7 December 2022

WHENUAPAI GREEN DEVELOPMENT

98-102 TOTARA ROAD, WHENUAPAI

GEOTECHNICAL INVESTIGATION REPORT

Neil Construction Limited

AKL2018-0085AF Rev 1

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EXECUTIVE SUMMARY

This report presents the results of a geotechnical investigation and geohazards assessment for the proposed development at 98-102 Totara Road, Whenuapai, which is considered for the construction of a residential subdivision and a future school.

The site comprises two individual lot parcels (LOT 2 DP 81411 and LOT 1 DP 53062) with a collective land area of approximately 16.4 hectares. Ground contours grade gently from approximately mRL 25.0 at the southern boundary to mRL 15.0 across the bulk of the site.

The current development proposal is to create 346 residential lots and one large lot designated for a school, with associated access roading extending from Totara Road and McCaw Avenue, and two stormwater basins, part way along the western boundary and near the northern tip of the site.

Based on the investigation results, the site is underlain by Puketoka Formation alluvial deposits, with Waitemata Group deposits encountered below the alluvium. Groundwater was encountered across the site between 0.7m and 4.0m depth below existing ground level.

A geotechnical assessment of the site in respect of the proposed development is summarised as follows:

- The site is located in a low seismicity region with the nearest active fault (Wairoa North Fault) located approximately 42 kilometres south-east of the site. The risk of fault rupture induced damage is considered ‘low’.
- Due to the geological age and soil fabric of the soils encountered, liquefaction is low risk for the proposed works.
- The Puketoka Formation soils underlying the site are generally of a stiff to very stiff consistency and unlikely to undergo large static settlements when subject to typical NZS3604 type development loads (excluding the future loads from the proposed school building which will require specific assessment). Notwithstanding this, any localised soft spots and/ or isolated pockets of weak alluvial deposits that may be encountered during earthworks should be over excavated and replaced with engineered fill or reworked to minimise the risk of potential differential settlements and lower bearing capacities.
- With reference to AS2870 and BRANZ Report SR120A, the preliminary expansive site class for this development has been assessed as M (moderately reactive soils).
- Slope stability analysis has been carried out for the proposed fill embankment required to bridge the existing gully in the eastern portion of the site. Slope stability has been assessed under a number of static and seismic conditions, as well as rapid drawdown conditions, and stability improvement works (e.g., RE slopes) have been recommended to ensure adequate FoS against instability is achieved.
- Similarly, slope stability analysis has also been undertaken for the existing (and proposed) steep slopes adjacent to the eastern site boundary and slope stability improvement works (e.g., Reinforced Earth Slopes) have been recommended to enhance stability.
- With reference to NZS1170.5:2004, the subject site has been assessed as Class C – Shallow Soils.
- A preliminary groundwater drawdown assessment has been undertaken for the stormwater reserve areas in accordance with CIRIA 113 guidelines and indicate that the drawdown zone of influence is likely to be limited to less than 3m distance from the edge of the pond excavation. As such, no groundwater drawdown is expected to occur beyond the site boundary.
- General earthworks recommendations are outlined in the report.
- Design recommendations and parameters for permanent and temporary retaining walls, construction of road pavements and service line trenches have been provided.
- The subsoils encountered beneath the site are considered suitable to be able to support up to 300kPa geotechnical ultimate bearing pressures from conventional NZS 3604 type structures. A higher ultimate bearing capacity may be provided (if needed) subject to specific investigation for specific (e.g., school) building platforms.

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1 INTRODUCTION

1.1 Project Brief

CMW Geosciences (CMW) was engaged by Neil Construction Limited to carry out a geotechnical investigation of a site located at 98-102 Totara Road, Whenuapai, which is being considered for the construction of a 346-lot residential subdivision development and a future school.

The scope of work and associated terms and conditions of our engagement were detailed in our services proposal letter referenced 2018-0085AF, Rev.0 dated 3 June 2022.

This report is intended to support a fast-track resource consent application to the Environment Protection Authority (EPA).

1.2 Scope of Work

As detailed in our proposal letter (referenced above), the agreed scope of work to be conducted by CMW was defined as follows:

- Desk top study of available information relevant to the proposed development.
- Arrange and execute a geotechnical site investigation (SI).
- Evaluate and develop an appropriate geological and geotechnical model, including seasonal groundwater variations.
- Identify any geohazards to the proposed development, including liquefaction, static settlements, sensitive soils, groundwater issues, and provide strategies to mitigate.
- Provide appropriate geotechnical parameters for the design of proposed building foundations, floor slabs, pavements and retaining walls.
- Provide recommendations for earthworks and a geotechnical works specification.
- Assess the suitability of and provide relevant parameters and limitations associated with the installation of soakwells.
- Compile all of the above detail into a concise geotechnical investigation report, incorporating relevant plans, field investigation data, laboratory test data and calculations.

2 SITE DESCRIPTION

2.1 Site Location

The site is located at 98-102 Totara Road, Whenuapai, and consists of two individual lot parcels (Lot2 2 DP 81411 and Lot 1 DP 53062) with a collective land area of approximately 16.4 hectares. The overall site location is shown on Figure 1 below.

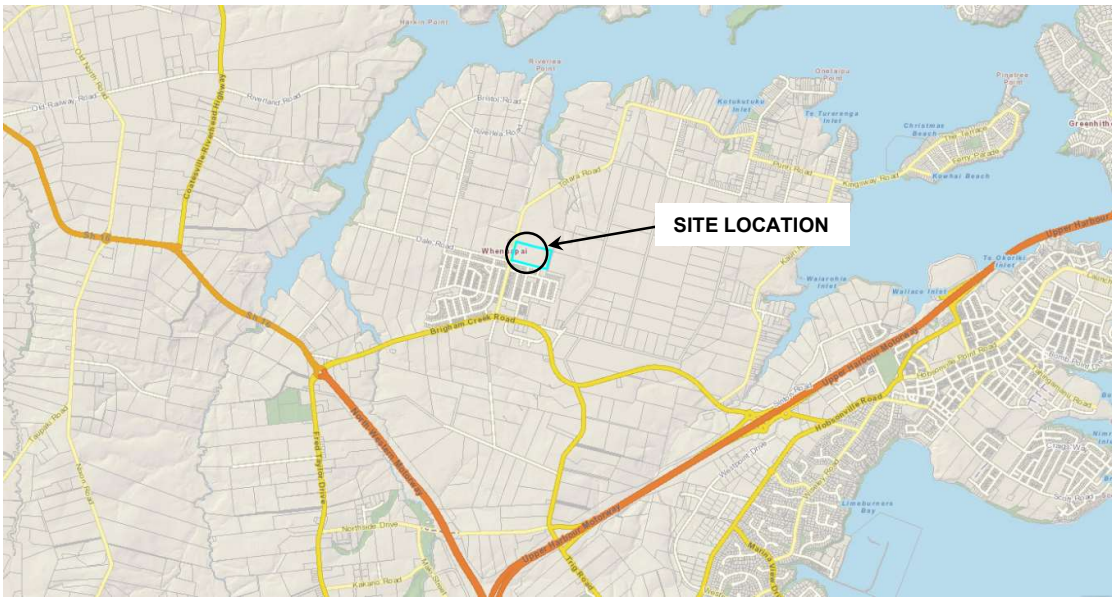


Figure 1: Site Location Plan (Source: Auckland council Geomaps)

2.2 Landform

The current general landform, together with associated features located within and adjacent to the site is presented on Geotechnical Site Plan, attached (***Drawing 02***).

The ground contours grade gently from approximately mRL 25.0 at the southern boundary to mRL 15.0 across the bulk of the site.

A south to north flowing tributary with approximately 2m deep invert is located in the eastern part of 98-100 Totara Road and collects the stormwater runoffs from the site and adjacent properties to the south. This tributary discharges north of the site boundary, into a permanent stream which flows from southeast to northwest and crosses the site at the north-eastern corner.

Part way up the western boundary there appears to be a field drain feeding a shallow over land flow path with flowing water. No signs of the drain could be found anywhere else. We presume that it is shallowly buried and only a short distance from where it is seen to discharge.

The site is bound to the north and west by Totara Road, to the south by McCaw Avenue and to the east by Whenuapai Airforce Base. Currently there are three dwellings (and associated ancillary structures) located on site. A single dwelling with a detached garage is located in the northern tip with access off Totara Road and two dwellings (102 and 102A Totara Road) with detached sheds are located in the south-western corner. Both these dwellings are accessed off Totara Road near the intersection with Dale Road and McCaw Avenue. The remainder of the site exists in pasture.

Historic aerial photography viewed on the Auckland GIS viewer and from the Retrolens website indicates the current dwelling located near the northern tip of 98-100 Totara Road was constructed between 1988 and 1996. The two dwellings located adjacent to the south western and southern boundaries of 102 Totara Road were constructed circa 1968 and 1996, respectively.

The historic photos show an area in the east of the site was used to grow a plantation of trees from around 1950 to around 1980. Other large single trees are visible in the historic photos over time that are no longer present.

Our review of the publicly available historic aerial photos found no signs of major slope instability.

3 PROPOSED DEVELOPMENT

The current development proposal, as shown on the draft scheme plan provided by Neil Construction Limited (***Appendix B***), is to form 346 residential lots and one large lot designated for a future school with associated access roading extending from Totara Road and McCaw Avenue.

Two stormwater detention basins, SW Basin A and B, will be formed to attenuate peak stormwater flows from the development. SW Basin A will be located half-way along the western boundary, and SW Basin B will be located near the northern tip. Stormwater flows from basins A and B will be released into the neighbouring Ratara Stream Tributary and Rarawaru Creek, respectively. The stormwater pond batters will be formed at 1:4 (vertical to horizontal) gradients to ensure long-term stability and relatively minor maintenance following construction.

As shown on the attached Earthworks Cut Fill Contours plan provided by Neil Construction (Dwg No: 4520-01-EW-205 rev A), maximum cut/ fill earthworks of up to 3m deep is proposed to achieve the required grades and levels for the proposed development. The proposed earthworks aim to ease and smooth the topography by filling in depressions and cutting locally elevated areas. Filling will be concentrated near the gully areas in the eastern portions, and across the low-lying areas in the central and western portions, whilst majority of the cuts are proposed in the southern portions. Several retaining walls have been proposed to support the proposed development.

4 INVESTIGATION SCOPE

4.1 Desktop Study

As part of this geotechnical assessment, CMW completed a desktop review of available geotechnical information pertaining to this site. The following information was reviewed as part of our desktop study:

- Published geological map[1]
- New Zealand Geotechnical Database;
- Topographical information available from Auckland Council GIS database;
- Aerial imagery (current and historic) available from Auckland Council GIS database;
- Currently proposed scheme plans provided by Neil Construction Ltd;
- Preliminary geotechnical Investigation Reports for 98-100 Totara Road (Ref: AKL2018-0085AB Rev. 0, dated 18 May 2018), and 102 Totara Road (Ref: AKL2019-0136AB Rev. 0) prepared by CMW Geosciences.

4.2 Field Investigation

Recent field investigations were carried out between 14 October 2022 and 15 October 2022. All fieldwork was carried out under the direction of CMW Geosciences in general accordance with the NZGS specifications[2] and logged in accordance with NZGS guidance[3]. The scope of fieldwork completed was as follows:

- Undertook a walkover survey of the site to assess the general landform and site conditions;
- Twenty-five hand auger boreholes, denoted HA01-22 to HA25-22, were drilled using a 50mm diameter auger to target depths of between 4.0m and 5.0m below existing ground levels to visually observe the near surface soil profile and to facilitate in-situ permeability / vane shear strength testing. HA09-22, HA11-22, HA13-22, HA19-22, HA20-22, HA21-22, and HA25-22 were terminated between 1.5m and 3.7m depth due to refusal. Engineering logs of the hand auger boreholes, together with peak and remoulded vane shear strengths are presented in ***Appendix C.***
- Dynamic cone (Scala) penetrometer (DCP) tests were carried out within auger boreholes that were refused early to a maximum depth of 2m below the base of the borehole to provide soil density profiles and investigate interface with rock material. Graphical results of the DCP testing are presented on respective borehole logs in ***Appendix C.***
- In-situ falling head permeability tests were completed in the open boreholes in locations labelled SS01-22 and SS02-22 at depths of 1.5m. The results of the permeability tests are presented in ***Appendix D***.

The approximate locations of the respective investigation sites referred to above are shown on the Site Plan (***Drawing 01***). Test locations were measured using a hand-held GPS device.

4.3 Laboratory Testing

Laboratory testing was carried out generally in accordance with the requirements of NZS4402[4] (where applicable). Two soil samples were taken from site (HA04-18 and HA11-18) during our 2018 investigation.

[1] Edbrooke, S. W. (compiler) 2001: Geology of the Auckland area. Institute of Geological & Nuclear Sciences 1:250 000 geological map 3. 1 sheet +74 p. Lower Hutt, New Zealand. Institute of Geological & Nuclear Sciences.

[2] NZ Geotechnical Society (2017) NZ Ground Investigation Specification, Volume 1 – Master Specification

[3] NZ Geotechnical Society (2005), Field Description of Soil and Rock, Guideline for the field classification and description of soil and rock for engineering purposes.

[4] New Zealand Standard NZS4402 (1986), Methods of testing soils for civil engineering purposes.

Both these samples were collected near ground surface (between 0.4m and 0.8m depth) and sent to a IANZ accredited soil testing laboratory to determine the expansiveness of the soils (test 2.2 and 2.6).

Results from the expansive soil testing are appended (***Appendix E***) and discussed below. Further expansive soil testing will be carried out on site following site development earthworks to assist with geotechnical completion reporting (GCR).

5 GROUND MODEL

5.1 Published Geology

Published geological maps[5] for the area depict the regional geology as comprising Late Pliocene to Mid Pleistocene alluvial deposits of the Puketoka Formation as illustrated in below.

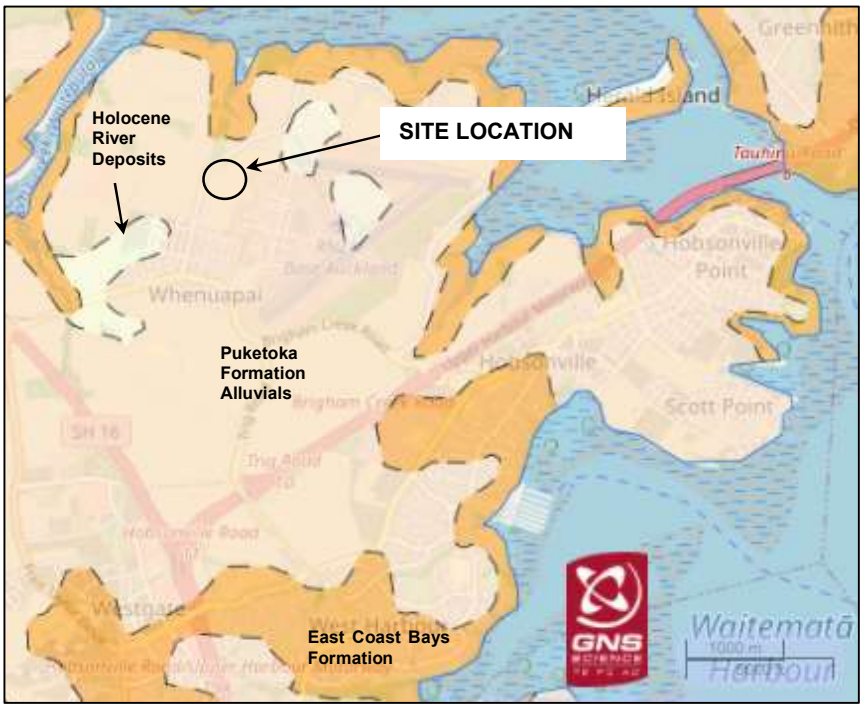


Figure 2: Regional Geology (GNS Science – Geology Web Map 1:250 000)

These alluvial deposits predominantly consist of inorganic clays and silts with occasional inclusions of sand and gravel with muddy peat and lignite, rhyolitic pumice (including non-welded ignimbrite, tephra and alluvial pumice deposits) and massive micaceous sand beds. Below these upper soil layers, the deeper geological formation is reported to comprise, interbedded muddy sandstones and siltstones of the East Cast Bays Formation within the Waitemata Group.

The main geotechnical hazards likely to be encountered within Puketoka Formation are low bearing capacity and settlement of soft/organic soils.

5.2 Stratigraphic Units

The ground conditions encountered and inferred from the investigation were considered to be generally consistent with the published geology for the area and our previous site investigations. These can be generalised according to the following subsurface sequences.

The distribution of the various units encountered is presented in the appended Geological Sections on ***Drawings 03 and 04***.

[5] Edbrooke, S. W. (compiler) 2001: Geology of the Auckland area. Institute of Geological & Nuclear Sciences 1:250 000 geological map 3. 1 sheet +74 p. Lower Hutt, New Zealand. Institute of Geological & Nuclear Sciences.

5.2.1 Topsoil / Fill

Topsoil generally consisting of dark brown silt was encountered in majority of the hand augers up to 400mm depth.

Isolated lenses of uncontrolled fill were encountered in HA04-22, HA05-22, and HA19-22 to a depth of up to 600mm below ground level.

5.2.2 Puketoka Formation

Residually weathered Puketoka Formation soils were encountered underlying the topsoil and fill in all boreholes across the site and comprised brown to grey streaked orange, stiff to very stiff clays, from 0.2m up to approximately 4.8m depth, overlying grey stiff to hard silt and silty to sandy clays from 0.9m to 5.0m depth.

Thin lenses of organic silt were found to be embedded within these soils in discrete locations across the site.

5.2.3 Recent Alluvium

Recent alluvial deposits comprising, brown and grey, low plasticity silt with minor organic inclusions were encountered in HA11-22 to 1.2m depth below ground surface.

5.2.4 Waitemata Group Transition Zone

Transitional Waitemata Group materials were encountered in several hand augers at depths from approximately 3m to 5m below ground surface, and typically comprised completely to highly weathered ECBF sandstone and mudstone deposits. These deposits were generally recovered as hard and saturated soils.

5.3 Groundwater

Standing groundwater was encountered in several hand auger boreholes drilled during the past and most recent site investigations. Groundwater levels were generally recorded between 0.7m and 4.0m depth below the existing ground level. A summary of the groundwater levels encountered across the site during our most recent site investigation undertaken on 14 October 2022 is presented in Table 1 below.

Table 1: Summary of Groundwater Levels across site

Borehole ID	Groundwater Depth (m bgl)	Borehole ID	Groundwater Depth (m bgl)
HA01-22	4.0	HA15-22	2.9
HA02-22	3.5	HA16-22	1.5
HA03-22	2.5	HA17-22	0.9
HA04-22	3.3	HA18-22	3.2
HA05-22	2.5	HA19-22	1.6
HA07-22	2.9	HA20-22	1.4
HA08-22	2.0	HA21-22	1.5
HA10-22	1.6	HA22-22	2.2
HA11-22	0.7	HA23-22	3.9

HA12-22	2.1	HA24-22	2.8
HA14-22	1.1		

It should be appreciated that the groundwater levels measured during the site investigations may not be representative of the worst-case groundwater conditions given the time of the year these investigations were undertaken. The actual worst-case groundwater levels may be higher following times of heavy or prolonged rainfall and/ or wetter winter conditions.

6 GEOHAZARDS ASSESSMENT

6.1 Context

Section 106 of the Resource Management Act[6] (RMA) requires an assessment of the risk from natural hazards to be carried out when considering the granting of a subdivision consent. S106 RMA specifically states that the assessment must consider the combined effect of the natural hazard likelihood and material damage to land or structures (consequence).

The following sections of this report provide an assessment of the geohazards relevant to this site and provide the basis for the Natural Hazards Risk Assessment presented in ***Appendix G***.

6.2 Seismicity

A seismic assessment has been carried out in general accordance with NZGS guidance[7] to calculate the peak horizontal ground acceleration or PGA (a_{max}) as follows:

$$a_{max} = C_{0,1000} \frac{R}{1.3} x\ f\ x\ g$$

Where: $C_{0,1000}$ = unweighted PGA coefficient (for subsoil class C)

R = return period factor given in NZS1170.5, Table 3.5 (for importance level IL2)

f = site response factor subject to subsoil class (for subsoil class C)

g = acceleration due to gravity

The ULS PGA was calculated based on a 50-year design life in accordance with the New Zealand Building Code[8] and importance level (IL) 2 structures. The PGA for the serviceability limit state (SLS) and ultimate limit state (ULS) earthquake scenarios is as follows:

Table 2: Design Peak Ground Acceleration (PGA) for Various Limit States

Limit State	AEP	R	PGA(g)	$Magnitude_{eff}$
SLS	1/25	0.25	0.04	5.9
ULS	1/500	1.0	0.19	6.5
ACCOPS	1/150	0.58	0.10	5.75

Note: SLS = serviceability limit state; ULS = ultimate limit state; ACCOPS = Auckland Council seismic stability case[9], AEP = annual exceedance probability

6.3 Fault Rupture

The site is located in a low seismicity region with the nearest active fault (Wairoa North Fault) located approximately 42 kilometres south-east of the site. The updated National Seismic Hazard Model (NZSM) estimates up to 4% chance of damage resulting from fault rupture to sites in Auckland located up to a distance of 40 kilometres from the source. We therefore consider fault rupture to be low risk.

[6] Resource Management Act (1991), as at 29 October 2019

[7] NZ Geotechnical Society publication "Earthquake geotechnical engineering practice, Module 1: Overview of the standards", (March 2016)

[8] Ministry of Business, Innovation and Employment (1992) NZ Building Code Handbook, Third Edition, Amendment 13 (effective from 14 February 2014)

[9] Auckland Council Code of Practice for Land Development and Subdivision, version 1.6, 24 September 2013, Table 2.C.1

6.4 Liquefaction and Lateral Spreading

In accordance with NZGS guidance[10] the liquefaction susceptibility of the soils at this site has been considered with respect to geological age, soil fabric and soil consistency / density.

The vast majority of case history data compiled in empirical charts for liquefaction evaluation come from Holocene deposits or man-made fills[11,12]. Pleistocene aged alluvium (>12,000 years) is also considered to have a very low to low risk of liquefaction[11].

Soils are also classified with respect to their grain size and plasticity to assess liquefaction susceptibility. Based on more recent case histories, there is general agreement that sands, non-plastic silts, gravels and their mixtures form soils that are susceptible to liquefaction. Clays, although they may significantly soften under cyclic loading, do not exhibit liquefaction features, and therefore are not considered liquefiable.

Given the majority of soils across the site are >12,000 years old and are plastic, we consider the liquefaction (and lateral spreading) susceptibility of the site is '**low**'.

In addition, the liquefaction vulnerability assessment (Level A Basic Assessment) present on the Auckland Council Geomaps shows the liquefaction potential for this site to be unlikely.

6.5 Slope Stability

6.5.1 Design Criteria

The stability of cut batters and fill embankments under a range of design conditions is expressed in terms of a factor of safety, which is defined as the ratio of forces resisting failure to the forces causing failure. The following performance standards are recommended for slope stability assessment:

Table 3: Slope Stability Factor of Safety Criteria

Condition	Required Factor of Safety
Normal Groundwater Condition	1.5
Extreme (worst credible) groundwater condition	1.3
Seismic condition with 1/500 yr event	1.0
Rapid Drawdown	1.2

6.5.2 Slope Stability Analyses

Slope stability analyses has been undertaken for Section E-E' and F-F' shown on the Neil Construction Drawings (Ref: 4520-01-EW-200, Rev A). These sections have been selected for the following reasons:

- **Section E-E'**: A 4.5m high fill embankment is proposed to be formed across the gully located in the eastern portion of the site to provide vehicle access to the lots adjacent to the eastern boundary. This embankment will be formed with approximately 1V:1H batters and may be susceptible to slope instability under rapid drawdown conditions.
- **Section F-F':** The existing ground profile near the eastern boundary falls into the stream further east at approximately 1V:3H grade. Fill up to 1m high is proposed on the crest of these slopes (battered at 1V:2H grade) and will induce a surcharge load on the slopes.

[10] Earthquake Geotechnical Engineering Practice, Module 3: Identification, assessment and mitigation of liquefaction hazards", (May 2016)

[11] Seed, H.B. and Idriss, I.M. (1971) *A simplified procedure for evaluating soil liquefaction potential*, Earthquake Engineering Research Centre, Report No. EERC 70-9, University of California

[12] Youd, T.L. and Perkins, D.M. (1978) Mapping liquefaction-induced ground failure potential, *Journal of the Geotechnical Engineering Division,* ASCE, Vol. 104, No. GT4, Proc Paper 13659, p. 433-446

Slope stability analyses have not been undertaken for the stormwater ponds as they will be constructed at or flatter than 1V:4H gradient.

Slope stability analyses were undertaken using the Morgenstern-Price method of slices under both circular and translational failure mechanisms using the proprietary software Slide2. Stability analyses were completed using an assumed groundwater table within 1 to 2m of the existing ground surface for elevated groundwater conditions and a deeper groundwater profile for the normal groundwater case, derived from the groundwater levels measured during the CMW site investigations.

Groundwater has been assumed to generally remain below the proposed engineered fill under elevated groundwater conditions due to the construction of underfill drainage beneath these fills, except for Section E-E' where groundwater is assumed to extend into the engineered fill to investigate rapid drawdown conditions, as discussed below.

Seismic loads were calculated in accordance with the New Zealand Transport Agency (NZTA) Bridge Manual and MBIE Earthquake Geotechnical Engineering Practice Guidelines (Module 6). An Ultimate Limit State design earthquake return period of 500 years has been assumed in the assessment. A peak ground acceleration (PGA) value of 0.19g has been assumed for the stability analyses.

Our analyses have assumed that the proposed access road, and dwellings will induce a surcharge load of 12kPa and 10kPa, respectively. Elsewhere, an allowance of 5kPa surcharge load has been adopted across the proposed development.

Slope stability outputs are attached in ***Appendix F*** with a brief summary of analyses results presented in Table 4. The results from our slope stability analyses have been compared with the minimum factor of safety criteria for each scenario, as outlined in Table 3 above.

Table 4: Slope Stability Analyses Results

Location	Slope Stability Factor of Safety		
	Prevailing	Transient	Seismic
Stability Section E-E'	1.4	2.0	3.9
Stability Section F-F'	1.5	1.2	2.4

Results show that for the proposed landform and ground model described above, inadequate slope stability factors of safety are achieved for normal and elevated groundwater cases and will require the implementation of specific remedial earthworks, as described in Section 7 below.

In addition, the stability of the proposed fill embankment (Cross Section E-E') has also been assessed under the following drawdown conditions. Initial groundwater level for the rapid drawdown analysis is assumed to be located at approximately 1.2m below the crest of the fill embankment (e.g., elevated groundwater case).

Case 1 – Partial Drawdown. This case assumes a partial drawdown of groundwater to 2.6m below the fill crest (1.4m below initial groundwater level) on the left side of fill embankment. During drawdown, the left embankment slope is assumed to be fully saturated to approximately 1.2m depth below the fill crest.

Case 2 – Full Drawdown. This case assumes a full groundwater drawdown (to existing channel invert level) on the left side of the fill embankment. During drawdown, the left embankment slope is assumed to be fully saturated to approximately 1.2m depth below the fill crest.

Slope stability outputs for the rapid drawdown cases are attached in ***Appendix F*** with a brief summary of analyses results presented in Table 5.

Table 5: Slope Stability Analyses Results – Rapid Drawdown

Section E-E' Case	Slope Stability Factor of Safety
Partial Drawdown	1.00

Table 5: Slope Stability Analyses Results – Rapid Drawdown	
Section E-E' Case	**Slope Stability Factor of Safety**
Full Drawdown	0.79

Based on the above results, the required FoS will not be achieved during partial and full drawdown and will require the implementation of specific slope improvement, as described in Section 7 below.

6.6 Load Induced Settlement

The residual Puketoka soils encountered on site generally conform to the definition of 'good ground' provided in NZS 3604 and should be able to sufficiently withstand up to 300kPa ultimate bearing pressures from shallow foundations and roads without undergoing settlement. Notwithstanding this, the presence of localised soft spots and pockets of compressible alluvial soils embedded within the residual soils can affect the overall mechanics of the bearing soils and introduce the risk of differential settlement within structures. The presence of such materials should be confirmed during construction and where possible excavated and replaced with engineered fill. Alternatively, where proposed roads and structures are expected to span over these materials (located at depth), remediation in the form of specifically designed foundation systems and/ or ground improvement techniques (e.g., lime stabilisation of surface soils) may be utilised.

The settlement potential for the proposed school development has not been assessed and will be subject to specific investigation and design for the structures.

6.7 Pumice Soil Exposure

Trace pumiceous silts were observed in some boreholes and can be commonly associated with other soft and sensitive soils.

Depending on the final development plans, undercutting portions of soft and sensitive soils may be required. The majority of this undercut material can generally be suitable for use as engineered fill once conditioned and blended with more plastic soils (clays).

6.8 Expansive Soils

Seasonal shrinking and swelling results in vertical surface ground movement which can cause significant cracking of floor slabs and walls. There have been instances of concrete floors and/ or foundations that have been poured on dry, desiccated subgrades in summer months on expansive soils and have undergone heaving and cracking requiring extensive repairs or re-building once the soil moisture contents have returned to higher levels. This hazard is addressed by a combination of careful foundation design and site preparation.

NZS 3604:2011[13] excludes from the definition of 'good ground', soils with a liquid limit of more than 50% and a linear shrinkage of more than 15% due to their potential to shrink and swell as a result of seasonal fluctuations in water content. For soils exceeding these limits, NZS 3604 has historically referenced AS 2870[14]. for foundation design advice. However, the November 2019 update of Acceptable Solution B1/AS1[15] provides amendments to NZS 3604 that define a method for testing and classifying the soils and provides foundation designs for specific, simple house configurations across the range of expansive soil conditions.

[13] Standards New Zealand (2011) Timber-framed buildings, NZS 3604:2011, NZ Standard

[14] Standards Australia Limited (2011) *Residential slabs and footings*, AS 2870-2011, Australian Standard, NSW

[15] Ministry of Business, Innovation and Employment (2019) *Acceptable Solutions and Verification Methods for NZ Building Code Clause B1 Structure,* B1/AS1, Amendment 19

Nevertheless, there is evidence[16] indicating that the use of the B1/AS1 method of assessment of expansiveness may be inaccurate. Accordingly, our assessments herein have been made in line with our experience, BRANZ Report SR120A[17] and AS2870.

The soil samples collected from the site were tested in a laboratory for linear shrinkage, natural water content, and cone penetration limit (the latter two tests can be correlated to the liquid limit of the soil) and have been used for the classification of the expansive soil class in addition to the visual-tactile method. The laboratory test results are attached in ***Appendix F***, and classification of expansive site class is provided in Section 8**.**

6.9 Groundwater Impact Assessment

An assessment has been made of the impact of the proposed works on groundwater conditions in accordance with the requirements of Section E7 of the Auckland Unitary Plan (AuP).[18] The assessment has considered the impacts of the proposals for taking, using, damming / diversion and drilling activities and the results are contained in the table presented in ***Appendix H***.

Our assessment has indicated that diversion of groundwater caused by the excavation of stormwater ponds will comply with the permitted activities listed under E7.6.1.10.

[16] Rogers, N., McDougall, N., Twose, G., Teal, J. & Smith, T. (2020) The Shrink Swell Test: A Critical Analysis, *NZ Geomechanics News,* Issue 99, pages 66-80.
[17] Fraser Thomas Limited (2008) - Addendum Study Report (BRANZ SR120A), Soil Expansivity in the Auckland Region – Final Report
[18] Auckland Unitary Plan Operative in Part (Updated 12 June 2020)

7 GEOTECHNICAL RECOMMENDATIONS

7.1 Seismic Site Subsoil Category

Based on those ground conditions observed during our site investigations, combined with experience working in the surrounding area, the seismic site subsoil category is assessed as being Class C (shallow soil site) in accordance with NZS1170.5.

7.2 Slope Stability Management

Results of the slope stability analyses discussed in Section 6.5 above demonstrate that design landform gradients through the proposed development will not achieve the requisite slope stability factors of safety.

Slope stability improvement works required to enhance the global stability of the proposed earthworks are discussed below:

Section E-E' - Fill Embankment (Road 9)

The approximately 1V:1H embankment slopes should be constructed as Reinforced Earth (RE) slopes with 6m long Tensar RE580 geogrid reinforcements (or equivalent alternative) installed at 0.7m centre spacings along the height of the embankment. The topmost geogrid layer should be installed at a minimum of 1.2m depth below the crest of the embankment to facilitate the installation of services. Secondary geogrid reinforcements (Tensar SS20) should be utilised in between the primary geogrids to minimise the risk of creep. These secondary grids should be a minimum of 2.0m long. Facing detail for the RE slopes should consist of pinned Geoweb (or approved equivalent) with topsoil infilling.

The proposed fill embankment should be installed on stiff, virgin ground following mucking-out of any softer/ weaker soils encountered in the gully. A layer of geogrid reinforcement should also be installed at the interface of the fill and natural ground.

Section F-F' – 1V:2H Fill Slope below Road 9 Cul-de-Sac

Based on our stability analysis results, the critical failure mechanism through Section F-F' is characterised by a failure plane extending into the natural ground due to the slope being 1V:2H. In order to intercept the potential failure plane and minimise the risk of global instability failure and ongoing creep movement, it is proposed to carry out a stability undercut of the natural ground and install 4.0m long RE580 geogrid reinforcement at 1.0m centre spacings along the height of the embankment. As above, the proposed fill slopes should be faced with Geoweb (or approved equivalent), and secondary geogrid reinforcements should be utilised in between the primary geogrids to minimise the risk of creep. These grids should be a minimum of 2.0m long (SS20).

Geogrids should be installed to the manufacturer's specifications under the supervision of a Geotechnical Engineer.

Re-assessment of slope stability for Sections E-E' and F-F' has been undertaken assuming the slope stability enhancement works discussed above. Results of these analyses are presented in Table 6 below and show adequate FoS being available for the previously marginally stable sections under normal and elevated groundwater cases.

Table 6: Slope Stability Analyses Results – Post Remedial Works

Remedial Works	Slope Stability Factor of Safety		
	Prevailing	Transient	Seismic
Geological Section E-E'	2.0	2.5	3.8
Geological Section F-F'	1.7	1.30	2.6

Slope stability has also been re-assessed for the partial and full rapid drawdown cases (Section E-E') and show that adequate FoS should be available following the incorporation of the proposed ground improvement works discussed above, as shown in Table 7 below.

Table 7: Slope Stability Analyses Results – Rapid Drawdown (Post-Remediation)	
Section E-E' Case	**Slope Stability Factor of Safety**
Partial Drawdown	1.5
Full Drawdown	1.2

7.3 Earthworks

7.3.1 General

All earthwork activities must be carried out in general accordance with the requirements of NZS 4431[19] and the requirements of the Auckland Council Infrastructure Development Code under the guidance of a Chartered Professional Geotechnical Engineer.

The earthworks proposals shown in the supplied drawings involve cuts and fills up to 3m deep to achieve the site development levels. The earthworks required to complete this development will largely be able to be completed with standard earthworks machinery and processes. Regular inspection and testing of fill placement will be required.

A Geotechnical Works Specification is provided as ***Appendix I***. Between them, these documents provide the requirements for site preparation, fill placement, subsoil drainage, compaction requirements, quality assurance testing and as-built requirements.

Those requirements are summarised below.

7.3.2 Subgrade Preparation

Preparation of the firm to stiff subgrade beneath the proposed fill areas should comprise stripping of all vegetation, topsoil, any pre-existing fill materials followed by benching of the exposed subgrade where natural slopes beneath the fill exceed gradients of nominally 1:5 (vertical to horizontal). The subgrade should then be scarified, and moisture conditioned where necessary, and proof rolled in the presence of a CMW geotechnical engineer or engineering geologist to verify the subgrade stiffness and consistency.

Where any particularly weak materials are encountered that weave excessively during the proof rolling process, they should be undercut and removed prior to placing engineered fill.

7.3.3 Underfill Drainage

Underfill drainage may be recommended by the geotechnical engineer during earthworks to allow for the continued release of groundwater seepages. If recommended, this should consist of perforated novacoils encapsulated in a filter sock and surrounded in appropriate drainage media, such as TNZ F2.

Underfill drainage location will be confirmed by the geotechnical engineer on site during earthworks.

7.4 Civil Works

7.4.1 Subgrade CBR

The subdivision roading is shown as being constructed in a combination of both cut and fill areas. Typical CBR values of between 5% and 6% should be available in fills. In areas of cut natural ground, CBR values as low as 2% or 3% are likely.

As described for the fills, subgrade improvement with lime (if desired) is expected to provide better results than the use of cement due to the clayey nature of the soils.

[19] Standards New Zealand (1989) Code of practice for earth fill for residential development, incorporating Amendment No. 1, NZS 4431:1989, NZ Standard

7.4.2 Service Trenches

All of the materials to be exposed during the excavation of service trenches should be readily removed using an excavator.

Trench collapse is expected to pose problems in areas wherever excavations extend below the water table and here, trench support is likely to be required. Temporary dewatering, in the form of regularly spaced sump pumps or well point dewatering spears may also be required.

Services trenches excavated along contour in areas of steep ground may need to be backfilled with engineered filling and if in natural ground, may require a drain coil in the base of the trench connected to the stormwater system. Identification of critical service lines must be made once drawings are available.

At the completion of the development, Specific Design Zones for services will be applied in the Geotechnical Completion Report to protect future foundations from settlement from poorly compacted trench backfill and to prevent new loads crushing service pipes. This is a restriction on building foundations within the 45 degree zone of influence from pipe inverts as depicted in Auckland Council's drawing SW22 from their Code of Practice for Land Development and Subdivision.

7.4.3 Retaining Walls

Design parameters for permanent and temporary retaining walls are summarised in Table 8.

Table 8: Retaining Wall Design Parameters

Soil Unit	Ɣ (kN/m^3)	Ø' (deg)	Effective Cohesion c' (kPa)	Undrained shear strength Su (kPa)	E' (MPa)
Puketoka Formation Soils	18	3	28	80	20,000
Waitemata Group Soils	18	5	32	120	35,000
Engineered Fill	18	5	30	120	35,000

Notes:

1. Refer to Section 5.2 for definition of soil units
2. Ɣ – soil unit weight; Ø' - angle of internal soil friction; E' – long term Young's modulus.
3. The above parameters are based on the condition of a horizontal ground surface behind the retaining structure. Applicable surcharge loads behind the wall must also be considered in the design.

It is noted that some ground movement will occur behind temporary or permanent retaining walls. By definition, movement of the wall must occur to fully mobilise the active and passive earth pressure coefficients. The extent of this movement is dependent on the height of retaining, type of wall selected and construction methodology. This must be considered during the design and construction of the retaining walls to ensure adjacent facilities are not adversely affected.

Retaining walls expected to support future roads and dwellings should be accordingly designed with appropriate surcharge load allowance.

At the completion of the development, **Specific Design Zones (retaining)** are expected to be applied in the Geotechnical Completion Report to protect retaining walls from future overloading at the crest or undermining at the toe that could lead to instability. These zones typically extend the same distance as the wall height and where they are present above a wall, require deepening of foundations unless the wall has been designed for future foundation loads. Where they are present below a wall, careful consideration needs to be given to location, depth, and timing of any future excavations.

7.4.4 Stormwater Soakage

We have undertaken 2 falling head percolation tests at the proposed stormwater reserve locations, as shown on the appended site plan. The soil units within the soakage test holes can be characterised as residually weathered Puketoka Formation soils, typically comprising clays and silts.

The falling head testing methodology is in accordance with the Auckland Council Technical Report 2013/040: Stormwater Disposal Via Soakage in the Auckland Region, dated October 2016.

Based on test data, we have estimated the percolation rates with the following methods:

- Ciria 113 Appendix 4, Control of Groundwater for Temporary Works
- Hvorslev Method based on wellpoint or hole extended into fully saturated uniform soil

The percolation rate estimates are summarised in Table 9 below.

Table 9: Percolation Rate Estimates

Location	Calculation Method	Percolation Rate	
		m/s	mm/hour
SS01-22	Ciria 113	3.78×10^{-5}	136.25
	Hvorslev	5.09×10^{-6}	18.33
SS02-22	Ciria 113	9.75×10^{-6}	35.00
	Hvorslev	1.49×10^{-6}	5.42

Note: CMW considers the CIRIA 113 value the most appropriate method for most purposes, but also provides the analysis method as outlined by Hvorslev if desired.

The use of rain gardens for storage capacity and water quality improvement is understood to be a requirement for this development.

7.4.5 Pond Liner

Based on a review of our borehole investigation data (specifically HA13-22 and HA17-22), we expect the natural soils encountered beneath the location of the proposed stormwater reserve areas to typically consist of less permeable clayey/ silty soils which should facililate adequate retention of stormwater.

Nevertheless, CMW should be given the opportunity to inspect the exposed pond areas during earthworks to confirm the presence of more permeable, sandy/ pumiceous soil layers. If such soils are encountered, they should be undercut and replaced with a less permeable clay fill liner constructed from the site won cut materials. The thickness of the pond liner (if required) will be confirmed by CMW during earthworks.

8 FOUNDATIONS

At the completion of the works, a Geotechnical Completion Report (GCR) will be prepared. The GCR will advise on anticipated foundation design parameters and any restrictions that require further engineering investigation and/ or design on individual lots to address any remaining natural hazards as described in Section 71(3) of the Building Act.

Restrictions that are expected to be applied in the GCR to protect the future buildings from natural hazards associated with retaining walls and drainage are outlined in the respective sections in this report.

On this site our provisional expectation is that provided earthworks are completed in accordance with the standards and recommendations described herein, the following will apply:

- A preliminary geotechnical ultimate bearing pressure of 300kPa should be available for shallow strip and pad foundations constructed within both the natural cut ground and engineered fill areas, subject to the short axis of those footings measuring no greater than 2.5m in plan.

  There may be areas where localised variations in shear strength within the natural cut ground occur, particularly where the depth of cut varies across the building platforms. Further confirmation of available bearing pressures will be addressed at the time of post earthworks soil testing.

- Specific testing for Expansive Site Class will be undertaken at the time of the GCR preparation for the development, preliminary laboratory testing indicates an AS2870 Site Class of M (moderate) in the natural ground with an anticipated characteristic surface movement of up to 40mm.

  Mitigation of the expansive soil hazard is undertaken by a combination of appropriate foundation design selection at Building Consent stage and appropriate moisture control within subgrade soils during construction. Foundation contractors must be aware of this issue and the need to maintain appropriate moisture contents in the footings and building platform subgrade between the time of excavation and pouring concrete.

  Remedial actions that may be appropriate include platform protection with a hard fill layer, pouring of a blinding layer of concrete in footing bases and soaking of the building platform with sprinklers for an extended period.

  Future owners must also be aware that the planting of high-water demand plants where their roots may extend close to footings can also cause settlement damage.

- As required by section B1/VM4[20] of the New Zealand Building Code Handbook, the following strength reduction factors must be applied to all recommended geotechnical ultimate soil capacities in conjunction with their use in factored design load cases:
  - 0.8 for load combinations involving earthquake overstrength;
  - 0.5 for all other load combinations.

[20] Ministry of Business, Innovation and Employment (2019) *Acceptable Solutions and Verification Methods for NZ Building Code Clause B1 Structure,* B1/VM4, Amendment 19

9 SAFETY IN DESIGN

Formation of the design landform will require incorporation of geotechnical works such as undercuts, temporary excavations, steep fill batters, and shallow subsoil drains as specified above.

There are no specific design risks associated with these works that require consideration of the Safety in Design (SiD) aspects. However, it is the contractor's responsibility to identify and cover construction related risks associated with these works in a more comprehensive manner (being the competent part in that respect). The CMW designs/ specifications for undercuts and drainage elements have been made so that no personnel are ever expected to enter unbattered or unprotected excavations to complete the construction. If at any stage a contractor does not consider that a design for excavations can be safely constructed, then CMW must be contacted immediately to discuss alternative design and/ or methods and avoid risk to personnel.

10 FURTHER WORK

The recommendations provided in this report are based on the supplied development plans appended to this report. If development plans change significantly from the current development proposal, the matter should be referred back to CMW or a Chartered Professional Geotechnical Engineer familiar with the contents of this report, who should be given the opportunity to review any changes against recommendations provided within this report.

11 CLOSURE

Additional important information regarding the use of your CMW report is provided in the '*Using your CMW Report*' document attached to this report.

This report has been prepared for use by Neil Construction Limited in relation to the Whenuapai Green development 98-102 Totara Road, Whenuapai project in accordance with the scope, proposed uses and limitations described in the report. Should you have further questions relating to the use of your report please do not hesitate to contact us.

Where a party other than Neil Construction Limited seeks to rely upon or otherwise use this report, the consent of CMW should be sought prior to any such use. CMW can then advise whether the report and its contents are suitable for the intended use by the other party.

USING YOUR CMW GEOTECHNICAL REPORT

Geotechnical reporting relies on interpretation of facts and collected information using experience, professional judgement, and opinion. As such it generally has a level of uncertainty attached to it, which is often far less exact than other engineering design disciplines. The notes below provide general advice on what can be reasonably expected from your report and the inherent limitations of a geotechnical report.

Preparation of your report

Your geotechnical report has been written for your use on your project. The contents of your report may not meet the needs of others who may have different objectives or requirements. The report has been prepared using generally accepted Geotechnical Engineering and Engineering Geology practices and procedures. The opinions and conclusions reached in your report are made in accordance with these accepted principles. Specific items of geotechnical or geological importance are highlighted in the report.

In producing your report, we have relied on the information which is referenced or summarised in the report. If further information becomes available or the nature of your project changes, then the findings in this report may no longer be appropriate. In such cases the report must be reviewed, and any necessary changes must be made by us.

Your geotechnical report is based on your project's requirements

Your geotechnical report has been developed based on your specific project requirements and only applies to the site in this report. Project requirements could include the type of works being undertaken; project locality, size and configuration; the location of any structures on or around the site; the presence of underground utilities; proposed design methodology; the duration or design life of the works; and construction method and/or sequencing.

The information or advice in your geotechnical report should not be applied to any other project given the intrinsic differences between different projects and site locations. Similarly geotechnical information, data and conclusions from other sites and projects may not be relevant or appropriate for your project.

Interpretation of geotechnical data

Site investigations identify subsurface conditions at discrete locations. Additional geotechnical information (e.g. literature and external data source review, laboratory testing etc) are interpreted by Geologists or Engineers to provide an opinion about a site specific ground models, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist due to the variability of geological environments. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. Interpretation of factual data can be influenced by design and/or construction methods. Where these methods change review of the interpretation in the report may be required.

Subsurface conditions can change

Subsurface conditions are created by natural processes and then can be altered anthropically or over time. For example, groundwater levels can vary with time or activities adjacent to your site, fill may be placed on a site, or the consistency of near surface conditions might be susceptible to seasonal changes. The report is based on conditions which existed at the time of investigation. It is important to confirm whether conditions may have changed, particularly when large periods of time have elapsed since the investigations were performed.

Interpretation and use by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical report. To help avoid misinterpretations, it is important to retain the assistance of CMW to work with other project design professionals who are affected by the contents of your report. CMW staff can explain the report implications to design professionals and then review design plans and specifications to see that they have correctly incorporated the findings of this report.

Your report's recommendations require confirmation during construction

Your report is based on site conditions as revealed through selective point sampling. Engineering judgement is then applied to assess how indicative of actual conditions throughout an area the point sampling might be. Any assumptions made cannot be substantiated until construction is complete. For this reason, you should retain geotechnical services throughout the construction stage, to identify variances from previous assumption, conduct additional tests if required and recommend solutions to problems encountered on site.

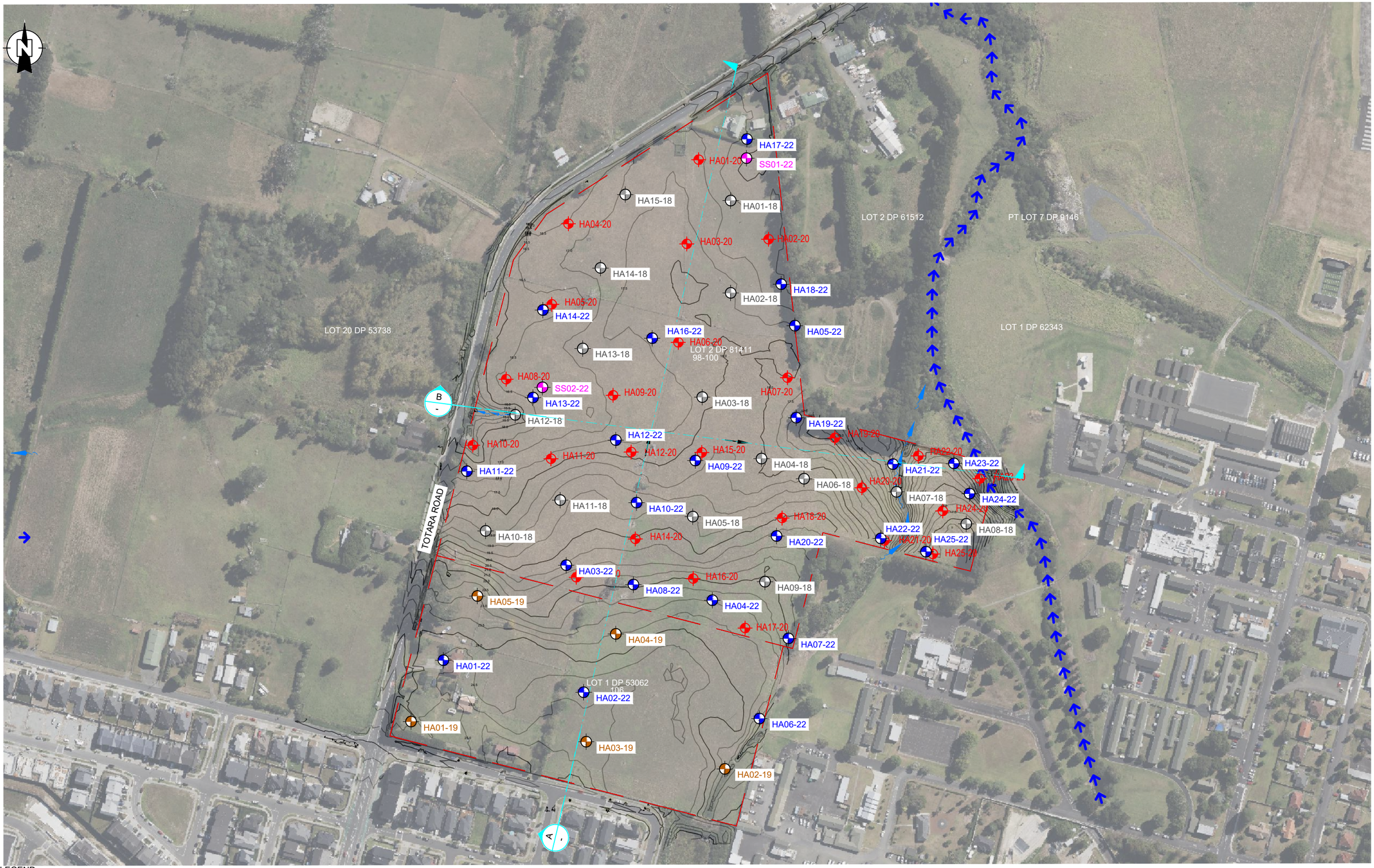
A Geotechnical Engineer, who is fully familiar with the site and the background information, can assess whether the report's recommendations remain valid and whether changes should be considered as the project develops. An unfamiliar party using this report increases the risk that the report will be misinterpreted.

Environmental Matters Are Not Covered

Unless specifically discussed in your report environmental matters are not covered by a CMW Geotechnical Report. Environmental matters might include the level of contaminants present of the site covered by this report, potential uses or treatment of contaminated materials or the disposal of contaminated materials. These matters can be complex and are often governed by specific legislation.

The personnel, equipment, and techniques used to perform an environmental study can differ significantly from those used in this report. For that reason, our report does not provide environmental recommendations. Unanticipated subsurface environmental problems can have large consequences for your site. If you have not obtained your own environmental information about the project site, ask your CMW contact about how to find environmental risk-management guidance.

Appendix A: Drawings



LEGEND:

HA01-22	HAND AUGER (HA) LOCATION
HA01-19	HAND AUGER (HA) LOCATION
HA01-18	HAND AUGER (HA) LOCATION
HA20-20	HAND AUGER (HA) LOCATION
SS01-22	SOAKAGE TEST LOCATION
	SITE BOUNDARY
	STREAM LINE
	OVERLAND FLOW

NOTES:

1. BASE PLAN ADAPTED FROM AUCKLAND COUNCIL'S GIS MAP.
2. EXISTING SURVEY DATA RECEIVED FROM NEIL CONSTRUCTION LIMITED.

1:3000 0 30 60 90 120 160 m

CMW Geosciences

CLIENT: NEIL CONSTRUCTION LIMITED		DRAWN: JS	PROJECT No: AKL2018-0085
PROJECT: 98-100 TOTARA ROAD, WHENUAPAI		CHECKED: HP	FIGURE: 02
		REVISION: 1	SCALE: 1:3000
TITLE: SITE INVESTIGATION PLAN		DATE: 07/11/2022	SHEET: A3

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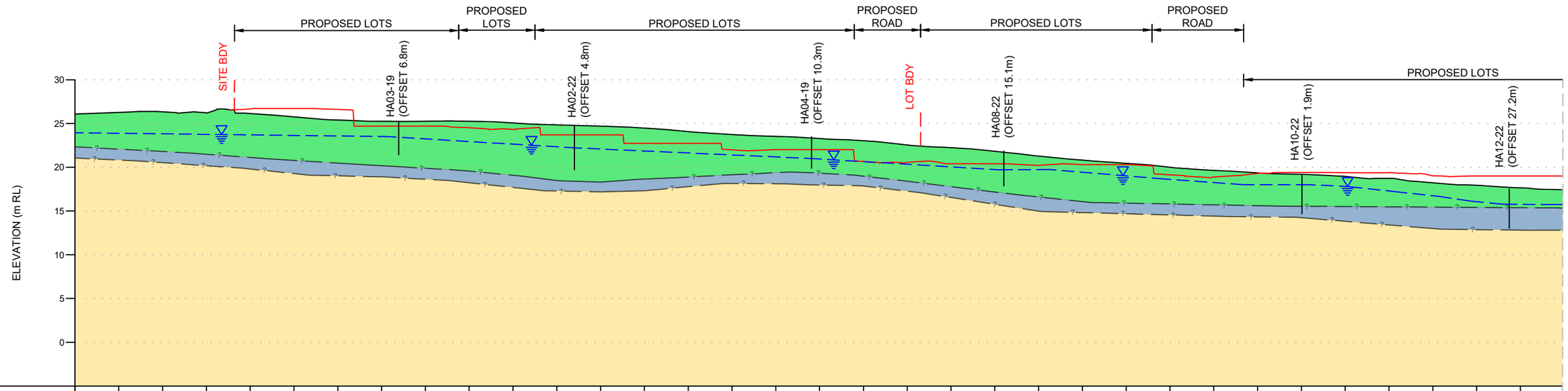
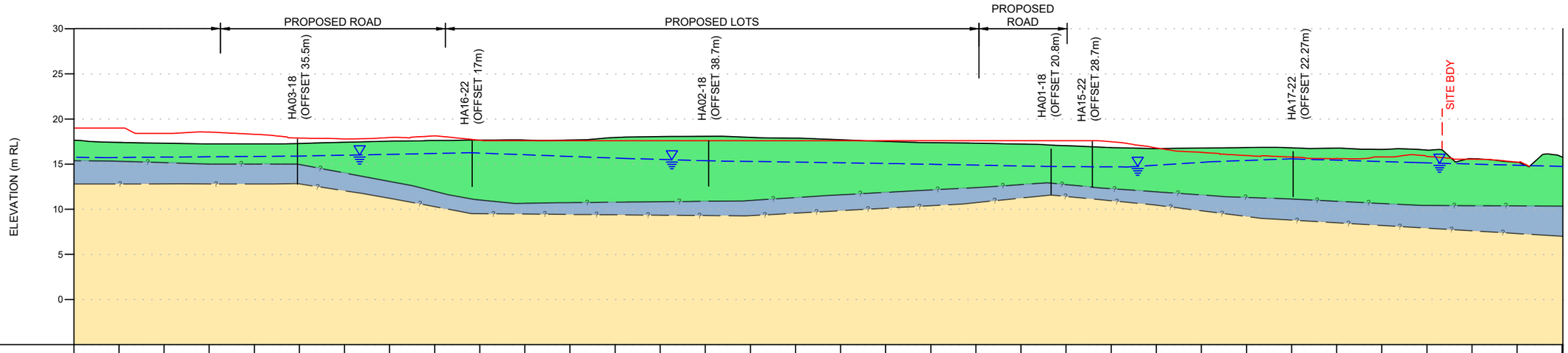


DISTANCE (m)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340
EXISTING GROUND (m RL)		26.32	26.20	26.13	25.76	25.40	25.25	25.25	25.25	25.05	24.84	24.69	24.47	24.08	23.74	23.53	23.28	23.03	22.56	22.23	21.83	21.28	20.81	20.44	20.00	19.64	19.36	19.20	18.96	18.74	18.23	17.94	17.64	17.42
DESIGN SURFACE (m RL)				26.67	26.70	26.60	24.70	24.70	24.51	24.33	23.70	23.70	22.74	22.74	21.99	22.00	22.00	20.66	20.57	20.40	20.40	20.22	20.31	20.30	19.13	18.89	19.30	19.40	19.38	19.39	19.02	19.00	19.00	19.00



DISTANCE (m)	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590	600	610	620	630	640	650	660
EXISTING GROUND (m RL)	17.42	17.33	17.25	17.25	17.30	17.42	17.55	17.63	17.66	17.67	17.68	17.95	18.05	18.08	17.97	17.88	17.70	17.52	17.39	17.33	17.23	17.05	16.84	16.73	16.80	16.84	16.82	16.78	16.64	16.57	15.61	15.21	
DESIGN SURFACE (m RL)	19.00	18.40	18.55	18.32	17.89	17.79	17.96	18.13	17.65	17.61	17.61	17.61	17.61	17.61	17.61	17.61	17.61	17.61	17.61	17.61	17.61	17.61	17.48	16.81	16.31	15.96	15.79	15.63	15.80	15.87	15.55	15.23	

LEGEND:

- EXISTING SURFACE
- DESIGN SURFACE
- STANDING GROUNDWATER LEVEL
- PUKETOKA FORMATION SOILS / ALLUVIUM
- WAITEMATA GROUP RESIDUAL SOILS
- WAITEMATA GROUP BEDROCK

1:500 — 0 5 10 15 20 25 m

1:1000 — 0 10 20 30 40 50 m

CMW Geosciences

CLIENT: NEIL CONSTRUCTION LIMITED	DRAWN: JS	PROJECT No: AKL2018-0085	
PROJECT: 98-100 TOTARA ROAD, WHENUAPAI	CHECKED: HP	FIGURE: 03	
	REVISION: 1	SCALE: H 1:1000 V 1:500	
TITLE: GEOLOGICAL SECTION-A	DATE: 07/12/2022	SHEET: A3	

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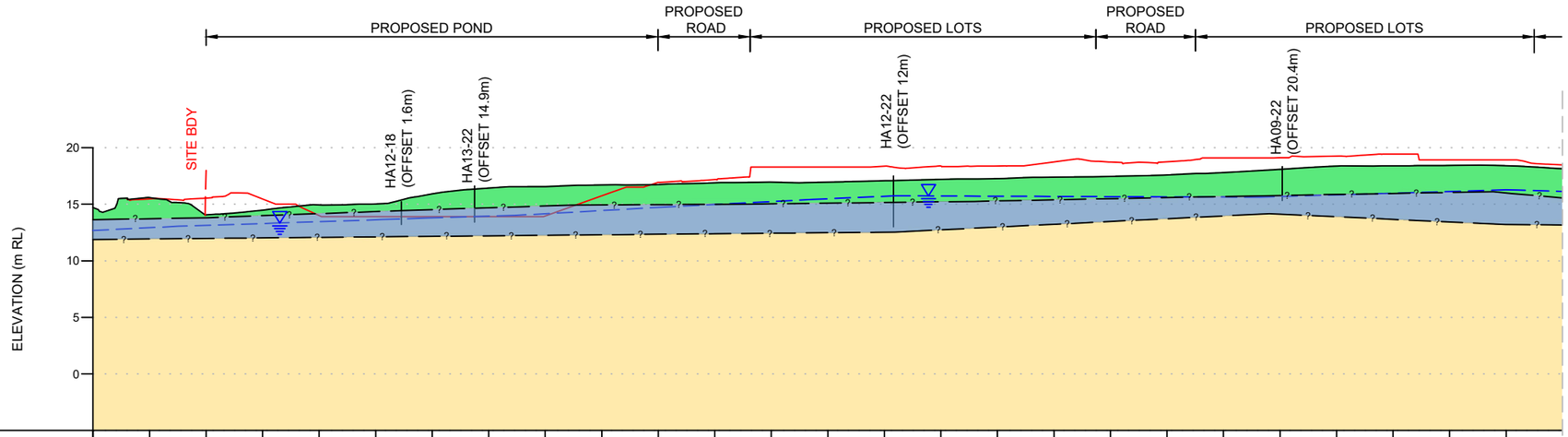
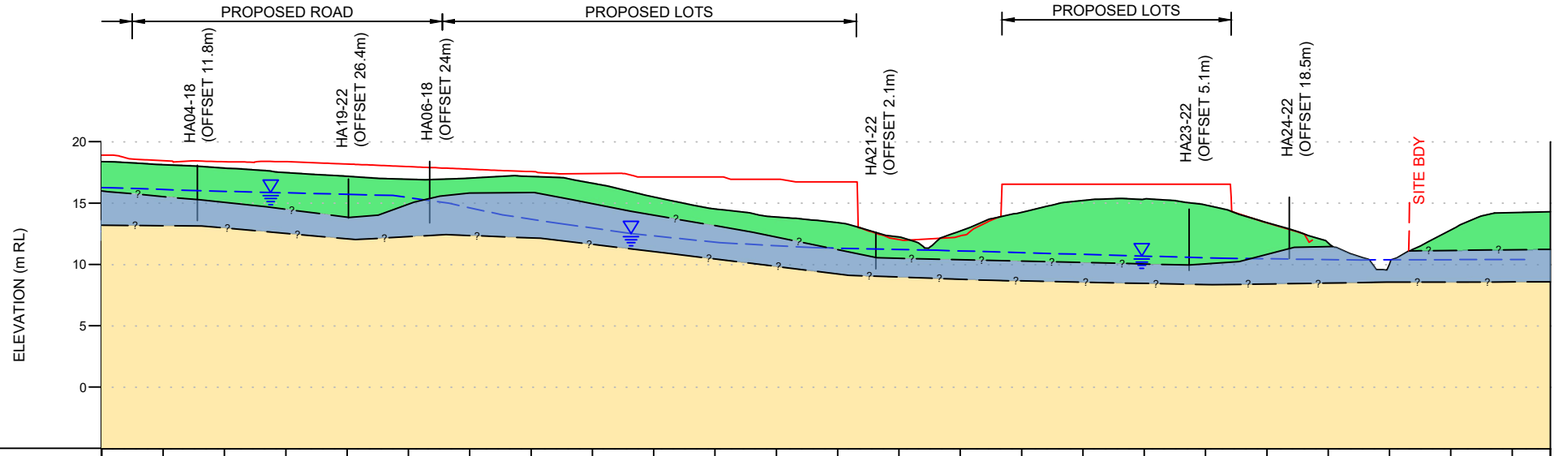


DISTANCE (m)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260
EXISTING GROUND (m RL)	15.58	14.05	14.48	14.94	15.03	15.92	16.43	16.56	16.70	16.75	16.90	16.95	16.95	17.08	17.20	17.27	17.39	17.46	17.59	17.79	18.08	18.38	18.39	18.43	18.40	18.15
DESIGN SURFACE (m RL)	15.58	14.05	14.48	14.94	15.03	15.92	16.43	16.56	16.70	16.75	16.90	16.95	16.95	17.08	17.20	17.27	17.39	17.46	17.59	17.79	18.08	18.38	18.39	18.43	18.40	18.15



DISTANCE (m)	260	270	280	290	300	310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	486
EXISTING GROUND (m RL)	18.15	17.87	17.50	17.20	16.95	17.04	17.19	16.64	15.51	14.53	13.88	13.43	12.25	12.74	14.26	15.22	15.35	14.86	13.42	11.77	10.02	12.83		
DESIGN SURFACE (m RL)	18.15	17.87	17.50	17.20	16.95	17.04	17.19	16.64	15.51	14.53	13.88	13.43	12.25	12.74	14.26	15.22	15.35	14.86	13.42	11.77	10.02	12.83		

LEGEND:

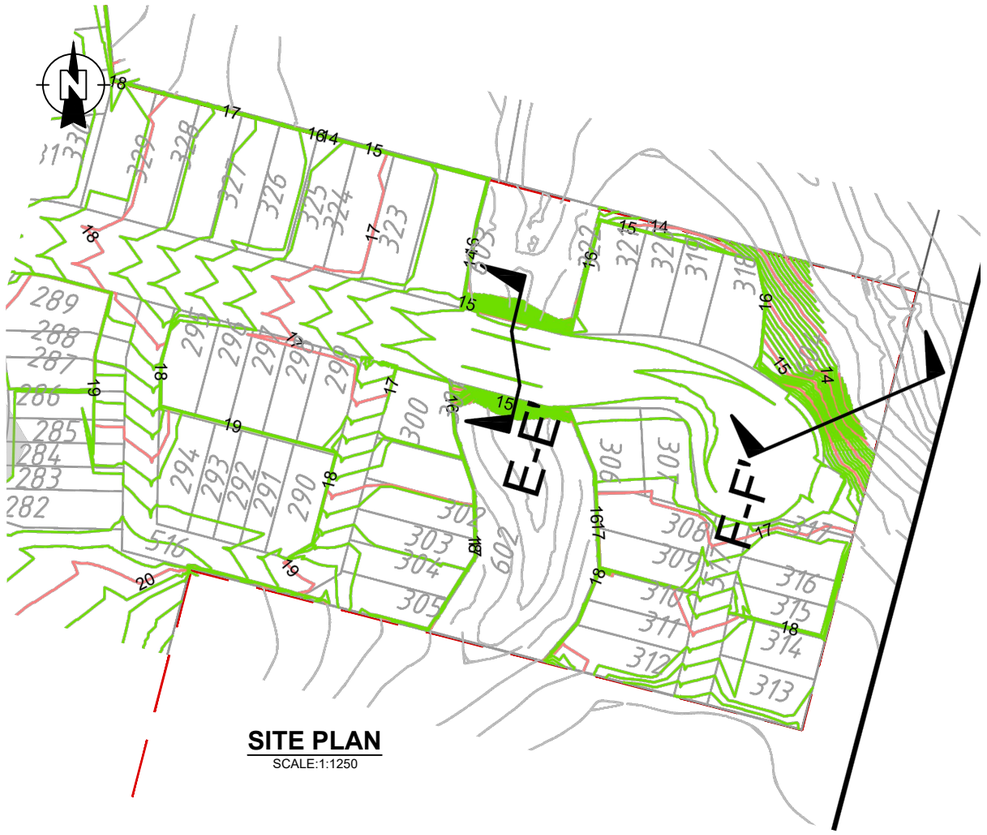
- EXISTING SURFACE
- DESIGN SURFACE
- STANDING GROUNDWATER LEVEL
- PUKETOKA FORMATION SOILS / ALLUVIUM
- WAITEMATA GROUP RESIDUAL SOILS
- WAITEMATA GROUP BEDROCK

1:1000 0 10 20 30 40 50 m

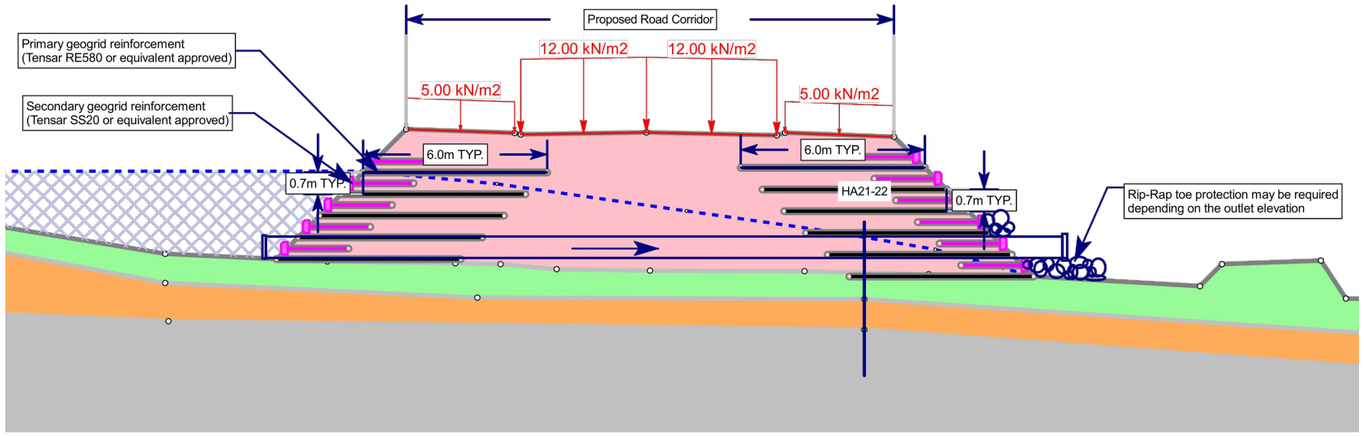
1:500 0 5 10 15 20 25 m

CMW Geosciences

CLIENT: NEIL CONSTRUCTION LIMITED		DRAWN: JS	PROJECT No: AKL2018-0085
PROJECT: 98-100 TOTARA ROAD, WHENUAPAI		CHECKED: HP	FIGURE: 04
		REVISION: 0	SCALE: H 1:1000 V 1:500
TITLE: GEOLOGICAL SECTION-B		DATE: 08/11/2022	SHEET: A3



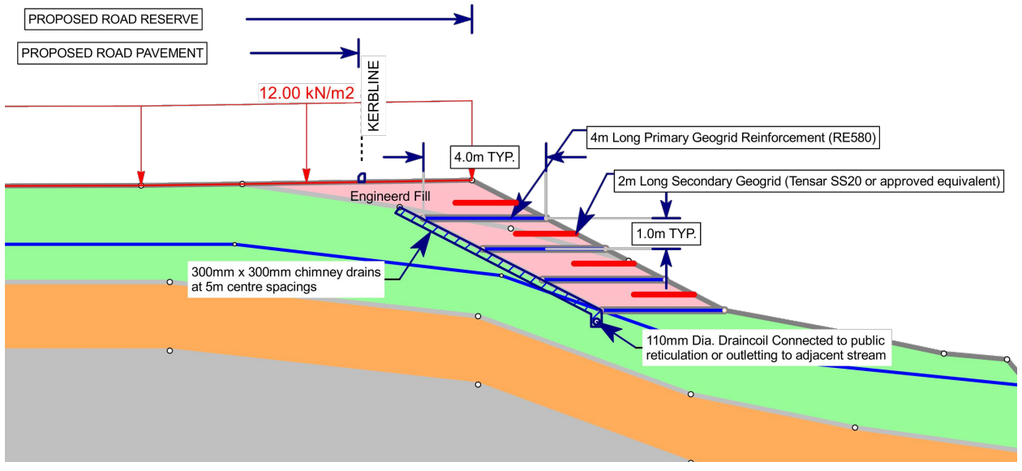
SITE PLAN
SCALE:1:1250



SECTION: E-E'
SCALE:1:200

GENERAL NOTES:

1. GEOGRID TO BE PLACED FLAT OR WITH 1% FALL TO REAR OF WALL, GRID SHOULD BE FREE OF WRINKLES AND LIGHTLY TENSIONED PRIOR TO AND DURING PLACEMENT OF FILL.
2. CARE MUST BE TAKEN TO ENSURE ADEQUATE TENSIONING OF THE GRID WHERE IT IS WRAPPED UP THE FACE.
3. WHERE GRIDS OVERLAP MORE THAN 1 METRE ON CURVED WALLS, 100MM OF FILL SHALL BE PLACED BETWEEN THE GRIDS TO SEPARATE THEM.
4. RUBBER TIRED VEHICLES MAY PASS OVER THE GRID AT SLOW SPEEDS, A MINIMUM OF150mm OF FILL SHALL BE PLACED ON THE GRID PRIOR TO TRAFFICKING BY TRACKED VEHICLES. EXTRA CARE MUST BE TAKEN WHEN USING SHEEPSFOOT TYPE COMPACTORS TO ENSURE THE GRID IS NOT DAMAGED DURING COMPACTION.
5. CONTRACTOR TO ENSURE GRIDS ARE PLACED IN THE CORRECT ORIENTATION. GRID SHOULD BE ROLLED OUT PERPENDICULAR TO THE WALL/ SLOPE FACE.
6. GRID LAYERS MUST BE CONTINUOUS OVER THE DESIGN EMBEDMENT LENGTH. NO JOINS ARE PERMITTED PARALLEL TO THE FACE. LAPS PERPENDICULAR TO THE FACE ARE TO OVERLAP BY 100MM.
7. ONLY HAND OPERATED EQUIPMENT TO BE OPERATED WITHIN 1 METER OF THE FACE OF THE WALL.
8. THE PROPOSED FILL EMBANKMENT (SECTION E-E') SHALL BE FOUNDED ON A MINIMUM 500mm THICK LAYER OF COMPACTED HARDFILL RAFT TO ENHANCE TOE STABILITY. THE EDGE OF THE HARDFILL RAFT SHOULD EXTEND A MINIMUM OF 1m OUTSIDE THE FOOTPRINT OF THE EMBANKMENT.
9. FACING DETAIL FOR THE RE SLOPES SHOULD CONSIST OF PINNED GEOWEB (OR APPROVED EQUIVALENT FILLED WITH TOPSOIL.

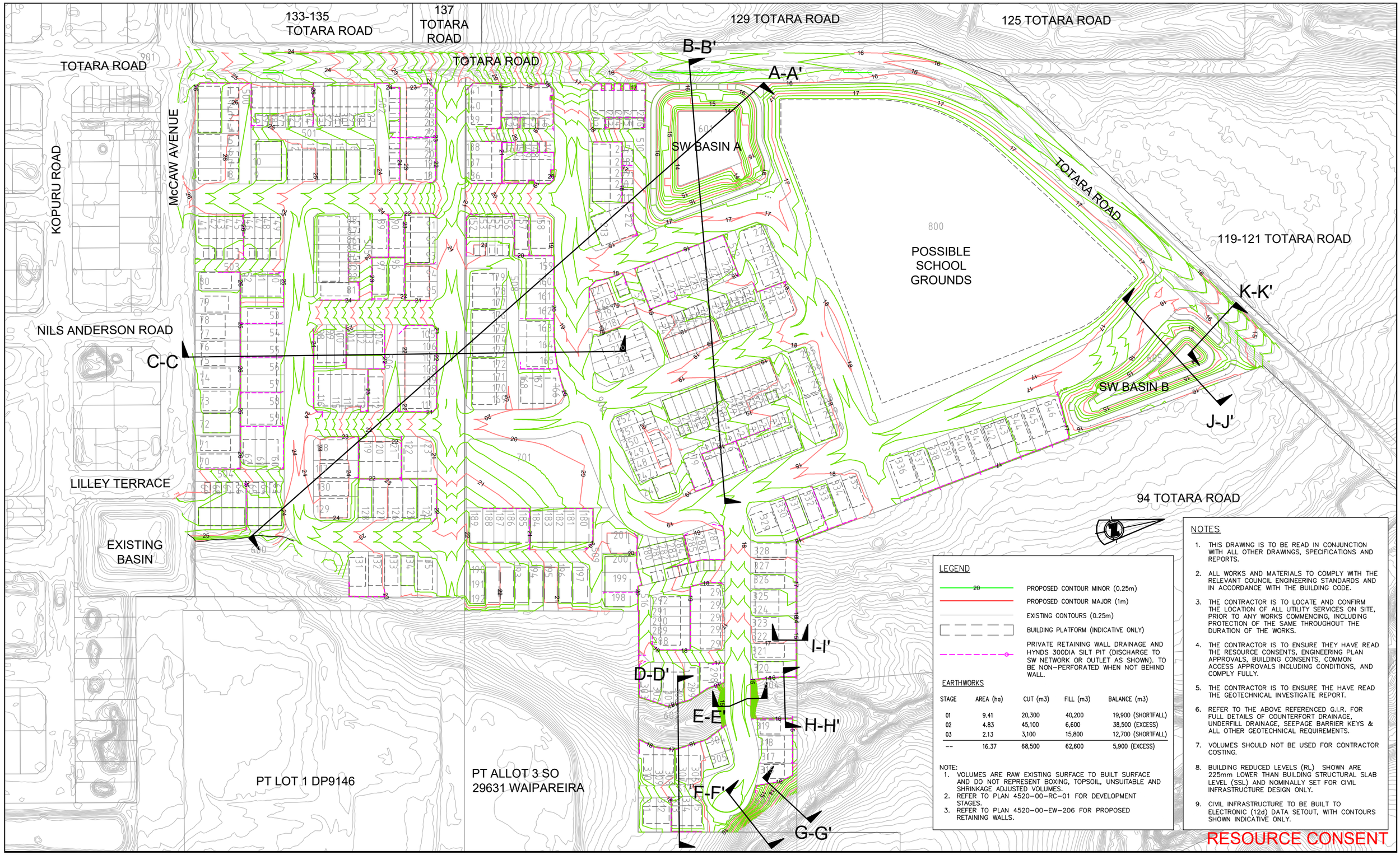


SECTION: F-F'
SCALE:1:200

CMW Geosciences

CLIENT: **NEIL CONSTRUCTION LIMITED**		DRAWN: JS	PROJECT: AKL2018-0085
PROJECT: **98-100 TOTARA ROAD, WHENUAPAI**		CHECKED: HP	DRAWING: 05
		REVISION: 1	SCALE: AS ABOVE
TITLE: **SLOPE REMEDIATION PLAN**		DATE: 07/12/2022	SHEET: A3 L

Appendix B: Whenuapai Green Development Plans



LEGEND

- 20 — PROPOSED CONTOUR MINOR (0.25m)
- PROPOSED CONTOUR MAJOR (1m)
- EXISTING CONTOURS (0.25m)
- BUILDING PLATFORM (INDICATIVE ONLY)
- PRIVATE RETAINING WALL DRAINAGE AND HYNDS 300DIA SILT PIT (DISCHARGE TO SW NETWORK OR OUTLET AS SHOWN). TO BE NON-PERFORATED WHEN NOT BEHIND WALL.

EARTHWORKS

STAGE	AREA (ha)	CUT (m3)	FILL (m3)	BALANCE (m3)
01	9.41	20,300	40,200	19,900 (SHORTFALL)
02	4.83	45,100	6,600	38,500 (EXCESS)
03	2.13	3,100	15,800	12,700 (SHORTFALL)
--	16.37	68,500	62,600	5,900 (EXCESS)

NOTE:
1. VOLUMES ARE RAW EXISTING SURFACE TO BUILT SURFACE AND DO NOT REPRESENT BOXING, TOPSOIL, UNSUITABLE AND SHRINKAGE ADJUSTED VOLUMES.
2. REFER TO PLAN 4520-00-RC-01 FOR DEVELOPMENT STAGES.
3. REFER TO PLAN 4520-00-EW-206 FOR PROPOSED RETAINING WALLS.

NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER DRAWINGS, SPECIFICATIONS AND REPORTS.
2. ALL WORKS AND MATERIALS TO COMPLY WITH THE RELEVANT COUNCIL ENGINEERING STANDARDS AND IN ACCORDANCE WITH THE BUILDING CODE.
3. THE CONTRACTOR IS TO LOCATE AND CONFIRM THE LOCATION OF ALL UTILITY SERVICES ON SITE, PRIOR TO ANY WORKS COMMENCING, INCLUDING PROTECTION OF THE SAME THROUGHOUT THE DURATION OF THE WORKS.
4. THE CONTRACTOR IS TO ENSURE THEY HAVE READ THE RESOURCE CONSENTS, ENGINEERING PLAN APPROVALS, BUILDING CONSENTS, COMMON ACCESS APPROVALS INCLUDING CONDITIONS, AND COMPLY FULLY.
5. THE CONTRACTOR IS TO ENSURE THE HAVE READ THE GEOTECHNICAL INVESTIGATE REPORT.
6. REFER TO THE ABOVE REFERENCED G.I.R. FOR FULL DETAILS OF COUNTERFORT DRAINAGE, UNDERFILL DRAINAGE, SEEPAGE BARRIER KEYS & ALL OTHER GEOTECHNICAL REQUIREMENTS.
7. VOLUMES SHOULD NOT BE USED FOR CONTRACTOR COSTING.
8. BUILDING REDUCED LEVELS (RL) SHOWN ARE 225mm LOWER THAN BUILDING STRUCTURAL SLAB LEVEL (SSL) AND NOMINALLY SET FOR CIVIL INFRASTRUCTURE DESIGN ONLY.
9. CIVIL INFRASTRUCTURE TO BE BUILT TO ELECTRONIC (12d) DATA SETOUT, WITH CONTOURS SHOWN INDICATIVE ONLY.

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	01/12/2022

THE NEIL GROUP

NEIL CONSTRUCTION LIMITED
LAND DEVELOPERS

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Job Title
WHENUAPAI GREEN
98-102 TOTARA ROAD
WHENUAPAI

Drawing Title
EARTHWORKS
PROPOSED CONTOURS

	By	Date	Scale	Job No.	Rev
Surveyed:	MS/CP		1:2000@A3	Drawing No. 4520-01-EW-200	A
Designed:	KLP				
Drawn:	KLP	12/2022			
Approved:	BJ				

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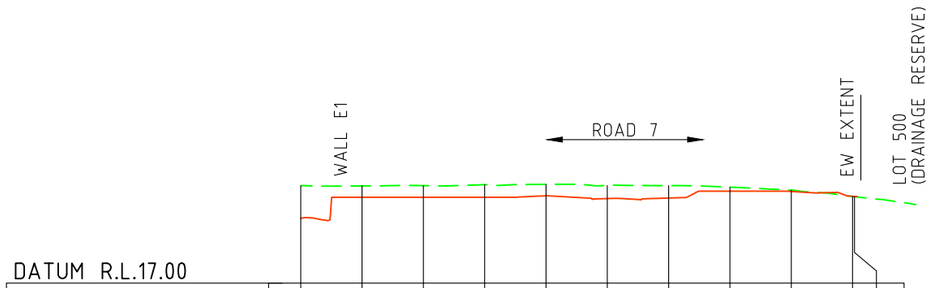
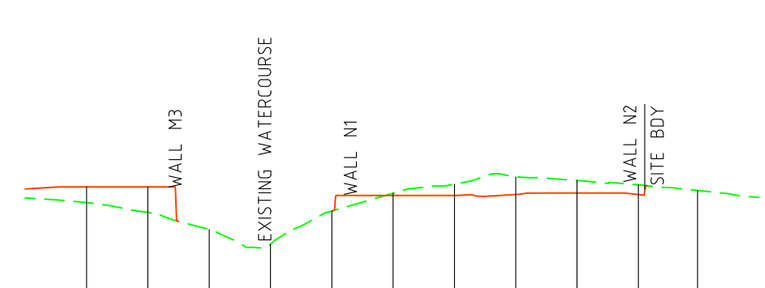


DATUM R.L.17.00

PROPOSED	22.29	24.00	24.00	24.00	24.12	23.89	23.94	24.50	24.49	24.07	24.06
EXISTING SURFACE	24.94	24.93	24.95	25.03	25.05	24.96	24.95	24.82	24.58	24.06	24.04
CUT / FILL DEPTH	2.65	0.93	0.95	1.03	0.94	1.06	1.02	0.32	0.1	-0.02	-0.03
CHAINAGE	310.00	320.00	330.00	340.00	350.00	360.00	370.00	380.00	390.00	400.00	400.31

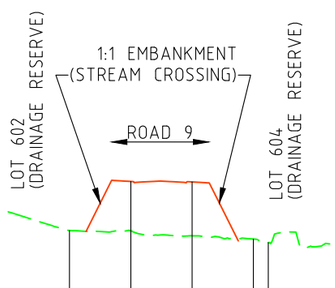
SECTION A-A' (CONT.)



DATUM R.L.7.00

17.85	17.85	14.38	13.17	15.88	17.15	17.15	17.23	17.34	17.22	17.56
16.57	15.76	14.38	13.17	15.88	17.33	18.07	18.66	18.37	18.02	17.56
-1.28	-2.09	0	0	-0	0.18	0.92	1.44	1.02	0.8	0
0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	99.66

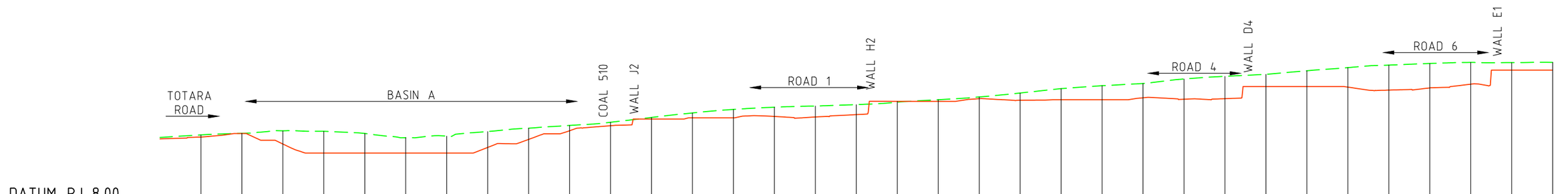
SECTION D-D'



DATUM R.L.5.00

12.29	16.29	16.25	11.59	11.31	
12.29	12.27	11.86	11.59	11.31	
0	-4.02	-4.39	0	0	
0.00	10.00	20.00	30.00	32.43	

SECTION E-E'



DATUM R.L.8.00

PROPOSED	15.85	16.28	15.00	13.90	13.90	13.90	13.90	14.58	15.56	16.62	17.23	18.05	18.20	18.20	18.36	18.30	18.58	20.20	20.20	20.52	20.33	20.40	20.40	20.63	20.46	20.53	22.00	22.00	21.94	21.57	21.84	22.29	24.00	24.00
EXISTING SURFACE	16.11	16.31	16.61	16.55	16.29	15.77	15.96	16.52	16.93	17.27	17.65	18.24	18.79	19.22	19.48	19.63	19.80	20.11	20.40	20.74	21.21	21.75	22.11	22.37	22.92	23.25	23.50	23.93	24.31	24.62	24.81	24.94	24.93	24.95
CUT / FILL DEPTH	0.26	0.03	1.61	2.65	2.39	1.87	2.06	1.94	1.37	0.66	0.42	0.19	0.59	1.02	1.12	1.33	1.22	-0.09	0.2	0.22	0.88	1.35	1.71	1.74	2.46	2.72	1.5	1.93	2.37	3.04	2.98	2.65	0.93	0.95
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00	150.00	160.00	170.00	180.00	190.00	200.00	210.00	220.00	230.00	240.00	250.00	260.00	270.00	280.00	290.00	300.00	310.00	320.00	330.00

SECTION A-A'

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	01/12/2022

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THE NEIL GROUP LIMITED
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WEB: www.neilgroup.co.nz

Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
EARTHWORKS
SITE SECTIONS

	By	Date	Scale	Job No.	
Surveyed:	MS/CP		1:1000@A3	Drawing No.	Rev
Designed:	KLP			4520–01–EW–201	A
Drawn:	KLP	12/2022			
Approved:	BJ				

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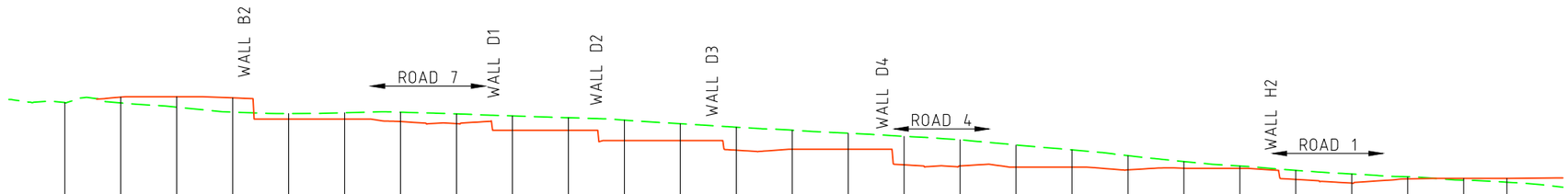


DATUM R.L.13.00

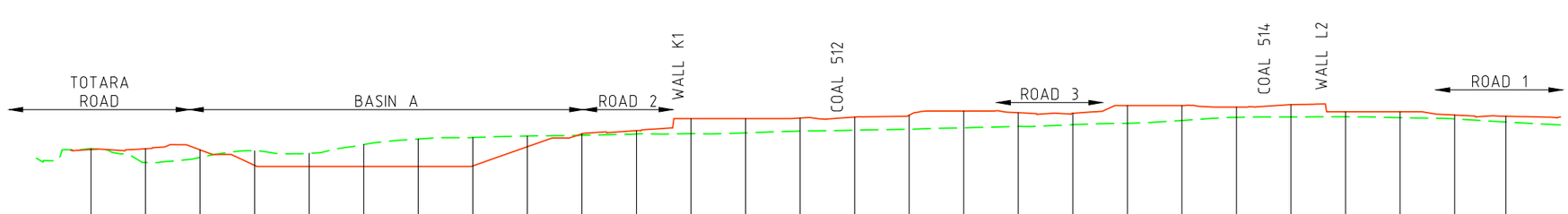
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00	150.00	160.00	170.00	180.00	190.00	200.00	210.00	220.00	230.00	240.00	250.00	257.73
CUT / FILL DEPTH	0	-0.52	-0.93	-1.28	0.49	0.57	0.84	0.87	1.28	1.13	1.83	1.5	2.06	1.71	1.44	2.55	2.34	1.98	1.55	1.27	0.6	0.21	0.81	0.82	0.19	-0.16	-0.34
EXISTING SURFACE	26.17	26.15	25.77	25.33	25.19	25.27	25.32	25.17	24.98	24.83	24.61	24.28	23.98	23.71	23.44	23.16	22.85	22.38	21.95	21.43	20.91	20.51	20.12	19.80	19.54	19.24	19.06
PROPOSED	26.17	26.66	26.70	26.60	24.70	24.70	24.48	24.29	23.70	23.70	22.78	22.78	21.92	22.00	22.00	20.61	20.51	20.40	20.40	20.16	20.31	20.30	19.31	18.98	19.36	19.40	19.40

SECTION C-C'

DATUM R.L.5.00

16.55	13.84	11.37	10.27	12.96	
15.38	13.85	11.37	10.27	12.96	
-1.16	0.01	0	0	0	
0.00	10.00	20.00	30.00	38.11	

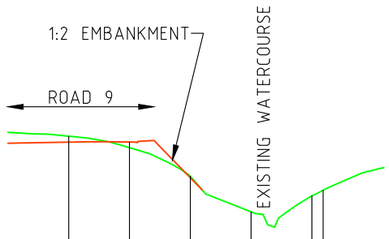
SECTION G-G'



DATUM R.L.8.00

CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00	150.00	160.00	170.00	180.00	190.00	200.00	210.00	220.00	230.00	240.00	250.00	259.39
CUT / FILL DEPTH	0.09	-1.25	-0.69	1.34	1.22	2.02	2.53	2.62	0.98	-0.13	-0.3	-1.38	-1.32	-1.19	-1.2	-1.29	-1.55	-1.26	-1.05	-1.63	-1.37	-0.94	-1.13	-0.46	-0.55	-0.35	-0.52
EXISTING SURFACE	15.55	14.28	14.75	15.35	15.12	15.92	16.43	16.57	16.70	16.77	16.89	16.92	16.98	17.16	17.24	17.32	17.45	17.59	17.75	17.87	18.13	18.42	18.45	18.47	18.38	18.28	17.99
PROPOSED	15.46	15.53	15.43	14.00	13.90	13.90	13.90	13.95	15.72	16.91	17.19	18.30	18.30	18.35	18.44	18.62	19.00	18.84	18.80	19.50	19.50	19.36	19.58	18.93	18.93	18.63	18.51

SECTION B-B'



16.51	16.51	13.58	10.77	12.09	12.55
17.00	16.05	13.70	10.77	12.09	12.55
0.49	-0.46	0.12	0	0	0
0.00	10.00	20.00	30.00	40.00	41.84

SECTION F-F'

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	01/12/2022

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LAND DEVELOPERS

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FACSIMILE: +64 9 918 6567
WEB: www.neilgroup.co.nz

Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
EARTHWORKS
SITE SECTIONS

	By	Date	Scale	Job No.	
Surveyed:	MS/CP		1:1000@A3	Drawing No.	Rev
Designed:	KLP			4520–01–EW–202	A
Drawn:	KLP	12/2022			
Approved:	BJ				

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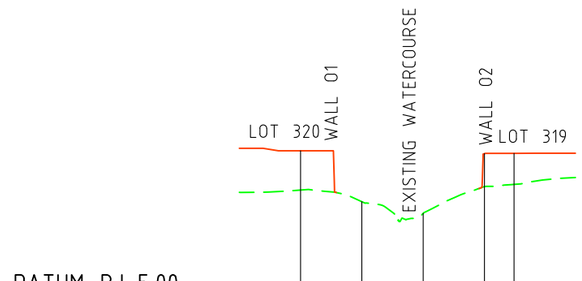
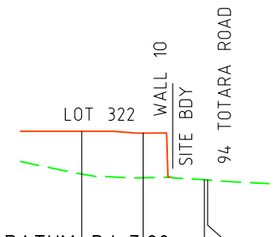


DATUM R.L.5.00

PROPOSED	16.75	12.60	11.64	16.52	16.54	
EXISTING SURFACE	13.54	12.60	11.64	13.83	14.01	
CUT / FILL DEPTH	-3.21	0	0	-2.68	-2.53	
CHAINAGE	0.00	10.00	20.00	30.00	34.82	

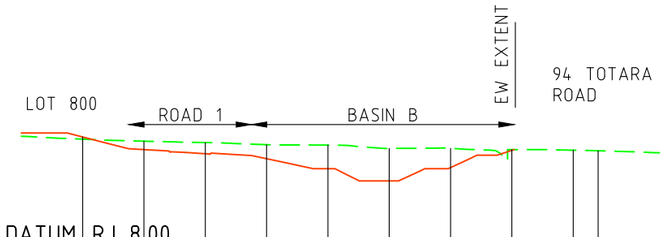
SECTION H-H'



DATUM R.L.7.00

	17.15	17.00	13.20	13.18	
	13.66	13.36	13.20	13.18	
	-3.49	-3.64	0	0	
	0.00	10.00	20.00	20.53	

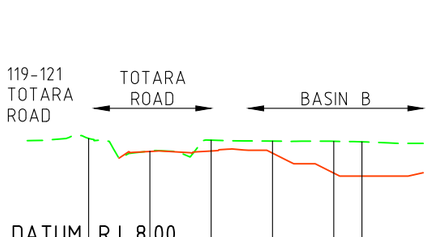
SECTION I-I'



DATUM R.L.8.00

	17.28	16.26	15.92	15.52	14.70	13.70	14.79	16.19		
	17.11	16.94	16.83	16.65	16.62	16.35	16.36	16.25	16.21	16.16
	-0.17	0.69	0.91	1.14	1.92	2.65	1.57	0.06		
	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	84.07

SECTION J-J'



DATUM R.L.8.00

	16.76	15.71	15.75	15.57	13.94	13.70
	16.76	15.73	16.62	16.55	16.54	16.49
	0	0.03	0.88	0.98	2.59	2.79
	0.00	10.00	20.00	30.00	40.00	44.58

SECTION K-K'

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	01/12/2022

THE NEIL GROUP

NEIL CONSTRUCTION LIMITED
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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
EARTHWORKS
SITE SECTIONS

	By	Date	Scale	Job No.	
Surveyed:	MS/CP		1:1000@A3	Drawing No.	Rev
Designed:	KLP			4520–01–EW–203	A
Drawn:	KLP	12/2022			
Approved:	BJ				

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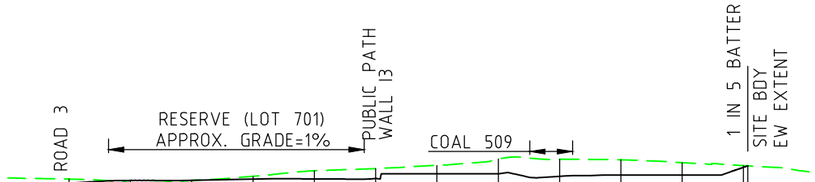
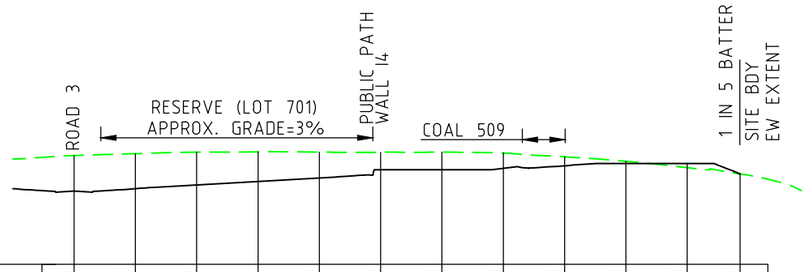


DATUM R.L.14.00

PROPOSED	19.69	19.96	19.97	20.07	20.08	20.11	20.50	20.50	20.29	20.40	20.40	20.52	21.14
EXISTING SURFACE	20.06	19.77	19.95	20.29	20.74	20.93	21.18	21.70	21.68	21.64	21.40	21.16	21.14
CUT / FILL DEPTH	0.38	-0.19	-0.02	0.22	0.66	0.82	0.68	1.2	1.39	1.24	1	0.64	0
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00	110.70

SECTION K-K'



DATUM R.L.14.00

PROPOSED	19.96	20.15	20.46	20.74	21.03	21.70	21.70	21.81	22.01	22.20	22.20	21.35
EXISTING SURFACE	22.85	23.00	23.13	23.16	23.14	23.12	23.13	23.06	22.75	22.39	21.87	21.35
CUT / FILL DEPTH	2.89	2.85	2.67	2.41	2.11	1.42	1.43	1.25	0.74	0.19	-0.33	0
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	108.64

SECTION J-J'

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	CK	01/11/2022

THE NEIL GROUP

NEIL CONSTRUCTION LIMITED
LAND DEVELOPERS

THE NEIL GROUP LIMITED
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Job Title
98–102 TOTARA ROAD
WHENUAPAI GREEN
WHENUAPAI

Drawing Title
EARTHWORKS
SITE SECTIONS

	By	Date	Scale	Job No.	
Surveyed:	MS		1:1000@A3	Drawing No.	Rev
Designed:	KLP			4520–01–EW–204	A
Drawn:	KLP	11/2022			
Approved:	BJ				

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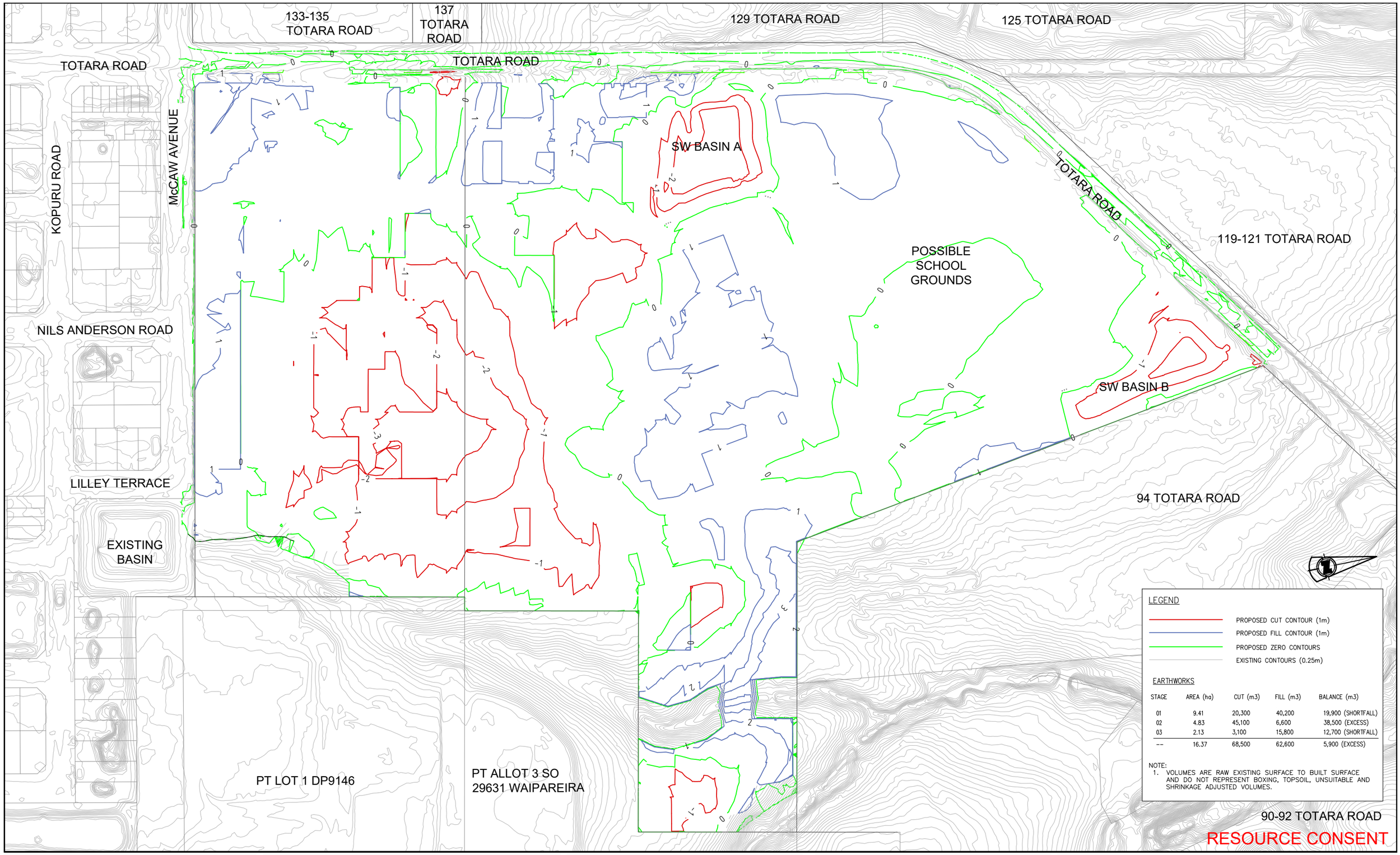

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	01/12/2022

THE NEIL GROUP

NEIL CONSTRUCTION LIMITED
LAND DEVELOPERS

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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
EARTHWORKS
CUTFILL CONTOURS

	By	Date	Scale	Job No.	
Surveyed:	MS/CP		1:2000@A3	Drawing No.	Rev
Designed:	KLP			4520–01–EW–205	A
Drawn:	KLP	12/2022			
Approved:	BJ				

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133-135 TOTARA ROAD

137 TOTARA ROAD

129 TOTARA ROAD

125 TOTARA ROAD

TOTARA ROAD

TOTARA ROAD

KOPURU ROAD

McCAW AVENUE

NILS ANDERSON ROAD

LILLEY TERRACE

EXISTING BASIN

SW BASIN A

SW BASIN B

POSSIBLE SCHOOL GROUNDS

TOTARA ROAD

119-121 TOTARA ROAD

94 TOTARA ROAD

90-92 TOTARA ROAD

PT LOT 1 DP9146

PT ALLOT 3 SO 29631 WAIPAREIRA

WALL A1
WALL A2
WALL A3
WALL A4
WALL B1
WALL B2
WALL B3
WALL B4
WALL B5
WALL C1
WALL C2
WALL C3
WALL C4
WALL D1
WALL D2
WALL D3
WALL D4
WALL E1
WALL E2
WALL F1
WALL G1
WALL G2
WALL G3
WALL G4
WALL G5
WALL H1
WALL H2
WALL I1
WALL I2
WALL I3
WALL J1
WALL J2
WALL K1
WALL K2
WALL K3
WALL K4
WALL L2
WALL M1
WALL M2
WALL M3
WALL M4
WALL M5
WALL N1
WALL N2
WALL O1
WALL O2
WALL P1

LEGEND

PROPOSED RETAINING WALL

PROPOSED STORMWATER NETWORK

PRIVATE RETAINING WALL DRAINAGE AND HYNDS 300DIA SILT PIT (DISCHARGE TO SW NETWORK OR OUTLET AS SHOWN). TO BE NON-PERFORATED WHEN NOT BEHIND WALL.

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	01/12/2022

THE NEIL GROUP

NEIL CONSTRUCTION LIMITED
LAND DEVELOPERS

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Job Title
WHENUAPAI GREEN
98-102 TOTARA ROAD
WHENUAPAI

Drawing Title
EARTHWORKS
RETAINING WALLS
LOCATION PLAN

	By	Date	Scale	Job No.	Rev
Surveyed:	MS/CP		1:2000@A3	Drawing No. 4520-01-EW-206	A
Designed:	KLP				
Drawn:	KLP	12/2022			
Approved:	BJ				

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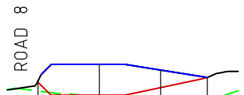
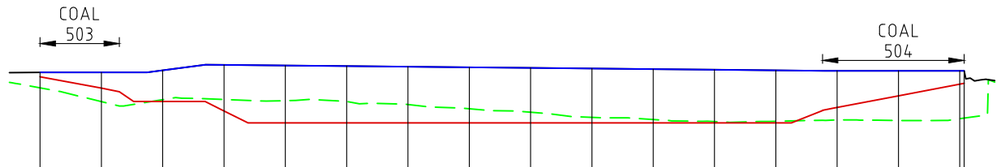


DATUM R.L.23.00

TOP OF WALL	25.86	26.30	26.12	25.87	
BOTTOM OF WALL	25.72	25.30	25.54	25.87	
HEIGHT	-0.14	-1.00	-0.57	-0.00	
CHAINAGE	0.00	10.00	20.00	27.63	

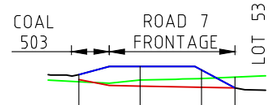
WALL B1



DATUM R.L.22.00

TOP OF WALL	26.35	26.35	26.42	26.59	26.57	26.55	26.53	26.51	26.50	26.48	26.46	26.44	26.42	26.40	26.40	26.40		
BOTTOM OF WALL	26.20	25.83	25.40	25.09	24.70	24.70	24.70	24.70	24.70	24.70	24.70	24.70	24.70	25.21	25.58	25.96	25.99	
HEIGHT	-0.15	-0.52	-1.02	-1.50	-1.87	-1.85	-1.83	-1.81	-1.80	-1.78	-1.76	-1.74	-1.72	-1.19	-0.82	-0.44	-0.41	
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00	150.00	150.71	

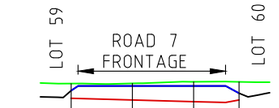
WALL B2



DATUM R.L.22.00

TOP OF WALL	25.13	25.40	25.28	24.70
BOTTOM OF WALL	24.97	24.76	24.72	24.70
HEIGHT	-0.16	-0.64	-0.56	0.00
CHAINAGE	0.00	10.00	20.00	25.47

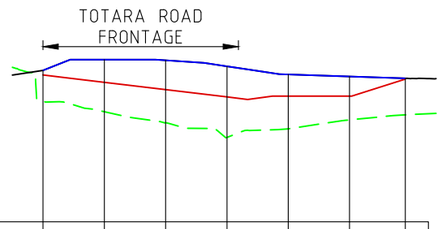
WALL B3



DATUM R.L.22.00

TOP OF WALL	24.55	24.70	24.70	24.46
BOTTOM OF WALL	24.30	24.25	24.19	24.24
HEIGHT	-0.25	-0.45	-0.51	-0.22
CHAINAGE	0.00	10.00	20.00	27.40

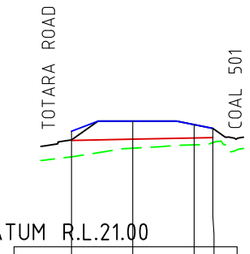
WALL B4



DATUM R.L.21.00

TOP OF WALL	25.94	26.29	26.27	26.07	25.80	25.74	25.68
BOTTOM OF WALL	25.79	25.55	25.31	25.07	25.10	25.10	25.66
HEIGHT	-0.15	-0.74	-0.96	-1.00	-0.70	-0.64	-0.03
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	59.10

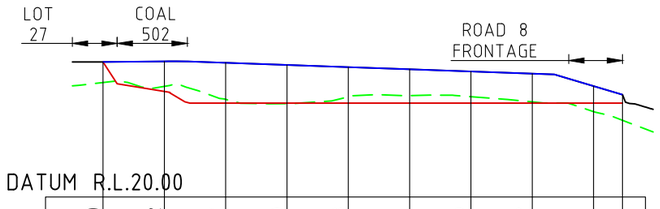
WALL A1



DATUM R.L.21.00

TOP OF WALL	24.77	25.10	24.98	24.86
BOTTOM OF WALL	24.47	24.51	24.55	24.56
HEIGHT	-0.30	-0.59	-0.43	-0.30
CHAINAGE	0.00	10.00	20.00	23.04

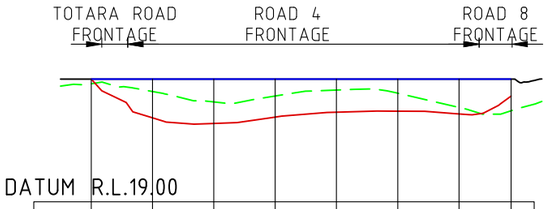
WALL A2



DATUM R.L.20.00

TOP OF WALL	24.40	24.42	24.37	24.30	24.23	24.16	24.09	24.02	23.61	23.33
BOTTOM OF WALL	24.40	23.44	23.06	23.06	23.06	23.06	23.06	23.06	23.06	23.06
HEIGHT	-0.00	-0.98	-1.32	-1.25	-1.18	-1.11	-1.03	-0.96	-0.56	-0.28
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	84.72

WALL A3



DATUM R.L.19.00

TOP OF WALL	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
BOTTOM OF WALL	23.00	21.74	21.55	21.76	21.92	21.96	21.87	22.45
HEIGHT	-0.00	-1.26	-1.45	-1.24	-1.08	-1.04	-1.13	-0.55
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	68.49

WALL A4

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	01/12/2022

THE NEIL GROUP

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WEB: www.neilgroup.co.nz

Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
EARTHWORKS
RETAINING WALL
ELEVATIONS

	By	Date	Scale	Job No.	
Surveyed:	--		1:1000@A3 5 x VERT.	Drawing No.	Rev
Designed:	KLP			4520–01–EW–207	A
Drawn:	KLP	12/2022			
Approved:	BJ				

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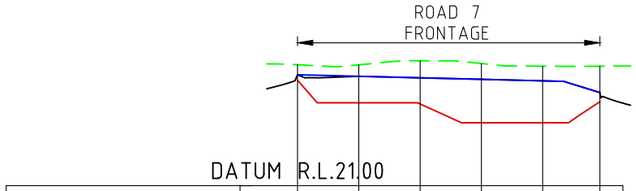
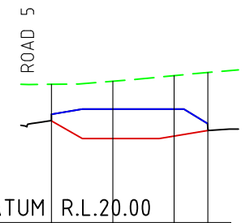


DATUM R.L.21.00

TOP OF WALL	24.62	24.57	24.52	24.47	24.42	24.04
BOTTOM OF WALL	24.44	23.70	23.66	23.05	23.05	23.74
HEIGHT	-0.18	-0.87	-0.85	-1.42	-1.37	-0.30
CHAINAGE	0.00	10.00	20.00	30.00	40.00	49.33

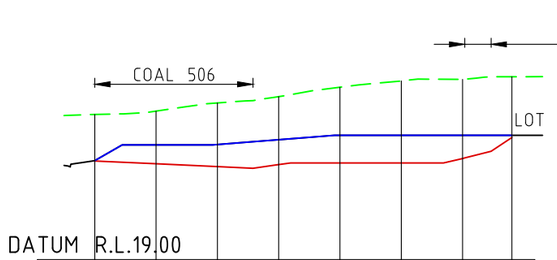
WALL D1



DATUM R.L.20.00

TOP OF WALL	23.53	23.70	23.70	23.23
BOTTOM OF WALL	23.31	22.74	22.82	23.00
HEIGHT	-0.22	-0.96	-0.88	-0.23
CHAINAGE	0.00	10.00	20.00	25.49

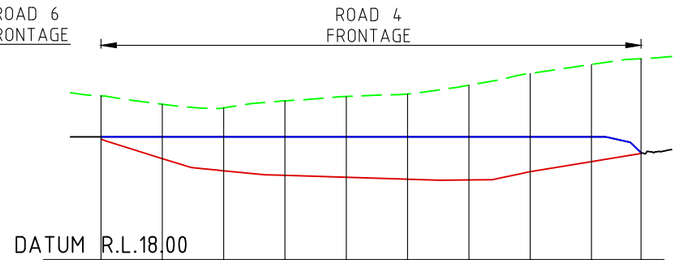
WALL D2



DATUM R.L.19.00

TOP OF WALL	22.22	22.74	22.75	22.91	23.05	23.05	23.05	23.05
BOTTOM OF WALL	22.21	22.12	22.03	22.10	22.15	22.15	22.29	22.98
HEIGHT	-0.01	-0.62	-0.72	-0.81	-0.90	-0.90	-0.76	-0.07
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	68.04

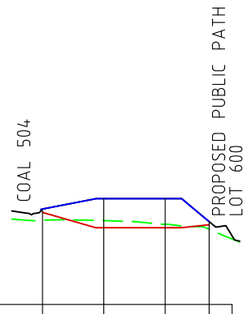
WALL D3



DATUM R.L.18.00

TOP OF WALL	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	21.46
BOTTOM OF WALL	21.93	21.29	20.89	20.75	20.68	20.62	20.60	20.86	21.19	21.46
HEIGHT	-0.07	-0.71	-1.11	-1.25	-1.32	-1.38	-1.40	-1.14	-0.81	0
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	88.08

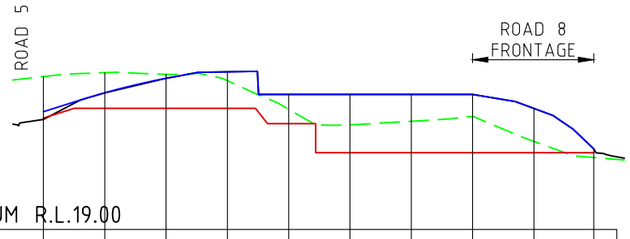
WALL D4



DATUM R.L.22.00

TOP OF WALL	25.11	25.45	25.45	24.70
BOTTOM OF WALL	25.00	24.50	24.50	24.60
HEIGHT	-0.11	-0.95	-0.95	-0.10
CHAINAGE	0.00	10.00	20.00	27.17

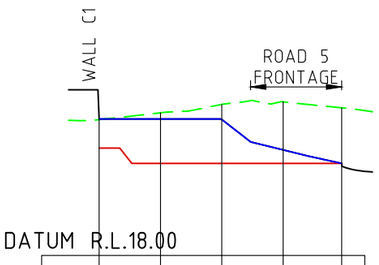
WALL B5



DATUM R.L.19.00

TOP OF WALL	22.84	23.45	23.93	24.14	23.40	23.40	23.40	23.40	22.95	21.63
BOTTOM OF WALL	22.63	22.95	22.95	22.95	22.45	21.50	21.50	21.50	21.50	21.50
HEIGHT	-0.21	-0.50	-0.98	-1.19	-0.95	-1.90	-1.90	-1.90	-1.45	-0.13
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	89.75

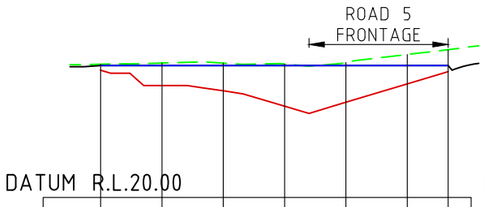
WALL C1



DATUM R.L.18.00

TOP OF WALL	22.45	22.45	22.43	21.44	21.00
BOTTOM OF WALL	21.50	21.00	21.00	21.00	21.00
HEIGHT	-0.95	-1.45	-1.43	-0.44	0.00
CHAINAGE	0.00	10.00	20.00	30.00	39.56

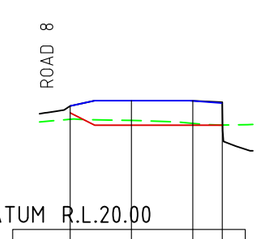
WALL C2



DATUM R.L.20.00

TOP OF WALL	24.30	24.30	24.30	24.30	24.30	24.30
BOTTOM OF WALL	24.15	23.65	23.48	22.98	23.10	23.70	24.10
HEIGHT	-0.15	-0.65	-0.82	-1.32	-1.20	-0.60	-0.20
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	56.68

WALL C3



DATUM R.L.20.00

TOP OF WALL	24.03	24.20	24.19	24.12
BOTTOM OF WALL	23.80	23.40	23.40	23.40
HEIGHT	-0.23	-0.80	-0.79	-0.72
CHAINAGE	0.00	10.00	20.00	24.80

WALL C4

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	01/12/2022

THE NEIL GROUP

NEIL CONSTRUCTION LIMITED
LAND DEVELOPERS

THE NEIL GROUP LIMITED
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WEB: www.neilgroup.co.nz

Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
EARTHWORKS
RETAINING WALL
ELEVATIONS

	By	Date	Scale	Job No.	
Surveyed:	--		1:1000@A3 5 x VERT.	Drawing No.	Rev
Designed:	KLP			4520–01–EW–208	A
Drawn:	KLP	12/2022			
Approved:	BJ				

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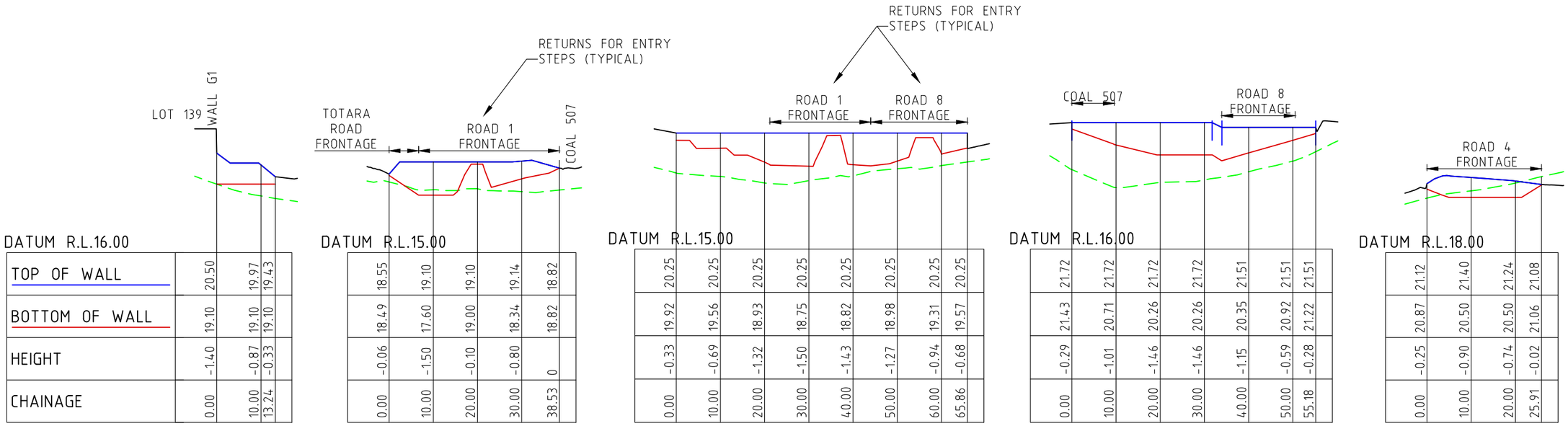


DATUM R.L.16.00

TOP OF WALL	20.50	19.97	19.43	
BOTTOM OF WALL	19.10	19.10	19.10	
HEIGHT	1.40	0.87	0.33	
CHAINAGE	0.00	10.00	13.24	

WALL G2

DATUM R.L.15.00

18.55	19.10	19.10	19.14	18.82	
18.49	17.60	19.00	18.34	18.82	
0.06	1.50	0.10	0.80		
0.00	10.00	20.00	30.00	38.53	0

WALL G3

DATUM R.L.15.00

20.25	20.25	20.25	20.25	20.25	20.25	20.25	20.25
19.92	19.56	18.93	18.75	18.82	18.98	19.31	19.57
0.33	0.69	1.32	1.50	1.43	1.27	0.94	0.68
0.00	10.00	20.00	30.00	40.00	50.00	60.00	65.86

WALL G4

DATUM R.L.16.00

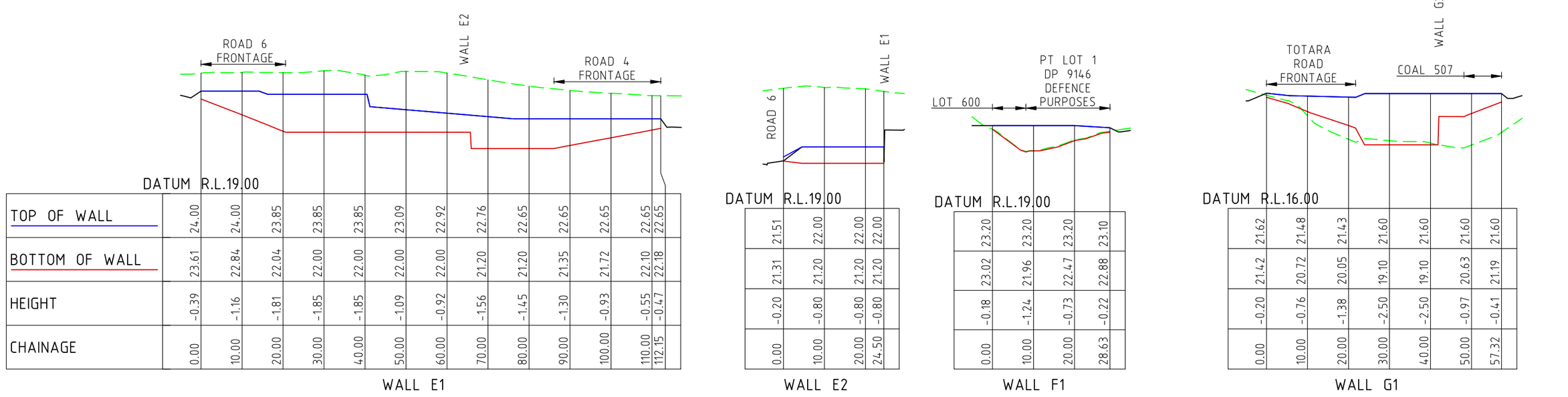
21.72	21.72	21.72	21.72	21.51	21.51	21.51
21.43	20.71	20.26	20.26	20.35	20.92	21.22
0.29	1.01	1.46	1.46	1.15	0.59	0.28
0.00	10.00	20.00	30.00	40.00	50.00	55.18

WALL G5

DATUM R.L.18.00

21.12	21.40	21.24	21.08	
20.87	20.50	20.50	21.06	
0.25	0.90	0.74	0.02	
0.00	10.00	20.00	25.91	

WALL H1



DATUM R.L.19.00

TOP OF WALL	24.00	24.00	23.85	23.85	23.85	23.09	22.92	22.76	22.65	22.65	22.65	22.65
BOTTOM OF WALL	23.61	22.84	22.04	22.00	22.00	22.00	22.00	21.20	21.20	21.35	21.72	22.10	22.18
HEIGHT	0.39	1.16	1.81	1.85	1.85	1.09	0.92	1.56	1.45	1.30	0.93	0.55	0.47
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00	112.15

WALL E1

DATUM R.L.19.00

21.51	22.00	22.00	22.00
21.31	21.20	21.20	21.20
0.20	0.80	0.80	0.80
0.00	10.00	20.00	24.50

WALL E2

DATUM R.L.19.00

23.20	23.20	23.20	23.10
23.02	21.96	22.47	22.88
0.18	1.24	0.73	0.22
0.00	10.00	20.00	28.63

WALL F1

DATUM R.L.16.00

21.62	21.48	21.43	21.60	21.60	21.60	21.60
21.42	20.72	20.05	19.10	19.10	20.63	21.19
0.20	0.76	1.38	2.50	2.50	0.97	0.41
0.00	10.00	20.00	30.00	40.00	50.00	57.32

WALL G1

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	01/12/2022

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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
EARTHWORKS
RETAINING WALL
ELEVATIONS

	By	Date	Scale	Job No.	
Surveyed:	--		1:1000@A3 5 x VERT.	Drawing No. 4520–01–EW–209	Rev A
Designed:	KLP				
Drawn:	KLP	12/2022			
Approved:	BJ				

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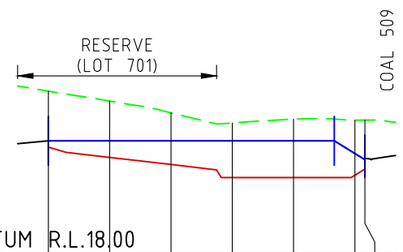
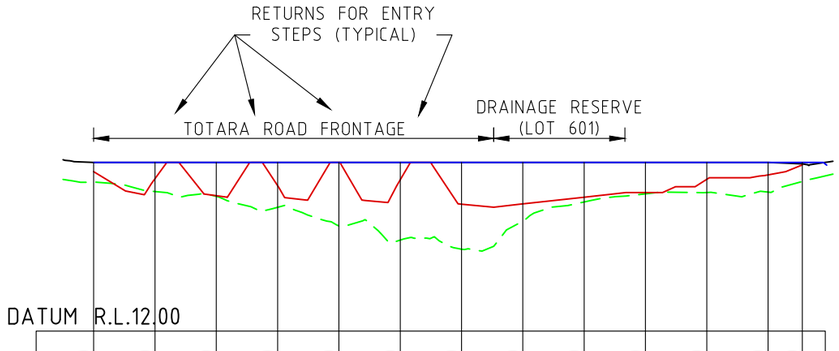


DATUM R.L.18.00

TOP OF WALL	21.70	21.70	21.70	21.70	21.70	21.28	21.08	
BOTTOM OF WALL	21.49	21.16	20.93	20.50	20.50	20.58	20.78	
HEIGHT	-0.21	-0.54	-0.77	-1.20	-1.20	-0.71	-0.31	
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	51.63	

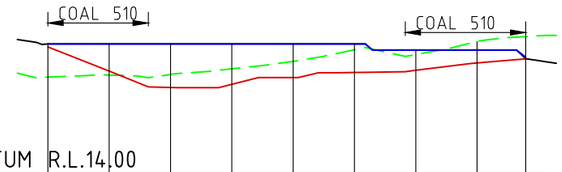
WALL I3



DATUM R.L.12.00

TOP OF WALL	17.50	17.50	17.50	17.50	17.50	17.50	17.50	17.50	17.50	17.50	17.50	17.50	17.50
BOTTOM OF WALL	17.20	16.97	16.42	16.74	17.50	16.94	16.14	16.15	16.36	16.52	16.95	17.09	17.42
HEIGHT	-0.30	-0.53	-1.08	-0.76	0.00	-0.56	-1.36	-1.35	-1.14	-0.98	-0.55	-0.41	-0.08
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00	115.58

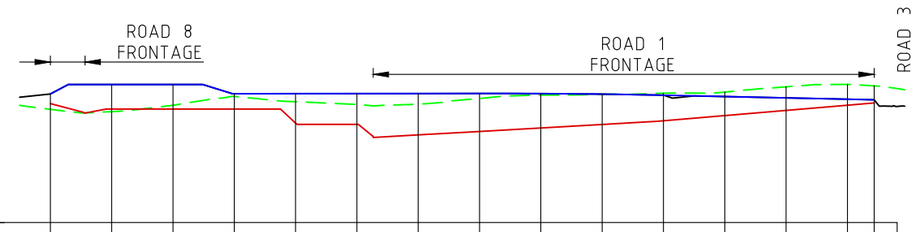
WALL J1



DATUM R.L.14.00

TOP OF WALL	18.25	18.25	18.25	18.25	18.25	18.25	18.05	18.05	17.82
BOTTOM OF WALL	18.15	17.36	16.83	16.93	17.15	17.32	17.39	17.63	17.76
HEIGHT	-0.10	-0.89	-1.42	-1.32	-1.10	-0.93	-0.66	-0.42	-0.06
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	77.94

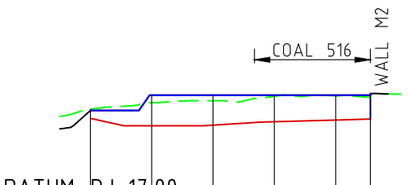
WALL J2



DATUM R.L.16.00

TOP OF WALL	20.19	20.50	20.50	20.20	20.20	20.20	20.20	20.21	20.20	20.18	20.15	20.11	20.06	20.02	20.00
BOTTOM OF WALL	19.88	19.70	19.70	19.70	19.24	19.20	18.86	18.97	19.08	19.20	19.31	19.48	19.66	19.83	19.90
HEIGHT	-0.32	-0.80	-0.80	-0.50	-0.96	-1.00	-1.35	-1.24	-1.12	-0.99	-0.84	-0.62	-0.41	-0.19	-0.10
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00	120.00	130.00	134.37

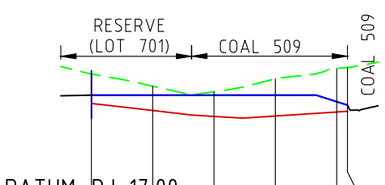
WALL H2



DATUM R.L.17.00

TOP OF WALL	20.00	20.50	20.50	20.50	20.50	20.50
BOTTOM OF WALL	19.74	19.50	19.52	19.63	19.69	19.72
HEIGHT	-0.26	-1.00	-0.98	-0.87	-0.81	-0.78
CHAINAGE	0.00	10.00	20.00	30.00	40.00	45.65

WALL I1



DATUM R.L.17.00

TOP OF WALL	20.50	20.50	20.50	20.50	20.29	20.17
BOTTOM OF WALL	20.23	20.00	19.80	19.82	19.95	19.97
HEIGHT	-0.27	-0.50	-0.70	-0.68	-0.34	-0.20
CHAINAGE	0.00	10.00	20.00	30.00	40.00	41.77

WALL I2

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	01/12/2022

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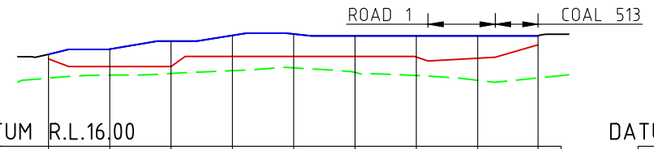
FACSIMILE: +64 9 918 6567
WEB: www.neilgroup.co.nz

Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
EARTHWORKS
RETAINING WALL
ELEVATIONS

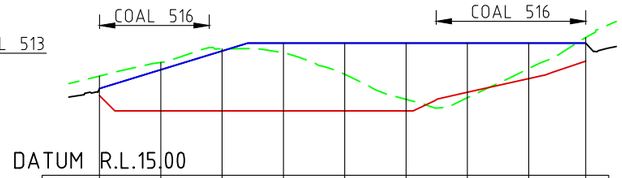
	By	Date	Scale	Job No.	
Surveyed:	--		1:1000@A3 5 x VERT.	Drawing No. 4520–01–EW–210	Rev A
Designed:	KLP				
Drawn:	KLP	12/2022			
Approved:	BJ				



DATUM R.L.16.00

TOP OF WALL	19.00	19.17	19.43	19.62	19.66	19.60	19.60	19.60	19.60
BOTTOM OF WALL	18.85	18.60	18.60	18.93	18.93	18.93	18.91	18.87	19.31
HEIGHT	-0.15	-0.57	-0.83	-0.69	-0.73	-0.67	-0.69	-0.73	-0.29
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	79.86

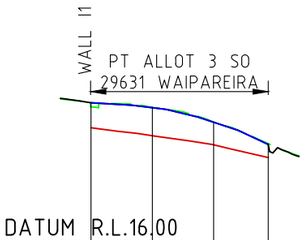
WALL L2



DATUM R.L.15.00

17.83	18.44	19.05	19.31	19.31	19.31	19.31	19.31	19.31
17.60	17.10	17.10	17.10	17.10	17.10	17.71	18.15	18.72
-0.23	-1.34	-1.95	-2.21	-2.21	-2.21	-1.60	-1.16	-0.59
0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	79.30

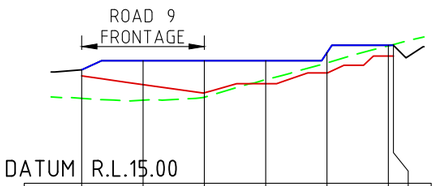
WALL M1



DATUM R.L.16.00

20.55	20.39	19.91	19.19	
19.74	19.47	19.18	18.76	
-0.81	-0.92	-0.74	-0.43	
0.00	10.00	20.00	28.91	

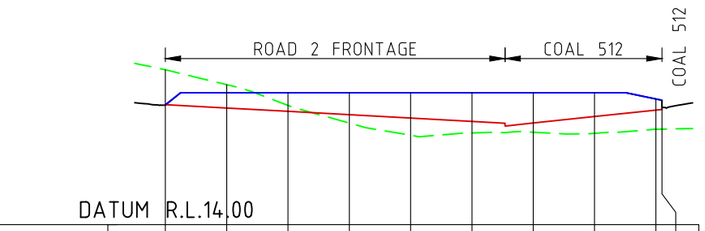
WALL M2



DATUM R.L.15.00

18.70	19.00	19.00	19.00	19.26	19.50	19.50
18.50	18.22	17.95	18.25	18.60	19.15	19.15
-0.20	-0.78	-1.05	-0.75	-0.66	-0.35	-0.35
0.00	10.00	20.00	30.00	40.00	50.00	50.83

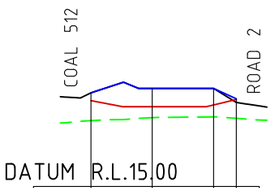
WALL M3



DATUM R.L.14.00

TOP OF WALL	17.91	18.30	18.30	18.30	18.30	18.30	18.30	18.30	18.21	18.05
BOTTOM OF WALL	17.91	17.80	17.69	17.58	17.47	17.36	17.31	17.52	17.73	17.75
HEIGHT	0	-0.50	-0.61	-0.72	-0.83	-0.94	-0.99	-0.78	-0.47	-0.3
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	80.99

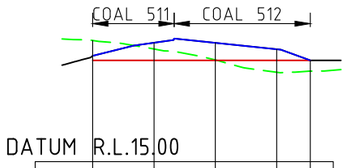
WALL K1



DATUM R.L.15.00

18.05	18.20	18.20	17.86
17.80	17.60	17.66	17.84
-0.25	-0.60	-0.54	-0.02
0.00	10.00	20.00	23.70

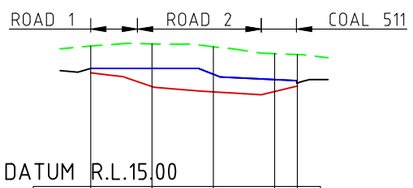
WALL K2



DATUM R.L.15.00

18.45	18.88	18.87	18.66	18.30
18.30	18.30	18.30	18.30	18.30
-0.15	-0.58	-0.57	-0.36	0.00
0.00	10.00	20.00	30.00	35.49

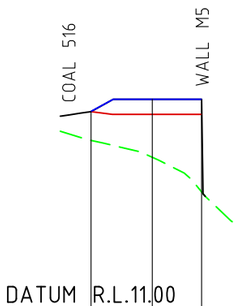
WALL K3



DATUM R.L.15.00

18.85	18.85	18.66	18.48	18.46
18.71	18.26	18.09	18.10	18.28
-0.14	-0.59	-0.57	-0.38	-0.18
0.00	10.00	20.00	30.00	33.71

WALL K4



DATUM R.L.11.00

17.46	17.85	17.85	
17.45	17.36	17.36	
-0.01	-0.49	-0.49	
0.00	10.00	18.04	

WALL M4

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	01/12/2022

THE NEIL GROUP
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LAND DEVELOPERS
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FACSIMILE: +64 9 918 6567
WEB: www.neilgroup.co.nz

Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
EARTHWORKS
RETAINING WALL
ELEVATIONS

	By	Date	Scale	Job No.	Rev
Surveyed:	--		1:1000@A3 5 x VERT.	Drawing No. 4520–01–EW–211	A
Designed:	KLP				
Drawn:	KLP	12/2022			
Approved:	BJ				

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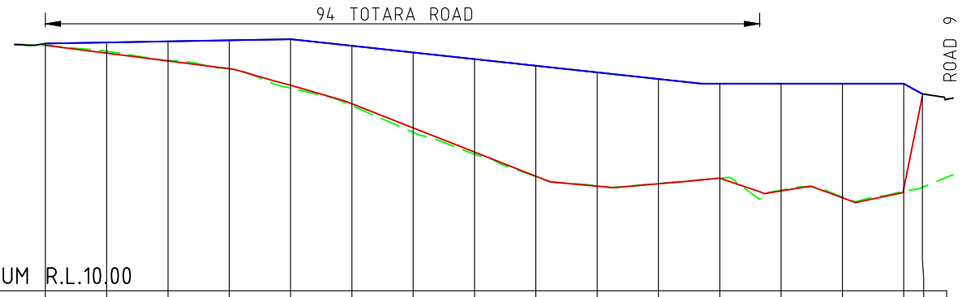
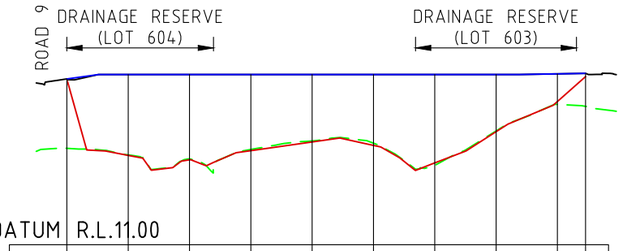


DATUM R.L.10.00

TOP OF WALL	18.06	18.09	18.13	18.16	18.20	17.99	17.77	17.55	17.34	17.12	16.90	16.75	16.75	16.75	16.75	16.75	
BOTTOM OF WALL	18.00	17.75	17.49	17.24	16.70	16.09	15.31	14.52	13.73	13.41	13.48	13.67	13.25	13.03	13.31	16.35	
HEIGHT	-0.06	-0.35	-0.64	-0.93	-1.50	-1.89	-2.46	-3.03	-3.60	-3.71	-3.42	-3.08	-3.50	-3.72	-3.44	-0.06	
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00	143.06	

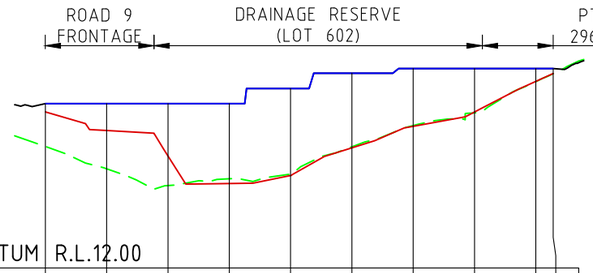
WALL 01



DATUM R.L.11.00

16.41	16.55	16.55	16.55	16.55	16.55	16.55	16.55	16.57	16.59	
16.41	13.91	13.77	14.07	14.35	14.24	13.67	14.68	15.63	16.48	
0.00	-2.64	-2.78	-2.48	-2.20	-2.31	-2.88	-1.87	-0.94	-0.10	
0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	84.60	

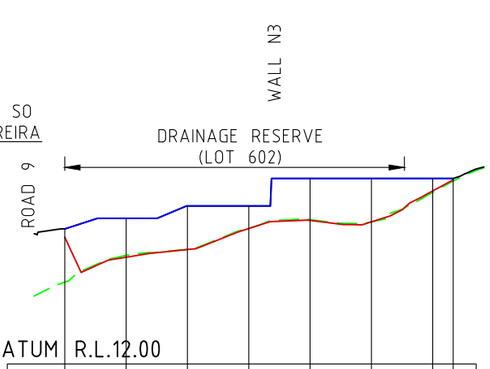
WALL 02 TOP



DATUM R.L.12.00

TOP OF WALL	17.36	17.36	17.36	17.36	17.85	18.35	18.50	18.50	18.50	18.50
BOTTOM OF WALL	17.09	16.48	15.65	14.75	15.02	15.91	16.62	17.08	18.08	18.34
HEIGHT	-0.27	-0.88	-1.71	-2.61	-2.83	-2.44	-1.88	-1.42	-0.42	-0.16
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	82.83

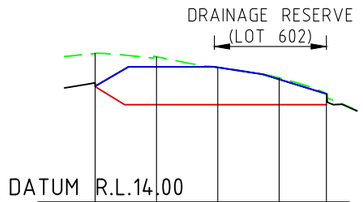
WALL M5



DATUM R.L.12.00

16.40	16.75	17.15	17.15	18.05	18.05	18.05	18.05	18.05
16.13	15.48	15.73	16.42	16.68	16.63	17.64	18.00	
-0.27	-1.27	-1.42	-0.73	-1.37	-1.42	-0.41	-0.05	
0.00	10.00	20.00	30.00	40.00	50.00	60.00	63.33	

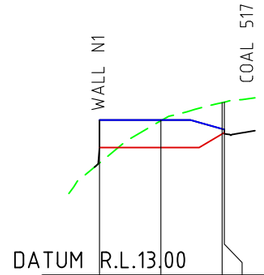
WALL N1



DATUM R.L.14.00

17.77	18.40	18.38	18.00	17.52	
17.76	17.17	17.17	17.17	17.17	
-0.01	-1.23	-1.21	-0.83	-0.35	
0.00	10.00	20.00	30.00	37.71	

WALL N2



DATUM R.L.13.00

18.05	18.05	17.76	17.74		
17.15	17.15	17.60	17.64		
-0.90	-0.90	-0.16	-0.10		
0.00	10.00	20.00	20.35		

WALL N3

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	01/12/2022

THE NEIL GROUP

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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
EARTHWORKS
RETAINING WALL
ELEVATIONS

	By	Date	Scale	Job No.	
Surveyed:	--		1:1000@A3 5 x VERT.	Drawing No. 4520–01–EW–212	Rev A
Designed:	KLP				
Drawn:	KLP	12/2022			
Approved:	BJ				

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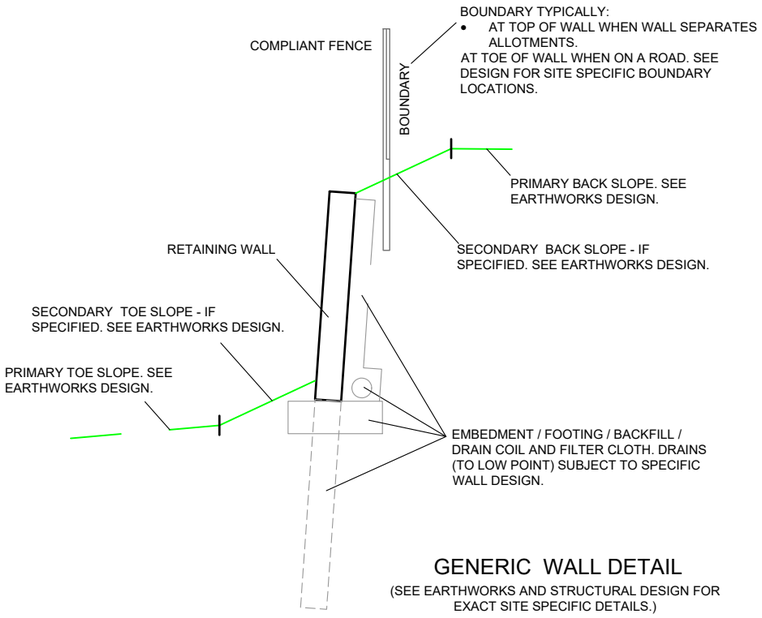
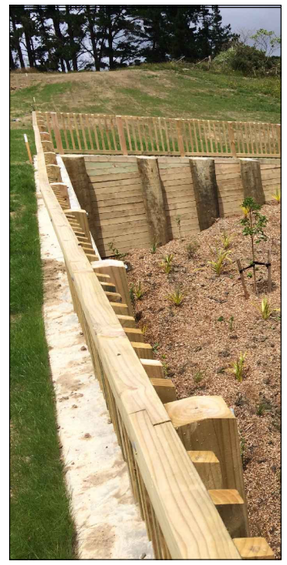


GENERIC WALL DETAIL

(SEE EARTHWORKS AND STRUCTURAL DESIGN FOR EXACT SITE SPECIFIC DETAILS.)

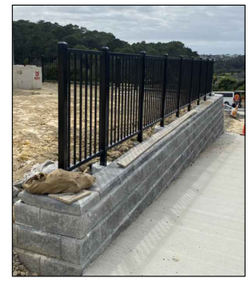
BUILDING CONSENT REQUIRED FOR RETAINING WALLS.
SEE BUILDING CONSENT FOR DETAILS

RETAINING WALL - EXAMPLE FINISH (ALLAN BLOCK - APPROX 1.5m HIGH)

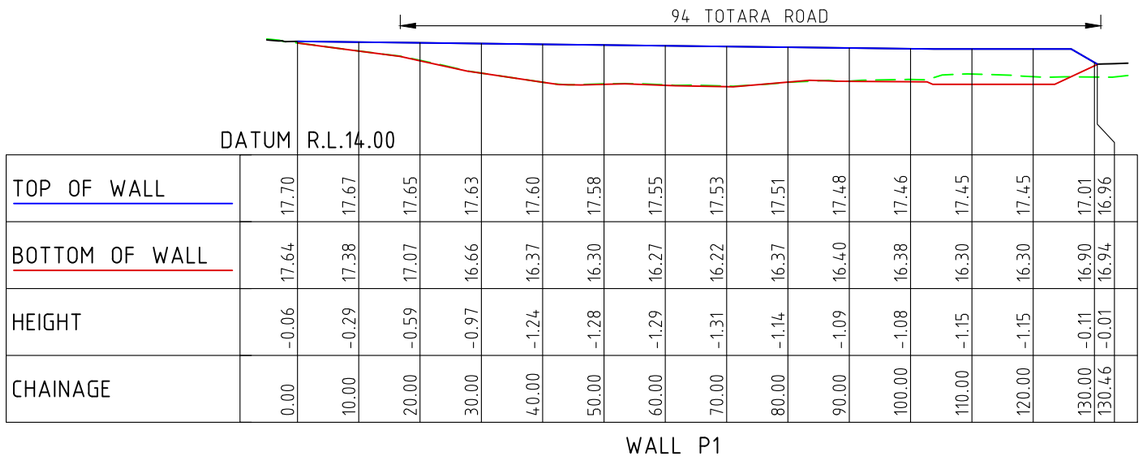


WALL FENCING EXAMPLE (WOODEN 50% VISUALLY PERVIOUS)

RETAINING WALL - EXAMPLE FINISH (STEEL POSTS AND TIMBER RAILS - APPROX 2m HIGH)



WALL FENCING EXAMPLE (STEEL 80% VISUALLY PERVIOUS)



TOP OF WALL	17.70	17.67	17.65	17.63	17.60	17.58	17.55	17.53	17.51	17.48	17.46	17.45	17.45	17.01	16.96
BOTTOM OF WALL	17.64	17.38	17.07	16.66	16.37	16.30	16.27	16.22	16.37	16.40	16.38	16.30	16.30	16.90	16.94
HEIGHT	-0.06	-0.29	-0.59	-0.97	-1.24	-1.28	-1.29	-1.31	-1.14	-1.09	-1.08	-1.15	-1.15	-0.11	-0.01
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00	120.00	130.00	130.46

WALL P1

NOTES:

1. RETAINING WALLS FACING ROAD RESERVE TO BE "ALLAN BLOCK" SEGMENTAL WALL.
2. ALL OTHER RETAINING WALLS TO BE STEEL POST AND TIMBER RAIL.
3. TOP AND BOTTOM OF WALL ARE FINISHED TOPSOIL LEVEL. TOPSOIL TO BE 150mm DEEP.
4. STEEL POST AND RAIL FENCE:
   4.1. FENCE FIXED TO WALL FACE IN COMPOSITE WALLS AND SLEEVED FOR BLOCK WALL.

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	CK	01/11/2022

THE NEIL GROUP

NEIL CONSTRUCTION LIMITED
LAND DEVELOPERS

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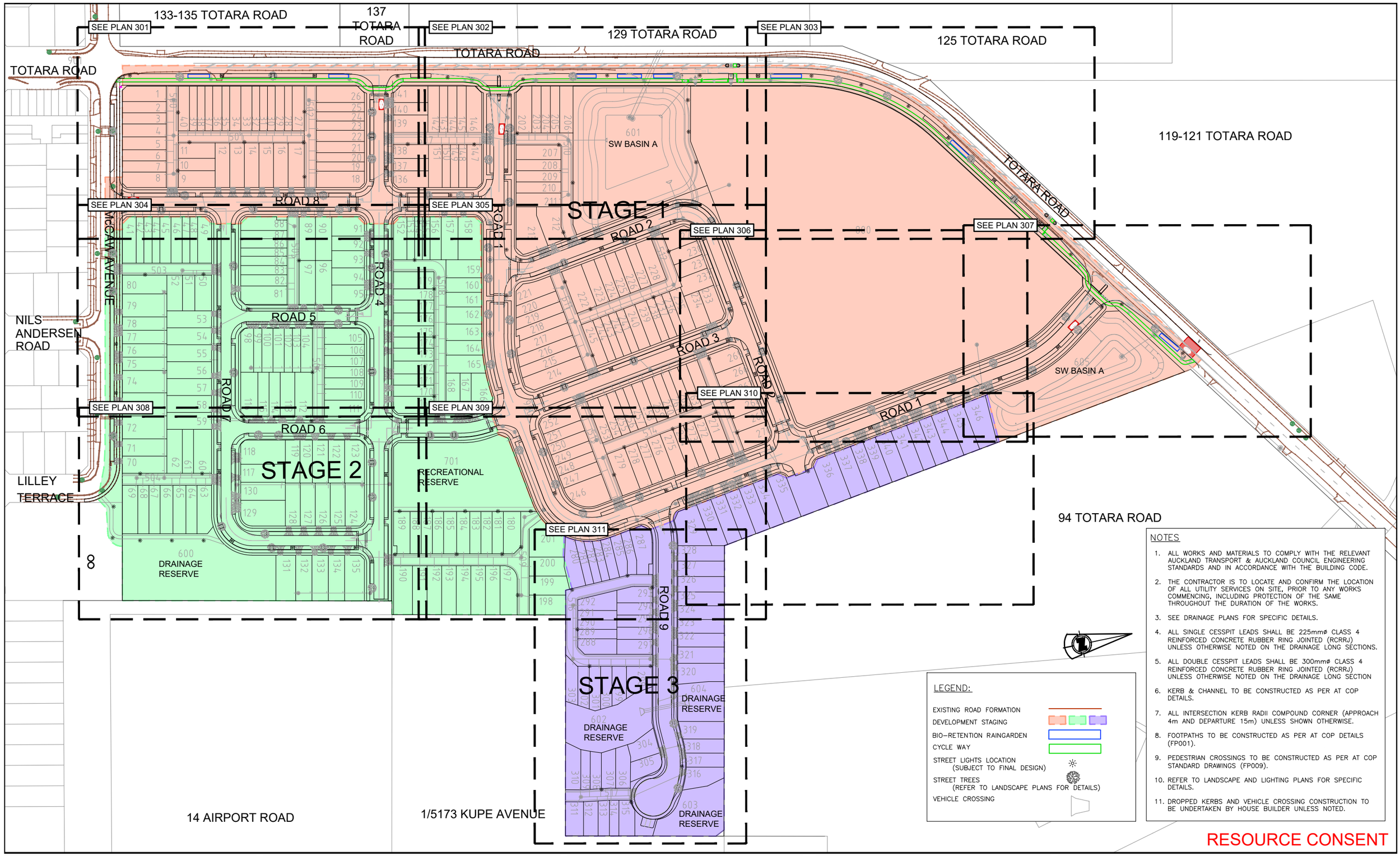
Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
EARTHWORKS
RETAINING WALL ELEVATIONS
EXAMPLES AND DETAILS

	By	Date	Scale	Job No.	Rev
Surveyed:	MS		1:1000@A3 5 x VERT.	Drawing No. 4520–01–EW–213	A
Designed:	KLP				
Drawn:	KLP	11/2022			
Approved:	BJ				



LEGEND:

- EXISTING ROAD FORMATION
- DEVELOPMENT STAGING
- BIO–RETENTION RAINGARDEN
- CYCLE WAY
- STREET LIGHTS LOCATION (SUBJECT TO FINAL DESIGN)
- STREET TREES (REFER TO LANDSCAPE PLANS FOR DETAILS)
- VEHICLE CROSSING

NOTES

1. ALL WORKS AND MATERIALS TO COMPLY WITH THE RELEVANT AUCKLAND TRANSPORT & AUCKLAND COUNCIL ENGINEERING STANDARDS AND IN ACCORDANCE WITH THE BUILDING CODE.
2. THE CONTRACTOR IS TO LOCATE AND CONFIRM THE LOCATION OF ALL UTILITY SERVICES ON SITE, PRIOR TO ANY WORKS COMMENCING, INCLUDING PROTECTION OF THE SAME THROUGHOUT THE DURATION OF THE WORKS.
3. SEE DRAINAGE PLANS FOR SPECIFIC DETAILS.
4. ALL SINGLE CESSPIT LEADS SHALL BE 225mmø CLASS 4 REINFORCED CONCRETE RUBBER RING JOINTED (RCRRJ) UNLESS OTHERWISE NOTED ON THE DRAINAGE LONG SECTIONS.
5. ALL DOUBLE CESSPIT LEADS SHALL BE 300mmø CLASS 4 REINFORCED CONCRETE RUBBER RING JOINTED (RCRRJ) UNLESS OTHERWISE NOTED ON THE DRAINAGE LONG SECTION
6. KERB & CHANNEL TO BE CONSTRUCTED AS PER AT COP DETAILS.
7. ALL INTERSECTION KERB RADII COMPOUND CORNER (APPROACH 4m AND DEPARTURE 15m) UNLESS SHOWN OTHERWISE.
8. FOOTPATHS TO BE CONSTRUCTED AS PER AT COP DETAILS (FP001).
9. PEDESTRIAN CROSSINGS TO BE CONSTRUCTED AS PER AT COP STANDARD DRAWINGS (FP009).
10. REFER TO LANDSCAPE AND LIGHTING PLANS FOR SPECIFIC DETAILS.
11. DROPPED KERBS AND VEHICLE CROSSING CONSTRUCTION TO BE UNDERTAKEN BY HOUSE BUILDER UNLESS NOTED.

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	01/11/2022

THE NEIL GROUP
NEIL CONSTRUCTION LIMITED
LAND DEVELOPERS
THE NEIL GROUP LIMITED
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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
ROADING
LAYOUT PLAN

	By	Date	Scale	Job No.	Rev
Surveyed:	MS		1: 2000@A3	Drawing No. 4520–01–RD–300	A
Designed:	KLP				
Drawn:	KLP	11/2022			
Approved:	BJ				

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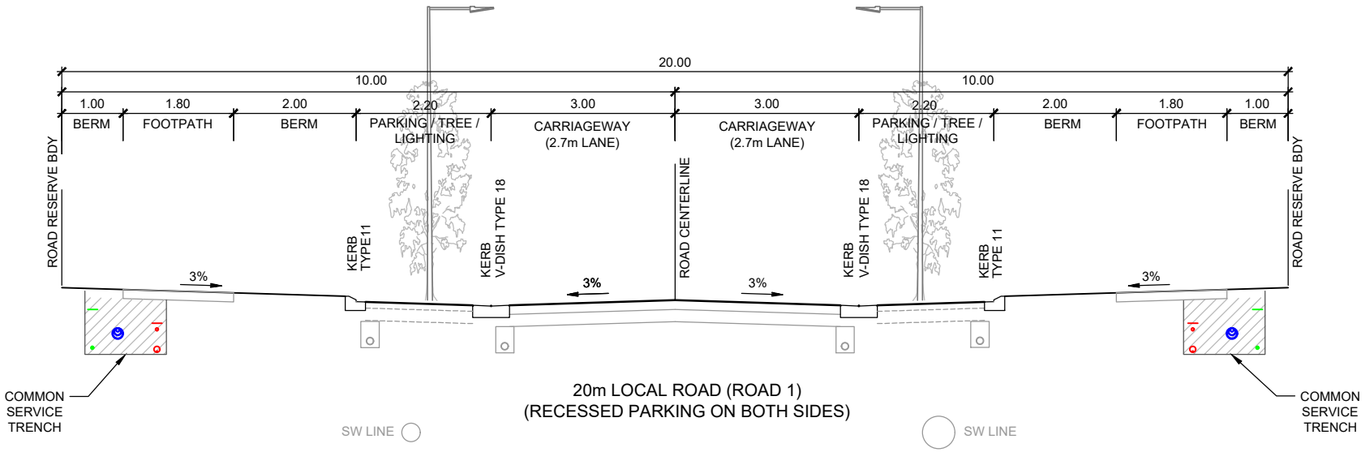
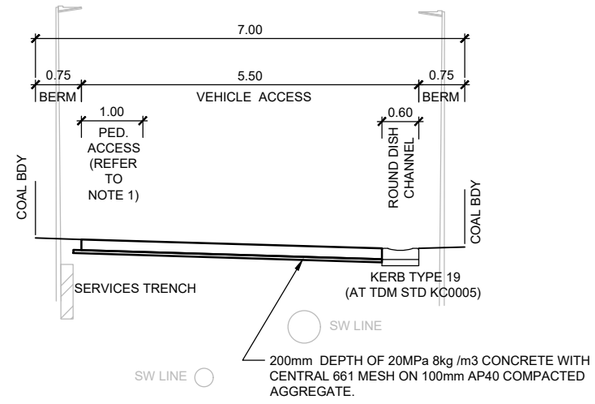
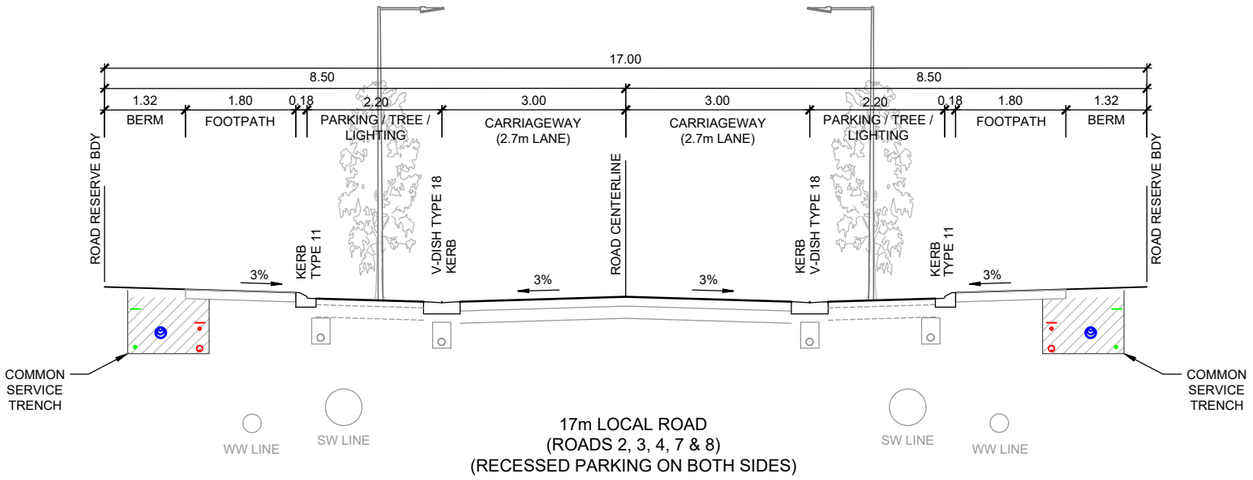


20m LOCAL ROAD (ROAD 1)
(RECESSED PARKING ON BOTH SIDES)

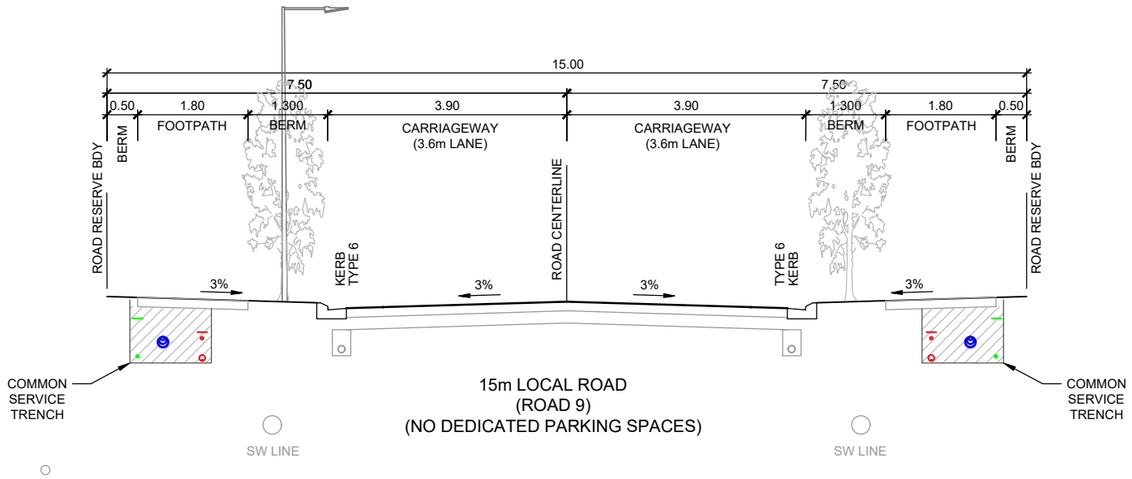


TYPICAL COAL CROSS SECTION
(SURFACE FINISHING DETAILS TBC)

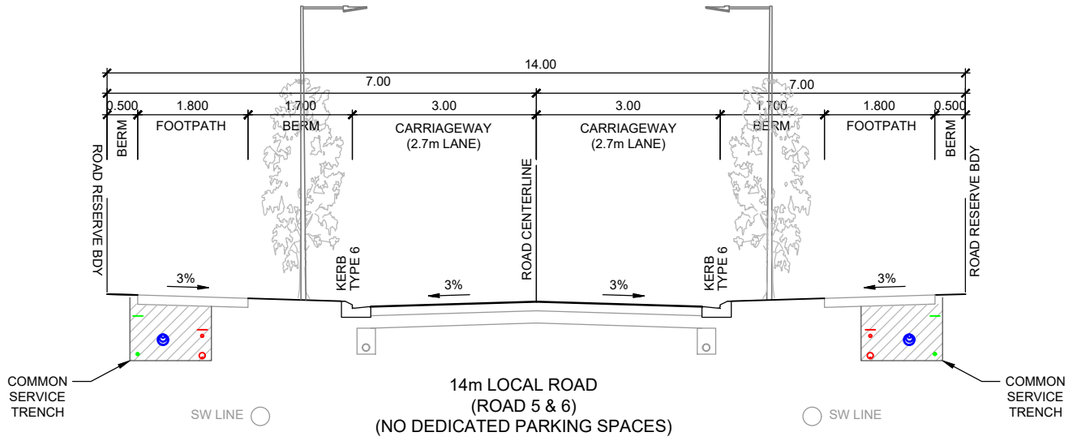
NOTE 1: PEDESTRIAN ACCESS ONLY PROVIDED FOR COALS 504, 509, 516 AND 517.



17m LOCAL ROAD
(ROADS 2, 3, 4, 7 & 8)
(RECESSED PARKING ON BOTH SIDES)



15m LOCAL ROAD
(ROAD 9)
(NO DEDICATED PARKING SPACES)



14m LOCAL ROAD
(ROAD 5 & 6)
(NO DEDICATED PARKING SPACES)

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	01/11/2022

THE NEIL GROUP
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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
ROADWORKS
TYPICAL CROSS SECTIONS

	By	Date	Scale	Job No.	
Surveyed:	MS		1:100@A3	Drawing No.	Rev
Designed:	KLP			4520–01–RD–330	A
Drawn:	KLP	11/2022			
Approved:	BJ				

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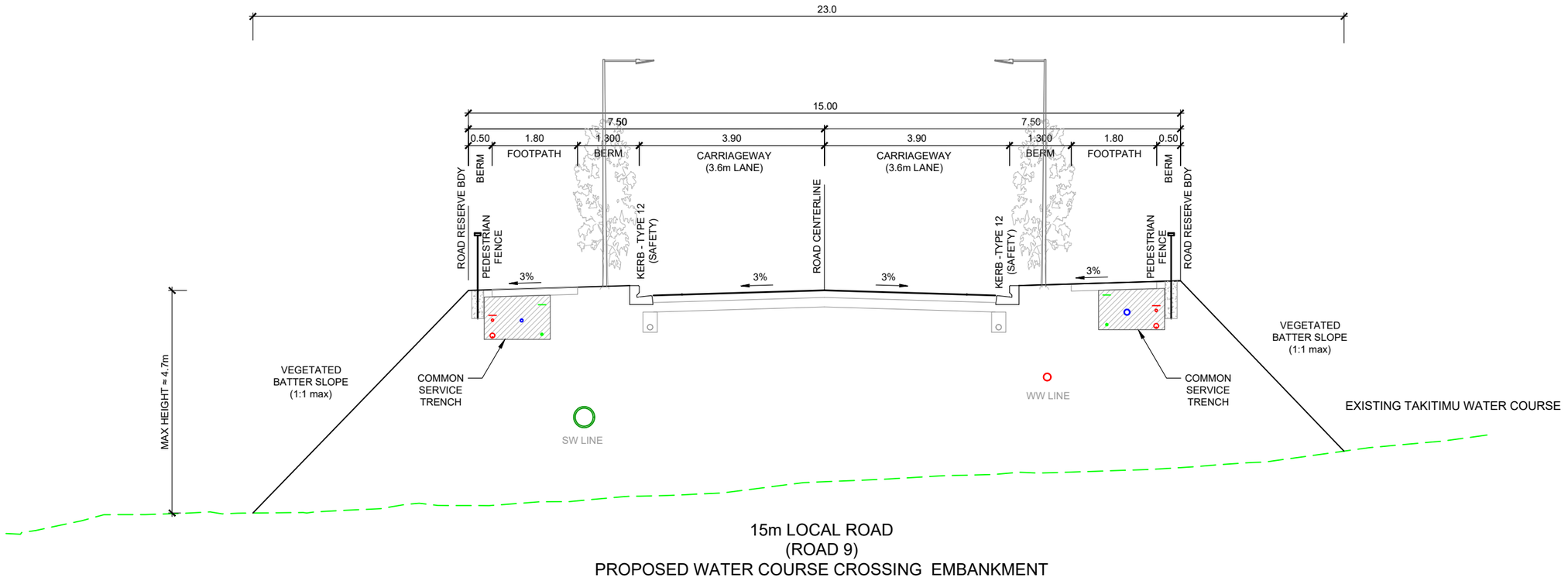

15m LOCAL ROAD
(ROAD 9)
PROPOSED WATER COURSE CROSSING EMBANKMENT

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	01/11/2022

THIS DRAWING AND DESIGN REMAINS THE PROPERTY OF
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NEIL CONSTRUCTION LIMITED
LAND DEVELOPERS
THE NEIL GROUP LIMITED
LEVEL 3, BUILDING B
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FACSIMILE: +64 9 918 6567
WEB: www.neilgroup.co.nz

Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
ROADWORKS
TYPICAL CROSS SECTIONS
WATER COURSE CROSSING

	By	Date	Scale	Job No.	
Surveyed:	MS		1:100@A3	Drawing No.	Rev
Designed:	KLP			4520–01–RD–331	A
Drawn:	KLP	11/2022			
Approved:	BJ				

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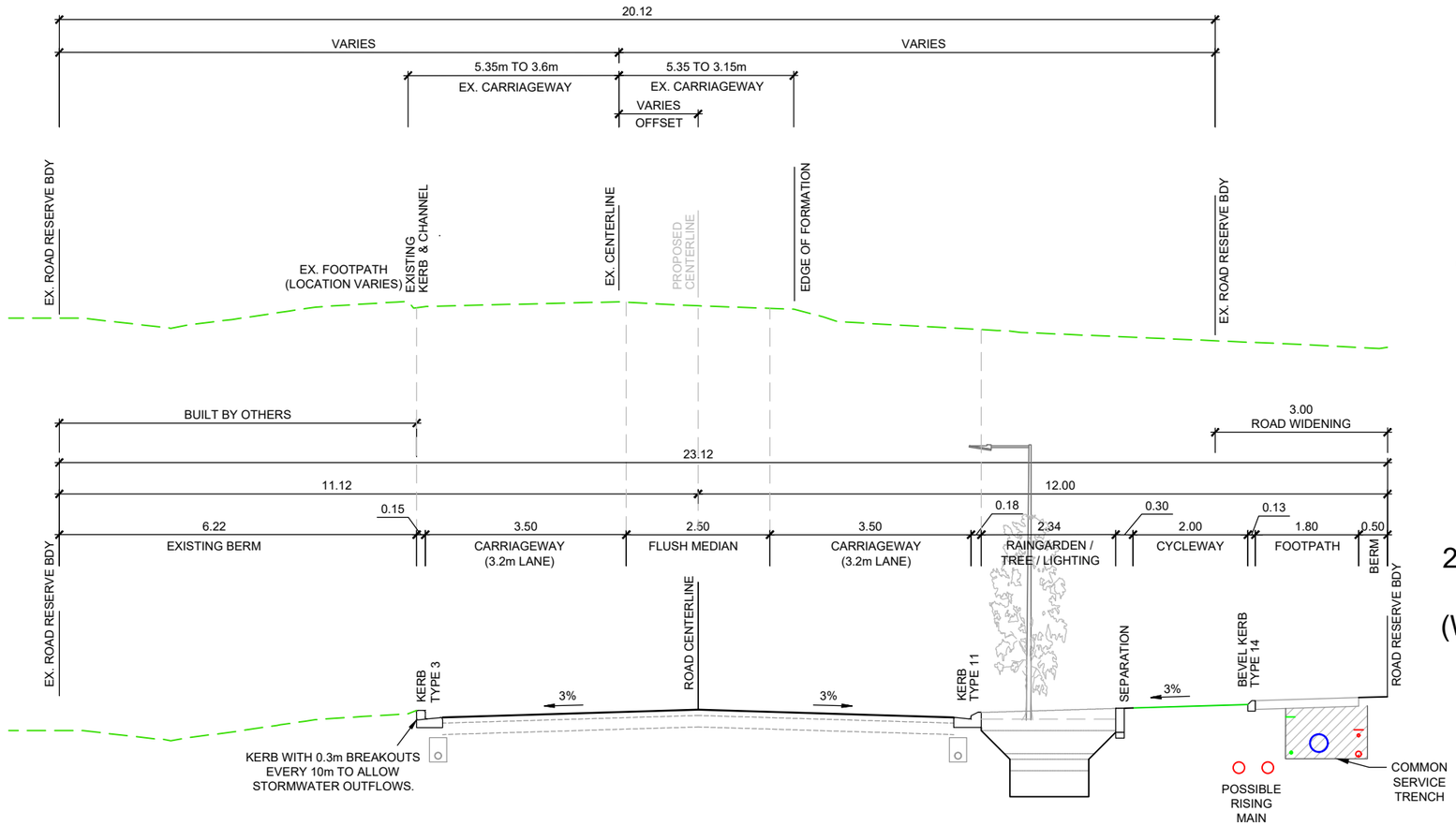
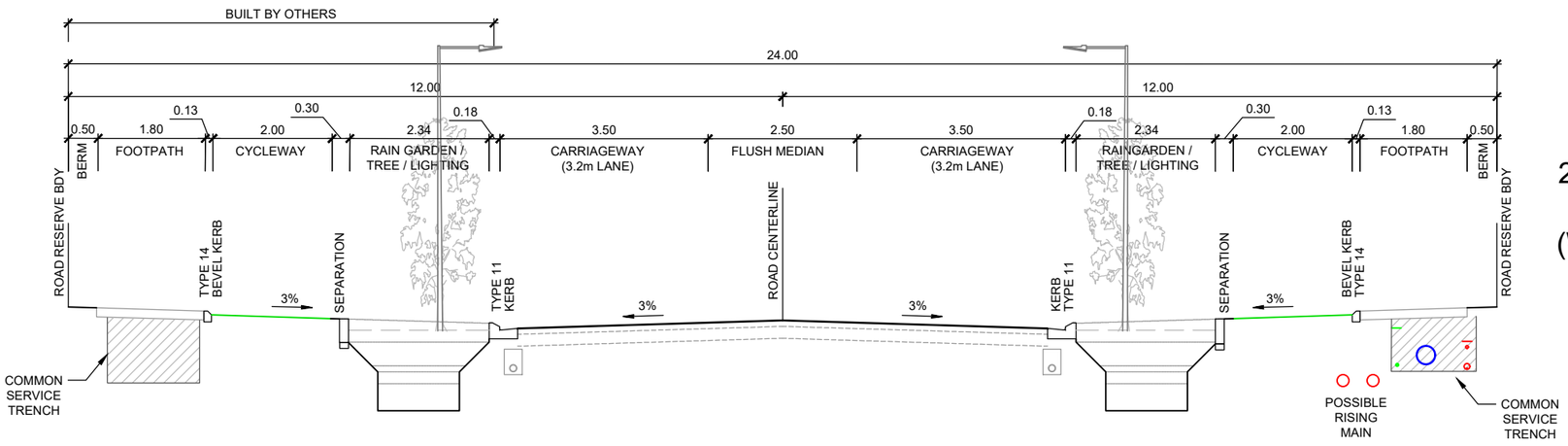


TOTARA ROAD EXISTING FORMATION
(20.12m COLLECTOR) [80km/h]
(CROSS FALL & BATTER SLOPE VARIES)



24m COLLECTOR (TOTARA ROAD) [50km/h]
(PROPOSED INTERIM DESIGN)
(WHEN ADJACENT TO RESIDENTIAL LOTS)

24m COLLECTOR (TOTARA ROAD) [50km/h]
(ULTIMATE DESIGN)
(WHEN ADJACENT TO RESIDENTIAL LOTS)

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	01/11/2022

THE NEIL GROUP

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Job Title
98–102 TOTARA ROAD
WHENUAPAI GREEN
WHENUAPAI

Drawing Title
ROADWORKS
TOTARA ROAD WIDENING
TYPICAL CROSS SECTION

	By	Date	Scale	Job No.	
Surveyed:	MS		1:100@A3	Drawing No.	Rev
Designed:	KLP			4520–01–RD–332	A
Drawn:	KLP	11/2022			
Approved:	BJ				

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Appendix C: Hand Auger Borehole Logs

HAND AUGER BOREHOLE LOG - HA01-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 13/10/2022
Borehole Location: See site plan Logged by: OP Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744061.4mE; 5927382.1mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Depth	Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT : dark brown. Low plasticity. (Topsoil)			
	0.3	Peak = 106kPa Residual = 20kPa				ML: Clayey SILT: orange brown mottled orange. Low plasticity. (Puketoka Formation)			
	0.6	Peak = 176kPa Residual = 86kPa							
	1.0	Peak = 149kPa Residual = 133kPa		1		CH: Silty CLAY: brownish white mottled orange. High plasticity. (Puketoka Formation)			
	1.2	Peak = 156kPa Residual = 76kPa							
	1.6	Peak = 183kPa Residual = 96kPa							
						... at 1.70m, Becoming purpleish grey			
	2.0	Peak = 179kPa Residual = 116kPa		2					
	2.5	Peak = UTP				*... at 2.50m, Becoming light pinkish grey*		VSt	
	3.0	Peak = 123kPa Residual = 93kPa		3					
						... at 3.10m, Iron ataining			
	3.5	Peak = 106kPa Residual = 73kPa				ML: Clayey SILT: light pinkish grey. Low plasticity. (Puketoka Formation)			
13-10-2022	4.0	Peak = 66kPa Residual = 50kPa		4					
	4.5	Peak = 159kPa Residual = 56kPa							
	5.0	Peak = 140kPa Residual = 50kPa		5		Borehole terminated at 5.0 m			

Termination Reason: Target depth
Shear Vane No: 2087 DCP No:
Remarks: Groundwater encountered 4.0m

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA02-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 13/10/2022
Borehole Location: See site plan Logged by: OP Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744206.2mE; 5927367.7mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT : dark brown. Low plasticity. (Topsoil)			
	0.3	Peak = 199kPa Residual = 100kPa				ML: Clayey SILT: orange brown mottled orange. Low plasticity. (Puketoka Formation)			
	0.6	Peak = 196kPa Residual = 103kPa							
	0.9	Peak = 199kPa Residual = 113kPa		1		CH: Silty CLAY: brownish white mottled orange. High plasticity. (Puketoka Formation)			
	1.2	Peak = UTP							
						ML: Clayey SILT: light brownish white mottled orange. Low plasticity. (Puketoka Formation)			
	1.6	Peak = 186kPa Residual = 120kPa							
	2.0	Peak = 219kPa Residual = 125kPa		2		CH: Silty CLAY: dark pinkish grey mottled orange. High plasticity. (Puketoka Formation)		VSt to H	
						... at 2.40m, Becoming white.			
	2.5	Peak = UTP							
	3.0	Peak = UTP		3					
13-10-2022	3.5	Peak = 189kPa Residual = 40kPa							
	4.0	Peak = 140kPa Residual = 43kPa		4				VSt	
	4.5	Peak = 149kPa Residual = 90kPa				ML: Clayey SILT: with some fine peat; bluish grey. Low plasticity. (Puketoka Formation)			
	5.0	Peak = 93kPa Residual = 66kPa		5		Borehole terminated at 5.0 m			

Termination Reason: Target depth
Shear Vane No: 2087 DCP No:
Remarks: Groundwater encountered 3.5m

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA03-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 13/10/2022
Borehole Location: See site plan Logged by: EM Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744323.5mE; 5927326.2mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT: black. (Topsoil)			
	0.3	Peak = >189kPa				CL: Silty CLAY: light brown mottled orange. Low plasticity. (Puketoka Formation)	D to M		
	0.6	Peak = >189kPa							
	0.9	Peak = >189kPa				... at 0.80m, becoming light grey mottled orange.			
	1.2	Peak = >189kPa		1				VSt to H	
	1.6	Peak = 143kPa Residual = 78kPa					M		
	2.0	Peak = 97kPa Residual = 57kPa		2					
13-10-2022	2.4	Peak = 70kPa Residual = 35kPa				... at 2.40m, becoming light grey, orange mottling absent.			
	2.8	Peak = 62kPa Residual = 19kPa				... at 2.80m, contains some small rootlets and black organic silt.			
				3		ML: Sandy SILT: light greyish brown. Low plasticity; sand, fine grained. (Puketoka Formation)			
						... at 2.80m, contains some small rootlets and black organic silt.		St to VSt	
	3.2	Peak = 46kPa Residual = 27kPa					S		
						... at 3.40m, becoming light grey.			
	3.6	Peak = 95kPa Residual = 32kPa							
						... at 3.80m, becoming light bluish grey.			
	4.0	Peak = UTP		4				H	
						Borehole terminated at 4.2 m			3 3 3 4 1 2 4 4
				5					

Termination Reason: Equipment refusal due to hard ground
Shear Vane No: 3239 DCP No: 22
Remarks: Groundwater encountered at 2.4m

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA04-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 14/10/2022
Borehole Location: See site plan Logged by: EM Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744229.2mE; 5927449.3mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT: black. (Topsoil)			
	0.3	Peak = 127kPa Residual = 35kPa				ML: SILT: brown. Non-plastic. (Fill)	D to M		
	0.6	Peak = >189kPa				CL: Silty CLAY: light yellowish brown. Low plasticity. (Puketoka Formation)			
	0.9	Peak = 135kPa Residual = 60kPa		1		... at 0.90m, becoming orange brown.			
	1.2	Peak = UTP							
						... at 1.40m, becoming grey mottled orange, contains some sand, fine to medium.		VSt to H	
	1.6	Peak = UTP				... at 1.60m, sand absent.	M		
	2.0	Peak = UTP		2		... at 2.10m, contains minor fine sand.			
	2.4	Peak = UTP							
	2.8	Peak = 141kPa Residual = 43kPa				ML: Sandy SILT: light grey mottled orange. Low plasticity; sand, fine to medium. (Puketoka Formation)			
14-10-2022				3		... from 2.90m to 3.00m, contains organic silt lens.	W	St to VSt	
	3.2	Peak = 95kPa Residual = 41kPa				... at 3.30m, becoming orange mottled grey.			
	3.6	Peak = 60kPa Residual = 30kPa				CL: Silty CLAY: light grey mottled orange. Low plasticity. (Puketoka Formation)			
						ML: Sandy SILT: light brownish grey. Low plasticity; sand, fine. (Puketoka Formation)			
	4.0	Peak = 46kPa Residual = 24kPa		4			S	F to St	
	4.4	Peak = 62kPa Residual = 27kPa							
	4.8	Peak = 60kPa Residual = 35kPa							
				5		Borehole terminated at 5.0 m			

Termination Reason: Target depth
Shear Vane No: 3239 DCP No:
Remarks: Groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA05-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 14/10/2022
Borehole Location: See site plan Logged by: EM Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744117.6mE; 5927450.8mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT: black. (Topsoil)			
	0.3	Peak = 81kPa Residual = 14kPa				ML: SILT: brown. Non-plastic. (Fill)	D to M	St	
						... at 0.40m, becoming brown mottled orange, contains minor clay.			
	0.6	Peak = >189kPa				CL: Silty CLAY: light yellowish brown. Low plasticity. (Puketoka Formation)			
						... at 0.80m, becoming light orange-brown with some bluish grey streaks.			
	0.9	Peak = >189kPa		1					
	1.2	Peak = UTP				... at 1.20m, becoming light bluish grey with orange mottling.	M	H	
	1.6	Peak = UTP							
	2.0	Peak = >189kPa		2		... at 2.00m, contains some sand, fine to medium.			
						ML: Sandy SILT: light grey mottled orange. Low plasticity; sand, fine to medium. (Puketoka Formation)			
						... at 2.20m, contains fine black organic silt lens.			
▼ 14-10-2022	2.4	Peak = 135kPa Residual = 81kPa				... at 2.40m, contains minor clay, sand becoming fine, orange mottling absent.	M to W	St to VSt	
						... at 2.60m, becoming orange, sand is now fine to medium.			
	2.8	Peak = 87kPa Residual = 30kPa							
				3		... at 3.00m, becoming grey mottled orange, sand is fine.			
	3.2	Peak = UTP				CL: Silty CLAY: light bluish grey. Low plasticity. (Puketoka Formation)	S		
						... at 3.40m, becoming dark orange.			
						... at 3.50m, becoming dark purplish brown, contains fine black organic silt lens.			
	3.6	Peak = UTP				... at 3.60m, material is extremely difficult to pull out of auger head.		H	1
									1
									1
									2
				4		Borehole terminated at 4.0 m			2
									3
									4
									5
									9
									11
									11
									18
									16
				5					20

Termination Reason: Equipment refusal due to hard ground
Shear Vane No: 3239 DCP No: 22
Remarks: Groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA06-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 14/10/2022
Borehole Location: See site plan Logged by: OP Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744358.2mE; 5927384.5mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
	0.3	Peak = 115kPa Residual = 29kPa				OL: Organic SILT: dark brown. Low plasticity. (Topsoil)			
	0.6	Peak = 208kPa Residual = 48kPa				CL: Silty CLAY: greyish brown mottled orange. Low plasticity. (Puketoka Formation)	D to M		
	0.9	Peak = 208kPa Residual = 83kPa		1					
	1.2	Peak = 208kPa Residual = 112kPa							
	1.5	Peak = 224kPa Residual = 109kPa				CL: Sandy SILT: light greyish white. Low plasticity. (Puketoka Formation)			
	1.8	Peak = 208kPa Residual = 112kPa							
	2.1	Peak = 183kPa Residual = 131kPa		2				VSt to H	
	2.4	Peak = 208kPa Residual = 112kPa							
	2.7	Peak = 160kPa Residual = 99kPa					M to W		
	3.0	Peak = 176kPa Residual = 102kPa		3					
	3.3	Peak = 160kPa Residual = 112kPa							
	3.6	Peak = 160kPa Residual = 144kPa							
	3.9	Peak = 130kPa Residual = 49kPa		4					
	4.5	Peak = 208kPa Residual = 160kPa				Borehole terminated at 4.5 m			
				5					

Termination Reason: Equipment refusal due to hard ground
Shear Vane No: 3434 DCP No:
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA07-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 14/10/2022
Borehole Location: See site plan Logged by: PT Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744382.7mE; 5927452.2mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT: dark brown. (Topsoil)			
	0.3	Peak = 213kPa Residual = 93kPa				CL: Clayey SILT: brownish grey mottled orange. Low plasticity. (Puketoka Formation)			
	0.6	Peak = 193kPa Residual = 100kPa				CL: Silty CLAY: light grey mottled orange. Low plasticity, moderately sensitive. (Puketoka Formation)			
	0.9	Peak = 216kPa Residual = 100kPa		1					
	1.2	Peak = UTP							
	1.6	Peak = 206kPa Residual = 130kPa				ML: Clayey SILT: with minor fine sand; light greyish brown mottled orange. Low plasticity, Iron stained. (Puketoka Formation)			
	2.0	Peak = 216kPa Residual = 106kPa		2				H	
	2.5	Peak = 203kPa Residual = 66kPa							
14-10-2022	3.0	Peak = >230kPa		3		CL: Gravelly SILT: dark pinkish grey light. Low plasticity. (Puketoka Formation) *... from 2.90m to 3.00m, Dark pinkish grey CLAY* *... from 3.30m to 3.40m, Organic/peat layer*			
	3.5	Peak = 133kPa Residual = 43kPa						VSt	
	4.0	Peak = 70kPa Residual = 47kPa		4		ML: Silty Fine to medium SAND: light grey mottled orange. Low plasticity, moderately sensitive. (Puketoka Formation)		St	
	4.5	Peak = UTP				*... at 4.50m, Becoming blueish grey.*		H	
	5.0	Peak = UTP		5		Borehole terminated at 5.0 m			

Termination Reason: Target depth
Shear Vane No: 2087 DCP No:
Remarks: Groundwater encountered at 2.9m

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA08-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 13/10/2022
Borehole Location: See site plan Logged by: EM Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744251.8mE; 5927497.6mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT: black. (Topsoil)			
	0.3	Peak = 141kPa Residual = 54kPa				CL: Silty CLAY: light brown mottled dark orange. Low plasticity. (Puketoka Formation)			
	0.6	Peak = >189kPa				... at 0.60m, becoming light grey mottled orange.	M		
	0.9	Peak = >189kPa		1				VSt to H	
	1.2	Peak = UTP							
	1.6	Peak = 119kPa Residual = 68kPa				... at 1.60m, becoming light grey.	M to W		
13-10-2022						... at 1.80m, becoming light brown.			
	2.0	Peak = 100kPa Residual = 70kPa		2					
	2.4	Peak = 65kPa Residual = 30kPa							
	2.8	Peak = 41kPa Residual = 22kPa				... at 2.80m, contains fine black organic silt lens.		F to St	
				3		ML: Sandy SILT: light greyish brown. Low plasticity; sand, fine. (Puketoka Formation)	S		
	3.2	Peak = 60kPa Residual = 35kPa							
	3.6	Peak = 84kPa Residual = 32kPa				... at 3.50m, becoming light greyish brown, contains a fine black organic silt lens.			
						... at 3.80m, contains some small rootlets and a fine black organic silt lens.			
						... at 3.90m, becoming light bluish grey.		H	
	4.0	Peak = UTP		4		Borehole terminated at 4.0 m			1, 1, 2, 2, 2, 3, 4, 5, 6, 4
				5					

Termination Reason: Equipment refusal due to hard ground
Shear Vane No: 3239 DCP No: 22
Remarks: Groundwater encountered at 2m

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA09-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 13/10/2022
Borehole Location: See site plan Logged by: PT Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744304.2mE; 5927602.4mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT: dark brown. (Topsoil)			
	0.3	Peak = 224kPa Residual = 48kPa				CL: CLAY: brownish grey. Low plasticity. (Puketoka Formation)			
	0.6	Peak = 176kPa Residual = 48kPa							
	0.9	Peak = 141kPa Residual = 48kPa		1					
	1.2	Peak = 176kPa Residual = 64kPa				CH: Silty CLAY: light greyish brown. High plasticity, moderately sensitive. (Puketoka Formation)			
	1.5	Peak = 163kPa Residual = 90kPa					M	VSt to H	
	1.8	Peak = 144kPa Residual = 61kPa							
	2.1	Peak = 160kPa Residual = 74kPa		2					
	2.4	Peak = UTP				ML: Sandy SILT: light grey. Low plasticity, moderately sensitive. (Puketoka Formation)			
	2.7	Peak = UTP							
	3.0	Peak = UTP		3		Borehole terminated at 3.0 m		D to VD	9, 13, 9, 7, 9, 10, 14, 17, 19, 20
				4					
				5					

Termination Reason: Equipment refusal due to hard ground
Shear Vane No: 3434 DCP No: 22
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA10-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 13/10/2022
Borehole Location: See site plan Logged by: PT Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744254.5mE; 5927566.9mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT: dark brown. (Topsoil)			
	0.3	Peak = 150kPa Residual = 35kPa							
						CL: Silty CLAY: brownish grey. Low plasticity. (Puketoka Formation)			
	0.6	Peak = 109kPa Residual = 32kPa							
	0.9	Peak = 150kPa Residual = 35kPa		1					
	1.2	Peak = 160kPa Residual = 64kPa					M to W		
13-10-2022	1.5	Peak = 141kPa Residual = 54kPa						VSt	
	1.8	Peak = 128kPa Residual = 42kPa							
	2.1	Peak = 112kPa Residual = 51kPa		2					
	2.4	Peak = 96kPa Residual = 51kPa				... at 2.40m, Poor recovery		St	
	2.7	Peak = 224kPa Residual = 48kPa							
	3.0	Peak = 141kPa Residual = 54kPa		3				VSt to H	
	3.3	Peak = 138kPa Residual = 64kPa					S		
	3.6	Peak = 144kPa Residual = 112kPa							
	3.9	Peak = 125kPa Residual = 80kPa		4					
	4.2	Peak = 224kPa Residual = 160kPa				ML: Sandy SILT: light grey. Low plasticity. (Puketoka Formation)			
	4.5					Borehole terminated at 4.5 m		D	9, 11, 13, 12, 17
				5					

Termination Reason: Equipment refusal due to hard ground
Shear Vane No: 3434 DCP No: 22
Remarks: Groundwater encountered at 1.6m

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA11-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 13/10/2022
Borehole Location: See site plan Logged by: EM Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744111.1mE; 5927593.4mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
13-10-2022 ▼						OL: Organic SILT: brownish black. (Topsoil)			
	0.3	Peak = 54kPa Residual = 14kPa				ML: SILT: with some clay; brown. Low plasticity. (Puketoka Formation)	M to W		
						... at 0.40m, becoming silty clay.			
	0.6	Peak = 41kPa Residual = 5kPa					W to S		
	0.9	Peak = 49kPa Residual = 5kPa		1				F to St	
	1.2	Peak = 97kPa Residual = 19kPa							
						... from 1.40m to 1.60m, contains some black organic silt.			
	1.6	Peak = UTP				... at 1.60m, becoming greyish brown with orange spots.	S		
						ML: Sandy SILT: bluish grey. Non-plastic; sand, fine. (Puketoka Formation)			
	2.0	Peak = UTP		2				H	
						... at 2.20m, contains small rootlets and green fibrous plant material.			
	2.4	Peak = UTP				... at 2.40m, low recovery.			
						Borehole terminated at 2.5 m			
				3					
				4					
				5					

Termination Reason: Equipment refusal due to hard ground
Shear Vane No: 3239 DCP No:
Remarks: Groundwater encountered at 0.8m

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA12-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 13/10/2022
Borehole Location: See site plan Logged by: PT Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744237.0mE; 5927619.6mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Depth	Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT: dark brown. (Topsoil)			
	0.3	Peak = 141kPa Residual = 19kPa							
						CL: CLAY: brownish grey. Low plasticity. (Puketoka Formation)			
	0.6	Peak = 144kPa Residual = 64kPa							
	0.9	Peak = 141kPa Residual = 48kPa		1					
						CH: Silty CLAY: light greyish brown. High plasticity, moderately sensitive. (Puketoka Formation)	M		
	1.2	Peak = 125kPa Residual = 67kPa							
	1.5	Peak = 144kPa Residual = 48kPa							
	1.8	Peak = 138kPa Residual = 51kPa				CH: Sandy CLAY: light brown. High plasticity, moderately sensitive. (Puketoka Formation)			
13-10-2022	2.1	Peak = 176kPa Residual = 61kPa		2				VSt to H	
	2.4	Peak = UTP				ML: Sandy SILT: light grey. Low plasticity. (Puketoka Formation)			
	2.7	Peak = UTP							
	3.0	Peak = UTP		3					
	3.3	Peak = UTP					W		
	3.6	Peak = UTP							
	3.9	Peak = UTP							
	4.2	Peak = UTP		4					
	4.5	Peak = UTP				Borehole terminated at 4.5 m		D	11, 18, 15, 7, 15, 17
				5					

Termination Reason: Equipment refusal due to hard ground
Shear Vane No: 3434 DCP No: 22
Remarks: Groundwater encountered at 2.1m

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA13-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 13/10/2022
Borehole Location: See site plan Logged by: PT Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744167.0mE; 5927655.6mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT: dark brown. (Topsoil)			
	0.3	Peak = 115kPa Residual = 32kPa				CL: CLAY: brownish grey. Low plasticity. (Puketoka Formation)			
	0.6	Peak = 128kPa Residual = 32kPa						VSt	
	0.9	Peak = 93kPa Residual = 29kPa		1					
	1.2	Peak = 96kPa Residual = 32kPa							
	1.5	Peak = 80kPa Residual = 35kPa					M to W	St	
	1.8	Peak = 80kPa Residual = 32kPa							
	2.1	Peak = UTP		2		ML: Sandy SILT: with minor siltstone; light grey. Low plasticity, moderately sensitive. (Puketoka Formation)			
	2.4	Peak = UTP							
	2.7	Peak = UTP						H	
	3.0	Peak = UTP		3					
						Borehole terminated at 3.2 m			3 4 4 6 8 7
								MD to D	10 10 11 12 13 20
				4					
				5					

Termination Reason: Equipment refusal due to hard ground
Shear Vane No: 3434 DCP No: 906
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA14-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 13/10/2022
Borehole Location: See site plan Logged by: PT Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744176.4mE; 5927729.1mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
13-10-2022 ▼	0.3	Peak = 144kPa Residual = 45kPa		0		OL: Organic SILT: dark brown. (Topsoil)			
	0.6	Peak = 192kPa Residual = 77kPa				CL: Silty CLAY: light grey. Low plasticity, moderately sensitive. (Puketoka Formation)	M	VSt	
	0.9	Peak = 160kPa Residual = 74kPa		1					
	1.2	Peak = 102kPa Residual = 45kPa							
	1.5	Peak = 128kPa Residual = 48kPa							
	1.8	Peak = 99kPa Residual = 51kPa							
	2.1	Peak = 96kPa Residual = 32kPa		2		ML: Sandy SILT: light grey. Low plasticity, moderately sensitive. (Puketoka Formation)		St to VSt	
	2.4	Peak = 128kPa Residual = 51kPa							
	2.7	Peak = 157kPa Residual = 58kPa				*... from 2.70m to 3.00m, Poor recovery*			
	3.0	Peak = 192kPa Residual = 48kPa		3		CL: Silty CLAY: light grey mottled light brown. Low plasticity, moderately sensitive. (Puketoka Formation)	W		
	3.3	Peak = 205kPa Residual = 45kPa				ML: Sandy SILT: light grey. Low plasticity, moderately sensitive. (Puketoka Formation)			
	3.6	Peak = 224kPa Residual = 54kPa							
	3.9	Peak = 224kPa Residual = 48kPa		4				H	
	4.2	Peak = UTP							
	4.5	Peak = UTP							
	4.8	Peak = UTP							
				5		Borehole terminated at 5.0 m			

Termination Reason: Target depth
Shear Vane No: 3434 DCP No:
Remarks: Groundwater encountered at 1.1m

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA15-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 13/10/2022
Borehole Location: See site plan Logged by: OP Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744287.9mE; 5927842.2mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Depth	Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT : dark brown. Low plasticity. (Topsoil)			
	0.3	Peak = 179kPa Residual = 76kPa				ML: Clayey SILT: orange brown mottled orange. Low plasticity. (Puketoka Formation)			
	0.6	Peak = >230kPa Residual = 90kPa				... at 0.70m, Becoming light yellowish brown.			
	0.9	Peak = 203kPa Residual = 106kPa		1		CH: Silty CLAY: brownish white mottled orange. High plasticity. (Puketoka Formation)			
	1.2	Peak = 169kPa Residual = 96kPa					M		
	1.6	Peak = 159kPa Residual = 66kPa							
	2.0	Peak = 159kPa Residual = 83kPa		2		... from 2.00m to 2.30m, Minor fine to coarse sand.			
	2.5	Peak = 130kPa Residual = 75kPa				... from 2.50m to 2.70m, Becoming orangeish brown.		VSt to H	
13-10-2022							M to W		
	3.0	Peak = 100kPa Residual = 53kPa		3					
	3.5	Peak = 146kPa Residual = 83kPa				... at 3.50m, Becoming grey.			
	4.0	Peak = 206kPa Residual = 33kPa		4			S		
						ML: Clayey SILT: grey. Low plasticity. (Puketoka Formation)			
	4.5	Peak = 226kPa Residual = 75kPa							
						ML: SILT: grey. Low plasticity. (Puketoka Formation)			
	5.0	Peak = UTP		5		Borehole terminated at 5.0 m			

Termination Reason: Target depth
Shear Vane No: 2087 DCP No:
Remarks: Groundwater encountered at 2.9m

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA16-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 13/10/2022
Borehole Location: See site plan Logged by: OP Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744267.7mE; 5927705.7mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT : dark brown. Low plasticity. (Topsoil)			
	0.3	Peak = >230kPa Residual = 63kPa				ML: SILT: brown orange. Low plasticity. (Puketoka Formation)			
	0.6	Peak = 216kPa Residual = 96kPa				*... at 0.50m, Becoming greyish brown mottled orange.*		H	
	0.9	Peak = 153kPa Residual = 63kPa				ML: Clayey SILT: light greyish brown. Low plasticity. (Puketoka Formation)			
				1					
13-10-2022	1.2	Peak = 120kPa Residual = 28kPa						VSt	
						... at 1.50m, Becoming iron stained.			
	1.6	Peak = 66kPa Residual = 25kPa							
	2.0	Peak = 83kPa Residual = 43kPa		2					
	2.5	Peak = 100kPa				ML: Sandy SILT: light greyish brown. Low plasticity, Iron stained. (Puketoka Formation)			
	3.0	Peak = 133kPa Residual = 40kPa		3				St to VSt	
	3.5	Peak = 159kPa Residual = 76kPa				ML: SILT: grey. Low plasticity. (Puketoka Formation)			
	4.0	Peak = 183kPa Residual = 40kPa		4					
	4.5	Peak = UTP							
						... at 4.70m, Trace fine sand,		VSt to H	
	5.0	Peak = 174kPa		5		Borehole terminated at 5.0 m			

Termination Reason: Target depth
Shear Vane No: 2087 DCP No:
Remarks: Groundwater encountered at 1.5m

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA17-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 14/10/2022
Borehole Location: See site plan Logged by: PT Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744347.7mE; 5927873.9mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Depth	Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
14-10-2022						OL: Organic SILT: dark brown. Low plasticity. (Topsoil)			
	0.3	Peak = 160kPa Residual = 74kPa				CH: Silty CLAY: greyish brown mottled orange. High plasticity. (Puketoka Formation)	M to W	VSt	
	0.6	Peak = 176kPa Residual = 80kPa							
	0.9	Peak = 176kPa Residual = 29kPa		1					
	1.2	Peak = 160kPa Residual = 26kPa							
	1.5	Peak = 176kPa Residual = 80kPa							
	1.8	Peak = 160kPa Residual = 96kPa							
	2.1	Peak = 144kPa Residual = 99kPa		2					
	2.4	Peak = 128kPa Residual = 67kPa							
	2.7	Peak = 96kPa Residual = 61kPa						St	
	3.0	Peak = 112kPa Residual = 64kPa		3		ML: Sandy SILT: light greyish white. Low plasticity. (Puketoka Formation)	W		
	3.3	Peak = 125kPa Residual = 48kPa							
	3.6	Peak = 128kPa Residual = 67kPa							
	3.9	Peak = 144kPa Residual = 80kPa				ML: Sandy SILT: light grey. Low plasticity, Iron stained. (Puketoka Formation)		VSt to H	
	4.2	Peak = 160kPa Residual = 99kPa		4					
	4.5	Peak = 176kPa Residual = 131kPa							
	4.8	Peak = UTP							
				5		Borehole terminated at 5.0 m			

Termination Reason: Target depth
Shear Vane No: 3434 DCP No:
Remarks: Groundwater encountered at 0.9m

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA18-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 14/10/2022
Borehole Location: See site plan Logged by: OP Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744376.6mE; 5927751.3mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Depth	Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT: dark brown. (Topsoil)	D to M		
	0.3	Peak = 60kPa Residual = 23kPa				CL: Clayey SILT: with trace fine to coarse sand; orange brown. Low plasticity. (Puketoka Formation)	M to W	St	
	0.6	Peak = 143kPa Residual = 13kPa							
	0.9	Peak = 146kPa Residual = 70kPa							
				1		CL: Silty CLAY: light brownish grey mottled orange. Low plasticity, moderately sensitive. (Puketoka Formation)			
	1.2	Peak = UTP				... at 1.30m, Becoming light brownish white mottled orange.			
	1.6	Peak = 163kPa Residual = 70kPa				ML: SILT: with some clay; light brownish white mottled orange. Low plasticity. (Puketoka Formation)			
	2.0	Peak = 209kPa Residual = 123kPa		2			W		
	2.5	Peak = 209kPa Residual = 116kPa				CL: CLAY: sandy silt; greyish brown mottled orange. Low plasticity, Some pink mottles. (Puketoka Formation)		VSt to H	
						ML: Clayey SILT: greyish brown. Low plasticity, Iron stained. (Puketoka Formation)			
14-10-2022	3.0	Peak = 189kPa Residual = 103kPa		3					
						ML: Sandy SILT: light grey mottled orange. Low plasticity, moderately sensitive. (Puketoka Formation)			
	3.5	Peak = 169kPa Residual = 90kPa							
	4.0	Peak = 169kPa Residual = 56kPa		4			S		
	4.5	Peak = 130kPa Residual = 83kPa				ML: Sandy SILT: bluish grey. Low plasticity. (Waitemata Group)			
	5.0	Peak = UTP		5		Borehole terminated at 5.0 m			

Termination Reason: Target depth
Shear Vane No: 2087 DCP No:
Remarks: Groundwater encountered at 3.2

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA19-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 13/10/2022
Borehole Location: See site plan Logged by: EM Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744389.3mE; 5927638.6mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Depth	Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT: black. (Topsoil)	D to M		
	0.3	Peak = UTP				ML: SILT: brown. Non-plastic. (Fill)		H	
						ML: SILT: with minor clay; orange brown. Low plasticity. (Puketoka Formation)			
	0.6	Peak = 138kPa Residual = 54kPa				CL: Silty CLAY: orange brown. Low plasticity. (Puketoka Formation)			
	0.9	Peak = 92kPa Residual = 32kPa						VSt to St	
				1		... at 1.00m, becoming lighter yellow-orange brown.	M		
	1.2	Peak = >189kPa				... at 1.20m, becoming light greyish brown mottled orange.			
						... at 1.40m, contains some sand, fine.			
13-10-2022	1.6	Peak = >189kPa				ML: Sandy SILT: light greyish brown mottled orange. Low plasticity; sand, fine to medium. (Puketoka Formation)		H	
	2.0	Peak = UTP		2		... at 2.00m, still sandy silt, sand becoming fine to coarse.			
						... at 2.20m, contains minor siltstone fine.			
	2.4	Peak = 78kPa Residual = 14kPa					S		
	2.8	Peak = 154kPa Residual = 35kPa				ML: Sandy SILT: with minor fine gravel; light grey mottled orange. Low plasticity; sand, fine. (Puketoka Formation)		St to VSt	
				3		... at 3.00m, becoming grey with white mottling. Contains some fine to medium gravel.			
	3.2	Peak = UTP				Borehole terminated at 3.2 m			3
				4					4
									4
									4
									6
									7
									6
									6
									7
									9
									10
									10
									11
									10
									12
									16
				5					16

Termination Reason: Equipment refusal due to hard ground
Shear Vane No: 3239 DCP No: 22
Remarks: Groundwater encountered at 1.6m

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA20-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 14/10/2022
Borehole Location: See site plan Logged by: EM Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744372.8mE; 5927538.7mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT: black. (Topsoil)			
	0.3	Peak = >189kPa				CL: Silty CLAY: with some fine sand; brown mottled orange. Low plasticity. (Puketoka Formation)			
						... at 0.40m, becoming light brownish grey mottled orange, sand absent.	M		
	0.6	Peak = >189kPa						H	
	0.9	Peak = 122kPa Residual = 43kPa				*... at 0.90m, becoming light grey mottled orange.*			
14-10-2022	1.2	Peak = UTP		1			W		
	1.6	Peak = 68kPa Residual = 22kPa							
	2.0	Peak = 106kPa Residual = 51kPa		2		ML: Sandy SILT: light grey mottled orange. Non-plastic, sand, fine. (Puketoka Formation)		St to VSt	
	2.4	Peak = UTP				*... at 2.40m, becoming light bluish grey mottled orange.*	S		
	2.8	Peak = >189kPa				CL: Silty CLAY: with minor fine sand; bluish grey mottled orange. Low plasticity. (Puketoka Formation)			
				3		*... at 3.00m, orange mottling absent.*		H	
	3.2	Peak = UTP				ML: Sandy SILT: bluish grey. Non-plastic, sand, fine. (Puketoka Formation)			
	3.6	Peak = UTP							
						Borehole terminated at 3.7 m			3
				4					5
									4
									5
									10
									11
									14
									15
									15
									15
				5					

Termination Reason: Equipment refusal due to hard ground
Shear Vane No: 3239 DCP No: 22
Remarks: Groundwater encountered at 1.4m

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA21-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 14/10/2022
Borehole Location: See site plan Logged by: EM Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744471.0mE; 5927599.3mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
14-10-2022	0.3	Peak = >189kPa		0		OL: Organic SILT: black. (Topsoil)			
	0.6	Peak = >189kPa				CL: Silty CLAY: brown mottled orange. Low plasticity. (Puketoka Formation)	M		
	0.9	Peak = >189kPa				... at 0.80m, becoming grey mottled orange.			
	1.2	Peak = UTP		1					
	1.6	Peak = 116kPa Residual = 43kPa				ML: Sandy SILT: light grey mottled orange. Low plasticity; sand, fine. (Puketoka Formation)			
						CL: Silty CLAY: light bluish grey mottled orange. Low plasticity. (Puketoka Formation)			
	2.0	Peak = UTP		2		ML: Sandy SILT: light grey mottled orange. Low plasticity; sand, fine. (Puketoka Formation)			
						... at 2.20m, becoming bluish grey mottled orange.	S		
	2.4	Peak = UTP				CL: Silty CLAY: bluish grey mottled orange. Low plasticity. (Puketoka Formation)			
						ML: Sandy SILT: bluish grey mottled orange. Low plasticity; sand, fine. (Puketoka Formation)			
	2.8	Peak = UTP				... at 2.90m, becoming bluish grey, orange mottling absent.			3
				3		Borehole terminated at 3.0 m			6
									7
									6
									8
									9
									8
									12
									13
									16
				4					15
									15
				5					

Dynamic Cone Penetrometer (Blows/100mm): 5 10 15

Termination Reason: Equipment refusal due to hard ground
Shear Vane No: 3239 DCP No: 22
Remarks: Groundwater encountered at 1.5

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA22-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 13/10/2022
Borehole Location: See site plan Logged by: OP Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744460.7mE; 5927536.6mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT : dark brown. Low plasticity. (Topsoil)			
	0.3	Peak = UTP				ML: Sandy SILT: orange brown orange. Low plasticity. (Puketoka Formation)			
	0.6	Peak = >230kPa Residual = 116kPa				*... at 0.50m, Becoming blueish grey, iron stained*			
	0.9	Peak = UTP		1				H	
						... at 1.10m, Becoming lighter grey.	M		
	1.6	Peak = 126kPa Residual = 66kPa							
13-10-2022	2.0	Peak = 126kPa Residual = 47kPa		2		ML: Clayey SILT: with minor fine sand; light greyish brown mottled orange. Low plasticity. (Waitemata Group)			
	2.5	Peak = 149kPa Residual = 83kPa							
	3.0	Peak = UTP		3		ML: Sandy SILT: grey. Low plasticity. (Waitemata Group)		VSt to H	
	3.5	Peak = UTP					S		
	4.0	Peak = UTP		4					
	4.5	Peak = UTP							
	5.0	Peak = UTP		5		Borehole terminated at 5.0 m			

Termination Reason: Target depth
Shear Vane No: 2087 DCP No:
Remarks: Groundwater encountered at 2.2m

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA23-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 14/10/2022
Borehole Location: See site plan Logged by: PT Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744522.6mE; 5927600.0mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT: dark brown. Low plasticity. (Topsoil)			
	0.3	Peak = 189kPa Residual = 48kPa				CL: CLAY: brown. Low plasticity. (Puketoka Formation)			
	0.6	Peak = 224kPa Residual = 128kPa				ML: SILT: with some fine sand; grey. Low plasticity. (Puketoka Formation)			
	0.9	Peak = 192kPa Residual = 112kPa		1					
	1.2	Peak = 224kPa Residual = 128kPa							
	1.5	Peak = 224kPa Residual = 128kPa							
	1.8	Peak = 208kPa Residual = 80kPa					M to W		
	2.1	Peak = 176kPa Residual = 64kPa		2		ML: Sandy SILT: light greyish white. Low plasticity. (Puketoka Formation)			
	2.4	Peak = 192kPa Residual = 32kPa							
	2.7	Peak = 208kPa Residual = 61kPa						VSt to H	
	3.0	Peak = 208kPa Residual = 61kPa		3					
	3.3	Peak = 224kPa Residual = 80kPa							
	3.6	Peak = 224kPa Residual = 112kPa							
14-10-2022	3.9	Peak = 224kPa Residual = 96kPa		4					
	4.2	Peak = 224kPa Residual = 64kPa							
	4.5	Peak = UTP					W		
				5		Borehole terminated at 5.0 m			

Termination Reason: Target depth
Shear Vane No: 3434 DCP No:
Remarks: Groundwater encountered at 3.9m

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA24-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 14/10/2022
Borehole Location: See site plan Logged by: OP Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744535.8mE; 5927574.5mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Depth	Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
						OL: Organic SILT: dark brown. (Topsoil)	D to M		
	0.3	Peak = >230kPa				ML: Clayey SILT: with trace fine to coarse sand; orange brown. Low plasticity. (Puketoka Formation)			
	0.6	Peak = 153kPa Residual = 33kPa				CL: Silty CLAY: light brownish grey mottled orange. Low plasticity, moderately sensitive. (Puketoka Formation)		H	
	0.9	Peak = 176kPa Residual = 47kPa							
				1		CL: Clayey SILT: with minor fine sand; light brownish grey. Low plasticity, Iron staining between 1m and 1.5m. (Puketoka Formation)			
	1.2	Peak = 216kPa Residual = 73kPa							
	1.6	Peak = 216kPa Residual = 90kPa					M to W		
	2.0	Peak = 173kPa Residual = 66kPa		2					
						... at 2.20m, Becoming iron stained			
14-10-2022	2.5	Peak = 179kPa Residual = 53kPa						VSt to H	
	3.0	Peak = 166kPa Residual = 73kPa		3					
	3.5	Peak = 173kPa Residual = 63kPa				ML: Sandy SILT: light orange grey. Low plasticity. (Puketoka Formation)			
						ML: Clayey SILT: greyish brown. Low plasticity, Iron stained. (Puketoka Formation)	S		
	4.0	Peak = 209kPa		4		ML: Sandy SILT: bluish grey. Low plasticity. (Waitemata Group)			
	4.5	Peak = UTP							
	5.0	Peak = UTP		5		Borehole terminated at 5.0 m			

Termination Reason: Target depth
Shear Vane No: 2087 DCP No:
Remarks: Groundwater encountered 2.8m

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA25-22

Client: Neil Construction Limited
Project: 98-100 Totara Road, Whenuapai
Site Location: Whenuapai
Project No.: AKL2018-0085
Date: 14/10/2022
Borehole Location: See site plan Logged by: PT Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 1744499.0mE; 5927525.5mN Projection: NZTM
Datum: AUCKHT1946 Survey Source: pLog Tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
	0.3	Peak = 173kPa Residual = 48kPa				OL: Organic SILT: dark brown. Low plasticity. (Topsoil)			
	0.6	Peak = 192kPa Residual = 64kPa				CL: Silty CLAY: greyish brown mottled orange. Low plasticity. (Puketoka Formation)		VSt to H	
	0.9	Peak = 179kPa Residual = 61kPa		1					
	1.2	Peak = 192kPa Residual = 83kPa				ML: Sandy SILT: grey. Low plasticity. (Waitemata Group)			
	1.5	Peak = 224kPa Residual = 83kPa				Borehole terminated at 1.7 m		D to VD	6, 9, 9, 9, 11, 7, 9, 10, 11, 15, 12, 20
				2					
				3					
				4					
				5					

Termination Reason: Equipment refusal due to hard ground
Shear Vane No: 3434 DCP No: 22
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

Appendix D: Soakage Test Results

SS01-22

CMW Geosciences	CLIENT: Neil Construction Ltd	DESIGNER:	PT
	PROJECT: - 98-100 Totara Road	CHECKED:	-
		REVISION:	4
	TITLE: Falling Head Permeability Test	DATE:	17/10/2022
		PROJECT:	AKL2018-0085

Specifications - Open-Ended Tube

Length L_1:	1.5	m
Diameter:	100	mm
Non-Perm L_2:		m
Above Gnd L_3:		m

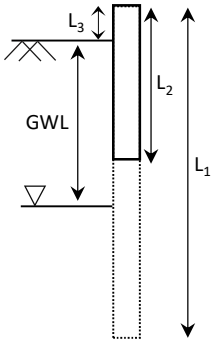
Ground Conditions

GWL: 0.3 m BGL (Blank = Bottom of hole)

Permeability Anisotropy

m: 1 $m = \sqrt{k_h/k_v}$

Bottom of Test Hole: 1.50 m BGL



Hydraulic Conductivity (k)

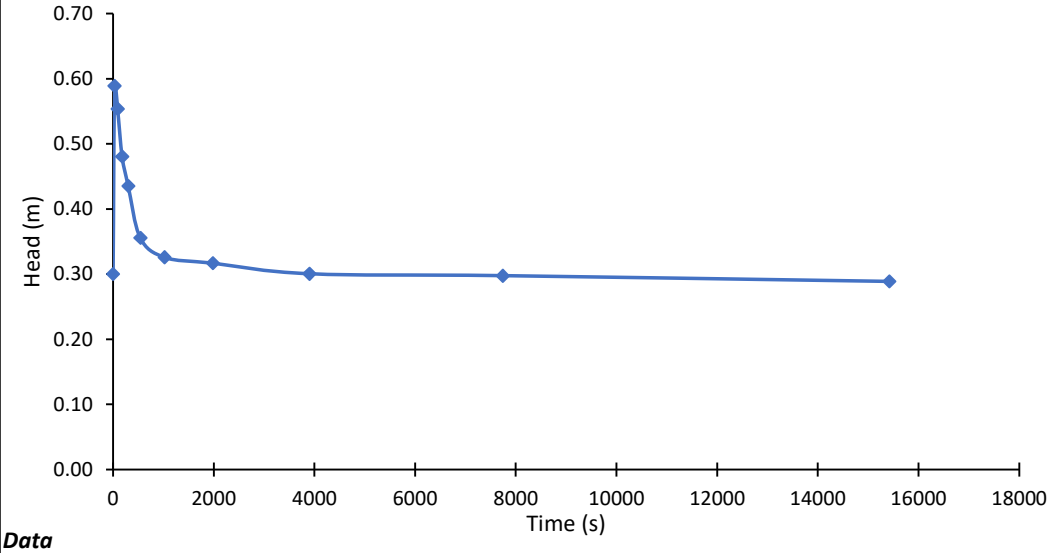
Note: CMW considers the CIRIA 113 value the most appropriate method for most purposes, but also provides the analysis method as outlined by Hvorslev if desired.

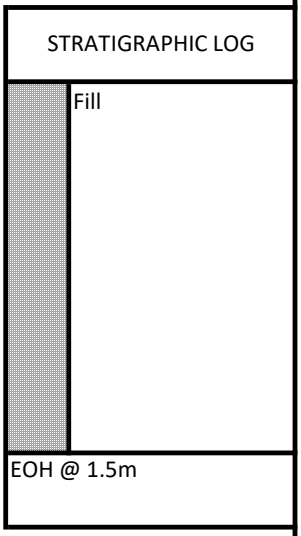
CIRIA 113: Somerville (1986), *Control of groundwater for temporary works,* CIRIA Report 113, Appendix 4

$$k = \left(log\frac{h_1}{h_2} - log\frac{2h_1 + d}{2h_2 + d}\right) \cdot \frac{(h_1 + h_2)}{2(t_2 - t_1)} =$$ -3.78E-05 ms^{-1} : -3.27 m/day

Hvorslev: Hvorslev (1951) *Time Lag and Soil Permeability in Ground-Water Observations* , Fig 18, p49

$$k = \frac{d^2 \ln\left(\frac{mL}{d} + \sqrt{\left(\frac{mL}{d}\right)^2 + 1}\right)}{2L \ln\frac{H_1}{H_2}} =$$ -5.09E-06 ms^{-1} : -0.44 m/day





Data

Time (s)	Tape Avg (m)	Head (m)	Perm. Length (m)		Hvorslev 'k' Case G (ms^{-1})	CIRIA 113 'k' (ms^{-1})
0	0.000	0.300				
30	-0.289	0.589	1.500		-6.37E-05	-4.67E-04
90	-0.253	0.553	1.500		2.92E-06	2.06E-05
180	-0.180	0.480	1.500		4.46E-06	3.13E-05
300	-0.135	0.435	1.500		2.32E-06	1.60E-05
540	-0.056	0.356	1.500		2.39E-06	1.64E-05
1020	-0.026	0.326	1.500		5.19E-07	3.47E-06
1980	-0.017	0.317	1.500		8.37E-08	5.55E-07
3900	0.000	0.300	1.500		7.75E-08	5.11E-07
7740	0.002	0.298	1.499		7.16E-09	4.70E-08
15420	0.011	0.289	1.493		1.10E-08	7.17E-08

SS02-22

CMW Geosciences	CLIENT: Neil Construction Ltd	DESIGNER:	PT
	PROJECT: - 98-100 Totara Road	CHECKED:	-
		REVISION:	4
	TITLE: Falling Head Permeability Test	DATE:	17/10/2022
		PROJECT:	AKL2018-0085

Specifications - Open-Ended Tube

Length L_1:	1.5	m
Diameter:	100	mm
Non-Perm L_2:		m
Above Gnd L_3:		m

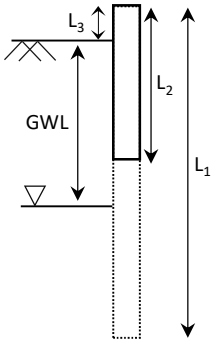
Ground Conditions

GWL: 0.9 m BGL (Blank = Bottom of hole)

Permeability Anisotropy

m: 1 $m = \sqrt{k_h / k_v}$

Bottom of Test Hole: 1.50 m BGL



Hydraulic Conductivity (k)

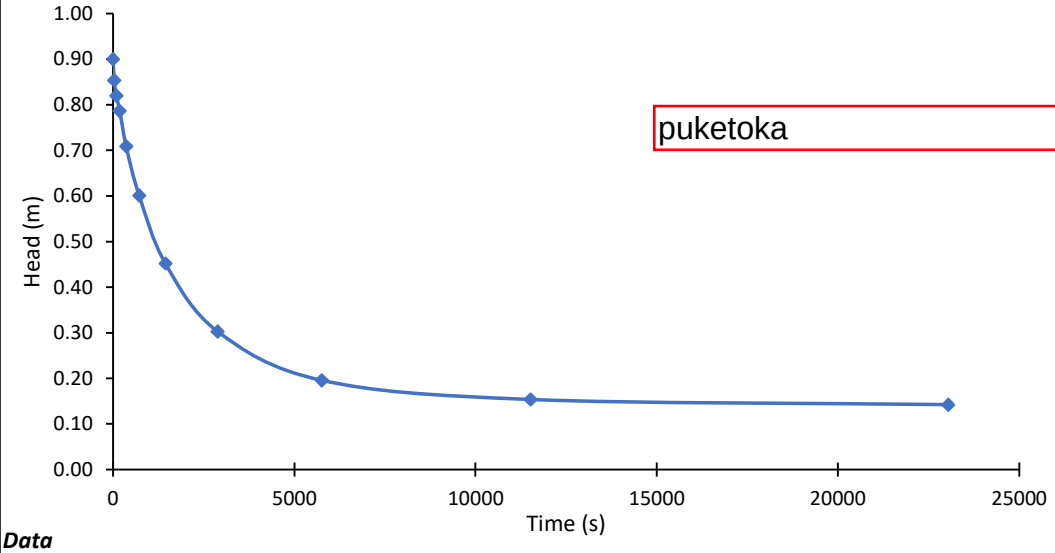
Note: CMW considers the CIRIA 113 value the most appropriate method for most purposes, but also provides the analysis method as outlined by Hvorslev if desired.

CIRIA 113: Somerville (1986), *Control of groundwater for temporary works,* CIRIA Report 113, Appendix 4

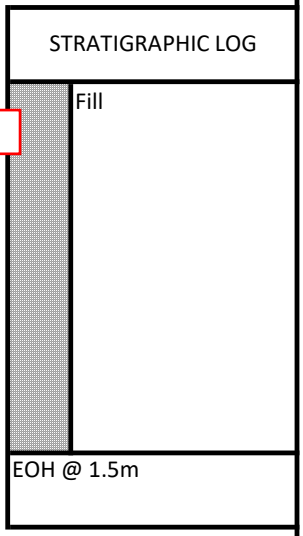
$$k = \left(log\frac{h_1}{h_2} - log\frac{2h_1 + d}{2h_2 + d}\right) \cdot \frac{(h_1 + h_2)}{2(t_2 - t_1)} =$$ 9.75E-06 ms^{-1} : 0.84 m/day

Hvorslev: Hvorslev (1951) *Time Lag and Soil Permeability in Ground-Water Observations* , Fig 18, p49

$$k = \frac{d^2 \ln\left(\frac{mL}{d} + \sqrt{\left(\frac{mL}{d}\right)^2 + 1}\right)}{2L \ln\frac{H_1}{H_2}} =$$ 1.49E-06 ms^{-1} : 0.13 m/day



puketoka



Data

Time (s)	Tape Avg (m)	Head (m)	Perm. Length (m)		Hvorslev 'k' Case G (ms^{-1})	CIRIA 113 'k' (ms^{-1})
0	0.000	0.900				
30	0.046	0.854	1.477		5.05E-06	3.62E-05
90	0.080	0.820	1.437		1.95E-06	1.37E-05
180	0.114	0.786	1.403		1.39E-06	9.56E-06
360	0.191	0.709	1.348		1.76E-06	1.18E-05
720	0.299	0.601	1.255		1.47E-06	9.30E-06
1440	0.448	0.452	1.127		1.36E-06	7.91E-06
2880	0.597	0.303	0.978		1.06E-06	5.47E-06
5760	0.704	0.196	0.849		6.34E-07	2.81E-06
11520	0.746	0.154	0.775		1.85E-07	7.12E-07
23040	0.758	0.142	0.748		2.98E-08	1.07E-07

Appendix E: Laboratory Test Results

ROADTEST LTD

Revision: 1

DETERMINATION OF THE LIQUID LIMIT & LINEAR SHRINKAGE
TEST METHOD NZS 4402 : 1986 TEST 2.2 & 2.6

Project Name : **98-100 Totara Ave**

Client : CMW Geosciences Ltd
Address : 9 Piermark Drive
Albany

Attention : J.Walden

Project No : 18 0160 00
Page : 1 of 1
Date of Order : 15/05/2018

Sample Method : Handauger
Sample Date : 14/05/2018
Sampled By : JW

Sample No.	Location	Depth (m)	Liquid Limit	Linear Shrinkage	Natural Water Content (%)
803G	HA04-18	0.4-0.8m	67	18	35.4
804G	HA11-18	0.4-0.8m	58	16	34.5

Comments :

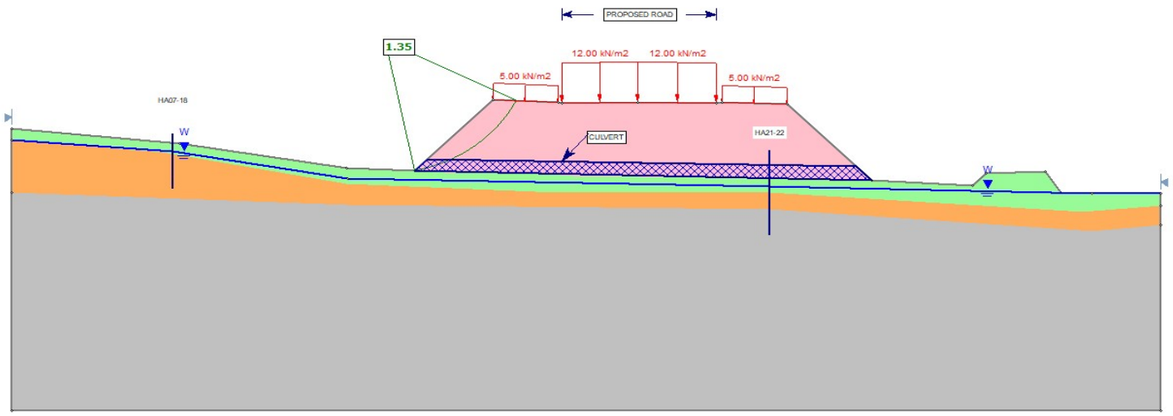
Tested By:	SN	Date :	17.05.18
Calculated By :	EC	Date :	19.05.18
Checked By :	EC	Date :	21.05.18

Appendix F: Slope Stability Outputs

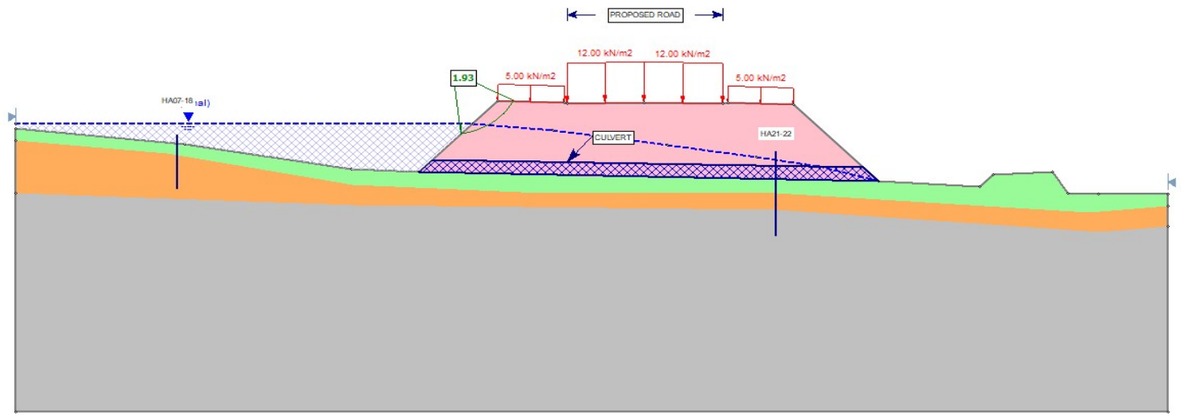
Stability Analysis Summary Table

Client:	Neil Construction Ltd
Project:	98-102 Totara Road, Whenuapai
Project Number	AKL2018-0085
Date:	29/11/2022
Notes:	NGW = Normal Groundwater — Target minimum FoS = 1.5
	HGW = High Groundwater — Target minimum FoS = 1.3
	SEIS = Seismic — Target minimum FoS = 1.0
	Rapid Drawdown — Target minimum FoS = 1.2

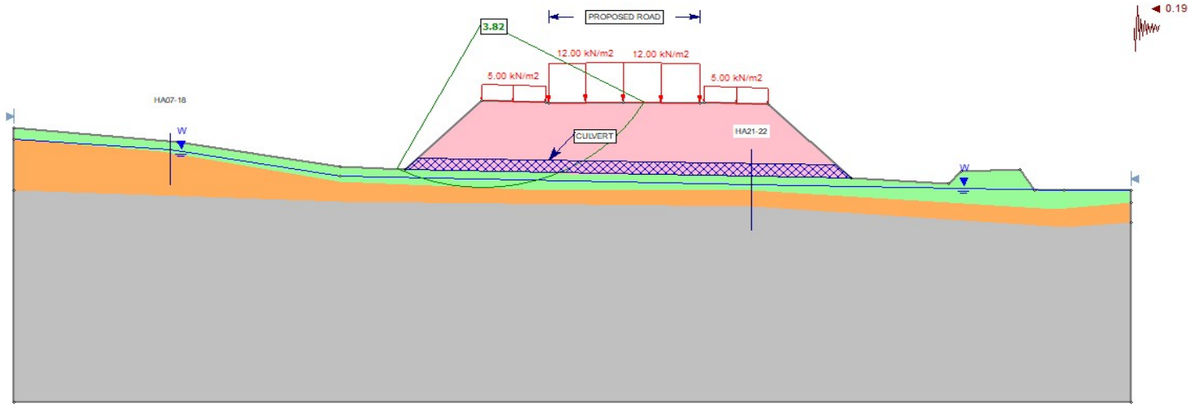
Cross Section	Profile	Design Case	Analysis Type	Factor of Safety	Printout Included	Additional Comments
Section E-E'	Proposed	NGW	CIRCULAR	1.4	Y	
		HGW	CIRCULAR	1.9	Y	
		SEIS	CIRCULAR	3.8	Y	
		RAPID DRAWDOWN - PARTIAL	CIRCULAR	1.0	Y	
		RAPID DRAWDOWN - FULL	CIRCULAR	0.8	Y	
Section E-E'	Remediated	NGW	CIRCULAR	2.0	Y	
		HGW	CIRCULAR	2.5	Y	
		SEIS	CIRCULAR	3.8	Y	
		RAPID DRAWDOWN - PARTIAL	CIRCULAR	1.5	Y	
		RAPID DRAWDOWN - FULL	CIRCULAR	1.2	Y	
Section F-F'	Proposed	NGW	NON-CIRCULAR	1.5	Y	
		HGW	NON-CIRCULAR	1.2	Y	
		SEIS	NON-CIRCULAR	2.4	Y	
Section F-F'	Remediated	NGW	NON-CIRCULAR	1.6	Y	
		HGW	NON-CIRCULAR	1.3	Y	
		SEIS	NON-CIRCULAR	2.4	Y	



Normal Groundwater Conditions



Transient Groundwater Conditions



Seismic Event

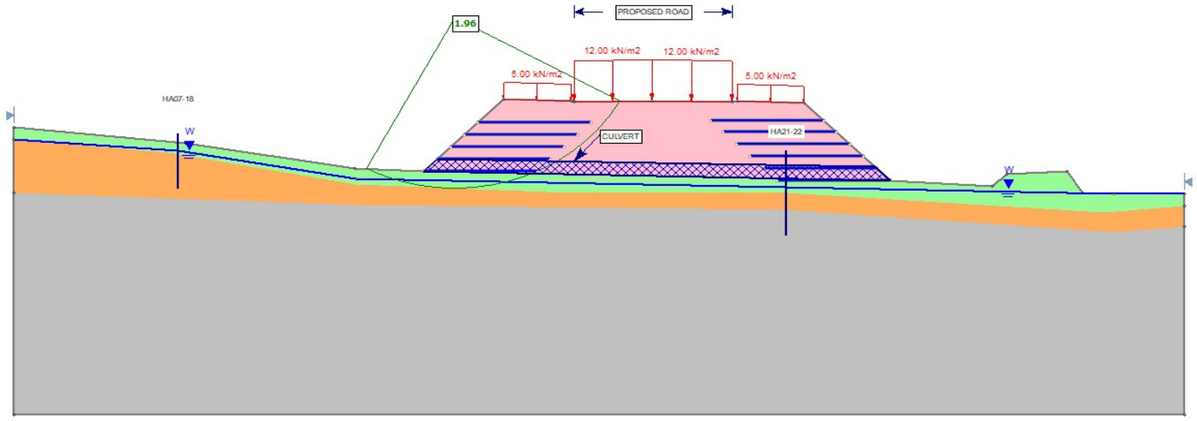
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
PUKETOKA ALLUVIUM		18	Mohr-Coulomb	3	28	Water Surface	Custom	1
ECBF RESIDUAL SOILS		18	Mohr-Coulomb	5	32	Water Surface	Custom	1
ECBF ROCK		20	Mohr-Coulomb	10	35	Water Surface	Custom	1
ENGINEERED FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Cohesion Type	Water Surface	Ru
PUKETOKA ALLUVIUM - UD		18	Undrained	50	Constant	None	0
ECBF RESIDUAL SOILS - UD		18	Undrained	120	Constant	None	0
ECBF ROCK - UD		18	Undrained	200	Constant	None	0
ENGINEERED FILL-UD		18	Undrained	120	Constant	None	0

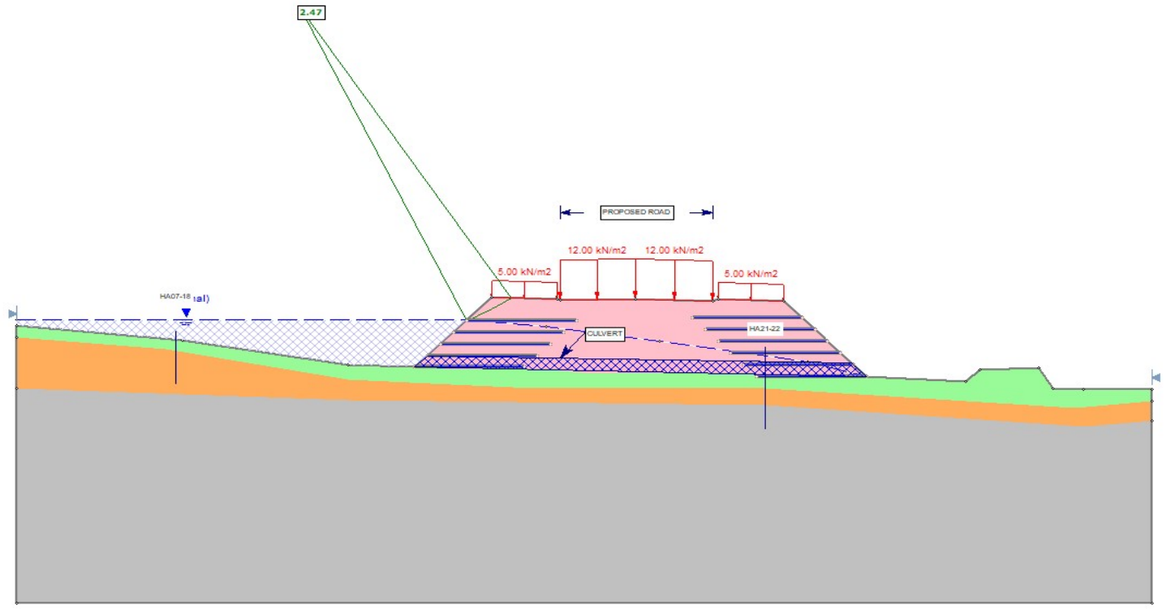
Parameters

CMW Geosciences

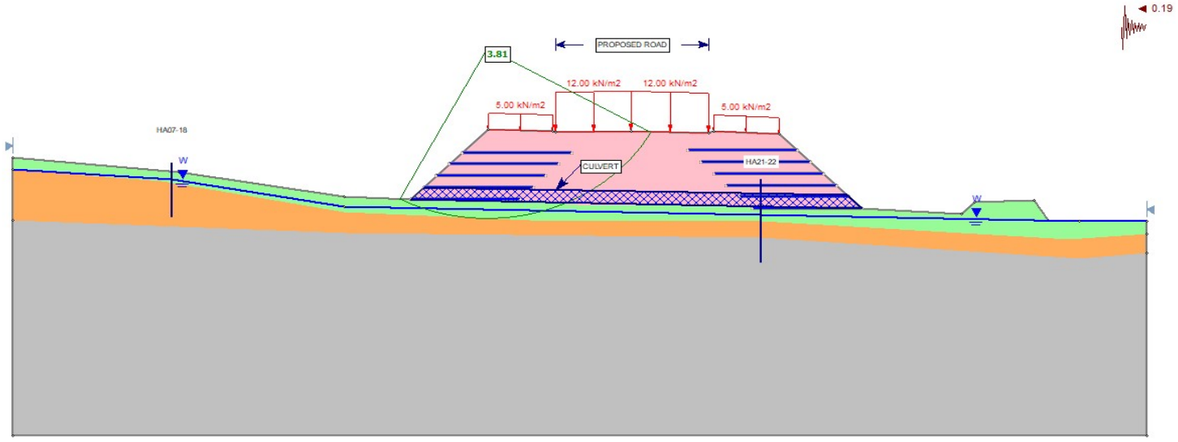
Project 98-102 Totara Road, Whenuapai	*Analysis* Circular	*Project No.* AKL2018-0085
Title Section E-E' - Proposed	*Date* 29/11/2022	*Drawing* STAB 01



Normal Groundwater Conditions



Transient Groundwater Conditions



Seismic Event

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
PUKETOKA ALLUVIUM		18	Mohr-Coulomb	3	28	Water Surface	Custom	1
ECBF RESIDUAL SOILS		18	Mohr-Coulomb	5	32	Water Surface	Custom	1
ECBF ROCK		20	Mohr-Coulomb	10	35	Water Surface	Custom	1
ENGINEERED FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

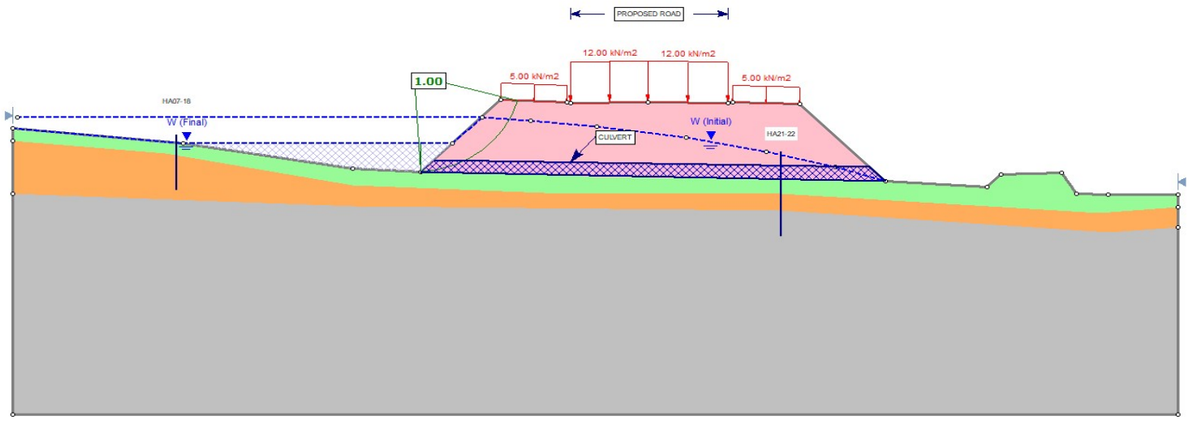
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Cohesion Type	Water Surface	Ru
PUKETOKA ALLUVIUM - UD		18	Undrained	50	Constant	None	0
ECBF RESIDUAL SOILS - UD		18	Undrained	120	Constant	None	0
ECBF ROCK - UD		18	Undrained	200	Constant	None	0
ENGINEERED FILL - UD		18	Undrained	120	Constant	None	0

Support Name	Color	Type	Selected Manufacturer	Force Application	Material Dependent	Input Type	Adhesion (kPa)	Friction Angle (°)	Shear Strength Model	Force Orientation	Anchorage	Strip Coverage (%)	Allowable Tensile Strength (kN/m)
RE Slope		Geosynthetic	Tensar RE580	Active (Method A)	No	Friction Angle & Adhesion	5	32	Linear	Parallel to Reinforcement	None	100	43.5106

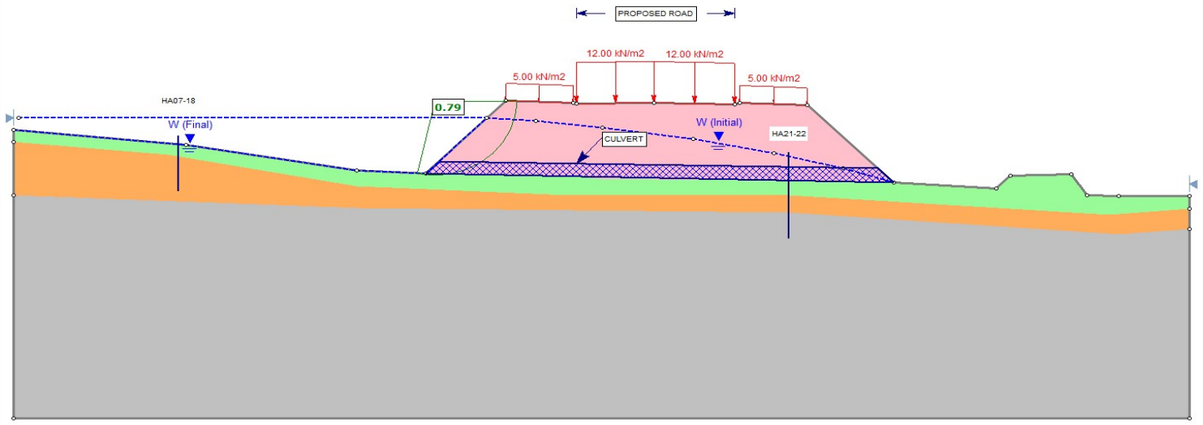
Parameters

CMW Geosciences

Project 98-102 Totara Road, Whenuapai	*Analysis* Circular	*Project No.* AKL2018-0085
Title Section E-E' - Remediated	*Date* 29/11/2022	*Drawing* STAB 02



Rapid Drawdown - Partial



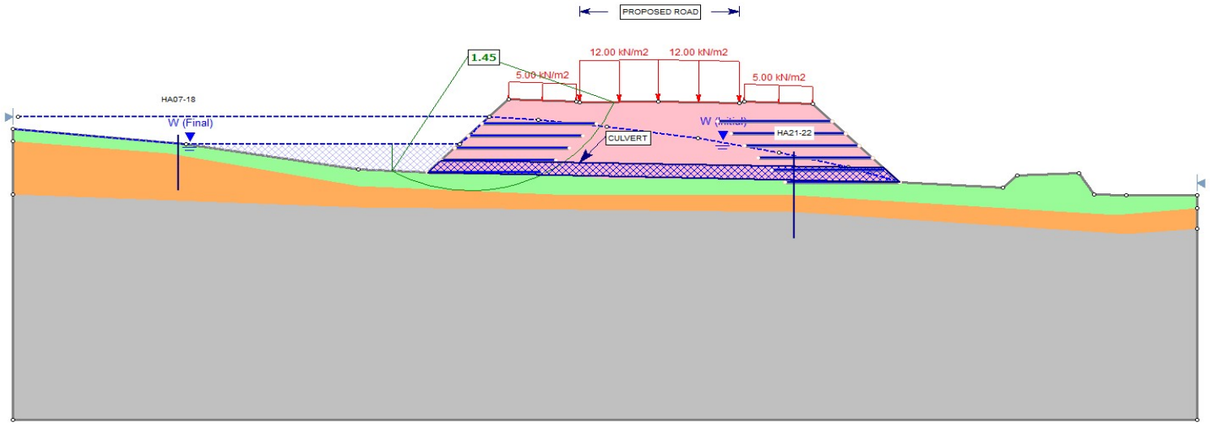
Rapid Drawdown - Full

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Rapid Drawdown (RD) Undrained Strength	RD Cr (kPa)	RD PhiR (deg)	Water Surface	Hu Type	Hu
PUKETOKA ALLUVIUM		18	Mohr-Coulomb	3	28	Yes	0	0	Water Surface	Custom	1
ECBF RESIDUAL SOILS		18	Mohr-Coulomb	5	32	Yes	0	0	Water Surface	Custom	1
ECBF ROCK		18	Mohr-Coulomb	10	35	Yes	0	0	Water Surface	Custom	1
ENGINEERED FILL		18	Mohr-Coulomb	5	32	Yes	0	0	Water Surface	Custom	1

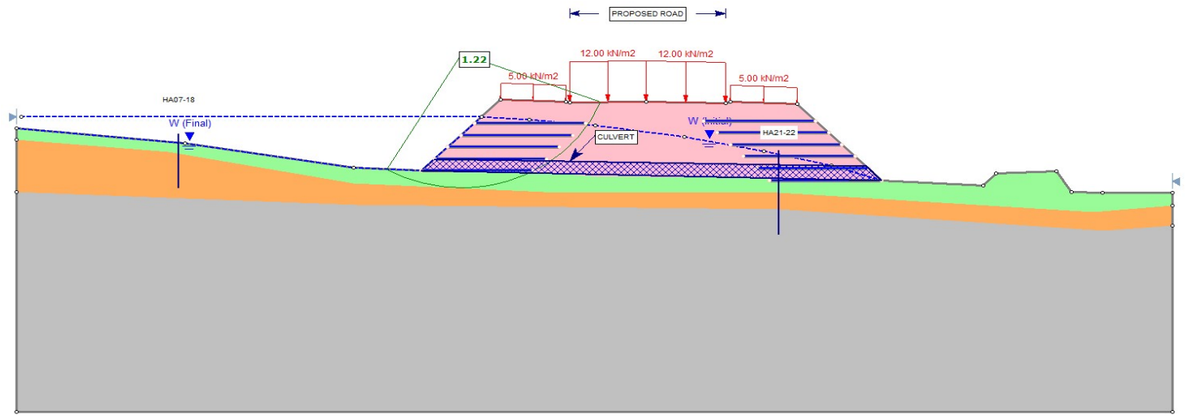
Parameters

CMW Geosciences

Project 98-102 Totara Road, Whenuapai	*Analysis* Circular	*Project No.* AKL2018-0085
Title Section E-E' - Proposed (RD)	*Date* 29/11/2022	*Drawing* STAB 01



Rapid Drawdown - Partial



Rapid Drawdown - Full

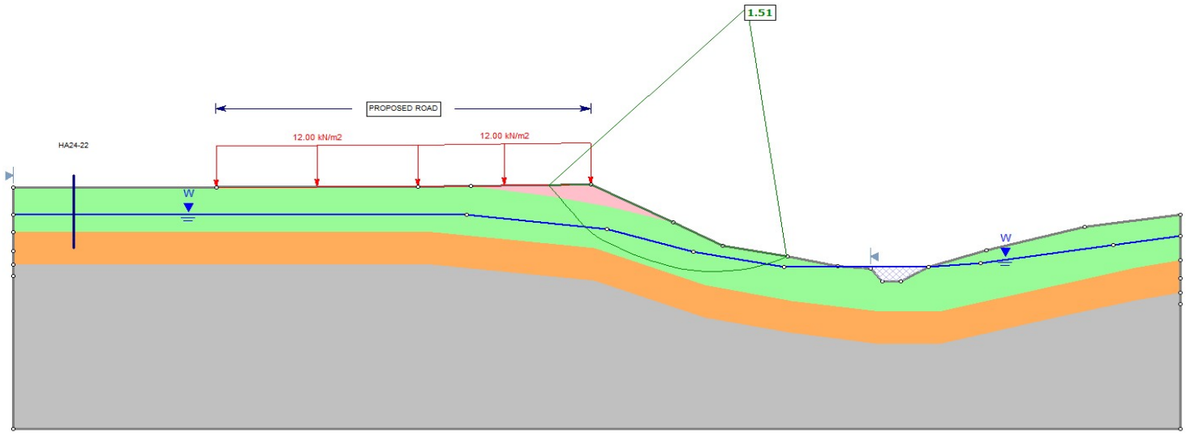
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Rapid Drawdown (RD) Undrained Strength	RD Cr (kPa)	RD PhiR (deg)	Water Surface	Hu Type	Hu
PUKETOKA ALLUVIUM		18	Mohr-Coulomb	3	28	Yes	0	0	Water Surface	Custom	1
ECBF RESIDUAL SOILS		18	Mohr-Coulomb	5	32	Yes	0	0	Water Surface	Custom	1
ECBF ROCK		18	Mohr-Coulomb	10	35	Yes	0	0	Water Surface	Custom	1
ENGINEERED FILL		18	Mohr-Coulomb	5	32	Yes	0	0	Water Surface	Custom	1

Support Name	Color	Type	Selected Manufacturer	Force Application	Material Dependent	Input Type	Adhesion (kPa)	Friction Angle (°)	Shear Strength Model	Force Orientation	Anchorage	Strip Coverage (%)	Allowable Tensile Strength (kN/m)
RE Slope		Geosynthetic	Tensar RE580	Active (Method A)	No	Friction Angle & Adhesion	5	32	Linear	Parallel to Reinforcement	None	100	43.5106

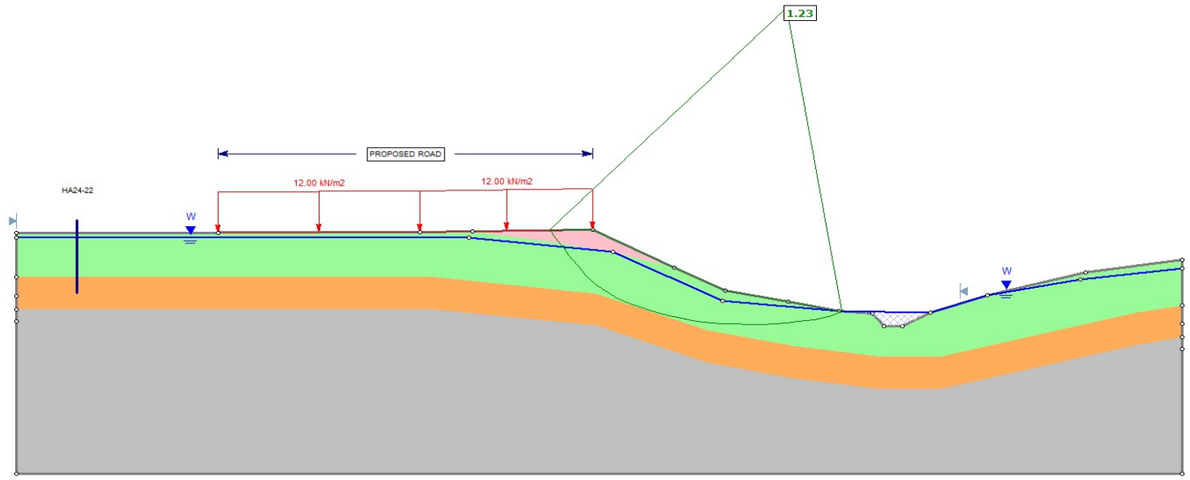
Parameters

CMW Geosciences

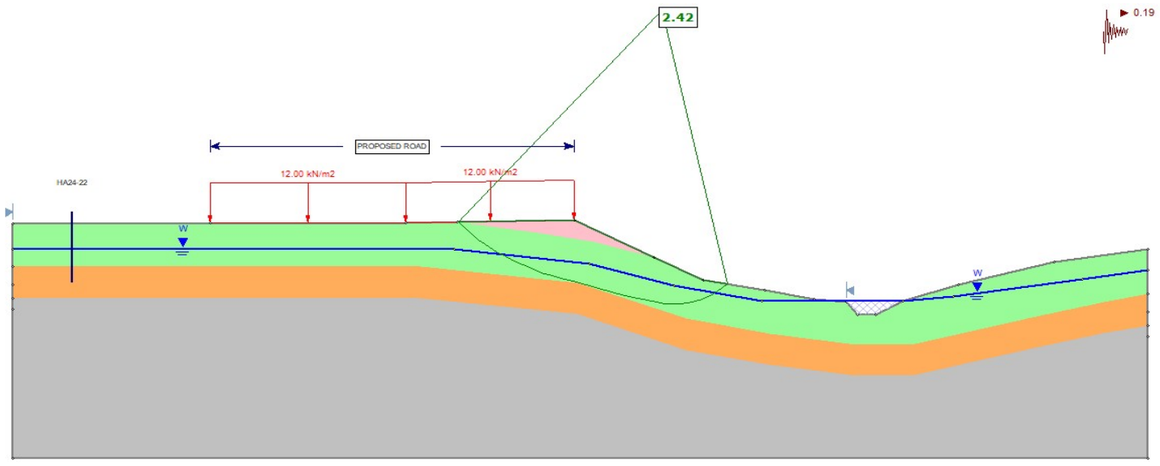
Project 98-102 Totara Road, Whenuapai	*Analysis* Circular	*Project No.* AKL2018-0085
Title Section E-E' - Remediated (RD)	*Date* 29/11/2022	*Drawing* STAB 02



Normal Groundwater Conditions



Transient Groundwater Conditions



Seismic Event

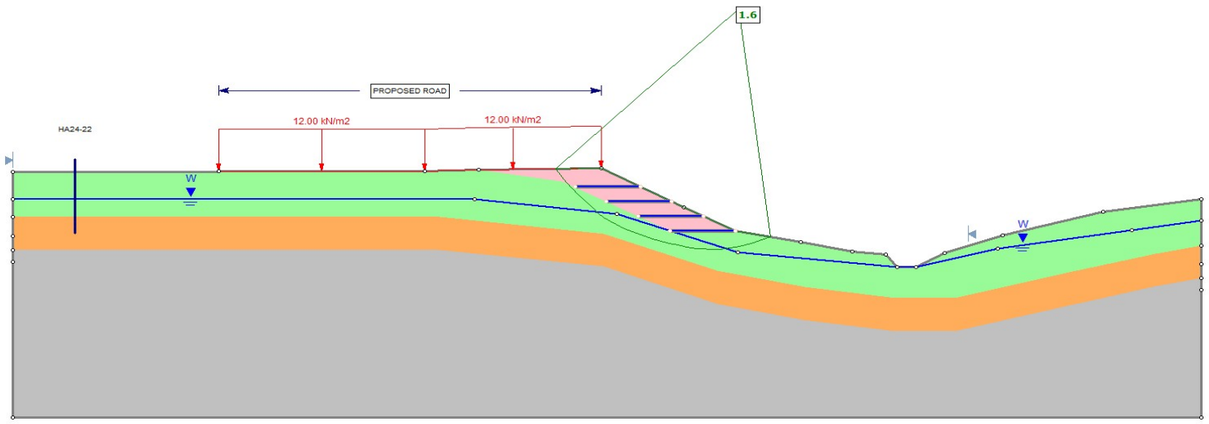
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
PUKETOKA ALLUVIUM		18	Mohr-Coulomb	3	28	Water Surface	Custom	1
ECBF RESIDUAL SOILS		18	Mohr-Coulomb	5	32	Water Surface	Custom	1
ECBF ROCK		20	Mohr-Coulomb	10	35	Water Surface	Custom	1
ENGINEERED FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Cohesion Type	Water Surface	Ru
PUKETOKA ALLUVIUM - UD		18	Undrained	50	Constant	None	0
ECBF RESIDUAL SOILS - UD		18	Undrained	120	Constant	None	0
ECBF ROCK - UD		18	Undrained	200	Constant	None	0
ENGINEERED FILL-UD		18	Undrained	120	Constant	None	0

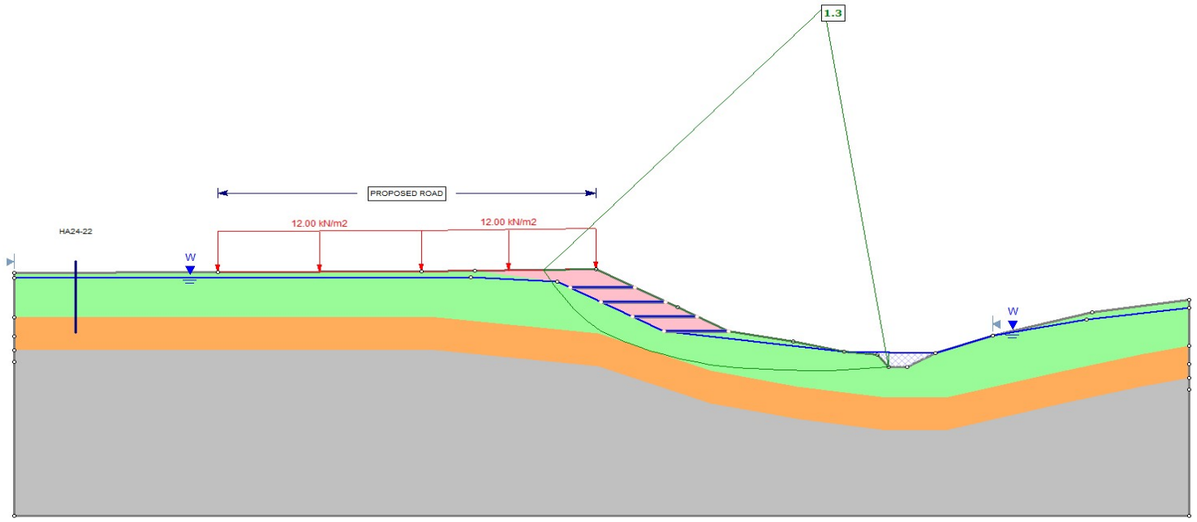
Parameters

CMW Geosciences

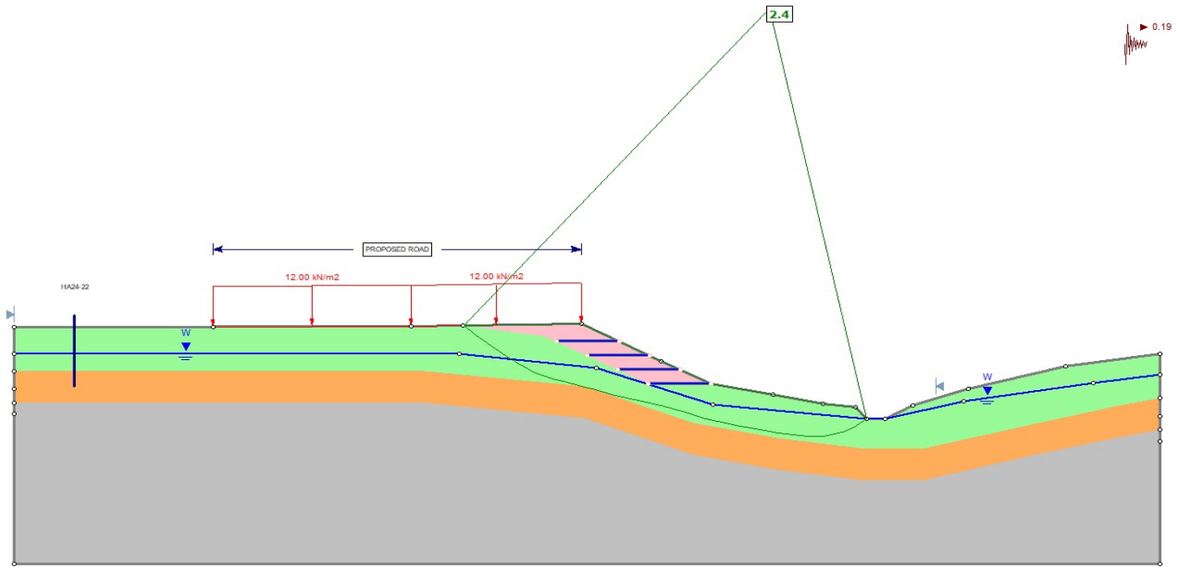
Project 98-102 Totara Road, Whenuapai	*Analysis* Non-Circular (Cuckoo)	*Project No.* AKL2018-0085
Title Section F-F' - Proposed	*Date* 29/11/2022	*Drawing* STAB 01



Normal Groundwater Conditions



Transient Groundwater Conditions



Seismic Event

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
PUKETOKA ALLUVIUM		18	Mohr-Coulomb	3	28	Water Surface	Custom	1
ECBF RESIDUAL SOILS		18	Mohr-Coulomb	5	32	Water Surface	Custom	1
ECBF ROCK		20	Mohr-Coulomb	10	35	Water Surface	Custom	1
ENGINEERED FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Cohesion Type	Water Surface	Ru
PUKETOKA ALLUVIUM - UD		18	Undrained	50	Constant	None	0
ECBF RESIDUAL SOILS - UD		18	Undrained	120	Constant	None	0
ECBF ROCK - UD		18	Undrained	200	Constant	None	0
ENGINEERED FILL - UD		18	Undrained	120	Constant	None	0

Support Name	Color	Type	Selected Manufacturer	Force Application	Material Dependent	Input Type	Adhesion (kPa)	Friction Angle (°)	Shear Strength Model	Force Orientation	Anchorage	Strip Coverage (%)	Allowable Tensile Strength (kN/m)
RE Slope		Geosynthetic	Tensar RE580	Active (Method A)	No	Friction Angle & Adhesion	5	32	Linear	Parallel to Reinforcement	None	100	43.5106

Parameters

CMW Geosciences

Project 98-102 Totara Road, Whenuapai	*Analysis* Non-Circular (Cuckoo)	*Project No.* AKL2018-0085
Title Section E-E' - Remediated	*Date* 29/11/2022	*Drawing* STAB 02

Appendix G: Natural Hazards Risk Assessment

NATURAL HAZARDS RISK ASSESSMENT FOR LAND SUBDIVISION WHENUAPAI GREEN, 98-102 TOTARA ROAD, WHENUAPAI

A. CONTEXT

Section 106 of the Resource Management Act (RMA) requires an assessment of the risk from natural hazards to be carried out when considering the granting of a subdivision consent. S106 RMA specifically states that the assessment must consider the combined effect of the natural hazard likelihood and material damage to land, other land or structures (consequence).

Section 2 of the RMA defines natural hazards as any atmospheric or earth or water related occurrence (including earthquake, tsunami, erosion, volcanic and geothermal activity, landslip, subsidence, sedimentation, wind, drought, fire or flooding) the action of which adversely affects or may adversely affect human life, property, or other aspects of the environment.

This appendix to CMW report reference AKL2018-0085AF Rev 1 sets out the criteria for and presents the results of an assessment of the geotechnical-related natural hazards associated with this proposed subdivision development. The remaining hazards, i.e. tsunami, wind, drought, fire and flooding hazards are not covered by this assessment.

B. BASIS OF ASSESSMENT

B.1. Risk Classification

The occurrence of natural hazards and their potential impacts on the proposed subdivision development is assessed in terms of risk significance, which is based on likelihood and consequence factors. A risk table is used to help assess the likelihood and consequence factors, the form of which used by CMW for this project is presented in Table B1.

Table B1: Natural Hazard Risk Classification

Risk Matrix		Consequence				
		Insignificant 1	**Minor 2**	**Moderate 3**	**Major 4**	**Catastrophic 5**
Likelihood	**Almost Certain 5**	Medium 5	High 10	Very high 15	Extreme 20	Extreme 25
	Likely 4	Low 4	Medium 8	High 12	Very high 16	Extreme 20
	Moderate 3	Low 3	Medium 6	Medium 9	High 12	Very high 15
	Unlikely 2	Very low 2	Low 4	Medium 6	Medium 8	High 10
	Rare 1	Very low 1	Very low 2	Low 3	Low 4	Medium 5

B.2. Likelihood

With respect to assessing the likelihood or chance of the risk occurring, the qualitative definitions used by CMW for this project are provided in Table B2 for each likelihood classification.

Table B2: Qualitative Natural Hazard Likelihood Definitions		
1	Rare	The natural hazard is not expected to occur during the design life of the project
2	Unlikely	The natural hazard is unlikely, but may occur during the design life
3	Moderate	The natural hazard will probably occur at some time during the life of the project
4	Likely	The natural hazard is expected to occur during the design life of the project
5	Almost Certain	The natural hazard will almost definitely occur during the design life of the project

B.3. Consequence

In terms of determining the consequence or severity of the natural hazard occurring, the qualitative definitions used by CMW for this project are provided in Table B3 for each consequence classification.

Table B3: Qualitative Natural Hazard Consequence Definitions		
1	Insignificant	Very minor to no damage, not requiring any repair, no people at risk, no economic effect to landowners.
2	Minor	Minor damage to land only, any repairs can be considered normal property maintenance no people at risk, very minor economic effect.
3	Moderate	Some damage to land requiring repair to reinstate within few months, minor cosmetic damage to buildings being within relevant code tolerances, does not require immediate repair, no people at risk, minor economic effect.
4	Major	Significant damage to land requiring immediate repair, damage to buildings beyond serviceable limits requiring repair, no collapse of structures, perceptible effect to people, no risk to life, considerable economic effect.
5	Catastrophic	Major damage to land and buildings, possible structure collapse requiring replacement, risk to life, major economic effect, or possible site abandonment.

B.4. Risk Acceptance

It is recognised that the natural hazard risk assessment provided herein is qualitative and, due to the wide range of possible geohazards that could occur, is somewhat subjective. Other methods are available to quantitatively assess an acceptable level of geotechnical related natural hazard risk, such as defining an acceptable factor of safety with respect to slope stability or acceptable differential ground settlements with respect to recommended building code limits.

Therefore, to give this qualitative natural hazard risk assessment some relevance to more commonly adopted numerical or quantitative geotechnical assessment techniques, a residual risk rating of very low to medium (risk value = 1 to 9 inclusive) is considered an acceptable result for the proposed subdivision development.

A risk rating of high to extreme (risk value ≥ 10) is considered an unacceptable result for the proposed subdivision development.

C. RISK ASSESSMENT

The natural hazards relevant to this proposed subdivision development and adjacent, potentially affected land have been assessed with respect to the criteria outlined above.

Assessment is based on proposed post development ground conditions with and without any geotechnical controls. The latent risk was first assessed with the site in its proposed developed state to consider the risks to the development and surrounding land, including assessment of land modifications from the pre-existing natural state, without any implemented geotechnical controls. The specific geotechnical mitigation measures and engineering design solutions outlined in the table below and CMW report, where relevant, were then considered to determine the natural hazard residual risk remaining after the proposed controls have been implemented.

Results of this assessment are presented in Table C1 below.

Table C1: Natural Hazard Risk Assessment Results

RMA S2 Hazard	Description	Proposed Site Latent Risk of Damage to Land / Structures			Comments and Geotechnical Control	Proposed Site Residual Risk of Damage to Land / Structures OR Acceleration/ Worsening of Hazard with Geotechnical Controls Implemented		
		Likelihood	Consequence	Risk Rating		Likelihood	Consequence	Risk Rating
Earthquake	Fault Rupture	1	5	Medium 5	Nearest active fault is approximately 80km away. Located in a low seismicity region	1	5	Medium 5
	Liquefaction Induced Flooding and/ or Subsidence	1	4	Low 4	Liquefaction risk assessed as not significant based on age and soil fabric criteria	1	4	Low 4
	Lateral Spread	1	4	Low 4	Risk of liquefaction induced lateral displacement is considered low due to absence of potentially liquifiable zone below ground surface	1	4	Low 4
Volcanic Activity	Ash & Pyroclastic Falls	1	5	Medium 5	No volcanoes in the area	1	5	Medium 5
	Lava flows & Lahars	1	5	Medium 5	No volcanoes in the area	1	5	Medium 5

Geothermal Activity	Formation of geysers, hot springs, fumaroles, mud pools	1	5	Medium 5	No geothermal activity in the area	1	5	Medium 5
Erosion	Cut Batters	5	2	High 10	Max 1V:3H gradient	2	2	Low 4
	Fill Batters	4	2	Medium 8	Appropriate drainage and stormwater flow, max gradient 1V:2.5H	2	2	Low 4
	Coastal (cliff top)	1	4	Low 4	No coastal cliffs located within the site	1	4	Low 4
Landslip	Global Slope Instability	5	4	Extreme 20	Appropriate drainage and control of groundwater levels, stability improvement works as recommended in the report	1	4	Low 4
	Soil Creep	5	4	Extreme 20	Appropriate design of footings, regrading of locally oversteepened slopes	1	4	Low 4
	Bearing Capacity Failure	2	4	Medium 8	Undercut and replace any unsuitable material, appropriate site gradients	1	4	Low 4
	Cut & Fill Batter Instability	4	4	Very High 16	Gradients of less than 1V:3H, engineered fill placed appropriately, use of specifically designed retaining walls with sufficient toe drainage	1	4	Low 4
Subsidence	Expansive Soils	5	3	Very High 15	Foundation design to account for expansive soils	1	3	Low 3
	Cut Batters	5	2	High 10	Max 1V:3H gradient	2	2	Low 4
	Fill Batters	4	2	Medium 8	Appropriate drainage and stormwater flow, max gradient 1V:2.5H	2	2	Low 4
	Effects of dewatering	2	4	Medium 8	Risk of dewatering induced ground settlement beyond site boundary is considered low due to adequate setback from proposed excavation	1	4	Low 4

Notes:

- Assessments include the impact of the proposed subdivision works on adjacent properties.

- The following reference(s) contain information on the hazards contained in this assessment and the non-geotechnical hazards that have not been included:
    - **Auckland**
      https://aucklandcouncil.maps.arcgis.com/apps/MapSeries/index.html?appid=81aa3de13b114be9b529018ee3c649c8

Appendix H: Groundwater Impacts Assessment

Project no: AKL2018-0085

Project name: 98-102 Totara Road, Whenuapai

Assessment of geotechnical aspects of proposed development with respect to the Auckland Unitary Plan Operative in Part (Updated 12 June 2020)

Chapter E: Auckland-wide rules, Natural resources»E7 Taking, using, damming and diversion of water and drilling»E7.6. Standards Permitted activities»E7.6.1. Permited activities »E7.6.1.6. Dewatering or groundwater level control associated with a groundwater diversion permitted under Standard E7.6.1.10

Condition		Geotechnical Interpretation of Compliance
1. The water take must not be geothermal water	-	1. NA
2. The water take must not be for a period of more than 10 days where it occurs in peat soils, or 30 days in other types of soil or rock	**Compliant**	2. Compliant groundwater removal only during the excavation of ponds
3. The water take must only occur during construction	**Compliant**	3. The water take will not be permanent

Chapter E: Auckland-wide rules, Natural resources»E7 Taking, using, damming and diversion of water and drilling»E7.6. Standards Permitted activities»E7.6.1. Permited activities »E7.6.1.10. Diversion of groundwater caused by any excavation, (including trench) or tunnel

Condition		Geotechnical Interpretation of Compliance
1.All of the following activities are exempt from the Standards E7.6.1.10(2) – (6)		
a. pipes cables or tunnels including associated structures which are drilled or thrust and are less than 1.2m in external diameter	-	a. NA
b. pipes including associated structures up to 1.5m in external diameter where a closed faced or earth pressure balanced machine is used	-	b. NA
c. piles up to 1.5m in external diameter are exempt from these standards	**Compliant**	c. The proposed culverts are a maximum 750mm in diameter
d. diversions for no longer than 10 days; or	**Compliant**	d. Diversions will be seasonal during wet winter months
e. diversions for network utilities and road network linear trenching activities that are progressively opened, closed and stabilised where the part of the trench that is open at any given time is no longer than 10 days	**Compliant**	e. Any part of the trench opened at any time will be closed and stabilised in no more than 10 days
2.Any excavation that extends below natural groundwater level, must not exceed:		
a. 1ha in total area; and	**Compliant**	a. The only excavation on site which is inferred to extend below the natural groundwater level is associated with the construction of the proposed stormwater reserves, which are collectively less than 1ha in area
b. 6m depth below the natural ground level	**Compliant**	b. The invert level of the proposed stormwater reserves will be located at a maximum 2m depth below existing ground level
3.The natural groundwater level must not be reduced by more than 2m on the boundary of any adjoining site.	**Compliant**	3. Expected groundwater drawdown at boundaries will be less than 2m deep
4.any structure, excluding sheet piling that remains in place for no more than 30 days, that physically impedes the flow of groundwater through the sit must not:	**Compliant**	
a. impede the flow of groundwater over a length of more than 20m; and	-	a. NA
b.extend more than 2m below the natural groundwater level.	-	b. NA
5.The distance to any existing building or structu re (excluding timber fences and small structures on the boundary) on an adjoining site from the edge of any:		
a.trench or open excavation that extends below natural groundwater level must be at least equal to the depth of the excavation	**Compliant**	a. The edge of the proposed stormwater detention ponds will be located at least 2m from the edge of Totara Road
b.tunnel or pipe with an external diameter of 0.2 - 1.5m that extends below natural groundwater level must be 2m or greater; or	-	b. NA
c.a tunnel or pipe with an external diameter of up to 0.2m that extends below natural groundwater level has no separation requirement.	-	c. NA
6.The distance from the edge of any excavation that extends below natural groundwater level, must not be less than:		
a.50m from the Wetland Management Areas Overlay	**Compliant**	The excavation is in excess of 50m from any wetland management overlays
b.10m from a scheduled Historic Heritage Overlay; or	**Compliant**	The excavation is in excess of 10m from any schedules historic heritage overlays
c.10m from a lawful groundwater take.	**Compliant**	The excavation is in excess of 10m from any lawful groundwater take

Appendix I: Geotechnical Earthworks Specifications

7 December 2022 Document Ref: AKL2018-0085 Rev 1

Land Development Geotechnical Works Specification
For: Whenuapai Green
98-102 Totara Road, Whenuapai

1. INTRODUCTION AND SCOPE

This specification covers the geotechnical remediation works and associated earthworks outlined in the CMW Investigation Report (GIR), referenced AKL2018-0085AF Rev.1. It supplements the information provided on the design drawings and GIR. It provides detail on the required specification for:

- Site clearance and preparation including topsoil stripping and stockpiling.
- Geotechnical stabilisation works such as stability undercuts.
- Subsoil drainage installation.
- Cut to fill earthworks operations.
- Fill materials and testing requirements.
- Earthworks finishing and respread of topsoil; and,
- As-built records.

Excluded from the scope are geogrid reinforced slopes with a face and steeper than 30 degrees or retaining structures covered by a building consent. Such works will be carried out in accordance with an independent structure specific specification.

Unless varied onsite by the Geotechnical Engineer, the following specification requirements must be met in order for CMW Geosciences (CMW) to provide a Geotechnical Completion Report for the works.

2. RELEVANT DOCUMENTS

2.1. Standards, Guidelines and Consents

The works shall comply with the relevant sections of the following standards, guidelines, and consents:

1. Health and Safety at Work Act 2015 and Regulations 2016.
2. All Project Resource Consent Conditions and Engineering Works Approvals.

3. The applicable Council Infrastructure Design Standard.
4. The Auckland Council, Erosion and Sediment Control Guidelines – Guidance document 2016/005.
5. NZS 4431:1989 Code of Practice for Earth Fill for Residential Development.
6. NZS 4402: 1986 Methods of Testing Soils for Civil Engineering Purposes; and,
7. NZS 4404: 2010 Code of Practice for Urban Land Subdivision.
8. WorkSafe NZ – Excavation Safety Good Practice Guidelines, July 2016.

2.2. Geotechnical Investigation and Design Report

Details of the geotechnical investigation, soil and rock conditions encountered, and the design of the geotechnical remedial works are contained in the CMW report AKL2018-0085AF Rev.1. The contractor should be aware of the contents and recommendations contained in that report.

The works shall comply with the recommendations contained in that report.

2.3. Construction Drawings

The works shall comply with the following geotechnical design drawings and standard details:

- Consented drawings and civil design specifications prepared by Neil Construction Ltd.
- CMW Drawings 05.

2.4. Conflicting Information

Where there is any conflict or discrepancy in the requirements of this specification and the documents listed above the matter shall be referred to the Geotechnical Engineer (CMW) for clarification.

3. GEOTECHNICAL OBSERVATION REQUIREMENTS

The following items form hold points in the construction works that require observation, testing and approval by the Geotechnical Engineer (CMW):

1. Foundations for filling once topsoil and unsuitable materials have been stripped prior to fill placement.
2. Stability undercuts to confirm depth and extents prior to backfilling.
3. Subsoil drain excavations prior to placement of aggregate;
4. Any imported soil fill materials prior to placement on site.
5. Drainage aggregate quality prior to placement.
6. Geotextile layers once in place and prior to backfilling.
7. Filling placed at regular intervals to comply with the fill test frequency requirements below.
8. Compaction of backfilling in critical service trenches.
9. Flushing of the subsoil drainage system at the completion of earthworks.
10. Any unforeseen ground conditions that may impact on the construction works or future land use; and,

It is the contractor's responsibility to ensure that the Geotechnical Engineer is given reasonable notice and opportunity to observe the above works and that the works do not proceed until approval has been gained from the Geotechnical Engineer.

24 hours is considered reasonable notice.

4. SAFETY IN DESIGN

Formation of the design landform will require incorporation of geotechnical works such as undercuts, temporary excavations, steep fill batters, and shallow subsoil drains as specified above.

There are no specific design risks associated with these works that require consideration of the Safety in Design (SiD) aspects. However, it is the contractor's responsibility to identify and cover construction related risks associated with these works in a more comprehensive manner (being the competent part in that respect). The CMW designs/ specifications for undercuts and drainage elements have been made so that no personnel are ever expected to enter unbattered or unprotected excavations to complete the construction. If at any stage a contractor does not consider that a design for excavations can be safely constructed, then CMW must be contacted immediately to discuss alternative design and/ or methods and avoid risk to personnel.

5. TEMPORARY BATTERS AND EXCAVATION STABILITY

The temporary stability of the works is the responsibility of the main contractor. All works are to be completed in accordance with the requirements of current safety legislation and WorkSafe NZ.

Slope instability during construction is a significant risk where earthworks may cause changes to slope geometry or groundwater conditions.

The causes of instability during earthworks may include:

- Removal of toe support due to excavation.
- Over steepening of slope angles in temporary batters.
- Geological defects in the soil or rock mass, particularly where these are exposed in excavation faces.
- Elevated groundwater levels following rainfall, perched groundwater or rapid recharge due to the reduced distance to an impermeable layer (i.e. undisturbed rock) due to cut operations; and,
- Additional loading upslope of excavations. i.e. construction equipment or stockpiles.
- To help mitigate these risks the contractor should consider:
- Staging excavations which reduce support to slopes or create temporarily over steepened slopes, to ensure large areas are not left unsupported. The allowable length of excavation to have open at any one time will vary and is dependent on a number of factors such as, local ground conditions, groundwater, length of time the excavation will be open, weather, depth of excavation, geological defects present, and the earthworks equipment and methodology used.
- Ceasing works in excavations during rainfall and assessing stability of excavations following rainfall events prior to resuming work.
- Benching or battering back of excavation faces.
- Ensuring good control of surface water runoff above excavations and batters.
- Covering steep batters with impermeable covers where they may be left without support for any significant period of time.
- Avoiding loading the crests of slopes and excavations (including loading with working plant);
- Putting in place comprehensive risk identification and management procedures and work methodologies for temporary excavation stability.
- Carrying out regular inspections upslope of excavations and of the excavation slope to look for signs of instability such as ground displacement and the development or propagation of cracks; and,
- Seeking advice from the Geotechnical Engineer where there is doubt as to the stability of a slope or excavation.

6. CONSTRUCTION SPECIFICATION

6.1. Site Preparation

The Contractor shall remove all vegetation from the site of the earthworks except for trees indicated for preservation either by marking on the site or noted on the drawings and clear the remainder of the site.

Clearing shall mean the felling of all trees, except those indicated, removal of all growth other than grass and weeds, extraction of tree stumps, demolition of fences and other minor items remaining in the way of site stripping, and the complete disposal of all items. Stumping shall mean the removal of all roots greater than 25mm in diameter.

Cleared areas shall be stripped to remove all turf and organic topsoil to depths designated by the Engineer ahead of or during the stripping operations. Stripping shall also cover picking up any old topsoil stockpiles and any buried topsoil detected during the course of the works. The depth shall be sufficient to remove all materials considered unsuitable as fill or unsuitable to remain beneath fill but will not necessarily extend to the full limit of organic penetration.

6.2. Erosion and Sediment Control

The works shall be carried out in accordance with the project Erosion and Sediment Control Management Plan and associated drawings.

The contractor shall ensure good control of surface water runoff at all times by shaping of the surface in cut and fill areas to prevent ponding during rainfall events.

The location of temporary Sediment Retention Ponds (SRP) on sloping ground shall be decided upon with input from the Geotechnical Engineer. Where comment of SRP stability is sought by Council then all fill materials used to form batters, must be placed as engineered fill and tested accordingly unless advised otherwise by the Geotechnical Engineer.

When decommissioning temporary sediment ponds, all water softened material in the bases and sides of the ponds shall be removed and undercut to the satisfaction of the Geotechnical Engineer. Backfilling of temporary ponds shall be to the compaction standard for general filling unless otherwise specified.

6.3. Stockpiles

Topsoil stockpiles can add significant driving force for slope instability when placed at or near the crest of a slope. The location of all temporary stockpiles must be approved by the Geotechnical Engineer prior to placement. Where stockpiles cannot be avoided above sloping ground, they should be placed over a wide area with the height restricted under the direction of the Geotechnical Engineer.

6.4. Fill Foundations and Benching Slopes

The foundation on which filling is to be placed must be observed by the Geotechnical Engineer following clearing and prior to the placement of any filling to confirm the strength of the underlying soils is sufficient.

Where it is found, after clearing and stripping operations as specified, that the foundation on which filling is to be placed is unstable, or in cuttings if it is found after the excavation has been cut down to the levels shown in the drawings that unstable ground is encountered, then the Engineer may direct that the soft, yielding, or unstable materials causing such instability shall be removed to such depth as directed.

Benching of slopes prior to the placement and compaction of filling should be carried out in accordance with the normal requirements of NZS 4431 and related documents as mentioned above, especially on the steeper areas of the site, to ensure that the filling placed is keyed into the underlying natural ground. This would involve the cutting of benches approximately the width of a bulldozer, with a slight reverse gradient back into the slope. The optimum depth of each bench is best confirmed by careful Engineering inspections during construction.

6.5. Fill Materials and Conditioning

6.5.1. Soil Fill, Rock Fill or Soil and Rock Mixed Fill

Site won materials used as engineered filling shall be free of topsoil, organic matter, rubbish and other unsuitable materials. The maximum particle size for soil and rock blended fill shall be 200mm and mixing and/ or crushing shall be carried in a manner that ensures that significant voids are not present in the filling between rock fragments.

For rock fill without soil blending, crushing is to occur to comply with the requirements for blended fills and needs to ensure that uniform compaction can occur without significant voids between particles in the absence of the soil fill.

6.5.2. Blending of Unsuitables

The blending of 'unsuitables' into structural fills may be undertaken only at the discretion of the Geotechnical Engineer following a request by the contractor and with sufficient time for appropriate consideration. Approval for any such blending must be sought from and provided by the Geotechnical Engineer in writing prior to the commencement of any blending.

In consideration of any such requests, the Geotechnical Engineer will need to be able to assess, et. al., the composition of the materials requested to be blended, the location on the site for the proposed fills, the fill depths and the elevation of the blended materials within the fills and any environmental constraints.

As a minimum, it is expected that any blended fills will be directed to comply with the following conditions:

- All significant, solid inorganics (such as roots and stumps) to be removed prior to blending; and,
- All inclusions of suitable man-made materials (e.g. concrete) and any excavated rock must comply with the normal compaction requirements specified herein in terms of size and ability for appropriate compaction to be achieved in close vicinity to the inclusions.
- All blended materials must be appropriately mixed/ blended normal fill materials to the specified ratio. Un-mixed interlayering of normal engineered filling with unsuitables will not be accepted.
- As a preliminary indication, it is expected that the ratio of unsuitables to suitable fill will not exceed 1 in 10 by volume.

It is expected that the Geotechnical Engineer will also need to apply limits to the location/ depth of blended fills within any specified fill area.

6.5.3. Hardfill

Hardfill used as structural filling shall be a graded, unweathered, durable, crushed rock product approved by the Geotechnical Engineer, with a grading suitable for compaction.

6.5.4. Material Conditioning

The cut materials on site may require some drying prior to compaction to achieve the required specification. This may be done by harrowing (such as with discs) and air drying when conditions permit or by the addition of hydrated lime.

The addition of lime and/or cement to engineered filling in concentrations greater than 3% requires the approval of the Geotechnical Engineer.

All additives such as lime or cement proposed for use in backfill materials for Reinforced Earth Slopes or other materials in contact with geosynthetics must be approved and monitored by the Geotechnical Engineer.

6.6. Fill Placement, Compaction and Testing Requirements

6.6.1. Soil Fill

Soil placed in fills shall be conditioned and compacted until the following conditions are satisfied. Alternative methods based on specified compaction techniques may be selected by the Geotechnical Engineer if the method below is considered inappropriate due to the granular nature of the materials.

There are three classes of filling defined:

1. General Fill: Structural engineered fill which does not fall into either of the other two classes below.
2. High Strength Fill: Where specified on the drawings or GDR. Typically used for critical batter faces, shear keys and road subgrades.
3. Landscape Filling: Lower strength filling (than General Filling) may be specified on a case-by-case basis by the Geotechnical Engineer where the strength and properties of General fill is not required, and such filling is approved by the client and regulatory authorities.

It should be noted that the surface of the fill area prior to placement of subsequent fill lifts should be in a state so as not to create a break in the consistency of the fill material between lifts. For example, if surfaces are left to dry out, or rolled to seal them from rainfall infiltration then the surface must be broken up and scarified with rippers or by other means to ensure a good bond between fill lifts.

The maximum lift of filling placed before compaction is dependent on the size and nature of the compaction equipment. Typically, 300mm loose depth is considered the maximum for a Cat 815/820 type compactor. In any event the contractor must ensure that the fill is placed and compacted to achieve even and adequate compaction throughout each layer/lift.

Preliminary test criteria and frequency for cohesive materials (Clays & Silts) are set out in Table 1 and 2 below. These are based on our experience in these materials and recommendations outlined in NZS4402:2022, and should be confirmed following sampling and laboratory testing of the source fill material. If non cohesive soils (i.e. Sands) are to be placed as engineered fill the matter should be referred to the Geotechnical Engineer to define the testing requirements.

TABLE 1: COHESIVE MATERIALS (SOIL FILL AND SOIL/ ROCK BLENDED FILL) COMPACTION TEST CRITERIA FOR ENGINEERED FILLING

	Air Voids [1]		Vane Shear Strength [2]		Moisture Content [3]	Dry Density [3]
	Average	Maximum Single Value	Average	Minimum Single Value	Maximum	Minimum
General Fill	10%	12%	140 kPa	110 kPa	40%	1.25 t/m^3
Landscape Fill	TBC by Geotechnical Engineer of case-by-case basis					

[1] Air Voids Percentage (as defined in NZS 4402:1986)

[2] Undrained Shear Strength (Measured by hand shear vane – calibrated using NZGS 2001 method)

[3] Moisture content and minimum dry density non-compliance may be accepted on site by the Geotechnical Engineer on a case-by-case basis depending on the nature of the material and the other criteria results.

TABLE 2: COHESIVE MATERIALS (SOIL FILL AND SOIL/ ROCK BLENDED FILL) COMPACTION TESTING FREQUENCIES FOR ENGINEERED FILLING				
	Field Density & Air Voids %	**Vane Shear Strength**	**Solid Density**	**Compaction Curve**
General Fill	1 test per 1500m^3 of fill placed with not less than 1 test per 500mm lift of filling for each area.	1 set of tests (4 readings within 1 metre of each other) per 500m^3 of filling placed with not less than 1 test per 500mm lift of filling for each fill area.	1 test per material type per 50,000m^3 or at least 1 test every 8 weeks.	1 test per material type per 30,000m^3 or at least 1 test every 5 weeks.
Landscape Filling	TBC by Geotechnical Engineer of case-by-case basis			

The test criteria and/or frequency may be relaxed at the discretion of the Geotechnical Engineer (CMW) for the project or in a discrete fill area subject to the consistency of the results achieved being acceptable over a specified period of time

6.6.2. Compaction Testing Reporting Requirements

1. All test location coordinates to be recorded by handheld GPS with reference to the NZTM projection. Test location coordinates, with date and test number reference are to be provided to the Geotechnical Engineer in electronic (excel) format on a weekly basis). Alternatively, the Geotechnical Engineer may approve the use of site plans to mark the location of tests in lieu of GPS location.
2. The volume of filling placed for each progress claim month (typically ending 20th of the month) including all filling placed (undercut and cut to fill) to be provided to the Geotechnical Engineer monthly by the contractor or Engineer to the Contract to allow assessment of test frequency adequacy.
3. Interim fill test summaries are to be provided to the Geotechnical Engineer for review on a regular basis.

6.6.3. Hardfill

A plateau compaction test shall be carried out on site under the supervision of the Geotechnical Engineer, for each type of hardfill placed to determine the achievable maximum dry density (MDD) with no more than 20% total voids unless a laboratory derived MDD can be provided. The Geotechnical Engineer shall be given the opportunity to approve the size and type of compaction equipment to be used prior to any plateau testing.

Hardfill shall be placed and compacted to 95% of the MDD determined from the plateau test or laboratory MDD. If these conditions are not able to be met, then appropriate adjustment of the moisture content or compaction equipment will be required.

In all cases, the dry density of the compacted fill at any one test site shall be not more than 5% below the minimum and the average of the dry densities of any ten consecutive test sites shall not be less than the specified minimum.

The Geotechnical Engineer may at their discretion, alter the compaction specification to a method compaction specification based on the plateau test result for materials with a maximum particle size greater than 65mm.

The test frequency shall be 1 test per 500m^3 of hardfill placed with not less than 1 test per 500mm lift of filling for each fill area.

The test frequency may be relaxed at the discretion of the Geotechnical Engineer (CMW) for the project or in a discrete fill area subject to the consistency of the results achieved being acceptable over a specified period of time.

6.7. Subsurface Drainage

6.7.1. General

Drainage for shear keys, fill drainage keys, buttress fills, underfill gully drains and counterfort drains shall be constructed in accordance with the design drawings and standard details.

6.7.2. Materials

6.7.2.1. Pipes

Drainage pipes used in subsoil drainage shall be 160mm diameter highway grade drain coil. Drain coil walls shall be perforated or solid as detailed in the design drawings or directed by the Geotechnical Engineer on site. Drain coils shall not have a geofabric filter sock unless requested by the Geotechnical Engineer on site.

6.7.2.2. Aggregate

Auckland Council now generally require that subsoil drainage has a 100-year design life and is essentially maintenance free, unless there is an entity such as body corporate or resident's association that maintenance responsibility can be transferred to. Maintenance by individual owners is not practical as the subsoil drainage systems usually cross over, and generally benefit, multiple lots.

This requires a high-quality drainage aggregate with the following properties:

- Self-filters against the soils present on site preventing loss of permeability over time; or, able to be practically wrapped in a suitable geofabric filter.
- High permeability, which translates to a low fines content; and
- Stable and not subject to crushing, weathering, internal erosion or piping, or significant loss of volume (settlement) over time.

Ideally the drainage aggregate should be a well graded self-filtering material such as a clean (free of significant cohesive fines) scoria SAP50 product or Transit F/2 specification filter media.

Alternatively, for shear key drainage, blanket drains, underfill drainage and all applications where full encapsulation with a geofabric filter cloth can be relatively simply and safely achieved, an open graded product, preferably 27/7 Scoria may be used. Care will need to be taken to ensure that the cloth fully encapsulates the aggregate. Observation of the cloth wrap should form an inspection hold point prior to backfilling over the drain. Drain coils in this instance do not require a filter sock.

For counterfort trench drains and applications where a full filter cloth wrap is not practical to construct, and the performance of the drain is not critical to maintaining slope stability then a SAP20 or SAP50 may be used without a filter cloth wrap. Drains which fall into this category must be defined and confirmed as such by the Geotechnical Engineer. Additionally, where such materials are used, regular visual inspections and approval of the aggregate quality and laboratory grading curves is required. This is to comprise visual inspection of each site stockpile prior to material being placed in the trench. One wet sieve grading curve from each site stockpile per week is required while material is being imported to site to monitor the fines content. Drain coils in this instance do not require a filter sock.

For counterfort trench drains and applications where a full filter cloth wrap is not practical to construct, and the performance of the drain is critical to maintaining slope stability then a TNZ/F2 or (approved) modified F2 aggregate must be used. In conjunction with this an approved high specification drainage pipe with filter cloth surround such as the Megaflo products may be specified.

Light compaction (i.e. tamping with back of excavator bucket) only is to be applied to drainage aggregates.

6.7.2.3. Filter Cloth

Any filter cloth surround specified on the drawings shall meet the requirements of Transit Specification TNZ/F7, Filtration Class 2 and Strength Class B unless otherwise specified on the drawings.

6.7.2.4. Trench Backfill in Service Trenches

It is important on all sloping land that service trenches running parallel to contours are avoided where possible as they can permit the ingress of surface water and/or lateral movement of trench sides that could lead to progressive land slippage, help develop tension cracks and possibly lead to slope and building instability.

Backfilling of all trenches should be to the general fill standard above unless specifically varied in writing by the Geotechnical Engineer and where possible the pipe bedding in all trenches on steep ground should contain a 50mm diameter perforated drain coil that is connected into each manhole on the line. This is to help prevent instability arising from the ingress of surface water and/or lateral movement of trench sides that could lead to progressive land slippage and is especially important where the lines are in close proximity to buildings.

The subdivision drain laying contractor must be made aware of these requirements and of the need to contact us when trench backfilling is to take place.

6.7.3. Depth and Extent

The location, extent and depth of the drainage shown on the design drawings may be varied on site by the Geotechnical Engineer in response to the ground conditions encountered.

6.7.4. Drainage Outlets and Inspection Points

Outlets for subsurface drainage shall be provided at regular intervals shown on the drawings or as determined on site by the Geotechnical Engineer. Pipe outlets shall be specifically formed structures with adequate protection such as a headwall and/or rock rip rap. The position of all outlets shall be recorded on the asbuilt drawings.

Where possible it is good practice to include additional inspection and/or flushing points in the subsoil drainage system in the event that their performance needs to be confirmed in the future.

In any event, at least one temporary flush point is required for each subsoil drainage system to enable flushing of the system once the earthworks are substantially complete.

The flushing of the subsoil drainage system must be witnessed by the Geotechnical Engineer.

6.8. Finishing Works and Topsoil Spread

6.8.1. Overcut

All areas cut to below finished level should be reinstated with engineered filling to the satisfaction of the Geotechnical Engineer.

6.8.2. Topsoil Depth

Topsoil respread depth should be between 100mm and 300mm, or as directed by the Engineer to the contract. On ground steeper than 1V:3H the surface should be roughened under the supervision of the Geotechnical Engineer prior to topsoil placement.

6.8.3. Unsuitable Materials

At the conclusion of earthworks all surplus unsuitable materials should be removed from site or placed in designated permanent stockpiles. The size and location of such stockpiles must be approved by the Geotechnical Engineer and recorded on the asbuilt drawings.

6.8.4. Road Subgrades

Testing and formation of road subgrades will be carried out as part of the subdivision civil works package.

6.9. Groundwater

The assumptions made in the design of the slope stabilising works with regard to long term groundwater levels are important. It is therefore considered prudent to reinstall several of the groundwater monitoring piezometers removed during construction in key areas to confirm the assumption made in the design and the performance of the subsoil drainage network.

The location of these will be determined by the Geotechnical Engineer at the completion of the earthworks.

7. ASBUILT INFORMATION REQUIREMENTS

In order to provide a Geotechnical Completion Report (GCR) certain as-built information must be provided to CMW. It is the contractor's responsibility to ensure that all of the following items are surveyed prior to placing filling. The survey of these items should therefore form a hold point in the construction sequence.

1. The location and invert of all sub surface drainage; and,
2. The depth of filling placed including all benching, undercuts, shear or fill drainage keys and temporary ponds which have been backfilled.

CMW require the following as-built information to be provided for the GCR:

1. Cut and fill depth plan (including undercuts and shear keys).
2. Final contour plan.
3. Drainage locations and inverts (surface and subsurface).
4. Drainage outlet locations (surface and subsurface).
5. Details of any defined overland flow paths.
6. Location and heights of any retaining walls..
7. Position and extent of any geogrid layers (in plan view).
8. Material data for imported products used such as draincoils, aggregates and geofabrics as well as confirmation that products installed comply with the requirements of the project drawings and this specification.