

Project Number: 2-9B463.00

# Mauao Base Track Reinstatement

18 December 2019

CONFIDENTIAL



Design Report



Contact Details

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### Document History and Status

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## 1 Introduction

WSP New Zealand Limited were engaged by Tauranga City Council (TCC) to undertake remedial design to repair a damaged section of the Mauao (Mt Maunganui) base track located on the southern side of Mauao.

The landslip occurred on 5 April 2017 following several days of sustained heavy rainfall during the passing of ex-tropical cyclone Debbie. TCC staff observed many groundwater springs at track level leading up to the event. Prior to the slip, a large tension crack had opened in the track before rain was experienced on April 5 which triggered the landslip. Several Pohutukawa trees and a large amount of slip debris slid onto the foreshore creating a debris mound up to approximately 1.3m high at the toe.

Based on these observations, we believe that the slip was likely caused by a build-up of pore water pressure in the slope along permeable sand and silt layers combined with water pressure build up along the tension crack and increased weight of the slope due to the infiltration of rainfall. The large Pohutukawa trees may have also contributed by penetrating topsoil and colluvium layers on the slope face creating a high-density root mass on the edge of the slope which could reduce the permeability and increase pore water pressures at the face.

WSP compiled an options assessment report dated 12 November 2019 titled "Mauao Base Track Repair Options Assessment". This report considered 4 potential mitigation options and explored associated advantages and disadvantages of each option. The report also presents the suggested maintenance inspection requirements and frequency for each option.

Following issue of the options assessment report and subsequent consultation with TCC, Mauao trustees, Regional Council and Heritage New Zealand, the agreed option was to widen the existing track, in combination with the installation of soil nails to improve the overall stability of the slope. Geotechnical investigations consisting of 5 hand augered boreholes and topographical surveys were undertaken in support of this preferred option.

## 2 Site Observations

WSP carried out a site investigation and walkover on 5 November 2019. Our observations of site conditions are summarised below. The site location is shown on the appended general layout plan C01.

The slip site is located at the toe of a large flat terrace on the southernmost flanks of Mauao. At the slip location a portion of the original track remains and ranges in width from 0.5 to 2.0m. The track either side of the landslip is approximately 2.5m wide.

The topography above track level is characterised by an approximately 10m high slope which stands at approximately 45 degrees and is occupied by two large Pohutukawa trees. Based on site records obtained by WSP, the track has shown little signs of regression since the 2017 landslip, however there has been small localised shallow failures in places, as well as small slips from above the track.

The slip scar is approximately 15m across and the slip face below the track ranges in height from 12.5 to 13m down to the foreshore, with a slope of 61 to 68 degrees relative to horizontal.

During our walkover we did not note any direct overland flow path leading towards the slip, however there may be sheet flows from the flat grassed area above the slip site. Seepages were noted from the slip face. No tension cracks were observed above the slip face, or within the crest of the slope above the track.

## 3 Geology

The published geologic map of the area by GNS Science indicates that the site is underlain by Minden Rhyolite which comprises Rhyolite and Rhyodacite flow banded lavas. No exposures of Minden Rhyolite were noted at the site apart from nearby boulders.

The observed site geology comprises a bedded sequence of silts, sand and clay. These deposits are likely to be colluvium, tephra and ash soils deposited over the underlying rhyolite deposits.

## 4 Site Survey

A topographical survey (Refer to drawing C01, Appendix A), in conjunction with a drone survey was undertaken on 4 November to facilitate the detailed design of the slip repair and assist with the geologic interpretation of the site.

## 5 Geotechnical Investigations

WSP undertook the drilling of 5 hand augered boreholes labelled HA01 to HA05. The boreholes were drilled to depths of up to 5m on 5 November 2019. Investigations were supervised by a WSP Engineering Geologist and were logged in accordance with the NZGS Guideline for the Field description of Soil and Rock (2005). All borehole records are contained in Appendix B. Test locations are shown on sheet No. C70 (Appendix A).

### 5.1 Subsurface Conditions

Hand auger boreholes 1 and 4 (HA01, HA04) were drilled on the flat area above the track and generally encountered stiff silt underlain by a silty sand layer and very stiff to hard clay to a depth of 5m.

Hand auger boreholes 2 and 5 (HA02, HA05) were drilled at the existing track level above the slip scarp and comprised very stiff to hard clay underlain by stiff silt and soft sandy silt layers. During the drilling of these holes highly sensitive silt layers and groundwater seepages were observed from sand and silt layers at a depth of approximately 3m. Based on our observation of the slip face, the soils exposed in the scarp comprised interbedded light orange and brown sandy silt layers which transitioned to an orange stiff silty clay from about 3 to 5m and which extended to the toe of the slope down to beach level. Hand auger 3 (HA03) was drilled through the slip debris at the toe of the slope and comprised a mixture of sandy silt to a depth of 1.9m. Underlying the slip debris was fine to coarse beach sand.

### 5.2 Groundwater

Groundwater seepage was encountered in HA02 at depths of approximately 2.8m and 3.3m. It is anticipated that this is a result of a groundwater spring or seepage through more permeable layers. HA03 encountered the anticipated static groundwater table at 1.8m below the ground surface. It is likely that the groundwater table at the base of the slope is close to sea level. For our stability analysis we have allowed for the possibility of raised pore water pressure within the permeable sand layers where we identified seepage.

### 5.3 Ground Model

An interpretation of the geological profile is shown on the annotated section shown on sheet C71 of the design drawings contained in Appendix A.

## 5.4 Geotechnical Design Parameters

Geotechnical design parameters have been assessed using investigation data and back analysis of slope models. The geotechnical design parameters are summarised in Table 1 below.

**Table 1: Geotechnical design parameters**

Material Type	Design Parameters		
	Unit Weight ( $\gamma$ ) kN/m <sup>3</sup>	Effective Cohesion (C') kPa	Effective Friction Angle ( $\phi'$ )
Stiff silt	16	5	30
Silty sand	17	1	30
Very stiff to hard clay	18	20	34
Stiff sandy silt	16	5	30
Sandy silt	16	10	30
Very stiff silty clay	16	15	34

## 6 Remediation Design

### 6.1 Seismicity

For derivation of seismic loads, the site is categorised as subsoil class C – shallow soil according to NZS 1170.5:2004.

Peak ground accelerations for the design have been derived from the NZTA Bridge Manual and NZS1170.5 as recommended in Section 5.1 of the New Zealand Geotechnical Society Module 1, Earthquake geotechnical engineering practice.

A summary of the seismic inputs used for calculation of design accelerations is given below in Table 2.

**Table 2: Seismic inputs derived from NZTABM and NZS1170.5**

Site subsoil class	C
Importance level	2
Unweighted peak ground acceleration coefficient ( $C_{0,1000}$ ) for subsoil class C site in Tauranga	0.34
Design Life (used to derive the PGA)	50
Annual probability of exceedance for ULS earthquake design actions	1/100
Return period factor, ( $R_u$ )	0.5
ULS peak ground acceleration $PGA = C_{0,1000} \frac{R_u}{1.3} fg$	0.17

### 6.2 Design Standards and Method

Slope stability analysis has been determined using the computer program GeoStudio 2018 Slope W. The assessment was carried out using the widely accepted Morgenstern- Price limit equilibrium slope stability method. The slope model has been created using the geological profile determined from the survey and investigation data. Soil parameters were assessed using back analysis of the slope, prior to failure using assumed groundwater conditions.

Design of the soil nail reinforcement followed the method described in the Soil Nail Wall Reference Manual, FHWA-NHI-14-007 using a combination of allowable stress design (ASD) and load resistance factored design (LRFD). Slope W was used to perform the ASD.

The degree of stability of a slope is expressed as the factor of safety (FoS). A minimum factor of safety of 1.5 is often adopted for typical civil engineering projects where consequence of failure is high. For this design TCC has accepted to design to a reduced Factor of Safety. The adopted FoS criteria is given below which is generally in accordance with FHWA-NHI-14-007 for non-critical structures.

A summary of the slope stability outputs is summarised in Table 3 below and the stability outputs are contained in Appendix C.

**Table 3: Slope stability analysis summary**

Analysis Case	Factor of Safety Achieved	Target Factor of Safety
Before Slip (back analysis)	1.01	-
Proposed Nailing (stage 1 nails installed in upper slope only static condition)	1.22	1.20
Proposed Nailing (stage 2 all nails installed transient groundwater condition Ru=0.3)	1.19	1.20
Proposed Nailing (stage 2 all nails installed long term static condition)	1.31	1.35
Proposed Nailing (stage 2 all nails installed seismic condition)	1.01	1.00

The soil nails will be installed in a grid pattern within the proposed cut face above the track and below the track within the existing slip face. The soil nails will be installed in a nail staggered pattern. The soil nail design is summarised in Table 4 below. Further details can be found in the appended design drawings in Appendix A and specification in Appendix D.

**Table 4: Soil nail design summary**

<b>Soil Nails Above Track (Cut Face)</b>	
Number of rows	2
Vertical spacing	1.5
Horizontal spacing	1.5
Nail Pattern	Staggered
Hole diameter	100mm
Hole inclination	15° from horizontal
Nail Bar	Treaded RB25, grade 500 steel, galvanised
Bar length	10m
Nail head	200x200x12 Grade 250 steel plate, galvanised, with 25mm diameter bevelled washer and nut.
Grout strength	30MPa
Facing	Macmat R or equivalent
Factored nail tensile strength	132kN/m
Factored pull out resistance	5.30kN/m
<b>Soil Nails Below Track (Slip Face)</b>	
Number of rows	9
Vertical spacing	1.5
Horizontal spacing	1.5
Nail Pattern	Staggered
Hole diameter	100mm
Hole inclination	15° from horizontal
Nail Bar	Treaded RB25, grade 500 steel, galvanised
Bar length	8m
Nail head	200x200x12 Grade 250 steel plate, galvanised, with 25mm diameter bevelled washer and nut.
Grout strength	30MPa
Facing	Macmat R or equivalent
Factored nail tensile strength*	132kN/m
Factored pull out resistance*	5.30kN/m

\*Load factors taken from FHWA-NHI-14-007

### 6.3 Bored Horizontal Drains

Bored horizontal drains will be installed to tap seepages/ groundwater springs. The general positions are shown on the design drawings and may be adjusted to suit site conditions. The bored horizontal drains will help to reduce water pressures in the slope and improve stability. Drains should be installed so they do not conflict with the installation of the soil nails. A summary of the proposed drains is shown in Table 5 below. Further drainage details can be found on the drawings and in the specification.

**Table 5: Bored horizontal drains design summary**

Number of drains	Estimated 5 to 10
Level	Refer to design drawings (Appendix A)
Horizontal spacing	3.0m (spaced to avoid soil nails)
Hole diameter	100mm
Hole inclination	Min 1/20 gradient
Pipe	65mm diameter PN9 (AS/NZS 1477:2006) PVC slotted as per specification
Drain length	10m

## 6.4 Construction Staging

The proposed works will be staged in the following manner:

- (1) Widen existing track and install soil nails above track to support the cut batter slope in conjunction with Mac Mat R facing.
- (2) Install first row of soil nails below track including placement of coconut matting over most of the lower slip face.

Following step 2 the track will be opened to public over Christmas.

- (3) After the Christmas break the remaining soil nails will be installed in the slip face below the track.

As previously discussed in our options assessment report, observations suggest that the current slip face has been stable, however under adverse (extreme) weather conditions the risk of further slippage of the face remains high.

We note that this staging leaves the slope vulnerable to adverse weather conditions until all nails have been installed below the track. We understand that the Client accepts this risk to have an operative track over the Christmas break. Therefore, we recommend that regular visual inspections are conducted to assess the track condition over this period as recommended in our options report.

## 6.5 Track Drainage

In order to prevent erosion of the slip face it is essential that the existing site drainage is cleared and functional and that direct discharge of culverts onto the slope below are prevented by using flexible culvert flume.

## 6.6 Verification and Proof Testing

Verification and proof testing should be undertaken as per the appended Geotechnical Specification contained in Appendix D.

## 6.7 Safety in Design

In accordance with the Health & Safety at Work Act 2015 safety in design has been considered for construction, maintenance and decommission of the proposed works. Our safety in design register is contained in Appendix D.

## 6.8 Slips from Slope Above Track

As we have not nailed the entire slope above the track, there is a remaining risk of slips and/ or erosion from areas outside those nailed. In the event of small failures from above the track then clearing of the debris would be required as part of the ongoing track maintenance.

## 6.9 Stability of Trees

It must be noted that although the trees appeared stable at the time of our investigations we cannot comment on the ongoing stability of the trees which is outside the scope of this design. It must also be noted that failure of these trees could have a detrimental effect on the track. We therefore recommend that on-going inspections by an arborist are undertaken to assess the condition, health and stability of the trees.

## 6.10 Coastal Erosion

We have not carried out a detailed coastal erosion assessment for this site, however based on survey information, the toe of the slip is above the influence of normal tidal fluctuations and it appears that the slip material at the toe of the slip is providing limited protection from waves with no evidence of active toe erosion.

Therefore, based on these observations, we do not believe that there is any immediate risk of erosion at the toe which could lead to instability, however if the coastal conditions change due to sediment migration or other mechanisms then the toe may be susceptible. In this case, we would recommend ongoing inspections to determine if any mitigation against coastal erosion should be required at a later stage. Such mitigation measures would likely involve the placement of rock rip rap at the toe of the slope.

## 6.11 References

AS/NZS 1477:2006 – PVC pipes and fittings for pressure applications. Sydney, Australia/Wellington, New Zealand: Standards Australia/Standards New Zealand.

Lazarte, C. A., Robinson, H., Gomez, J. E., Baxter, A., Cadden, A., Berg, R. (2015). "Geotechnical Engineering Circular No.7 Soil Nail Walls – Reference Manual". National Highway Institute, U.S. Department of Transportation, Federal Highway Administration, Report No. FHWA/NHI-14-007.

NZGS Earthquake Geotechnical Engineering Practice – Module 1: Overview of the guidelines (2016).

NZS 1170.5:2002. Australia / New Zealand Standard, Structural and Design Actions – Part 5: Earthquake actions New Zealand.

NZTA (2018) Bridge Manual (SP/M/022) Third Edition, Amendment 3. Wellington: NZ Transport Agency.

## 6.12 Limitations

This design report has been prepared for TCC for the Mauao base track slip remediation. The interpretation of ground conditions presented in this report is based on the tests undertaken at discreet locations at the site and surface logging of the slip face. Ground conditions may change suddenly over short distances resulting in variations across the site.

Data or opinions in this document may not be relied upon or used out of context, by any other party or for any other purpose without further reference to the Tauranga Geotechnical section of WSP NZ Limited.

It is recognised that the passage of time effects the information and assessment provided in this document. WSP's opinions are based upon information that existed at the time of the production of this Design Report. It is understood that the services provided allowed WSP to form no more than an opinion on the actual ground conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings or any laws or regulations.

# Appendix A: Drawings



*Tauranga City*

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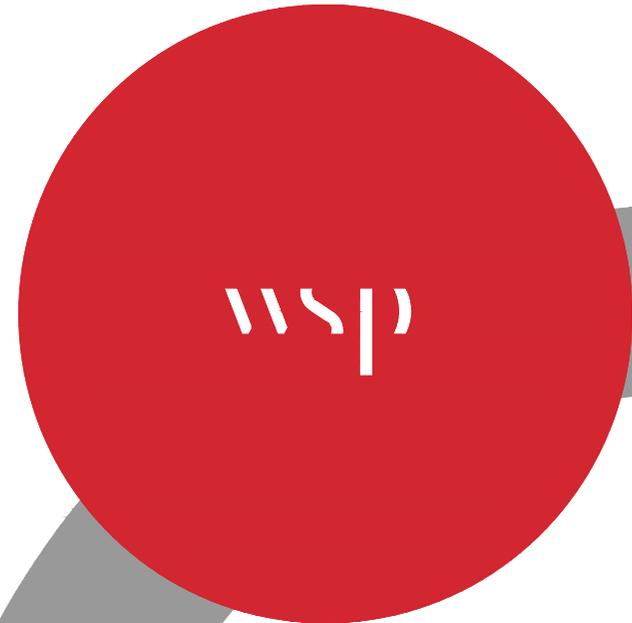
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MAUAO BASE TRACK REINSTATEMENT  
MOUNT MAUNGANUI, TAURANGA**

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Project No: 2-9B463.00

Date: 2019-11-22

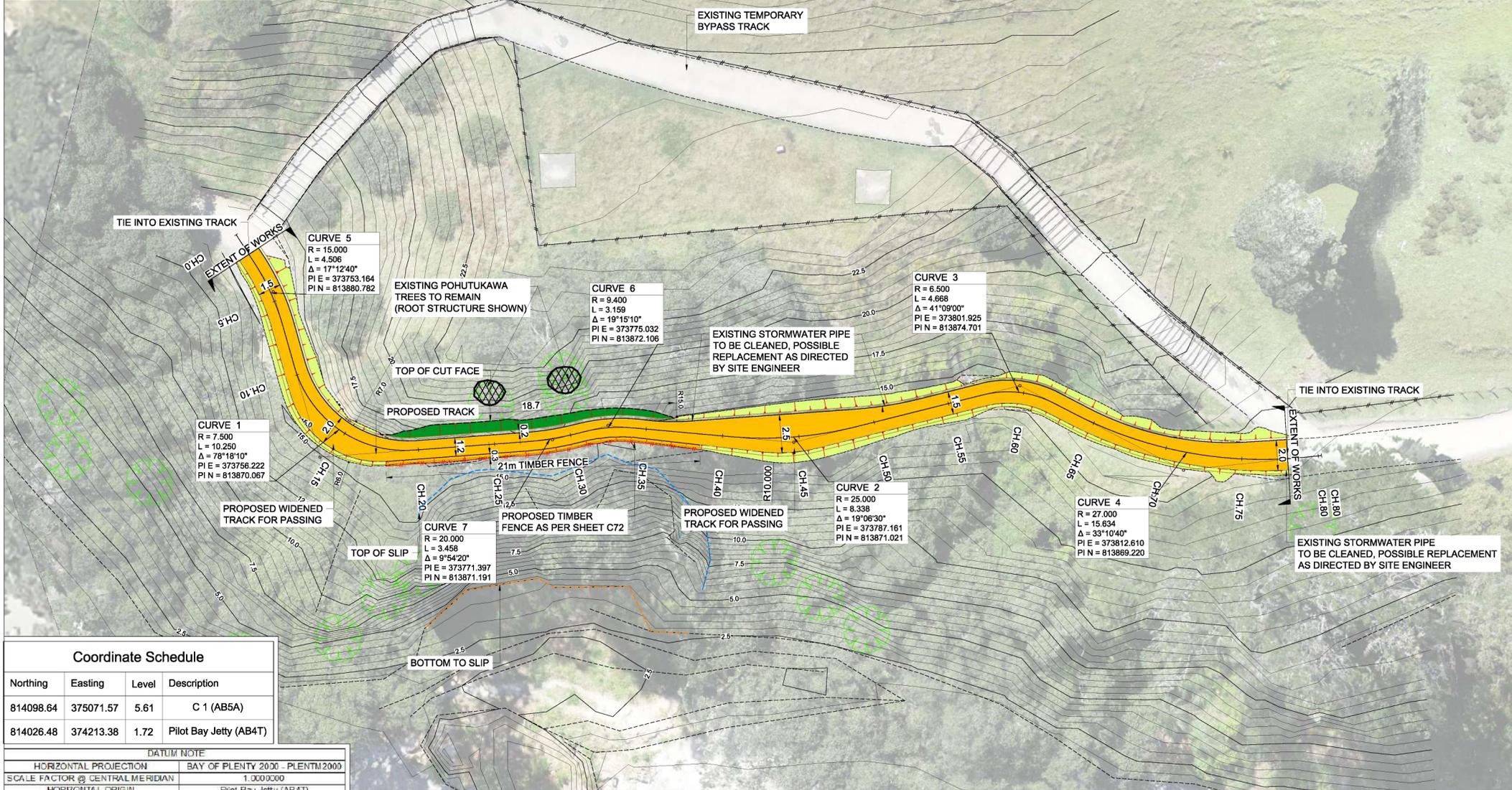


LOCALITY PLAN  
NOT TO SCALE



**LEGEND**

- PROPOSED TRACK.
- PROPOSED EARTHWORKS - AREA OF CUT
- PROPOSED EARTHWORKS - AREA OF FILL
- EXISTING POHUTUKAWA TREES TRUNK.



**Coordinate Schedule**

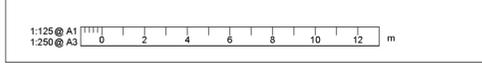
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814026.48	374213.38	1.72	Pilot Bay Jetty (AB4T)

**DATUM NOTE**

HORIZONTAL PROJECTION	BAY OF PLENTY 2000 - PLENTY2000
SCALE FACTOR @ CENTRAL MERIDIAN	1.0000000
HORIZONTAL ORIGIN	Pilot Bay Jetty (AB4T)
VERTICAL DATUM	MOTURIKI 1953
VERTICAL ORIGIN	Pilot Bay Jetty (AB4T)

**COMMENTS:**

THIS WORK INCLUDES DATA WHICH IS LICENSED BY LAND INFORMATION NEW ZEALAND (LINZ) FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.



Revision	Amendment	Approved	Revision Date
1	ISSUED FOR CONSTRUCTION	B.P.	2019-11-22



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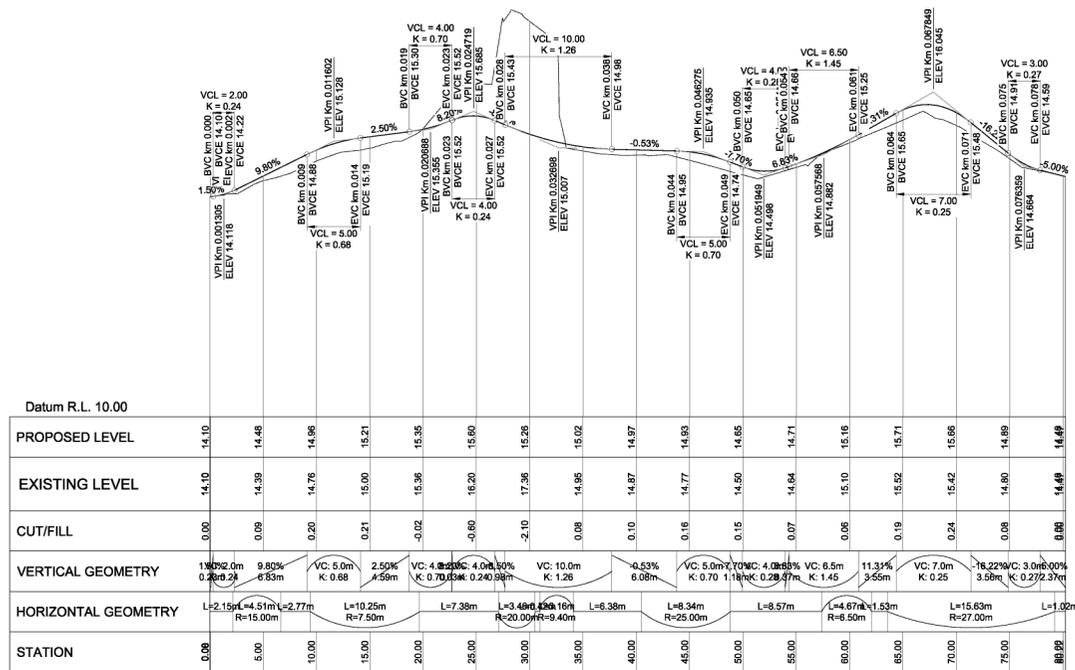
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MAUAO BASE TRACK REINSTATEMENT  
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Sheet: GENERAL LAYOUT  
SHEET 1 OF 1

Project No.: 2-98463.00

Sheet No.	Revision
C01	1



**MAUAO BASE TRACK  
LONGSECTION BETWEEN CH: 0.00 AND 80.22**  
HORIZONTAL SCALE 1:500  
VERTICAL SCALE 1:100

**LEGEND**

- PROPOSED TRACK.
- PROPOSED EARTHWORKS - AREA OF CUT
- PROPOSED EARTHWORKS - AREA OF FILL
- EXISTING POHUTUKAWA TREES TRUNK.

Revision	Amendment	Approved	Revision Date
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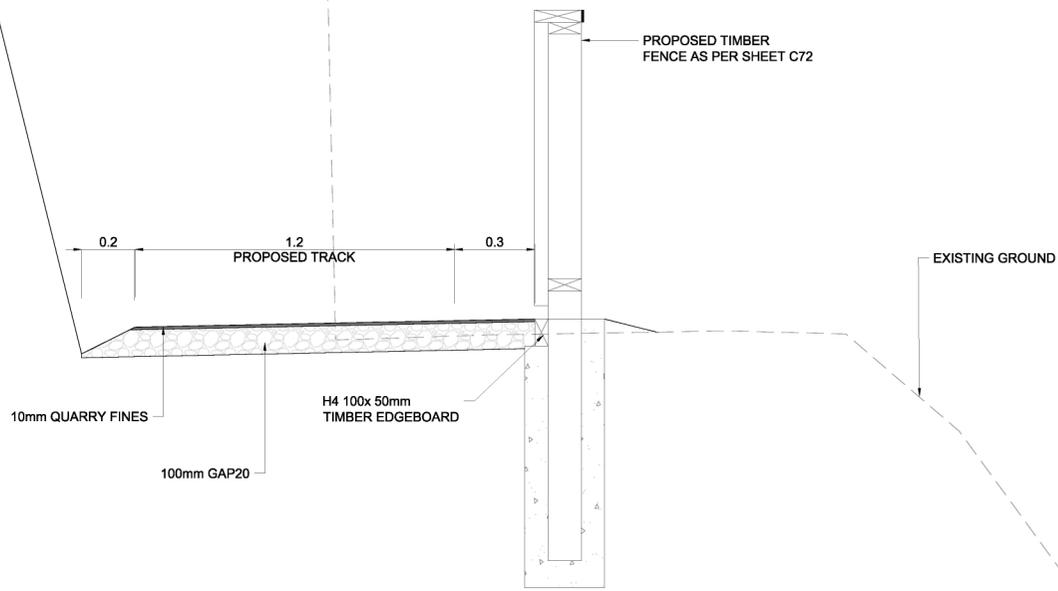


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Project No. 2-9B463.00	Sheet No. C10
Revision 1	Revision 1

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200  
100  
50  
0 10 mm



**TYPICAL CROSS SECTION @ SLIP**  
Scale 1:10 (A1) 1:20 (A3)

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1:10 @ A1  
1:20 @ A3  
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Revision	Amendment	Approved	Revision Date
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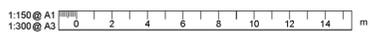
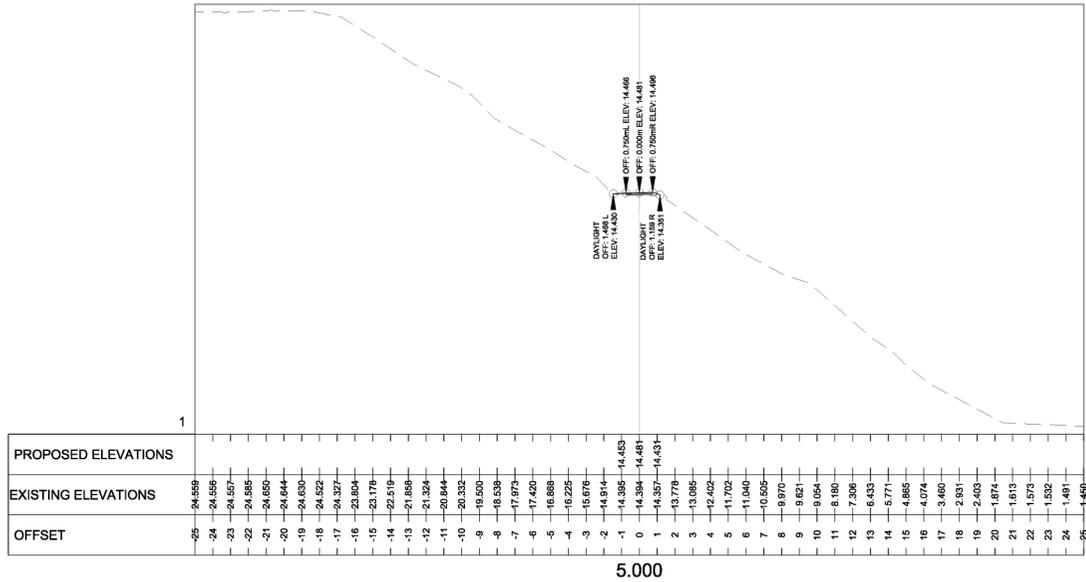
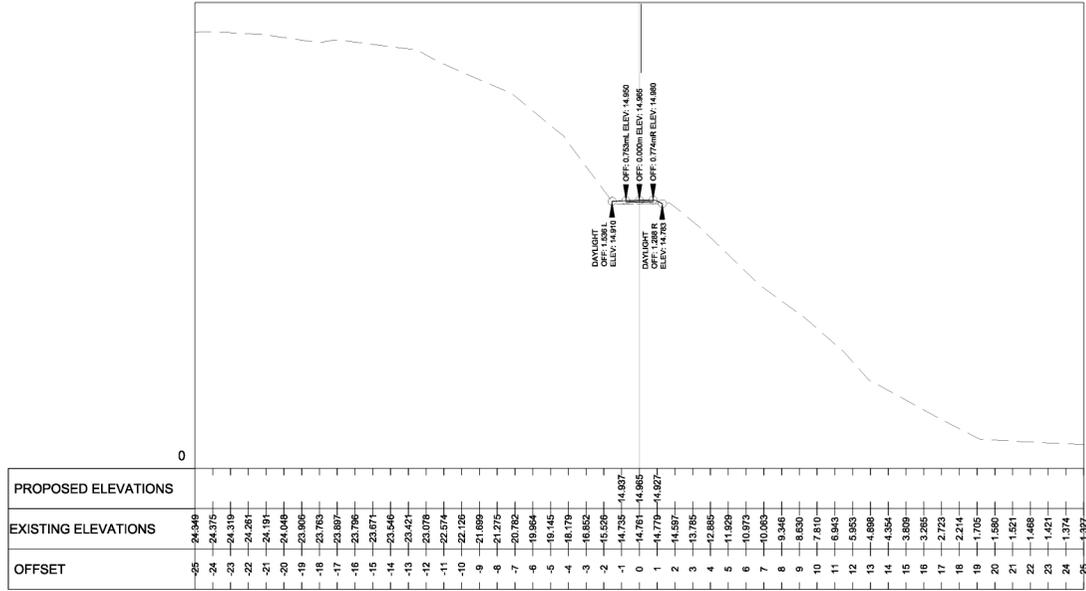
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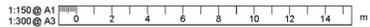
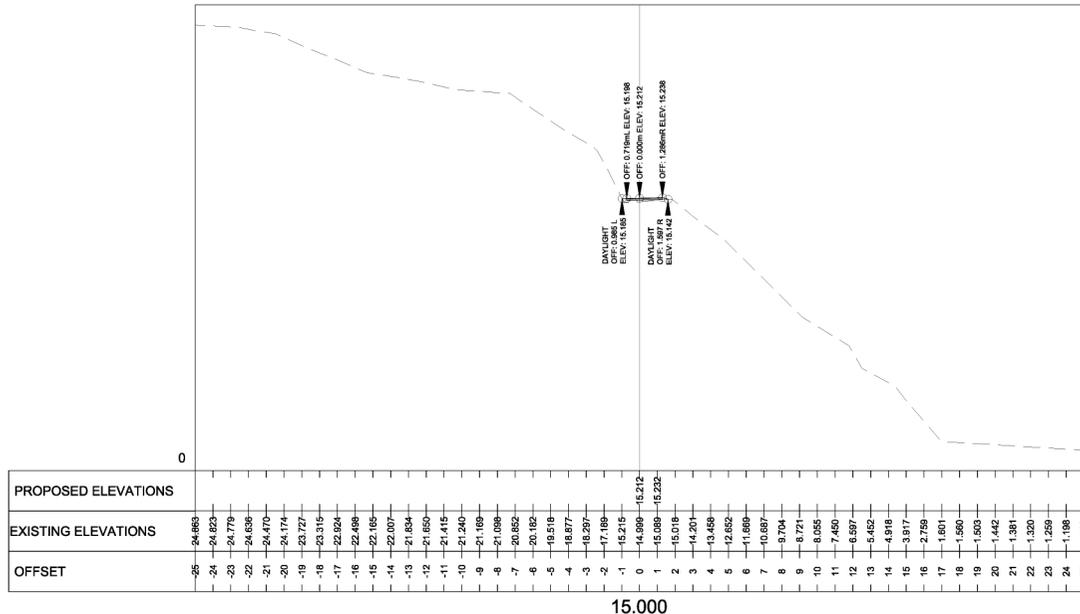
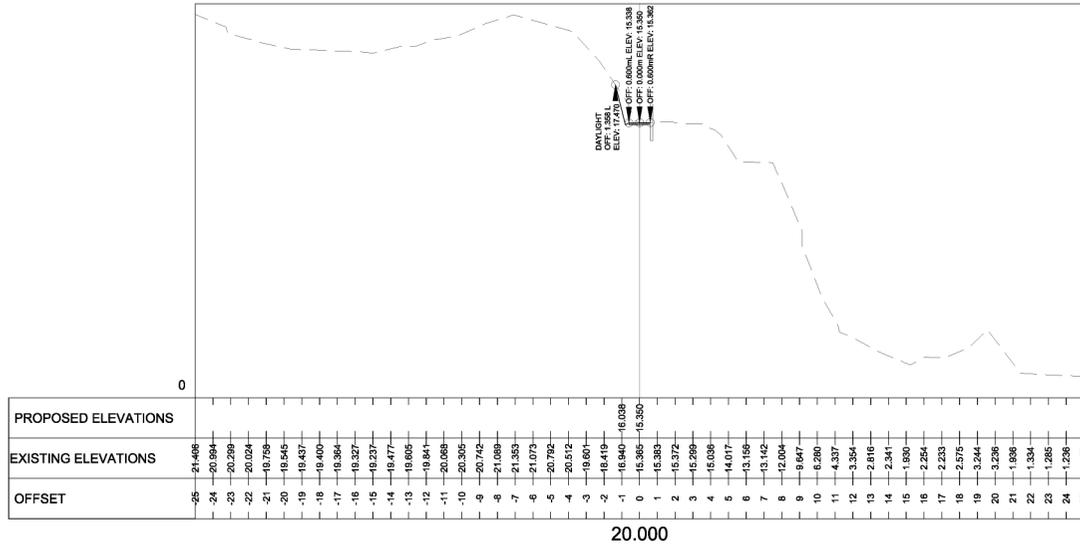
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CROSS SECTIONS SHEET 1 OF 8	
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Revision	1

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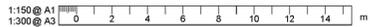
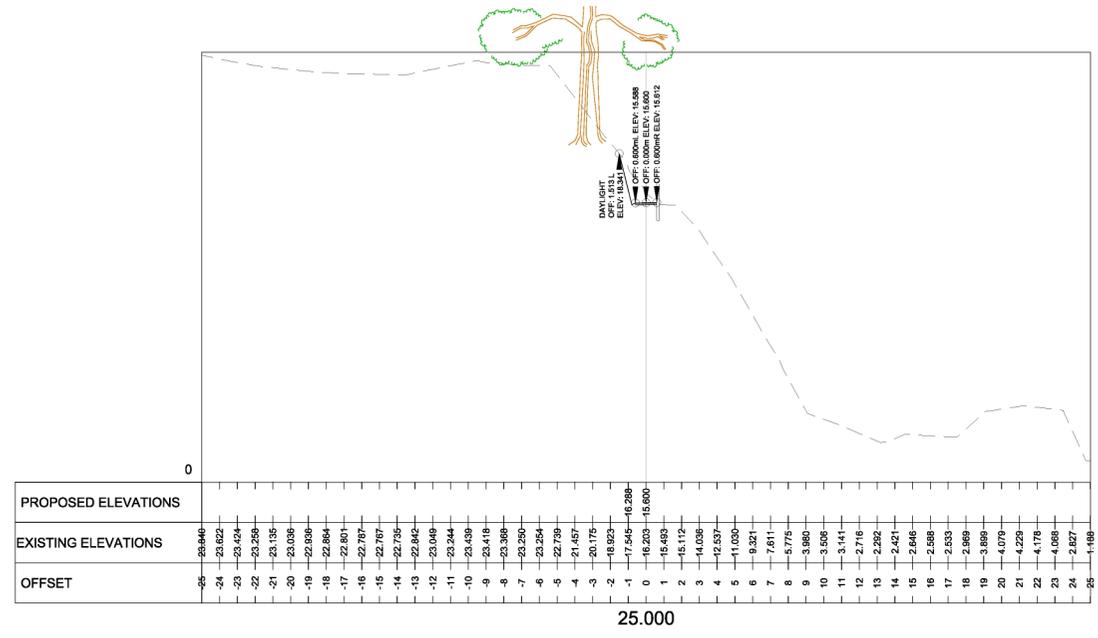
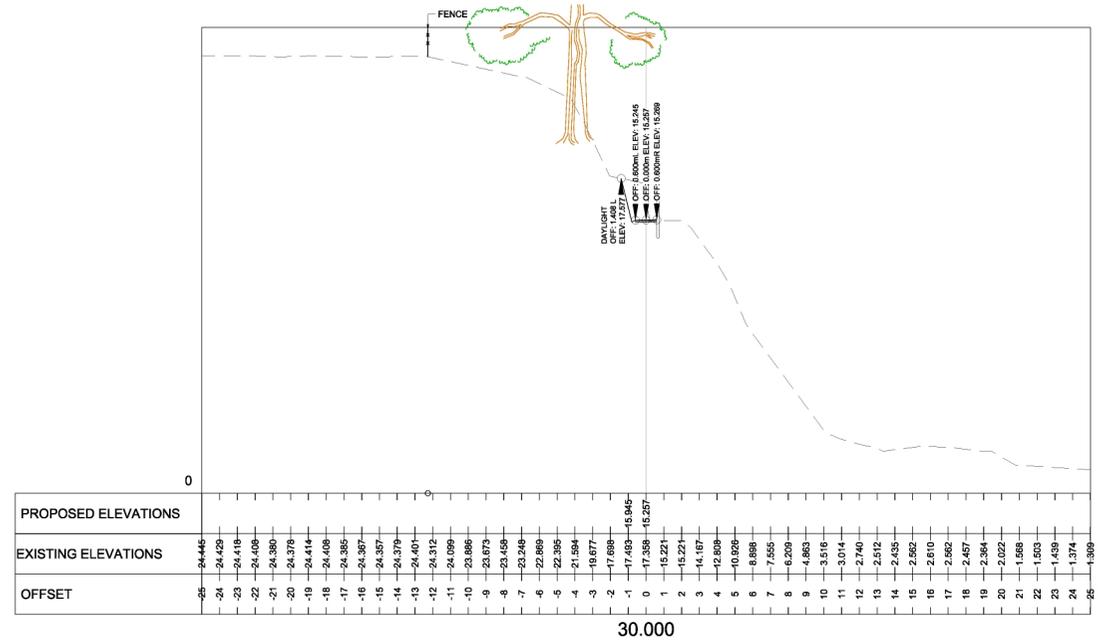
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CROSS SECTIONS - OPTION 1  
SHEET 2 OF 8

Project No.	Sheet No.	Revision
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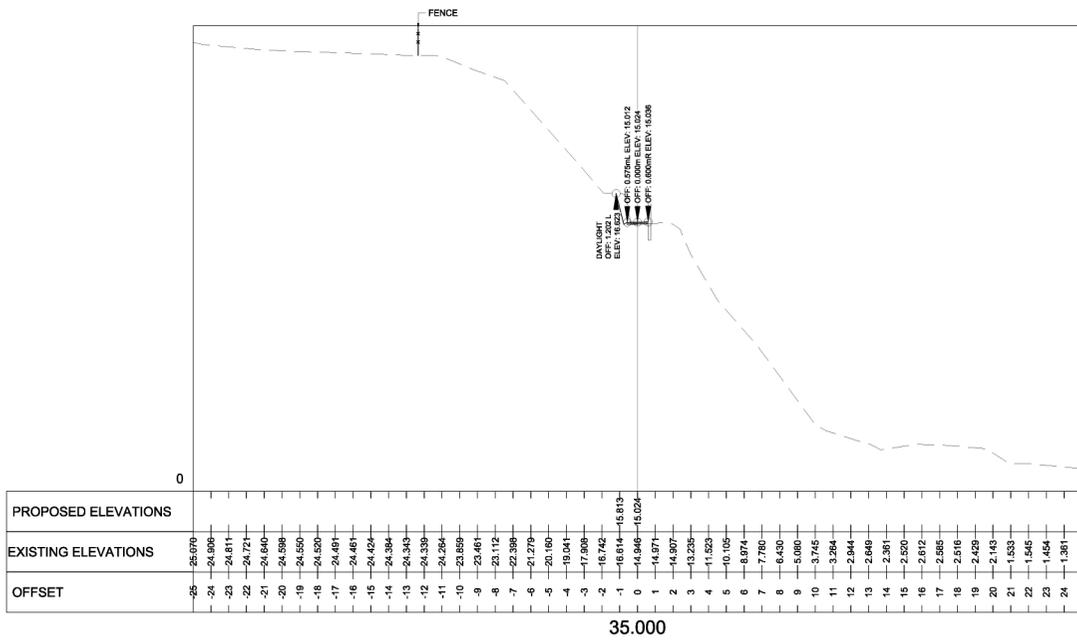
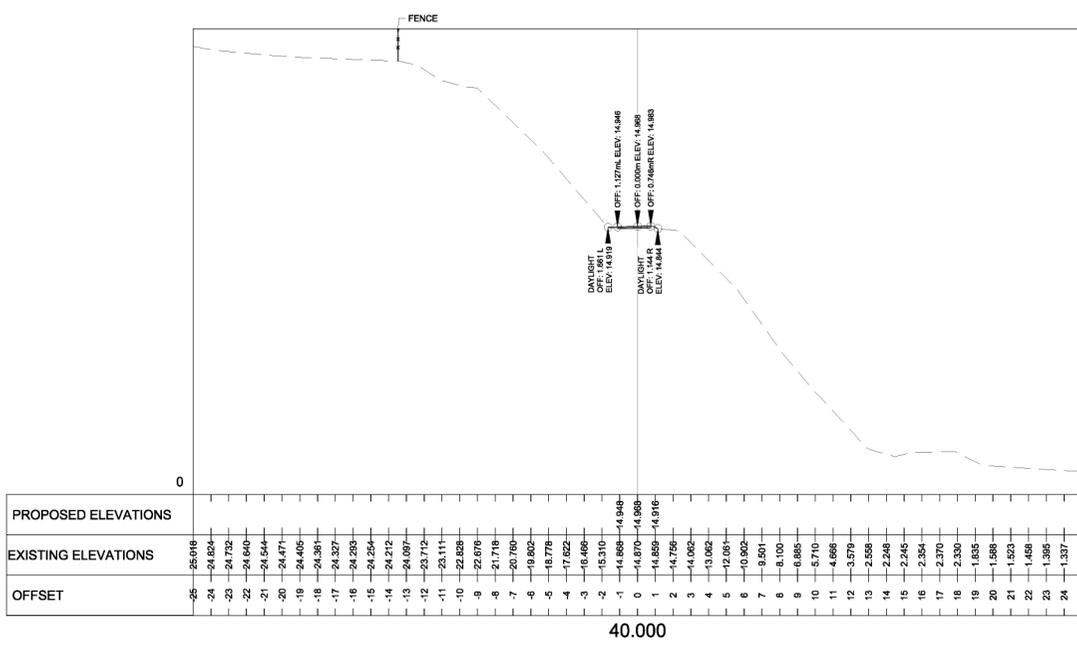
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Revision: 1

Project	Sheet	Project No.	Sheet No.	Revision
TAURANGA CITY COUNCIL MAUAO BASE TRACK REINSTATEMENT MOUNT MAUNGANUI, TAURANGA	CROSS SECTIONS - OPTION 1 SHEET 3 OF 8	2-98463.00	C23	1

0 10 mm 50 100 200 300 mm



Revision	Amendment	Approved	Revision Date
1	ISSUED FOR CONSTRUCTION	B.P.	2019-11-22

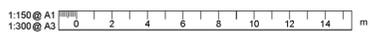
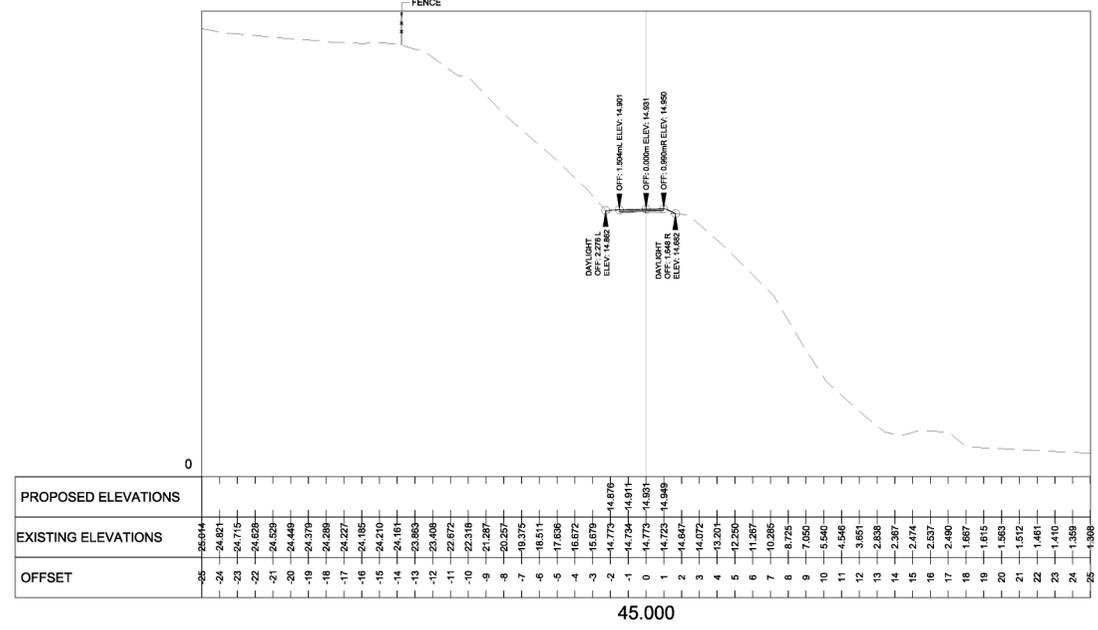
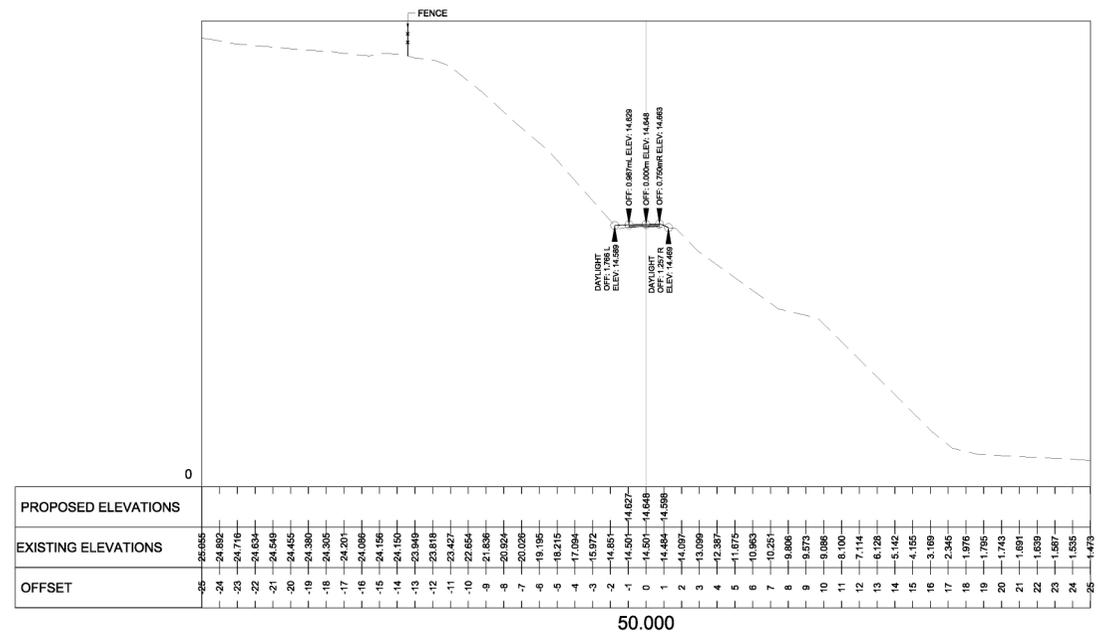


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§ 7(2)(a) ... Privacy		2019-11-22
Drawn	Stated	
§ 7(2)(a)	1:150 (A1) 1:300 (A3)	

Project	TAURANGA CITY COUNCIL MAUAO BASE TRACK REINSTATEMENT MOUNT MAUNGANUI, TAURANGA
Sheet	CROSS SECTIONS SHEET 4 OF 8
Project No.	2-9B463.00
Sheet No.	C24
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1:150 @ A1  
1:300 @ A3



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Drawn	States	
s 7(2)(a) ... Pr		

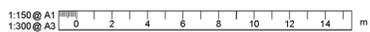
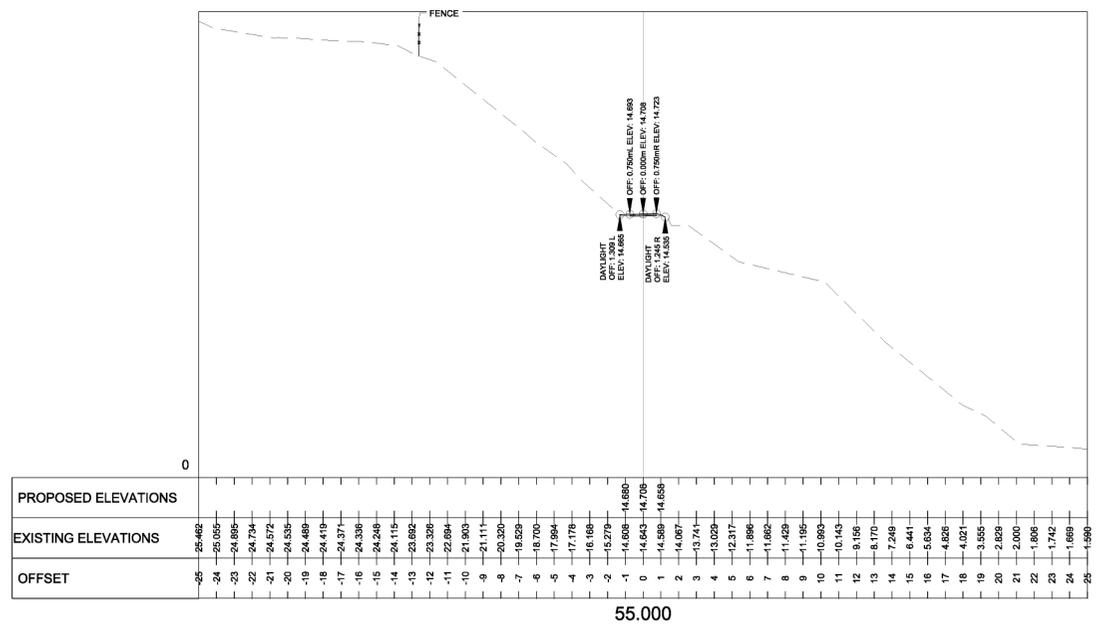
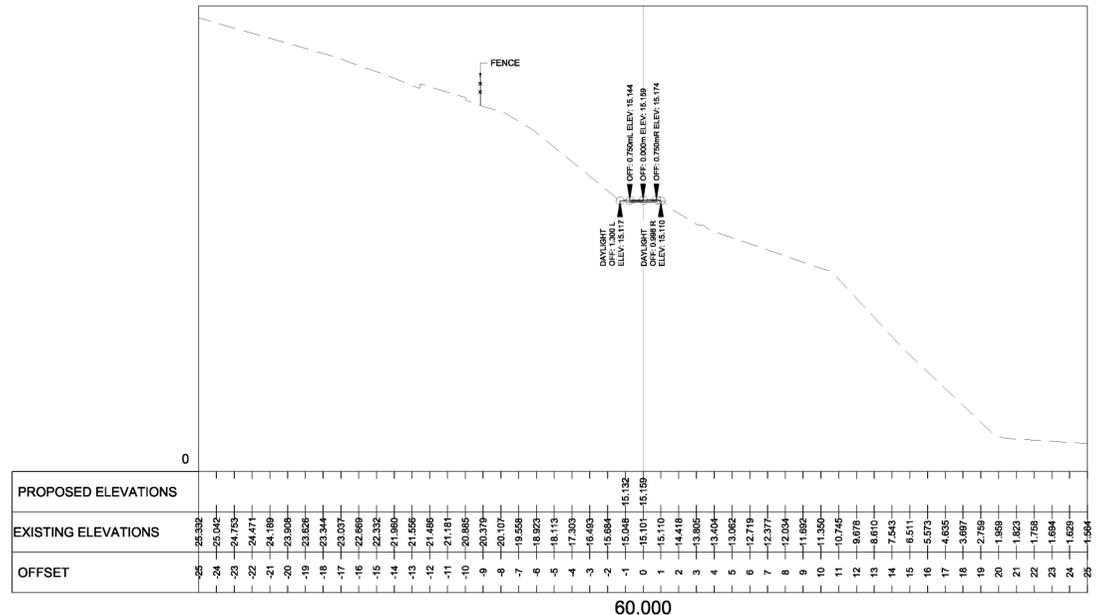
1:150 (A1) 1:300 (A3)

Project  
TAURANGA CITY COUNCIL  
MAUAO BASE TRACK REINSTATEMENT  
MOUNT MAUNGANUI, TAURANGA

Sheet  
**CROSS SECTIONS**  
SHEET 5 OF 8

Project No.	Sheet No.	Revision
2-98463.00	C25	1

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Revision	Amendment	Approved	Revision Date
1	ISSUED FOR CONSTRUCTION	B.P.	2019-11-22



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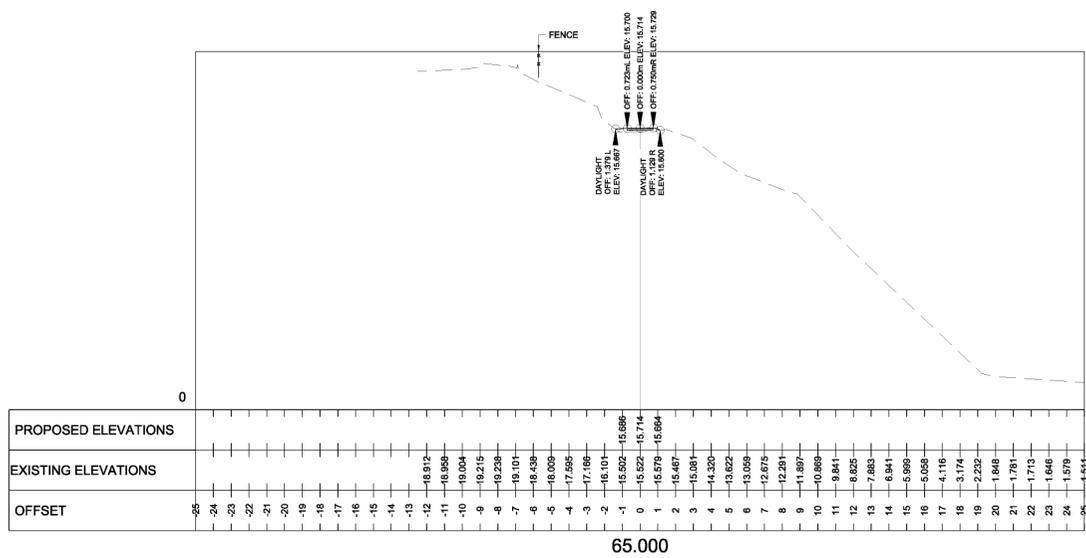
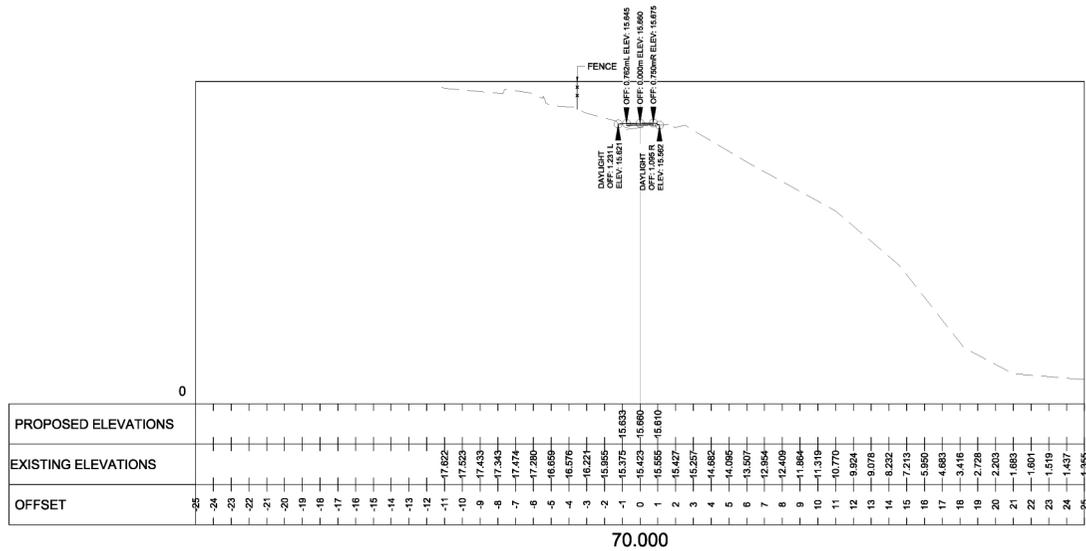
Designated: s 7(2)(a) ... Privacy  
Checked: s 7(2)(a) ... P

Approved Date: 2019-11-22

Project No.: 1:150 (A1) 1:300 (A3)

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Sheet	CROSS SECTIONS SHEET 6 OF 8
Project No.	2-98463.00
Sheet No.	C26
Revision	1

0 10 mm  
50  
100  
200  
300 mm



1:150 @ A1  
1:300 @ A3

Revision	Amendment	Approved	Revision Date
1	ISSUED FOR CONSTRUCTION	B.P.	2019-11-22



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Approved: s 7(2)(a) ... P

Approved Date: 2019-11-22

Project No.: 2-98463.00

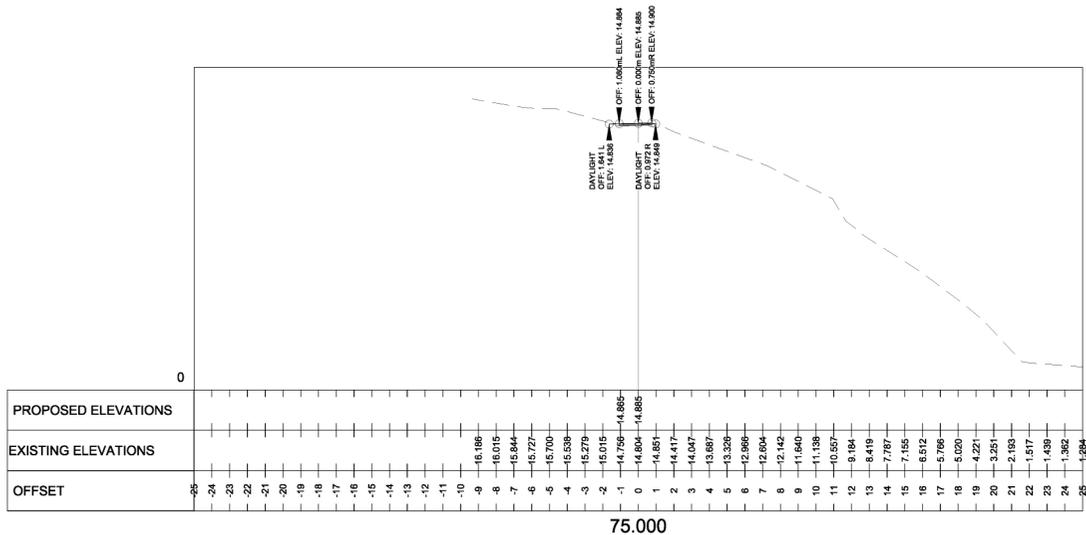
Sheet No.: C27

Revision: 1

Project
TAURANGA CITY COUNCIL MAUAO BASE TRACK REINSTATEMENT MOUNT MAUNGANUI, TAURANGA
Sheet
CROSS SECTIONS SHEET 7 OF 8
Project No.
2-98463.00
Sheet No.
C27
Revision
1

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0 10 mm 50 100 200 300 mm



1:150 @ A1  
1:300 @ A3

Revision	Amendment	Approved	Revision Date
1	ISSUED FOR CONSTRUCTION	B.P.	2019-11-22



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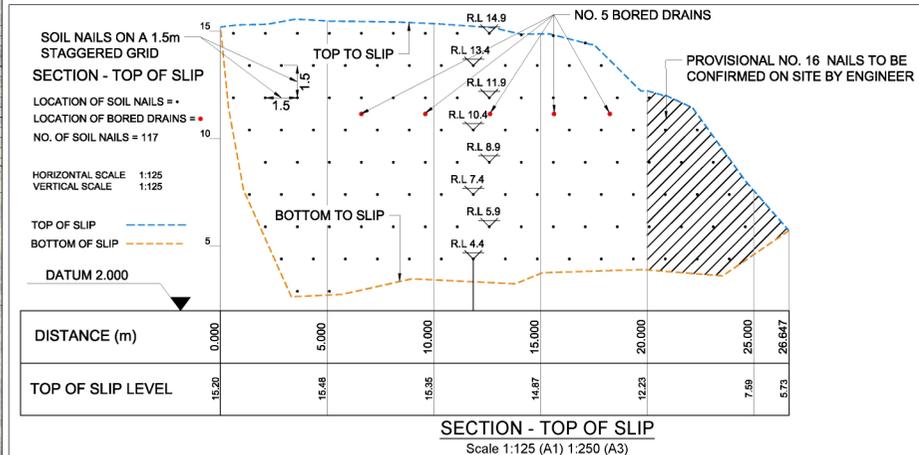
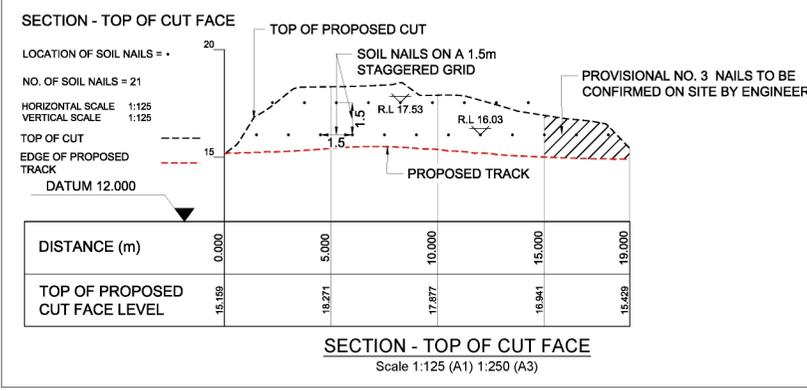
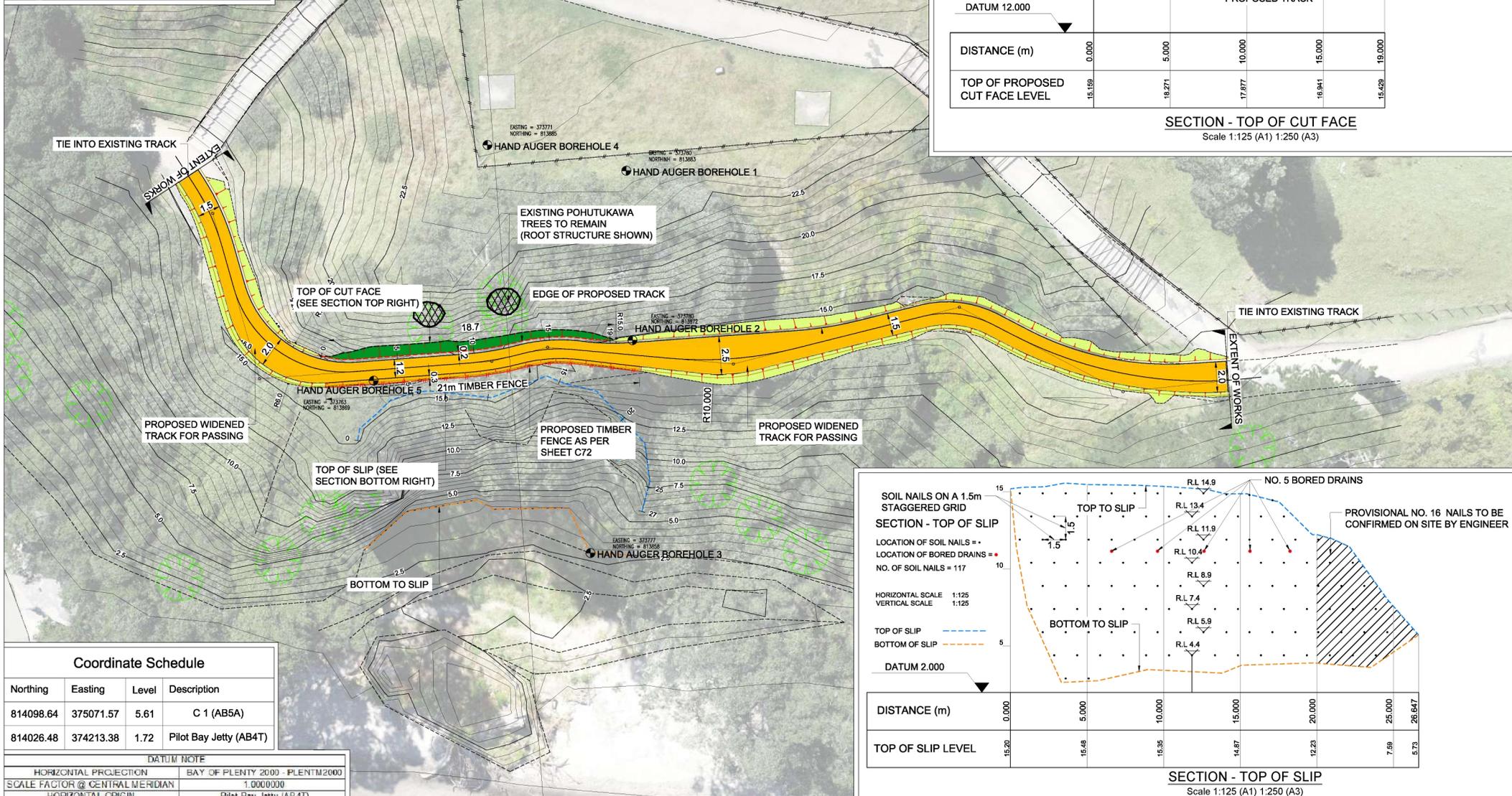
Scale: 1:150 (A1) 1:300 (A3)

Project	Sheet	Project No.	Sheet No.	Revision
TAURANGA CITY COUNCIL MAUAO BASE TRACK REINSTATEMENT MOUNT MAUNGANUI, TAURANGA	CROSS SECTIONS SHEET 8 OF 8	2-98463.00	C28	1

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**LEGEND**

- PROPOSED TRACK.
- PROPOSED EARTHWORKS - AREA OF CUT
- PROPOSED EARTHWORKS - AREA OF FILL
- EXISTING POHUTUKAWA TREES TRUNK.



**Coordinate Schedule**

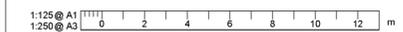
Northing	Easting	Level	Description
814098.64	375071.57	5.61	C 1 (AB5A)
814026.48	374213.38	1.72	Pilot Bay Jetty (AB4T)

**DATUM NOTE**

HORIZONTAL PROJECTION	BAY OF PLENTY 2000 - PLENTY2000
SCALE FACTOR @ CENTRAL MERIDIAN	1.0000000
HORIZONTAL ORIGIN	Pilot Bay Jetty (AB4T)
VERTICAL DATUM	MOTURIKI 1953
VERTICAL ORIGIN	Pilot Bay Jetty (AB4T)

**COMMENTS:**

THIS WORK INCLUDES DATA WHICH IS LICENSED BY LAND INFORMATION NEW ZEALAND (LINZ) FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.



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1	ISSUED FOR CONSTRUCTION	D.D.	2019-11-22



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 Scale: 1:125 (A1) 1:250 (A3)

**Project**  
 TAURANGA CITY COUNCIL  
 MAUAO BASE TRACK REINSTATEMENT  
 MOUNT MAUNGANUI, TAURANGA

**Sheet**  
 SLIP LAYOUT PLAN  
 SHEET 1 OF 1

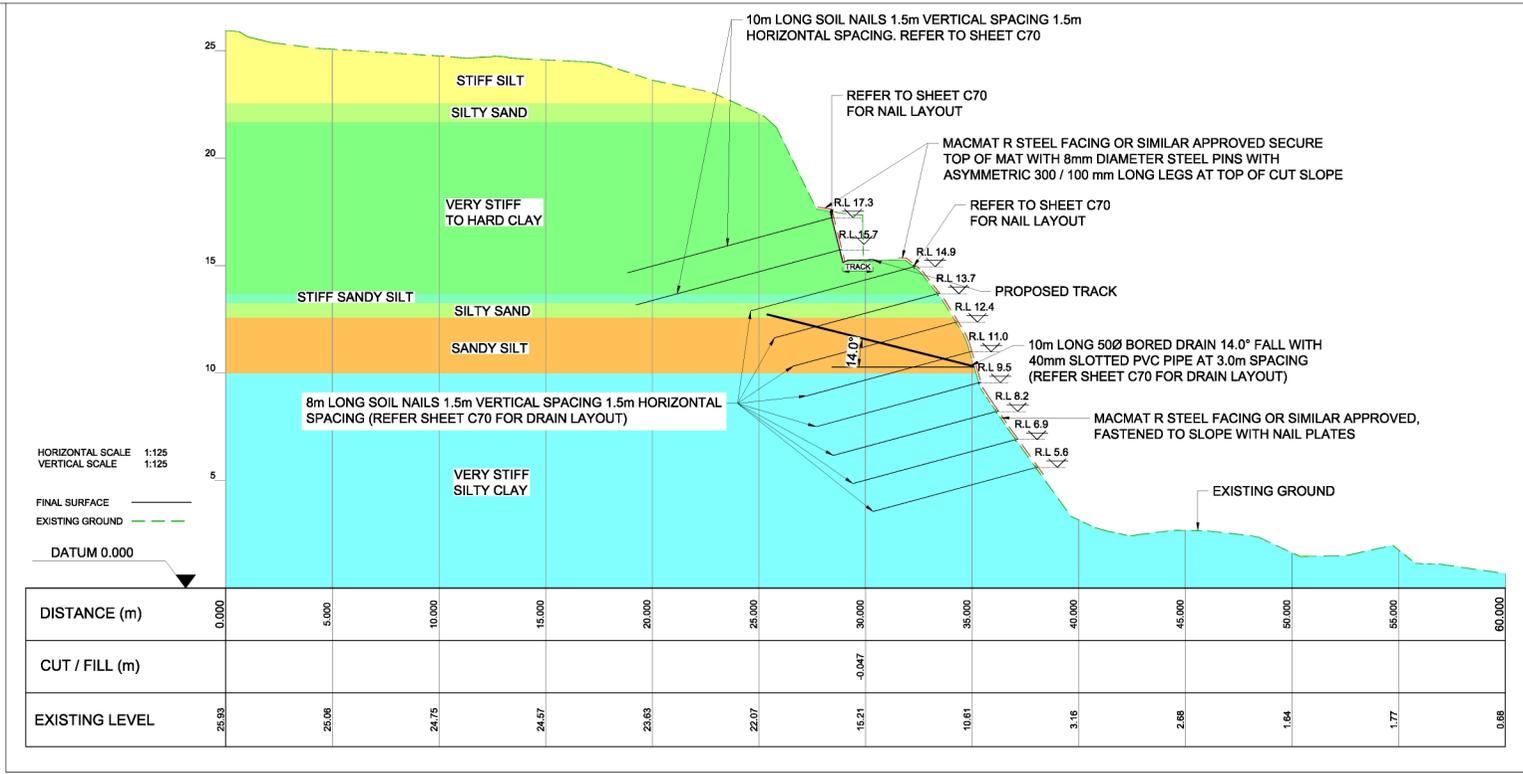
Project No. 2-98463.00  
 Sheet No. C70  
 Revision 1

FOR CONSTRUCTION

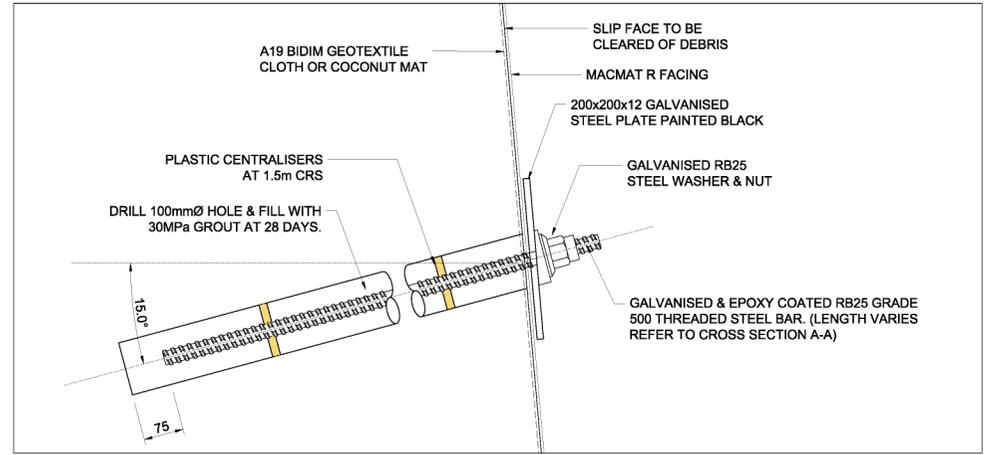
300 mm  
200  
100  
0 10 mm

100  
50  
0 10 mm

1:125 @ A1  
1:250 @ A3  
0 2 4 6 8 10 12 m



SECTION A - A DETAIL - SHEET C70  
Scale 1:125 (A1) 1:250 (A3)



TYPICAL SOIL NAIL DETAIL  
Scale N.T.S

NOTES

- SOIL NAIL WORKING LOAD VARIES REFER TO SPECIFICATION FOR TESTING REQUIREMENTS.
- LEVEL OF SOIL NAIL SHOWN IS APPROXIMATE ONLY.
- BORED DRAINS TO BE LOCATED TO AVOID CONFLICT WITH NAILS.

Coordinate Schedule			
Northing	Easting	Level	Description
814098.64	375071.57	5.61	C 1 (AB5A)
814026.48	374213.38	1.72	Pilot Bay Jetty (AB4T)

DATUM NOTE	
HORIZONTAL PROJECTION	BAY OF PLENTY 2000 - PLENTY2000
SCALE FACTOR @ CENTRAL MERIDIAN	1.0000000
HORIZONTAL ORIGIN	Pilot Bay Jetty (AB4T)
VERTICAL DATUM	MOTURIKI 1953
VERTICAL ORIGIN	Pilot Bay Jetty (AB4T)
COMMENTS:	
THIS WORK INCLUDES DATA WHICH IS LICENSED BY LAND INFORMATION NEW ZEALAND (LINZ) FOR REUSE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.	

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1	ISSUED FOR CONSTRUCTION	D.D.	2019-11-22

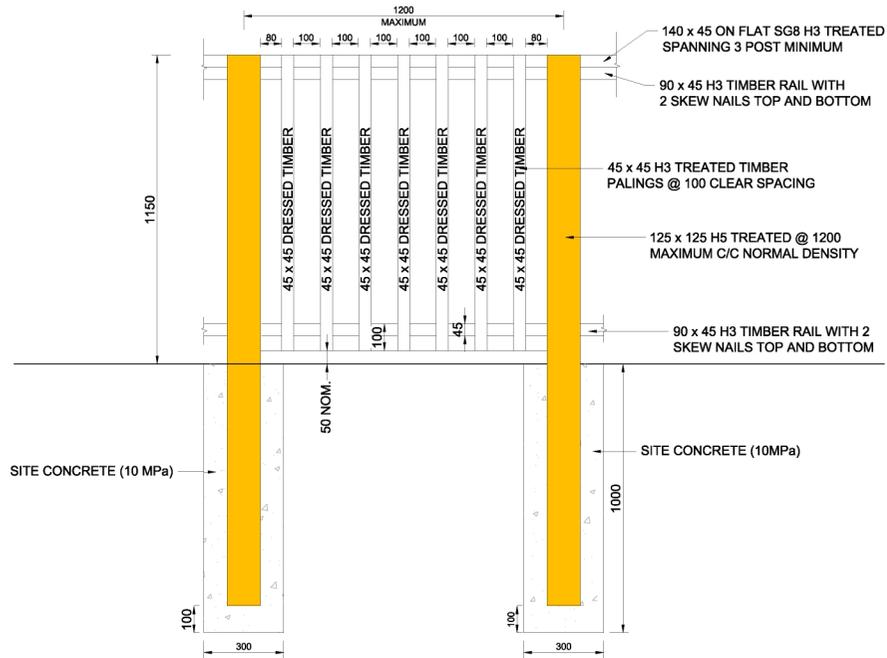


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Approved: 2019-11-22  
Drawn: s 7(2)(a) ... F  
Scale: 1:125 (A1) 1:250 (A3)

Project	TAURANGA CITY COUNCIL MAUAO BASE TRACK REINSTATEMENT MOUNT MAUNGANUI, TAURANGA
Sheet	SLIP - SECTION A & DETAILS SHEET 1 OF 1
Project No.	2-9B463.00
Sheet No.	C71
Revision	1

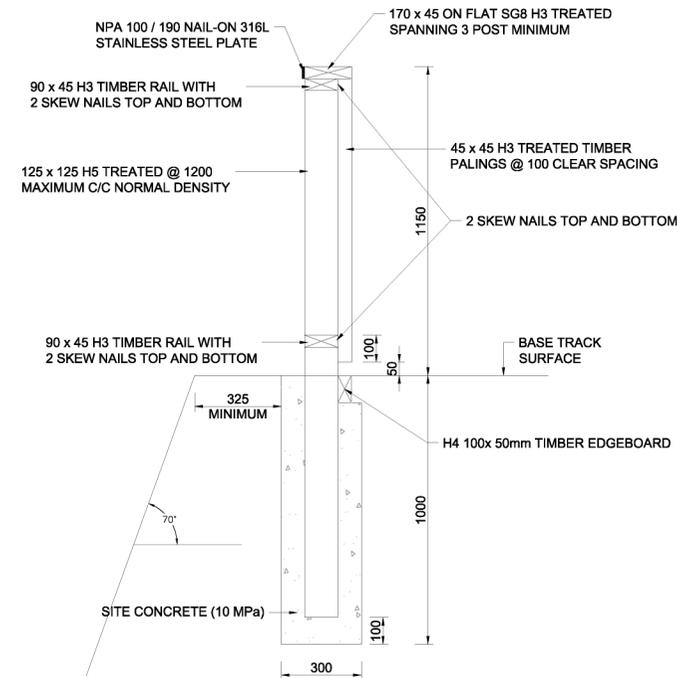
300 mm  
200  
100  
50  
0 10 mm



**TYPICAL TIMBER FENCE PANEL:  
ELEVATION (21m LONG)**  
1:10 (A1) 1:20 (A3)



**TIMBER FENCE PANEL:  
SCHEMATIC REPRESENTATION ONLY**



**TYPICAL SECTION THROUGH TIMBER  
FENCE (21m LONG)**  
1:10 (A1) 1:20 (A3)

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1:10 @ A1 1:20 @ A3 0 100 200 300 400 500 600 700 800 900 1000 mm

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Designed	Approved	Approved Date
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Drawn	Check	Issue
s 7(2)(a) ... P	AS SHOWN	

<p>Project TAURANGA CITY COUNCIL MAUAO BASE TRACK REINSTATEMENT MOUNT MAUNGANUI, TAURANGA</p>	
<p>Sheet TIMBER FENCE TYPICAL DETAILS SHEET 1 OF 1</p>	
Project No.	Sheet No. / Revision
2-98463.00	C72 / 1

# Appendix B: Geotechnical Investigation Data







Project: Mount Base Track Investigations  
 Client: Tauranga City Council  
 Contractor:  
 Project No.: 2-9B463.00

Location: Mauao  
 Coordinates: Not established  
 Ref. Grid: n/a  
 R.L.: Not established

DEPTH (m)	DESCRIPTION	GRAPHIC LOG	WATER LEVEL	R.L. (m)	DEPTH (m)	SOIL TESTS										SHEAR STRENGTH (kPa)	OTHER TESTS	SAMPLES		
						SCALA PENETROMETER (Blows per 100mm)														
						0	2	4	6	8	10	12	14	16	18				20	
	Topsoil, rootlets																			
1	SILT, trace sand and gravel with some clay  becoming orange brown, no clay, moist				1															148/32
2	Sandy SILT; orange brown, moist, moderately plastic  minor sand Sand, minor silt; light brown, moist, becoming wet  fine sand				2															188+ 80/16 64/16 105/27
3	Clayey SILT, trace sand and gravel, brown with orange mottles, moist, moderately plastic  CLAY, with minor silt and trace medium gravel, angular, moist, highly plastic. limonite gravel. (coluvium) CLAY, trace sand; orange brown, mottled, moist, high plasticity				3															78/20 188+
4	with grey streaks  becoming wet				4															188+ 188+
	unable to auger - too hard END OF AUGER AT 4.65m - Unable to Advance Auger - Too Hard					0	4	8	13	18	23	28	33	38	43	48				

**Test Methods:**

Field Description of Soil and Rock, NZ Geotechnical Soc., 2005  
 Determination of the Penetration Resistance of a Soil, NZS 4402 Test 6.5.2:1988  
 Inferred CBR values taken from AustRoads Pavement Design Manual, 2004

**Notes:**

Date Tested: 05/11/2019

Tested by: [Redacted]

Date Reported: [Redacted]

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**Approved by**

Signed by: [Redacted]

Designation:

Date: 18/12/2019

Project: Mount Base Track Investigations  
 Client: Tauranga City Council  
 Contractor:  
 Project No.: 2-9B463.00

Location: Mauao  
 Coordinates: Not established  
 Ref. Grid: n/a  
 R.L.: Not established

DEPTH (m)	DESCRIPTION	GRAPHIC LOG	WATER LEVEL	R.L. (m)	DEPTH (m)	SOIL TESTS										SHEAR STRENGTH (kPa)	OTHER TESTS	SAMPLES		
						SCALA PENETROMETER (Blows per mm)														
						0	2	4	6	8	10	12	14	16	18				20	
0	Sandy CLAY; orange brown, dry, friable																			
0.5	CLAY, with minor sand; orange brown, moist, highly plastic																			
1	CLAY, minor sand; light brown with black flecks																			
1.5	CLAY, with some silt, and minor sand; orange brown, moist, highly plastic																			
2	with black streaks																			
2.5	CLAY, with some sand; orange brown, moist, high plasticity																			
3	Clayey SILT, with some sand and trace gravel, light brown, moist, high plasticity, appears soft	X X X X																		
3.5	becoming wet	X X X X																		
4	Clayey sandy SILT; light brown, wet, high plasticity, soft	X X X X																		
4.5	Sandy SILT, minor clay, light brown, moist, moderately plastic	X X X X																		
5	Silty SAND; light brown, moist	X X X X																		
5.5	Sandy SILT	X X X X																		
6	Silty SAND	X X X X																		
6.5	Sandy SILT; light whitish brown, moist, pumiceous	X X X X																		
7	SAND; light whitish brown, moist pumiceous	X X X X																		
7.5	Silty fine SAND, with some clay; light brown and grey, wet, highly plastic, very soft	X X X X																		
8	END OF AUGER AT 5m - Target Depth Reached																			

**Test Methods:**

Field Description of Soil and Rock, NZ Geotechnical Soc., 2005

**Notes:**

Date Tested: 05/11/2019

Tested by: [Redacted] s 7(2)(a) † Privacy

Date Reported:

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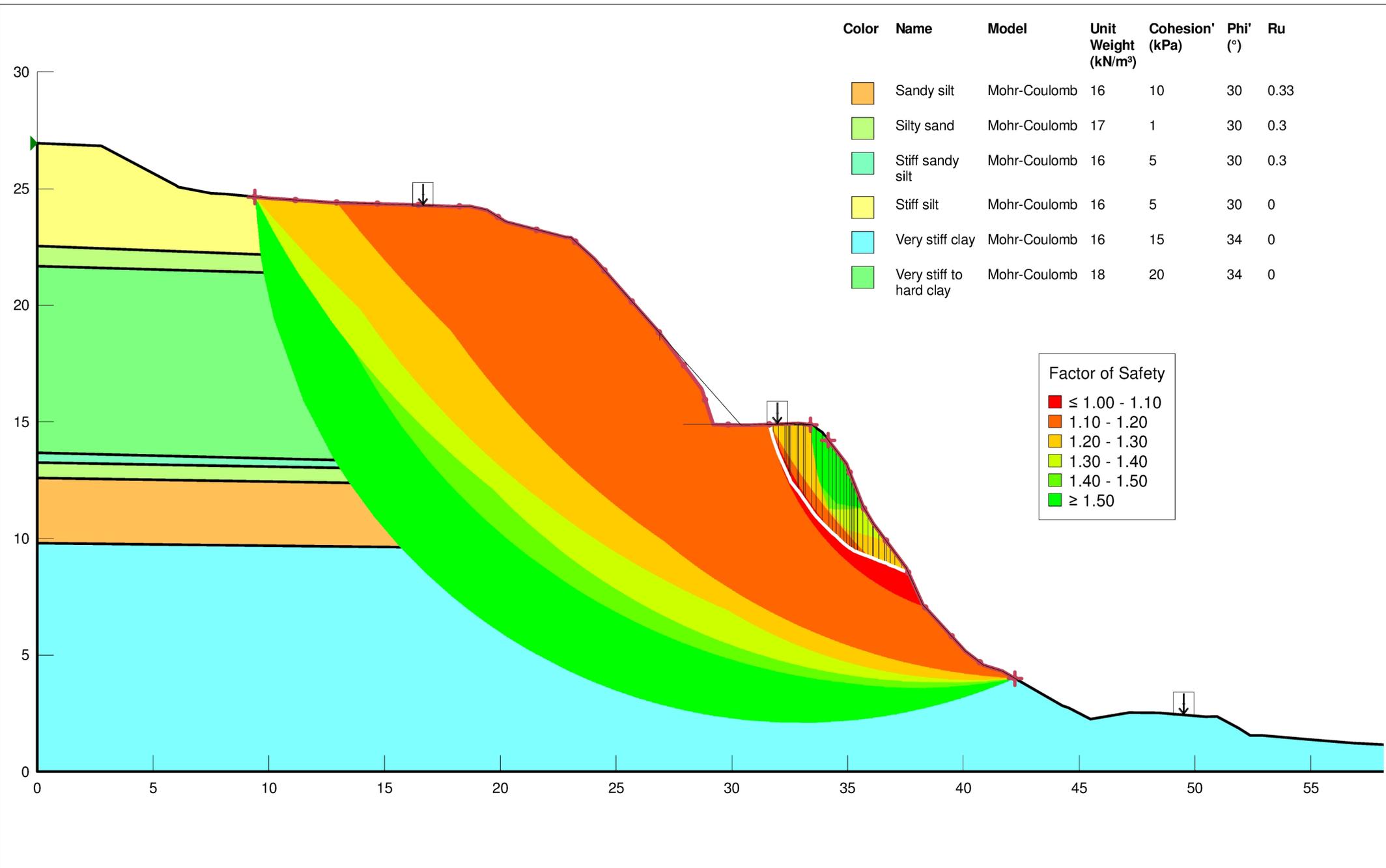
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Signed by: [Redacted] s 7(2)(a) † Privacy

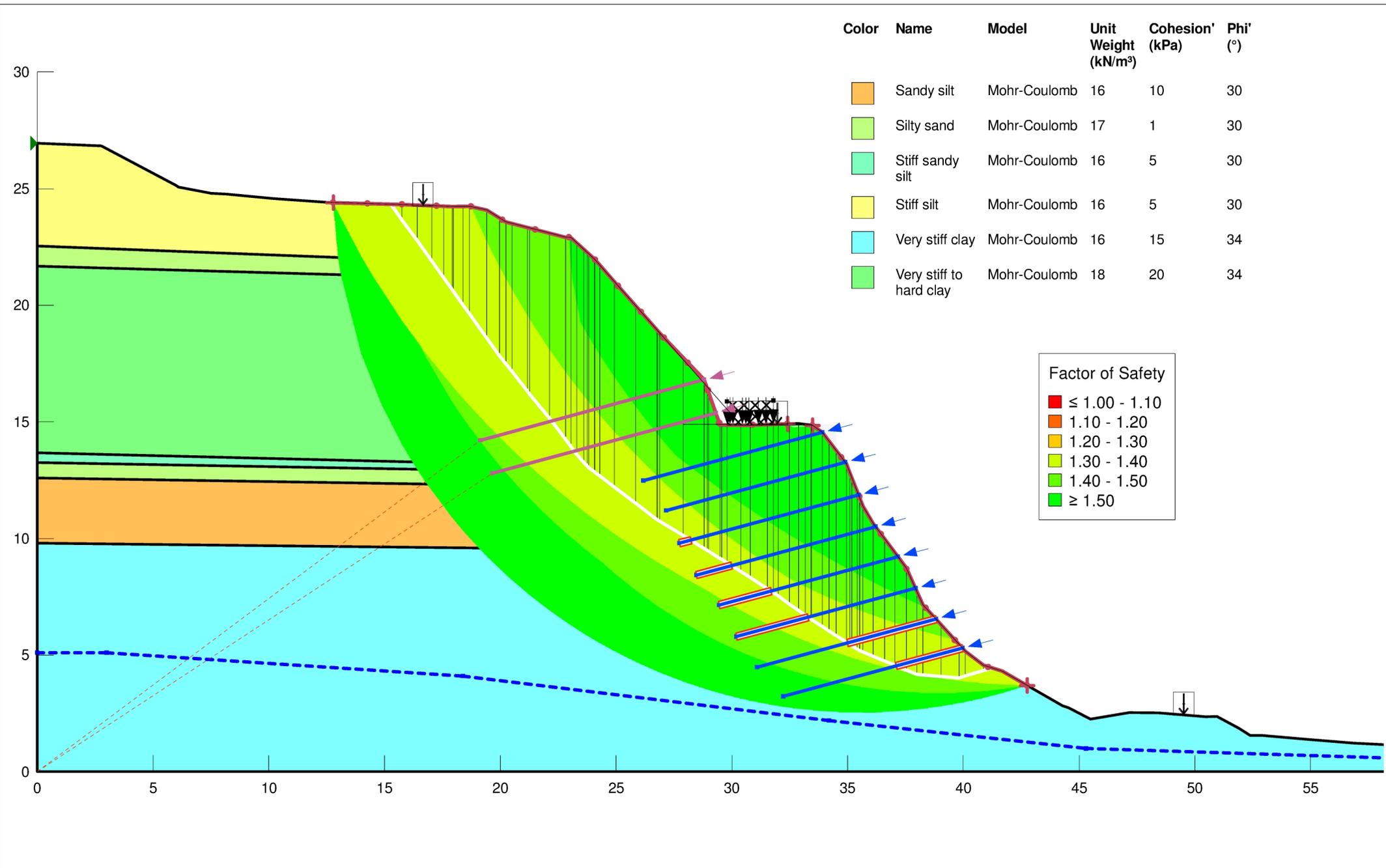
Designation:

Date: 18/12/2019

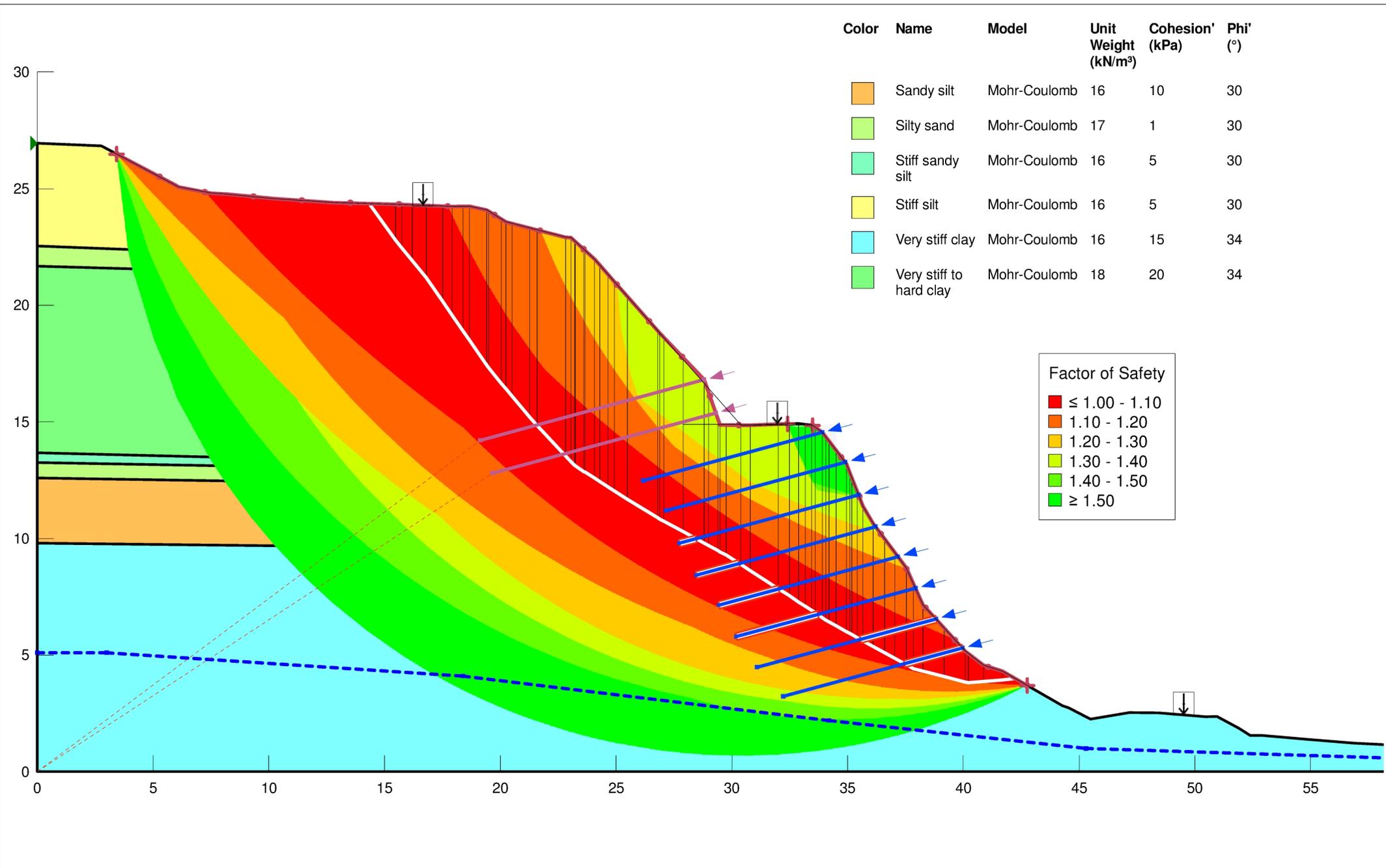
# Appendix C: Slope Stability Analysis



Project: <b>2-9B463.00 - Mount Base Track</b> Analysis: <b>CH37.5_Final Model 141119 back analysis</b> Modelled By: [Redacted] s 7(2)(a) † Privacy Checked By: [Redacted] s 7(2)(a) † Privacy	Model	SLOPE/W	Proj No.	2-9B463.00
	Method	Morgenstern-Price	Date:	10/12/2019
	PGA	g	Scale	1:150
	FOS	1.01	Sheet No.	



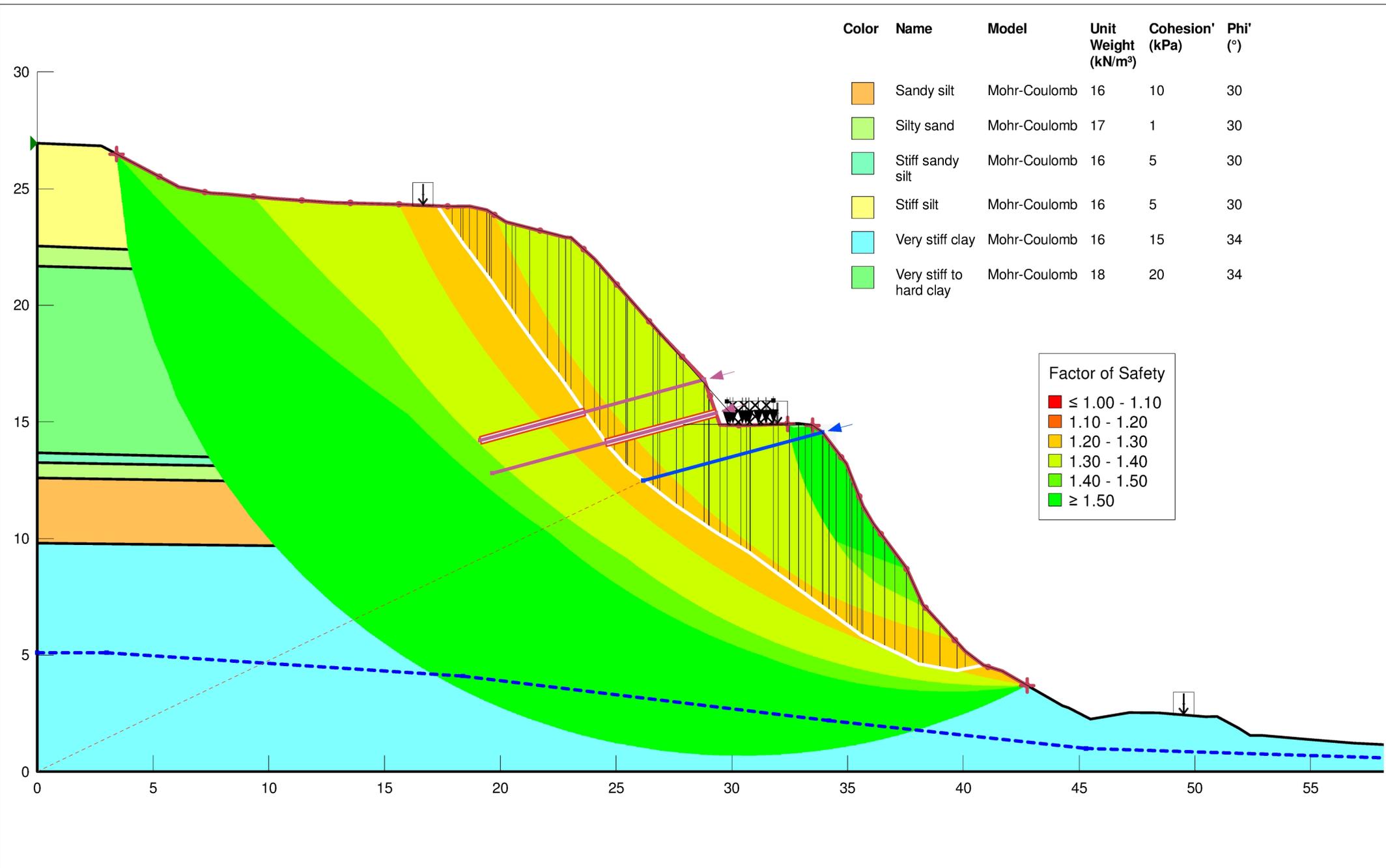
Project: <b>2-9B463.00 - Mount Base Track</b> Analysis: <b>CH37.5_Soil Nail Design Rev.A Normal GW all nails</b> Modelled By: s 7(2)(a) † Privacy Checked By: s 7(2)(a) † Privacy	Model	SLOPE/W	Proj No.	2-9B463.00
	Method	Morgenstern-Price	Date:	10/12/2019
	PGA	g	Scale	1:150
	FOS	1.31	Sheet No.	



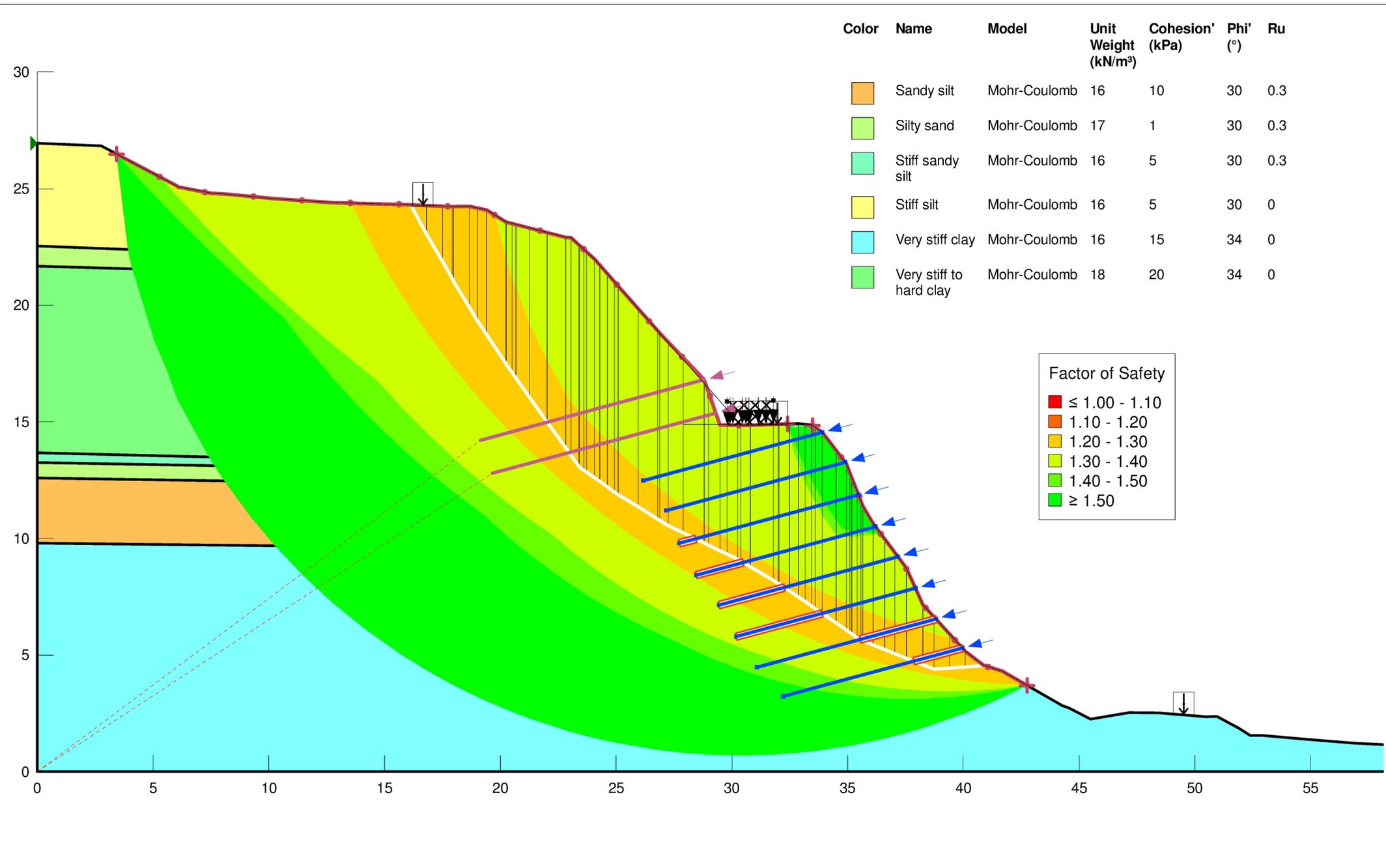
Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
Orange	Sandy silt	Mohr-Coulomb	16	10	30
Light Green	Silty sand	Mohr-Coulomb	17	1	30
Teal	Stiff sandy silt	Mohr-Coulomb	16	5	30
Yellow	Stiff silt	Mohr-Coulomb	16	5	30
Cyan	Very stiff clay	Mohr-Coulomb	16	15	34
Green	Very stiff to hard clay	Mohr-Coulomb	18	20	34

Factor of Safety	
Red	≤ 1.00 - 1.10
Orange	1.10 - 1.20
Yellow	1.20 - 1.30
Light Green	1.30 - 1.40
Green	1.40 - 1.50
Dark Green	≥ 1.50

	Project:	<b>2-9B463.00 - Mount Base Track</b>	Model	SLOPE/W	Proj No.	2-9B463.00
	Analysis:	<b>CH37.5_Soil Nail Design Rev.A Normal GW seismic</b>	Method	Morgenstern-Price	Date:	10/12/2019
	Modelled By:	§ 7(2)(a) † Privacy	PGA	0.17g	Scale	1:150
	Checked By:	§ 7(2)(a) † Privacy	FOS	1.01	Sheet No.	



Project: <b>2-9B463.00 - Mount Base Track</b> Analysis: <b>CH37.5_Soil Nail Design Rev.A Normal GW upper nails only</b> Modelled By: [Redacted]	Model: SLOPE/W Method: Morgenstern-Price PGA: g FOS: 1.22	Proj No.: 2-9B463.00 Date: 10/12/2019 Scale: 1:150 Sheet No.:
	Checked By: [Redacted]	



Color	Name	Model	Unit Weight (kN/m <sup>3</sup> )	Cohesion' (kPa)	Phi' (°)	Ru
Orange	Sandy silt	Mohr-Coulomb	16	10	30	0.3
Light Green	Silty sand	Mohr-Coulomb	17	1	30	0.3
Yellow-Green	Stiff sandy silt	Mohr-Coulomb	16	5	30	0.3
Yellow	Stiff silt	Mohr-Coulomb	16	5	30	0
Cyan	Very stiff clay	Mohr-Coulomb	16	15	34	0
Green	Very stiff to hard clay	Mohr-Coulomb	18	20	34	0

Factor of Safety	
Red	≤ 1.00 - 1.10
Orange	1.10 - 1.20
Yellow	1.20 - 1.30
Light Green	1.30 - 1.40
Green	1.40 - 1.50
Dark Green	≥ 1.50



Project: <b>2-9B463.00 - Mount Base Track</b> Analysis: <b>CH37.5 Soil Nail Design Rev.A transient GW all nails</b> Modelled By: s 7(2)(a) † Privacy Checked By: s 7(2)(a) † Privacy	Model	SLOPE/W	Proj No.	2-9B463.00
	Method	Morgenstern-Price	Date:	10/12/2019
	PGA	g	Scale	1:150
	FOS	1.19	Sheet No.	

# Appendix D: Project Specification and Supplementary Documents



# Mauao Base Track Reinstatement – Project Technical Specification

This specification relates to the Mauao Base Track underslip remediation using soil nailing, with geosynthetic facing, bored horizontal drains and earthworks as shown on the drawings:

2-9B463.00 C70

2-9B463.00 C71

2-9B463.00 C72

## 1 Earthworks Operations

### 1.1 Site Clearance

General site clearance shall be in accordance with TNZ F/1: 1997 Earthworks Construction. Any topsoil shall be stripped and stored on site for re-use.

### 1.2 Setting Out

The Contractor shall be responsible for the correct set-out of all works based on coordinates supplied by the Designer. The Designer shall provide the Contractor with a reference point for set-out.

On completion of the set-out of the works at the site, the Contractor shall immediately advise the Designer for the purposes of checking the set-out. No other works shall be carried out until this has been checked and approved by the Designer.

If the set out is found to be incorrect, the works shall again be set out by the Contractor and re-checked by the Designer.

### 1.3 Service Locate and Protection

The Contractor shall familiarise themselves with all underground services prior to start of any site works and adequately mark and identify underground services within the site works.

### 1.4 Excavation and Batters

The Contractor is responsible for safely excavating the loose material from the slope face. The Contractor shall undertake the minimum excavation required to construct the works and to remove all debris, organic and other deleterious material from the area of works. It is the Contractor's responsibility to ensure that all temporary works excavations are in safe working conditions at all times.

Excavation batter angles may need to be adjusted on site if the excavations encounter any unexpected ground conditions or if the excavation batters are showing any signs of instability. Further guidance to manage health and safety risks associated with excavation work can be found on the Worksafe NZ website. <https://worksafe.govt.nz/>.

The Contractor should refer to the construction drawings for the required excavation dimensions and cut details. Once the excavation is at design level and gradient the Contractor shall inform the



Designer so the Designer can arrange for an inspection of the excavation in order to confirm design assumptions.

### 1.5 Preparation for Filling

Prior to any filling being placed it will be necessary to strip all surface topsoil including buried topsoil and any soft deposits immediately beneath it to be stockpiled for later use. The stripped surface should be inspected by the Designer. The organic materials should be separated from any inorganic soils and stockpiled for inspection by the Designer. It is anticipated that the organic or topsoil material can be respread over the completed work site.

### 1.6 Fill Placement, Compaction and Testing Requirements

The Contractor must ensure that the fill is placed and compacted to achieve even and adequate compaction throughout each layer/ lift. The fill shall not be track rolled and be compacted by a 2 tonne roller. The fill compaction will be visually assessed by the Designer.

## 2 Soil Nail Requirements

### 2.1 Documents

The documents listed below and cited in the Clauses that follow are part of this specification. However, this specification takes precedence in the event of it being at variance with the cited document:

NZS 3109:1997 Concrete construction

NZS 3112.4:1986 Tests relating to grout

NZS 3112.2:1986 Tests relating to determination of strength of concrete. FHWA0-IF-03-017 Pull-out tests

AS/NZS 1477:2006 PVC pipes and fittings for pressure applications

MacMat® and MacMat® R Installation Guidelines Int / IG / MMR / Rev: 02, Nov 2010

## 3 Materials

### 3.1 Nail Reinforcing Bar

Nail bars shall be those stated in the design drawings or an equivalent as approved by the Designer. Nail bars shall be properly labelled and shall be kept protected from dirt, rust and any deleterious substances prior to and during installation. Nail bars shall be rejected if damaged as a result of abrasion, cuts, nicks, welds, and weld splatter, handling, placing and fabrication. Nail bars shall be galvanised to the requirement stated in the design drawings.

### 3.2 Nail Grout

The grout shall be neat cement grout or similar as approved by the Designer. The grout shall achieve a minimum characteristic strength as stated in the design drawings after 28 days.

The Contractor shall engage an IANZ accredited laboratory to undertake two compressive strength tests for every batch of grout at 1, 7 and 28 days in accordance with NZS 3112.4. Grout test results shall be supplied to the Designer within 24 hours of testing.

The grout water/cement ratio by weight shall be below 0.45 and bleed at 20°C shall be less than 2% after 3 hours from mixing. No admixtures shall be permitted without the Designer's prior



approval. Standard flow cone tests for the grout shall be carried out in accordance with NZS 3112 at the Contractor's expense.

### 3.3 Nail Hole Drilling

The drill hole should be temporarily cased and shall be drilled 200mm beyond the lower end of the nail bar.

The inclination and spacing of drill holes shall be those as shown on the drawings. The Contractor may vary the inclination and spacing as approved by the Designer to avoid conflicts such as tree roots or to suit the drilling rig. The nails in adjacent rows shall be offset in a staggered drill pattern as shown on the design drawings.

### 3.4 Nail Bar Installation

Each nail bar shall be centralised in the drill hole using centralizers as shown on the drawings. The centralizers shall be installed at an approximate spacing as shown on the drawings.

If necessary, geotextile grout socks should be utilised to minimise loss of grout. Socks shall be pre-assembled prior to installation of nail bars.

The drill hole shall be checked to ensure that it is clear of debris prior to installation of the nail bar. The nail bar shall be inserted in the drill hole to the minimum design length but shall not be pushed beyond the drill hole length.

### 3.5 Nail Grouting

Grout shall be injected through a grout pipe from the lowest point upwards. The grout shall flow continuously as the casing is withdrawn. The withdrawal rate shall be controlled to ensure that the end of the casing is always below the grout. The Contractor shall record the grout volume and grout consistency. The grout tube shall be removed from the drill hole after the grouting is completed.

### 3.6 Reinforced Mat Facing

The Contractor shall use MACMAT R (steel) facing. If the Contractor proposes an alternative, the proposed alternative reinforced mat facing material should be submitted to the Designer for approval before construction. The reinforced mat facing shall be installed in accordance with manufacturer's instructions and guidelines.

Prior to installing MACMAT R, a geotextile such as bidim A19 or coconut matting shall be installed below the MACMAT R to prevent migration of fines. Refer to drawings for details.

### 3.7 Nail Head Installation

Bearing plates shall be placed firmly against the new slope/wall facing with bevelled washers. Nuts shall be tightened by using a large hand wrench.

### 3.8 Bored Horizontal Drains

The Contractor shall construct bored horizontal drains in the locations and at the grades shown on the Construction Drawings and to the requirements set out below.

The work shall be carried out by persons who have the equipment and a proven track record to carry out this type of work.



The outlet of the pipes shall be terminated a minimum distance of 500mm beyond the face of the slope. Details are given in the Construction Drawings. The bored diameter in the ground shall not exceed 50mm.

PVC pipes for bored drains shall be Class PN9 pressure pipes complying with AS/NZS 1477:2006. Circumferential slots, 2.0mm wide, shall be machine cut and have a length of at least 20mm each on the 40mm pipe. The slots shall be located in pairs in the upper half of the pipe on the same circumferential section. The pair of slots shall be spaced to give 10 pairs every 100mm length. The maximum length of pipe without slots shall be 100mm. The slots shall be machined and free of swarf or burred edges. Hacksaw slots are unacceptable. Pipes shall be unslotted from the discharge point to 1m into the bored hole. The outer annulus between the borehole and the drain pipe OD should be blocked with a grout plug at the slip face to prevent weeping at the face and ensure water drains to the end of the pipe.

The bored drains shall be inclined a minimum gradient above the horizontal of 1/100 to give drainage towards the outlet, as shown on the Construction Drawings.

The Contractor shall clean out the bored drains using low pressure water flushing within three months of completion.

## 4 Soil Nail Testing

### 4.1 General Requirements

The Contractor shall perform a minimum of one 'Verification' test for each different anchor length to be used in the design. Bare rods may be used for the sacrificial verification test anchors.

'Proof' tests shall be undertaken for at least 10% of the proposed nails. The Designer may require extra tests based on the results of the testing results. Installation of additional nails may also be required if the testing results are unsatisfactory.

Soil nail testing shall not be performed until the grout has reached a minimum compressive strength of 70% of the design strength.

The Designer shall be given a minimum of 24-hour notice prior to the first 'Verification' or 'Proof' test. The Designer or his representative shall be present during the above tests. The Contractor shall be responsible for recording, analysing and interpreting all test results and reporting the data to the Designer for review and approval.

### 4.2 Testing Equipment

The Contractor shall design the test frame and reaction system, which should be submitted to the Designer for approval at least 48 hours before commencing the testing. All testing equipment shall be calibrated and checked to be in good working condition prior to each test.

The maximum jack force and pressure gauge shall not be less than 150% of the required test load with an accuracy of  $\pm 1\%$  of the required test load. Dial gauges shall have an accuracy of  $\pm 0.02\text{mm}$  to measure deformation during creep test and shall have an accuracy of  $\pm 0.2\text{mm}$  to measure deformation during other load increments. The dial gauges shall have sufficient travel to allow the test to be completed without having to reset the gauges. The gauges shall be supported independently of the jack, reaction frame or wall local to the test site.

During testing, the jacking equipment shall be placed over the nail in such a manner that the jack, bearing plates, load cell, and jacking anchorage are all aligned. The jack shall be positioned at the



beginning of the test such that unloading and repositioning of the jack during the test is not required.

### 4.3 Verification Test

The Verification Test shall be undertaken as per the load increments given in the following table in accordance with section 9.4 of FHWA-NHI-14-007, FHWA GEC 007, February 2015 or otherwise stated in this document.

The verification test anchors shall have a 4m bonded zone.

- The Verification Test Load is 44kN.

Verification test anchors shall be incrementally loaded as per the following schedule.

Load increment (Verification Test Load)	Minimum period of observation (min)
Alignment load (AL)	1
0.13 VTL	10 (recorded at 1, 2, 4, 5, 10)
0.25 VTL	10 (recorded at 1, 2, 4, 5, 10)
0.38 VTL	10 (recorded at 1, 2, 4, 5, 10)
0.50 VTL	10 (recorded at 1, 2, 4, 5, 10)
0.63 VTL	10 (recorded at 1, 2, 4, 5, 10)
0.75 VTL (Creep Test)	60 (recorded at 1, 2, 4, 5, 6, 10, 20, 30, 50, 60)
0.88 VTL	10
1.00 VTL	10
Alignment load (AL)	1

### 4.4 Proof Test (Acceptance)

The Proof Test shall be undertaken as per the load increments given in the following table in accordance with section 9.4 of FHWA-NHI-14-007, FHWA GEC 007, February 2015.

The proof test Anchors shall have a 4m bonded zone.

- The Proof Test Load is 33kN.

Proof test anchors shall be incrementally loaded as per the following schedule.

Load increment (Proof Test Load)	Minimum period of observation (min)
----------------------------------	-------------------------------------



Alignment load (AL)	1
0.17 PTL	Until Movement Stabilises
0.33 PTL	Until Movement Stabilises
0.50 PTL	Until Movement Stabilises
0.67 PTL	Until Movement Stabilises
0.83 PTL	Until Movement Stabilises
1.00 PTL (Creep Test)	10 recorded at 1, 2, 4, 5, 6 and 10
Alignment load (AL)	1

## 5 Construction Records

The contractor shall keep construction records for every nail and bored drain constructed. The construction records shall contain the following information as a minimum:

- Nail/drain number, location, and dimensions
- A drilling record showing date and time of drilling, the drilling method, the type of materials encountered and the location at which the materials were encountered, water loss/seepage during drilling, problems during drilling.
- Nominal and actual volumes of grout placed.
- Soil nail test records.

## 6 Designers Inspections

The Contractor shall give a minimum 24 hour notice to the Designer for the minimum inspection scheduled as follows:

- Setting out details.
- Inspection of cut batters.
- Inspection of filling.
- Installation of the first nail.
- First Verification and Acceptance Test.
- Installation of bored drains.
- Completion of soil nail slopes.
- Inspection of underslip and cut face following rain events.

## Safety in Design Record – Simplified Procedure

This document records the H&S hazards that could give rise to reasonably foreseeable risks to the health & safety of those interacting with the design option, or any part of it, as a work place during its lifecycle.

**Limitation on Safety in Design Information provided:** Only H&S hazards and risks which will or may result from the design have been identified and recorded. The hazards recorded are those that were identified at the date and associated with stage of the design.

Project information					
Project Name	Mauao Base Track, Mount Maunganui	Project Number	2-9B463.00	Date	27/11/19
Client	Tauranga City Council	Project Stage	Design		
Brief description of design option, including its intended use	Base track widening and securing of slopes with soil nails	Prepared by	s 7(2)(a) † Privacy		

For information on the process refer to our Safety in Design policy and guidelines PO-HS 504

Keywords & Questions (1)	Identified hazards (2)	How is hazard managed in design (3)	Residual risk (4) and Additional requirements (5)	
<b>Design standards</b>	Remediation solution is designed to a reduced standard – i.e. static case not designed to a factor of safety of 1.50	<ul style="list-style-type: none"> <li>The soil nail slope has been designed to a factor of safety of 1.35 which is usually acceptable to owners where the structure (slope in this case) is deemed as non-critical.</li> <li>In the critical case a design factor of safety of 1.50, is typically required.</li> <li>Design will withstand a 1:100 year seismic event, based on an importance level 2 structure.</li> </ul>	High	<ul style="list-style-type: none"> <li>The completed soil nail slope will likely achieve a greater factor of safety than more vulnerable areas of track outside of the repair area.</li> <li>TCC have accepted this reduced factor of safety for the static case</li> <li>Inspection regime to be undertaken, during and post construction</li> </ul>
<b>Construction Earthworks, Soil Nails &amp; bored drains</b>	Reduced track width – On completion, the minimum track width will be 1.20m at the critical section	<ul style="list-style-type: none"> <li>Mitigated risk by including timber fencing; installation of reduced path width signage each side of narrowest section.</li> </ul>	Low	
<b>Construction Earthworks, Soil Nails &amp; bored drains</b>	Reduced track width – During construction	<ul style="list-style-type: none"> <li>The track will be progressively widened in 5m sections to create a stable working platform for the excavator– a 0.70m minimum set back from crest of slope is required for any plant/machinery.</li> <li>Loads and working platform have been assessed for stability based on data supplied by The Contractor and small plant has been selected to reduce loads applied to top of slip.</li> </ul>	Extreme	<ul style="list-style-type: none"> <li>Spotter required on site at all times noting for any signs of instability</li> <li>Ensure a highly visible safety barrier is installed to ensure the machinery do not deviate from the track</li> <li>Minimise vibrations wherever possible during the course of the works</li> <li>Only operate in fine weather conditions and stop works immediately if unexpected rain events occur</li> <li>Geotechnical inspections are required following rain events before recommencing work.</li> </ul>
<b>Construction – Installation of soil nails &amp; bored drains</b>	Working at heights	<ul style="list-style-type: none"> <li>Minimise: Construction materials have been chosen so that all materials can be hoisted down the slope safely. Abseil access will be required for the lower slope.</li> </ul>	High	<ul style="list-style-type: none"> <li>Use suitably trained and experienced contractors</li> </ul>
<b>Construction – Installation geogrid facing</b>	Working at heights	<ul style="list-style-type: none"> <li>Minimise: We have used a geogrid facing which is light weight compared to other systems. The geogrid can be spooled down from the top of the track and fastened with abseil access.</li> </ul>	High	<ul style="list-style-type: none"> <li>Use suitably trained and experienced contractors</li> </ul>
<b>Construction – Installation of Timber Fence</b>	Working at heights	<ul style="list-style-type: none"> <li>Minimise: Reasonable lightweight construction materials have been chosen for the fence.</li> <li>Temporary safety fence to be placed between the installation area and the Slip Edge.</li> </ul>	High	<ul style="list-style-type: none"> <li>Use suitably trained and experienced contractors</li> </ul>
<b>Maintenance of soil nails</b>	Working at heights	<ul style="list-style-type: none"> <li>Minimise: Soil nails are galvanised and epoxied to increase time to first maintenance activities. Only facing and nail plates should need repair work during design life.</li> </ul>	High	<ul style="list-style-type: none"> <li>Use suitably trained and experienced contractors</li> </ul>

## Safety in Design Record – Simplified Procedure

Keywords & Questions (1)	Identified hazards (2)	How is hazard managed in design (3)	Residual risk (4) and Additional requirements (5)	
<b>Maintenance of bored drains</b>	Working at heights	<ul style="list-style-type: none"> <li>Drains can be maintained via abseil access.</li> </ul>	High	<ul style="list-style-type: none"> <li>Use suitably trained and experienced contractors</li> </ul>
<b>Decommissioning of nails and drains</b>	Working at heights	<ul style="list-style-type: none"> <li>Soil nails can be left in-situ at the end of their design life. Further remediation measures may be required at this time.</li> </ul>	Low	
<b>Construction methodology</b>	Increased risk of up slope failure during construction	<ul style="list-style-type: none"> <li>Methodology of construction excavate 5m then nail, excavate 5m then nail and so on.</li> </ul>	High	<ul style="list-style-type: none"> <li>Adhere to construction methodology</li> <li>Use of spotters when excavating loose material or working around tree roots</li> <li>Consider alternative methodologies such as hand tools</li> <li>Arborist on call to assist in assessing stability of trees</li> </ul>
<b>Construction Methodology</b>	Risk of failure of under slope will remain during Christmas period – Not enough time to install all of nails before Christmas	<ul style="list-style-type: none"> <li>Install coconut or geotextile matting to limit erosion, inspection regime particularly after rain events, install horizontally bored drains before Christmas</li> </ul>	High	<ul style="list-style-type: none"> <li>Install as many nails as possible, particularly on the lower slope before Christmas</li> <li>Undertake inspections, particularly after periods of heavy rain</li> <li>Retreat slope back further – Decision made on site during construction (taking in to account the Consent condition)</li> </ul>
<b>Track opening</b>	End users congregating at top of relic slip once track is open, particularly when cruise liners are entering/leaving Port	<ul style="list-style-type: none"> <li>Signage installed, hand rail offset from slip, avoid using during inclement weather</li> </ul>	Low	<ul style="list-style-type: none"> <li>Retreat slope further back in to slope – Decision made on site during construction (taking in to account the Consent condition)</li> </ul>
<b>Construction in bad weather</b>	Working during inclement weather – ie rainfall	<ul style="list-style-type: none"> <li>Stop works immediately and evacuate the work site back to where the containers are kept</li> </ul>	Low	<ul style="list-style-type: none"> <li>Review long term forecast</li> <li>Be prepared to place temporary cover over exposed soil faces</li> <li>Jared to inspect post event</li> </ul>
<b>Public interaction during construction</b>	General public interaction during works	<ul style="list-style-type: none"> <li>Secure fencing either side of work site and place signage/fencing on the top plateau to warn public</li> </ul>	Low	
<b>Unforeseen ground conditions</b>	Soil nails may not achieve desired capacity	<ul style="list-style-type: none"> <li>Geotechnical investigations have been completed, so reasonable understanding of expected ground conditions.</li> <li>Sacrificial testing and proof testing of soil nails required</li> </ul>	Low	<ul style="list-style-type: none"> <li>Sacrificial test needs to be undertaken early, to identify any issues</li> </ul>

### Notes:

- (1) The above categories are **not** an exhaustive list of issues that should be considered to ensure safety in design—but are a guide only. You must consider what H&S hazards may arise during the entire lifecycle of the design option from construction of the structure to its use/operation, alteration, maintenance, or demolition.
- (2) When considering what hazards should be recorded, only record hazards and risks that arise from the design and that users need to be aware of to ensure there are no resulting risks to their H&S. A useful test is to ask yourself, “Can I influence this risk through my design?” if the answer is yes then it should be recorded.
- (3) Record how each hazard has been managed (either eliminated, substituted, isolated, or mitigated) including reference to any additional supporting information (such as codes or design regulations) if required.
- (4) Record the residual risk, i.e. the level of risk after the hazard has been managed, as Extreme (E), High (H), Medium (M) or Low (L) based on the table below (extracted from PO-CG-108g, enterprise risk management framework):

## Safety in Design Record – Simplified Procedure

		Potential Consequence of Threats				
		Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
<b>Likelihood</b>	V Almost certain	Low	Medium	High	Extreme	Extreme
	IV Likely	Low	Medium	High	Extreme	Extreme
	III Possible	Low	Medium	Medium	High	Extreme
	II Unlikely	Low	Low	Medium	High	High
	I Rare	Low	Low	Low	Medium	High

Where the definition of the consequence of the threats are:

Insignificant	No harm incidents
Minor	First aid treatment for one or more people
Moderate	Medical treatment injury to one or more people
Major	Serious harm injury to one person
Catastrophic	Death or multiple serious harm injuries

- (5) For any hazards that have a residual risk other than 'Low', record what additional conditions (if any) the users of the structure must be aware of to ensure that each hazard is reduced to 'Low', including who is responsible for completing that.

wsp

[wsp.com/nz](http://wsp.com/nz)

Project Number: 2-9B463.00

# Mauao Base Track Reinstatement

## Geotechnical Completion Report

24 June 2020



Contact Details

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s 7(2)(a) † Privacy

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Figure 3 Slip face showing geological units observed in the slip scarp.

## Appendices

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- B Testing Records.
- C As-Built Information.
- D Inspection Records & Correspondence.

## 1 Introduction

WSP New Zealand Limited were engaged by Tauranga City Council (TCC) in November 2019 to undertake remedial design to repair a damaged section of the Mauao (Mt Maunganui) base track located on the southern side of Mauao.

WSP were also engaged to undertake the construction monitoring phase of the project. The track was damaged by a landslide following several days of sustained rainfall in April 2017 during the passing of ex-tropical cyclone Debbie.

This document summarises our site visits to observe construction of earthworks and the installation of soil nails and horizontal bored drains for the Mauao base track repair.

Site visits were undertaken from 28 November 2019 to 16 March 2020 to observe critical aspects of construction. This report provides a record of site visits that were undertaken to observe the required hold points during the construction period.

The site of the underslip repair is on the southern side of Mauao approximately 620m south west along the Mauao base track from the Pilot Quay carpark which is located at the north western end of Pilot Bay. The site location is indicated on Figure 1 below.

The slip repair involved widening the existing track where the width was reduced due to the underslip in combination with the installation of soil nails and horizontal bored drains to improve the overall stability of the site.

Figure 1- Site Location Plan (Source: TCC Mapi).



## 2 Related Reports

The following documents and reports formed the basis of our investigations, design and construction documents for the reinstatement of the Mauao base track.

- Mauao Base Track Repair Options Assessment dated 12 November 2019.
- Mauao Base Track Temporary Works Assessment dated 22 November 2019.
- Mauao Base Track Reinstatement Design Report dated 18 December 2019.
- Mauao Base Track Reinstatement – Project Technical Specification dated 18 December 2019.
- Mauao Base Track Construction Review Letter dated 19 December 2019.
- Mauao Base Track, Crack Observations and Recommendations dated 6 March 2020.

### 3 Hold Points

The following hold points were covered during our inspections. The hold points were set out in our project geotechnical specification dated 18 November 2018.

- Setting out details,
- Observations of earthworks and inspection of cut batters and fill placement;
- Installation of soil nails;
- Observations of verification and acceptance tests for soil nails;
- Installation of bored drains and subsoil drainage;
- Construction of soil nail slopes.

Site inspection photograph records are summarised in Appendix A.

### 4 Project Roles and Responsibilities

For this project the roles and responsibilities are summarised below in the following sections.

#### 4.1 Client

The Client for this project was Tauranga City Council (TCC).

TCC also undertook the contract management during construction with technical support provided by WSP.

Gareth John was the Project Manager and Engineers Representative appointed by TCC.

#### 4.2 Contractor

The lead contractor for this project was Waiotahi Contractors Limited who managed construction on site and carried out all earthworks operations.

s 7(2)(a) f Privacy was the lead contractors site supervisor and project manager with support from s 7(2)(a) f Privacy of Waiotahi.

##### 4.2.1 Subcontractors

The main sub-contractors for this project were Earth Stability Limited and Rock Control Limited. The role of the subcontractors were to drill and install the soil nails and horizontally bored drains using auger and air percussion drilling methods.

##### 4.2.2 Plant List

A simplified list of the main equipment used during construction is given below.

- 3 tonne hydraulic excavator
- 3 tonne compact track loader (skid steer loader).
- 200 kg portable drilling mast.
- High volume air compressor.
- Rope access gear and frame for drilling mast.

#### 4.3 Consultant

Construction monitoring services were provided by WSP New Zealand Limited for key aspects of construction as recommended in the Design Report and Project Technical Specification dated 18 December 2019.

s 7(2)(a) f Privacy was the geotechnical lead for this project with technical support from s 7(2)(a) f Privacy s 7(2)(a) f Privacy also provided support and construction monitoring services on behalf of WSP New

Zealand Limited. s 7(2)(a) f Privacy assisted with the supplementary geology section provided in this report.

#### 4.4 Arborist

Arboricultural work during construction was undertaken by s 7(2)(a) f Pri from Arbor Care Limited.

#### 4.5 Cultural Monitors

The cultural monitors for this project were on site during construction to identify and recover any artefacts that were exposed during excavations.

s 7(2)(a) f Priva and s 7(2)(a) f Privacy were appointed as cultural monitors by the Mauao Trustees (Asset Owner).

## 5 Construction Summary

Construction for the remediation of the Mauao base track slip commenced in late November 2019 with the clearance of vegetation from site and installation of the first row of soil nails above track level. As the soil nailing works progressed, the existing track was widened in stages by cutting into bank above.

Horizontal bored drains were installed above track level where saturated zones were encountered during the drilling of the soil nails. The drain and nail locations are summarised on the asbuilt drawing contained in Appendix C.

Three additional soil nails were also installed above track level. The purpose of the additional nails was to secure the top of the erosion protection mat (MacMat R steel).

The earthworks were completed by early December 2019 and most of soil nails had been installed above the track. By mid-December 2019 the works had been completed up to the end of stage 1, with the installation of a safety fence and the track was open to public for the Christmas period.

The track was then closed to public at the end of January 2020 and stage 2 started. This involved the continued installation of soil nails on the lower slip face, below the first row installed within stage 1.

Voids were encountered in two soil nail auger holes below track level. These voids were then filled with additional grout. Following the drilling of further anchors, it was established that the voids were isolated to these locations.

Cracking in the track was also noted approximately 15m to the west of the slip repair on 25 February 2020 and it was concluded that this was likely due to shrink and swell of clay soils rather than tension cracking which would indicate instability.

The installation of soil nails was complete by the end of February and the final installation of erosion mat was completed by early March 2020, when the track was reopened to the public. A total of 134 soil nails and 8 horizontally bored drains were installed.

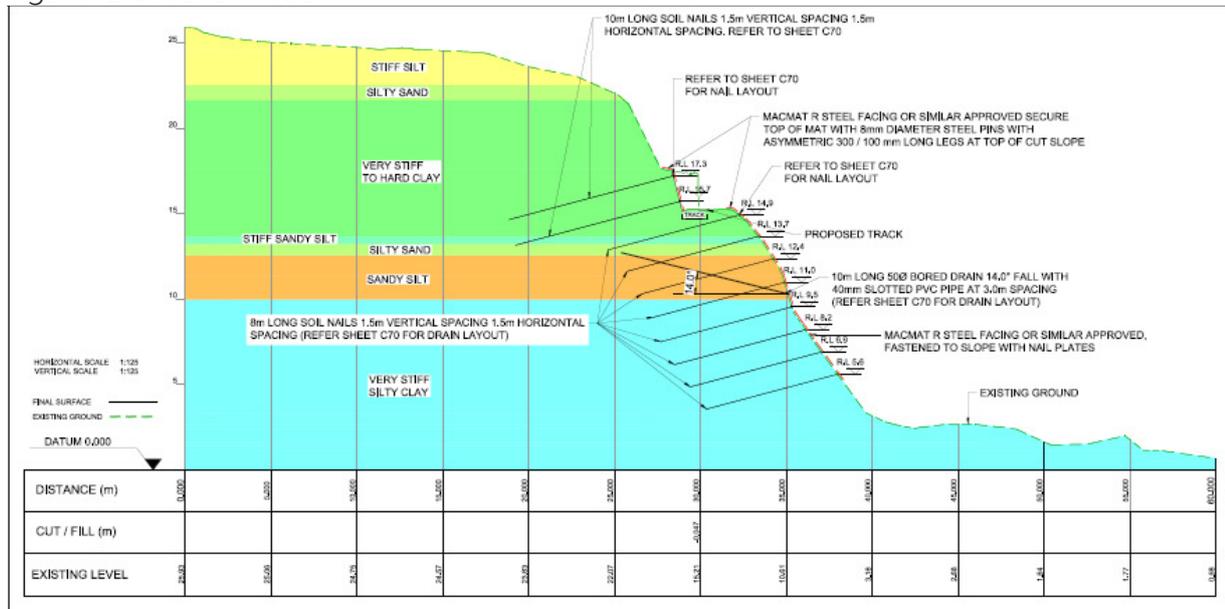
Remaining items such as hydroseeding of the MacMat R and other bare areas is scheduled to be complete in 2020.

Discussions were also held with the arborist as to the stability of the trees at the site. The arborist indicated that the Pohutukawa trees were currently stable from a tree health and structural perspective. WSP provided an opinion that the Pohutukawa tree located at the western extent of the slip on the lower slope may fail under high rain events due to the failure of the slope below the tree. TCC are currently investigating further stabilisation measures in vicinity of this tree.

## 6 Confirmation of Geotechnical Ground Model

The geotechnical ground model was based on hand augers and field mapping of geologic units on site. Ground conditions observed during construction were generally as described in the design report. Figure 2 from our design report summarises the geotechnical ground model used for the design of the soil nails.

Figure -2 Ground Model



## 7 Geology

The following geology interpretation supplements the geology section of our design report. The various stratigraphic units were confirmed during construction.

The geology encountered at the site (Figure 3, borehole logs 1 – 5, Appendix B) comprised a sequence of colluvium and air fall tephra units (above the level of the base track), alluvial deposits of the Matua Subgroup (directly below the base track) and a weakly welded ignimbrite (near the toe of the slope).

The weakly welded ignimbrite encountered at the base of the slope has characteristics similar to the Te Puna Ignimbrite described by Briggs et al. (1996)<sup>1</sup> i.e. a non-welded to partially-welded, buff brown ignimbrite which weathers to a firm clay. It is plausible that Te Puna Ignimbrite could exist at this site given that sections have been described at Matakana Island, Pahoia, and Omokoroa (Briggs et al., 1996).

The materials encountered in HA02 and HA05 are typical of the Matua Subgroup; interbedded, volcanic tephra derived clays, silts and sands (Briggs et al., 1996). The Matua Subgroup encompasses all sediment deposited in fluvial, estuarine and lacustrine regimes between approximately 2 million to 50 thousand years ago (Briggs et al., 1996). Shear vane readings indicate that some of the silts and clays are highly sensitive, meaning that these materials lose a significant amount of strength when the peak strength is overcome. Sensitive materials are typically wet to saturated due to the ability of the unique halloysite clay minerals to bind with pore water (Kluger et al., 2018<sup>2</sup>).

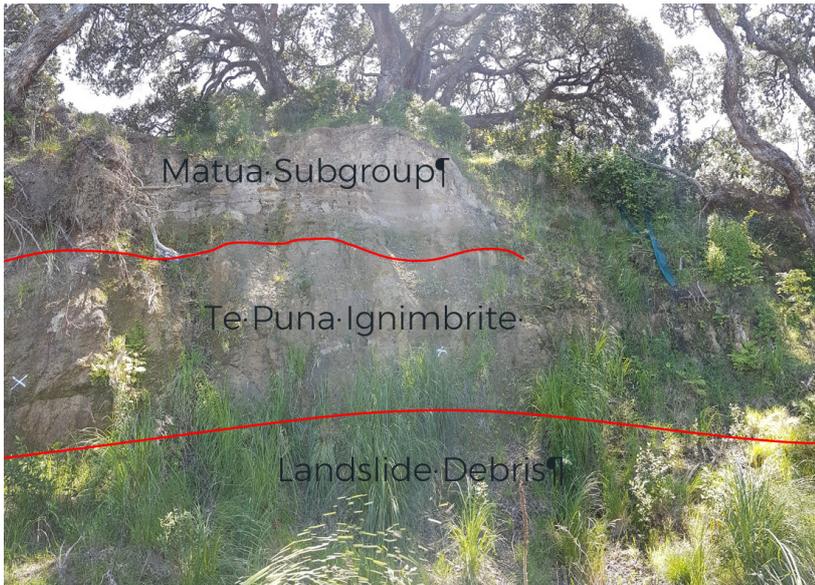
<sup>1</sup> Briggs, R.M., Hall, G.J., Harmsworth, G.R., Hollis, A.G., Houghton, B.F., Hughes, G.R., Morgan, M.D., Whitbread-Edwards, A.R. (1996). Geology of the Tauranga Area. Occasional Report No. 22, Department of Earth Sciences, University of Waikato.

<sup>2</sup> Kluger, M.O., Moon, V.C., Krieter, S., Lowe, D.J., Churchman, G.J., Hepp, D.A., Seibel, D., Jorat, E., Morz, T. (2016). A new attraction-detachment model for explaining flow sliding in clay-rich tephra. *Geology*, 45(2):131-134.

Ashes interbedded with colluvium were encountered above the Matua Subgroup. The lack of horizontal marker beds make it difficult to place these ashes within the Matua Subgroup or Hamilton Ashes, which typically overlies the Matua Subgroup in the wider Tauranga area. The colluvium encountered at the site is typified by the presence of rhyolite gravel and mottled colours. The thick sequence of colluvium (~3.5m) indicates that slope instability above the site has been an historically active process.

The landslide debris consists of weak, remoulded Matua Subgroup and possibly the Te Puna Ignimbrite.

Figure - 3 Geologic units observed in the slip scarp.



## 8 Test Records and Design

Soil nail pull-out testing was carried out in accordance with Section 9.4 of FHWA-NHI-14-007, FHWA GEC 007, February 2015. In total, 7 acceptance and 3 verification tests were conducted during the works. Our soil nail design was based on a factored pull-out resistance of 5.3kN per metre.

Based on the testing it was shown that the unfactored pull-out resistance in the Matua Subgroup materials ranged from 5.5 to 21.5kN per metre with the majority of the anchor tests achieving greater than 8.25kN per meter above track level. It was believed that the 5.5kN test was an outlier and may have been due to defects in the soil grout interface.

Verification testing conducted in the Te Puna Ignimbrite below the track achieved 1.0x the factored design load without extension or creep and no failures. All acceptance tests carried out in the Te Puna Ignimbrite returned results of 8.25kN per metre without failure. Just over 5% of all nails were tested which is in accordance with the FHWA standard referenced above.

During construction the design slope model was updated to incorporate the actual pull out resistance achieved in the field. The revised slope stability model (Figure 3) achieved a FoS of 1.36 when incorporating the unfactored pull-out resistance of 8.25kN per metre which is satisfactory.

All test records are contained in Appendix B.

## 9 Outstanding Items/ Defects

As of June 2020, the following items remained outstanding and still need to be addressed.

- Hydroseeding of the MacMat R and all other bare areas.

## 10 Geotechnical Monitoring and Maintenance

As recommended in our previous correspondence with TCC and our geotechnical design report WSP recommended the following inspections to monitor the ongoing performance of the site.

- Inspections to determine the condition of site drainage, including culverts, swales and horizontally bored drains.
- Inspection of cut slopes noting for signs of erosion or slippage.
- Topographical survey and inspection of the toe area of the slip repair to monitor coastal erosion.
- General track condition and vegetation establishment.

Since May 2020, WSP has been engaged by TCC to continue to monitor the site and produce regular monitoring reports.

## 11 Closure

Based on our inspections and testing, we can confirm that the soil nail and track construction meet the criteria outlined in WSP's geotechnical design report reference 2-9B463.00, dated 18 December 2019 except for those items stated in section 9 above.

For further information regarding the contents of this report please contact the author.

# Appendix A

## Site Photograph Records

Site Inspection Photos



Photograph 1 - 1<sup>st</sup> test anchor installation prior to track widening.



Photograph 2 - Setting out of soil nails above track level.



Tauranga City Council

Photograph 1 & 2

Project No:

2-9b463.00

Mauao Base Track- Geotechnical Completion Report

Site Inspection Photos



Photograph 3 - Excavations for track widening. Cultural monitor inspecting the excavation.



Photograph 4 - Further track widening and soil nail installation.



Tauranga City Council

Photograph 3 & 4

Project No:

2-9b463.00

Site Inspection Photos



Photograph 5 - Earthworks for track widening advancing.



Photograph 6 - Subgrade preparation.



Tauranga City Council

Photograph 5 & 6

Project No:

2-9b463.00

Mauao Base Track- Geotechnical Completion Report

Site Inspection Photos



Photograph 7 - Soil nail installations, top row above track level.



Photograph 8 - WSP installation of set out pegs for checking track alignment.



Tauranga City Council

Photograph 7 & 8

Project No:

2-9b463.00

Site Inspection Photos



Photograph 9 – Setup for test anchors.



Photograph 10 – Horizontal drain installed above track level.



Tauranga City Council

Photograph 9 & 10

Project No:

2-9b463.00

Mauao Base Track- Geotechnical Completion Report

Site Inspection Photos



Photograph 11 - Installation of Macmat R above track level.



Photograph 12 - Installation of first row of anchors below track level.



Tauranga City Council

Photograph 11 & 12

Project No:

2-9b463.00

Mauao Base Track- Geotechnical Completion Report



Photograph 13 - Installation of safety fence posts.



Photograph 14 - measuring hole depths for posts.



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Photograph 13 & 14

Project No:

2-9b463.00

Mauao Base Track- Geotechnical Completion Report



Photograph 15 – Completion of stage 2 of works as per design report.



Photograph 16 – Soil nail installation, lower slope.



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Photograph 15 & 16

Project No:

2-9b463.00

Mauao Base Track- Geotechnical Completion Report



Photograph 17, 18 – All soil nails completed and Macmat for lower slope.



Tauranga City Council

Photograph 17 & 18

Project No:

2-9b463.00

Mauao Base Track- Geotechnical Completion Report

# Appendix B

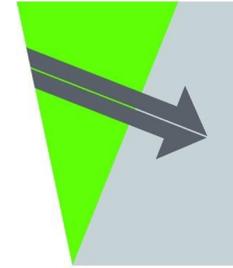
## Testing Records

Anchor Ref: Generic for site

Job Name: Mauao Base Track

Job Number: 1820

Client: Waiotahi Contractors Ltd



**EARTH  
STABILITY**  
CIVIL & GEOTECHNICAL ENGINEERING SOLUTIONS

**Drilling Log:**

Depth: 8.0m (m)      Hole Diameter: 150 (mm)  
Inclination: 15 (degrees)      Drilling Mode: Continuous Flight Auger

Observations:      0 - 0.5m Firm Light Brown Silt  
                          0.5 - 1.0m Firm Light Brown Silt  
                          1.0 - 1.5m Light Brown Sandy / Silt  
                          1.5 - 2.0m Light Brown Sandy / Silt  
                          2.0 - 2.5m Light Brown Sandy / Silt  
                          2.5 - 3.0m Light Brown Sandy / Silt  
                          3.0 - 3.5m Damp Light Brown Silt  
                          3.5 - 4.0m Damp Light Brown Silt  
                          4.0 - 4.5m Damp Light Brown Silt  
                          4.5 - 5.0m Damp Light Brown Silt  
                          5.0 - 5.5m Wet Light Brown Silt

5.5 - 6.0m Wet Light Brown Silt  
6.0 - 6.5m Wet Light Brown Silt  
6.5 - 7.0m Wet Light Brown Silt  
7.0 - 7.5m Wet Light Brown Silt  
7.5 - 8.0m Wet Light Brown Silt  
8.0 - 8.5m End hole @ 8.0m  
8.5 - 9.0m \_\_\_\_\_  
9.0 - 9.5m \_\_\_\_\_  
9.5 - 10.0m \_\_\_\_\_  
10.0 - 10.5m \_\_\_\_\_  
10.5 - 11.0m \_\_\_\_\_

**Anchor Fabrication Details:**

Type: Grade 500 RB25 HD Galvanised  
Spacers: PVC Lanterns @ 1.5m c/c

Free Length: 0\* (m)  
Bonded Length: 8 (m)

\* NB: Designated Test anchors were debonded with a 4.0m section of denso tape wrapped in 3 x layers of PVC tape.

**Grouting Log**

Cement Type: OPC  
Additives: NIL  
Grout Plant: Chemgrout

W/C Ratio: 0.45 (18l water + 40kg cement = 30.9l grout)  
Grout Volume: 140 litres  
Sample taken: YES /-NO

Sample Reference: \_\_\_\_\_

**\*\*\*In the event of pre-grouting or secondary grouting being required a new log will be filled out for each occurrence**

**Permeability Testing:**

Start Time: \_\_\_\_\_ Total Time: \_\_\_\_\_ (m)  
Stop Time: \_\_\_\_\_ Water Loss: \_\_\_\_\_ (m)  
Comments: \_\_\_\_\_

Name: s 7(2)(a) f Privacy

Signature: \_\_\_\_\_ Date: Feb-20



Job Name: 1820 - Mauao Base Track

Date: 11.02.2020

Anchor No. \_\_\_\_\_

Verification -  
D8

**NOTE: LOAD SHOWN BELOW IS 80% OF THE TENSILE BREAKING STRAIN FOR GRADE 500 RB25 BAR**

**\*\*\*\*\*THESE LOADS MUST NOT BE EXCEEDED UNDER ANY CIRCUMSTANCES\*\*\*\*\***

**RB25 196kN**

LOAD	HOLD TIME	4.48 t	psi	Extension (mm)	
				1	2
Alignment Load	1 minutes				
0.13 Verification test load	10 minutes	0.58	103.2	3.12	50.00
0.25 Verification test load	10 minutes	1.12	198.5	6.78	47.32
0.38 Verification test load	10 minutes	1.70	301.7	12.65	42.21
0.50 Verification test load	10 minutes	2.24	397.0	17.16	31.75
0.63 Verification test load	10 minutes	2.82	500.3	25.97	23.86
0.75 Verification test load ( Creep test)	60 minutes	3.36	595.6	35.21	17.67
0.88 Verification test load	10 minutes	3.94	698.8	41.01	8.89
1.00 Verification test load	10 minutes	4.48	794.1	47.96	1.02
Alignment Load	1 minute				

\*Deflection readings are required during this period as detailed below

Time (minutes)	Dial gauge reading (mm)	
	1	2
1	35.11	20.21
2	35.13	20.21
4	35.13	20.21
5	35.13	19.76
6	35.14	19.51
10	35.17	19.51
20	35.20	19.01
30	35.21	18.31
50	35.21	17.87
60	35.21	17.87

Dial gauge 1 = bar extension 1

Dial gauge 2 = compaction 2

**CALCULATING GAUGE PRESSURE REQUIRED**

TONNES OF FORCE REQUIRED X 1000  
CYLINDER EFFECTIVE AREA (cm<sup>2</sup>)

= kgf/cm<sup>2</sup> (gauge pressure)  
(Multiply by 14.233 for PSI gauge)

**Notes:**

60t Jack cross sectional area  
= 80.3cm<sup>2</sup> / stroke of 50mm

Verification test load x 1 Anchor

Cells Marked in yellow require readings to be taken 1,2,4,5, and 10 minutes

DG2 Preset to 50.00mm

	1	2	4	5	10
0.13	3.12	3.12	3.12	3.12	3.12
0.25	6.77	6.77	6.77	6.78	6.78
0.38	12.64	12.64	12.65	12.65	12.65
0.50	17.14	17.15	17.16	17.16	17.16
0.63	25.94	25.94	25.96	25.97	25.97

\* No incremental comp readings taken

\* No creep was witnessed and compaction matched

Deformation on exposed nail due to differing bands of material and excessive Compaction of lower test frame

Name: (tester) s 7(2)(a) † Privacy

Clients Rep: \_\_\_\_\_

Engineer: \_\_\_\_\_



Job Name: 1820 - Mauao Base Track

Anchor No. 2b

Date: 3.03.2020

**NOTE: LOAD SHOWN BELOW IS 80% OF THE TENSILE BREAKING STRAIN FOR GRADE 500 RB25 BAR**

**\*\*\*\*\*THESE LOADS MUST NOT BE EXCEEDED UNDER ANY CIRCUMSTANCES\*\*\*\*\***

**RB25 196kN**

LOAD	HOLD TIME	3.36 t	psi	Extension (mm)	
				1	2
Alignment Load	1 minute			0.00	50.00
0.17 Proof test load	UMS	0.57	101.2	3.12	29.57
0.33 Proof test load	UMS	1.11	196.5	6.48	40.72
0.50 Proof test load	UMS	1.68	297.8	8.21	13.17
0.67 Proof test load	UMS	2.25	399.0	8.76	2.59
0.83 Proof test load	UMS	2.79	494.3	10.03	-6.32
1.00 Proof test load ( Creep test)	10 minutes	3.36	595.6	11.21	-15.89
Alignment Load	1 minute			0.87	25.32

*\*Deflection readings are required during this period as detailed below*

Time (minutes)	Dial gauge reading (mm)	
	1	2
1	11.21	15.89
2	11.21	15.90
4	11.21	15.90
5	11.22	15.91
6	11.23	-15.91
10	11.23	-15.91

**CALCULATING GAUGE PRESSURE REQUIRED**

TONNES OF FORCE REQUIRED X 1000  
CYLINDER EFFECTIVE AREA (cm<sup>2</sup>)

= kgf/cm<sup>2</sup> (gauge pressure)  
 (Multiply by 14.233 for PSI gauge)

**Notes:**  
 60t Jack cross sectional area  
 = 80.3cm<sup>2</sup> / stroke of 50mm

Proof test load x 4 Anchors

Reset due to compaction 45mm  
 Timber frame bed snapped during test

Test conducted by 7(2)(a) Privacy

UMS = Until Movement Stabilises

Dial gauge 1 = bar extension 1

Dial gauge 2 = compaction 2

QA03c -Testing sheet RB25 Bar

Clients Rep: \_\_\_\_\_

Engineer: \_\_\_\_\_



Job Name: 1820 - Mauao Base Track

Anchor No. 4d

Date: 3.03.2020

**NOTE: LOAD SHOWN BELOW IS 80% OF THE TENSILE BREAKING STRAIN FOR GRADE 500 RB25 BAR**

**\*\*\*\*\*THESE LOADS MUST NOT BE EXCEEDED UNDER ANY CIRCUMSTANCES\*\*\*\*\***

**RB25 196kN**

LOAD	HOLD TIME	3.36 t	psi	Extension (mm)	
				1	2
Alignment Load	1 minute			1.25	50.00
0.17 Proof test load	UMS	0.57	101.2	1.65	38.79
0.33 Proof test load	UMS	1.11	196.5	2.11	30.01
0.50 Proof test load	UMS	1.68	297.8	3.27	23.02
0.67 Proof test load	UMS	2.25	399.0	3.56	18.72
0.83 Proof test load	UMS	2.79	494.3	4.23	12.36
1.00 Proof test load ( Creep test)	10 minutes	3.36	595.6	5.09	5.73
Alignment Load	1 minute			1.67	43.22

*\*Deflection readings are required during this period as detailed below*

Time (minutes)	Dial gauge reading (mm)	
	1	2
1	5.09	5.73
2	5.09	5.73
4	5.09	5.73
5	5.10	5.73
6	5.10	5.73
10	5.11	5.73

Dial gauge 1 = bar extension 1

Dial gauge 2 = compaction 2

QA03c -Testing sheet RB25 Bar

**CALCULATING GAUGE PRESSURE REQUIRED**

TONNES OF FORCE REQUIRED X 1000

CYLINDER EFFECTIVE AREA (cm<sup>2</sup>)

= kgf/cm<sup>2</sup> (gauge pressure)

(Multiply by 14.233 for PSI gauge)

**Notes:**

60t Jack cross sectional area

= 80.3cm<sup>2</sup> / stroke of 50mm

Proof test load x 4 Anchors

Total Compression of face material

44.27mm

Test conducted by s 7(2)(a) † Privacy

# Best test setup anchor on level (ish)

ground

UMS = Until Movement Stabilises

Clients Rep: \_\_\_\_\_

Engineer: \_\_\_\_\_



Job Name: 1820 - Mauao Base Track

Anchor No. 4e

Date: 3.03.2020

**NOTE: LOAD SHOWN BELOW IS 80% OF THE TENSILE BREAKING STRAIN FOR GRADE 500 RB25 BAR**

**\*\*\*\*\*THESE LOADS MUST NOT BE EXCEEDED UNDER ANY CIRCUMSTANCES\*\*\*\*\***

**RB25 196kN**

LOAD	HOLD TIME	3.36 t	psi	Extension (mm)	
				1	2
Alignment Load	1 minute			1.25	50.00
0.17 Proof test load	UMS	0.57	101.2	1.85	41.50
0.33 Proof test load	UMS	1.11	196.5	5.11	17.82
0.50 Proof test load	UMS	1.68	297.8	6.72	-6.11
0.67 Proof test load	UMS	2.25	399.0	11.32	-19.87
0.83 Proof test load	UMS	2.79	494.3	11.67	-21.31
1.00 Proof test load ( Creep test)	10 minutes	3.36	595.6	15.73	-30.75
Alignment Load	1 minute			1.75	-28.32

*\*Deflection readings are required during this period as detailed below*

Time (minutes)	Dial gauge reading (mm)	
	1	2
1	15.73	-30.75
2	15.73	-30.82
4	15.73	-30.85
5	15.74	-30.85
6	15.74	-30.85
10	15.74	30.85

Dial gauge 1 = bar extension 1

Dial gauge 2 = compaction 2

QA03c -Testing sheet RB25 Bar

**Notes:**

60t Jack cross sectional area  
= 80.3cm<sup>2</sup> / stroke of 50mm

Proof test load x 9 Anchor

Total Compression of face material  
80.75mm

Test conducted by s 7(2)(a) † Privacy

UMS = Until Movement Stabilises

**CALCULATING GAUGE PRESSURE REQUIRED**

TONNES OF FORCE REQUIRED X 1000

CYLINDER EFFECTIVE AREA (cm<sup>2</sup>)

= kgf/cm<sup>2</sup> (gauge pressure)

(Multiply by 14.233 for PSI gauge)

Clients Rep: \_\_\_\_\_

Engineer: \_\_\_\_\_



Job Name: 1820 - Mauao Base Track

Anchor No. 5b

Date: 3.03.2020

**NOTE: LOAD SHOWN BELOW IS 80% OF THE TENSILE BREAKING STRAIN FOR GRADE 500 RB25 BAR**

**\*\*\*\*\*THESE LOADS MUST NOT BE EXCEEDED UNDER ANY CIRCUMSTANCES\*\*\*\*\***

**RB25 196kN**

LOAD	HOLD TIME	3.36 t	psi	Extension (mm)	
				1	2
Alignment Load	1 minute			0.00	50.00
0.17 Proof test load	UMS	0.57	101.2	0.52	46.20
0.33 Proof test load	UMS	1.11	196.5	11.33	26.18
0.50 Proof test load	UMS	1.68	297.8	15.70	9.24
0.67 Proof test load	UMS	2.25	399.0	18.74	-3.27
0.83 Proof test load	UMS	2.79	494.3	19.21	-18.78
1.00 Proof test load ( Creep test)	10 minutes	3.36	595.6	20.13	-23.11
Alignment Load	1 minute			1.08	45.21

*\*Deflection readings are required during this period as detailed below*

Time (minutes)	Dial gauge reading (mm)	
	1	2
1	20.13	-23.11
2	30.13	-23.78
4	20.14	-23.82
5	20.14	-24.01
6	20.14	-24.09
10	20.14	-24.97

**CALCULATING GAUGE PRESSURE REQUIRED**

TONNES OF FORCE REQUIRED X 1000

CYLINDER EFFECTIVE AREA (cm<sup>2</sup>)

= kgf/cm<sup>2</sup> (gauge pressure)

(Multiply by 14.233 for PSI gauge)

**Notes:**

60t Jack cross sectional area  
= 80.3cm<sup>2</sup> / stroke of 50mm

Proof test load x 4 Anchors

Total Compression of face material  
73.11mm

Test conducted by s 7(2)(a) † Privacy

UMS = Until Movement Stabilises

Dial gauge 1 = bar extension 1

Dial gauge 2 = compaction 2

QA03c -Testing sheet RB25 Bar

Clients Rep: \_\_\_\_\_

Engineer: \_\_\_\_\_



6A	3/12/2019	RB25	100.00	10.00	15.00	0.00	10.00	Mud		3/12/2019		80.00	1349
6B	4/12/2019	RB25	100.00	10.00	15.00	0.00	10.00	Mud		5/12/2019		80.00	1059
7A	3/12/2019	RB25	100.00	10.00	15.00	0.00	10.00	Mud		7/12/2019		80.00	1350
7B	4/12/2019	RB25	100.00	10.00	15.00	0.00	10.00	Mud		5/12/2019		80.00	1059
8A	4/12/2019	RB25	100.00	10.00	15.00	0.00	10.00	Mud		5/12/2019		80.00	1059
8B	5/12/2019	RB25	100.00	10.00	15.00	0.00	10.00	Mud		5/12/2019		80.00	1060
9A	5/12/2019	RB25	100.00	10.00	15.00	0.00	10.00	Mud		5/12/2019		80.00	1060
9B	7/12/2019	RB25	100.00	10.00	15.00	0.00	10.00	Mud		7/12/2019		80.00	1061
10A	5/12/2019	RB25	100.00	10.00	15.00	0.00	10.00	Mud		5/12/2019		80.00	1060
10B	7/12/2019	RB25	100.00	10.00	15.00	0.00	10.00	Mud		7/12/2019		80.00	1061
11A	7/12/2019	RB25	100.00	10.00	15.00	0.00	10.00	Mud		7/12/2019		80.00	1061
12A	7/12/2019	RB25	100.00	10.00	15.00	0.00	10.00	Mud		7/12/2019		80.00	1062
Drain 1	29/11/2019	50mm PVC	100.00	10.00	50.00	0.00	4.50	Mud		N/A			1348
						4.50	10.00	Hard Moist Clay					
Drain 2	29/11/2019	50mm PVC	100.00	10.00	70.00	0.00	5.00	Mud		N/A			1348
						5.00	10.00	Hard Moist Clay					



Project: Mount Track

Anchor #	1B
Date	6/12/2019

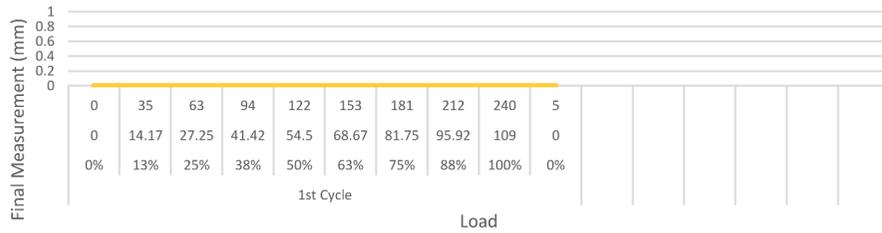
s 7(2)(a) - Privacy	30t
DTL (Kn)	109

Stressing Length

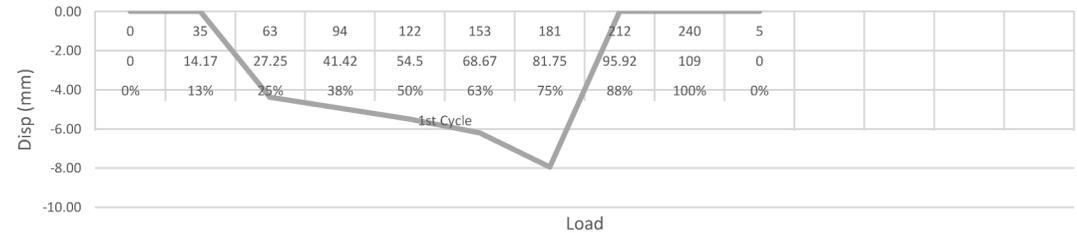
	Loading			Reading Increments												Final (mm)	Total Disp (mm)	Total Movement at Load (mm)
	Applied Test Load		Gauge Value	LHS (mm)														
	%	kN	Bar	Intial	1min	2min	4min	5min	6min	10min	20min	30min	50min	60min				
1st Cycle	0%	0	0													0.00	0.00	0.00
	13%	14.17	35													0.00	0.00	0.00
	25%	27.25	63	4.38	4.38											0.00	0.00	-4.38
	38%	41.42	94	4.93	4.93											0.00	0.00	-4.93
	50%	54.5	122	5.49	5.49											0.00	0.00	-5.49
	63%	68.67	153	6.20	6.20											0.00	0.00	-6.20
	75%	81.75	181	7.94	7.94	7.94	7.94	7.94	8.14	8.14						0.00	0.00	-7.94
	88%	95.92	212													0.00	0.00	0.00
	100%	109	240													0.00	0.00	0.00
	0%	0	5													0.00	0.00	0.00

s 7(2)(a) - Privacy pumped to maintain pressure hence 0.2mm creep

Load vs. Total Displacement



Total Displacement at Load



Project: Mount Track

Anchor #	2A
Date	6/12/2019

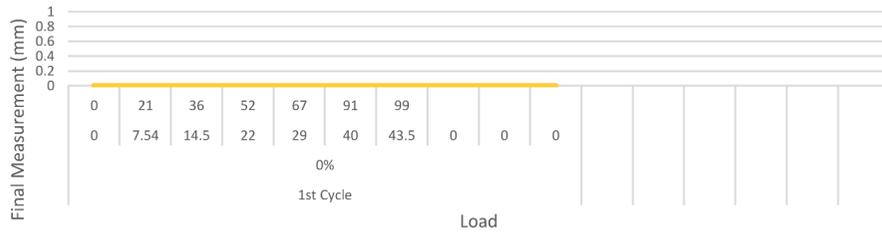
DTL (Kn)	109
Capacity	30t

Stressing Length

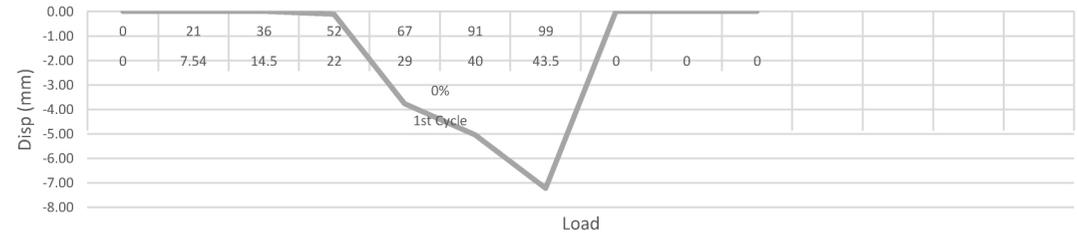
	Loading			Reading Increments												Final (mm)	Total Disp (mm)	Total Movement at Load (mm)	
	Applied Test Load	Gauge Value	Bar	LHS (mm)															
				Intial	1min	2min	4min	5min	6min	10min	20min	30min	50min	60min					
%	kN	Bar																	
1st Cycle	0%	0	0														0.00	0.00	0.00
		7.54	21	0.00	0.00												0.00	0.00	0.00
		14.5	36	0.00	0.00												0.00	0.00	0.00
		22	52	0.11	0.11												0.00	0.00	-0.11
		29	67	3.76	3.76												0.00	0.00	-3.76
		40	91	5.04	5.04												0.00	0.00	-5.04
		43.5	99	7.22	7.22	7.22	7.22	7.22	7.22	7.22	7.22						0.00	0.00	-7.22
		0															0.00	0.00	0.00
		0															0.00	0.00	0.00
		0															0.00	0.00	0.00

Loads changed on site as per s 7(2)(a) instruction - new loads on spreadsheet

Load vs. Total Displacement



Total Displacement at Load



Project: Mount Track

Anchor #	4B
Date	6/12/2019

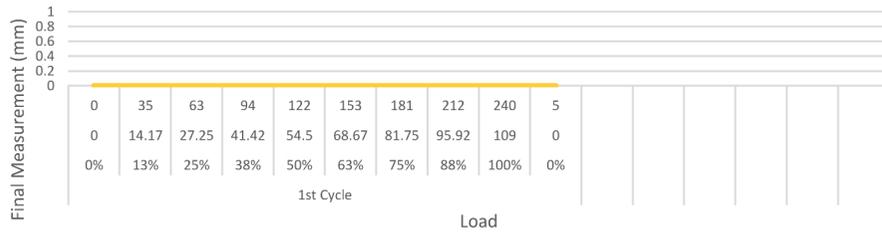
DTL (Kn)	109
	30t

Stressing Length

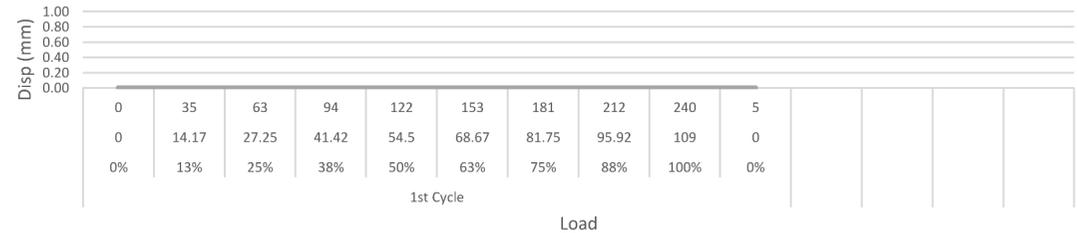
	Loading			Reading Increments											Final (mm)	Total Disp (mm)	Total Movement at Load (mm)		
	Applied Test Load	Gauge Value	Bar	LHS (mm)															
				Intial	1min	2min	4min	5min	6min	10min	20min	30min	50min	60min					
	%	kN	Bar																
1st Cycle	0%	0	0														0.00	0.00	0.00
	13%	14.17	35														0.00	0.00	0.00
	25%	27.25	63														0.00	0.00	0.00
	38%	41.42	94														0.00	0.00	0.00
	50%	54.5	122														0.00	0.00	0.00
	63%	68.67	153														0.00	0.00	0.00
	75%	81.75	181														0.00	0.00	0.00
	88%	95.92	212														0.00	0.00	0.00
	100%	109	240														0.00	0.00	0.00
	0%	0	5														0.00	0.00	0.00

Failed at 55KN - when preloading bar

Load vs. Total Displacement



Total Displacement at Load



Project: Mount Track

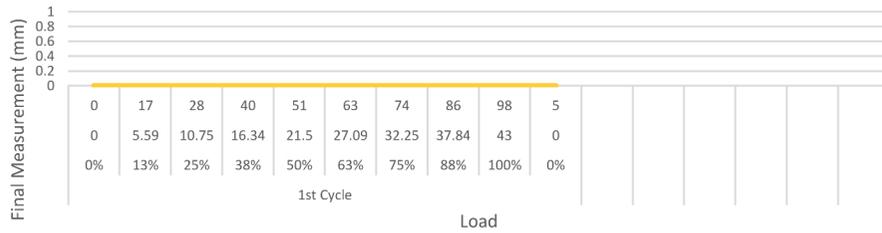
Anchor #	Bottom Slope Test Anch	§ 7(2)(a) – Privacy	30t
Date	9/12/2019	DTL (Kn)	43

Stressing Length

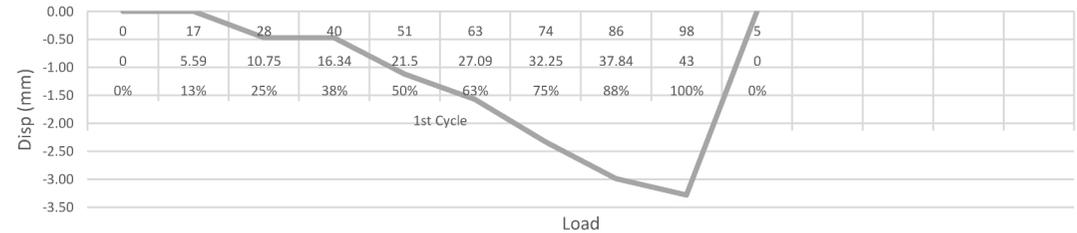
	Loading			Reading Increments												Final (mm)	Total Disp (mm)	Total Movement at Load (mm)
	Applied Test Load	Gauge Value	Bar	LHS (mm)														
				Intial	1min	2min	4min	5min	6min	10min	20min	30min	50min	60min				
%	kN	Bar																
1st Cycle	0%	0	0	0.00												0.00	0.00	0.00
	13%	5.59	17	0.00	0.00											0.00	0.00	0.00
	25%	10.75	28	0.47	0.47											0.00	0.00	-0.47
	38%	16.34	40	0.47	0.47											0.00	0.00	-0.47
	50%	21.5	51	1.12	1.12											0.00	0.00	-1.12
	63%	27.09	63	1.57	1.57											0.00	0.00	-1.57
	75%	32.25	74	2.33	2.39	2.39	2.40	2.40	2.40	2.40	2.41	2.41				0.00	0.00	-2.33
	88%	37.84	86	2.99												0.00	0.00	-2.99
	100%	43	98	3.28												0.00	0.00	-3.28
	0%	0	5													0.00	0.00	0.00

▲ Took anchor to failure which was 190 bar

Load vs. Total Displacement



Total Displacement at Load



Project: Mount Track

Anchor #	TEST 1 - SAC
Date	2/12/2019

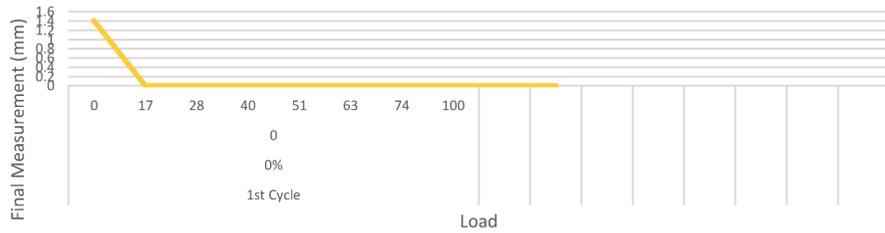
§ 7(2)(a) - Privacy	30t
DTL (Kn)	109

Stressing Length

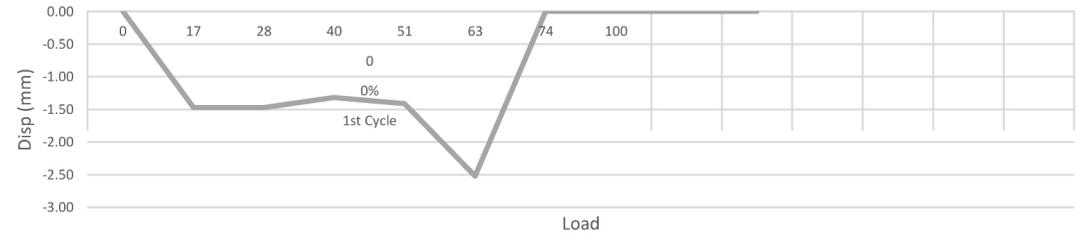
	Loading			Reading Increments												Final (mm)	Total Disp (mm)	Total Movement at Load (mm)
	Applied Test Load		Gauge Value	LHS (mm)														
	%	kN	Bar	Intial	1min	2min	4min	5min	6min	10min	20min	30min	50min	60min				
1st Cycle	0%	0	0	1.41												1.41	0.00	0.00
			17	1.47	1.47											0.00	1.41	-1.47
			28	1.47	1.47											0.00	1.41	-1.47
			40	1.32	1.32											0.00	1.41	-1.32
			51	1.41	1.41											0.00	1.41	-1.41
			63	2.52	2.52											0.00	1.41	-2.52
			74													0.00	1.41	0.00
			100													0.00	1.41	0.00
																0.00	1.41	0.00
																0.00	1.41	0.00

Loads given on site.

Load vs. Total Displacement



Total Displacement at Load



**GROUT DENSITY & COMPRESSION  
TEST REPORT**



Project : Mount Base Track Investigations  
 Location : Mount Maunganui  
 Client : WSP Tauranga  
 Contractor : Unknown  
 Sampled by : Unknown  
 Date sampled : 28 November 2019  
 Sampling method : Unknown  
 Sample description : Grout Cubes  
 Sample condition : Dry (as received)

Project No : 29B463.00/00002  
 Lab Ref No : TG3716  
 Client Ref No : --

Test Results			
Lab reference :	TG3716-1	TG3716-2	TG3716-3
Client reference :	1	2	3
Age at test (days) :	4	4	4
Cube average width (mm) :	51.0	50.9	51.0
Cube average height (mm) :	54.2	54.4	53.6
Cube end area (m <sup>2</sup> ) :	0.0026	0.0026	0.0026
Density (kg/m <sup>3</sup> ) :	1920	1920	1930
Ends capped :	2	2	2
Maximum load (kN) :	64	64	62
Compressive strength (MPa) :	24.6	24.6	23.8
Ave. Compressive strength (MPa) :	24.3		
Date tested :	2/12/19	2/12/19	2/12/19
<b>Test Method :</b>		<b>Notes</b>	
Test Method : BS EN 12390-3 : 2009, Part 3		This report may only be reproduced in full.	

Date reported : 2 December 2019

Approved : s 7(2)(a) † Privacy

Designation : Senior Civil Engineering Technician

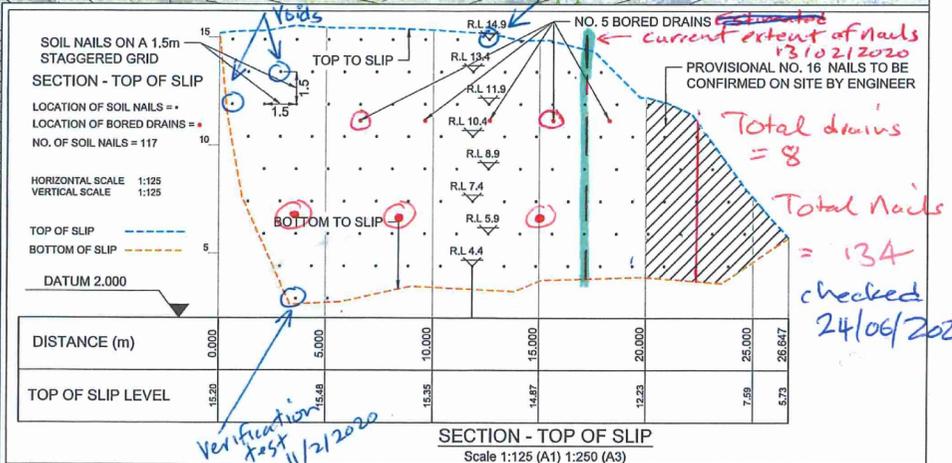
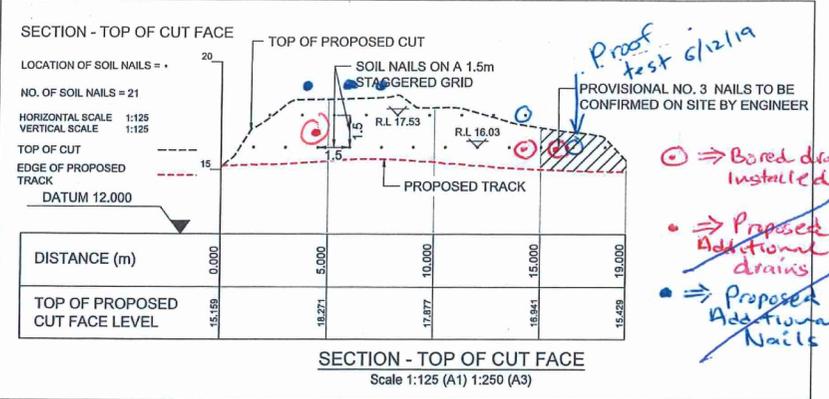
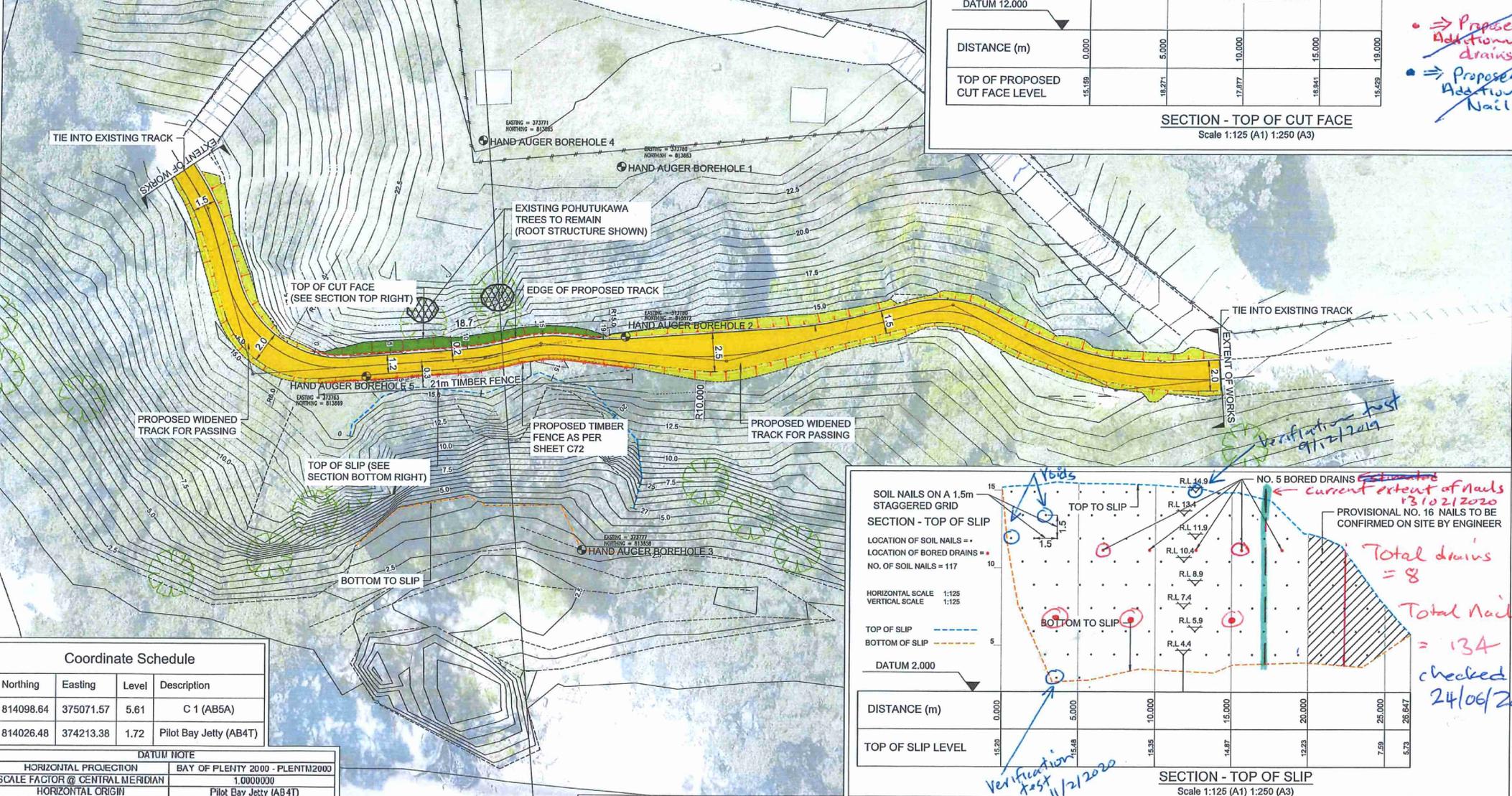
Date : 2 December 2019

# Appendix C

## As-Built Information

**LEGEND**

	PROPOSED TRACK.
	PROPOSED EARTHWORKS - AREA OF CUT
	PROPOSED EARTHWORKS - AREA OF FILL
	EXISTING POHUTUKAWA TREES TRUNK.



**Coordinate Schedule**

Northing	Easting	Level	Description
814098.64	375071.57	5.61	C 1 (AB5A)
814026.48	374213.38	1.72	Pilot Bay Jetty (AB4T)

**DATUM NOTE**

HORIZONTAL PROJECTION	BAY OF PLENTY 2000 - PLINTM2003
SCALE FACTOR @ CENTRAL MERIDIAN	1.0000000
HORIZONTAL ORIGIN	Pilot Bay Jetty (AB4T)
VERTICAL DATUM	MOTURKI 1953
VERTICAL ORIGIN	Pilot Bay Jetty (AB4T)

**COMMENTS:**

THIS WORK INCLUDES DATA WHICH IS LICENSED BY LAND INFORMATION NEW ZEALAND (LINZ) FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.



Revised	Amendment	Approved	Revision Date
1	ISSUED FOR CONSTRUCTION	D.D.	2019-11-22



**wsp**  
Tauranga Office  
464 578 2089

PO Box 646  
Tauranga 3140  
New Zealand

Project: s 7(2)(a) ... Privacy  
Date: 2019-11-22

Scale: 1:125 (A1) 1:250 (A3)

**FOR CONSTRUCTION**

Project	TAURANGA CITY COUNCIL MAUAO BASE TRACK REINSTATEMENT MOUNT MAUNGANUI, TAURANGA
Sheet No.	C70
Revision	1

# Appendix D

## Inspection Records & Correspondence

**From:** s 7(2)(a) † Privacy  
**Sent:** Monday, 2 December 2019 4:28 PM  
**To:** s 7(2)(a) † Privacy  
**Cc:** s 7(2)(a) † Privacy  
**Subject:** Mauao Site Visit 021219

Hi s 7(2)(a) † just a summary from today.

- We carried out a verification test to 1.0x the design load and was holding so good result.
- The horizontally bored drains are functioning well, however there was some saturation of the track over the weekend. Since my visit I instructed Waiotahi to flume the drains to the closest existing culvert to prevent further saturation. They will then dig out the wet material tomorrow and replace with dry material borrowed from the bank.
- Hopefully the guys will have the rest of the anchors up to the tree installed by the end of today.
- If the anchors have been installed successfully today we will be scratching further past the tree (Chainage 30 mark).
- I have arranged to have our surveyor there tomorrow to confirm design heights and track width are adequate.

Thanks will see you tomorrow at 7.30am.

Regards

s 7(2)(a) † Privacy

Engineer Geology



s 7(2)(a) † Privacy

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Tauranga 3110  
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s 7(2)(a) † Privacy

---

**From:** s 7(2)(a) † Privacy  
**Sent:** Tuesday, 3 December 2019 5:51 PM  
**To:** s 7(2)(a) † Privacy  
**Cc:**  
**Subject:** Mauao Base Track Site Visit 031219

Hi s 7(2)(a) – Privacy

Today we managed to cut the track through achieving an average width of 3m from the slip face. Anchor works are continuing today / tomorrow. I will give you an update tomorrow of how many installed to date. Tomorrow I am meeting our surveyor on site at 9am to check levels and width and also set out fence/ hand rail. Drains are working well and the guys should have some half round pipe installed to prevent saturation of the track at the toe of the cut batter.

Regards,

s 7(2)(a) † Privacy

Engineer Geology



s 7(2)(a) † Privacy

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New Zealand

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s 7(2)(a) † Privacy

---

**From:** s 7(2)(a) † Privacy  
**Sent:** Wednesday, 4 December 2019 6:13 PM  
**To:** s 7(2)(a) † Privacy  
**Cc:** s 7(2)(a) † Privacy  
**Subject:** Mauao Base Track Update 041219  
**Attachments:** 041219.jpg; 041219 - 2.jpg

Hi s 7(2)(a) † f just a quick update.

- We have now drilled and grouted 16 anchors to 10m depth with another 7 remaining on the top slope which should hopefully be completed tomorrow to finish the top section. We also are proposing to install some shorter lengths approx. 5x 1.5m long bars to secure the top of the Mac Mat where it would be difficult to pin.
- Today we checked the track width and set out the hand rail which looks satisfactory. We also checked fill heights.
- A subsoil drain will be installed tomorrow which will comprise a roughly 300mm x 300mm trench lined with geotextile cloth with a 110mm diameter draincoil backfilled with drainage 40 metal to drain the bank water table. We will extend this across the full width of the cut. I have also recommended we install a half round pipe dish channel as a permanent feature to control water coming from horizontally bored drains.
- We will try get some performance testing of the anchors above the track and a proof test below the track this week.

Regards

s 7(2)(a) † Privacy

Engineer Geology



s 7(2)(a) † Privacy

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s 7(2)(a) † Privacy

---

**From:** s 7(2)(a) † Privacy  
**Sent:** Thursday, 5 December 2019 3:49 PM  
**To:** s 7(2)(a) † Privacy  
**Cc:** s 7(2)(a) † Privacy  
**Subject:** RE: Mauao 5 Dec

Hi s 7(2)(a) † P It appears the water seeps were accumulating overnight with no way to get into the culvert. We now have a subsoil drain installed on site which appears to be controlling the seepage effectively and the saturated material has now been scraped off.

With regards to the anchors, these should be completed today and the guys will be testing two anchors tomorrow. With the loads confirmed the guys can use for anchorage if required or they may anchor to the large tree.

Regards,

s 7(2)(a) † Privacy  
Engineer Geology



s 7(2)(a) † Privacy

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New Zealand

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---

**From:** s 7(2)(a) † Privacy <[redacted]@tauranga.govt.nz>  
**Sent:** Thursday, 5 December 2019 3:00 PM  
**To:** s 7(2)(a) † Privacy <[redacted]@wsp.com>  
**Cc:** s 7(2)(a) † Privacy <[redacted]@wsp.com>  
**Subject:** Fwd: Mauao 5 Dec

s 7(2)(a) † P

Any issue with the water as per photos attached

s 7(2)(a) † Privacy

Team Leader: Infrastructure Projects  
Tauranga City Council

Begin forwarded message:

**From:** s 7(2)(a) † Privacy <[redacted]@tauranga.govt.nz>  
**Date:** 5 December 2019 at 10:28:34 AM NZDT  
**To:** s 7(2)(a) † Privacy <[redacted]@tauranga.govt.nz>  
**Subject:** Mauao 5 Dec

s 7(2)(a) † Privacy

**From:** s 7(2)(a) † Privacy  
**Sent:** Monday, 9 December 2019 1:39 PM  
**To:** s 7(2)(a) † Privacy  
**Cc:**  
**Subject:** Mauao Base Track 091219  
**Attachments:** 20191209131810592.pdf; 1.jpg; 2.jpg

Hi s 7(2)(a) † Privacy as discussed and following my site visit on Friday 6. We carried out a proof test on 3 anchors close to chainage 37.5.  
The first anchor tested passed the proof test / creep test however the anchor immediately next to it failed. This area is noticeably wet and is where the horizontal drains are located.  
Following the failure we then tested the anchor next to it which passed. I therefore recommended that we install an additional anchor to a depth of 15m in this region.

I also recommend we place an additional drain at track level chainage 37.5 (this is the third drain we previously discussed as we have only installed 2/3 drains to date.)  
I also recommend that we install at least 2 bored drains to 10m in the slip face below the track in addition to the first row of anchors prior to Christmas as this will be important to for stability of the slope.  
I have attached a plan indicating where the drains should be installed these are highlighted in green.  
Once we receive the test results from the test anchor below the track later today we can confirm the anchor length for the lower slope.  
Any questions, please don't hesitate to contact me.

s 7(2)(a) † Privacy

Engineer Geology



s 7(2)(a) † Privacy

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s 7(2)(a) † Privacy

**From:** s 7(2)(a) † Privacy  
**Sent:** Thursday, 13 February 2020 11:59 AM  
**To:** s 7(2)(a) † Privacy  
**Subject:** Mauao Base track Inspection 12/02/2020  
**Attachments:** 20200213114355475.pdf

Hi s 7(2)(a) † Privacy

Just letting you know I popped out to site yesterday as requested. Regarding the voids, we will just fill these with additional grout. Earth Stability have established that the void is isolated to two anchors only and are within the length of the anchor so should form a good grout bulb. See plan attached. I have annotated some as-built information including where I think we will need additional anchors (blue dots at the top of sheet) and drains (red dots). Also of interest is highlighted dashed line where I believe the current extent of nails finishes leaving approx. 3m before we even get to the provisional area so might be some savings but better to have a look on site as discussed to confirm. Would like to optimise position of anchors to provide best resilience within the budget.

Regards,  
s 7(2)(a) † Privacy  
Engineer Geology



s 7(2)(a) † Privacy

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Tauranga 3110  
New Zealand

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s 7(2)(a) † Privacy

**From:** s 7(2)(a) † Privacy  
**Sent:** Thursday, 13 February 2020 11:59 AM  
**To:** s 7(2)(a) † Privacy  
**Subject:** Mauao Base track Inspection 12/02/2020  
**Attachments:** 20200213114355475.pdf

Hi s 7(2)(a) † Privacy

Just letting you know I popped out to site yesterday as requested. Regarding the voids, we will just fill these with additional grout. Earth Stability have established that the void is isolated to two anchors only and are within the length of the anchor so should form a good grout bulb. See plan attached. I have annotated some as-built information including where I think we will need additional anchors (blue dots at the top of sheet) and drains (red dots). Also of interest is highlighted dashed line where I believe the current extent of nails finishes leaving approx. 3m before we even get to the provisional area so might be some savings but better to have a look on site as discussed to confirm. Would like to optimise position of anchors to provide best resilience within the budget.

Regards,  
s 7(2)(a) † Privacy  
Engineer Geology



s 7(2)(a) † Privacy

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**From:** s 7(2)(a) † Privacy  
**Sent:** Friday, 13 December 2019 4:35 PM  
**To:** s 7(2)(a) † Privacy  
**Cc:** s 7(2)(a) † Privacy  
**Subject:** Mauao Base Track

Hi s 7(2)(a) † Privacy

Just an update.

- I checked the set out for fence which looked good confirming >325mm in front of post. We have achieved nominal 2.0m width.
- Mac Mar R looking tidy with edges folded etc.
- First row of anchors installed with the exception of 1.
- Coconut mat is now installed over half the face below the track.

Outstanding items:

I have recommended an additional drain above the track which has not been installed.

An additional anchor will need to be drilled at the top row in place of the sacrificial test anchor.

These will now have to be installed in the new year.

I have not observed the "caps" for the lower anchors as they will arrive Monday. I understand that Waiotahi are proposing to use a 25mm nut which I would like to check.

I will likely poke my head in next week prior to opening to check completed earthworks.

Have a good weekend

Cheers

s 7(2)(a) † Privacy

---

**From:** s 7(2)(a) † Privacy  
**Sent:** Friday, 29 November 2019 4:03 PM  
**To:** s 7(2)(a) † Privacy  
**Cc:**  
**Subject:** RE: Mauao Works (programme/progress)  
**Attachments:** 20191129\_121259.jpg; 20191129\_121309.jpg; 20191129\_121246.jpg

Hi s 7(2)(a) †, further to our phone conversation just a quick summary of operations.

- Waiotahi have advanced/ widened the excavation to approx. chainage 30 or about half way.
- Arborist happy with root anchorage and there was minimal root removal required close to tree.
- Waiotahi have drilled 1x test anchor to 4m and two production anchors to 10m.
- Waiotahi have drilled 2x production anchor holes but left un-grouted in case we need to increase the hole diameters.
- Before I left the guys were in the process of drilling two horizontally bored drains so should be complete.
- I will be on site first thing on Monday to observe the anchor testing. Based on the testing we will confirm the bond strength and if satisfactory we will continue installing anchors as per current specifications.
- If unsatisfactory we may need to adjust the anchor length and / or diameter if required.
- Our lab will be testing the grout samples also on Monday to confirm strength of grout.
- I will keep you updated as the works progress next week.
- I have attached some photos from today.

Have a good weekend.

cheers

s 7(2)(a) † Privacy

Engineer Geology



s 7(2)(a) † Privacy

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New Zealand

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---

**From:** s 7(2)(f)(ii) @tauranga.govt.nz>  
**Sent:** Friday, 29 November 2019 7:56 AM  
**To:** s 7(2)(a) † Privacy @waiotahi.co.nz>; s 7(2)(a) @waiotahi.co.nz; s 7(2)(a) † Privacy @wsp.com>;  
s 7(2)(a) † Privacy @wsp.com>  
**Cc:** s 7(2)(f)(ii) @tauranga.govt.nz>; s 7(2)(f)(ii) @tauranga.govt.nz>;  
s 7(2)(a) † Pri@gmail.com; s 7(2)(a) † Privacy @gmail.com>  
**Subject:** Mauao Works (programme/progress)

Kia Ora Gents,

Hope everyone is well.

It is great to see that we have commence construction on such an important and cultural sensitive project.

**From:** s 7(2)(a) † Privacy  
**Sent:** Wednesday, 18 December 2019 11:03 AM  
**To:** s 7(2)(a) † Privacy  
**Cc:** s 7(2)(a) † Privacy  
**Subject:** Mauao Site Visit 181219

Hi s 7(2)(a) † Privacy

Following my site visit this morning I just have a few observations. I have discussed these with s 7(2)(a) while on site.

- Anchors below track need to be tightened with a large spanner to align the base plate to the face and ensure it is snug against the face. There appeared to be at least one anchor nut that was loose towards the Matakana side.
- Further to my email regarding the track width, with the fence now installed the narrowest section is 1.7m wide which may be a bit tight for the surf quad bike. At this section the fence is the closest allowable distance to the slip so to widen would require some more cutting into the toe of the bank and relaying Macmat. I would suggest we revisit this in the new year?
- The slot for the subsoil drain that is picked up by the culvert needs to be deepened to ensure the drain coil/metal has enough fall to flow into the culvert inlet.
- The lower anchor nuts have been covered with Macmat so do not require caps.
- Everything else looking pretty tidy.

Please let me know if you have any questions.

Regards,



**From:** s 7(2)(a) † Privacy  
**Sent:** Tuesday, 28 January 2020 11:12 AM  
**To:** s 7(2)(a) † Privacy  
**Cc:** s 7(2)(a) † Privacy  
**Subject:** RE: Mauao Monitoring  
**Attachments:** Base Track Test Results

Hi s 7(2)(a) † thanks for the heads up, I saw something on the TCC Facebook page about the works recommencing over the weekend which made me wonder when the start date was so thanks for that.

Regarding the soil nails, I still have not received the formal (typed) test records for the Verification and Proof tests of the soil nails or construction records as below. I requested this from Waiotahi last year but still have not received so I was wondering if you could also follow this up with them. See also email requesting these items on 12/12/19. I have photos of the field sheets but that is about all. I have also sniped out our construction records requirements from the geotechnical specification below.

## 5 Construction Records

The contractor shall keep construction records for every nail and bored drain constructed. The construction records shall contain the following information as a minimum:

- Nail/drain number, location, and dimensions
- A drilling record showing date and time of drilling, the drilling method, the type of materials encountered and the location at which the materials were encountered, water loss/seepage during drilling, problems during drilling.
- Nominal and actual volumes of grout placed.
- Soil nail test records.

Regarding the maintenance inspection routine I would suggest the following below:

### Track inspection requirements

- Inspect all drains, i.e. culverts and bored horizontal drains to ensure they are functioning. Check for signs of blockage or sediment build up especially the existing culvert. Also ensure that the flume (green sock) is firmly attached to the culvert. Regarding the bored drains, similarly check for blockage or sediment build up. If these drains become completely blocked then they may require re-drilling or flushing. In addition the water tables leading to the culverts should be inspected for signs of blockage by detritus or signs of scour.
- The cut bank above the track should be visually inspected for signs of instability or slippage, the large tree should also be inspected for signs of instability and health. I think these inspections will be more critical after heavy rain events and storms but should also be inspected periodically.
- In addition to the above, the condition of the toe should also be inspected. There is a small wave cut bank at the base which is about 0.4m high (see images below where the red crosshair is on the 3D image below ). This needs to be inspected for signs of regression and erosion as does the toe of the slope. I think the best way to do this would be to survey 6 monthly or after storms. It could also be done by tape and visual but would not be as good as would be hard to know if you were measuring the same points each time. We can provide this service if you require?
- In addition, the establishment of vegetation on the face should be monitored as this will enhance the erosion protection capability of the erosion mat.



Monitoring frequency

As per our options report we suggested the following frequency for monitoring.

- 0 to 2 months following construction – weekly monitoring suggested.
- 2 to 4 months following construction – fortnightly inspections.
- 4 to 12 months – monthly inspections.
- After a 12 month period consider reducing to ongoing regular inspections every 2 months.
- Inspection required after each major rain or seismic event.

Further to the above I think monitoring in good / fine weather conditions once every 2 months would be sufficient but during winter or wet periods once a month for the first year to establish the performance of the site (particularly erosion of the toe or slippage outside the nailed areas). I also think an inspection should be carried out after each major rain or seismic event. I assume TCC have a maintenance inspection programme for the rest of the track?

Also can you confirm if you would like us to monitor this site post construction or were you thinking this would be managed by TCC?

In relation to your email regarding asset life, for the purpose of the register the durability of the materials/ soil nails have been designed for 50years.

That said the slopes above and below the soil nails are susceptible to erosion slippage and these may impact / reduce the overall design life due to slippage or erosion, this is why the inspections are important as issues are identified in advance and mitigation implemented to preserve the slope.

In addition, the stability of the trees/ slope above the track could affect / damage the track if they failed this is outlined in our design report on sections 6.8 and 6.9.

I hope this answers your questions, please come back to me if you need more detail or further clarification.

Regards

s 7(2)(a) † Privacy

Engineer Geology

s 7(2)(a) † Privacy

WSP  
Gartshore House  
Level 3 116 Cameron Rd  
Tauranga 3110  
New Zealand

<http://www.wsp.com/nz>

-----Original Message-----

From: s 7(2)(f)(ii) @tauranga.govt.nz>

Sent: Tuesday, 28 January 2020 7:36 AM

To: s 7(2)(a) † Privacy @wsp.com>; s 7(2)(a) † Privacy @wsp.com>

Cc: s 7(2)(f)(ii) @tauranga.govt.nz>; s 7(2)(f)(ii) @tauranga.govt.nz>

Subject: RE: Mauao Monitoring

Hi [redacted]

Just a heads up that Waiotahi will be re-establishing onsite today and the drilling will recommence tomorrow.

FYI - Rock Control will no longer be doing the nails, Earth Stability are now the subby.

I will endeavour to duck out to site later today to catchup with the team.

On another note, I have had a lot of interest from the Asset Owner re the inspection routine once we complete the works. Can you please provide more detail re this? What is the inspection/maintenance routine post construction.

Cheers,

-----Original Message-----

From: [redacted] <[redacted]@wsp.com>

Sent: Thursday, 9 January 2020 12:23 PM

To: [redacted] <[redacted]@tauranga.govt.nz>; [redacted] <[redacted]@wsp.com>

Subject: RE: Mauao Monitoring

Happy new years [redacted] I hope you had a good break.

I am back on board now. Our staff visited the site several times over the break and all is as expected.

We did note that the flow from a horizontal drain had slowed which is probably due to the dry conditions we have been experiencing.

So nothing to report at this stage. I will try to get out there before the stage 3 works are carried out after Auckland anniversary weekend and provide you with an update.

Feel free to call me if you have any questions.

Regards,

[redacted]

Engineer Geology

[redacted]

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New Zealand

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-----Original Message-----

From: [redacted] <[redacted]@tauranga.govt.nz>

Sent: Wednesday, 8 January 2020 6:44 PM

To: [redacted] <[redacted]@wsp.com>; [redacted] <[redacted]@wsp.com>

Subject: Mauao Monitoring

wsp

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