

Project Number: 2-9B463.00

# Mauao Base Track Reinstatement

18 December 2019

CONFIDENTIAL



Design Report

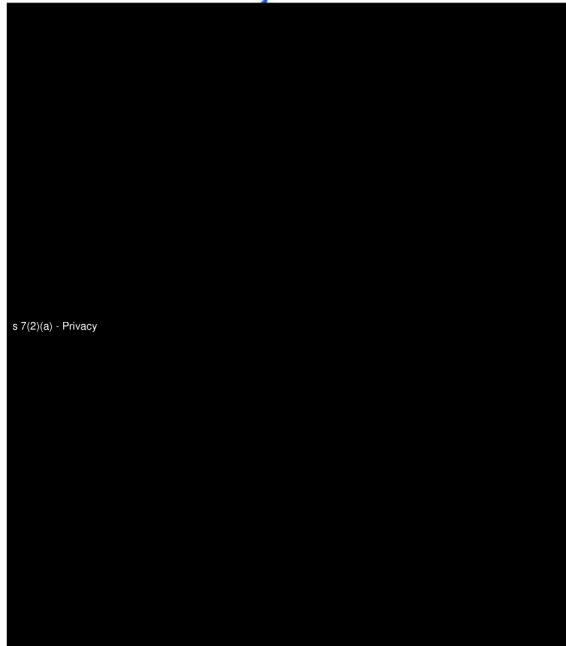


Contact Details



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Date: 18 December 2019  
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## Document History and Status

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## Revision Details

Revision	Details
V1	Updated 10.12.19



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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 dropouts in places, as well as small slips from above the track.

The total lateral extent of the slip is approximately 23m 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 derived of 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 $R_u=0.3$ )	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 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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**TAURANGA CITY COUNCIL  
MAUAO BASE TRACK REINSTATEMENT  
MOUNT MAUNGANUI, TAURANGA**

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Project No: 2-9B463.00

Date: 2019-11-22

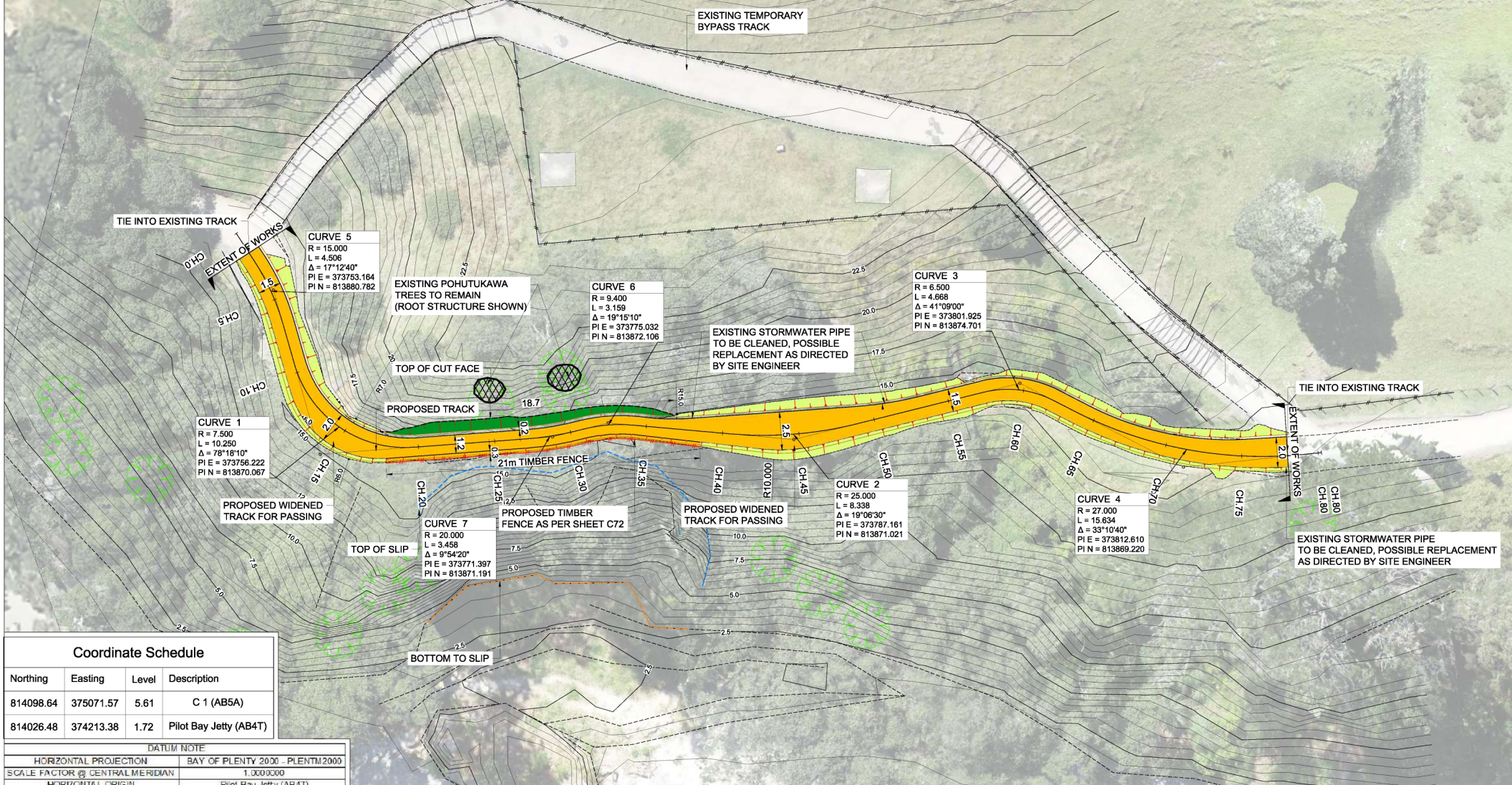


LOCALITY PLAN  
NOT TO SCALE



**LEGEND**

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



**Coordinate Schedule**

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 - PLENTY 2000
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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Revision	Amendment	Approved	Revision Date
1	ISSUED FOR CONSTRUCTION	[Signature]	2019-11-22



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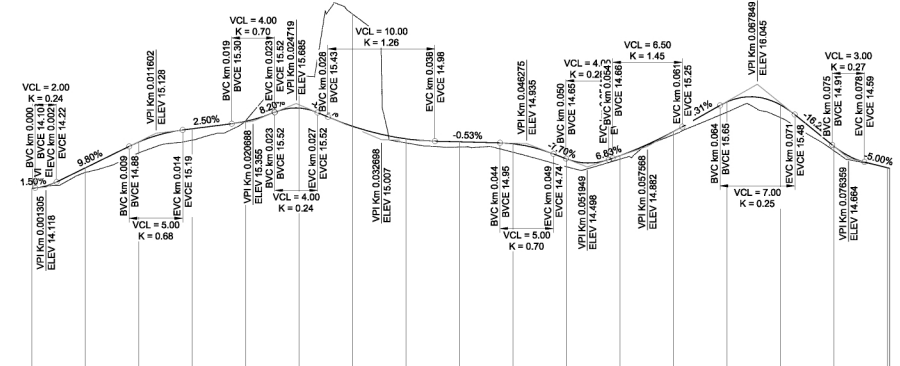
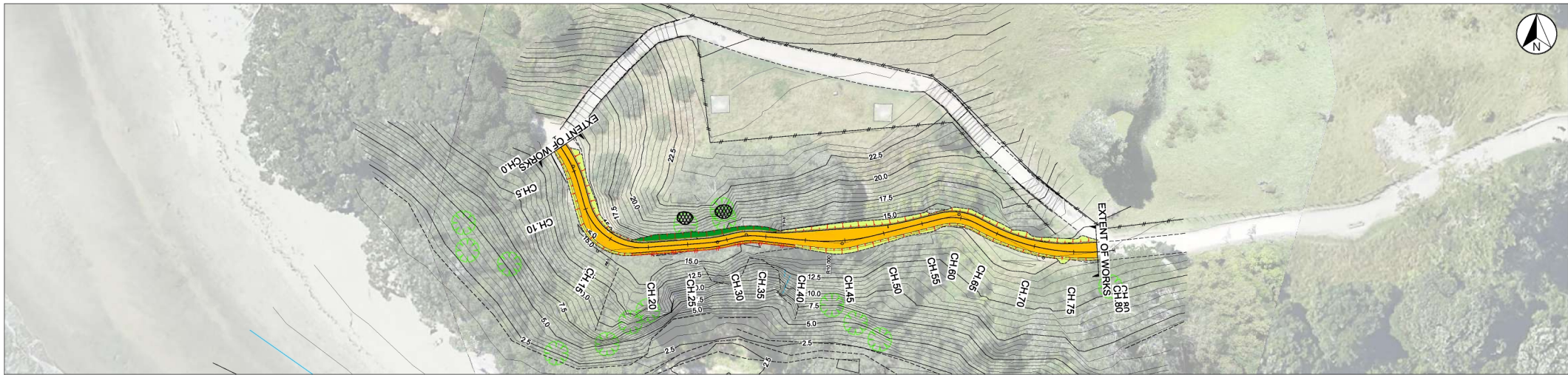
Designed	Approved	Approved Date
s 7(2)(a) - Privacy	s 7(2)(a) - Privacy	2019-11-22
Drawn	Checked	
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Project  
TAURANGA CITY COUNCIL  
MAUAO BASE TRACK REINSTATEMENT  
MOUNT MAUNGANUI, TAURANGA

Sheet  
GENERAL LAYOUT  
SHEET 1 OF 1

Project No.  
2-98463.00

Sheet No.	Revision
C01	1



Datum R.L. 10.00

STATION	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00	60.00	65.00	70.00	75.00	80.00					
PROPOSED LEVEL	14.10	14.10	14.46	14.96	15.21	15.35	15.60	15.92	14.97	14.93	14.85	14.71	15.16	15.71	15.66	14.89	14.49					
EXISTING LEVEL	14.10	14.39	14.76	15.00	15.36	15.60	17.96	14.95	14.87	14.77	14.80	14.64	15.10	15.52	15.42	14.80	14.49					
CUT/FILL	0.00	0.09	0.20	0.21	-0.02	-0.60	-2.10	0.08	0.10	0.16	0.15	0.07	0.06	0.19	0.24	0.08	0.00					
VERTICAL GEOMETRY	VC: 2.0m K: 0.68		VC: 5.0m K: 0.68		VC: 4.0m K: 0.70		VC: 10.0m K: 1.26		VC: 5.0m K: 0.70		VC: 4.0m K: 1.45		VC: 6.5m K: 0.25		VC: 7.0m K: 0.25		VC: 3.0m K: 0.27					
HORIZONTAL GEOMETRY	L=2.15m R=15.00m		L=4.51m R=7.50m		L=10.25m R=15.00m		L=7.38m R=20.00m		L=3.48m R=20.00m		L=6.38m R=25.00m		L=8.34m R=25.00m		L=8.57m R=6.50m		L=4.67m R=1.53m		L=15.63m R=27.00m		L=1.00m	

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

**LEGEND**

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

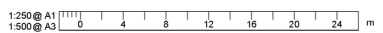
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1	ISSUED FOR CONSTRUCTION		2019-11-22



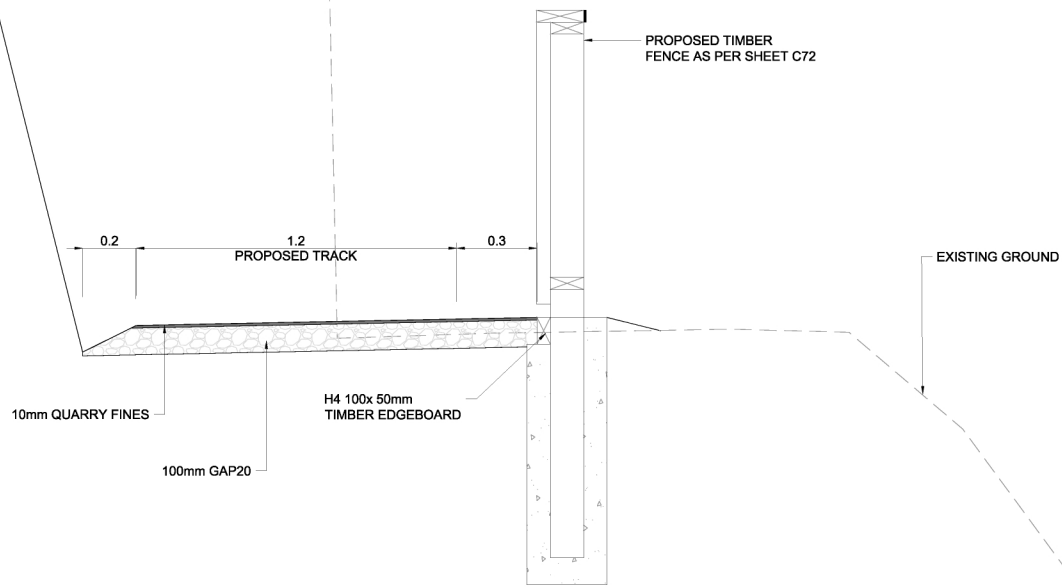
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§ 7(2)(a) - Privacy	§ 7(2)(a) - Privacy	2019-11-22
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Project TAURANGA CITY COUNCIL MAUAO BASE TRACK REINSTATEMENT MOUNT MAUNGANUI, TAURANGA	
Sheet LONGSECTIONS SHEET 1 OF 1	
Project No.	Sheet No.
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**TYPICAL CROSS SECTION @ SLIP**  
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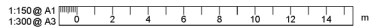
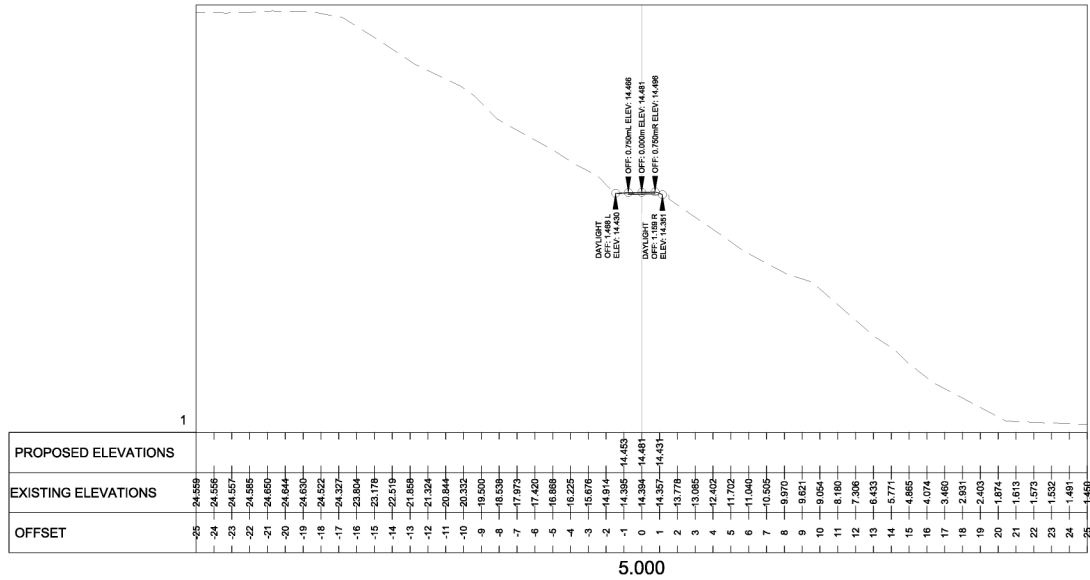
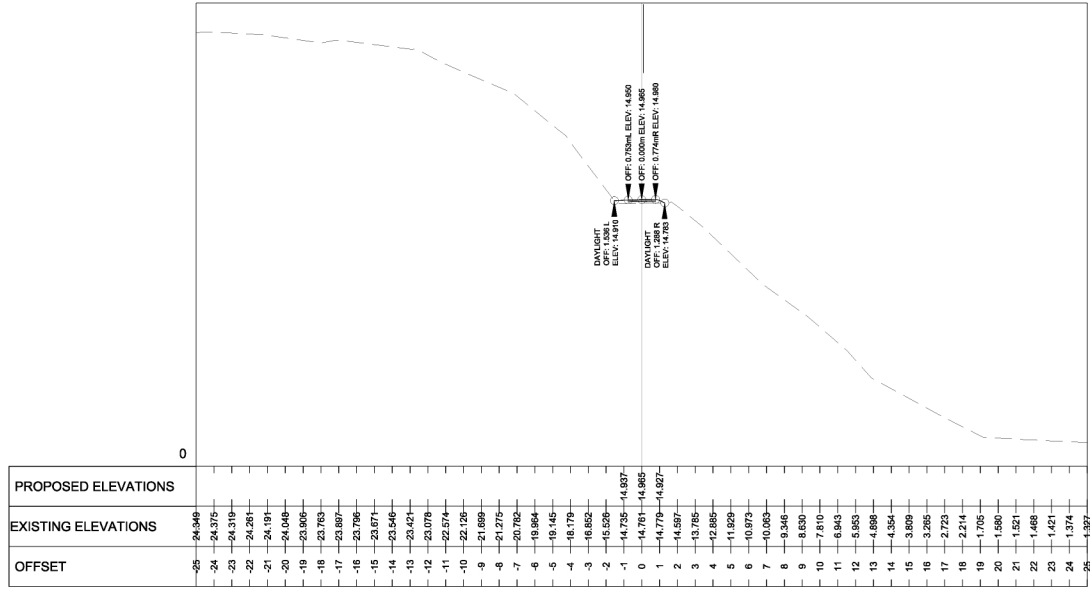
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1:20 @ A3

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s 7(2)(a) - Privacy	s 7(2)(a) - Privacy	2019-11-22	
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TAURANGA CITY COUNCIL MAUAO BASE TRACK REINSTATEMENT MOUNT MAUNGANUI, TAURANGA		
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TYPICAL CROSS SECTION SHEET 1 OF 1		
Project No.	Sheet No.	Revision
2-9B463.00	C20	1



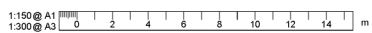
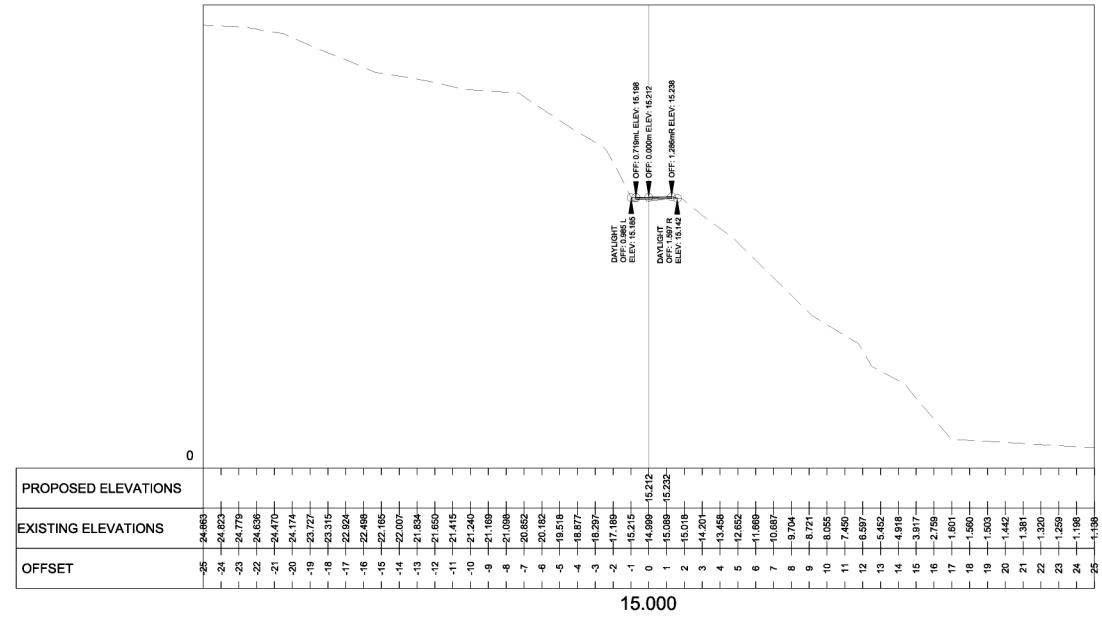
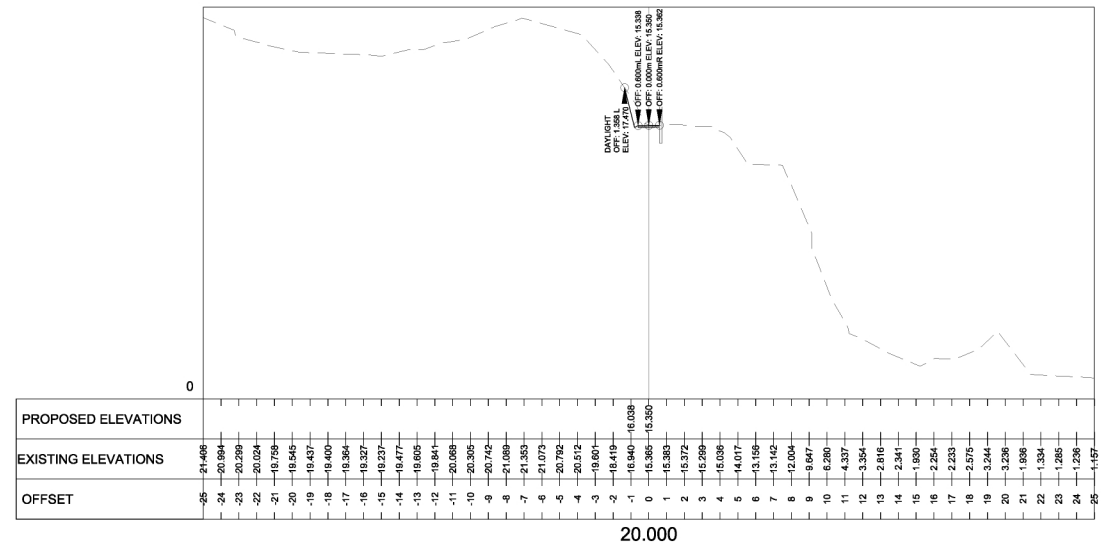
Revision	Amendment	Approved	Revision Date
1	ISSUED FOR CONSTRUCTION	§ 7(2)(a)	019-11-22



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Design	Approved	Approved Date	
§ 7(2)(a) - Privacy		2019-11-22	
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§ 7(2)(a) - Privacy	1:150 (A1) 1:300 (A3)	2-98463.00	

Project	
TAURANGA CITY COUNCIL MAUAO BASE TRACK REINSTATEMENT MOUNT MAUNGANUI, TAURANGA	
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CROSS SECTIONS SHEET 1 OF 8	
Sheet No.	Revision
C21	1

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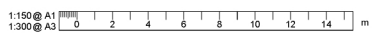
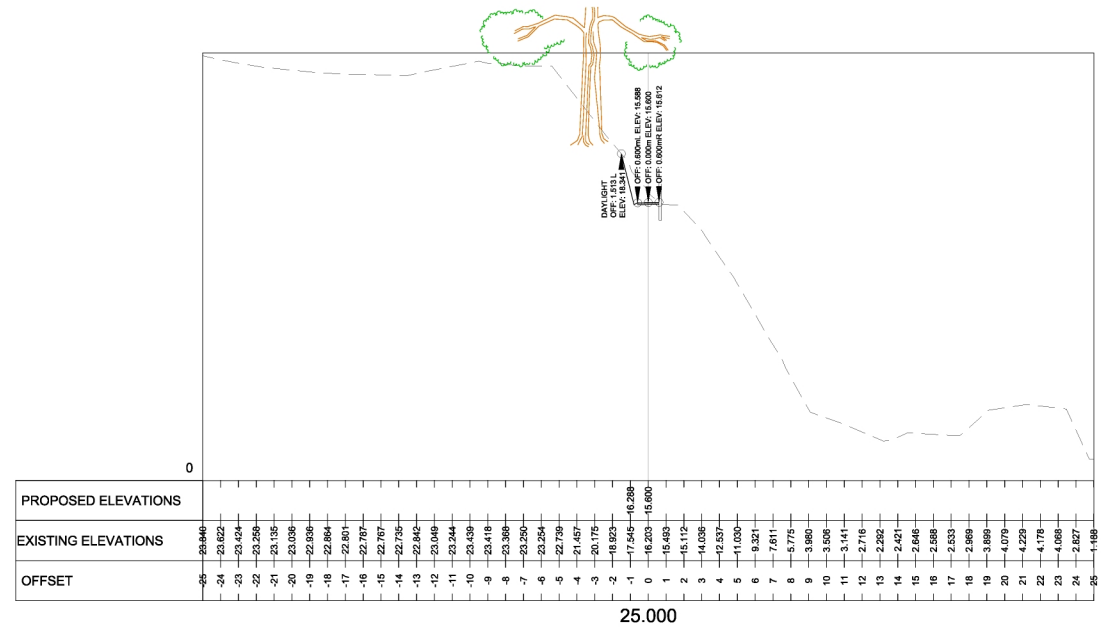
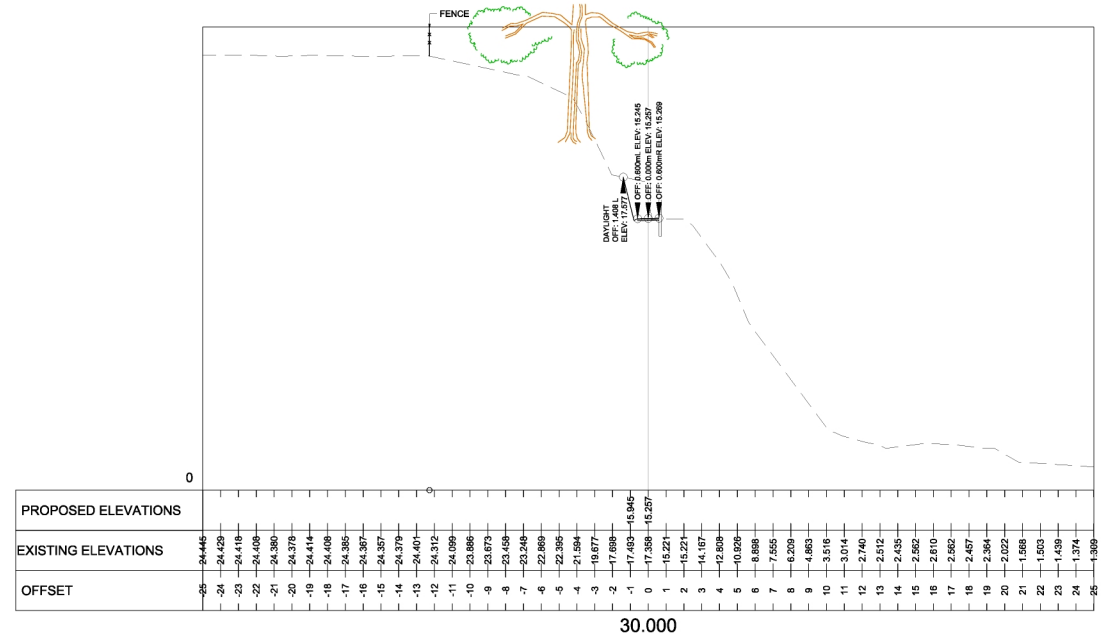
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MAUAO BASE TRACK REINSTATEMENT  
MOUNT MAUNGANUI, TAURANGA

Sheet: CROSS SECTIONS - OPTION 1  
SHEET 2 OF 8

Project No: 2-98463.00

Sheet No: C22  
Revision: 1

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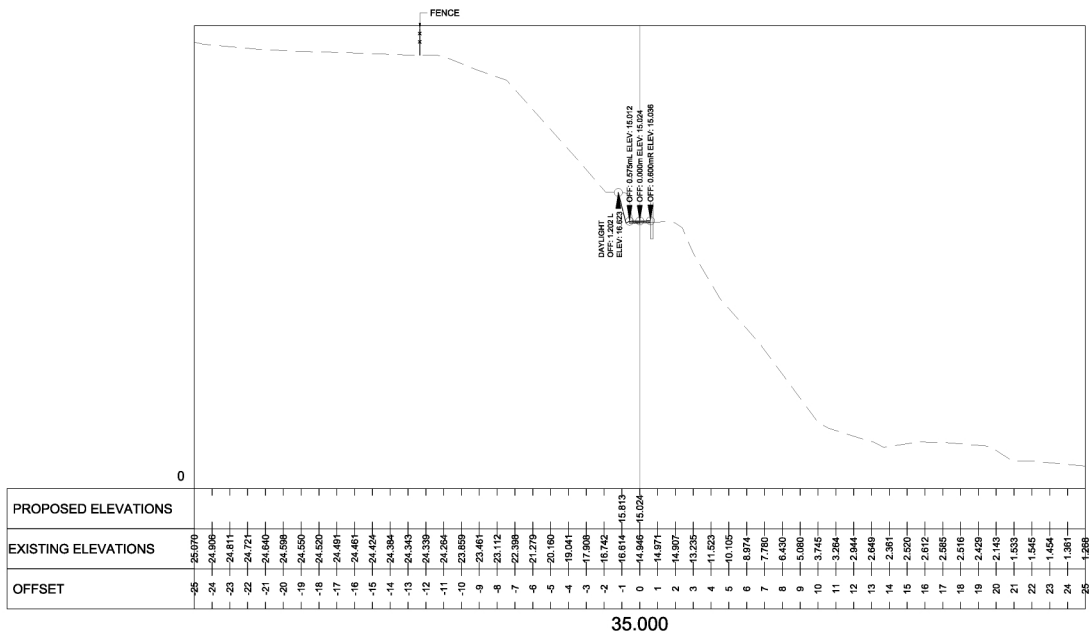
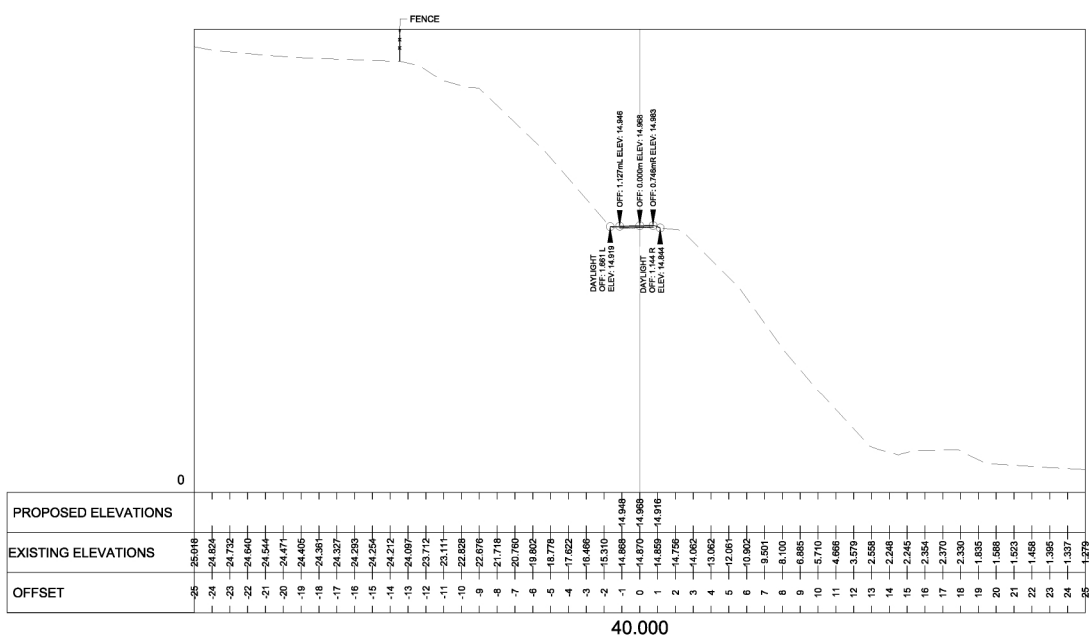
Designed: [Signature]  
Approved: [Signature]  
Approved Date: 2019-11-22

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

FOR CONSTRUCTION

0 10 mm 50 100 200 300 mm



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1:300 @ A3

Revision	Amendment	Approved	Revision Date
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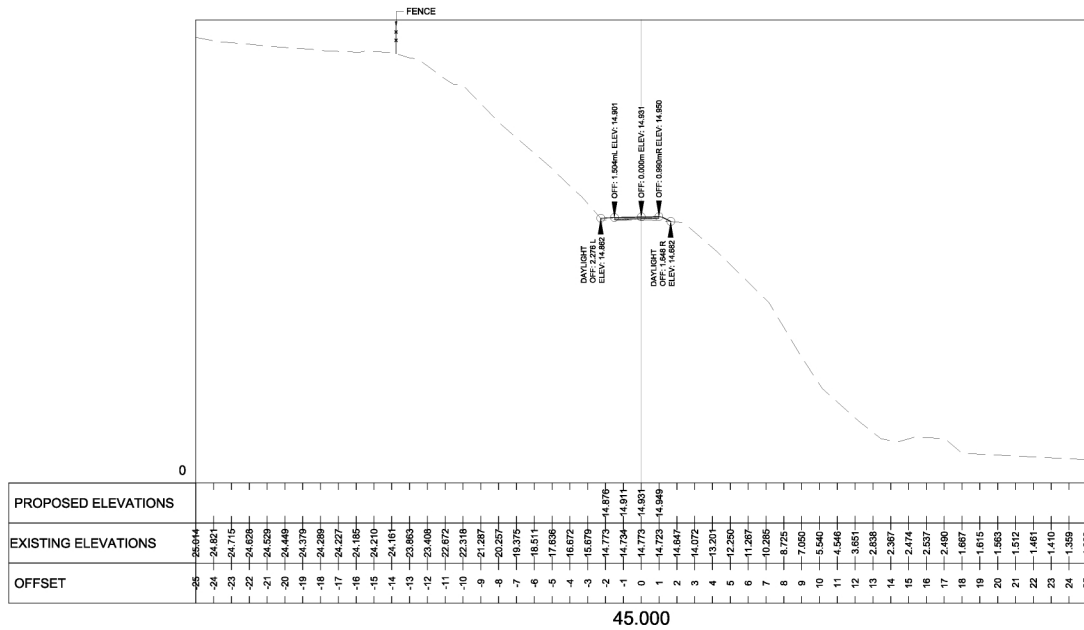
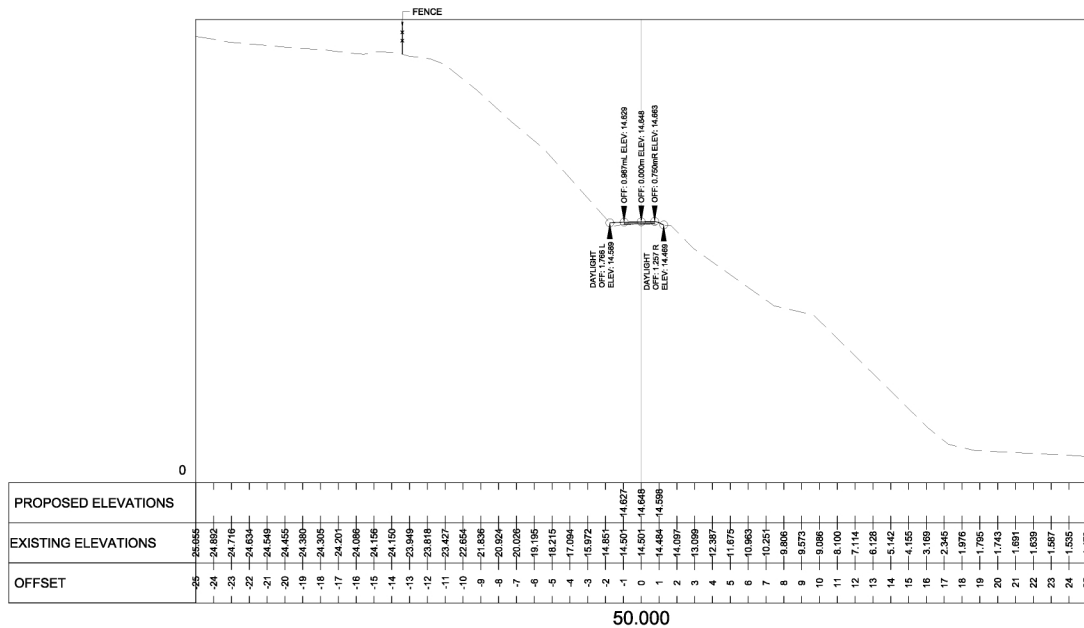


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Drawn s 7(2)(a) - Privacy	Approved [Signature] 2019-11-22
Date 7(2)(a) - Privacy	Scale 1:150 (A1) 1:300 (A3)

Project TAURANGA CITY COUNCIL MAUAO BASE TRACK REINSTATEMENT MOUNT MAUNGANUI, TAURANGA	
Sheet CROSS SECTIONS SHEET 4 OF 8	
Project No. 2-98463.00	Sheet No. C24
Revision 1	

FOR CONSTRUCTION

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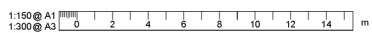
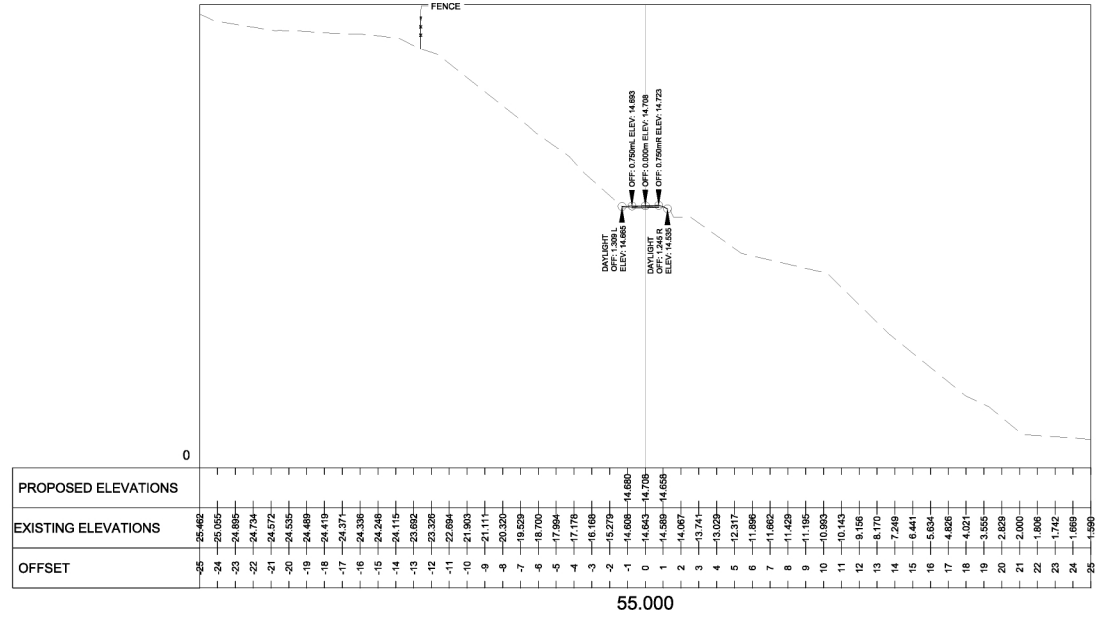
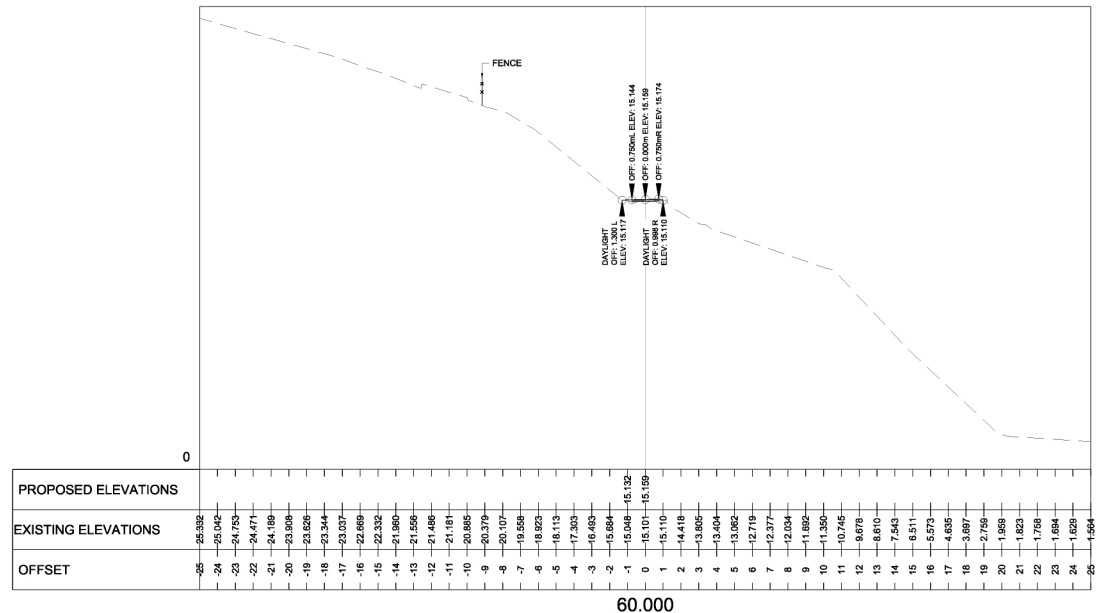
Revision	Amendment	Approved	Revision Date
1	ISSUED FOR CONSTRUCTION	[Signature]	2019-11-22



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Drawn	Status	
s 7(2)(a) - Privacy	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.	2-98463.00
Sheet No.	C25
Revision	1

FOR CONSTRUCTION



FOR CONSTRUCTION

Revision	Amendment	Approved	Revision Date
1	ISSUED FOR CONSTRUCTION	7(2)(a)	2019-11-22



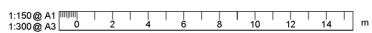
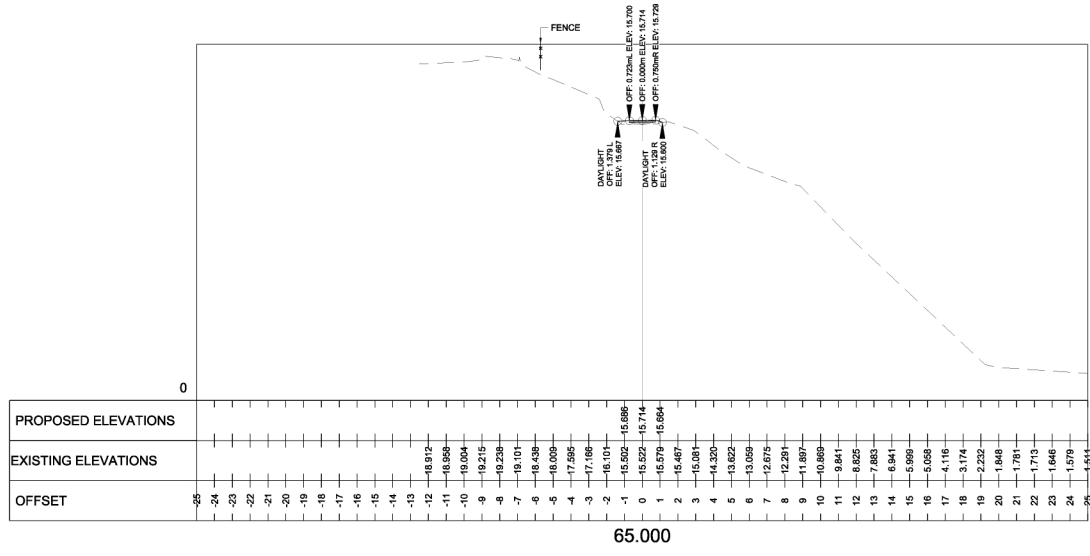
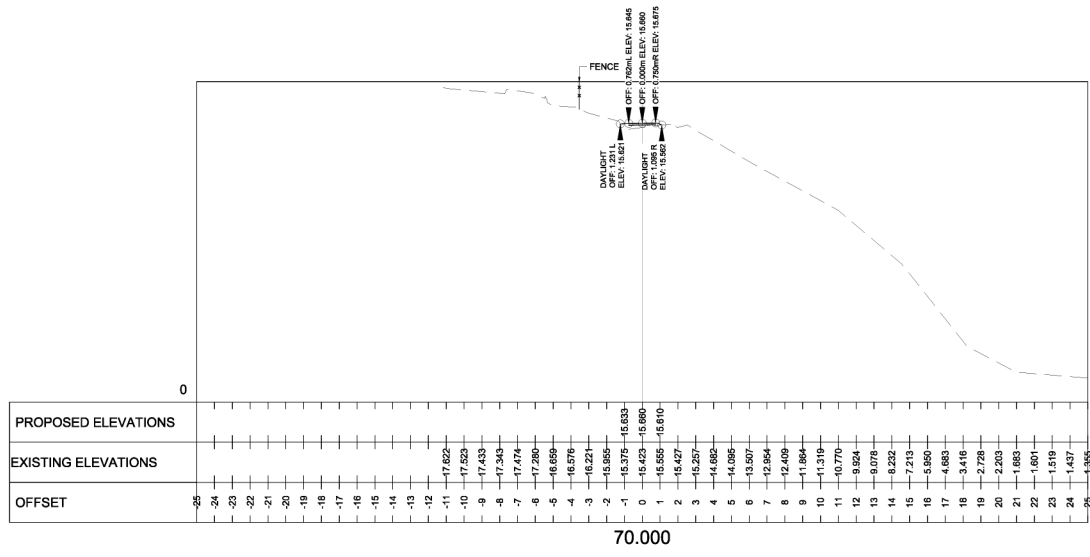
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Designated: s 7(2)(a) - Privacy  
Approved: s 7(2)(a)  
Approved Date: 2019-11-22

Drawn: s 7(2)(a) - Privacy  
Status: 1:150 (A1) 1:300 (A3)

Project TAURANGA CITY COUNCIL MAUAO BASE TRACK REINSTATEMENT MOUNT MAUNGANUI, TAURANGA	
Sheet CROSS SECTIONS SHEET 6 OF 8	
Project No. 2-98463.00	Sheet No. / Revision C26 / 1



FOR CONSTRUCTION

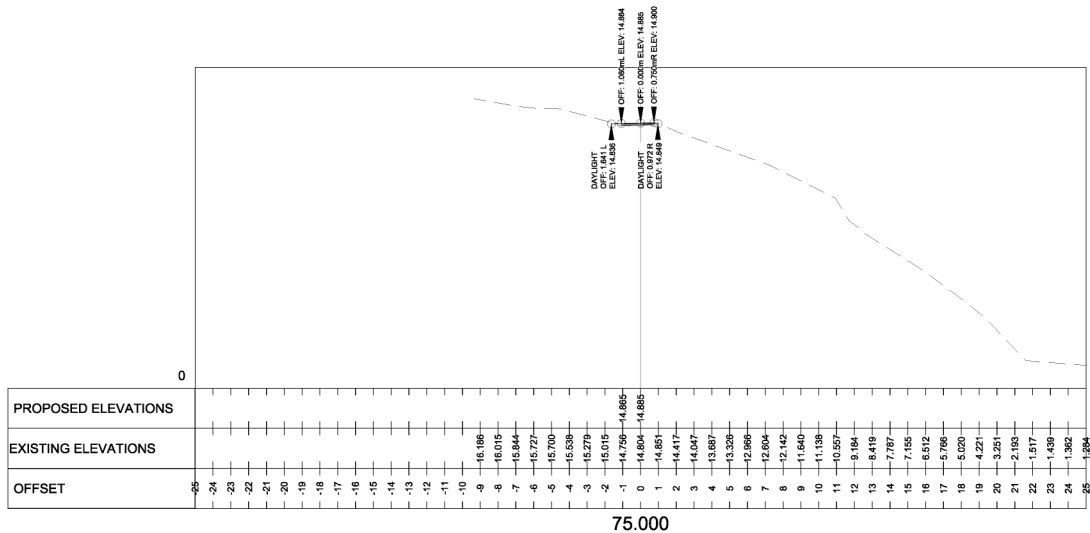
Revision	Amendment	Approved	Revision Date
1	ISSUED FOR CONSTRUCTION	§ 7(2)(a)	2019-11-22



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Designated	Approved	Approved Date	
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Drawn	Status		
§ 7(2)(a) - Privacy	1:150 (A1) 1:300 (A3)		

Project TAURANGA CITY COUNCIL MAUAO BASE TRACK REINSTATEMENT MOUNT MAUNGANUI, TAURANGA	
Sheet CROSS SECTIONS SHEET 7 OF 8	
Project No.	Sheet No.
2-9B463.00	C27
Revision	1

0 10 mm 50 100 200 300 mm



FOR CONSTRUCTION

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1:300 @ A3

Revision	Amendment	Approved	Revision Date
1	ISSUED FOR CONSTRUCTION	[Signature]	2019-11-22

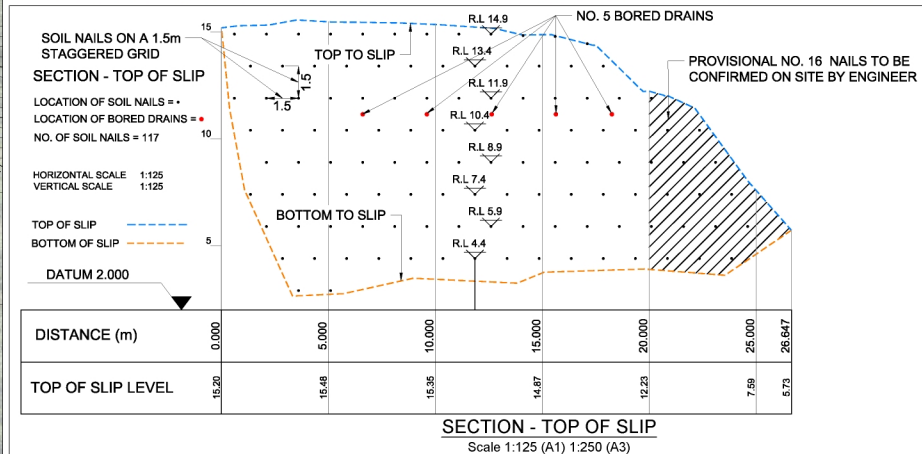
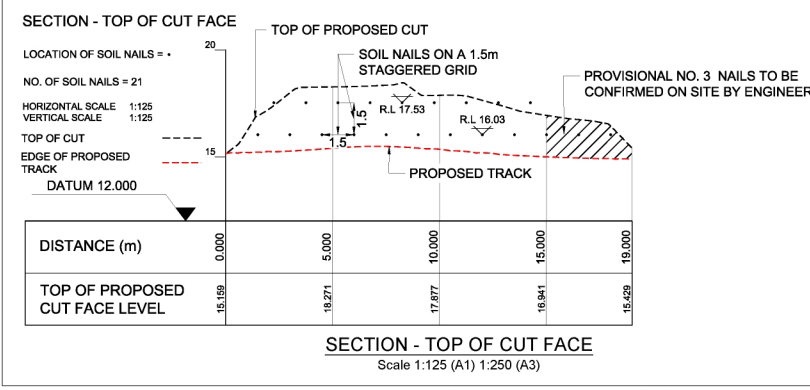
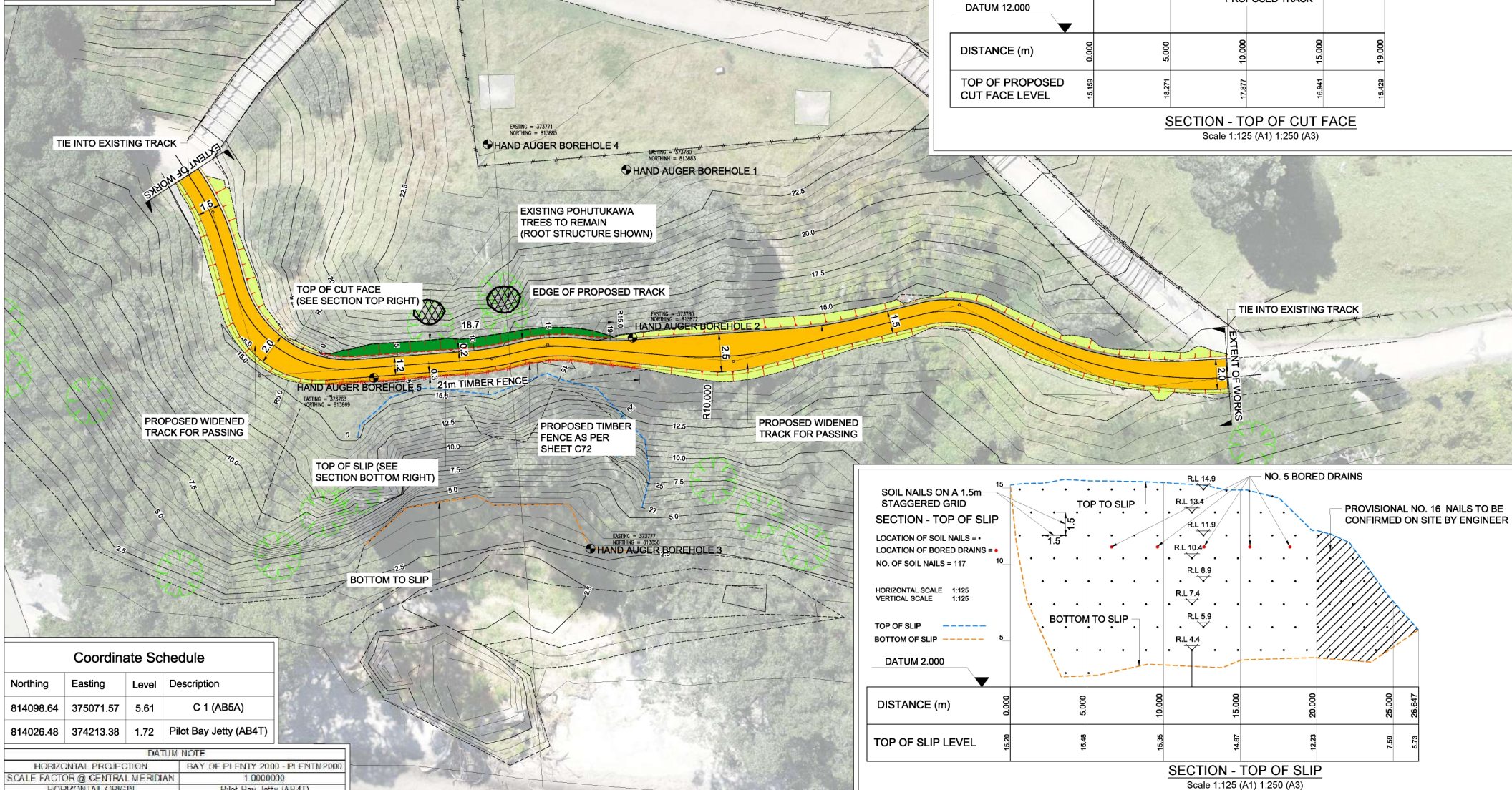


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Designed	Approved
s 7(2)(a) - Privacy	[Signature]
Drawn	Status
s 7(2)(a) - Privacy	1:150 (A1) 1:300 (A3)

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

**LEGEND**

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



**Coordinate Schedule**

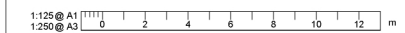
Northing	Easting	Level	Description
814098.64	375071.57	5.61	C 1 (AB5A)
814026.48	374213.38	1.72	Pilot Bay Jetty (AB4T)

**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.



Revision	Amendment	Approved	Revision Date
1	ISSUED FOR CONSTRUCTION	§ 7(2)(a)	2019-11-22



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 Approved Date: 2019-11-22

Drawn: § 7(2)(a) - Privacy  
 Status: 1:125 (A1) 1:250 (A3)

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

Sheet: SLIP LAAYOUT PLAN SHEET 1 OF 1

Project No.: 2-98463.00

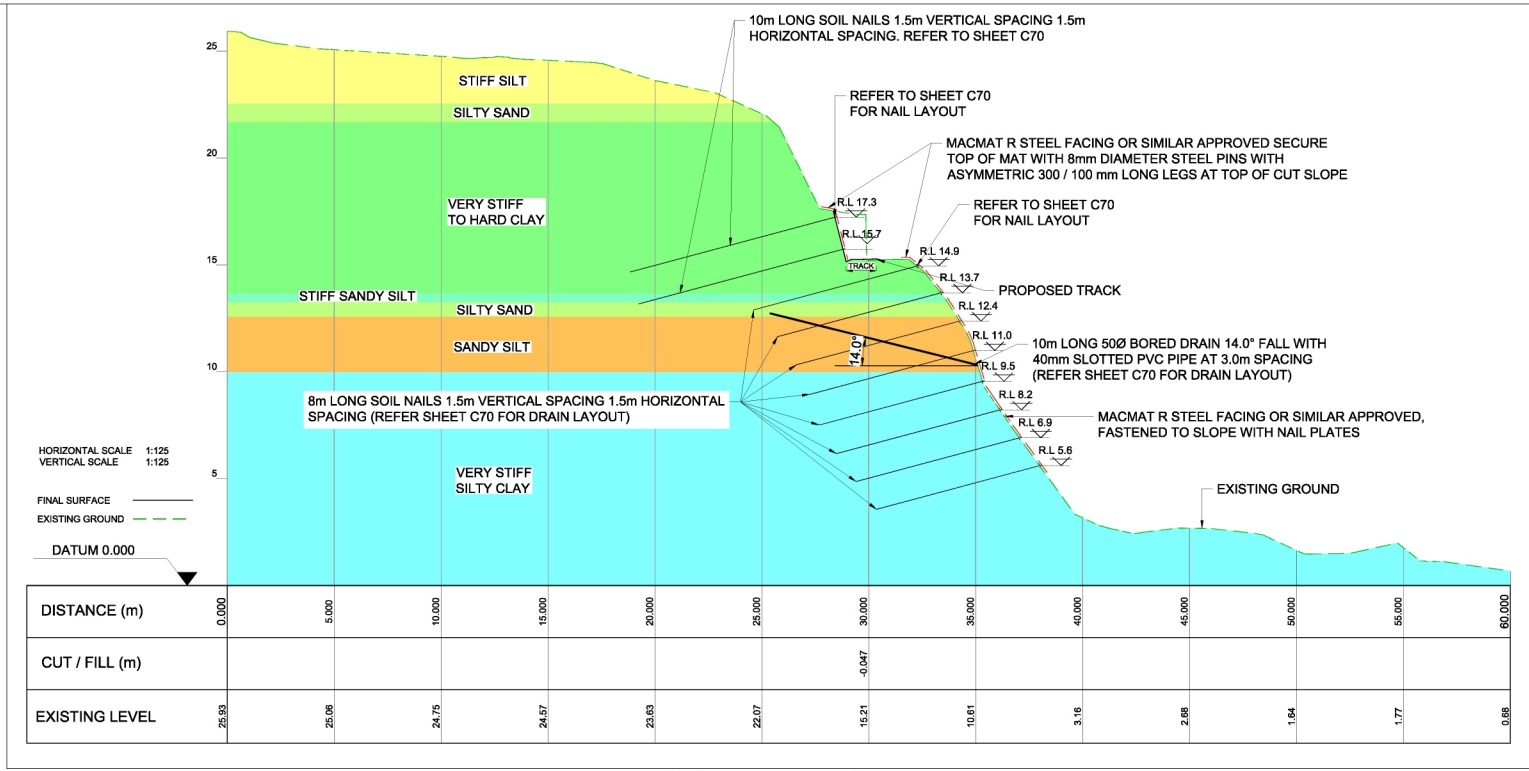
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 Revision: 1

FOR CONSTRUCTION

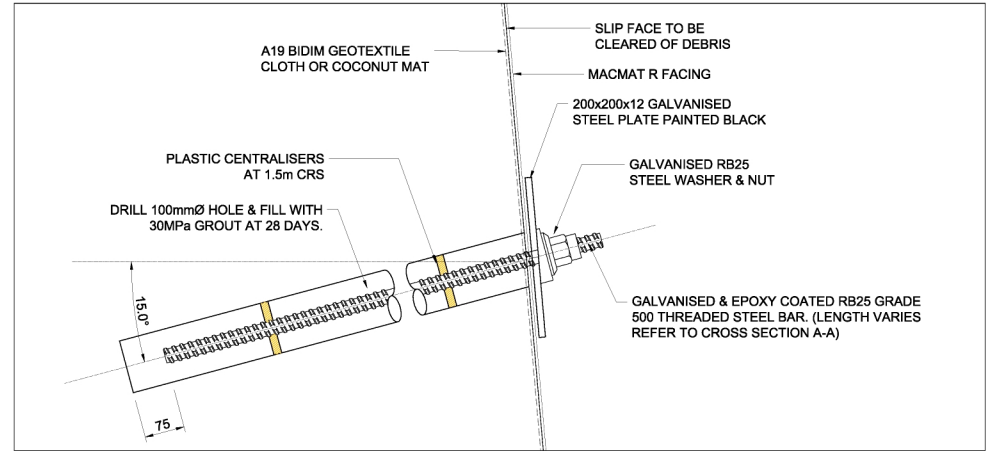
300 mm  
200  
100  
0 10 mm

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 RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.	

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Revision	Amendment	Approved	Revision Date
1	ISSUED FOR CONSTRUCTION	[Signature]	2019-11-22

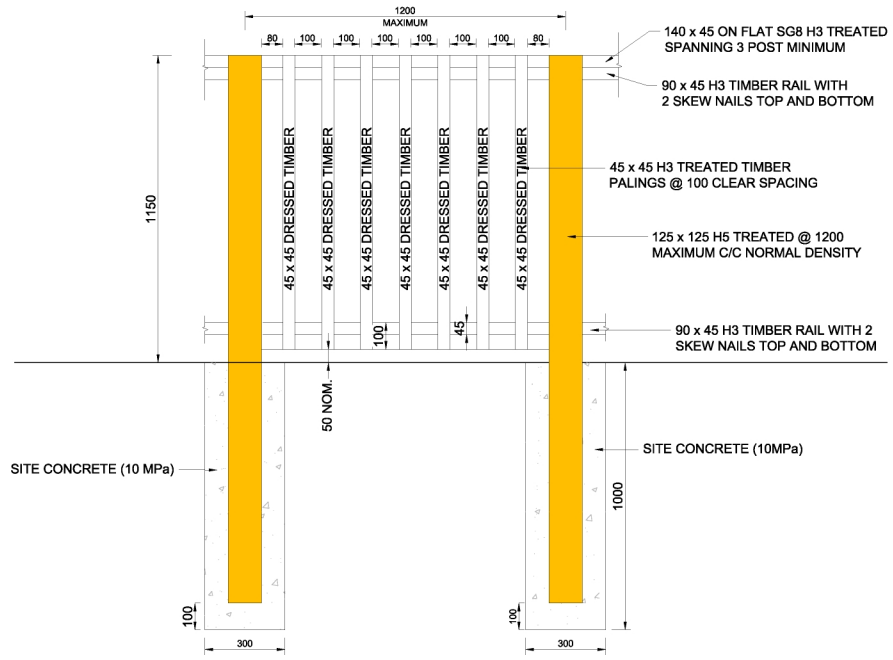


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Designed: [Signature]  
Drawn: [Signature]  
Checked: [Signature]  
Approved: [Signature]  
2019-11-22

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

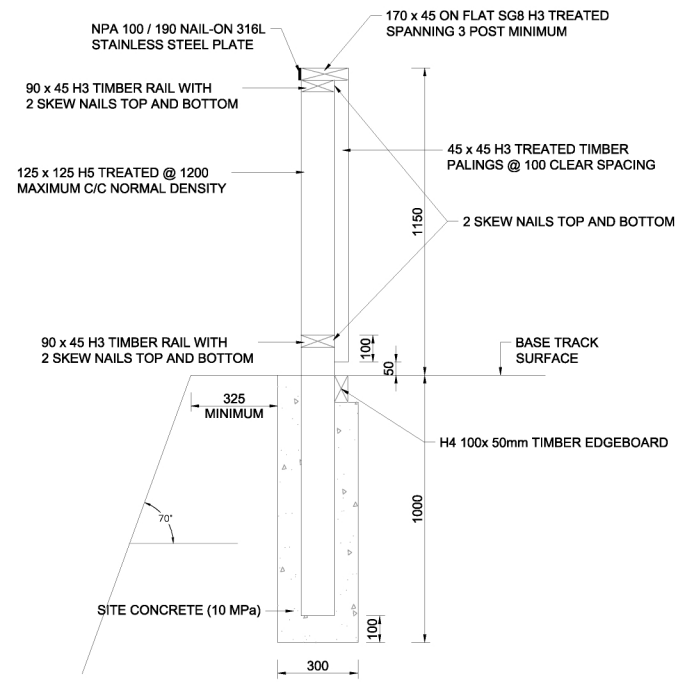
0 10 mm  
50  
100  
200  
300 mm



**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)

FOR CONSTRUCTION

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

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



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Designed: s 7(2)(a) - Privacy  
Drawn: s 7(2)(a) - Privacy

Approved: AS SHOWN

Approved Date: 2019-11-22

Project	Sheet	Project No.	Sheet No.	Revision
TAURANGA CITY COUNCIL MAUAO BASE TRACK REINSTATEMENT MOUNT MAUNGANUI, TAURANGA	TIMBER FENCE TYPICAL DETAILS SHEET 1 OF 1	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:

Tested by:

Date Reported:

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**Approved by**

Signed by:

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																			
1.0	CLAY, minor sand; light brown with black flecks																			
1.5	CLAY, with some silt, and minor sand; orange brown, moist, highly plastic																			
2.0	with black streaks																			
2.5	CLAY, with some sand; orange brown, moist, high plasticity																			
3.0	Clayey SILT, with some sand and trace gravel, light brown, moist, high plasticity, appears soft	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
3.5	becoming wet	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
4.0	Clayey sandy SILT; light brown, wet, high plasticity, soft	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
4.5	Sandy SILT, minor clay, light brown, moist, moderately plastic	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
5.0	Silty SAND; light brown, moist																			
5.5	Sandy SILT	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
6.0	Silty SAND	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
6.5	Sandy SILT; light whitish brown, moist, pumiceous	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7.0	SAND; light whitish brown, moist pumiceous	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7.5	Silty fine SAND, with some clay; light brown and grey, wet, highly plastic, very soft																			

END OF AUGER AT 5m - Target Depth Reached

**Test Methods:**

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

**Notes:**

Date Tested:

Tested by: § 7(2)(a) - Private

Date Reported:

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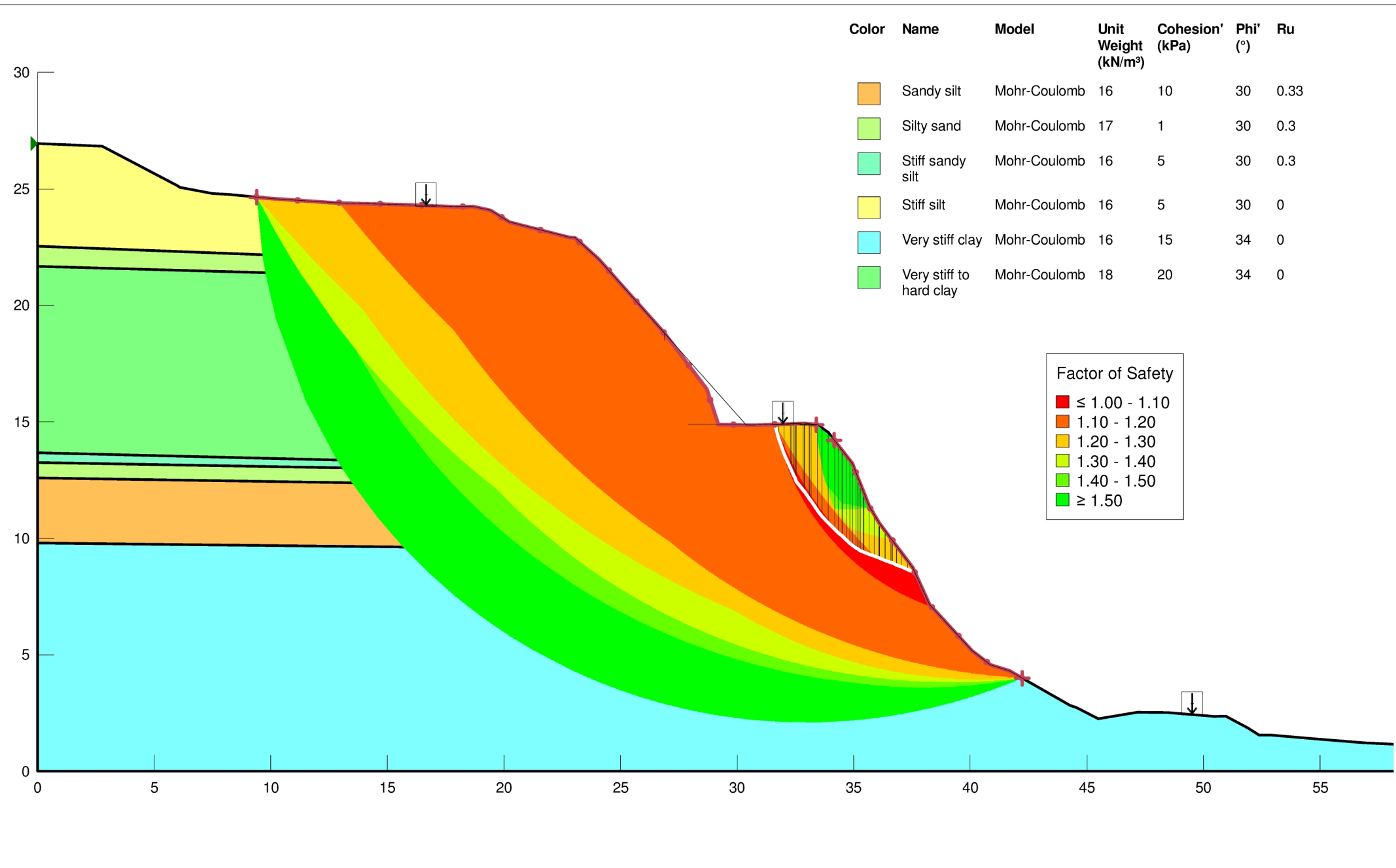
**Approved by**

Signed by:

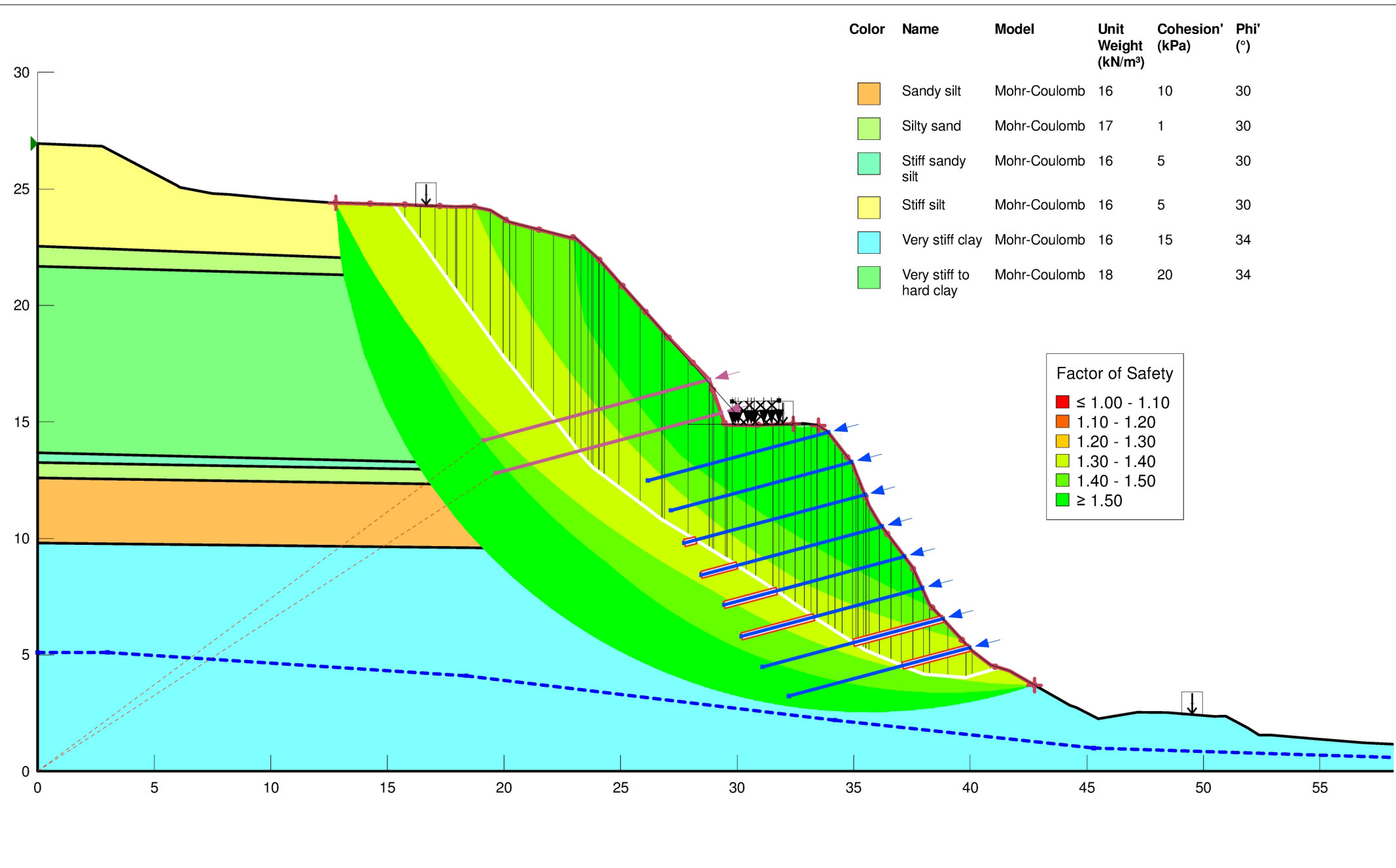
Designation:

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: § 7(2)(a) - Privacy Checked By: § 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.	



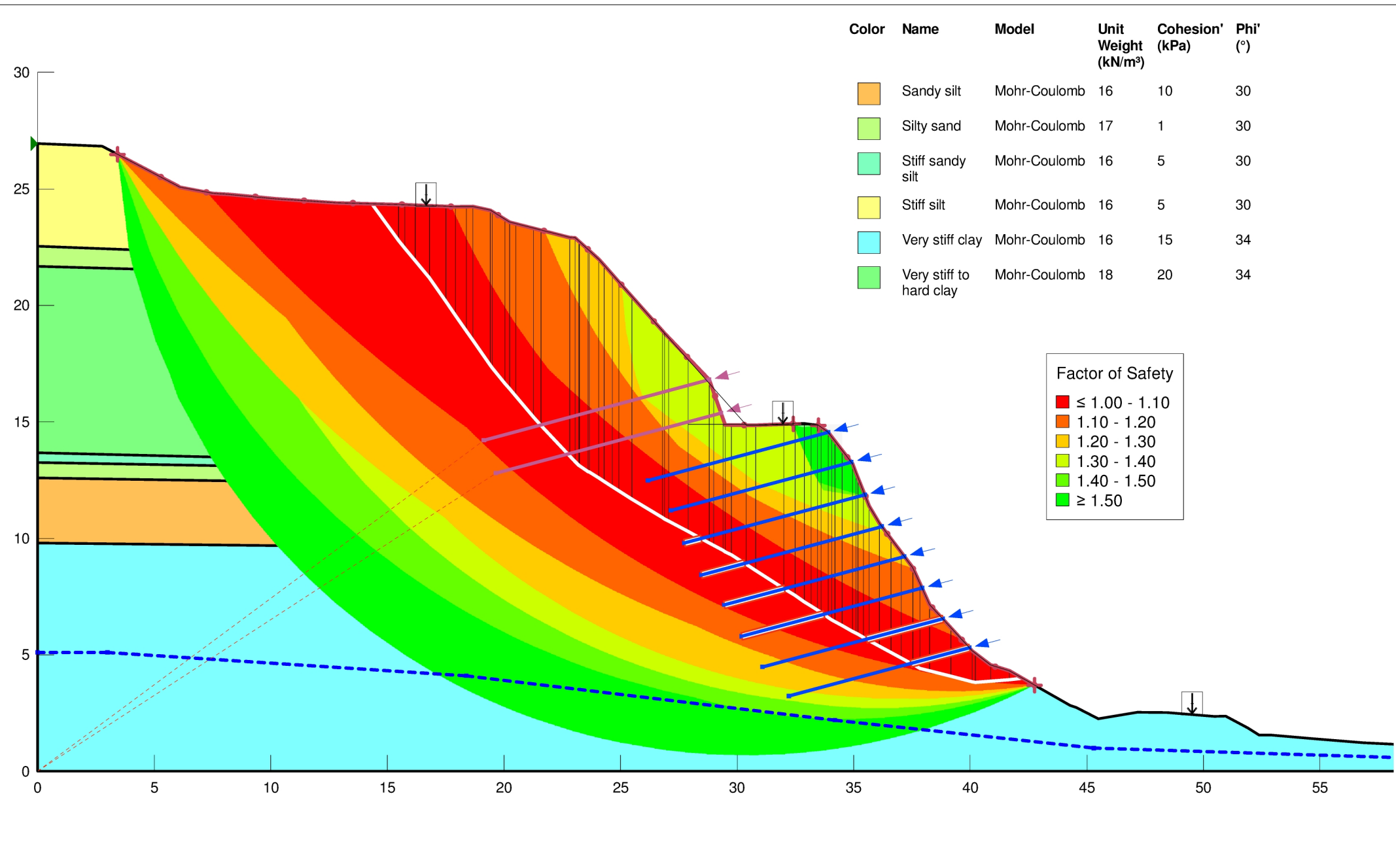
Project: **2-9B463.00 - Mount Base Track**

Analysis: **CH37.5\_Soil Nail Design Rev.A Normal GW all nails**

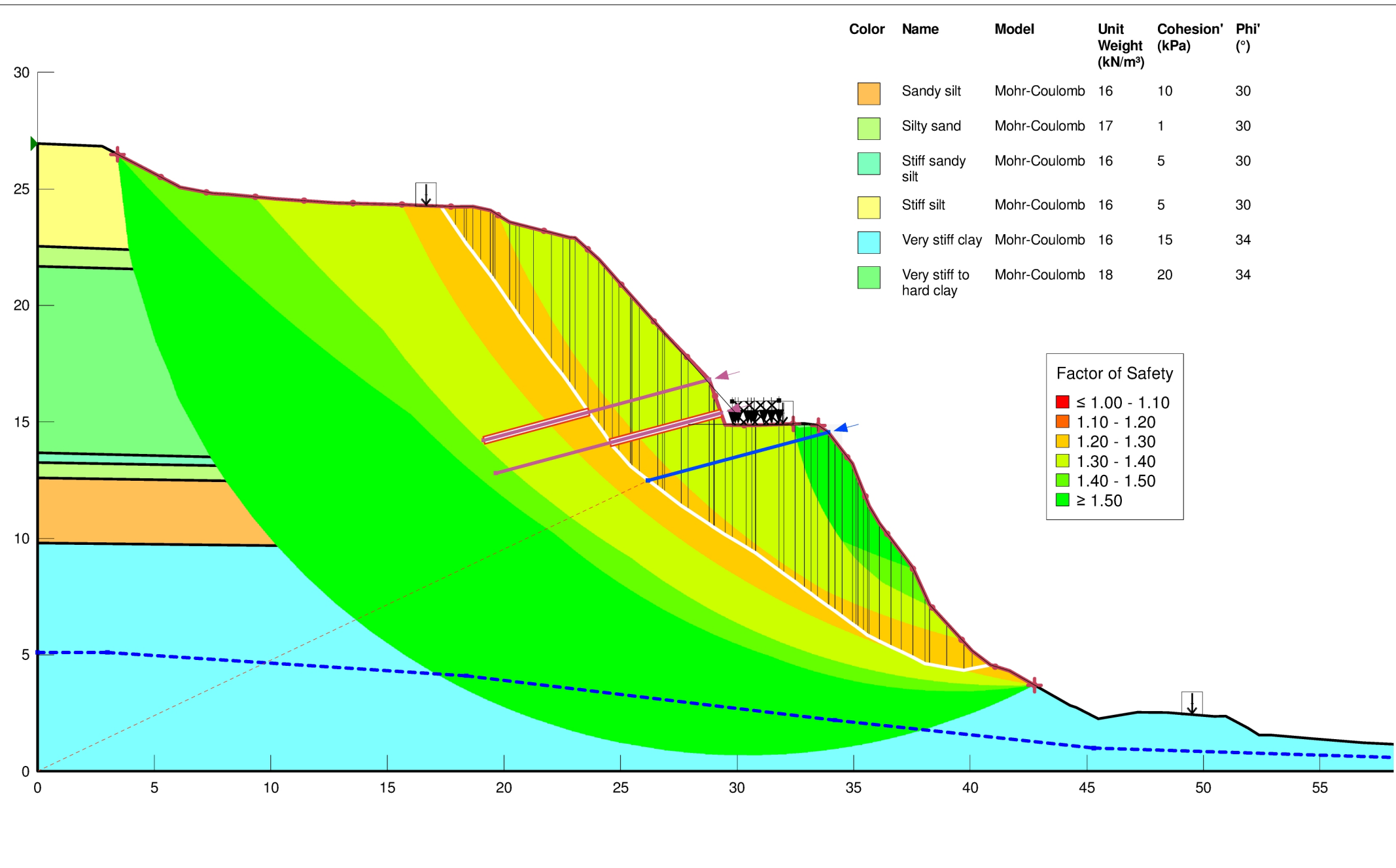
Modelled By: § 7(2)(a) - Privacy

Checked By: Name

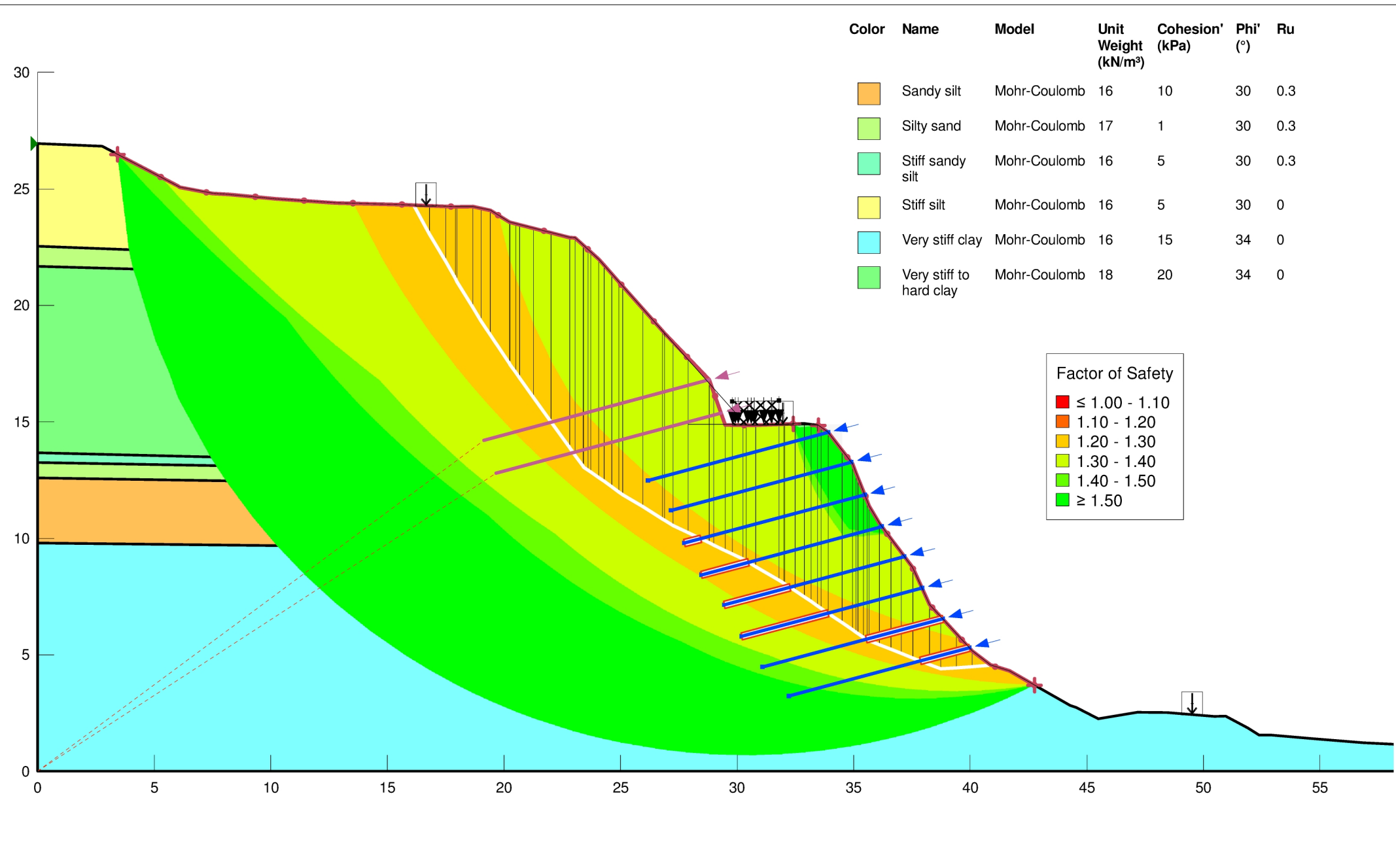
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Method	Morgenstern-Price	Date:	10/12/2019
PGA	g	Scale	1:150
FOS	1.31	Sheet No.	



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



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: <small>s 7(2)(a) - Privacy</small>	Model	SLOPE/W	Proj No.	2-9B463.00
	Method	Morgenstern-Price	Date:	10/12/2019
	PGA	g	Scale	1:150
	FOS	1.22	Sheet No.	
Checked By:	Name			



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: <small>s 7(2)(a) - Privacy</small> Checked By: <b>Name</b>	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)
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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
Likelihood	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.

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