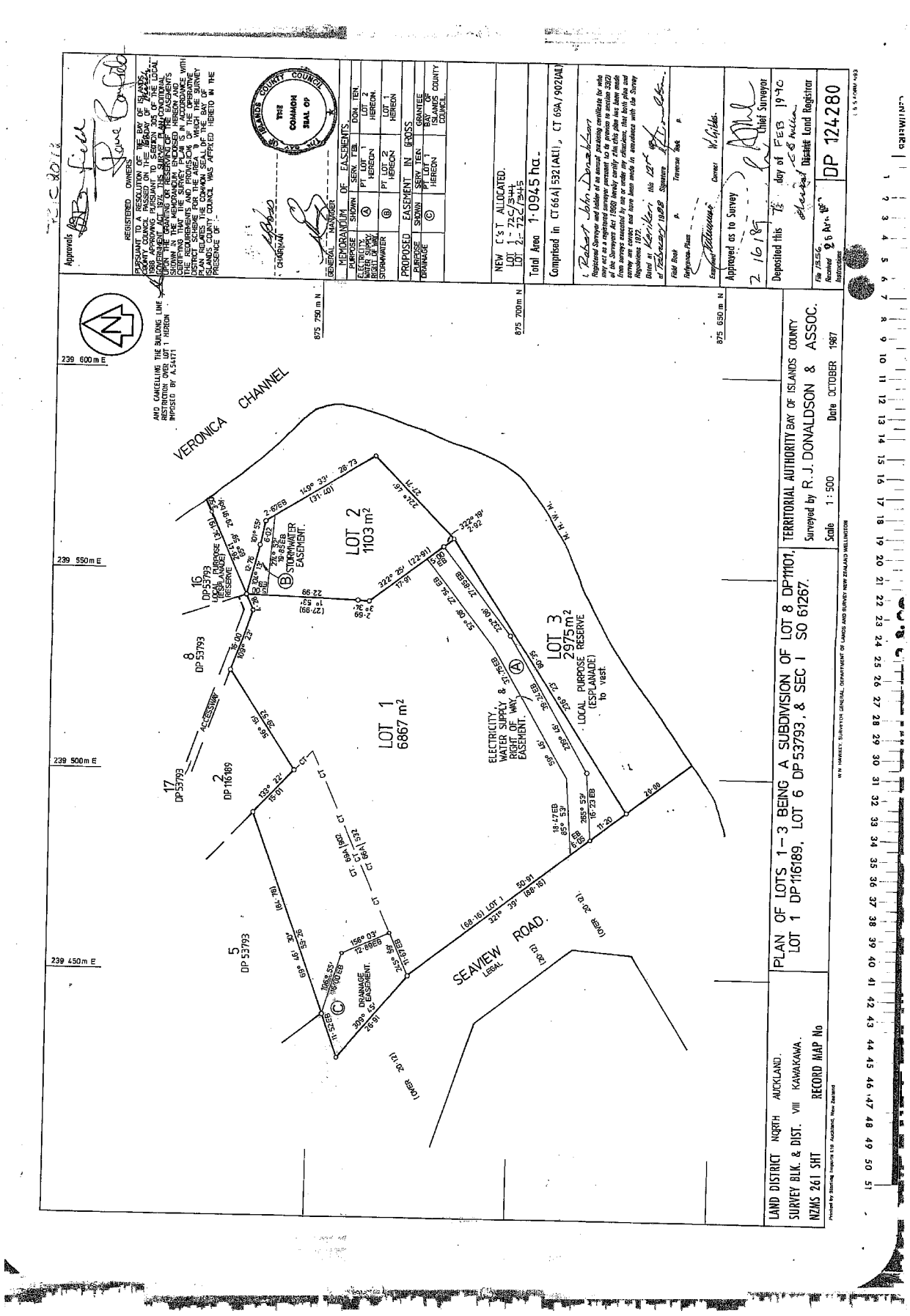
C099389.2 Resolution pursuant to Section 321(3)(c) Local Government Act 1974 - 7.2.1990 at 11.07 am

Subject to a stormwater right over part marked B on DP 124280 specified in Easement Certificate C099389.5 - 7.2.1990 at 11.07 am

Appurtenant hereto is a right of way and to electricity and water supply rights specified in Easement Certificate C099389.5 - 7.2.1990 at 11.07 am

The easements specified in Easement Certificate C099389.5 are subject to Section 309 (1) (a) Local Government Act 1974

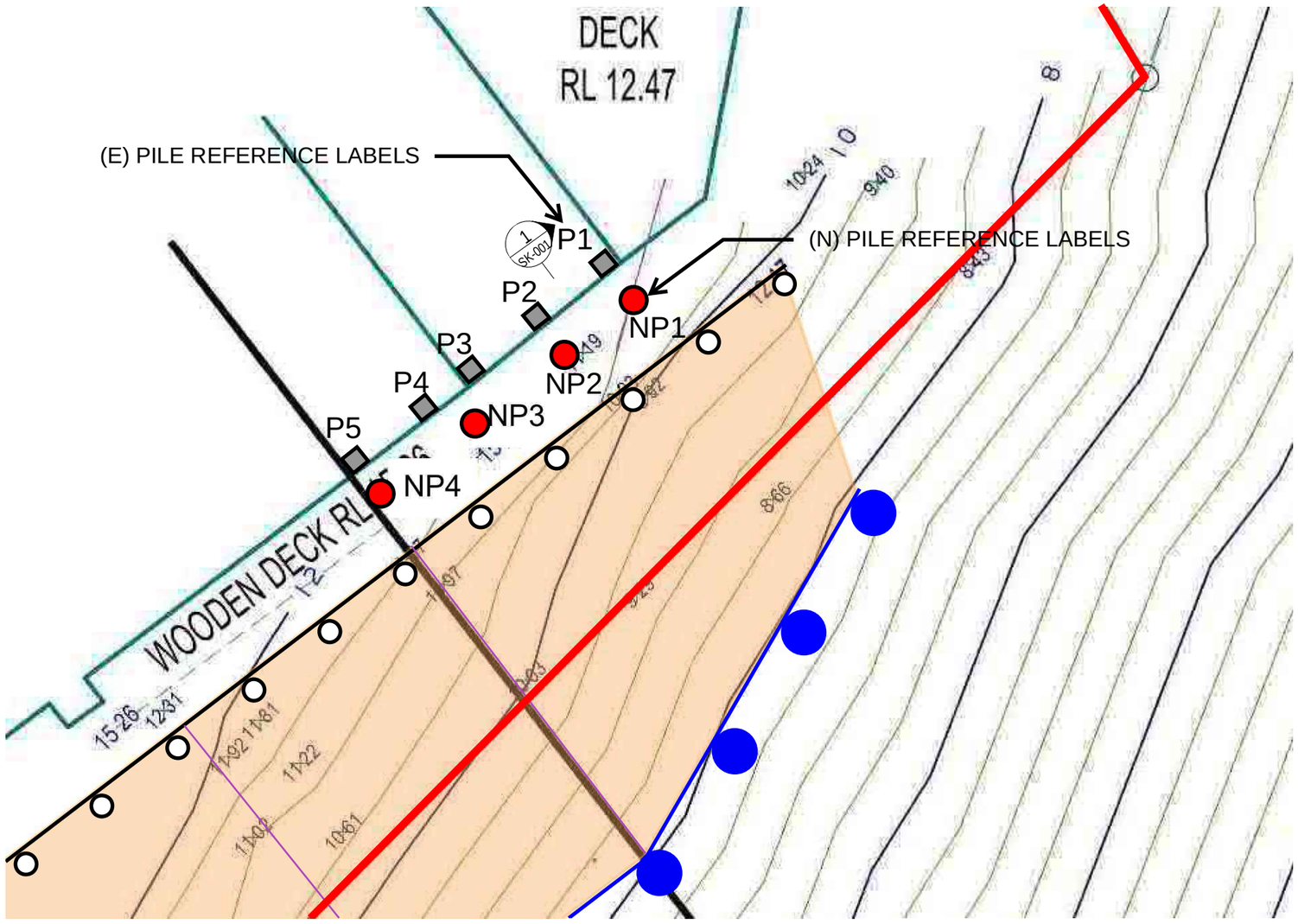
11407705.1 Subject to conditions pursuant to Section 461(1) Local Government Act 1974 and certifying that a private drain passes through Lot 1 on DP 124280 and serves the within land - 5.4.2019 at 4:05 pm



Appendix G: Structural Design Package

- SCS Structures Ltd Drawings SK-SE-000 to -003
- Structural Calculation Report
- PS1 – Design
- Certificate of Design Work

NOTE: BACKGROUND TAKEN FROM NGS LTD DRAWINGS



EXISTING CONCRETE PILE

NEW CONCRETE PILE

(PILES SHOWN INDICATIVELY ON GENERAL LAYOUT PLAN)

1 / - GENERAL LAYOUT PLAN

1:50 A3

4No. OFF NEW 450mm DIAM BORED CONCRETE UNDERPINNING PILES. SEE DETAILS AND SECTION VIEWS ON SK-SE-001 TO 002.

NOTES:

1.0 GENERAL NOTES

1.1 - All dimensions are in mm

1.2 - All dimensions shall be verified on site by the Contractor prior to fabrication / or construction commencing.

1.3 - Structural drawings shall be read in conjunction with the drawings of other Consultants (e.g. Architect, Geotech)

2.0 TEMPORARY WORKS

2.1 - The Contractor shall be responsible for the design & procurement of any temporary works should these be required such as propping or temporary working platform or formwork.

7.0 DRILL IN CONCRETE ANCHORS

7.1 - Contractor is to locate all existing reinforcement at fixing locations by x-ray or scanner prior to any drilling.

7.2 - No existing reinforcement to be cut or damaged.

7.3 - Pilot drill all holes as added precaution.

9.0 CONSTRUCTION NOTES

9.1 - Any discrepancies, unexpected conditions exposed on site, or structural details missing shall be referred to the engineer for resolution.

9.2 - The Contractor shall keep the engineer abreast of progress on site to enable inspections of completed work.

9.3 - All levels & dimensions to be confirmed on site by the Contractor.

9.4 - Refer to NGS Ltd Geotech drawings for all retaining wall requirements, locations, sizes & set out of retaining.

9.5 - Do not use the structural drawings for set out dimensions. Contractor to carry out site measurements.

9.6 - All works to comply with the Contractor's Health & Safety Manual and the Health & Safety at Work Act 2015.

9.7 - Contractor's proposed methodology and sequencing for installation of reinforced concrete underpinning piles to be submitted to the engineer for review and approval prior to commencing the work.

FOR BUILDING CONSENT

FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
1	FOR BUILDING CONSENT & CONSTRUCTION	SCS			10.03.22
B	PRELIMINARY ISSUE	SCS			4.03.22
A	FOR REVIEW & COMMENT	SCS			3.03.22

Drawing Originator: SCS STRUCTURES

Original Scale (A1) / Reduced Scale (A3): AS NOTED

Design: SCS | Drawn | Dsg Verifier | Dwg Check

* Refer to Revision 1 for Original Signature

Client: JANE BANFIELD

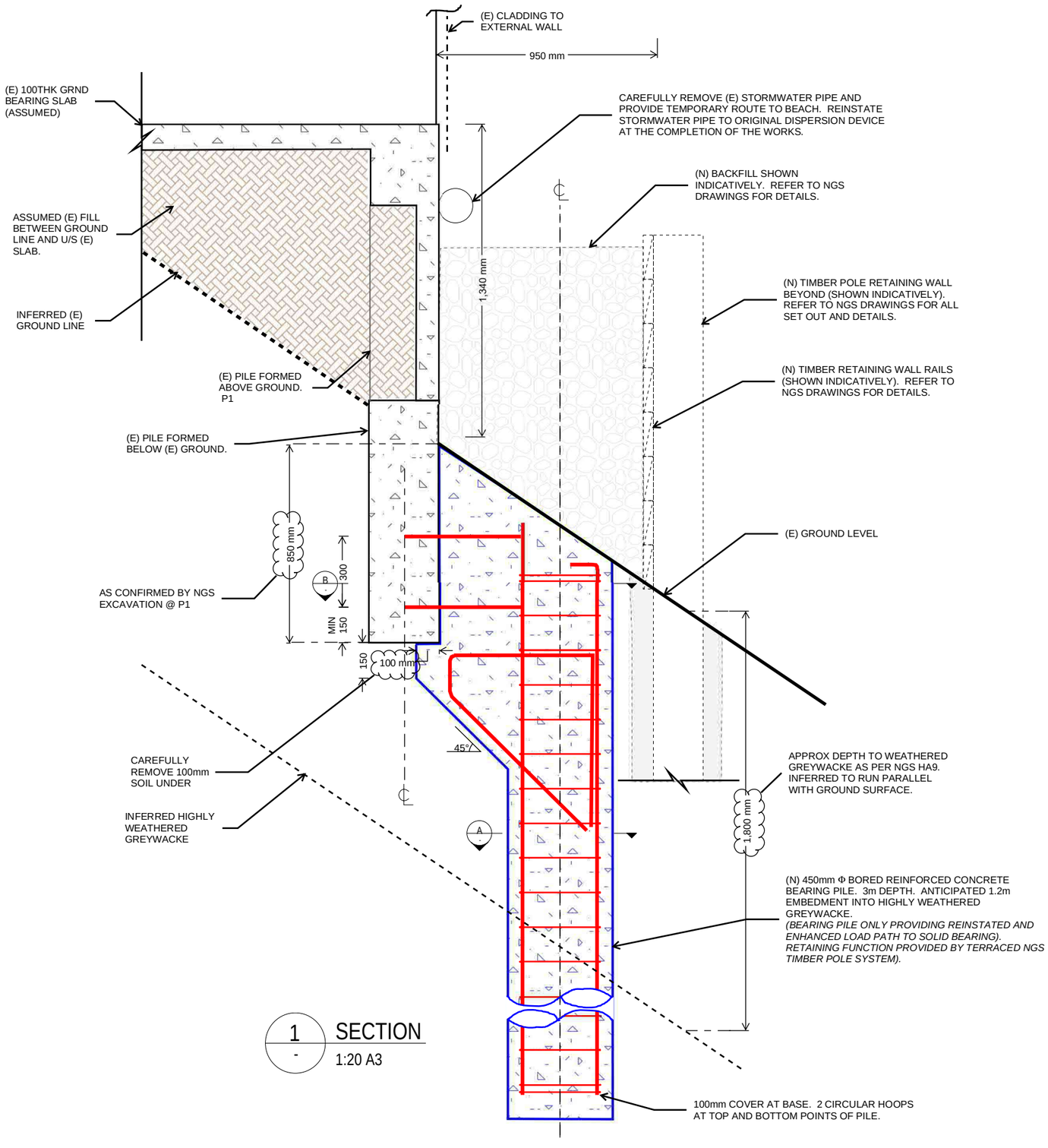
Project: FOUNDATION REMEDIAL WORKS
1A SEAVIEW RD, PAIHIA

Title: GENERAL ARRANGEMENT

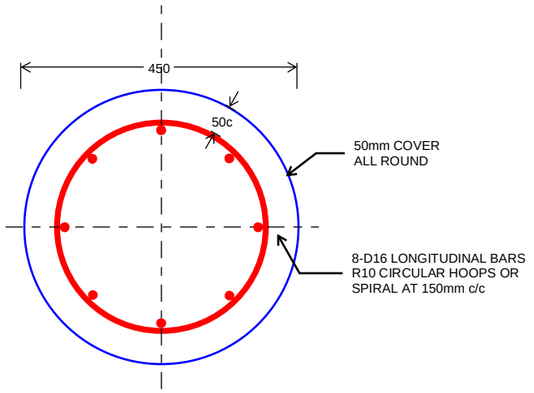
Discipline: STRUCTURAL

Drawing No.: SK-SE-000

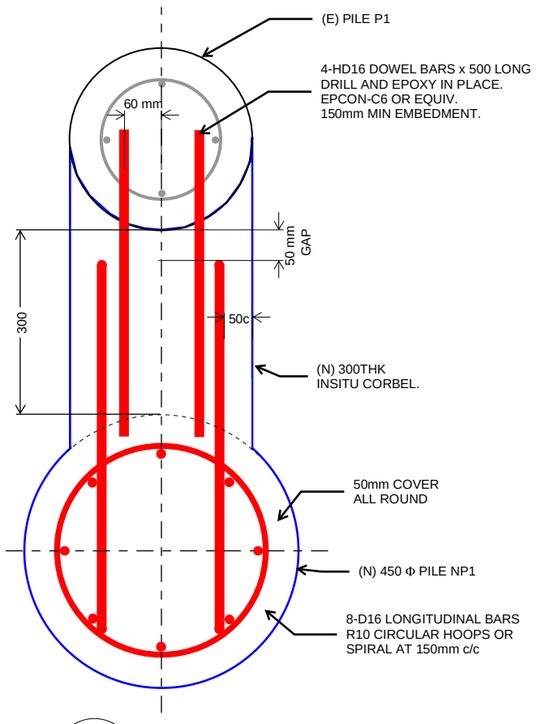
Rev.: 1



1 - SECTION
1:20 A3



A - SECTION
1:10 A3



B - SECTION
1:10 A3

FOR BUILDING CONSENT

FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
1	FOR BUILDING CONSENT & CONSTRUCTION	SCS			10.03.22
A	FOR REVIEW & COMMENT	SCS			3.03.22

Drawing Originator: SCS STRUCTURES

Original Scale (A1) | Reduced Scale (A3): AS NOTED

Design	SCS	
Drawn		
Dsg Verifier		
Dwg Check		

* Refer to Revision 1 for Original Signature

Client: JANE BANFIELD

Project: FOUNDATION REMEDIAL WORKS
1A SEAVIEW RD, PAIHIA

Title: STRUCTURAL DETAIL SHEET 1

Discipline: STRUCTURAL

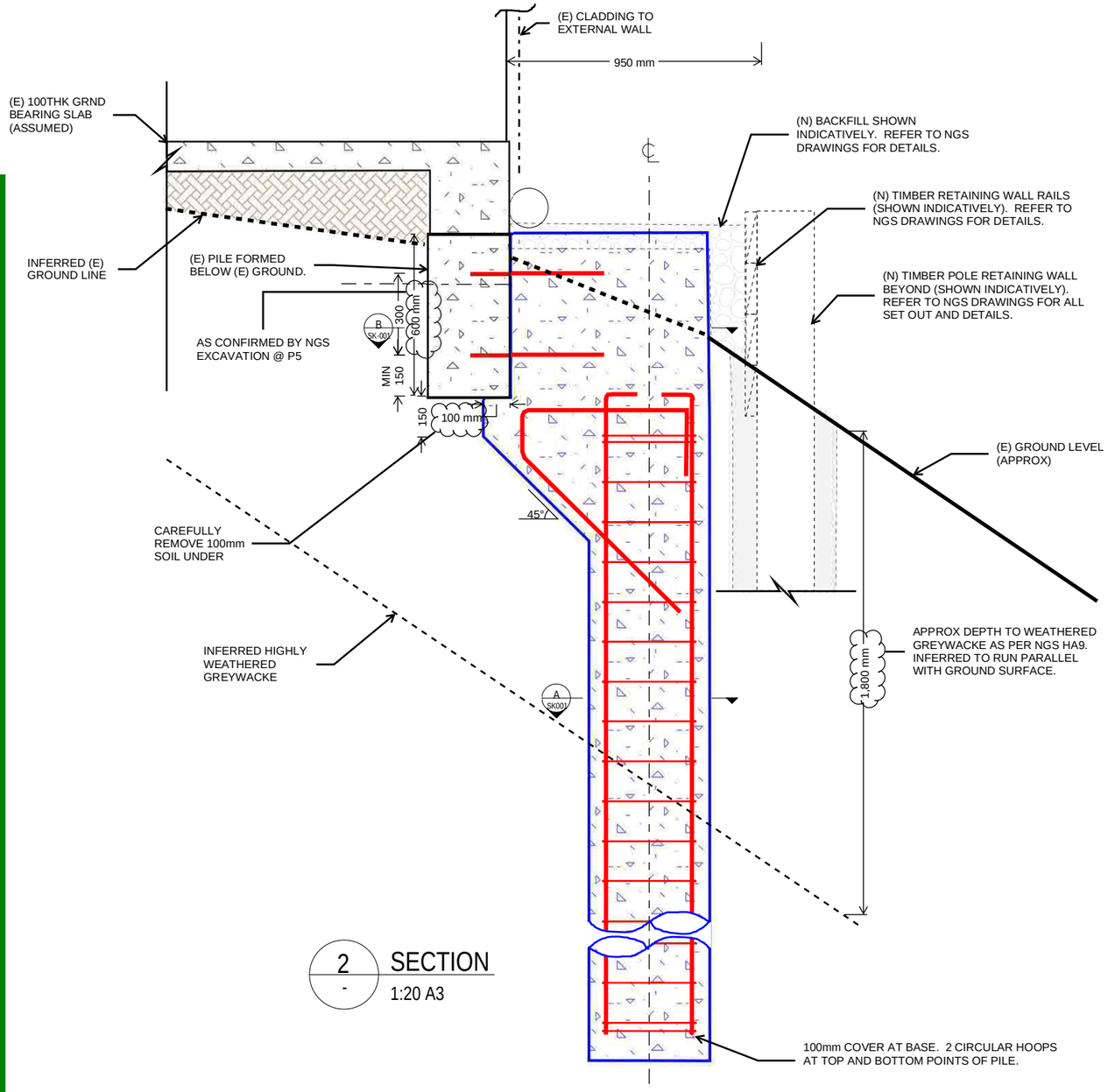
Drawing No.: SK-SE-001

Rev.: 1

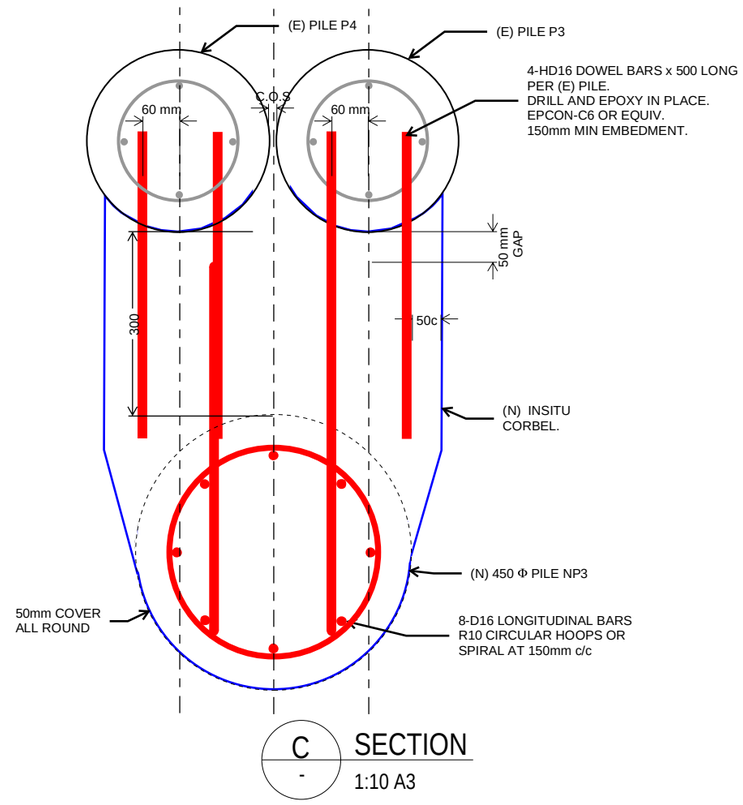
DO NOT SCALE

IF IN DOUBT ASK.

BLUEBEAM



2 - SECTION
1:20 A3



C - SECTION
1:10 A3

FOR BUILDING CONSENT

FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
1	FOR BUILDING CONSENT & CONSTRUCTION	SCS			10.03.22
A	FOR REVIEW & COMMENT	SCS			3.03.22

Drawing Originator: SCS STRUCTURES

Original Scale (A1)	Design	SCS	
	Drawn		
Reduced Scale (A3)	Dsg Verifier		
AS NOTED	Dwg Check		

* Refer to Revision 1 for Original Signature

Client: JANE BANFIELD

Project: FOUNDATION REMEDIAL WORKS
1A SEAVIEW RD, PAIHIA

Title: STRUCTURAL DETAIL SHEET 2

Discipline: STRUCTURAL

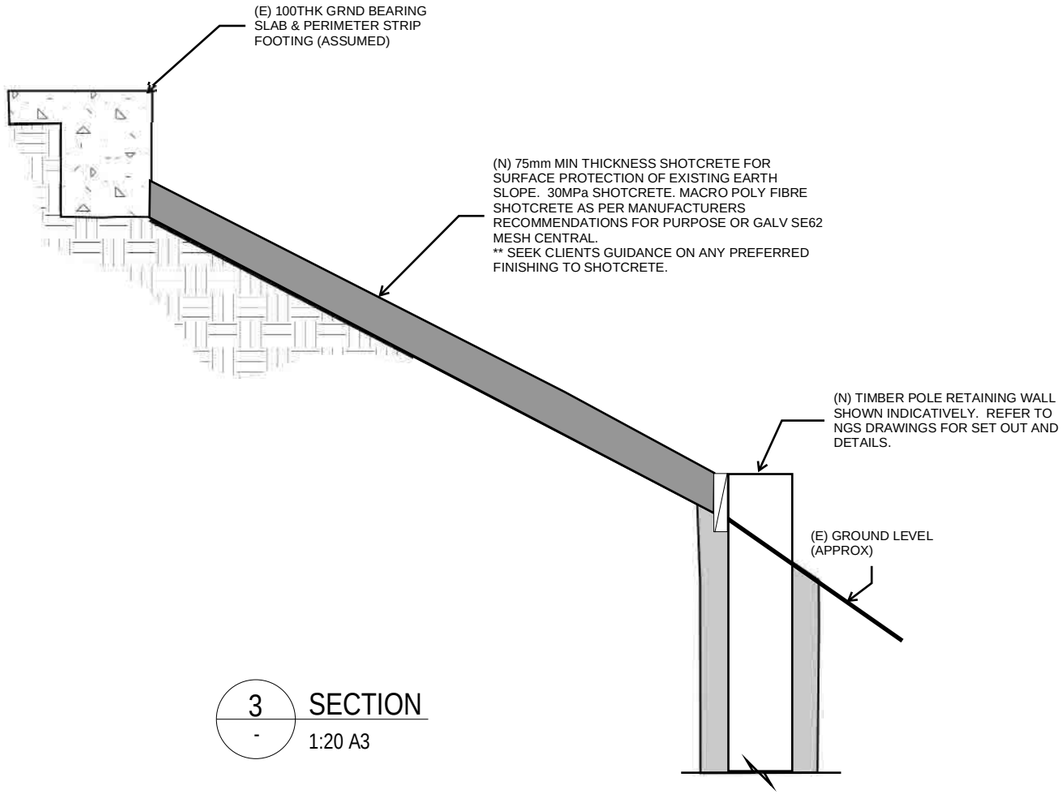
Drawing No.: SK-SE-002

Rev.: 1

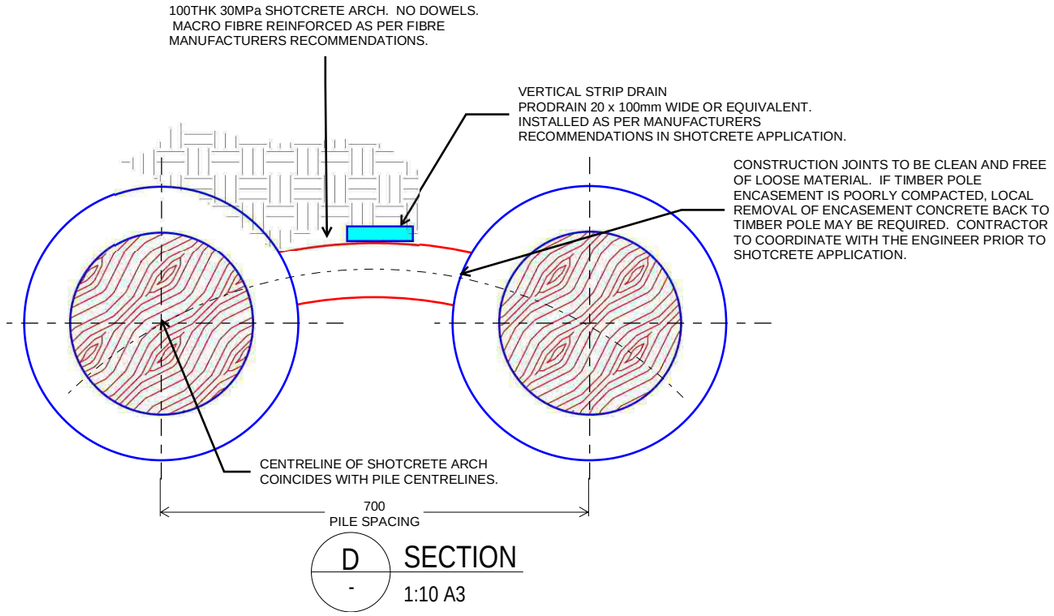
BLUEBEAM

DO NOT SCALE

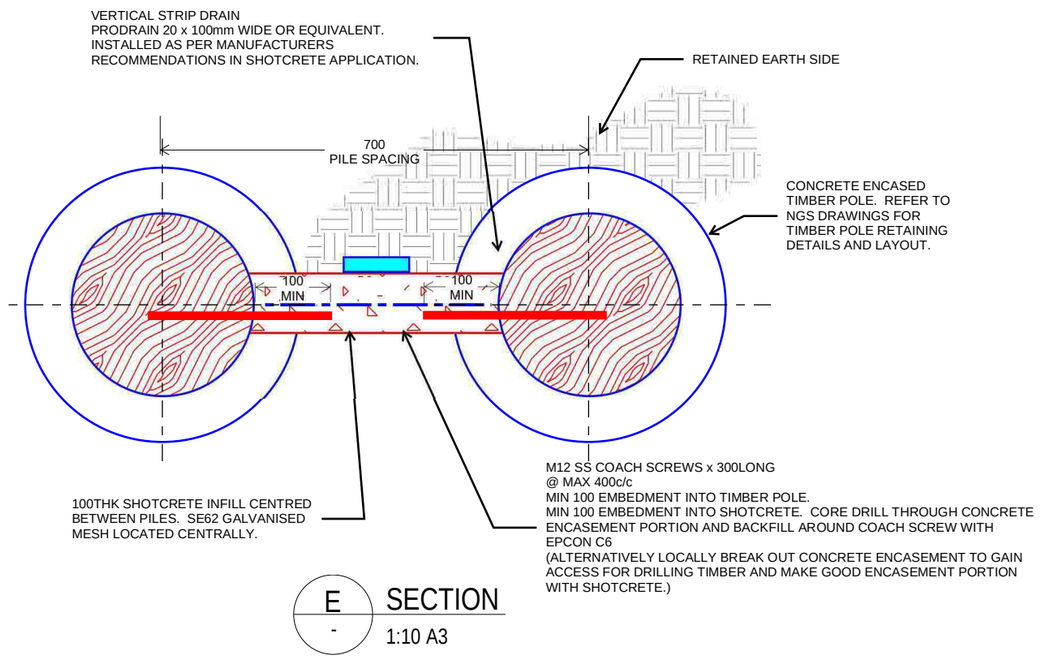
IF IN DOUBT ASK.



3 - SECTION
1:20 A3



D - SECTION
1:10 A3



E - SECTION
1:10 A3

FOR BUILDING CONSENT

FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
1	FOR BUILDING CONSENT & CONSTRUCTION	SCS			10.03.22
A	FOR REVIEW & COMMENT	SCS			3.03.22

Drawing Originator: SCS STRUCTURES

Original Scale (A1)	Design	SCS	
	Drawn		
Reduced Scale (A3)	Dsg Verifier		
AS NOTED	Dwg Check		

* Refer to Revision 1 for Original Signature

Client: JANE BANFIELD

Project: FOUNDATION REMEDIAL WORKS
1A SEAVIEW RD, PAIHIA

Title: STRUCTURAL DETAIL SHEET 3

Discipline: STRUCTURAL

Drawing No.: SK-SE-003

Rev.: 1

BLUEBEAM

DO NOT SCALE

IF IN DOUBT ASK.

STRUCTURAL CALCULATION REPORT

FOUNDATION REMEDIAL WORKS
1A SEAVIEW ROAD, PAIHIA
JANE BANFIELD

Prepared by

SCS STRUCTURES

3/03/2022

SCS STRUCTURES

Job Number: 1845 Date 2/03/2022

Job Name: 1A SEAVIEW RD, PAIHIA

Subject: FOUNDATION REMEDIAL WORKS

By: SCS Page No: of

DESCRIPTION:

Following the occurrence of a slip in close proximity to the existing dwelling at 1A Seaview Rd, Paihia, and subsequent geotechnical investigations by Northland Geotechnical Specialists (NGS), SCS Structures Ltd (SCS) was engaged to assist with the NGS design solution by covering specialist structural input for reinforced concrete underpinning and shotcrete stabilising works.

SCS Structures carried out an initial site visit on 26/01/22 which incorporated a high level visual assessment of parts of the dwelling. No obvious signs of movement were observed during this initial site walkover. No assessment of the building condition in general or compliance with current building code was attempted.

The presence of an old dead Pohutukawa tree stump was observed in close proximity to the existing foundations within the zone of influence of the slip. The NGS geotechnical inspection suggests that tension cracking was present in the soil profile above the tree stump and that some rotation at the base of the stump may have caused this. This raised concerns about the vertical load carrying load path of the adjacent existing foundations to solid bearing material in the vacinity of this stump. NGS locally hand excavated to expose the depth of existing piles. Some loose soil was found and it appeared that there was a gap under the pile P1. The existing piles are noted to be of varying depths and appear to consist of what was a fully embedded length cast against the soil surrounding the hole dug for the pile, and then an upper formed square or rectangular segment extending up to slab or perimeter strip footing level. The gap between formed piles above ground was lined with some sort of RC lining wall assumed to be 100mm thk. It is assumed that fill material was placed on top of the existing ground, retained by the lining wall and pile extensions to create the formation level for the adjacent ground floor slab.

Therefore it was concluded that as part of the overall land stabilisation & ground retention works being carried out by NGS that SCS would provide design and details for a reinstated and strengthened vertical load path to competent bearing strata (Highly Weathered Greywacke) for the existing piles labelled P1-P5.

DESIGN PHILOSOPHY:

1. New RC piles are bearing piles only to reinstate and enhance the vertical load path to the competant highly weathered greywacke. Ground retention to be provided by NGS tiered retaining wall system.

2. 4 new RC piles proposed. 1 in front of each existing pile except at existing piles P3& P4 which are located right next to ea other. Here just one new pile will suffice.

3. New piles to be 450mm diam bored concrete piles taken down 3.0m below existing ground level. This is on the basis that depth to top of highly weathered greywacked in NGS hand auger location HA9 was 1.8m, and then we anticipate 1.2m of embedment into they highly weathered greywacke.

4. Underpinning detail to be developed to allow transfer of vertical load from existing piles to the new piles through a continuous robust load path.

5. Due to physical and geometrical constraints it is assumed that the new underpinning piles will be eccentric to the existing piles. Therefore a bridging element will be needed to tie the existing and new piles together and the new piles will need to be designed for the induced moment due to this eccentricity.

6. Design life of new underpinning piles = 50yrs

SHOTCRETE

5. Two conditions of shotcrete required.

(5.1) When existing ground is excavated in front of the new NGS 'upper retaining wall' the soil is expected to arch adequately between piles in the short term, but to protect against long term case and frittering of this vertical soil face a shotcrete detail is proposed to act between the new permanent piles.

(5.2) Part way along the building between the seaward corner and the carpark area the building footprint steps back at ground level. This creates a new condition where there is a slope of exposed existing soil above the top of the new NGS upper retaining wall and the edge of the existing foundation. This soil slope is currently showing signs of frittering and for the long term protection against erosion of the slope which could ultimately undermine the existing footing it is proposed to protect this slope with a shotcrete lining.

PILE DESIGN:

DESIGN LOADINGS:

Loadings calculated as per NZS1170

Imposed Load Allowances: NZS 1170.1:2002
Residential floor load = 1.5kPa
Residential deck load = 2.0kPa
Roof access for maintenance = 0.25kPa

Dead Load Allowances:

Lightweight roof = 0.5kPa
External wall = 0.5kPa x 5m = 2.5kN/m (Ground to roof)
Lightwt timber floor = 0.5kPa (Sunroom floor at L1)
L1 partitions allowance = 0.5kPa

L0 slab = 0.11*24 = 2.64kPa
L0 Floor finishes = 20mm x 24 = 0.48kPa
L0 partitions allowance = 0.5kPa

Allowance for SW of (E) perimeter strip footing = 0.2*0.3m*24 = 1.44kN/m
Allowance for SW of (E) pile = 0.3*0.3m*24* 2.25m long = 4.86kN
Allowance for SW of (E) lining wall = 0.1m*24*1.4m = 3.36kN/m

Floor trib width allowance to (E) strip footing =2.5m allowance
(E) strip footing / lining wall trib width allowance = 1m

Dead load demand allowance per new underpinning pile:
G = (5.12kPa x 2.5m*1m) + (2.5*1m) + (4.8*1m) + 4.86 = 25kN

Live load demand allowance per new underpinning pile:
Q = (1.5kPa *2.5m*1m * 2 levels) = 7.5kN

LOAD COMBINATIONS
1.2G+1.5Q = 41kN
1.35G = 34kN

DURABILITY
Exposure category A2 to NZS3101 table 3.1 = Surfaces in contact with the ground (in non-aggressive soils).
Min cover as per Table 3.6 = 30mm for 30MPa concrete A2, 50yr design life.
Choose 50mm cover.

PILE DESIGN:

450mm diam bored insitu RC piles
Ag = 0.15e6mm2
As min = 0.8% * Ag = 1272mm2 (CL14.3.6.5)
Try D16 longitudinal bars
Min number of bars = 1272 /201 = 6.33 bars

M* = 41kN * 0.7m = 30kNm ULS
ΦMn = 75kNm with 8-D16's longitudinal steel, R10 links at 200c/c, 50mm cover all round, 30MPa normal concrete.

M*/Capacity = 30/75 = 40% utilisation < 100% Therefore OK

See GEN-COL calculation below.

Gen-Col
Analysis of Reinforced Concrete Columns
Licensed to: SESOC

Job number (or name): 1 Seaview Rd, Paihia
Column number:

User name : OEM

Concrete properties:

Rectangular stress block as defined by NZS 3101:2006.
Concrete cylindrical compressive strength = 30.0 MPa
Concrete compression stress coefficient, a1 = 0.85
Compression zone depth coefficient, B1 = 0.85
Concrete maximum strain = 0.0030

Steel properties:

Steel modulus of elasticity = 200 000 MPa
Steel yield strength = 300.0 MPa

Dimensions of the column section:

Circular section.
Diameter = 450.0 mm
Clear cover to ties = 50.0 mm

Results:

Load combination number 1 :
Strength reduction factor, Phi = 0.85
Phi Axial load = 0.8 kN, Phi Mx = 74.7 kNm, Phi My = 0.0 kNm
Required reinforcement ratio = 0.01011, Required reinforcement area = 1607.1 mm2
Initial reinforcement ratio = 0.01010, Initial reinforcement area = 1605.5 mm2
Initial reinforcement ratio scaled by = 1.0000
Moment ratio = 0.00000, Target moment ratio = N/A
Skew angle = 0.0 degrees, NA depth = 78.1 mm
Force (unfactored) carried by concrete = 400.5 kN
Force (unfactored) carried by reinforcement = -399.6 kN
Axial load eccentricity: ex = 0.0 mm, ey = 93375.0 mm

The analysis has been finished.

PILE DESIGN:

Check shear in pile: CL10.3.10.5
Adopt min steel = R10's at 150mm c/c, OK by inspection

PILE BEARING

450 diam pile OK by inspection for ULS demand of 41kN

CHECK DOWEL BARS

Design reduced ultimate concrete edge shear capacity, ϕV_{urc}

$$\phi V_{urc} = \phi V_{uc} * X_{vc} * X_{vd} * X_{va} * X_{vn} * X_{vs}$$

Try HD16 rebar dowels x 500long with EPCON C6 with 150mm embedment

Phi.Vuc = 12kN (e = 90mm)
Xvc = 0.91 (for fc'=30MPa)
Xvd = 2.0
Xva = 0.7 (e = 90, a = 120)
Xvn = 0.84 (n = 4, a/e = 1.33)
Xvs = 1.0 (not corner)

Therefore, Phi.Vurc = 12.8kN * 4 anchors = 51kN > 41 ULS Demand OK

Therefore adopt 450mm Φ bored reinforced concrete piles
6-D16 longitudinal bars, R10 links @ 150c/c, 30MPa Normal concrete

use 4-HD16 dowel bars x 500long. Drill and epoxy with 150mm embedment EPCON C6 or equivalent.

One new pile per existing pile, except at (E) P3 & P4 which are paired up next to each other.

SHOTCRETE DESIGN:

Check to span between timber poles in timber retaining walls.

LOADING:

At rest earth pressure = 11.5kPa (given)

SPAN:

Max span = 700mm face of pole to face of pole.

DEMAND:

Take 400mm wide strip

M* = 11.5*0.4*0.7*0.7/8 = 0.28kNm

phi =	0.85						alpha1	0.85	
fy =	500	MPa					beta1	0.85	
f'c =	30	MPa					Moment redistribution =	0	(0.2 = 20%)
b =	400	mm				Does element contribute to lateral strength of structure =		N	Y or N
D =	100	mm					min As to 9.3.8.2.1 =	0.0028	
cover =	50	mm					reduced min As to 9.3.8.2.3 =	0.001032	1 = N/A
d =	46.95	mm							
Tension reinforcement									
Bar size	6.1	mm diam	min reinf ratio =	0.00103	0.10%	*Reduced MIN As to 9.3.8.2.3*			
1 bar area	29.2	mm2	max reinf ratio =	0.017734	1.77%				
# bars	2	bars in tension							
As =	58	mm2	reinf ratio =	0.0031	0.31%	**STEEL RATIO OK**			
Phi.Mn =	1.1	kNm							
M* =	0.28	kNm	25% Utilisation						

V* =		1.61	kN		
Shear Capacity =					
ka =	0.85	*Conservative assuming <10mm aggregate*			
kn =	1.00	*Ignore axial effects (compression is beneficial)*			
kd =	1.00	*Is Av > Av min*	N	Y or N	
pw =	0.003				
vb =	0.101	SQRT(fc') :	0.55	MPa	
	Shear area, Av=		18780	mm2	*allowing for cover*
		vc =	0.79	MPa	
		Vc =	14.9	kN	
		phiVc =	11.1	kN	**14% Utilisation**

Demand per M12 coach screw = 1.6kN ULS with coach screws at 400c/c
OK by inspection. Use 300mm long with 100mm embedment into shotcrete.
Long coach screw to penetrate timber pole and some variability in concrete encasement anticipated.

Therefore 100thk, min 30MPa shotcrete ok for bending with SE62 mesh central for max 700mm span.

From: Rebekah Buxton <rebekah@northlandgeotech.co.nz>
Sent: Monday, 28 February 2022 3:55 PM
To: sam@fns.co.nz
Subject: RE: lateral earth pressure for shotcrete design

Sorry Sam, We are changing section part way. At this end of the wall we are making it 300SEDs at 1m c/c so pile face to face spacing is 700mm. Please ignore previous email below.
No change to lateral pressure.

From: Rebekah Buxton
Sent: Monday, 28 February 2022 3:32 pm
To: sam@fns.co.nz
Subject: lateral earth pressure for shotcrete design

Based on maximum depth of shotcrete of 1.60m with 250SED piles at 1.0m c/c.
Maximum lateral at rest earth pressure = 11.5kPa, pile face to pile face spacing 750mm.
Can you show a vertical strip drain detail.
Thanks

AT REST EARTH PRESSURE GIVEN

Kind Regards

Rebekah Buxton
Geotechnical Engineer, MEngNZ

Northland Geotechnical Specialists
M: 022 304 1171 **W**: www.northlandgeotech.co.nz

NGS
Northland Geotechnical Specialists

PRODUCER STATEMENT – PS1
DESIGN

BUILDING CODE CLAUSE(S): B1 **JOB NUMBER:** 1845
ISSUED BY: SCS Structures Ltd
(Engineering Design Firm)
TO: Jane Banfield
(Owner/Developer)
TO BE SUPPLIED TO: Far North District Council
(Building Consent Authority)
IN RESPECT OF: Foundation remedial works
(Description of Building Work)
AT: 1A Seaview Road
(Address, Town/City)
LEGAL DESCRIPTION: Lot 2 DP 124 280 **N/A** ☐

We have been engaged by the owner/developer referred to above to provide *(Extent of Engagement)*:
Structural engineering design
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 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: Subsoil conditions are as expected.
- 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 4 level of **construction monitoring**.

I *(Name of Engineering Design Professional)* Sam Chapman-Smith , am:

- ☑ CPEng number 230 257

and hold the following qualifications B.E.(Hons) Civil

The Engineering Design Firm holds a current policy of Professional Indemnity Insurance no less than $200,000
The Engineering Design Firm is not a member of ACE New Zealand.

SIGNED BY *(Name of Engineering Design Professional)*: Sam Chapman-Smith
(Signature below):

ON BEHALF OF *(Engineering Design Firm)*: SCS Structures Ltd Date: 10/03/2022

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:

SK-SE-000 rev 1
SK-SE-001 rev 1
SK-SE-002 rev 1
SK-SE-003 rev 1

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

Form 2A

Memorandum from licensed building practitioner: Certificate of design work

Section 30C or 45, Building Act 2004

Please fill in the form as fully and correctly as possible.
If there is insufficient room on the form for requested details, please continue on another sheet and attach the additional sheet(s) to this form.

THE BUILDING			
Street address:	1A Seaview Road		
Suburb:	Paihia		
Town/City:	Paihia	Postcode:	0200

THE OWNER(S)			
Name(s):	Jane Banfield		
Mailing address:	P O Box 417, Paihia, 0247		
Suburb:	Paihia	PO Box/Private Bag:	417
Town/City:	Paihia	Postcode:	0247
Phone number:	022 018 3366	Email address:	accommodationatthebeach@gmail.com

BASIS FOR PROVIDING THIS MEMORANDUM

I am providing this memorandum in my role as the: Please tick the option that applies ✓

○	**sole** designer of all of the RBW design outlined in this memorandum – I carried out all of the RBW design work myself – no other person will be providing any additional memoranda for the project
○	**lead** designer who carried out some of the RBW design myself but also supervised other designers – this memorandum covers their RBW design work as well as mine, and **no other** person will be providing any additional memoranda for the project
○	**lead** designer for all but specific elements of RBW – this memorandum only covers the RBW design work that I carried out or supervised and the **other** designers will provide their own memorandum relating to their specific RBW design
✓	**specialist** designer who carried out specific elements of RBW design work as outlined in this memorandum – other designers will be providing a memorandum covering the remaining RBW design work

IDENTIFICATION OF DESIGN WORK THAT IS RESTRICTED BUILDING WORK (RBW)

I Sam Chapman-Smith carried out / supervised the following design work that is restricted building work

PRIMARY STRUCTURE: B1

Design work that is RBW	Description of RBW	Carried out or supervised	Reference to plans and specifications
Tick ✓ if included. Cross ✗ if excluded	If appropriate, provide details of the RBW	Tick ✓ whether you carried out this design work or supervised someone else carrying out this design work	If appropriate, specify references
All RBW design work relating to B1 ✗		○ Carried out ○ Supervised	
Foundations and subfloor framing ✓	Reinforced concrete underpinning piles, and shotcrete infill between selected new retaining wall piles.	✓ Carried out ○ Supervised	SCS Structures Ltd Drawings: SK-SE-000 to 003 rev 1.

Design work that is RBW	Description of RBW	Carried out or supervised	Reference to plans and specifications
Tick ✓ if included. Cross ⊗ if excluded	If appropriate, provide details of the RBW	Tick ✓ whether you carried out this design work or supervised someone else carrying out this design work	If appropriate, specify references
Walls ⊗		◯ Carried out ◯ Supervised	
Roof ⊗		◯ Carried out ◯ Supervised	
Columns and beams ⊗		◯ Carried out ◯ Supervised	
Bracing ⊗		◯ Carried out ◯ Supervised	
Other ⊗		◯ Carried out ◯ Supervised	

Design work that is RBW	Description of RBW	Carried out or supervised	Reference to plans and specifications
Tick ✓ if included. Cross ✗ if excluded	If appropriate, provide details of the RBW	Tick ✓ whether you carried out this design work or supervised someone else carrying out this design work	If appropriate, specify references
EXTERNAL MOISTURE MANAGEMENT SYSTEMS: E2			
All RBW design work relating to E2 ☒		◯ Carried out ◯ Supervised	
Damp proofing ☒		◯ Carried out ◯ Supervised	
Roof cladding or roof cladding system ☒		◯ Carried out ◯ Supervised	
Ventilation system (for example, subfloor or cavity) ☒		◯ Carried out ◯ Supervised	
Wall cladding or wall cladding system ☒		◯ Carried out ◯ Supervised	
Waterproofing ☒		◯ Carried out ◯ Supervised	
Other ☒		◯ Carried out ◯ Supervised	

Design work that is RBW	Description of RBW	Carried out or supervised	Reference to plans and specifications
Tick ✓ if included. Cross ✗ if excluded	If appropriate, provide details of the RBW	Tick ✓ whether you carried out this design work or supervised someone else carrying out this design work	If appropriate, specify references
FIRE SAFETY SYSTEMS: C1 - C6			
Emergency warning systems Evacuation and fire service operation systems ✗ Suppression or control systems Other		○ Carried out ○ Supervised	

Note: The design of fire safety systems is only restricted building work when it involves small-to-medium apartment buildings as defined by the Building (Definition of Restricted Building Work) Order 2011.

WAIVERS AND MODIFICATIONS

Waivers or modifications of the Building Code are required. ✓ Yes ○ No

If Yes, provide details of the waivers or modifications below:

Clause	Waiver/modification required
List relevant clause numbers of building code	Specify nature of waiver or modification of building code required
B2	We are not able to cover Clause B2 as there is no effective verification method for B2 contained within the Building Code. However, we supply this letter to confirm that for the structural elements shown in our documentation: Concrete – Concrete strength and covers have been selected in accordance with Section 3 of NZS 3101:Part 1, and Section 4.5 of NZS 3604:2011 as applicable.
	Exposed Steel Connection Hardware - to NZS3604 exposure classification Zone C

ISSUED BY

Name and contact details of the licensed building practitioner who is licensed to carry out or supervise design work that is restricted building work.

Name: Sam Chapman-Smith	LBP or Registration number: 230 257
The practitioner is a: ◯ Design LBP ◯ Registered architect ✓ Chartered professional engineer	
Design Entity or Company (optional): SCS Structures Ltd	
Mailing address (if different from below):	
Street address/Registered office:	
Suburb:	Town/City: Kerikeri
PO Box/Private Bag: PO Box 871	Postcode: 0245
Phone number:	Mobile: 027 702 2008
After hours:	Fax:
Email address: sam@scsstructures.co.nz	Website: www.scsstructures.co.nz

DECLARATION

I Sam Chapman-Smith LBP, state that I have applied the skill and care reasonably required of a competent design professional in carrying out or supervising the Restricted Building Work (RBW) described in this form, and that based on this, I also state that the RBW:

- Complies with the building code, or
- Complies with the building code subject to any waiver or modification of the building code recorded on this form

Signature: 

Date: 10/03/2022